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Annual European Union greenhouse gas inventory 1990–2020 and inventory report 2022

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Annexes published alongside the EU NIR:

Annex I: Key category analysis (Excel file)

Annex II: Uncertainty assessment (included in NIR section 1.6)

Annex III: Detailed methodological descriptions for individual source or sink categories (zip file containing several Excel files by sector)

Annex IV: not included (see explanation in chapter 1.8.4)

Annex V: Improvements made in response to the UNFCCC review process (Excel file)

ES-1 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES AND CLIMATE CHANGE

The present report is the official inventory submission of the European Union (EU) for 2022 under the United Nations Framework Convention on Climate Change (UNFCCC) and also under the Kyoto Protocol (KP).

The European Union (EU), as a party to the UNFCCC, reports annually on greenhouse gas (GHG) inventories for the years between 1990 and the current calendar year (t) minus two (t-2), for emissions and removals within the area covered by its Member States (i.e. emissions taking place within its territory).

The United Kingdom (UK) left the EU on February 1, 2020, but key provisions of Regulation (EU) No 525/2013 (“Mechanism for Monitoring and Reporting GHG”) and of Decision No 406/2009/EC (“Effort Sharing”) apply to the UK in respect of greenhouse gases emitted during 2019 and 2020. Article 5 of Commission Regulation (EU) No 389/2013 (“EU registry”) applies to the UK until the closure of the second commitment period of the KP[1].

The European Union, its Member States, Iceland and the UK fulfil their quantified emission limitation and reduction commitments for the second commitment period to the KP, reflected in the Doha Amendment, jointly. The EU, its Member States, Iceland and the UK agreed to a quantified emission reduction commitment that limits their average annual emissions of GHG during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment. Article 4 of the KP requires parties that agree to fulfil their commitments under Article 3 of the KP jointly to set out in the relevant joint fulfilment agreement the respective emission level allocated to each of the parties. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The emission levels define the Member States’, Iceland’s and UK’s assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing EU legislation for the period 2013-2020 under the ‘Climate and Energy package’.

The EU, Iceland and the UK jointly report their national greenhouse gases emissions during the second commitment period of the KP. The present report and the inventory presented here refer to the EU GHG inventory under the UNFCCC (scope EU-27+UK) and the KP (scope EU-27+ISL+UK = EU-KP). This report, therefore, presents the totals of the EU-27 plus Iceland, plus the UK (EU-KP)[2][3].

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[1] Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community (2019/C 384 I/01), Article 96(5).

[2] EU-27 refers to the current EU. Please note that in some cases the terms ‘Member States’ and ’EU’ and ‘Union’ may be used. For the purpose of this report as the EU’s submission under the Kyoto Protocol, these terms would also generally include Iceland and the UK.

[3] The EU totals shown in the NIR reflect the emissions and removals from EU Member States, Iceland and the UK, as reported in their inventories to the EU by March 15, 2022. For Hungary, emissions and removals in the present EU NIR correspond to the 15 January 2022 inventory, whereas emissions and removals in the EU CRF tables include Hungary’s latest March submission to the EU. The EU will resubmit its GHG inventory (NIR and CRF tables) by 27 May 2022 to include any updates in MS GHG inventories received by 8 May.

The EU will resubmit its 2022 GHG inventory to UNFCCC later in the year to be the sum of emissions and removals of its 27 Member States, the UK and Iceland. This resubmission will reflect their final reviewed GHG inventories under the Kyoto Protocol.

The legal basis for the compilation of the EU inventory is Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting GHG emissions and for reporting other information at national and EU level relevant to climate change and repealing Decision No 280/2004/EC[4].

This Regulation establishes a mechanism for:

a) ensuring the timeliness, transparency, accuracy, consistency, comparability and completeness of reporting by the EU and its Member States to the UNFCCC Secretariat;
b) reporting and verifying information relating to commitments of the EU and its Member States pursuant to the UNFCCC, to the KP and to decisions adopted thereunder, and evaluating progress towards meeting those commitments;
c) monitoring and reporting all anthropogenic emissions by sources, and removals by sinks, of GHGs not controlled by the Montreal Protocol on substances that deplete the ozone layer in Member States;
d) monitoring, reporting, reviewing and verifying GHG emissions and other information pursuant to Article 6 of Decision No 406/2009/EC;
e) reporting the use of revenue generated by auctioning allowances under Article 3d(1) or (2) or Article 10(1) of Directive 2003/87/EC, pursuant to Article 3d(4) and Article 10(3) of that Directive;
f) monitoring and reporting on the actions taken by Member States to adapt to the inevitable consequences of climate change in a cost-effective manner;
g) evaluating progress by the Member States towards meeting their obligations under Decision No 406/2009/EC.

The Monitoring Mechanism Regulation sets out the reporting rules on GHG emissions to meet the requirements arising from international climate agreements, it replaces and expands the previous Monitoring Mechanism Decision 280/2004/EC.

The EU GHG inventory comprises the direct sum of emissions from the national inventories compiled by the countries making up the EU-27 plus Iceland and the UK. Energy data from Eurostat are used for the reference approach for CO_2 emissions from fossil fuels, developed by the Intergovernmental Panel on Climate Change (IPCC).

The main institutions involved in the compilation of the EU GHG inventory are the Member States plus Iceland and the UK, the European Commission Directorate-General for Climate Action (DG CLIMA), the European Environment Agency (EEA) and its European Topic Centre on Climate Change Mitigation (ETC/CM), Eurostat, and the Joint Research Centre (JRC).

The annual process of compiling the EU GHG inventory is described below:

1. Member States/countries submit their annual GHG inventories by 15 January each year to the European Commission (DG CLIMA), with a copy to the EEA.
2. The EEA and its ETC/CM, Eurostat, and the JRC then perform initial checks on the data submitted. Specific findings from the initial quality assurance/quality control (QA/QC) checks are communicated to Member States by 28 February. In addition, the draft EU

[4] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&qid=1527153180542&from=EN

GHG inventory and inventory report are circulated to Member States for review and comments by 28 February.

3. Member States check their national data and the information presented in the EU GHG inventory report, respond to specific findings from the initial QA/QC checks by the EU inventory team, send updates if necessary and review the EU inventory report by 15 March.
4. The EEA and its ETC/CM review final inventory submissions from Member States and their responses to the initial checks and prepare the final EU GHG inventory and inventory report by 15 April so that they can be submitted to the UNFCCC[5].
5. A resubmission is prepared by 27 May if needed.

ES-2 SUMMARY OF GREENHOUSE GAS EMISSIONS TRENDS IN THE EU

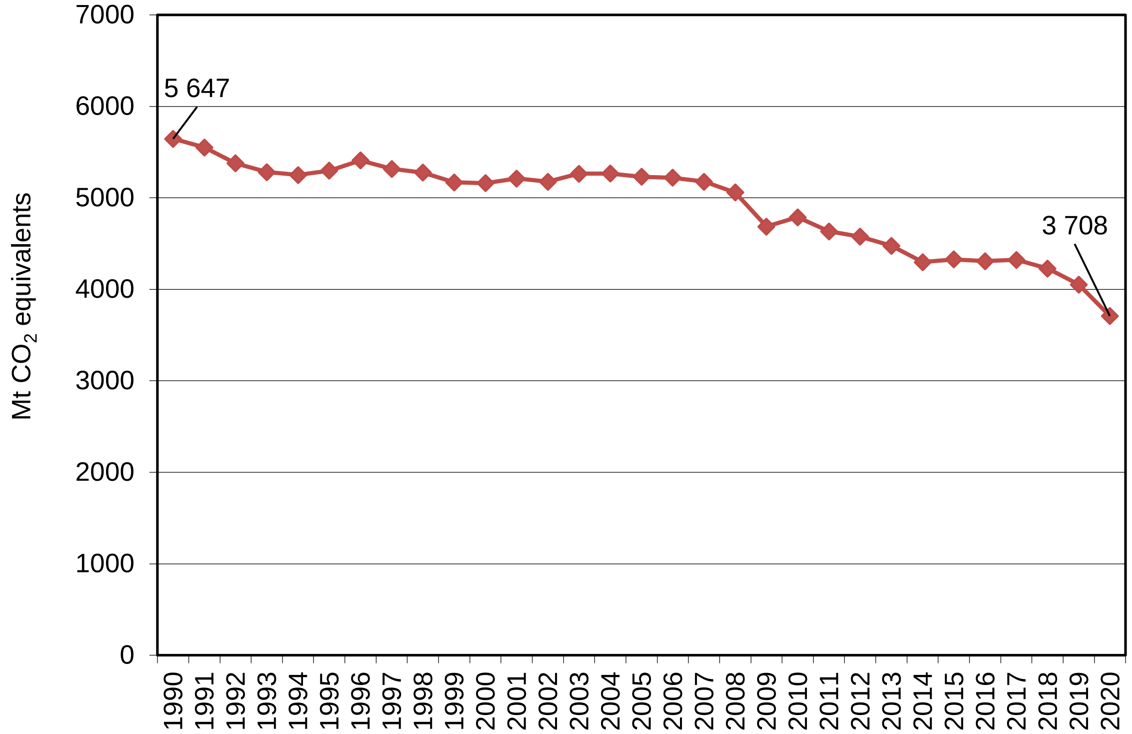
Total GHG emissions - excluding Land Use, Land Use Change and Forestry (LULUCF) and international aviation - in the EU-KP amounted to 3 708 million tonnes CO_2 equivalent in 2020 (including indirect CO_2 emissions). All GHG emission totals provided in this report include indirect CO_2 emissions[6].

In 2020, total GHG emissions were 34.3 % (-1 939 million tonnes CO_2 equivalents) below 1990 levels. Emissions decreased by 8.5 % or 346 million tonnes CO_2 equivalent) between 2019 and 2020 (Figure ES. 1).

[5] The EU, as Party to the UNFCCC and the Kyoto Protocol, reports its GHG inventory according to UNFCCC Decision 24/CP.19 (reporting guidelines on annual GHG inventories). The EU should not be held liable for any errors caused by the UNFCCC CRF Reporter software during the technical review of the information submitted.

[6] According to the UNFCCC reporting guidelines, Annex I Parties may report indirect CO_2 from the atmospheric oxidation of CH_4, CO and NMVOCs. For Parties that decide to report indirect CO_2, the national totals will be presented with and without indirect CO_2. The EU national total includes indirect CO_2 emissions if Member States have reported these emissions. The CRF tables include national totals, including and excluding indirect CO_2 emissions.

Figure ES. 1 EU-27, Iceland and the UK (EU-KP) GHG emissions (excl. LULUCF)



Notes: The GHG emissions data shown in this figure include indirect CO_2 emissions, and do not include emissions and removals from LULUCF; nor do they include emissions from international aviation and international maritime transport. CO_2 emissions from biomass with energy recovery are reported as a Memorandum item according to UNFCCC guidelines and are not included in national totals. In addition, no adjustments for temperature variations or electricity trade are considered. The 100-year global warming potentials are those from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) and are included in Annex III of UNFCCC Decision 24/CP.19.

1.1 Main trends by source category, 1990-2020

Total GHG emissions (excluding LULUCF and excluding international aviation) decreased by 1939 million tonnes CO_2 eq. since 1990 (or 34.3 %) reaching their lowest level during this period in 2020 (3708 million tonnes CO_2 eq.). There has been a progressive decoupling of gross domestic product (GDP) and GHG emission compared to 1990, with an increase in GDP by 54 % alongside a decrease in emissions of about 34 % over the period.

The reduction in GHG emissions over the 30-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fossil fuels and improvements in energy efficiency, as well as to structural changes in the economy. On top of these long-lasting changes, which account for the main share in the reduction in GHG emissions, the economic recession linked to the Covid-19 pandemic also played a role in 2020.

The long-lasting changes have resulted in a lower energy intensity of the economy and in a lower carbon intensity of energy production and consumption in 2020 compared to 1990. Demand for energy to heat households has also been lower, as Europe on average has experienced milder winters since 1990, which has also helped reduce emissions.

GHG emissions decreased in the majority of sectors between 1990 and 2020, with the notable exception of transport, and refrigeration and air conditioning. At the aggregate level, emission reductions were largest for manufacturing industries and construction, electricity and heat production, iron and steel production (including energy-related emissions) and residential combustion.

Besides the 2020 economic recession, a combination of factors explains lower emissions in industrial sectors, such as improved efficiency and lower carbon intensity as well as structural changes in the economy, with a higher share of services and a lower share of more-energy-intensive industry in total GDP.

Emissions from electricity and heat production decreased strongly since 1990. In addition to improved energy efficiency there has been a move towards less carbon intense fuels. Between 1990 and 2020, the use of solid and liquid fuels in thermal power stations decreased strongly whereas natural gas consumption more than doubled. Coal consumption in 1990 was three times higher than in 2020. The use of renewable energy sources in electricity and heat generation has increased substantially in the EU since 1990. Improved energy efficiency and a less carbon intensive fuel mix have resulted in reduced CO_2 emissions per unit of fossil energy generated.

Emissions in the residential sector also represented one of the largest reductions. Energy efficiency improvements from better insulation standards in buildings, and a less carbon-intensive fuel mix, can partly explain lower demand for space heating in the EU over the past 30 years.

In terms of the main GHGs, CO_2 was responsible for the largest reduction in emissions since 1990. Reductions in emissions from N_2O and CH_4 have been substantial, reflecting lower levels of mining activities, lower agricultural livestock, as well as lower emissions from managed waste disposal on land and from reduced adipic and nitric acid production.

A number of policies (both EU and country-specific) have contributed to the overall GHG emission reduction, including key agricultural and environmental policies in the 1990s and climate and energy policies in the past 15 years since 2005.

Almost all EU Member States reduced emissions compared to 1990 and thus contributed to the overall positive EU performance. The UK and Germany accounted for 47% of the total net reduction in the EU-KP of the past 30 years.

Table ES. 1 shows those sources that made the largest contribution to the change in total GHG emissions in the EU plus Iceland and UK between 1990 and 2020.

Table ES. 1 Overview of EU-KP source categories whose emissions increased or decreased by more than 20 million tonnes CO2 equivalent in the period 1990–2020

Source category	Million tonnes (CO_2 equivalents)
Refrigeration and Air conditioning (HFCs from 2.F.1)	80
Road Transportation (CO2 from 1.A.3.b)	53
Aluminium Production (PFCs from 2.C.3)	-21
Agricultural soils: Direct N2O emissions (N2O from 3.D.1)	-27
Fluorochemical Production (HFCs from 2.B.9)	-28
Cement Production (CO2 from 2.A.1)	-28
Enteric Fermentation: Cattle (CH4 from 3.A.1)	-42
Fugitive Emissions from Oil and Natural Gas (CH4 from 1.B.2)	-42
Nitric Acid Production (N2O from 2.B.2)	-47
Adipic Acid Production (N2O from 2.B.3)	-57
Fuels used Commercial/Institutional Sector (CO2 from 1.A.4.a)	-61
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-70
Fugitive Emissions from Solid Fuels (CH4 from 1.B.1)	-74
Managed Waste Disposal Sites (CH4 from 5.A.1)	-77
Fuels used Residential Sector (CO2 from 1.A.4.b)	-138
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-144
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.	-275
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-732
Total	**-1939**

Notes: As the table only presents sectors whose emissions have increased or decreased by at least 20 million tonnes CO_2 equivalent, the sum of the EU key categories in this table does not match the total change in emissions listed at the bottom of the table, which includes all emission sources in the EU inventory. Note that LULUCF categories or Memorandum items such as international aviation and international navigation are not included in this table.

1.2 Main trends by source category, 2019–2020

Total GHG emissions (excluding LULUCF and international aviation) decreased in 2020 by 346 million tonnes, or 8.5 % compared to 2019, to reach 3 708 million tonnes CO_2 equivalent in 2020. The reduction in GHG emissions in 2020 was the second largest in absolute terms (after that of the 2009 economic recession) and the highest in relative terms year-on-year in the EU since 1990. This was by and large due to the strong contraction in economic activity caused by the Covid-19 pandemic.

At EU level, about 70 % of the net reduction in GHG emissions in 2020 took place in road transportation and public electricity and heat production. Almost all economic sectors saw significant emission reductions in 2020.

Road transport CO_2 emissions decreased by 123 million tonnes (or -14%) due to a drastic reduction in transport activity resulting from the lockdown measures during the Covid-19 pandemic. Passenger cars accounted for the bulk of emission reductions in road transportation, but emissions from light duty and heavy-duty vehicles also decreased sharply in 2020.

The second largest reduction in CO_2 emissions in 2020 came from electricity and heat production, with 118 million tonnes less compared to 2019 (or -14% year on year). Most of this reduction was linked to lower use of coal in power stations. Greenhouse gas emissions from stationary installations in the EU

ETS also decreased 11.6%, which represents the largest drop in emissions since the ETS began operating in 2005. It is comparable only to the decrease observed in 2009 at the height of the financial crisis.

Based on Eurostat energy statistics, while total electricity production declined in the EU in 2020, the use of renewable energy sources in electricity generation increased, mostly from wind, solar and hydro. Higher use of renewables supports the ongoing decarbonisation trend in the sector.

Although less substantial than in road transportation and the power sector, GHG emissions in 2020 also decreased in manufacturing industries and construction, iron and steel, petroleum refining and commercial buildings, among others. HFC emissions from refrigeration and air conditioning continued the downtrend that started in 2014.

Table ES. 2 shows the source categories making the largest contribution to the change in GHG emissions in the EU between 2019 and 2020.

Table ES. 2 Overview of EU-27 plus Iceland and UK source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2019–2020

Source category	Million tonnes (CO_2 equivalents)
Cement Production (CO2 from 2.A.1)	-4
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-6
Domestic Aviation (CO2 from 1.A.3.a)	-8
Refrigeration and Air conditioning (HFCs from 2.F.1)	-9
Fuels used Commercial/Institutional Sector (CO2 from 1.A.4.a)	-10
Petroleum Refining (CO2 from 1.A.1.b)	-11
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A	-17
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-18
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-118
Road Transportation (CO2 from 1.A.3.b)	-123
Total	**-346**

Notes: *As the table only presents sectors whose emissions have increased or decreased by at least 3 million tonnes of CO_2 equivalent, the sum of the EU key categories in this table does not match the total change in emissions listed at the bottom of the table, which includes all emission sources in the EU inventory. Note that LULUCF categories or Memorandum items such as international aviation and international navigation are not included in this table.*

1.3 Overview of total GHG emissions by countries

Table ES.3 gives an overview of total GHG emissions by countries, illustrating where the main changes occurred.

Table ES. 3 GHG emissions in million tonnes CO_2 equivalent (excl. LULUCF).

	1990 (million tonnes)	2020 (million tonnes)	2019 - 2020 (million tonnes)	Change 2019 - 2020 (%)	Change 1990-2020 (%)
Austria	78.4	73.6	-6.1	-7.7%	-6.2%
Belgium	145.7	106.4	-10.0	-8.6%	-26.9%
Bulgaria	98.4	49.2	-10.3	-17.3%	-50.0%
Croatia	31.4	23.8	-0.9	-3.5%	-24.4%
Cyprus	5.6	8.9	0.0	-0.3%	59.0%
Czechia	198.8	113.3	-10.2	-8.3%	-43.0%
Denmark	71.1	41.7	-2.8	-6.2%	-41.3%
Estonia	40.2	11.6	-3.1	-21.0%	-71.2%
Finland	71.2	47.8	-5.0	-9.5%	-32.9%
France	544.1	393.0	-41.6	-9.6%	-27.8%
Germany	1241.9	728.7	-71.0	-8.9%	-41.3%
Greece	103.5	74.8	-10.8	-12.6%	-27.7%
Hungary	94.8	62.8	-1.8	-2.7%	-33.8%
Ireland	54.4	57.7	-2.1	-3.6%	6.1%
Italy	519.9	381.2	-37.1	-8.9%	-26.7%
Latvia	25.9	10.5	-0.7	-5.9%	-59.6%
Lithuania	47.9	20.2	-0.2	-0.9%	-57.8%
Luxembourg	12.7	9.1	-1.7	-15.5%	-28.8%
Malta	2.6	2.1	0.0	-0.5%	-18.4%
Netherlands	220.5	164.3	-15.9	-8.8%	-25.5%
Poland	475.9	376.0	-14.5	-3.7%	-21.0%
Portugal	58.5	57.6	-6.0	-9.5%	-1.5%
Romania	249.7	109.9	-4.0	-3.5%	-56.0%
Slovakia	73.5	37.0	-2.8	-7.0%	-49.6%
Slovenia	18.6	15.9	-1.2	-7.2%	-14.8%
Spain	290.1	274.7	-39.1	-12.5%	-5.3%
Sweden	71.4	46.3	-4.5	-8.9%	-35.2%
United Kingdom	793.4	402.1	-42.1	-9.5%	-49.3%
EU-27+UK	**5640.0**	**3700.3**	**-345.5**	**-8.5%**	**-34.4%**
Iceland	3.7	4.5	-0.2	-4.3%	22.7%
United Kingdom (KP)	796.2	404.8	-42.6	-9.5%	-49.2%
EU-KP	**5646.5**	**3707.6**	**-346.1**	**-8.5%**	**-34.3%**

ES-3 SUMMARY OF EMISSIONS AND REMOVALS BY MAIN GREENHOUSE GAS

Table ES. 4 gives an overview of the main trends in the EU-KP GHG emissions and removals for the period 1990–2020. By far the most important GHG is CO_2, which accounted for 80 % of total EU-KP emissions in 2020, excluding LULUCF. In 2020, EU-KP CO_2 emissions excluding LULUCF were 2962 million tonnes, which was 34 % below 1990 levels. Compared to 2019, CO_2 emissions decreased by 9.9 %. During that period CH_4 and N_2O emissions decreased by 1.4 % and 1.3 % respectively.

Table ES. 4 Overview of EU-KP GHG emissions and removals from 1990 to 2020 in million tonnes CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Net CO2 emissions/removals	4 256	3 910	3 872	3 996	3 622	3 481	3 418	3 326	3 168	3 211	3 201	3 261	3 177	3 033	2 716
CO2 emissions (without LULUCF)	4 479	4 216	4 185	4 321	3 961	3 819	3 763	3 670	3 494	3 531	3 515	3 526	3 444	3 287	2 962
CH4	712	655	595	536	480	470	466	456	448	448	441	440	434	425	419
N2O	384	347	303	284	238	232	230	231	234	233	233	237	234	230	227
HFCs	29	43	53	73	99	103	106	109	112	106	108	108	104	100	89
PFCs	26	17	12	7	4	4	4	4	3	3	4	3	4	3	2
Unspecified mix of HFCs and PFCs	6	6	2	1	1	0	1	1	1	1	1	1	2	2	2
SF6	11	15	10	8	6	6	6	6	6	6	6	7	7	7	6
NF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (with net CO2 emissions/removals)	**5 456**	**5 026**	**4 880**	**4 936**	**4 480**	**4 326**	**4 261**	**4 162**	**4 000**	**4 038**	**4 024**	**4 090**	**3 990**	**3 830**	**3 491**
Total (without CO2 from LULUCF)	**5 678**	**5 332**	**5 193**	**5 262**	**4 819**	**4 664**	**4 607**	**4 505**	**4 327**	**4 358**	**4 338**	**4 355**	**4 258**	**4 083**	**3 737**
Total (without LULUCF)	**5 647**	**5 299**	**5 162**	**5 231**	**4 789**	**4 635**	**4 576**	**4 477**	**4 298**	**4 329**	**4 308**	**4 322**	**4 228**	**4 054**	**3 708**

Notes: CO_2 emissions include indirect CO_2. Please note that historical data may have changed compared to last year's Inventory Report due to recalculations

More detailed information can be found in Chapter 2.

ES-4 SUMMARY OF EMISSIONS AND REMOVALS BY MAIN SOURCE AND SINK CATEGORY

Table ES. 5 gives an overview of EU-KP GHG emissions in the main source categories for the period 1990–2020. The most important sector in terms of GHG emissions is energy (i.e. combustion and fugitive emissions), which accounted for 76% of total EU emissions excluding LULUCF in 2020. The second largest sector is agriculture (11 %), followed by industrial processes (9 %). More detailed trend descriptions are included in the individual sector chapters (chapters 3-7).

Table ES. 5 Overview of EU-KP GHG emissions (in million tonnes CO_2-equivalent) in the main source and sink categories for the period 1990 to 2020

GHG SOURCE AND SINK	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Energy	4 323	4 062	3 995	4 108	3 795	3 651	3 609	3 510	3 323	3 364	3 348	3 351	3 270	3 113	2 801
2. Industrial Processes	548	523	480	487	407	404	393	396	402	393	391	400	392	382	351
3. Agriculture	532	466	457	434	419	418	417	420	427	428	430	433	429	425	424
4. Land-Use, Land-Use Change and Forestry	-191	-272	-282	-295	-309	-308	-315	-315	-298	-290	-285	-232	-238	-224	-217
5. Waste	238	244	227	199	166	160	156	150	144	141	137	136	135	133	130
6. Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	4	4	3	3	2	2	2	2	2	2	2	2	2	2	1
Total (with net CO_2 emissions/removals)	**5 456**	**5 026**	**4 880**	**4 936**	**4 480**	**4 326**	**4 261**	**4 162**	**4 000**	**4 038**	**4 024**	**4 090**	**3 990**	**3 830**	**3 491**
Total (without LULUCF)	**5 647**	**5 299**	**5 162**	**5 231**	**4 789**	**4 635**	**4 576**	**4 477**	**4 298**	**4 329**	**4 308**	**4 322**	**4 228**	**4 054**	**3 708**

ES-5 SUMMARY OF EU MEMBER STATE EMISSION TRENDS

Table ES. 6 gives an overview of countries' contributions to EU GHG emissions for the period 1990–2020. Countries show large variations in GHG emissions trends.

Table ES. 6 Overview of countries' contributions to total EU GHG emissions, excluding LULUCF and including indirect CO_2, from 1990 to 2020 in million tonnes CO_2-equivalent

Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Austria	78	79	80	92	84	82	79	80	76	78	79	82	79	80	74
Belgium	146	154	149	146	134	123	120	120	115	119	117	117	118	116	106
Bulgaria	98	72	57	62	59	65	60	56	59	62	60	63	60	59	49
Croatia	31	22	25	30	28	28	26	25	24	24	25	25	24	25	24
Cyprus	5.6	7.0	8.3	9.2	9.5	9.2	8.6	7.9	8.3	8.3	8.8	9.0	8.9	8.9	8.9
Czechia	199	158	151	149	141	139	135	130	128	129	130	131	129	124	113
Denmark	71	79	71	67	64	59	54	56	52	49	51	49	48	45	42
Estonia	40	20	17	19	21	21	20	22	21	18	20	21	20	15	12
Finland	71	72	70	70	76	68	62	63	59	55	58	55	56	53	48
France	544	536	549	551	507	483	485	486	455	458	459	463	443	435	393
Germany	1242	1115	1037	987	936	911	917	934	894	898	901	886	851	800	729
Greece	103	109	127	136	119	116	112	103	99	95	92	96	92	86	75
Hungary	95	77	75	77	66	64	61	58	58	61	62	65	65	65	63
Ireland	54	59	68	70	62	58	59	59	58	60	63	62	62	60	58
Italy	520	534	557	591	518	505	486	450	429	442	439	433	430	418	381
Latvia	26	12	10	11	12	11	11	11	11	11	11	11	11	11	10
Lithuania	48	22	19	23	21	21	21	20	20	20	20	21	20	20	20
Luxembourg	13	10	10	13	12	12	12	11	11	10	10	10	11	11	9
Malta	2.6	2.7	2.8	3.0	2.9	2.9	3.1	2.8	2.8	2.1	1.8	2.0	2.0	2.1	2.1
Netherlands	221	230	218	213	212	198	193	194	186	193	194	191	186	180	164
Poland	476	447	397	405	413	412	404	400	387	389	400	414	413	391	376
Portugal	58	68	82	86	69	67	66	64	64	68	66	71	67	64	58
Romania	250	185	139	147	123	130	128	116	115	115	113	117	118	114	110
Slovakia	73	53	49	51	46	45	42	42	40	41	41	42	42	40	37
Slovenia	19	19	19	20	20	20	19	18	17	17	18	18	18	17	16
Spain	290	330	388	442	358	358	351	324	326	337	326	339	333	314	275
Sweden	71	73	68	67	65	60	58	56	54	54	54	53	52	51	46
United Kingdom	793	745	710	687	605	560	577	563	523	505	480	469	460	444	402
EU-27+UK	**5640**	**5292**	**5154**	**5224**	**4781**	**4627**	**4569**	**4469**	**4291**	**4321**	**4300**	**4314**	**4220**	**4046**	**3700**
Iceland	3.7	3.5	4.1	4.0	4.9	4.6	4.7	4.7	4.7	4.7	4.7	4.8	4.8	4.7	4.5
United Kingdom (KP)	796	748	714	690	608	563	580	566	526	508	483	472	463	447	405
EU-KP	**5647**	**5299**	**5162**	**5231**	**4789**	**4635**	**4576**	**4477**	**4298**	**4329**	**4308**	**4322**	**4228**	**4054**	**3708**

The largest emitters in the EU-KP inventory in 2020 were Germany (20 % of EU-KP emissions), the UK (11 %) and France (11 %), followed by Italy (10 %), Poland (10 %) and Spain (7 %).

Germany and the UK accounted for 47 % of the total EU-KP GHG emission reduction between 1990 and 2020. Romania, France, Italy, Poland and the Czech Republic, together, contributed to almost another third to the total EU reduction since 1990.

The main reasons for the favourable trend in Germany were an increase in the efficiency of power and heating plants and the economic restructuring of the five new Länder after the German reunification, particularly in the iron and steel sector. Other important reasons include a reduction in the carbon intensity of fossil fuels (with the switch from coal to gas), a strong increase in renewable energy use and waste management measures that reduced the landfilling of organic waste. Lower GHG emissions in the UK were primarily the result of liberalising energy markets and the subsequent fuel switch from oil and coal to gas in electricity production. Other reasons include the shift towards more efficient combined cycle gas turbine stations, decreasing iron and steel production and the implementation of methane recovery systems at landfill sites.

Common drivers to lower GHG emissions in most EU countries over the past 30 years, excluding the short term impact of the economic recession in 2020, have been, the use of less carbon intensive fuels, with a switch from coal to gas and a strong increase in the use of renewable energy sources, as well as significant improvements in energy efficiency, both in transformation and end use.

More information on GHG emission trends by country can be found in the relevant national inventory reports to UNFCCC https://unfccc.int/ghg-inventories-annex-i-parties/2022.

ES-6 OTHER INFORMATION

INTERNATIONAL AVIATION AND MARITIME TRANSPORTATION

At EU-KP level, GHG emissions from international aviation increased by 145 % between 1990 and 2019. Due to the decline in air transport during the Covid-19 pandemic, they dropped by 59 % between 2019 and 2020. Overall, emissions from international aviation were almost at 1990 levels in 2020. GHG emissions from international shipping increased by 32 % during 1990-2019, and dropped by 11 % due to the economic downturn. In 2020, they were 17 % above 1990 levels. In 2020, international aviation accounted for 71 million tonnes CO_2 equivalent (compared to 171 million tonnes in 2019) and international shipping for 131 million tonnes CO_2 equivalent (compared to 148 million tonnes in 2019).

For detailed information on emissions from international bunkers, see Chapter 3.7 of this report.

INFORMATION ON RECALCULATIONS

According to UNFCCC Reporting Guidelines, the inventory for the whole time series should be estimated using the same methodologies, and the underlying activity data and emissions factors should be used in a consistent manner, ensuring that changes in emissions trends are not introduced as a result of changes in estimation methods. Thus, recalculations of past emissions data occur every year based on GHG inventory improvements by countries, and should ensure the consistency of the time series and be carried out to improve the accuracy and/or completeness of the inventory.

Based on EU Member States', Iceland's and UK's GHG inventories in 2022, total EU GHG emissions (excluding LULUCF) for 2019 were 0.33 % lower than those reported in the 2021 GHG inventories. Total EU emissions in 1990, reported in the 2022 GHG inventories, were 0.39 % lower than the 1990 emissions reported in 2021 inventories.

For detailed information on recalculations see Chapter 10 and the sector-specific recalculations in the sectoral chapters of the main report.

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1 INTRODUCTION TO THE EU GREENHOUSE GAS INVENTORY

The present report is the official inventory submission of the European Union for 2021 under the UNFCCC and the Kyoto Protocol (KP).

The European Union (EU), as a party to the United Nations Framework Convention on Climate Change (UNFCCC), reports annually on greenhouse gas (GHG) inventories for the years between 1990 and the current calendar year (t) minus two (t-2), for emissions and removals within the area covered by its Member States (i.e. emissions taking place within its territory).

The UK left the EU on February 1, 2020, but applies EU law until the end of the transition period, December 31, 2020. Key provisions of Regulation (EU) No 525/2013 ("Mechanism for Monitoring and Reporting GHG") and of Decision No 406/2009/EC ("Effort Sharing") apply to the United Kingdom also in respect of greenhouse gases emitted during 2019 and 2020. Article 5 of Commission Regulation (EU) No 389/2013 ("EU registry") applies to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol.

In addition, the European Union, its Member States, Iceland and the United Kingdom (UK) have agreed to fulfil their quantified emission limitation and reduction commitments for the second commitment period to the Kyoto Protocol, reflected in the Doha Amendment, jointly. The Union, its Member States, the United Kingdom and Iceland agreed to a quantified emission reduction commitment that limits their average annual emissions of greenhouse gases during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment. Article 4 of the Kyoto Protocol requires parties that agree to fulfil their commitments under Article 3 of the Kyoto Protocol jointly to set out in the relevant joint fulfilment agreement the respective emission level allocated to each of the parties. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The emission levels define the Member States', the United Kingdom's and Iceland's assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing Union legislation for the period 2013-2020 under the 'Climate and Energy package'.

In this context, the EU, Iceland and the UK jointly report their national greenhouse gases emissions during the second commitment period of the Kyoto Protocol. As described above, the present report is under the UNFCCC and the Kyoto Protocol and as such the inventory presented here corresponds to the EU GHG inventory under both scopes. This report, therefore, refers to the totals of the EU-27 plus Iceland, plus the United Kingdom (EU-KP). For reasons of clarity, please note that in some cases the terms 'Member States' and ''EU' and 'Union' may be used. As a general rule, these terms also include Iceland and the United Kingdom.

The EU should not be held liable for any remaining errors caused by the CRF Reporter in the review of the information submitted.

This report aims to present transparent information on the process and methods of compiling the EU GHG inventory. It addresses the relevant aspects at EU level, but does not describe detailed sectoral methodologies of the Member States' GHG inventories. As the data used in the EU inventory are the aggregation of the scope-relevant data of the Member States inventories, the detailed sectoral methodologies used in the EU inventory are fully consistent with the methodologies reported by the Member States to the UNFCCC. As such, the complete details on the methodologies used by the

Member States are available in the national inventory reports of the Member States, which are submitted to the UNFCCC and published in the UNFCCC website. To facilitate the work of the expert review teams during the annual UNFCCC review process, and as follow up to previous review recommendations, the EU submission in 2021 includes an Annex (Annex III) with a summary description of the methodologies used by each Member State for the EU key categories. The more detailed descriptions can be found in Member State's own submissions. Note that all Member States' submissions (common reporting format (CRF) tables and inventory reports), are considered to be part of the EU inventory. Several chapters in this report refer to information provided by the Member States, where additional insights can be gained. In many cases this Member State information is presented in summary overview tables.

The EU greenhouse gas inventory has been compiled under Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC[7] (hereafter referred to as the Monitoring Mechanism Regulation or MMR). Decision No 280/2004/EC has been revised in order to enhance the reporting rules on GHG emissions to meet requirements arising from current and future international climate agreements as well as the 2009 EU Climate and energy package. The emissions compiled in the EU GHG inventory are the sum of the respective emissions in the respective national inventories, except for the Intergovernmental Panel on Climate Change (IPCC) reference approach for CO_2 emissions from the combustion of fossil fuels.

The EU-27 Member States are: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden. Croatia is the newest Member State and accessed the EU in July 2013. Even though not all Member States were part of the European Union in 1990, GHG emissions in the EU are time-series consistent since 1990 and account for all sources and sinks of the current 27 EU MS.

The EU will resubmit its 2022 GHG inventory to UNFCCC later in the year to be the sum of emissions and removals of its 27 Member States, the UK and Iceland. This resubmission will reflect their final reviewed GHG inventories under the Kyoto Protocol.

1.1 Background information on greenhouse gas inventories and climate Change

The annual EU GHG inventory is required for two purposes.

Firstly, the EU, as the only regional economic integration organisation having joined the UNFCCC and the Kyoto Protocol as a Party, has to report annually on GHG inventories within the area covered by its Member States.

Secondly, under the EU GHG Monitoring Mechanism Regulation, the European Commission has to assess annually whether the actual and projected progress of Member States is sufficient to ensure fulfilment of the EU's commitments under the UNFCCC and the Kyoto Protocol, and with respect to EU

[7] OJ L 165, 18.06.2013, p. 13.

legislation for reduction of GHG emissions[8]. For this purpose, the Commission has to prepare a progress evaluation report, which has to be forwarded to the European Parliament and the Council. The annual EU inventory is used for the evaluation of actual progress.

The legal basis of the compilation of the EU inventory is the MMR. The MMR establishes a mechanism for inter alia: (1) ensuring the timeliness, transparency, accuracy, consistency, comparability and completeness of reporting by the Union and its Member States to the UNFCCC Secretariat; (2) reporting and verifying information relating to commitments of the Union and its Member States pursuant to the UNFCCC, to the Kyoto Protocol and to decisions adopted thereunder and evaluating progress towards meeting those commitments; (3) monitoring and reporting all anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol on substances that deplete the ozone layer in the Member States; (4) monitoring, reporting, reviewing and verifying greenhouse gas emissions and other information pursuant to Article 6 of Decision No 406/2009/EC; (5) evaluating progress by the Member States towards meeting their obligations under Decision No 406/2009/EC.

Under the provisions of Article 7 of the MMR, the Member States shall determine and report to the Commission by 15 January each year (year X) inter alia:

- their anthropogenic emissions of greenhouse gases listed in Annex I of the MMR (same as in Annex A to the Kyoto Protocol) for the year X-2, in accordance with UNFCCC reporting requirements
- data in accordance with UNFCCC reporting requirements on their anthropogenic emissions of carbon monoxide (CO), sulphur dioxide (SO2), nitrogen oxides (NOx) and volatile organic compounds, for the year X-2
- their anthropogenic greenhouse gas emissions by sources and removals of CO_2 by sinks resulting from LULUCF, for the year X-2, in accordance with UNFCCC reporting requirements
- any changes to the information referred to in points above relating to the years between 1990 and the year three-years previous (year X – 3);
- information from their national registry on the issue, acquisition, holding, transfer, cancellation, retirement and carry-over of AAUs, RMUs, ERUs, CERs, tCERs and lCERs for the year X-1;
- the elements of the national inventory report necessary for the preparation of the EU greenhouse gas inventory report, such as information on the Member State's quality assurance/quality control plan, a general uncertainty evaluation, a general assessment of completeness, and information on recalculations performed.

Submissions of updated or additional inventory data and complete national inventory reports by Member States shall be reported by 15 March.

Specific requirements on structure, format, submission processes under the MMR are detailed in an implementing Act since June 2014[9]. According to the MMR and its implementing decision the reporting

[8] Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (OJ L 140, 05.06.2009, p.136).

[9] Commission Implementing Regulation (EU) No 749/2014 of 30 June 2014 on structure, format, submission process and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European parliament and of the Council (OJ L 203, 11.07.2014, p.23).

requirements are exactly the same as for the UNFCCC, regarding content and format. The EU and its Member States prepare the inventory according to the relevant provisions under the UNFCCC.

In relation to the UNFCCC review of the EU GHG inventory, it is relevant to highlight that the EU GHG inventory is based on the inventories of its MS, Iceland and the UK. They are responsible for the methods, emission factors and emissions used, and for the implementation of the UNFCCC reporting guidelines and the 2006 IPCC Guidelines, taking into account inventory priorities and resource constraints.

The unique nature of the EU GHG inventory has been recognized by the GHG lead reviewers and is reflected in their conclusions (16th and 19th meetings, respectively).

Conclusions of the 16th meeting of GHG lead reviewers:

Reviewing the GHG inventory of the European Union (EU): the LRs noted that the review of the EU submission is unique in that it is the direct sum of emissions and removals from the national inventories compiled by the EU member States as well as Iceland, and that individual member States as well as Iceland are also subject to an inventory review. The LRs further noted that the focus of the EU review should be on ensuring that the EU submission accurately reflects the summation of the emissions and removals of its member States as well as Iceland and that information is transparently reported in the EU NIR, particularly for key categories identified at the level of the EU. Recommendations directed at specific member States as well as Iceland are beyond the scope for inclusion in the ARR of the EU. The LRs encouraged the secretariat to conduct the review of the EU submission after the submissions from individual EU member States and Iceland have been reviewed;

Conclusions of the 19th meeting of GHG lead reviewers, on the scope of and approach to the review of the EU GHG inventory:

The LRs concluded that the conclusions from the 16th meeting of LRs on the focus of the EU review, considering elements of the conclusions from the 3rd meeting of LRs, should be supplemented with the following recommendations for ERTs:

(i) At the start of the review, the LRs should request the ERT to focus the review on the transparency of the information reported in the EU national inventory report and provide guidance thereon, particularly for key categories identified at the EU level, followed by categories for which recalculations have been performed, and categories that are the subject of recommendations in the previous review report, as well as for findings in the initial assessment and progress in the implementation of planned improvements. The LRs recalled that the EU GHG inventory is compiled from the national GHG inventories of the EU member States, Iceland and the United Kingdom of Great Britain and Northern Ireland and that the ERT should assess whether the EU GHG inventory is compiled in accordance with the UNFCCC Annex I inventory reporting guidelines.

(ii) (ii) The LRs should ensure that recommendations in the review report are addressed to the EU, because the inventories of the member States, Iceland and the United Kingdom fall outside the scope of the EU review.

(iii) (iii) The LRs noted that the ERT may also consider information on the efforts undertaken at the EU level to address the main issues pertaining to the member States, Iceland and the United Kingdom, as reflected in previous EU review reports.

1.2 A description of the institutional arrangements

1.2.1 Institutional, legal and procedural arrangements

In accordance with the MMR Article 6(1), a Union Inventory system is established to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of national inventories with regard the Union greenhouse gas inventory. The Commission's Staff Working Document (SWD (2013) 308 final[10]) outlines the main elements of the Union inventory system. An overview is presented in Figure 1.1.

The Directorate General Climate Action of the European Commission has overall responsibility for the inventory of the European Union (EU) while each Member State is responsible for the preparation of its own inventory which is the basic input for the inventory of the European Union. DG Climate Action is supported in the establishment of the inventory by the following main institutions: the European Environment Agency (EEA) and its European Topic Centre on Climate Change Mitigation (ETC/CM) as well as the following other DGs of the European Commission: Eurostat, and the Joint Research Centre (JRC) [11].

[10] https://ec.europa.eu/clima/sites/clima/files/strategies/progress/monitoring/docs/swd_2013_308_en.pdf

[11] The Statistical Office of the European Communities (Eurostat) and the Joint Research Centre (JRC) are DGs of the European Commission. For simplicity reasons, these institutions are referred to as 'Eurostat' and the 'JRC' in this report.

Figure 1.1 Inventory system of the European Union

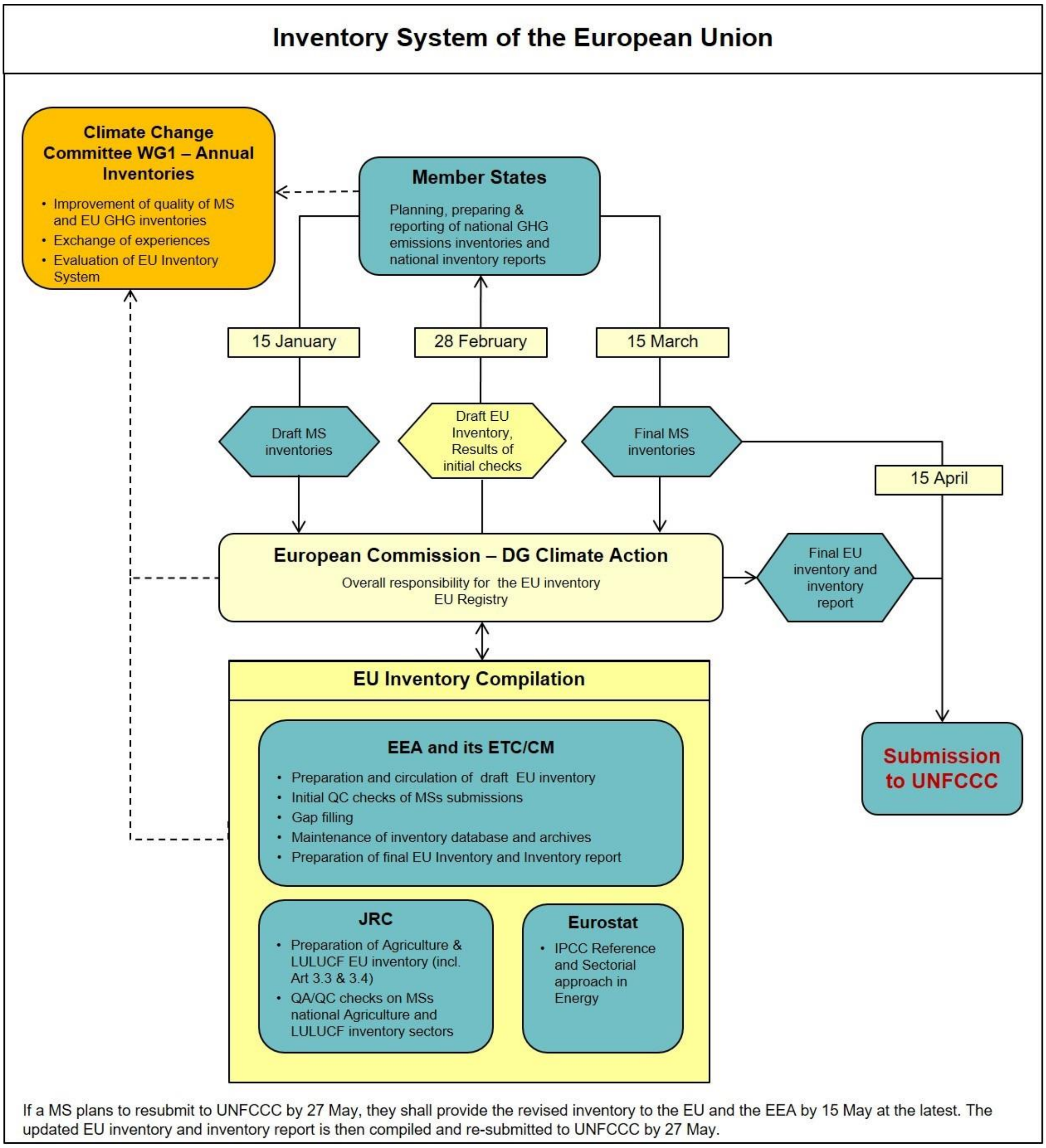


Table 1.1 shows the main institutions and persons involved in the compilation and submission of the EU inventory.

Table 1.1 List of institutions and experts responsible for the compilation of Member States' inventories and for the preparation of the EU inventory

Member State/EU institution	Contact address
Austria	Elisabeth Rigler Umweltbundesamt elisabeth.rigler@umweltbundesamt.at
Belgium	Peter Wittoeck Federal Department of the Environment

Member State/EU institution	Contact address
Bulgaria	Detelina Petrova Executive Environment Agency dpetrova@moew.government.bg
Croatia	Ms Vlatka Palčić and Ms Tatjana Obučina Ministry of Economy and Sustainable Development vlatka.palcic@mingor.hr; tatjana.obucina@mingor.hr Ms Iva Švedek Ekonerg - Energy and Environmental Protection Institute iva.svedek@ekonerg.hr
Cyprus	Theodoulos Mesimeris Department of Environment tmesimeris@environment.moa.gov.cy
Czech Republic	Ing. Eva Krtkova Czech Hydrometeorological Institute (CHMI) eva.krtkova@chmi.cz
Denmark	Ole-Kenneth Nielsen Aarhus University okn@envs.au.dk
Estonia	Kristiina Joon Ministry of the Environment Senior Officer, Climate Department kristiina.joon@envir.ee Hanna-Lii Kupri Adviser, Estonian Environmental Research Centre hanna-lii.kupri@klab.ee
Finland	Riitta Pipatti Statistics Finland riitta.pipatti@stat.fi
France	Pascale Vizy Ministère de l'Environnement, de l'Energie et de la Mer (MEEM) Pascale.VIZY@developpement-durable.gouv.fr Jean-Pierre Chang Centre Interprofessionel Technique d'Etudes de la Pollution Atmosphérique (CITEPA) jean-pierre.chang@citepa.org
Germany	Dirk Günther Federal Environmental Agency Dirk.Guenther@uba.de
Greece	Mr. Kyriakos Psychas Ministry of Environment and Energy
Hungary	Mr. Gábor KIS-KOVÁCS Hungarian Meteorological Service kiskovacs.g@met.hu
Iceland	Nicole Keller, Environment Agency of Iceland, nicole.keller@umhverfisstofnun.is
Ireland	Paul Duffy Environmental Protection Agency p.duffy@epa.ie
Italy	M. Contaldi, R. de Lauretis, D. Romano National Environment Protection Agency (ANPA) riccardo.delauretis@isprambiente.it, daniela.romano@isprambiente.it
Latvia	Agita Gancone Ministry of Environmental Protection and Regional Development agita.gancone@varam.gov.lv

Member State/EU institution	Contact address
Lithuania	Ms. Jolanta Merkeliene Climate Change Policy Division of the Ministry of Environment Lithuanian Ministry of Environment j.merkeliene@am.lt
Luxembourg	Eric De Brabanter Département de l'Environnement Ministère du Développement durable et des Infrastructures eric.debrabanter@mev.etat.lu Dr. Marc Schuman Administration de l'Environnement marc.schuman@aev.etat.lu
Malta	Mr Saviour Vassallo Malta Resources Authority – Climate Change Unit Saviour.vassallo@mra.org.mt
Netherlands	Margreet van Zanten National Institute for Public Health and the Environment margreet.van.zanten@rivm.nlmailto:
Poland	Anna Olecka National Centre for Emissions Management Institute of Environmental Protection - National Research Institute anna.olecka@kobize.pl
Portugal	Eduardo Santos Agência Portuguesa do Ambiente, Departamento de Alterações Climáticas (DCLIMA)
Romania	Sorin Deaconu National Environmental Protection Agency sorin.deaconu@anpm.ro
Slovakia	Janka Szemesova Department of Emissions and Biofuels, Slovak Hydrometeorological Institute janka.szemesova@shmu.sk
Slovenia	Tajda Mekinda Majaron Environmental Agency of the Republic of Slovenia tajda.mekinda-majaron@gov.si
Spain	Maj Britt Larka Abellán Dirección General de Calidad y Evaluación Ambiental y Medio Natural Ministerio de Agricultura, Alimentación y Medio Ambiente
Sweden	Anne Wisten The Ministry of the Environment anne.wisten@regeringskansliet.se Frida Löfström The Swedish Environmental Protection Agency frida.lofstrom@naturvardsverket.se
United Kingdom	Neil Lambert Department for Business, Energy and Industrial Strategy UK Greenhouse Gas Inventory team **neil.lambert@beis.gov.uk**
European Commission	Xavier Seront European Commission, DG Climate Action Xavier.SERONT@ec.europa.eu
European Environment Agency (EEA)	Ricardo Fernandez, Claire Qoul, Melanie Sporer European Environment Agency Ricardo.Fernandez@eea.europa.eu, Claire.Qoul@eea.europa.eu, melanie.sporer@eea.europa.eu

Member State/EU institution	Contact address
European Topic Centre on Climate Change Mitigation and Energy (ETC/CM)	Nicole Mandl, Michaela Gager, Elisabeth Rigler European Topic Centre on Climate Change Mitigation Umweltbundesamt nicole.mandl@umweltbundesamt.at, michaela.gager@umweltbundesamt.at, elisabeth.rigler@umweltbundesamt.at
Eurostat	Michael Goll Statistical Office of the European Communities (Eurostat) Michael.Goll@ec.europa.eu
Joint Research Centre (JRC)	Giacomo Grassi, Frank Dentener Joint Research Centre, Directorate D – Sustainable Resources Giacomo.GRASSI@ec.europa.eu, Frank.DENTENER@ec.europa.eu

1.2.1.1 The Member States

All EU Member States are Annex I parties to the UNFCCC Therefore, all Member States have committed themselves to prepare individual national GHG inventories in accordance with UNFCCC reporting guidelines and to submit those inventories to the UNFCCC secretariat by 15 April.

In this context, all Member States are required to establish, operate and seek to continuously improve national inventory systems in accordance to Article 5 of the MMR. Detailed information on institutional arrangements/national systems of each Member State is included in the respective national inventory reports.

The European Union's inventory is based on the inventories supplied by Member States. The total estimate of the EU greenhouse gas emissions should accurately reflect the sum of Member States' national greenhouse gas inventories. Member States are responsible for choosing activity data, emission factors and other parameters used for their national inventories as well as the correct application of methodologies provided in the 2006 IPCC Guidelines. Member States are also responsible for establishing quality assurance/quality control (QA/QC) programmes for their inventories. The QA/QC activities of each Member State are described in the respective national inventory reports.

For the EU to be able to provide the GHG inventory to the UNFCCC on time, all Member States are required to report individual GHG inventories prepared in accordance with UNFCCC reporting guidelines to the European Commission and to the European Environment Agency (EEA) by 15 January every year.

After the submission of national GHG inventories and inventory reports, QA/QC checks are performed by the EU team. The outcome of these 'initial checks', together with the draft EU inventory report is sent to Member States for checking, reviewing and providing of comments. The Member States take part in the review and comment phase of the draft EU inventory report. The purpose of circulating the draft EU inventory report is to improve the quality of the EU inventory. The Member States check their national data and information used in the EU inventory report, answer to the initial checks findings and send updates, as relevant by the 15th March. In addition, they can comment on the general aspects of the EU inventory report by the same deadline.

During the UNFCCC review of the Union inventory, Member States are also required to provide answers related to the issues under their responsibility as soon as possible. In these cases, the issues are forwarded directly as requested by the EU team.

The inventory authorities of the Member States take part in the Working Group 1 ‘Annual Inventories’ (WG1) of the Climate Change Committee established under the MMR. The purpose of the Climate Change Committee is to assist the European Commission in its tasks under the MMR. Information on the WG1 tasks and responsibilities can be found in the next paragraph, but the main task of the WG1 members is to ensure the coordination of inventory activities between the Union system and the national inventory systems.

1.2.1.2 The European Commission, Directorate-General Climate Action

The European Commission’s DG Climate Action in consultation with the Member States has the overall responsibility for the EU inventory. Member States are required to submit their national inventories and inventory reports under the Monitoring Mechanism Regulation to the European Commission, DG Climate Action; and the European Commission, DG Climate Action itself submits the inventory and inventory report of the EU to the UNFCCC Secretariat, on behalf of the European Union. In the actual compilation of the EU inventory and inventory report, the European Commission, DG Climate Action, is assisted by the EEA including the EEA’s ETC/ACM and by Eurostat and the JRC.

The consultation between the DG Climate Action and the Member States takes place in the Climate Change Committee established under Article 26 of the MMR. The Committee is composed of the representatives of the Member States and chaired by the representative of the DG Climate Action. Procedures within the Committee for decision-making, adoption of measures and voting are outlined in the rules of procedure, adopted in November 2003. In order to facilitate decision-making in the Committee, working groups have been established, one of which is Working Group 1 on ‘Annual inventories’. The objectives and tasks of Working Group 1 under the Climate Change Committee include:

- the promotion of the timely delivery of national annual GHG inventories as required under the monitoring mechanism;
- the improvement of the quality of GHG inventories on all relevant aspects (transparency, consistency, comparability, completeness, accuracy and use of good practices);
- the exchange of practical experience on inventory preparation, on all quality aspects and on the use of national methodologies for GHG estimation;
- the evaluation of the current organisational aspects of the preparation process of the EU inventory and the preparation of proposals for improvements where needed.

1.2.1.3 The European Environment Agency

Under MMR Article 24 the role of the European Environment Agency (EEA) is defined as providing assistance to the Commission in its work. In relation to the inventories, this assistance includes the following:

(a) Compilation of the Union greenhouse gas inventory and preparation of the Union greenhouse gas inventory report;
(b) Performance of the quality assurance and quality control procedures for the preparation of the Union greenhouse gas inventory;
(c) Preparation of estimates for data not reported in the national greenhouse gas inventories;
(d) Conduction of the reviews of MS inventories.

The tasks of the EEA are facilitated by the European environmental information and observation network (Eionet), which consists of the EEA as central node (supported by European topic centres) and national institutions in the EEA member countries[12] (see http://eionet.eea.europa.eu). Member States report the information reported pursuant to Article 7 of the MMR to the Commission with a copy to the European Environment Agency, and for this reason they are making use of the EEA's ReportNet's Central Data Repository under the Eionet ('CDR', see http://cdr.eionet.europa.eu/).

Apart from the data capturing processes, and as part of its responsibility to compile the GHG inventory and prepare the Union GHG inventory report, the EEA is also responsible for the implementation of the QA/QC Programme of the EU, by performing inter alia a number of QA/QC checks focused on ensuring the completeness and consistency of the Union and Member States inventories.

Finally, in the end of the process the EEA is publishing the GHG inventory dataset and the EU National Inventory Report on its website. To facilitate the access of the GHG information to the general public, the EEA data viewer is also provided.

The EEA is further assisted by its European Topic Centre on Climate Change Mitigation and Energy (ETC/CM), which is an international consortium working with the EEA under a framework partnership agreement. The activities of the EEA's ETC/CM are further deployed in the next paragraph.

1.2.1.4 The European Topic Centre on Climate Change Mitigation

The EEA's European Topic Centre on Climate Change Mitigation and Energy (ETC/CM) was established by a contract between the lead organisation Vito (vision on technology) in Belgium and EEA for the years 2022-2026, continuing the work of the previous ETC on part of the work of the previous ETC/CM on Climate change Mitigation and Energy, which ended in 2021.

The EEA's ETC/CM involves 11 organisations and institutions in nine European countries. The technical annex of the work plan for the EEA's ETC/CM and a yearly action plan defines the specific tasks of the EEA's ETC/CM partner organisations with regard to the preparation of the EU inventory and inventory report. Environment Agency Austria is the task leader for the compilation of the EU annual inventory and inventory report in the EEA's ETC/CM. The specific tasks undertaken by EEA's ETC/CM in this task include:

- Implementation of the quality assurance and quality control (QA/QC) procedures of the EU GHG inventory national system for the compilation and submission of the Union GHG inventory to the UNFCCC. Initial QA/QC checks of Member States' submissions are performed in cooperation with Eurostat, and the JRC, and documented in the EEA review tool
- Performing the first step of the annual Effort Sharing Decision (ESD) review and identifying significant issues according to Art. 29 and 30 of the Commission Implementing Regulation (EU) No 749/2014 (MMR Implementing Regulation).
- Consultation with Member States in order to clarify data and other information provided;
- Preparation of the draft EU inventory and inventory report by 28 February based on Member States' submissions;
- Preparation of the final EU inventory and inventory report by 15 April (to be submitted by the Commission to the UNFCCC Secretariat);

The EEA's ETC/CM provides the CRF Aggregator developed to ensure the EU submission is fully consistent with member state's (MS) submissions. From the CRF aggregator the aggregated EU

[12] EEA member countries include the EU Member States, Iceland, Liechtenstein, Norway, Switzerland and Turkey.

inventory is transferred into the CRF reporter software for preparing the official EU GHG inventory submission.

1.2.1.5 Eurostat

Eurostat collects national energy statistics reported under the EU Energy Statistics Regulation on an annual basis. These data are used for the estimation of the IPCC Reference Approach and the Sectoral Approach. The EEA compares the results of the two approaches with MS CRF submissions. These comparisons are sent to MS during the consultation on the Draft EU GHG inventory by 28 February. The Energy Statistics Regulation (Regulation EC/1099/2008) as amended by Commission Regulation (EU) No 147/2013 of 13 February 2013 is the basis for MS reporting of energy data to Eurostat. Article 6(2) of the Energy statistics regulation stipulates: 'Every reasonable effort shall be undertaken to ensure coherence between energy data declared in the energy statistics regulation, and data declared in accordance with Commission Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol'. The consistency of energy balances and CRF activity data is essential for good quality GHG estimates in the energy sector, and therefore it is at the core of the QA/QC activities at EU level.

1.2.1.6 Joint Research Centre

The Joint Research Centre (JRC) performs the QA/QC of the LULUCF and Agriculture sectors and is responsible of the writing of the respective chapters. The QA/QC main activity is the annual checking of early versions of the each national GHG inventory. Focus is on errors and inconsistencies, with numerous interactions with national representatives for clarifications and improvements. Specific completeness and consistency checks are also carried out. For LULUCF, additional efforts to help member states in improving their reporting include annual technical workshops (http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/), dedicated EU-funded projects, the AFOLU database, and a forest growth model whose results which may be used by countries to compare with their estimates. More information is provided in the QAQC sections of the LULUCF and Agriculture chapters.

1.2.2 Overview of inventory planning, preparation and management

1.2.2.1 A description of the process of inventory preparation

The annual process of compilation of the EU inventory is summarised in Table 1.2 . The Member States submit their annual GHG inventory by 15 January each year to the European Commission’s DG Climate Action using the EEA’s ReportNet Central Data Repository. Then, EEA’s ETC/CM, Eurostat and the JRC perform initial checks of the submitted data up to 28 February. The ETC/CM transfers the nationally submitted data from the xml-files into the CRF aggregator database which was developed for aggregating the EU submission from member state (MS) submissions. From the CRF aggregator the aggregated EU inventory is transferred into the CRF reporter software for preparing the official EU GHG inventory submission. Any information reported by MS in categories that do not have standardized UIDs or in categories for which several country settings are possible have to be included in the CRF Reporter manually.

Table 1.2 Annual process of submission and review of Member States inventories and compilation of the EU inventory

Element	Who	When	What
1. Submission of annual greenhouse gas inventories (complete common reporting format (CRF) submission and elements of the national inventory report) by Member States under Council Decision No 280/2004/EC	Member States	15 January	Elements listed in Article 7(1) of Regulation (EU) No 525/2013 and Article 3 of the implementing regulation (EU) No 749/2014
2. 'Initial checks' of Member States submissions	Commission (incl. Eurostat, the JRC), assisted by the EEA	For the Member State submission from 15 January at the latest until 28 February	Initial checks and consistency checks (by EEA). Comparison of energy data provided by Member States in the CRF with Eurostat energy data (sectoral and reference approach) by Eurostat and EEA. Check of Member States' agriculture and land use, land- use change and forestry (LULUCF) inventories by JRC (in consultation with Member States). The findings of the initial checks will be documented.
3. Compilation of draft EU inventory	Commission (incl. Eurostat, the JRC), assisted by the EEA	up to 28 February	Draft Union inventory and inventory report (compilation of Member State information), based on Member State inventories and additional information where needed (as submitted on 15 January).
4. Circulation of 'initial check' findings including notification of potential gap-filling	Commission (DG Climate Action) assisted by the EEA	28 February	Circulation of 'initial check' findings including notification of potential gap-filling and making available the findings
5. Circulation of draft **Union** inventory and inventory report	Commission (DG Climate Action) assisted by the EEA	28 February	Circulation of the draft Union inventory on 28 February to Member States. Member States check data.
6. Submission of updated or additional inventory data and complete national inventory reports by Member States	Member States	15 March	Updated or additional inventory data submitted by Member States (to remove inconsistencies or fill gaps) and complete national inventory reports.
7. Member State commenting on the draft Union inventory	Member States	15 March	If necessary, provide corrected data and comments to the draft Union inventory
8. Member State responses to the 'initial checks'	Member States	15 March	Member States respond to 'initial checks' if applicable.
9. Circulation of follow-up initial check findings	Commission assisted by EEA 31 March	Commission assisted by EEA 31 March	Circulation of follow-up initial check findings and making available the findings
10. Estimates for data missing from a national inventory	Commission (DG Climate Action) assisted by EEA	31 March	The Commission prepares estimates for missing data by 31 March of the reporting year, following consultation with the Member State concerned, and communicate these to the Member States.
11. Comments from Member States regarding the Commission estimates for missing data	Member States	7 April	Member States provide comments on the Commission estimates for missing data, for consideration by the Commission.
12. Member States responses to follow-up 'initial checks'	Member States	7 April	Member States provide responses to follow up of 'initial checks'.
13. Member States submissions to the UNFCCC	Member States	15 April	Submissions to the UNFCCC (with a copy to EEA)
14. Final annual Union inventory (incl. EU inventory report)	Commission (DG Climate Action) assisted by EEA	15 April	Submission to UNFCCC of the final annual Union inventory.
15. Any resubmissions by Member States	Member States	By 8 May	Member States provide to the Commission the resubmissions which they submit to the UNFCCC secretariat. The Member States must clearly specify which parts have been revised in order to facilitate the use for the Union

Element	Who	When	What
			resubmission. Resubmissions should be avoided to the extent possible. As the Union resubmission also has to comply with the time-limits specified in the guidelines under Article 8 of the Kyoto Protocol, the Member States have to send their resubmission, if any, to the Commission earlier than the period foreseen in the guidelines under Article 8 of the Kyoto Protocol, provided that the resubmission corrects data or information that is used for the compilation of the Union inventory.
16. **Union** inventory resubmission in response to Member States' resubmissions		27 May	If necessary, resubmission to UNFCCC of the final annual Union inventory.
17. Submission of any other resubmission after the initial check phase	Member States	When additional resubmissions occur	Member States provide to the Commission any other resubmission (CRF or national inventory report) which they provide to the UNFCCC secretariat after the initial check phase.

By 28 February, the draft EU GHG inventory and inventory report are circulated to the Member States for review and comment. The Member States check their national data and information used in the EU inventory report and send updates, if necessary, and review the EU inventory report by 15 March. This procedure should assure the timely submission of the EU GHG inventory and inventory report to the UNFCCC Secretariat and it should guarantee that the EU submission to the UNFCCC Secretariat is consistent with Member States' UNFCCC submissions.

The final EU GHG inventory and inventory report is prepared by the EEA's ETC/CM by 15 April for submission to the UNFCCC Secretariat. Resubmissions of the EU GHG inventory and inventory report are prepared by 27 May, if needed. By 8 May, Member States provide to the Commission any resubmission in response to the UNFCCC initial checks which affect the EU inventory, in order to guarantee that the EU resubmission to the UNFCCC Secretariat is consistent with the Member States' resubmissions. By the end of May the inventory and the inventory report are published on the EEA website (http://www.eea.europa.eu) and the data are made available through the EEA data service (http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-9) and the EEA GHG data viewer

(http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer.)

Table 1.3 summarises timeliness and completeness of the EU-27 Member States, Iceland and the United Kingdom (EU-KP) submissions in 2022 that were taken into account for the compilation EU GHG inventory.

Table 1.3 Date, mode and content of submission of EU-27 Member States, Iceland and the United Kingdom (EU-KP) in 2022 that were taken into account for the compilation of EU GHG inventory

MS	date	Submission mode	XML	CRF	NIR
AUT	14.04.2022	CDR	AUT_2022_3_13042022_0001156693347981248452031.xml	1990-2020	x
BEL	06.05.2022	CDR	BEL_2022_2_05052022_1849596821897297876151306.xml	1990-2020	x
BGR	15.04.2022	CDR	BGR_2022_1_08042022_1043528008730560114178460.xml	1988-2020	x
CYP	14.03.2022	CDR	CYP_2022_5_14032022_091125777627715728132931.xml	1990-2020	x
CZE	14.04.2022	CDR	CZE_2022_1_14042022_1010173292070173424806670.xml	1990-2020	x
DEU	11.03.2022	CDR	DEU_2022_1_09032022_1307349059789313728039888.xml		
DEU	14.03.2022	CDR			x (de)
DNM	15.04.2022	CDR	DNM_2022_1_05042022_1624486434476201882411286.xml	1990-2020	x
ESP	14.03.2022	CDR	ESP_2022_1_07032022_1624002989037472851025443.xml	1990-2020	x (es)
EST	15.03.2022	CDR	EST_2022_1_11032022_0833496790583129475309325.xml	1990-2020	x
FIN	14.04.2022	CDR	FIN_2022_6_13042022_2100178628064658895985257.xml	1990-2020	x
FRK	16.03.2022	CDR	FRK_2022_1_11032022_2114401401414822133558052.xml	1990-2020	x (fr)
GRC	15.03.2022	CDR			x
GRC	06.05.2022	CDR	GRC_2022_4_06052022_135437384618509595432368.xml	1990-2020	
HRV	06.05.2022	CDR	HRV_2022_2_05052022_1036447819374347510896596.xml	1990-2020	x
HUN	17.03.2022	CDR	HUN_2022_2_16032022_154859249086908265939596.xml	1985-2020	
HUN	25.03.2022	CDR			x
IRL	15.03.2022	CDR	IRL_2022_1_07032022_1356036367873419862839710.xml	1990-2020	x
ITA	15.04.2022	CDR	ITA_2022_1_06042022_224238524144856716242276.xml	1990-2020	x
LTU	15.04.2022	CDR			x
LTU	08.05.2022	CDR	LTU_2022_2_06052022_1826248693110678179109500.xml	1990-2020	
LUX	14.04.2022	CDR	LUX_2022_1_13042022_2230177674752390873441538.xml	1990-2020	x
LUX	06.05.2022	CDR			x
LVA	14.04.2022	CDR	LVA_2022_2_11042022_1020397013489929466391910.xml	1990-2020	x
MLT	13.04.2022	CDR	MLT_2022_3_11042022_1525585523840982511712798.xml	1990-2020	x
NLD	14.04.2022	CDR	NLD_2022_1_14042022_0603046775341011500807411.xml	1990-2020	x
POL	06.05.2022	CDR	POL_2022_3_05052022_0911395814420304150794492.xml	1988-2020	
POL	12.05.2022	CDR			x
PRT	15.03.2022	CDR	PRT_2022_1_12032022_0028578531025574299349601.xml	1990-2020	x
ROU	06.05.2022	CDR	ROU_2022_5_03052022_0748436478895286069515378.xml	1989-2020	x
SVK	05.05.2022	CDR	SVK_2022_4_06042022_2040405229825853848691361.xml	1990-2020	x
SVN	15.04.2022	CDR	SVN_2022_4_13042022_0622272568663170709198778.xml	1986-2020	x
SWE	15.03.2022	CDR	SWE_2022_1_14032022_1642267126877797914688130.xml	1990-2020	x
GBK	15.03.2022	CDR			x
GBK	06.05.2022	CDR	GBK_2022_2_06052022_1727165161355352201146233.xml	1990-2019	
ISL	13.04.2022	CDR			x
ISL	06.05.2022	CDR	ISL_2022_2_06052022_2125489069601836515951843.xml	1990-2020	

Table 1.4 gives an overview on people involved in the compilation of the EU GHG inventory submission in 2022 and their individual responsibilities in this process.

Table 1.4 Responsibility list for the compilation of the EU GHG inventory submission in 2022

	Name	EU GHG inventory/inventory report compilation				Initial Checks			
		Overall responsibility	Project manager	Sector experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts/ expert	Quality expert
Commission	Xavier Seront (DG Clima) Xavier.SERONT@ec.europa.eu	X		Chapter 13 - Changes national system	Executive summary, introduction				
	Roxanne Lake (DG Clima) Roxanne.LAKE@ec.europa.eu	X		Chapter 13 - Changes national system	Executive summary, introduction				
	Francesca LANZA (DG Clima) Francesca.LANZA@ec.europa.eu			Chapter 12 - Kyoto units, Chapter 14 - Changes to registry, EU-SEF Tables					
	BogdanVoinea (DG Clima) Bogdan.VOINEA@ext.ec.europa.eu			Chapter 14 Changes to registry, EU-SEF Tables					
	Frank Dentener (JRC) frank.dentener@ec.europa.eu				sector 3				sector3
	Simona Bosco (JRC) Simona.BOSCO@ec.europa.eu			sector 3				sector 3	
	SOLAZZO Efisio (JRC) Efisio.SOLAZZO@ext.ec.europa.eu			sector 3, plots				sector 3, plots	
	Giacomo Grassi (JRC) giacomo.grassi@ec.europa.eu				LULUCF and KP LULUCF				LULUCF and KP-LULUCF
	Raul Abad-Vinas (JRC) raul.abad-vinas@ec.europa.eu			LULUCF and KP LULUCF				LULUCF and KP LULUCF	
	Michael Goll (Eurostat) Michael.Goll@ec.europa.eu			1A Reference approach				1A Reference approach	
EEA and ETC-CM	Ricardo Fernandez (EEA) ricardo.fernandez@eea.europa.eu	X			Executive summary, chapter 1, trend chapter, chapter 10				
	Claire Qoul (EEA) claire.qoul@eea.europa.eu	X			Executive summary, chapter 1, trend chapter, chapter 10	X			
	Peter Iversen (EEA) peter.iversen@eea.europa.eu			LULUCF	LULUCF and KP LULUCF			LULUCF	
	Melanie Sporer (EEA) melanie.sporer@eea.europa.eu					X			

Name	EU GHG inventory/inventory report compilation				Initial Checks			
	Overall responsibility	Project manager	Sector experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts/ expert	Quality expert
Herdis Gudbrandsdottir (EEA) herdis.gudbrandsdottir@eea.europa.eu			Data checks					
Michaela Gager (ETC-CM; UBA-V) michaela.gager@umweltbundesamt.at		Data manager						
Günther Schmidt (ETC-CM; UBA-V) guether.schmidt@umweltbundesamt.at		Data manager						
Nicole Mandl (ETC-CM, UBA-V) nicole.mandl@umweltbundesamt.at		X	Executive summary, introduction, trend chapter			X	cross-cutting issues	cross-cutting issues
Bernd Gugele (ETC-CM, UBA-V) bernd.gugele@umweltbundesamt.at			1A Refeernce approach				1A Reference approach	
Bradley Matthews (ETC-CM, UBA-V) bradley.matthews@umweltbundesamt.at			uncertainty analysis				Uncertainty analysis	
Maria Purzner (CM ETC/CM, UBA-V) maria.purzner@umweltbundesamt.at								sector 2 - f-gases only
Marion Pinterits (ETC-CM; Klarfakt) marion.pinterits@umweltbundesamt.at		X	1B, 1C, chapter 10			X	1B, 1C	1AB
Elisabeth Kampel (ETC-CM) e.kampel@klarfakt.com			support					
Eva Krtkova (ETC-CM;CHMI) eva.krtkova@chmi.cz			1A2, 1A4, 1A5	1A1, 1AB			1A2, 1A4, 1A5	1A1
Markéta Müllerová (ETC-CM; CHMI) marketa.mullerova@chmi.cz			1A2, 1A4, 1A5	1A1			1A2, 1A4, 1A5	1A1
SAARIKIVI RISTO JUHANA (CM ETC/CM; CHMI) ristojuhana.saarikivi@chmi.cz				sector 5				sector 5
Céline GUEGUEN (ETC-CM) celine.gueguen2@gmail.com			sector 5				sector 5	
Coralie JEANNOT (ETC-CM; CITEPA) coralie.jeannot@citepa.org			EU ETS, 2C				EU ETS, 2C	
Julien Vincent (ETC-CM; CITEPA) julien.vincent@citepa.org			1A1, 2D, 2G3-2G4, 2H	1A2, 1A4, 1A5; 1B, 1C			1A1, 2D, 2G3-2G4, 2H	1A2, 1A4, 1A5; 1B, 1C
Giorgos Mellios (ETC-CM; Emisia) giorgos.m@emisia.com			1A3 + bunkers, comparison with Eurocontrol					1A3 + bunkers
Maria Georgakaki (ETC/CM, Emisia) Maria Georgakaki <maria.g@emisia.com			1A3 + bunkers, comparison with Eurocontrol				1A3 + bunkers	
Barbara Gschrey (ETC-CM; Oeko Recherche) b.gschrey@oekorecherche.de			F-gases, 2B9 2E, 2F, 2G1-2				F-gases, 2B9 2E, 2F, 2G1-2	

	Name	EU GHG inventory/inventory report compilation				Initial Checks			
		Overall responsibility	Project manager	Sector experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts/ expert	Quality expert
	Kristina Kaar (ETC-CM; Oeko Recherche) kristina.kaar@oekorecherche.de			F-gases 2E, 2F, 2G1-2				F-gases 2E, 2F, 2G1-2	
	Lorenz Moosmann (ETC-CM; Oeko) l.moosmann@oeko.de			sectors 2A, 2B, Chapter 15				2A, 2B	
	Lukas Emele (ETC-CM; Oeko) l.emele@oeko.de			sectors 2A, 2B,				2A, 2B,	
	Ils Moorkens (ETC-CM; VITO) ils.moorkens@vito.be				sector 2				sector 2 (excl. f-gases)

1.2.3 Quality assurance, quality control of the European Union inventory

1.2.3.1 Quality assurance and quality control procedures in the EU

The European Commission (Directorate General Climate Action) is responsible for coordinating QA/QC procedures for the EU inventory and ensures that the objectives of the QA/QC programme are implemented in the design of the QA/QC manual defining general and specific QC procedures for the EU GHG inventory submission. The European Environment Agency (EEA) is responsible for the annual implementation of these QA/QC procedures for the EU inventory.

The EU QA/QC programme is established in Chapter II of the Commission's Staff Working Document (SWD(2013) 308). In the EU QA/QC programme the general responsibilities for the QA/QC are defined as follows:

- The Member States are responsible for the quality of activity data, emission factors and other parameters used for their inventories, for adherence to the IPCC methodologies and the establishment of the national QA/QC programmes. As EU Member States inventories form part of the EU inventory submission information on the individual Member States QA/QC procedures can be found in their national inventory reports.
- The European Commission (DG Clima) is responsible for setting up the QA/QC Programme, ensuring the establishment and fulfilment of its objectives and ensuring the development of a QA/QC plan.
- The EEA, together with its ETC/CM, are responsible for the practical implementation and coordination of QA/QC procedures for the Union inventory, as well as for the archiving and documentation.

The following part focuses on QA/QC procedure at EU level.

The overall objectives of the EU QA/QC programme are:

- To establish quality objectives for the EU GHG inventory taking into account its specific nature of the EU GHG inventory as a compilation of MS GHG inventories:
- To implement the quality objectives in the design of the QA/QC plan defining general and specific QC procedures for the EU GHG inventory submission taking into account the specific nature of the EU GHG inventory:
- to provide an EU inventory of greenhouse gas emissions and removals consistent with the sum of Member States' inventories of greenhouse gas emissions and removals submitted to the EU and covering the EU geographical area:
- to ensure the timeliness of MS GHG inventory submissions to the EU for the compilation of the EU's GHG inventory;
- to ensure the completeness of the EU GHG inventory, inter alia by implementing procedures to estimate any data missing from the national inventories, in consultation with the MS concerned;
- to contribute to the improvement of quality of Member States' inventories and
- to provide assistance for the implementation of national QA/QC programmes.

A number of specific objectives have been elaborated in order to ensure that the EU GHG inventory complies with the UNFCCC inventory principles of transparency, completeness, consistency, comparability, accuracy and timeliness. The quality objectives are implemented via the QA/QC plan that, among others, aims at ensuring the consistency of the Union inventory with the sum of Member States inventories so that the inventory is complete in terms of both geographical and sectoral coverage. The QA/QC plan describes the quality control procedures that take place before the EU inventory compilation, for checking the consistency, completeness and correctness of the Member

States inventories, as well as during the compilation of the EU GHG inventory, for ensuring the correctness of the EU data prior to its submission. In addition, QA procedures, procedures for documentation and archiving, the time schedules for QA/QC procedures and the provisions related to the inventory improvement plan are also included.

Based on the EU QA/QC programme a quality management manual was developed which includes all specific details of the QA/QC procedures (in particular checklists and forms). The structure of the EU quality management manual has been developed on the basis of the Austrian quality management manual. The reason for using the Austrian manual as a template for the EU manual is that the EU GHG inventory is compiled by Environment Agency Austria and the implementation of the annual QA/QC procedures are coordinated by Environment Agency Austria. By using the Austrian quality manual as a template for the EU quality manual the EU can benefit from the experience made during the set-up of the Austrian quality management system which fulfils the requirements of EN ISO/IEC 17020 (Type A); procedures and documents from the Austrian system have been taken and adapted according to the need of the EU quality management system.

The EU quality management manual is structured along three main processes (management processes, inventory compilation processes and supporting processes) of the quality management system (Table 1.5).

Table 1.5 Structure of the EU quality management manual

Chapter		Chapter description
Management processes		
ETC 01	EU inventory system	Describes the organisation and responsibilities within the EU GHG inventory system
ETC 02	QA/QC programme	Describes the preparation and evaluation of the EU QA/QC programme by the European Commission
ETC 03	Quality management system	Describes the responsibilities and the structure of the quality management system and gives an overview of the forms and checklists used
ETC 04	Quality management evaluation	Describes the evaluation of the status and effectiveness of the quality management system
ETC 05	Correction and prevention	Describes the procedures for the correction and prevention of mistakes that occur in the EU inventory
ETC 06	Information technology systems	Describes the information technology systems used such as CIRCA, Reportnet and the systems set up at Environment Agency Austria
ETC 07	External communication	Describes the communication with Member States and other persons and institutions
Inventory compilation processes		
ETC 08	QC MS submissions	Describes the quality control activities performed on the GHG inventories submitted by the EU Member States
ETC 09	QC EU inventory compilation	Describes the quality control activities performed during the compilation of the EU GHG inventory including checks of database integrity
ETC 10	QC EU inventory report	Describes the checks carried out during and after the compilation of the EU GHG inventory report
Supporting processes		
ETC 11	Documents	Describes the production, change, proofreading, release and archiving of quality management documents
ETC 12	Documentation and archiving	Describes the procedure for preparing documentation and archiving

The quality checks performed during inventory compilation process are the central part of the quality manual. Quality checks are made at three levels:

QUALITY CONTROL MS SUBMISSIONS

The QC activities of MS submissions include:

Completeness checks

- Check if all gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3) are available for all years
- Check correct use of notation keys related to completeness
  - Check categories where a MS report the notation key "NE" and where the current guidelines include methods/emission factors
  - Check categories where MS report a notation key ("NE", "NO", "NA", "IE") and >= 20 MS report emissions
  - Check categories where MS report "NE" and in the previous years they reported emissions
- Check blank cells

Time series consistency checks

- Check time series of emissions
- Check time series of implied emission factors
- Check if identical values have been used for the last two reporting years.

Comparisons of implied emission factors across Member States

Recalculations

- Check categories where MSs provide recalculations and focus on those of more than 0.05% of national total emissions for each main gas and assess if there are potential over- or underestimates (excluding the effect of GWPs).
- Explanations for recalculations also need to be checked
- Check recalculations at more detailed category level compared to submission of the same year (e.g. recalculations between 15 January submission and 15 March submission of the same year)

EU ETS

- Check of consistency/transparency of EU ETS data with the CRF

Eurostat energy data

- Check of consistency of Eurostat energy data with the CRF

Recommendations

- Check whether recommendations from earlier Union or UNFCCC reviews, have been implemented by the Member State

Potential over- and underestimations in key categories

- Assess whether there are potential overestimations or underestimations relating to a key category in a Member State's inventory

For the communication with Member States and the documentation of the observations made by sector experts during the 'initial checks' phase the EEA Emission Review Tool (EMRT; https://emrt.eea.europa.eu/) is used. For this reason Member States nominations have been made to DG Clima and the EEA. The workflow in the tool allows the implementation of the 'four-eye' principle since the questions of the 'sectoral experts' are approved by the 'quality experts' team. Issues related to 'completeness', especially the ones that might need to be followed up by 'gap filling procedures' are also highlighted. All the issues identified in the EMRT are archived and can be accessed by the future EU sectoral and quality experts in the annual QA/QC procedures, to avoid repetition of questions on known issues.

According to the timeline provided above, the checks are performed between 15th January and 28th February.

On 28 February MS receive the EIONET/WG1 consultation package. In particular, Member States are asked to check:

1. the QA/QC findings flagged in the EMRT;
2. if the correct data/information has been included in the draft CRF tables/draft inventory report, including the information on methodologies and EFs used for the EU key categories (Annex III).

Both responses to the findings included in the EMRT and comments to the draft EU GHG inventory and inventory report are provided by latest 15 March to the EU inventory team. By that date Member States can resubmit their inventories, also correcting issues that came up during the initial checks. In order to follow up on significant issues, as provided for in the MMR, all the tools supporting the checks are re-produced and the findings in the EMRT are followed up. Between 15th March and 7th April follow-up questions and questions on new material received from MS may be asked in the EMRT.

Observations by the EU review team (first step ESD review[13]) that are not followed-up in step two and remain unresolved or partly resolved at the end of the QA/QC process in one submission year will be followed-up in the consecutive year.

QUALITY CONTROL EU INVENTORY COMPILATION

After the initial checks of the emission data, the ETC/CM transfers the national data from the xml-files into the ETC/CM CRF aggregator database. The ETC/CM CRF aggregator database is maintained and managed by Environment Agency Austria. The new CRF Aggregator has been designed in a way that the EEA can also perform the aggregation to ensure that there is always a back-up option and minimizing the risk of not submitting to the UNFCCC.

As the EU GHG inventory is compiled on the basis of the inventories of the EU Member States, the focus of the quality control checks performed during the compilation of the EU GHG inventory lays on checking if the correct MS data are used, if the data can be summed-up (same units are used) and that the summing-up is correct. Finally, the consistency and the completeness of the EU GHG inventory is checked. These checking procedures are performed by the EEA and the results are shared with the ETC/CM and are archived. Comments to these results are then provided and used as relevant for approving the inventory prior to its submission. All the checks are carried out for the original submission by 15 April each year and for any resubmission. Two checklists from the QA/QC manual are used for this purpose: 'Inventory preparation/consistency' and 'Data file integrity'.

QUALITY CHECKS EU INVENTORY REPORT

[13] See explanation of annual and comprehensive review within this chapter.

The checks carried out during and after the compilation of the EU GHG inventory report, are specified in the checklist 'EU inventory report' as defined in the QA/QC manual. They cover e.g. checks of data consistency between the inventory and the inventory report, data consistency between the tables and the text, but also layout checks. Since 2014 the EU team has also been reinforced by 'quality control' experts who have the additional task of reviewing the content and the consistency between the CRF data and tables and the NIR.

The circulation of the draft EU inventory and inventory report on 28 February to the EU Member States for reviewing and commenting also aims to improve the quality of the EU inventory and inventory report. The Member States check their national data and information used in the EU inventory report and send updates, if necessary, and review the EU inventory report. This procedure should assure the timely submission of the EU GHG inventory and inventory report to the UNFCCC secretariat and it should guarantee that the EU submission to the UNFCCC secretariat is consistent with the Member States UNFCCC submissions.

EU peer review

A collaborative internal review mechanism is established within the European Union such that all participants (MS, EEA, Eurostat, and JRC) may contribute to the identification of shortcomings and propose amendments to existing procedures. The review activities with experts from Member States are coordinated by the ETC/CM through WG1 and normally take place during the period from April through September each year. The synthesised findings of collaborative reviews provide a basis for the planned progressive development of inventories both at Member State and at EU level.

In 2014, such activities included the identification of areas where inconsistent reporting between different Member States could have taken place, in cases where the 2006 IPCC Guidelines are not sufficiently clear, and discussions on how the ETS data are used in the inventories. These discussions were followed up in 2016 and 2017, after analysing the inventory reporting of the Member States and the conclusions from the UNFCCC reviews.

In 2017, a team of Member States' experts reviewed the EU GHG NIR and provided recommendations for improvements. Several of these recommendations have been implemented in the current submission, whereas others will be taken into account in future submissions. See chapter 10 for more information.

EU internal reviews (Reviews under the 'Effort Sharing Decision')

Since 2012, eight EU internal inventory reviews have been carried out in order to determine the emission allocations 2013-2020 for the EU internal GHG emission reduction targets for 2020 and in order to determine compliance with the ESD targets. In the climate and energy package the European Union has committed itself to reduce greenhouse gas emissions by 20% below 1990 levels by 2020. The package comprises two pieces of legislation related to GHG emissions:

1. A revision and strengthening of the Emissions Trading System (ETS), the EU's key tool for cutting emissions cost-effectively. A single EU-wide cap on emission allowances will apply from 2013 and will be cut annually, reducing the number of allowances available to businesses to 21% below the 2005 level in 2020. The free allocation of allowances will be progressively replaced by auctioning, and the sectors and gases covered by the system will be somewhat expanded.

2. An 'Effort Sharing Decision' (ESD) governing emissions from sectors not covered by the EU ETS, such as transport, housing, agriculture and waste. Under the Decision each Member State has agreed to a binding national emissions limitation target for 2020 which reflects its relative wealth. The targets range from an emissions reduction of 20% by the richest Member States to an increase in emissions of 20% by the poorest. These national targets will cut the EU's overall emissions from the non-ETS sectors by 10% by 2020 compared with 2005 levels.

The ESD sets out the 2020 emission limit of a Member State in relation to its 2005 emissions, and its emission limits from 2013 to 2020 form a linear trajectory. In accordance with Article 3.2 of the ESD, the starting point of the linear trajectory is defined as the average annual ESD emissions during 2008, 2009 and 2010 in 2009 (for Member States with positive limits under Annex II of the ESD) or in 2013 (for Member State with negative limits). The annual emission allocations shall be determined using reviewed and verified emission data. Thus, complete emission inventories for the reference years (2005, and 2008-2010) had to be available and reviewed prior to determining the annual emission allocations in 2012. In order to determine compliance with the ESD targets accurate, reliable and verified information on annual greenhouse gas emissions is needed from the inventory year 2013 onwards.

The ESD reviews are coordinated by the EEA, and are carried out in two steps: Step 1 is implemented by the EU team and makes use of the procedures available in the EU QA/QC system, taking into account both the existing quality assurance/quality control procedures for Member States' emission inventory submissions under the MMR and the separate inventory review process occurring under the UNFCCC. Step 2 is implemented by independent review teams comprising of lead reviewers and sector experts. The ESD reviews are carried out either as comprehensive review or as annual review (see separate box). Further information on the ESD review can be found in the MMR (Article 19) and its implementing act (Chapter III).

The reviews under the ESD can be seen as a more robust and consistent QA of MS GHG inventories that have led to improvements in the quality of the EU and its Member States' GHG inventory submissions to UNFCCC in the years thereafter.

Specific activities for the LULUCF sector are described under Ch. 7.10 Quality Assurance and Quality control.

Annual and comprehensive ESD review

In 2012, the first comprehensive ESD review was carried out in order to determine the emission allocations 2013-2020 for the EU internal GHG emission reduction targets 2020 and respective trajectories. All 28 Member States have been reviewed by a team of 22 reviewers.

From 2015 onwards the GHG emission inventories are reviewed annually in the context of the "ESD review". The MMR enhanced the reporting rules on GHG emissions to meet reporting requirements to the UNFCCC Secretariat and introduced requirements concerning the monitoring, reporting, reviewing and verifying of GHG emissions and other information pursuant to Article 6 of the Effort Sharing Decision.

The ESD and the MMR introduced an annual compliance cycle requiring a review of Member States' greenhouse gas inventories within a shorter time frame than the current UNFCCC inventory review to enable the use of flexibilities and the application of corrective action, where necessary, at the end of each relevant year.

Article 19 of the MMR establishes an EU-internal review process to ensure that compliance with annual GHG emission limits is assessed in a credible, consistent, transparent and timely manner. The reviewed inventory data is used to check Member States' compliance with their annual ESD targets. There are two types of reviews: annual and comprehensive. Comprehensive reviews have been carried out in 2016 and 2020 – for all other years an annual review is carried out. The annual review consists of two steps. The first step verifies the transparency, accuracy, consistency, comparability and completeness of the national inventory data. The checks of step 1 are made by the same team that carries out the initial checks before the compilation of the EU GHG inventory. If the first step of the annual review reveals a significant issue as defined by Article 19(4) of the MMR, such as overestimations or underestimations relating to a key category in a Member State's inventory, a review team performs the second step checks of the national inventory data of this Member State to identify cases where inventory data is prepared in a manner which is inconsistent with UNFCCC guidance documentation or Union rules. Where appropriate, the review team calculates the resulting technical corrections, in consultation with the concerned Member State, to correct originally submitted estimates.

In 2015, due to the problems with the CRF reporting software the annual review had to be postponed to 2016. However, the European Commission decided to organize a trial review in order to support Member States in improving their GHG inventories and to gain experience organizing reviews and reviewing under the new guidelines. In 2015, step 1 checks were made for all 28 Member States whereas step 2 was carried out only for 18 Member States which volunteered to participate in step 2.

In April-August 2016, the second comprehensive review was carried out. All 28 Member States have been reviewed by a team of 22 reviewers. As it was not possible to carry out the ESD review in 2015 due to the problems with CRF reporter software the ESD comprehensive review 2016 has been an extended review and covered the years 2005, 2008-2010 and 2013-2014. The review considered the six GHGs CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6. It did not consider NF_3 because NF_3 is not covered by the ESD. All sectors were considered with the exception of LULUCF; domestic and international aviation was also reviewed but no technical corrections were made because aviation is covered under the EU ETS and excluded under the ESD.

In 2017, 2018 and 2019 annual reviews have been performed. The annual review is a two steps process where all 28 MS have to undergo step 1 and only those Member States are subject to step 2 for which significant issues are identified during step 1.

- In 2017 15 MS were subject to step 2; the final review reports include 70 recommendations, 16 revised estimates provided by the Member States and four technical corrections calculated by the review team.
- In 2018 eleven MS were subject to step 2; the final review reports include 34 recommendations, ten revised estimates provided by the Member States and one technical correction calculated by the review team.

- In 2019 13 MS were subject to step 2. In addition Norway and Iceland participated in step 2 on a voluntary basis. The final review reports include 56 recommendations, 16 revised estimates provided by the Member States and four technical correction calculated by the review team.

In April-August 2020, the third comprehensive review was carried out. All 27 EU Member States + UK, Iceland and Norway were reviewed by a team of 28 reviewers. On the basis of the GHG inventories reviewed in 2020, the European Commission fixed the base year and the greenhouse gas emissions targets for 2030, and the trajectory years for 2021-2029. The review covered the years 2005 and 2016-2018, all gases and all sectors apart from LULUCF. The review resulted in 133 recommendations, 79 revised estimates received from countries and eight technical corrections calculated by the review team.

In 2021, an annual review is organized in order to assess compliance of the MS with the ESD targets for the inventory year 2019. 18 MS were subject to step 2. The final review reports include 32 recommendations, 14 revised estimates provided by the Member States and three technical correction calculated by the review team.

In 2022, an annual review is organized in order to assess compliance of the MS with the ESD targets for the inventory year 2020. Eight MS are subject to step 2. The final review reports will be available by end of June 2022.

Capacity building activities based on the ESD reviews

After the ESD review in autumn, each year capacity building workshops/webinars are organized in order to discuss cases where MS had problems with implementing the 2006 IPCC guidelines and/or where the guidelines are not clear enough or where there are gaps and/or errors in the guidelines.

In 2017, four webinars were organized for following the sectors Energy, IPPU, Agriculture, and Waste. Overall experts from 26 Member States + Iceland and Norway participated in the webinars. The webinar conclusions include 55 issues, 47 of which were considered to be resolved by 30 November 2017. Eight issues have been subject to follow-up activities.

In 2018, four webinars were organized following the sectors Energy, IPPU, Agriculture, and Waste on four days. The IPPU webinar was split into two sessions following the (group of) subcategories of the ESD review 2018: (1) IPPU excluding F-gases and (2) IPPU F-gases. Overall experts from 23 Member States plus Iceland and Norway registered for the webinars. In total 110 experts registered for one or more webinars. During the webinars in 2018 the status of all open issues from previous webinars was presented and discussed. Seven out of eight follow-up issues from 2017 have been resolved and closed during 2018.

In 2019, four webinars were organized following the sectors Energy, IPPU, Agriculture, and Waste on four days. Overall 109 experts from 21 Member States registered for one or more webinars.

In 2020, four webinars were carried for the sectors Energy, IPPU, Agriculture, and Waste. As the ESD review 2020 was a comprehensive review covering all Member States a larger number of Member

States' experts participated in the webinars. Overall, 176 experts from 23 Member States registered for one or more webinars.

In 2021, four webinars were carried for the sectors Energy, IPPU, Agriculture, and Waste. Overall, 193 experts from 26 Member States registered for one or more webinars. In addition, a webinar was also organized for LULUCF based on the findings from the LULUCF trial review 2021 that was carried out in parallel with the ESD review 2021. The purpose of the LULUCF trial review 2021 was to prepare the Member States for the new reporting needs regarding the EU LULUCF Regulation. 15 volunteering countries were subject to the LULUCF trial review 2021. At the LULUCF webinar, 64 experts from 22 countries participated.

As a result of the capacity building webinars guidance documents have been developed in order to support the Member States in improving their inventories. By April 2022 19 guidance documents are available: five for the Energy Sector; six for the IPPU Sector; four for the Agriculture Sector; four for the Waste Sector.

Apart from the capacity building webinars open to all Member States the ESD project team carried out additional capacity building targeted at specific countries in 2018, 2019 and 2020. In this context the experts:

- Provided support via e-mail or webinar for several MS related to the sectors energy, transport, F-gases, agriculture and waste;
- Organized five in-country visits in the sectors energy, transport, F-gases, agriculture and waste.

UNFCCC reviews

In addition, European Union QA procedures build on the issues identified during the independent UNFCCC inventory review of Member States' inventories. Quality assurance procedures based on outcomes of the UNFCCC inventory review consist of the:

- Annual compilation of issues identified during the UNFCCC inventory review related to sectors, key source categories and the major inventory principles transparency, consistency, completeness, comparability and accuracy for all Member States;
- Identification of major issues from the compilation and discussion of ways to resolve them in WG1, including identification and documentation of follow-up actions that are considered as necessary within WG1;
- Reviews of the extent to which issues identified through this procedure in previous years have been addressed by Member States;
- Ongoing investigations of ways to produce a more transparent inventory for the unique circumstances of the European Union.

In 2020 the European Union was last reviewed by the UNFCCC inventory review. The latest review report is publicly available on the UNFCCC web site[14].

Improvement plan

Based on the findings of the UNFCCC reviews, the EU peer review, and the EU ESD review, and other recommendations the improvement plan for the EU GHG inventory and inventory report is compiled

[14] Inventory Review Reports 2020 | UNFCCC

before the annual compilation process starts. After the finalisation of the annual EU GHG inventory, it is evaluated if the improvements planned have been implemented.

1.2.3.2 Further improvement of the QA/QC procedures

One of the most important activities for improving the quality of national and EU GHG inventories is the organisation of workshops and expert meetings under the EU GHG Monitoring Mechanism. Sector-specific workshops are conducted under the Monitoring Mechanism that aim to address specific inventory issues and develop follow-up activities with the aim to address problems, clarify approaches and to improve the quality of Member States' inventory submissions. The follow-up activities are subsequently addressed in meetings of WG 1 under the Climate Change Committee.

A number of other workshops and expert meetings have been organised in recent years with a focus on sector-specific quality improvements. Table 1.6 lists the most recent workshops.

Table 1.6 Overview of recent GHG inventory related workshops and expert meetings organised by the EU national

Workshop/expert meeting	Date and venue
JRC virtual technical workshop: LULUCF in transition: present and future challenges for reporting and	7-8 June 2021
JRC technical LULUCF workshop under the UNFCCC, the Kyoto Protocol (KP) and the EU LULUCF Decision No 529/2013	28-29 May 2019, Varese, Italy
JRC technical workshop on LULUCF reporting under the Kyoto Protocol	16-17 May 2018, Arona, Italy
Joint Workshop of the Eurostat Working Group Agro-Environmental Statistics and DG CLIMA Working Group 1	30 November 2017, ESTAT Luxembourg
JRC technical LULUCF workshop under the UNFCCC, the Kyoto Protocol (KP) and the EU LULUCF Decision No 529/2013	26-27 April 2017, Stresa, Italy
ESD capacity building webinars 2017	19 September (IPPU); 21 September (Energy); 25 September; 28 September & 6 November (Waste)
Joint workshop of the Eurostat Working Group Agro-Environmental Statistics and DG CLIMA Working Group 1	30 November 2017, Luxembourg

1.2.4 Changes in the national inventory arrangements since previous annual GHG inventory submission

There have been no major changes to the structure and functioning of the EU national inventory arrangements.

1.3 Inventory preparation and data collection, processing and storage

1.3.1 The compilation of the EU GHG inventory

The EU inventory is compiled in accordance with the recommendations for inventories set out in the 'UNFCCC guidelines for the preparation of national communications by parties included in Annex 1 to the Convention, Part 1: UNFCCC reporting guidelines on annual inventories'

(FCCC/CP/2013/10/Add.3), to the extent possible. In addition, the *2006 IPCC guidelines for national greenhouse gas inventories* have been applied where appropriate and feasible. Finally, for the compilation of the EU GHG inventory, the Monitoring Mechanism Regulation and its implementing legislation is applicable.

The EU-KP GHG inventory is compiled on the basis of the inventories of the 27 Member States, Iceland and the United Kingdom. The emissions of each source category are the sum of the emissions of the respective source and sink categories of the Member States. For the reporting under the KP, this is also valid for the base year estimate of the EU-as fixed in the initial review report. As the information the initial report for the CP2 has not been included by the time of writing this report, this information cannot be provided yet.

The reference approach is calculated for the EU on the basis of Eurostat energy data (see Section 3.6) and the key category analysis (Section 1.5) is separately performed at EU level[15].

Since Member States use different national methodologies, national activity data or country-specific emission factors in accordance with IPCC and UNFCCC guidelines, these methodologies are reflected in the EU GHG inventory data. The EU believes that it is consistent with the UNFCCC reporting guidelines and the IPCC good practice guidance to use different methodologies for one source category across the EU especially if this helps to reduce uncertainty of the emissions data provided that each methodology is consistent with the IPCC good practice guidance.

In general, no separate methodological information is provided at EU level except summaries of methodologies used by Member States. The EU submission in 2016 includes an Annex with a summary description of the methodologies used by each Member State for the EU key categories. The more detailed descriptions can be found in Member State's own submissions, which are considered to be part of the EU inventory.

1.3.1.1 Internal consistency of the EU CRF tables

In principle every single EU value is aggregated from the respective value of the EU Member States. However, sometimes there are consistency problems when compiling the EU CRF tables (i.e. the sum of sub-categories is not equal to the category total) in those categories where Member States have difficulties to allocate emissions to the sub-categories. Member States use notation keys like IE or C if they cannot provide an emission estimate for a certain sub-category. At Member State level, the use of the notation keys makes transparent the reason for not providing emission estimates. However, at EU-level, the sub-category emission value is the sum of Member States emission values and the information of the notation keys used by some Member States is lost in the EU CRF submission. In order to make this more transparent, the CRF tables now include the values or notation keys reported by the MS as comments. In order to address this problem, some source categories have been reallocated for the EU CRF tables.

A second problem is the reporting of Member States in "grey cells" or in categories that do not have standardized UIDs which then need to be included in the CRF reporter manually.

Table 1.7 lists the procedures applied for the EU-27, Iceland and the United Kingdom

[15] However, the choice of the emission calculation methodology is made at Member State level and is based on the key category analysis of each individual Member State.

Table 1.7 Manual changes in the CRF Reporter

Year	Sector	Source category	Parameter	Manual changes / inclusion in the CRF Reporter
1990-2020	Energy	1 AB, 1AC, 1AD	All	Enter Reference Approach data from Eurostat (GBE, GBK for year 2020: CRF tables)
2013-2020	Energy, IPPU	1.A.1, 1.A.2, 1.B.2, 2.C, 2G	CO_2, CH_4, N_2O, NOx, NMVOC and CO	Shift differences due to SWE confidential data into 'Other fossil fuels' within the same sub-category, if the total emissions of the sub-category are available. Otherwise shift differences to 'Other' sub-category.
1990-2020	IPPU	2.B, 2.C, 2.E, 2.F, 2.G, 2.H	f gases	Enter country-specific f gases
1990-2020	IPPU	2.C.7, 2.G.4, 2.H	CO_2, CH_4, N_2O, NOx, NMVOC, SO2	Enter country-specific emissions and recovery data.
1990, 2020	IPPU	2.A.1, 2.A.2, 2.B.1	AD	Replace aggregated activity ('AD') data with gap-filled AD provided by sector experts
1990-2020	IPPU	2.A, 2.B, 2.C, 2.D, 2.G	AD	Replace aggregated AD with notation key 'NE' if an aggregation does not make sense due to inhomogeneous AD
1990-2020	Agriculture	3	CH_4, N_2O, NMVOC	Enter aggregated data from JRC
1990-2020	Agriculture	3	AD	Correct additional information with aggregated data from JRC
1990-2020	LULUCF	4.G	All	Enter aggregated data (approach B)
1990-2020	KP.LULUCF		All	Incorporate aggregated data and comments from JRC

1.3.2 Documentation and archiving

The documentation consists of quality management documentation in forms, checklists, inventory reports and correspondence. Archiving includes archiving of inventory documents and QM documents; a systematic archiving procedure is a prerequisite for a transparent inventory system.

All the material used for the compilation of the EU GHG inventory including inventory documents and QM documents are posted in the following directory:

\\Umweltbundesamt.at\projekte\1000\1840_ETC_CME\Intern\0 ETC CME 2022\2.1.1.1 GHG inventory

There are four sub-directories under this directory:

1. \Inventory
2. \Archive
3. \Quality manual
4. \General

The Member States submissions and all correspondence are stored in the sub-directory\Archive. The central tool for documenting all the material received from MS (including correspondence) is the MS archive database which includes references, short characterisations and links to e-mails for all MS submissions. The MS archive database can be searched for documents (CRF, XML, NIR, etc.) or for mails. Each submission is numbered consecutively.

1.4 Brief general description of methodologies and data sources used

For the key categories (see Chapter 1.5) the most accurate methods for the estimation of the greenhouse gas inventory should be used. Table 1.8 gives an overview on the share of emissions for which higher tiers are used in the EU 27, Iceland and the United Kingdom for all key categories for which this estimation was possible.

As mentioned above, the EU GHG inventory is based on the inventories of its MS, Iceland and the UK. They are responsible for the methods, emission factors and emissions used, and for the implementation of the UNFCCC reporting guidelines and the 2006 IPCC Guidelines, taking into account inventory priorities and resource constraints.

Table 1.8 Share of higher tier methodologies used on the total of each EU key categories (excluding LULUCF)

Source category gas	Share of higher Tier
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	97.0 %
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	98.1 %
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	93.6 %
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	97.7 %
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	95.2 %
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	98.4%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	98.1%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	92.3%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	97.2%
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	99.86
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	99.15
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	99.95
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	95.72
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	92.43
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	99.25
1.A.2.c Chemicals: Liquid Fuels (CO_2)	92.74
1.A.2.c Chemicals: Solid Fuels (CO_2)	99.96
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	92.06
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	84.21
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	94.89
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	97.52
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	62.90
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	94.00
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	98.69
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	94.87
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	70.87

Source category gas	Share of higher Tier
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	96.65
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	98.87
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	98.87
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	98.87
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	96.3%
1.A.3.b Road Transportation: Diesel Oil (CO_2)	88.3%
1.A.3.b Road Transportation: Diesel Oil (N_2O)	89.3%
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	78.5%
1.A.3.b Road Transportation: Gasoline (CH_4)	91.1%
1.A.3.b Road Transportation: Gasoline (CO_2)	92.4%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	98.5%
1.A.3.c Railways: Liquid Fuels (CO_2)	
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	92.3%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	77.8%
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	89%
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	80%
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	98%
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	98%
1.A.4.b Residential: Biomass (CH_4)	50%
1.A.4.b Residential: Gaseous Fuels (CO_2)	91%
1.A.4.b Residential: Liquid Fuels (CO_2)	83%
1.A.4.b Residential: Solid Fuels (CH_4)	8%
1.A.4.b Residential: Solid Fuels (CO_2)	98%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	88%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	77%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	97%
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	100%
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	83%
1.B.1.a Coal Mining and Handling (CH_4)	74%
1.B.2.a Oil: Operation (CH_4)	50%
1.B.2.a Oil: Operation (CO_2)	89%
1.B.2.b Natural Gas (CH_4)	83%
1.B.2.c Venting and Flaring (CO_2)	77%
2.A.1 Cement Production (CO_2)	100%
2.A.2 Lime Production (CO_2)	99.98%
2.A.4 Other Process Uses of Carbonates (CO_2)	89.65%
2.B.1 Ammonia Production (CO_2)	98.3%
2.B.2 Nitric Acid Production (N_2O)	86.3%
2.B.3 Adipic Acid Production (N_2O)	100.0%
2.B.8 Petrochemical and Carbon Black Production (CO_2)	84,2%
2.B.9 Fluorochemical Production (HFCs)	100.0%
2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)	100.0%
2.B.10 Other chemical industry (CO_2)	81.1%
2.C.1 Iron and Steel Production (CO_2)	98,6%

Source category gas	Share of higher Tier
2.C.3 Aluminium Production (PFCs)	100%
2.F.1 Refrigeration and Air conditioning (HFCs)	99%
2.F.4 Aerosols (HFCs)	92%
3.A.1 Enteric Fermentation: Cattle (CH_4)	99%
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	91%
3.A.4 Enteric Fermentation: Other livestock (CH_4)	51%
3.B.1 CH_4 Emissions: Farming (CH_4)	97%
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	98%
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	52%
3.D.2 Agricultural Soils: Farming (N_2O)	36%
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	95,9%
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	94.8%
5.B.1 Waste Composting: Waste (CH_4)	45,5%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	49.1%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	21,9%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	53,5%

1.4.1 Use of data from EU ETS for the purposes of the national GHG inventories in EU Member States

1.4.1.1 Overview

In January 2005 the European Union Greenhouse Gas Emission Trading System (EU ETS) commenced operation as the largest multi-country, multi-sector Greenhouse Gas Emission Trading System world-wide, based on Directive 2003/87/EC (European Community 2003). The European emissions trading system (EU ETS) covers around 11,700 installations in 31 participating countries. Besides the 28 Member States of the European Union, Norway, Iceland and Liechtenstein joined the EU ETS in 2008.

Emissions trading under the EU ETS has taken place in three 'trading periods' so far (2005–2007, also referred to as Phase I; 2008–2012 or Phase II; 2013–2020 or Phase III). The EU ETS Directive was amended in 2009 to improve and extend the EU ETS. The main changes in the third trading period compared to previous trading periods are:

- A single, EU-wide cap on emissions applies in place of the previous system of national caps;
- Auctioning, not free allocation, is the default method for allocating allowances. For allowances allocated for free, harmonised allocation rules apply which are based on EU-wide benchmarks of emissions performance;
- Inclusion of additional activities and gases, such as N_2O from production of nitric, adipic, glyoxal and glyoxylic acid production, PFCs and CO_2 from primary and secondary aluminium production, CO_2 from production and processing of ferrous metals and non-ferrous metals, CO_2 from manufacture of mineral wool, CO_2 from drying and calcination of gypsum or plaster boards, CO_2 emissions from carbon back production, CO_2 from ammonia production, CO_2 from bulk organic

chemicals production, CO_2 from hydrogen production, CO_2 from soda ash and sodium bicarbonate production and CO_2 from CO_2 capture, transport and storage in storage sites).

• The aviation sector has been included in the EU ETS since 1 January 2012. The aviation sector, in the EU ETS context covering flights internal to the European Economic Area, has a separate cap to power stations and other fixed installations which is reduced at a slower rate. Surrender of emission allowances and reporting for 2013 is not required until 2015, and the inclusion of flights to and from countries outside the European Economic Area has been postponed until after 31st December 2016 (EU 2014);

• Regulations for accreditation and verification (EU 2018a, EU2020a) and for monitoring and reporting were adopted (EU 2018b, EU2020b).

Articles 14 and 15 of the Emission Trading Directive require Member States to ensure that emissions are monitored, reported and verified in accordance with legal requirements in the monitoring and reporting regulation (MRR) (EU 2018b) and in the accreditation and verification regulation (AVR) (EU 2018a), starting from 1 January 2013 (Phase III). All installations covered by the EU ETS have been required to monitor and report their emissions annually. Data for the installations covered by the EU ETS are reported by operators to national competent authorities based on a monitoring plan, elaborated by the operator and approved by the national competent authority, in accordance with the methodologies established in the monitoring and reporting regulation. The reported emissions for each installation are included in an annual emission report that must be verified by accredited verifiers in accordance with the provisions of the regulation on the verification of GHG emission reports (EU 2018a).

Similar to the IPCC 2006 Inventory Guidelines, the EU ETS monitoring and reporting regulation is based on a tier system which defines a hierarchy of different ambition levels for methods, activity data, calculation factors (such as emission factors, oxidation or conversion factors). The operator must, in principle, apply the highest tier level established in the MRR for his installation category, unless he can demonstrate to the competent authority that this is technically not feasible or would lead to unreasonably high costs. The operator must periodically prepare and submit to the competent authorities an improvement report, aiming at improvement of the accuracy of the greenhouse gas emissions.

Thus, the EU ETS generates an EU-28 data set on verified installation-specific emissions for the sectors covered by the scheme. For 2020 the main activities, number of entities and verified emissions reported under the EU ETS are presented in Table 1.9.

Table 1.9 Activities and emissions covered by the EU ETS in 2020 (Member States and United Kingdom)

Main activity	**Activity code**	**Number of entities**	**Verified emissions (Mt CO_2-eq.)**
Combustion of fuels	20	7 535	808
Refining of mineral oil	21	136	111
Production of coke	22	20	10
Metal ore roasting or sintering	23	10	2
Production of pig iron or steel	24	242	105
Production or processing of ferrous metals	25	246	8
Production of primary aluminium	26	23	5
Production of secondary aluminium	27	35	1
Production or processing of non-ferrous metals	28	81	6
Production of cement clinker	29	259	113
Production of lime, or calcination of dolomite/magnesite	30	288	27
Manufacture of glass	31	366	17
Manufacture of ceramics	32	1 064	13
Manufacture of mineral wool	33	52	2
Production or processing of gypsum or plasterboard	34	39	1
Production of pulp	35	172	5
Production of paper or cardboard	36	587	20
Production of carbon black	37	18	1
Production of nitric acid	38	36	4
Production of adipic acid	39	3	0
Production of glyoxal and glyoxylic acid	40	1	0
Production of ammonia	41	29	21
Production of bulk chemicals	42	358	34
Production of hydrogen and synthesis gas	43	43	9
Production of soda ash and sodium bicarbonate	44	15	4
Capture of greenhouse gases under Directive 2009/31/EC	45	3	0,005
Transport of greenhouse gases under Directive 2009/31/EC	46	0	0
Other activity opted-in under Art. 24	99	249	1
All stationary installations		11 910	1 330

Source: EEA, 2022 (EU ETS data viewer)

1.4.1.2 Mapping table between EU ETS activities and CRF categories (Table 1.10)

The table below indicates the mapping between the EU ETS activities and the IPCC/CRF categories, with supporting comments. Such table is based on the scope of the EU ETS in the third phase and the CRF categories based on the revised UNFCCC reporting guidelines (decision 24/CP.19) that implemented the 2006 IPCC Guidelines.

The legal framework defining the scope and the methodologies for the reporting of greenhouse gas emissions under the EU ETS presents differences compared to the 2006 IPCC guidelines. These differences lead to a different way of reporting emissions under the EU ETS and in the GHG inventory. Some of these differences may also prevent inventory compilers from using verified emissions reported under the EU ETS directly for emission reporting in the national GHG inventory. In order to use greenhouse gas emissions reported under the EU ETS in the national inventories, the inventory compilers need to deal with these differences.

Table 1.10 Mapping table outlining the correspondence of CRF categories related to the EU ETS activities

EU ETS activity	CRF category	Comment
20 Combustion of fuels	1.A.1.a Public electricity and heat production 1.A.1.b Petroleum refining 1.A.2.a Iron and steel 1.A.2.b Non-ferrous metals 1.A.2.c Chemicals 1.A.2.d Pulp, paper and print 1.A.2.e Food processing, beverages and tobacco 1.A.2.f Non-metallic minerals 1.A.2.g Other 1.A.3.e Other transportation (pipeline transport) 1.A.4.a Commercial/ Institutional 1.A.4.c Agriculture/ Forestry / Fisheries 1.B Fugitive emissions from fuels	• For standalone combustion installations, EU ETS covers combustion of fuels in installation with a total rated thermal input exceeding 20 MW. For GHG inventories no such threshold applies. • In the GHG inventory, emissions are classified based on the purpose of the combustion activity, while such a differentiation does not exist in the definition of EU ETS activities. • Installations for the incineration of hazardous or municipal waste are excluded in the definition of 'combustion activities' under the EU ETS, but included in GHG inventories. Installations used for research, development and testing of new products and processes are also not covered by the ETS Directive according to Annex I paragraph 1. • In the EU ETS an installation with different types of activities is classified according to the activity with predominant emissions, while in the inventory such activities should be reported in separate categories if so defined. This difference mostly applies in cases of large integrated installations. • Usually a very small share of EU ETS emission from fuel combustion falls in the category of 1.A.4.a Commercial/ Institutional and 1.a.4.c Agriculture/ Forestry/ Fisheries as installations in these sectors mostly are below the EU ETS threshold.
21 Refining of mineral oil	1.A.1.b Petroleum refining 1.A.1.c Manufacture of solid fuels and other energy industries 1.A.2.c Chemicals 1.B.2.c Venting and flaring 1.B.2.a.iv Fugitive emissions from oil refining/ storage 2.B.8 Petrochemical and carbon black production	EU ETS activity covers CO_2 emissions from combustion and also fugitive and process emissions. Emission sources reported under these activities are allocated to different CRF categories in the inventory: • Combustion emissions →1.A.1.b Petroleum refining • Flaring emissions → 1.B.2.c Venting and flaring • Refining → 1.B.2.a.iv Oil Refining/ storage • Hydrogen production → may be reported in 1.B.2.a.iv refining/ storage or in 2.B.10 Other chemical industry • Coke production / calcination → 1.A.1.c.i Manufacture of solid fuels

EU ETS activity	CRF category	Comment
		• Flue gas scrubbing → 1.A.1.b Petroleum refining • Gasification of heavy fuel oil, methanol production → 2.B.8 Petro-chemical and carbon black production • Production of terephtalic acid → 2.B.10 Other chemical industry • Claus plants → 1.A.1.b Petroleum refining
22 Production of coke	1.A.1.c Manufacture of solid fuels and other energy industries 1.B Fugitive emissions 1.A.2 Manufacturing Industries 2.C.2 Iron and Steel	• Scopes of EU ETS and 2006 IPCC Guidelines are generally consistent, however EU ETS emissions may be allocated to several CRF categories in the inventory. • The use of mass balance approaches in integrated iron and steel installations may complicate allocation between iron and steel categories and coke production.
23 Metal ore roasting or sintering, including palletisation	1.A.2a Iron and steel 2.C.1 Iron and steel production 2.C.5 Lead production 2.C.6 Zinc production 2.C.7 Other metal production	• No clear separate category for this EU ETS activity in the inventory, allocation depends on the metal type • Combustion emissions should be allocated to 1.A.2a Iron and steel • Process emissions should be allocated to 2.C.1 Iron and steel production or other metal production categories under industrial processes
24 Production of pig iron or steel including continuous casting	1.A.2.a Iron and steel 2.C.1 Iron and steel production 1.B Fugitive emissions 1.A.1.c Manufacture of solid fuels and other energy industries	• Emissions are included in EU ETS only for those pig iron or steel installations with a capacity exceeding a threshold of 2.5 tonnes per hour while in GHG inventories there is no threshold. • EU ETS activity includes combustion and process emissions. • Combustion emissions should be allocated to 1.A.2a Iron and steel • Process emissions should be allocated to 2.C.1 Iron and steel production • Emissions from coke production should be allocated to 1.A.1.c Manufacture of solid fuels and other energy industries • Clear separation of combustion and process emissions is not always possible when mass balance approaches are used. • Comparability of emissions is influenced by the allocation of the transfer of CO_2 in the process gases (coke oven gas, blast furnace gas, basic oxygen furnace gas) to EU ETS activities as well as to CRF categories. Article 48 of the EU ETS MRR specifies the allocation of inherent CO_2 which results from an EU ETS activity and is contained in a gas which transferred to other installations as a fuel. If transfers of inherent CO_2 take place between EU ETS installations, the CO_2 transferred should not be counted as emissions for the installation of origin, but for the installation where it is finally emitted. However, if the transfer occurs to an installation outside the EU ETS scope, the transferring installation has to account for the emissions.
25 Production or processing of ferrous metals	1.A.2.a Iron and steel 2.C.1. Iron and steel production 2.C.2 Ferroalloys production 1.A.1.c Manufacture of solid fuels and other energy industries	• Emissions are included in EU ETS only for those ferroalloy production installations exceeding rated thermal input of 20 MW while in GHG inventories there is no threshold. • EU ETS scope of activity 25 covers CO_2 emissions related to the production or processing of ferrous

EU ETS activity	CRF category	Comment
		metals from: • conventional and alternative fuels, • reducing agents including coke, • graphite electrodes, • raw materials including limestone and dolomite, • carbon containing metal ores and concentrates, • secondary feed materials. • Combustion related emissions from EU ETS activity code 25 are included in in CRF 1.A.2.a. Iron and Steel • Process related emissions can be included in CRF 2.C.1 Iron and steel production or 2.C.2. Ferroalloys Production
26 Production of primary aluminium	2.C.3 Aluminium production 1.A.2.b Non-ferrous metals	• In EU ETS operators shall report emissions from the production of electrodes for primary aluminium smelting, including stand-alone-installations for the production of such electrodes. The operator shall consider CO_2 emissions from: fuels for the production of heat or steam, electrode production, reduction of Al2O3 during electrolysis which is related to electrode consumption, use of soda ash or other carbonates for waste gas scrubbing. • For PFC emissions resulting from anode effects the scope of the EU ETS activity and CRF category 2.C.3 are consistent. • CRF category 1.A.2.b Non-ferrous metals includes combustion emission and emission from waste gas scrubbing. • Emissions from electrode consumption in EU ETS activity code 26 are included in CRF 2.C.3 Aluminium Production. • PFC emissions are allocated to 2.C.3 Aluminium production.
27 Production of secondary aluminium	1.A.2.b Non-ferrous metals	• Emissions are included in EU ETS only for installations exceeding rated thermal input of 20 MW while in GHG inventories there is no threshold. • In secondary aluminium production no process emissions occur therefore all emissions in activity code 27 are from fuel combustion and are reported in CRF category 1.A.2.b Non-ferrous metals.
28 Production or processing of non-ferrous metals	1.A.2.b Non-ferrous metals 2.C.4 Magnesium production 2.C.5 Lead production 2.C.6 Zinc production 2.C.7 Other metal production	• Emissions are included in EU ETS only for non-ferrous metals production or processing installations exceeding rated thermal input of 20 MW (including reducing agents) while in GHG inventories there is no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 28 are included in CRF 2.C.4 Magnesium Production, 2.C.5 Lead production, 2.C.6 Zinc Production and 2.C.7 Other metal industry. • 2006 IPCC Guidelines do not provide methodologies for metals other than iron and steel, ferroalloys, aluminium, magnesium, lead and zinc while the EU ETS has a broader scope and covers, e.g. copper production.
29 Production of cement clinker in rotary kilns	2.A.1 Cement Production 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with production capacity exceeding 500 tonnes per day or in other furnaces with capacity

EU ETS activity	CRF category	Comment
		exceeding 50 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 29 are included in CRF 2.A.1 Cement Production • Combustion related emissions from ETS activity code 29 are included in CRF 1.A.2.f. Non-metallic minerals
30 Production of lime, or calcination of dolomite/magnesite in rotary kilns or in other furnaces	2.A.2 Lime production 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with production capacity exceeding 50 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 30 are included in CRF 2.A.2 Lime Production • Combustion related emissions from EU ETS activity code 30 are included in CRF 1.A.2.f. Non-metallic minerals • Non-marketed lime production in some industries such as iron and steel or sugar refining are included in the inventory in category 2.A.2, but may be included in the EU ETS in the dominant activity, e.g. iron and steel industry or fuel combustion.
31 Manufacture of glass including glass fibre	2.A.3 Glass production 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with a melting capacity exceeding 20 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 31 are included in CRF 2.A.3 Glass Production • Combustion related emissions from EU ETS activity code 31 are included in CRF 1.A.2.f. Non-metallic minerals
32 Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain	2.A.4 Other process uses of carbonates 1.A.2.f Non-metallic minerals	• Emissions are included in EU ETS only for installations with a production capacity exceeding 75 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • Process related emissions from EU ETS activity code 32 are included in CRF 2.A.4 Other process uses of carbonates • Combustion related emissions from EU ETS activity code 32 are included in CRF 1.A.2.f. Non-metallic minerals • EU ETS method A is based on carbonate input and is equivalent to IPCC tier 1 to 3 methods. EU ETS method B based on the alkali oxide output in the product has no equivalent method in the 2006 IPCC Guidelines. IPCC Guidelines also do not provide methods to estimate emissions from additives.
33 Manufacture of mineral wool insulation material using glass, rock or slag	2.A.3 Glass production 2.A.4 Other process uses of carbonates 2.A.5 Other	• Emissions are included in EU ETS only for installations with a melting capacity exceeding 20 tonnes per day. Inventory methodology has no threshold.

EU ETS activity	CRF category	Comment
	1.A.2.f Non-metallic minerals	• EU ETS activity includes combustion and process emissions. • 2.A.3 Glass Production includes emissions from the production of glass wool, a category of mineral wool, where the production process is similar to glass making. Where the production of rock wool is emissive these emissions should be reported under IPCC Subcategory 2A5.
34 Drying or calcination of gypsum or production of plaster boards and other gypsum products	1.A.2.f Non-metallic minerals	• EU ETS covers CO_2 emissions from this activity, where combustion units have a total rated thermal input exceeding 20 MW. For GHG inventories no such threshold applies. • EU ETS activity only includes combustion-related emissions
35 Production of pulp from timber or other fibrous materials	1.A.2.d Pulp, paper and print 2.A.4 Other process uses of carbonates (soda ash use)	• EU ETS activity includes combustion and process emissions. • Combustion related emissions from EU ETS activity code 35 are included in CRF 1.A.2.d. • Process related emissions are included in 2.A.4. Other process uses of carbonates
36 Production of paper or cardboard	1.A.2.d Pulp, paper and print 2.A.4 Other process uses of carbonates (soda ash use)	• EU ETS activity includes combustion and process emissions. • Threshold in EU ETS: installations involved in the production of paper or cardboard a production capacity exceeding 20 tonnes per day. Inventory methodology has no threshold. • Combustion related emissions from EU ETS activity code 36 are included in CRF 1.A.2.d. • Process related emissions are included in 2.A.4 Other process uses of carbonates
37 Production of carbon black involving the carbonisation of organic substances such as oils, tars, cracker and distillation residues	2.B.8 Petrochemical and carbon black production 1.A.2.c Chemicals	• EU ETS covers CO_2 emissions from this activity, where combustion units have a total rated thermal input exceeding 20 MW. For GHG inventories no such threshold applies. • EU ETS activity includes combustion and process emissions.
38 Production of nitric acid	2.B.2. Nitric acid production 1.A.2.c Chemicals	• Scopes of EU ETS and 2006 IPCC Guidelines for CO_2 emissions from nitric acid production are consistent. • EU ETS activity includes combustion and process emissions. • For EU ETS activity 38 all N_2O emissions are process-related and should be allocated to 2.B.2 Nitric acid production • CO_2 emissions in activity code 38 are from fuel combustion and should be allocated to 1.A.2.c Chemicals
39 Production of adipic acid	2.B.3. Adipic acid production (CO_2) 1.A.2.c Chemicals	• Scopes of EU ETS and 2006 IPCC Guidelines for CO_2 emissions from Adipic Acid production are consistent. • EU ETS activity includes combustion and process emissions. • For EU ETS activity 39 all N_2O emissions are process-related and should be allocated to CRF code 2.B.3 Adipic Acid Production • CO_2 emissions in activity code 38 are from fuel combustion and should be allocated to 1.A.2.c Chemicals

EU ETS activity	CRF category	Comment
40 Production of glyoxal and glyoxylic acid	2.B.4. Caprolactam, glyoxal and glyoxylic acid production 1.A.2.c Chemicals	• Scopes of EU ETS and 2006 IPCC Guidelines for N_2O emissions from glyoxal production and glyoxylic acid production are consistent. • EU ETS activity includes combustion and process emissions. • N_2O emissions should be allocated to CRF code 2.B.4 Caprolactam, glyoxal and glyoxylic acid production • CO_2 emissions in activity code 40 are from fuel combustion and should be allocated to 1.A.2.c Chemicals

41 Production of ammonia	2.B.1. Ammonia production
	CO_2 captured for urea production:
	3.H Urea Application
	1.A.3.b Road transport
	2.D.3 Other non-energy products from fuels and solvent use
		• EU ETS scope of activity code 41 ammonia production includes
		  • combustion of fuels supplying the heat for reforming or partial oxidation,
		  • fuels used as process input in the ammonia production process (reforming or partial oxidation),
		  • fuels used for other combustion processes including for the purpose of producing hot water or steam.
		• According to 2006 IPCC Guidelines to avoid double counting, fuel consumption in ammonia production should be reported under Ammonia production. In this regard EU ETS and IPCC scopes are consistent.
		• In the inventory CO_2 from ammonia production which is recovered and used for urea production is subtracted and reported by the users. Urea use can be reported in different CRF sectors, e.g. in 1.A.3.b Road transport, 3.H Urea application in agriculture, 2.D.3 Other (e.g. in industry catalysts). Under the EU ETS the CO_2 transfer via urea out of the EU ETS system cannot be deducted from ammonia production.

42 Production of bulk organic chemicals by cracking, reforming, partial or full oxidation or by similar processes	2.B.8 Petrochemical and carbon black production 2.B.10 Other chemical industry 1.A.2.c Chemicals	• Emissions are included in EU ETS only for installations with a production capacity exceeding 100 tonnes per day. Inventory methodology has no threshold. • EU ETS activity includes combustion and process emissions. • The combustion related emissions are allocated to CRF code 1.A.2.c Chemicals. • Some of the emissions reported under this EU ETS activity could be allocated to CRF category 2.B.8 Petrochemical and carbon black production (e.g. CO_2 process emissions) • Some of the emissions reported under this EU ETS activity could be allocated to CRF category 2.B.10 Other chemical industry (e.g. CO_2 emissions from flaring in chemical industry)
43 Production of hydrogen and synthesis gas by reforming or partial oxidation	1.A.2.c Chemicals 2.B.1. Ammonia production 2.B.8 Petrochemical and carbon black production 2.B.10 Other chemical industry 1.B.2.a.iv Fugitive emissions from oil refining/ storage	• Emissions are included in EU ETS only for installations with a production capacity exceeding 25 tonnes per day. IPCC methodology has no threshold. • EU ETS activity includes combustion and process emissions. • In the CRF, there is no separate reporting category for emissions from hydrogen production. Hydrogen and synthesis gas production are recognised as part of integrated chemical production. Therefore, MS

EU ETS activity	CRF category	Comment
		have chosen different approaches for the inclusion of emissions from hydrogen production (e.g. 2.B.8 or 2.B.10) • Some emissions may also be reported under CRF category 1.B.2.a.iv Fugitive emissions from oil subcategory refining/ storage
44 Production of soda ash and sodium bicarbonate	1.A.2.c Chemicals 2.B.7 Soda ash production	• EU ETS activity includes combustion and process emissions. • Combustion related emissions from EU ETS activity code 44 for production are included in CRF 1.A.2.c Chemicals • Process related emissions are included in 2.B.7. Soda Ash Production
45 Capture of greenhouse gases under Directive 2009/31/EC	Capture of emissions would be reported under the respective inventory sector e.g. 1.A.1.a Public electricity and heat production.	• Consistent with scope and methodologies of inventory
46 Transport of greenhouse gases by pipelines for geological storage in a storage site permitted under Directive 2009/31/EC	1.C.1 Transport of CO_2	• Consistent with scope and methodologies of inventory
47 Geological storage of greenhouse gases in a storage site permitted under Directive 2009/31/EC	1.C.2 Injection and storage	• Consistent with scope of inventory (currently no emissions reported under the EU ETS)
99 Other activity opted-in under Art. 24 of the ETS Directive	Depending on type of activity opted-in	Article 24 allows the unilateral inclusion of additional activities and gases under the EU ETS. These activities and gases are not allocated to a specific activity, but under a separate activity code.

In the GHG inventory, the emissions are reported per CRF categories (Annex V under the MMR). In the EU ETS a single installation can include several ETS activities as defined in Annex I of the EU ETS Directive. In the EU ETS emissions are attributed to a specific installation, independently from the Annex I activities covered. Nevertheless, the operator must report detailed information for each source stream of the installation, and include activities classification as per Annex I, in his annual report to the competent authorities. The different approaches can lead to differences in reported emissions if ETS activities and inventory categories are compared directly.

Scope of activities and installation boundaries

For several activities, the EU ETS includes installations only if they exceed certain capacity thresholds. Such capacity thresholds are not used for the inventory reporting. In addition, installation boundaries and the scope as to what constitutes an activity under the EU ETS may be different to a source category for the inventory reporting. Therefore, the scope of activities and the installation boundaries need careful consideration before EU ETS data are used for inventory purposes.

Determination of tiers

Both IPCC guidelines are based on methodological tiers that require higher tier levels of accuracy for emission sources contributing to a significant extent to the total emissions in a country. In the inventory reporting, the key category analysis determines which methodological tier should be used which is based on the contribution of a source category to the total emission level and the emission trend. If a source category is determined as key, all emissions from this source/sector have to be estimated based the same minimum tier methodology.

In the EU ETS the tiers are related to the admissible level of uncertainty for each parameter involved in the reporting. In the EU ETS tiers apply at installation level for each source stream activity data and calculation factor, and are defined in legislation on the basis of the installation emissions (thresholds are < 50 kt, ≥ 50 kt and ≤ 500 kt and > 500 kt CO_2eq). EU ETS verified emissions, if aggregated at sectoral level, may include contributions from small, medium and large emitters and are therefore based on different EU ETS tiers. When ETS data are used for key categories in the GHG inventory, it therefore has to be checked carefully whether the EU ETS tiers used for the monitoring of emissions are in conformity with the IPCC guidance related to the IPCC tiers for a particular source category.

In GHG inventories time series consistency is a mandatory requirement which has also implications on the choice of methodology. While methodological consistency is also required under the EU ETS (Article 6 of Regulation No 2018/2066), the EU ETS only started in 2005 and plant-specific and measured data is often not available for the whole time series back to 1990 and it may be challenging to construct a consistent time series back to 1990.

The mapping table above shows that a direct comparison between verified emissions from EU ETS activities and emissions reported in CRF categories is not straightforward.

An analysis of data consistency between EU ETS and inventory data requires: (1) an assessment of the assignment of the detailed data reported by each individual EU ETS installation to national competent authorities with respect to the CRF categories; (2) a detailed comparison of the methodological parameters (methods, activity data, calculation parameters).

1.4.1.3 Use of EU ETS data reported in 2022

Under the MMR Article 7 (EU 2013), Member States are required to perform consistency checks between the emissions reported in the GHG inventories and the verified emissions reported under the EU ETS Directive. The installation-specific emissions data reported by operators under the EU ETS can be used in different ways for the purposes of the national GHG inventories:

1. Reported verified emissions can be directly used in the GHG inventory to report CO_2 emissions for a specific source category. This requires a number of careful checks, e.g. whether the coverage of the respective EU ETS emissions is complete for the respective source category and that EU ETS activities and CRF source categories follow the same definitions. If EU ETS emissions are not complete, the emissions for the remaining part of the source category not covered by the EU ETS have to be calculated separately and added to the EU ETS emissions.
2. Emission factors (or other parameters such as oxidation factors) reported under the EU ETS can be compared with emission factors used in the inventory and the latter can be harmonised if the EU ETS provides improved information.
3. Activity data reported under the EU ETS can be used directly for the GHG inventory, in particular for source categories where energy statistics face difficulties in disaggregating fuel

consumption to specific subcategories, e.g. to specific industrial sectors or for specific non-marketed fuels.

4. Data from EU ETS can be used for more general verification activities as part of national quality assurance (QA) activities without the direct use of emissions, activity data or emission factors.
5. Data from EU ETS can improve completeness of the estimation of IPCC source categories when additional data for sub-categories become available from EU ETS.
6. EU ETS data can improve the allocation of industrial combustion emissions to sub-categories under 1A2 Manufacturing Industries and Construction.
7. The comparison of the data sets can be used to improve the uncertainty estimation for the GHG inventories based on the uncertainties of data reported by installations.

Based on the information submitted in the national inventory reports (NIRs) in 2022 to the European Commission, all Member States indicated that they used EU ETS data at least for QA/QC purposes (Table 1.11). 25 Member States indicated to directly use the verified emissions reported by installations under the EU ETS (depending of the sectors). All Member States used EU ETS data to improve country-specific emission factors. And all Member States reported that they used activity data (e.g. fuel use) provided under the EU ETS in the national inventory (depending of the sectors).

Table 1.11 Use of EU ETS data for the purposes of the national GHG inventory

Member State	Use of emissions	Use of Activity data	Use of emission factors	Use for quality assurance
Austria	✓	✓	✓	✓
Belgium	✓	✓	✓	✓
Bulgaria	✓	✓	✓	✓
Croatia	✓	✓	✓	✓
Cyprus	✓	✓	✓	✓
Czech Republic	✓	✓	✓	✓
Denmark	✓	✓	✓	✓
Estonia		✓	✓	✓
France	✓	✓	✓	✓
Finland	✓	✓	✓	✓
Germany	✓	✓	✓	✓
Greece	✓	✓	✓	✓
Hungary	✓	✓	✓	✓
Ireland	✓	✓	✓	✓
Italy	✓	✓	✓	✓
Latvia	✓	✓	✓	✓
Lithuania	✓	✓	✓	✓
Luxembourg	✓	✓	✓	✓
Malta	✓	✓	✓	✓
Netherlands	✓	✓	✓	✓
Poland	✓	✓	✓	✓
Portugal	✓	✓	✓	✓
Romania	✓	✓	✓	✓
Slovakia		✓	✓	✓
Slovenia		✓	✓	✓
Spain	✓	✓	✓	✓
Sweden	✓	✓	✓	✓
United Kingdom	✓	✓	✓	✓

Source: NIR 2022 submissions of Member States

1.4.1.4 References

EC 2003: Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (OJ L275, 25.10.2003, p. 32) amended by Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004, Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 and Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009, Directive 2018/410 of the European Parliament and of the Council of 14 March 2018.

EEA (European Environment Agency) 2022: EU Emissions Trading System (ETS) data viewer https://www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

EU 2012a: Commission Regulation (EU) No 600/2012 of 21 June 2012 on the verification of greenhouse gas emission reports and tonne-kilometre reports and the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council Text with EEA relevance (OJ L 181, 12.7.2012, p. 1–29).

EU 2012b: Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council (OJ L 181, 12.7.2012, p. 1-28).

EU 2014: Regulation No 421/2014 of the European Parliament and of the Council of 16 April 2014 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in view of the implementation by 2020 of an international agreement applying a single global market-based measure to international aviation emission (OJ L 129, 30.4.2014, p. 1–4).

EU 2018a: Commission Implementing Regulation (EU) 2018/2067 of 19 December 2018 on the verification of data and on the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council (OJ L 334, 31.12.2018, p. 94–134)

EU 2018b: Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012 (OJ L 334, 31.12.2018, p. 1–93)

EU 2020a: Commission Implementing Regulation (EU) 2020/2084 of 14 December 2020 amending and correcting Implementing Regulation (EU) 2018/2067 on the verification of data and on the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council (OJ L 423, 15.12.2020, p. 23–36)

EU 2020b: Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012 (OJ L 334, 31.12.2018, p. 1–93)

1.4.2 Cooperation with EUROCONTROL

At the end of 2010 the European Commission signed a framework contract with EUROCONTROL, the European organization for the safety of air navigation, regarding 'the support to the European Commission in relation to climate change policy and the implementation of the EU ETS'. This support project is organized in different Work Packages (WP) corresponding to the different areas identified in the framework contract and has been regularly continued.

One of these Work Packages pertains to the improvement of GHG and air pollutant emissions inventories submitted by the 27 Member States and the European Union to the UNFCCC and to the UNECE. The main objective of the WP is to assist EU Member States improve the reporting of annual greenhouse gas (and other air pollutant) emission inventories by e.g., estimating the fuel split domestic/international using real flight data from EUROCONTROL. The European Environment Agency and its ETC/CME assist DG CLIMA regarding the technical requirements.

To support the inventory process for the submission in 2022, in October 2021 Member States received fuel and emissions data for the years 2005 to 2020 as calculated by EUROCONTROL using a TIER 3b methodology applying the Advanced Emissions Model (AEM). This is a follow up of ERT recommendations made to perform QA exercises and to make data from EUROCONTROL available to Member States on a regular basis. In November 2021 one webinar took place to exchange information between EUROCONTROL and Member States on the data provided.

In the course of the 'initial checks' of MS inventories in the first months of 2022 the comparison between Tier 3b calculations from EUROCONTROL and time series of MS inventories has been conducted with most actual inventories from Member States. In case of considerable differences between Member State results and those from EUROCONTROL, the European Environment Agency and its ETC/CME asked Member States via the EMRT about possible reasons. In addition, the European Environment Agency provided MS with a comparison between EUROCONTROL data and MS data on fuel consumption of civil and international aviation for the years 2015 and 2020, related CO_2 emissions and implied emission factors of CH_4 and N_2O. For more information on the results of the comparison, see chapter 3.2.

During the whole process countries have been encouraged to provide feedback to these EUROCONTROL results so that suggestions and questions could be taken into account in the next modelling exercise. Based on the experience gained during this QA/QC process, recommendations will be made to EUROCONTROL to safeguard and improve time-series calculations for use by MS. Under a new framework contract with DG CLIMA, EUROCONTROL will provide data for the year 2022 and eventually recalculate time series for the period 2005 to 2020 in case of considerable changes in the model.

As explained in the NIR 2014, comparing emissions reported by Member States with independent modelling results such as performed by EUROCONTROL is a genuine quality assurance exercise and assists in identifying areas in need for improvement of aviation emission calculations. In this sense, the EUROCONTROL results are used for identifying ways of checking and improving the accuracy of emission estimates for the EU and its Member States in accordance with the ARR of 2014.

1.5 Description of key categories

A key category analysis has been carried out according to the Tier 1 method (quantitative approach) described in the 2006 IPCC guidelines. A key category is defined as an emission source that has a significant influence on a country's GHG inventory in terms of the absolute level of emissions, the trend in emissions, or both.

In addition to the key category analysis at Union level, every Member State provides a national key category analysis which is independent from the assessment at Union level. The Union key category analysis is not intended to replace the key category analysis by Member States. The key category analysis at Union level is carried out to identify those categories for which overviews of Member States' methodologies, emission factors, quality estimates and emission trends are provided in this report. In addition, the Union key category analysis helps identifying those categories that should receive special attention with regard to QA/QC at EU level. The Member States use their key category analysis for improving the quality of emission estimates at Member State level.

To identify key categories of the EU-27, Iceland and the United Kingdom, the following procedure was applied:

- Starting point for the key category identification for this report was the EEA database. Most categories where GHG emissions/removals occur were listed, at an aggregation level such as 2.B.1 and split by gas, while for the sector Energy a less aggregated level such as 1.A.1.a, split by fuel and per gas was chosen. It makes sense for the EU to rely on this less aggregated level for the KCA as also the initial checks of the MS submissions are performed at this level of detail and therefore guarantee a more profound quality checking for all EU key categories (at fuel level). Additionally the EU KCA (at detailed level) is used in order to select the categories for which more detailed information is provided in the EU NIR. Although the more detailed EU approach differs from the KCA generated in the CRF overall the results are very similar.
- A level and a trend assessment was carried out for the years 1990 and 2020. The assessment was carried out for emissions excluding LULUCF and including LULUCF.
  The key category analysis excluding LULUCF identified 86 key categories for the EU cover 96 % of total EU GHG emissions in 2020 (see Annex I). The key category analysis including LULUCF resulted in 99 key categories (Table 1.12).

In Chapters 3 to 7 overview tables are presented for each EU key category showing the Member States' contributions to the EU-KP key category in terms of level and trend.

Table 1.12 Key categories for the EU-27, Iceland and the United Kingdom (Gg CO_2 equivalents)

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2020		1990	2020
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107640	235579	T	L	L
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	176699	21927	T	L	L
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10744	43273	T	L	L
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	9162	5051	0	L	L
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1126033	392059	T	L	L
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5277	25622	T	0	L
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	111002	75626	T	L	L
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	20093	18155	T	L	L
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91155	25360	T	L	L
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	31933	18636	0	L	L
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	9183	873	T	L	0
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	113361	50941	T	L	L
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3835	6874	T	0	L
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	8066	1172	T	L	0
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	55475	42257	T	L	L
1.A.2.c Chemicals: Liquid Fuels (CO_2)	40418	18714	T	L	L
1.A.2.c Chemicals: Solid Fuels (CO_2)	14761	7142	0	L	L
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13247	17903	T	L	L
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11544	1627	T	L	0
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	8503	2083	T	L	0
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19432	31732	T	L	L
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	20540	2579	T	L	0

1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12812	3564	T	L	0
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27928	30278	T	L	L
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	45862	20479	T	L	L
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1432	15169	T	0	L
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	58631	15484	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	92874	83694	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	103954	46998	T	L	L
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	92264	10487	T	L	L
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	13188	8468	0	L	L
1.A.3.b Road Transportation: Diesel Oil (CO_2)	303434	549167	T	L	L
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1817	6942	T	0	L
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	508	4302	T	0	0
1.A.3.b Road Transportation: Gasoline (CH_4)	6077	708	T	0	0
1.A.3.b Road Transportation: Gasoline (CO_2)	406396	200889	T	L	L
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7346	13844	T	0	L
1.A.3.c Railways: Liquid Fuels (CO_2)	13007	4822	T	L	0
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17757	12444	0	L	L
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	9632	5322	0	L	L
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	65963	96550	T	L	L
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	79450	28441	T	L	L
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	748	6210	T	0	L
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	48484	3027	T	L	0
1.A.4.b Residential: Biomass (CH_4)	9434	9420	T	L	L
1.A.4.b Residential: Gaseous Fuels (CO_2)	184731	239788	T	L	L
1.A.4.b Residential: Liquid Fuels (CO_2)	181315	97173	T	L	L
1.A.4.b Residential: Solid Fuels (CH_4)	9227	2292	T	L	0
1.A.4.b Residential: Solid Fuels (CO_2)	135130	29119	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12472	11582	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	71359	61776	T	L	L
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9735	3211	0	L	0
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5941	5	T	0	0
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	13368	4160	T	L	0
1.B.1.a Coal Mining and Handling: Operation (CH_4)	97099	23569	T	L	L
1.B.2.a Oil: Operation (CH_4)	6663	816	T	0	0
1.B.2.a Oil: Operation (CO_2)	9010	10011	T	L	L
1.B.2.b Natural Gas: Operation (CH_4)	51544	18552	T	L	L
1.B.2.c Venting and Flaring: Operation (CO_2)	9128	5611	0	L	L
2.A.1 Cement Production: no classification (CO_2)	102698	74304	T	L	L
2.A.2 Lime Production: no classification (CO_2)	25242	16903	0	L	L
2.A.4 Other Process Uses of Carbonates: no classification (CO_2)	12192	9291	0	L	L
2.B.1 Ammonia Production: no classification (CO_2)	32487	22646	0	L	L
2.B.10 Other chemical industry: no classification (CO_2)	6931	12043	T	0	L
2.B.2 Nitric Acid Production: no classification (N_2O)	49649	2813	T	L	0
2.B.3 Adipic Acid Production: no classification (N_2O)	57555	279	T	L	0
2.B.8 Petrochemical and Carbon Black Production: no classification (CO_2)	14807	14501	T	L	L
2.B.9 Fluorochemical Production: no classification (HFCs)	29033	1010	T	L	0

2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	5567	45	T	0	0
2.C.1 Iron and Steel Production: no classification (CO_2)	126872	67779	T	L	L
2.C.3 Aluminium Production: no classification (PFCs)	21277	491	T	L	0
2.D.3 Other non energy products: no classification (CO_2)	7911	5349	0	0	L
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	13	80077	T	0	L
2.F.4 Aerosols: no classification (HFCs)	2	3159	T	0	0
3.A.1 Enteric Fermentation: Cattle (CH_4)	199074	157379	T	L	L
3.A.2 Enteric Fermentation: Other Sheep (CH_4)	25451	17854	0	L	L
3.A.4 Enteric Fermentation: Other livestock (CH_4)	6024	5799	0	0	L
3.B.1 CH_4 Emissions: Farming (CH_4)	49938	41292	T	L	L
3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	30488	22124	0	L	L
3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	156486	129569	T	L	L
3.D.2 Agricultural Soils: Farming (N_2O)	38620	29354	T	L	L
3.G.1 Limestone CaCO3: Farming (CO_2)	7986	5267	0	0	L
4.A.1 Forest Land: Land Use (CO_2)	-312066	-292922	T	L	L
4.A.2 Forest Land: Land Use (CO_2)	-38448	-34573	T	L	L
4.B.1 Cropland: Land Use (CO_2)	32668	12995	T	L	L
4.B.2 Cropland: Land Use (CO_2)	42700	38304	T	L	L
4.C.1 Grassland: Land Use (CO_2)	53826	38148	T	L	L
4.C.2 Grassland: Land Use (CO_2)	-20999	-25375	T	L	L
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	5431	5954	0	0	L
4.D.1 Wetlands: Land Use (CO_2)	7518	9314	T	0	L
4.D.2 Wetlands: Land Use (CO_2)	828	4262	T	0	0
4.E.2 Settlements: Land Use (CO_2)	31070	34023	T	L	L
4.G Harvested Wood Products: Wood product (CO_2)	-30084	-38405	0	L	L
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	158011	81344	T	L	L
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	26131	11227	T	L	L
5.B.1 Waste Composting: Waste (CH_4)	596	3854	T	0	0
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	27361	11269	T	L	L
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	7853	6908	0	0	L
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	9385	6041	0	L	L

Note: EU totals for 2020 in sector Energy may not include data for Sweden due to confidential reporting. For more details on confidential reporting from Sweden refer to section1.7.2.

1.6 General uncertainty evaluation

The uncertainty analysis was made on basis of the Tier 1 uncertainty estimates, which were submitted by EU Member States, Iceland and United Kingdom under Article 7(1)(p) of Regulation (EU) 525/2013.

In previous NIR submissions, the emissions and removals reported in the tables containing the EU uncertainties were inconsistent with the final aggregate-, sector- and subsector values reported in the EU CRF tables and elsewhere in the NIR document. This was due to the fact that the Tier 1 uncertainty estimates provided by the by EU Member States, Iceland and United Kingdom under Article 7(1)(p) of Regulation (EU) 525/2013 are not always revised with updated CRF submissions during a submission cycle and that some of these Tier 1 uncertainty estimates were incomplete e.g. uncertainties not estimated for LULUCF and indirect CO_2 emissions, certain subsector emissions are confidential. Further complexity is also introduced by the fact that the sector and gas resolution at which uncertainties were provided varies between the countries.

The methodology was however updated this year to harmonise and gap-fill these uncertainty estimates so that the tables containing the EU uncertainties are consistent with the final aggregate-, sector- and subsector values reported in the EU CRF tables and elsewhere in the NIR document. A processing routine, implemented in R, reads the individual country uncertainty files that are pre-formatted manually to assign consistent sector and gas labels to the respective estimates of emissions/removals and uncertainties. The uncertainty values are then aggregated to a common sector resolution, at which the emissions and removals reported in the Tier 1 uncertainty tables of the countries are then replaced with the respective values from the final CRF tables of the countries. These final CRF data of the May submission are accessed via an SQL query of the EEA database containing the CRF submissions.

Due to the issue of incompleteness mentioned above, the country-level data are then screened to identify residual emissions and removals for which no uncertainty estimates have been provided. Where sectors are partially complete, the residual net emission is quantified in CO_2 equivalents and incorporated. An uncertainty is then estimated, by calculating the overall sector uncertainty of the sources and sinks that were included in that country's reported Tier 1 uncertainties estimates and assigning this percentage average to the residual net emission. In cases where for certain sectors no uncertainties have been provided at all (e.g. indirect CO_2 emissions, LULUCF), an average sector uncertainty in percent is calculated from all the countries for which complete sectoral emissions and uncertainties were reported, and this average uncertainty is assigned to the country's sector GHG total reported in its final CRF tables.

With complete data on uncertainties as well as emissions and removals for all EU Member States, Iceland and United Kingdom, the routine then aggregates emissions and uncertainties in units of kt CO_2e (uncertainties summed in quadrature) for a specified gas and subsector resolution at the EU level. Despite working with Tier 1 data from the countries, a hybrid approach is applied to estimate level uncertainties that allows consideration of error correlations. The gas and subsector resolution applied was chosen to allow the routine to access respective data from CRF Table Summary 3 on emission factors and apply correlation coefficients (r) when aggregating the uncertainties. For a given gas and subsector, it is assumed that the errors of countries using default factors are completely correlated (r = 1), while errors of countries using country-specific factors are assumed uncorrelated (r = 0). For countries using a mix of default and country-specific factors, it is assumed that these errors are partially correlated (r = 0.5) with one another and with the errors of countries using the default factors only.

Based on these correlation assumptions, the routine then aggregates emissions and uncertainties for the specified gas and subsector resolution at the EU level. Uncertainties at the GHG and sector total level (Table 1.15) are then aggregated from the subsector and gas estimates assuming no correlation between subsectors and gases. However, for countries reporting very coarse resolution estimates (e.g. total sector GHG emissions/removals) or where the sector has been partially or completely gap-filled, it is assumed that these uncertainties are partially correlated (r = 0.5) with one another and with the other reported subsector- and gas level estimates. Level uncertainties on the total emissions and removals (with and without LULUCF) are then aggregated from the sector estimates assuming no correlation between sectors.

Trend uncertainties are also calculated with a hybrid method with varying assumptions with respect to error correlations in time. At the individual gas and subsector resolution of each country, a trend and trend uncertainty are calculated assuming full error correlation between the base year and latest year estimates (r = 1). In the IPCC GPG 2000, it is suggested to assume that emission factors between years are fully correlated, and activity data are independent. However, in the EU uncertainty estimate, it is assumed that activity data uncertainties also correlate to some extent between years, because typically the same data collection methods are used each year. Therefore, for the EU uncertainty estimate it was decided to assume that emissions (at the gas and subsector level) between years are fully correlated, even though this may underestimate trend uncertainty to some extent. For countries reporting very coarse resolution estimates (e.g. total sector GHG emissions/removals) or where the sector has been partially or completely gap-filled, it is assumed in the trend uncertainty that the base year and latest year uncertainties at country level are only partially correlated with one another (r = 0.5). These trends and trend uncertainties at country level are then aggregated at EU level (Table 1.15) assuming no correlation in the trend uncertainties between the countries. Correlation in trend uncertainties between countries is more difficult to quantify, where correlation between different countries in different years should also be quantified. Furthermore, effect of correlation on uncertainty (increasing or decreasing) depends on the direction and magnitude of trend for each country and each source category. Therefore, a simple conservative assumption cannot be made, and for simplicity, it was assumed that the trend uncertainty estimates between the countries is independent. Note that the trend and trend uncertainties are calculating by aggregated in units of kt CO_2e (uncertainties summed in quadrature) and then expressed as percentages relative to the respective base year emissions/removals. The trend and level uncertainties reported throughout the NIR represent 95 % confidence intervals in the respective values.

Given the Tier 1 format of the reported country level uncertainties (95 % confidence intervals assuming normal distributions) the above method for the EU applies a first order, Gaussian error propagation approach. However, given the application of the pragmatic yet defensible assumptions of error correlations described above, it nonetheless constitutes a more sophisticated, hybrid approach than required minimum Tier 1 approach under the IPCC guidelines. For instance, assuming no correlation between level uncertainties between countries would almost certainly lead to underestimates of the EU total level uncertainties. The EU inventory team therefore considers the outlined pragmatic approach a workable and defensible methodology to estimate level uncertainties. Likewise, the assumptions applied to the trend uncertainty analysis is also considered justified, given that it is most important to consider the strong uncertainty correlation in time.

Effects of correlations were tested in previous submissions both with the previous analytical method developed, and by using Monte Carlo (MC) simulation, where normal distributions was used in all the cases to ensure comparability with analytical estimates. Table 1.13 gives an example of such comparison made in 2006. The source category chosen for the example is 4D, N_2O emissions from agricultural soils, as this category has a major effect on inventory uncertainty in most MS. Both the effects of correlations between years and between Member States were tested.

Table 1.13 Trend uncertainty for EU emissions 2006 of N_2O from agricultural soils by using different assumptions of correlation estimated using Monte Carlo simulation

Years correlate	MS correlate	Trend uncertainty
YES	YES	-27 to +26
YES	NO	±13
NO	YES	-294 to +292
NO	NO	-116 to +115

Note: "YES" denotes full correlation between years or Member States. Trend uncertainty is presented as percentage points.

It should furthermore be mentioned that applying a MC approach in the EU case would not improve the uncertainty estimate. Given that the input data are provided by the countries in a Tier 1 format assuming normal error distributions, applying an MC procedure without any further detailed assumptions on distributions would simply lead to comparable estimates as the first order approximation (Table 1.14).

Table 1.14 .Comparison of trend uncertainty estimates 2005 for EU Waste Sector using the modified Tier 1 method and Monte Carlo simulation (Tier 2).

Sector	GHG	Tier 1	Tier 2
6A. Landfills	CH_4	±12	±12
6B. Wastewater	CH_4	±27	-28 to +27
6B. Wastewater	N_2O	±9	±9
6C. Waste incineration	CO_2	±7	±7
6C. Waste incineration	CH_4	±23	-23 to +24
6C. Waste incineration	N_2O	±18	±18
Waste Other	CH_4	±990	-976 to +993
Total Waste Sector		±11	±11

Note: Trend uncertainty is presented as percentage points.

Table 1.15 shows the main results of the Tier 1 uncertainty analysis for the EU-27, Iceland and United Kingdom. The lowest level uncertainty estimates are for Fuel combustion activities (2.8 %) and the highest estimates are for Waste (37.7 %). Overall level uncertainty estimates on total GHG emissions and removals including LULUCF is calculated at 5.0 %. If LULUCF is excluded, the total level uncertainty is lower at 4.5 %.

With regard to trend uncertainty estimates, the lowest uncertainty estimates are for Fuel combustion activities (+/-2.1 percentage points) and the highest estimates are for Waste (16.8 percentage points). Overall trend uncertainty (including LULUCF) of total emissions and removals is estimated to be 1.8 percentage points.

These results of trend and level uncertainties differ to some extent to the results of the previous year, due to the update and improvement of the methodology applied. For instance, the application of full-, partial- and no correlation assumptions (compared to previous binary assumptions of either full or no correlation) has led to an increase in level uncertainties in sector 1A Fuel combustion activities (2.8% compared to 0.8% in the last submission) and sector 5 Waste (37.7% compared to 34.0% in the last submission), whereas the uncertainties in sectors 3 Agriculture (31.9% compared to 49.4% in the last submission) and 2 IPPU (8.1% compared to 10.4% in the last submission) have been revised downwards. It should also be noted that the changes in results are also influenced by the gap-filling of uncertainties, particularly for sector 4 LULUCF. Overall, these uncertainty estimates are considered more accurate, consistent and complete than those reported in previous submissions. More detailed uncertainty estimates for the source categories are provided in Chapters 3-7.

Table 1.15 Tier 1 uncertainty estimates of EU-Member States, Iceland and the United Kingdom GHG emissions (in CO_2 equivalents) for the main sectors

Source category	Gas	Emissions Base Year	Emissions 2020	Emission trends Base Year-2020	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A Fuel combustion activities	all	4,130,294	2,731,155	-33.9%	2.8%	2.1%
1.B Fugitive emissions	all	193,194	70,262	-63.6%	29.0%	7.1%
2. Industrial processes	all	548,435	350,527	-36.1%	8.1%	2.5%
3. Agriculture	all	532,447	423,768	-20.4%	31.9%	3.2%
4. LULUCF	all	-190,759	-216,749	13.6%	23.7%	9.8%
5. Waste	all	237,823	130,397	-45.2%	37.7%	16.8%
Indirect CO2 emissions	all	4,317	1,470	-66.0%	20.6%	8.9%
Total (excl LULUCF)	**all**	**5,646,509**	**3,707,580**	**-34.3%**	**4.5%**	**1.7%**
Total (incl LULUCF)	**all**	**5,455,750**	**3,490,830**	**-36.0%**	**5.0%**	**1.8%**

Table 1.16 gives an overview of information provided by EU Member States, Iceland and United Kingdom on uncertainty estimates in their 2022 national inventory reports and presents summarised results of these estimates.

Table 1.16 Overview of uncertainty estimates available from EU Member States, Iceland and the United Kingdom

Member State	**Austria**		**Belgium**	**Bulgaria**	**Croatia**			**Cyprus**	**Czechia**		**Denmark**	
Citation	NIR May 2022, pp.66-79		NIR May 2022, pp.51-52	NIR April 2022, pp.51-52	NIR May 2022, pp.52-53			NIR March 2022, p.50-51	NIR April 2022, pp.45-46		NIR April 2022, pp.61-67	
Method used	Tier 1		Tier 1	Tier 1	Tier 1 + Tier 2			Tier 1	Tier 1		Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex 2)		Yes (Annex 2)	Yes (Annex 2)	Yes (Annex 2)			Yes (Annex 2)	Yes (Annex 2)		Yes (Annex 2)	
Years and sectors included	emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; including LULUCF	emissions: 2020; trends: 1990-2020; excluding LULUCF	emissions: 2020; trends: 1990-2020; including LULUCF			emissions: 2020; trends: 1990-2020; excluding LULUCF	emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; including LULUCF	
Uncertainty (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1	Tier 1 (i .L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											5.70%	2.60%
CH_4											14.3%	
N_2O											101.7%	
F-gases											43.6%	
Total	16.20%	5.10%	3.96%	16.18%	44.68%	- 10.75 %		9.75%	5.63%	3.11%	14.0%	14.5%
Uncertainty in trend (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1	Tier 1 (i .L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											1.60%	1.20%
CH_4											11.30%	
N_2O											20.90%	
F-gases											50.3%	
Total	2.92%	2.03%	1.98%	2.66%	6.86%	- 17.17 %	- 17.62 % -	2.43%	3.40%	1.94%	3.10%	3.20%

*Base year for F-gases is 1995

Member State	Estonia		Finland				France		Germany				Greece		Hungary	Ireland	
Citation	NIR March 2022, p.44-45		NIR April 2022, pp.45-47				NIR March 2022, pp.85-88		NIR March 2022, pp.135				NIR March 2022, pp.71-75		NIR March 2022, pp.27-28	NIR March 2022, pp.19-21	
Method used	Tier 1		Tier 1 + Tier 2				Tier 1		Tier 1 + Tier 2				Tier 1		Tier 1	Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex 2)		Yes (Annex 2)				Yes (Annex 6)		Yes (Annex 7)				Yes (Annex 4)		Yes (Annex 2)	Yes (Tab. 1.11 - 1.12)	
Years and sectors included	emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; including LULUCF				emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; including LULUCF				emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; excluding LULUCF	emissions: 2020; trends: 1990-2020; including LULUCF	
Uncertainty (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2													2.9%	2.5%	2.6%		
CH_4													24.5%	24.5%	48.4%		
N_2O													108.4%	108.8%	145.0%		
F-gases													263.6%	263.6%	13.0%		
Total	23.53%	8.54%	44.0%	5.0%	-37% +42%	-3% +5%	12.6%	11.7%	3.56%	3.62%	-3.18% +3.45%	-2.07% +2.64%	13.9%	13.5%	13.3%	12.22%	4.02%
Uncertainty in trend (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (i .L.)	Tier 2 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2																	
CH_4																	
N_2O																	
F-gases																	
Total	5.25%	1.99%	33.0%	5.0%	-21% +28%	-3% +4%	2.1%	1.9%	3.95%	3.35%	-9.01% +9.45%	-6.56% +7.01%	10.1%	9.9%	3.2%	10.49%	2.33%

Member State	Italy		Latvia		Lithuania		Luxembourg		Malta	Netherlands			Poland	
Citation	NIR April 2022, pp.44-45		NIR April 2022, pp.68-69		NIR April 2022, pp.41-42		NIR April 2022, pp.70-75		NIR April 2022, pp.46	NIR April 2022, pp.46-50			NIR April 2022, p.26/491	
Method used	Tier 1		Tier 1		Tier 1		Tier 1		Tier 1	Tier 1 + Tier 2			Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex 1)		Yes (Annex 2)		Yes (Annex 2)		Yes (pp.70-75)		Yes (pp. 47)	Yes (Annex 2)			Yes (Annex 8)	
Years and sectors included	emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; including LULUCF	emissions: 2020; trends: 1990-2020*; including LULUCF			emissions: 2020; trends: 1988-2020; including LULUCF	
Uncertainty (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (e.L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											3%	3%	3.2%	1.8%
CH_4											8%	9%	21.9%	21.9%
N_2O											27%	27%	43.2%	46.2%
F-gases											27%	27%		
Total	4.5%	3.1%	23%	6%	28.1%	10.6%	5.24%	4.50%	5.00%	3%	3%	3%	4.8%	4.1%
Uncertainty in trend (%)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2 (e.L.)	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2											1%		1.13%	1.07%
CH_4											5%		2.51%	2.51%
N_2O											5%		2.28%	2.26%
F-gases											5%			
Total	3.0%	2.2%	14%	2%	6.3%	2.3%	5.40%	4.63%	5.60%	2%	2%			

* Base year for F-gases is 1995

Member State	Portugal	Romania		Slovakia		Slovenia		Spain		Sweden		UK	Iceland	
Citation	NIR March 2022, pp."1-23"	NIR May 2022, pp.99-100		NIR May 2022, p.42		NIR April 2022, pp.34-35		NIR March 2022, pp.79		NIR March 2022, pp.65-67		NIR April 2022, p.103	NIR April 2022, p.19	
Method used	Tier 1	Tier 1		Tier 1		Tier 1		Tier 1		Tier 1		Tier 1 + Tier 2	Tier 1	
Documentation in NIR (according to IPCC 2006 GL)	Yes (Annex H)	Yes (Annex 2)		Yes (Annex 3)		Yes (Annex 2)		Yes (Annex 6)		Yes (Annex 7)		Yes (Annex 2)	Yes (Annex 2)	
Years and sectors included	emissions: 2020; trends: 1990-2020; including LULUCF **	emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1990-2020; including LULUCF		emissions: 2020; trends: 1986-2020; including LULUCF		emissions: 2020; trends: 1990-2020*; including LULUCF		emissions: 2020; trends: 1990-2020*; including LULUCF		emissions: 2020; trends: 1990-2020*; including LULUCF	emissions: 2020; trends: 1990-2020*; including LULUCF	
Uncertainty (%)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2													22.0%	1.6%
CH_4													54.5%	3.1%
N_2O													2.4%	7.2%
F-gases														
Total	7.90%	32.70%	21.50%	11.61%	3.64%	13.52%	6.22%	14.8%	10.8%	103%	5.80%	3.0%	58.9%	9.2%
Uncertainty in trend (%)	Tier 1	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 1 (i .L.)	Tier 1 (e. L.)	Tier 2	Tier 1 (i .L.)	Tier 1 (e. L.)
CO_2													15.5	2.3
CH_4													8.5	4.3
N_2O													0.8	3.3
F-gases														
Total	6.40%	2.10%	1.90%	6.62%	1.14%	19.94%	1.93%	9.5%	6.9%	27.26% ***	2.00%	-49.0%	17.9%	10.0%

* Base year for F-gases is 1995
** The uncertainty analysis was performed only for the direct GHG: CO2, CH4, N2O
*** Value from NIR 2020

1.7 General assessment of the completeness

1.7.1 Completeness checks of Member States' submissions

The EU GHG inventory is compiled on the basis of the inventories of the EU Member States. Therefore, the completeness of the EU inventory depends on the completeness of the Member States' submissions.

In response to the Saturday paper 2010 the EU implemented an action plan in 2011 aiming at improving the completeness regarding NEs of the EU greenhouse gas inventory.

1. Given the fairly wide interpretations and applications of notation keys, the identification of a "real" gap needs expert assessment which is provided by the UNFCCC review and which cannot be automated by existing EU internal procedures. Thus any action plan implemented by the EU needs to continue to be based primarily on the UNFCCC review reports. This is in particular evident with regards to the KP LULUCF, where a carbon pool can be not reported ('NR' should be used) provided that transparent and verifiable information is provided indicating that the pool is not a source, while notation keys such as NO and NA may also sometimes be linked to incomplete estimates. In this respect it needs to be stressed that the late availability of the review reports complicates the follow-up with Member States related to potential missing GHG estimates before the next EU inventory submission.
2. The notation key 'NE' is not in all cases an indication of a problem and neither the IPCC guidelines nor the UNFCCC review guidelines foresee an automatic procedure of gap filling when NEs are reported. For example, the notation "NE" can be used if there are no methods available in the 2006 IPCC Guidelines. Overall, a fair and complete analysis of the use of "NE" including the situations highlighted in point 1 above was considered to be indispensable (see chapter 1.7.1).

Given the above considerations the specific steps of the action plan followed since 2011 are as follows:

1. Member States are required by the Monitoring Mechanism Regulation to submit their national GHG inventories electronically to the European Commission by 15 January of each year. A software program was created by the EEA so that upon submission of the relevant XML/CRF files a report is generated containing a list of all non-estimated source categories per Member State, specifying which of these source categories have been flagged in the Saturday Papers and for which ones IPCC methods are available. This report is then immediately notified to each Member State. During February the experts of the EU inventory team consult and discuss with Member States' experts inter alia:
   a. how MS have addressed and documented (or plan to address) the potential issues flagged in their Saturday Papers regarding missing estimates;
   b. the need for applying gap-filling procedures and the selection of the most appropriate methods;
   c. the need to use different notation keys.
2. Any finding with regard to the use of the notation key "NE" or relevant blank cells is communicated to the Member States' via the EMRT by 28 February latest. According to the procedures and time scales described in Annex IX of the Implementing Regulation, the Draft EU inventory is sent to MS also by 28 February. Updated or additional inventory data submitted by MS (to remove inconsistencies or fill gaps) and complete final national inventory reports are submitted to the European Commission by 15 March.

3. In cases where, even after the two preceding steps a Member State's GHG inventory as submitted to the European Commission by 15 March still contained NEs for categories where IPCC methods exist, and/or if such reporting has been identified as a problem in previous reviews, then the EU inventory experts, in close cooperation with Member States, prepare the missing GHG source estimates in accordance with the gap-filling provisions in articles 13-16 of Commission Decision 2005/166/EC. Article 16 requires Member States to use the gap-filled estimates in their national submissions to the UNFCCC to ensure consistency between the EU inventory and Member States' inventories.
4. A general assessment of completeness is included in the EU Greenhouse Gas Inventory Report. For transparency reasons, since 2011 the EU's inventory submission contains an improved description of this section to reflect the additional improvements discussed above.
5. In addition to the steps detailed above the regular QA/QC procedures established to ensure the transparency, accuracy, comparability, consistency, and completeness of the EU inventory continue to be applied. The WG1 on annual inventories continues to address issues of completeness giving them priority and the EU peer reviews and the ESD reviews focus on identifying issues that may lead to an under- or overestimation of emissions.

Since 2012 the completeness checks have been extended to the use of the notation key NO and NA. All cases where less than seven Member States reported NO or NA and all other MS reported emission estimates were checked by the sector experts and clarified with Member States, if needed. With the implementation of the new 2006 IPCC Guidelines, there is an additional check regarding 'insignificance' as described in paragraph 37 of the UNFCCC Reporting Guidelines, which is also relevant for the ESD review.

Member States may only report NEs if:

1. There are no 2006 IPCC methods/EFs available.
2. Emissions are considered insignificant: below 0.05% of the NT & do not exceed 500 kt CO_2 eq. The sum of insignificant NEs shall remain below 0.1% of the NT.
    a. MS shall indicate in both the NIR and the CRF completeness table why such emissions/removals have not been estimated.
    b. MS should provide justifications for exclusion in terms of the likely level of emissions in the NIR, using approximated AD and default IPCC EFs.
3. Emissions have not been reported in a previous submission, otherwise they shall be reported in subsequent submissions.

➢ If MS report unjustified NEs (according to 1. 2. and 3. above) gap-filling rules will apply: art. 4 Delegated Act of the MMR.

For the sectors energy, industrial processes and product use, agriculture, LULUCF and waste sector-specific checks are performed by the EU sector experts using outlier tools similar to those of the UNFCCC and other QA/QC tools. The results of the consistency and completeness checks as well as the main findings of the sector specific checks are documented in the web-based EEA Emission Review Tool (EMRT). This tool is accessible for MS inventory coordinators and inventory experts. The Member States are asked to respond to findings in this tool and if needed provide revised emission estimates or additional information.

For every updated inventory submission provided by the MS by 15 March follow-up checks are performed by the sector experts and additional findings are documented in the EEA Emission Review Tool (EMRT). In addition it is checked if issues identified in the QA/QC communication tool (initial checks), which are relevant for the EU inventory (report) have been clarified by the MS. If this is not the case MS are contacted for clarification.

Since 2015 also cases where neither numeric values nor notation keys have been reported (blank cells) have been included in the checking procedure. EU experts have checked with Member States if blank cells have been caused by the new CRF reporter software or if in fact the blank cells should be replaced by notation keys or a numeric values.

1.7.2 Reporting of notation key “NE”

As the EU GHG inventory is the sum of MS inventories all categories reported as “NE” by Member States are also reflected in the EU GHG inventories. However, the EU CRF tables include only a small number of categories where “NE” is actually visible because the “NE” of a Member State is only visible in the EU CRF in a category where all EU MS report notation keys. Table 1.17 shows that 13 mandatory categories have “NE” visible in the CRF tables for 2020.

Table 1.17 Overview of the number of NE visible in the EU CRF tables for 2020

Sector	Number of NE visible in the EU CRF for the year 2020 for mandatory categories (MS reporting NE)
Energy	3 (CZE, DEU, GBK, POL)
IPPU	9 (CYP, DEU, FRK, GBK, SWE)
Agriculture	0
Waste	1 (CZE, GBK)

1.7.3 Reporting of confidential data

According to the UNFCCC reporting guidelines Parties may report specific categories with the notation key C in case of confidentiality. In 2022 only two MS made use of this option; for the year 2020 Croatia reported CO_2, CH_4 and N_2O emission from 1D2 as confidential (Multilateral operations), while Sweden reported correct sector totals for all sectors but in the sectors Energy and IPPU on a less aggregated level the country reported 25 sub-categories as confidential. Manual changes have been performed in order to reflect this in the most appropriate way in the EU CRF tables. For further details refer to Table 1.7. Please note that the EU GHG inventory team – on request - obtains access to confidential MS data for quality checking purposes which has been the case for Sweden in 2022.

Therefore, in the relevant sector chapters, EU trends at fuel level do not always include Sweden for confidentiality reasons and also to preserve time series consistency for the EU. Consequently, the EU CRF tables at sub-category level and data shown on the same level in the NIR are not always consistent. Note that at sector level and at national totals level the EU NIR and the EU CRF tables are fully consistent. Table 1.18 confidential data reported by MS on the level of the EU key category analysis for the EU-27, Iceland and the United Kingdom.

Table 1.18 Confidential data reported by MS in key categories for the EU-27, Iceland and the United Kingdom

Source category gas	Confidential data	
	1990	2020
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)		SWE
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)		SWE
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)		SWE
1.A.2.c Chemicals: Liquid Fuels (CO_2)		SWE
1.A.2.c Chemicals: Solid Fuels (CO_2)		SWE
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)		SWE
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)		SWE

As the EU GHG inventory is the sum of MS inventories all categories reported as confidential by Member States are also reflected in the EU GHG inventories. If Member States report confidential data the notation key “C” will be shown in the comments of the relevant cell in the CRF tables only.

In 2020 no “C”s were shown for emissions in the comments of the relevant cells in the CRF tables.

1.7.4 Data gaps and gap-filling

1.7.4.1 Gap filling of emissions

The EU GHG inventory is compiled by using the inventory submissions of the EU Member States. If a Member State does not submit all data required for the compilation of the EU inventory by 15 March of a reporting year, the Commission prepares estimates for data missing in collaboration with the relevant Member State. In the following cases gap filling is made:

- To complete specific years in the GHG inventory time-series for a specific Member State for example were a Member States does not provide new estimates for the latest reporting year.
- To complete individual source categories for individual Member States that did not estimate specific source categories for any year of the inventory time series and reported ‘NE’. Gap filling methods are used for major gaps when it is highly certain that emissions from these source categories exist in the Member States concerned.

For data gaps in Member States’ inventory submissions, the following procedure is applied by the ETC/CM in accordance with the implementing provisions under the MMR for missing emission data:

- If a consistent time series of reported estimates for the relevant source category is available from the Member State for previous years that has not been subject to adjustments under Article 5.2 of the Kyoto Protocol, extrapolation of this time series is used to obtain the emission estimate. As far as CO_2 emissions from the energy sector are concerned, extrapolation of emissions should be based on the percentage change of Eurostat CO_2 emission estimates if appropriate.
- If the estimate for the relevant source category was subject to adjustments under Article 5.2 of the Kyoto Protocol in previous years and the Member State has not submitted a revised estimate, the basic adjustment method used by the expert review team as provided in the ‘Technical guidance on methodologies for adjustments under Article 5.2 of the Kyoto Protocol’ is used without application of the conservativeness factor.

- If a consistent time series of reported estimates for the relevant source category is not available and if the source category has not been subject to adjustments under Article 5.2 of the Kyoto Protocol, the estimation should be based on the methodological guidance provided in the 'Technical guidance on methodologies for adjustments under Article 5.2 of the Kyoto Protocol' without application of the conservativeness factor.

The Commission prepares the estimates by 31 March of the reporting year, following consultation with the Member State concerned, and communicates the estimates to the other Member States. The Member State concerned shall use the estimates referred to for its national submission to the UNFCCC to ensure consistency between the EU inventory and Member States' inventories.

The methods used for gap filling include interpolation, extrapolation and clustering. These methods are consistent with the adjustment methods described in UNFCCC Adjustment Guidelines (Table 1) and in the 2006 IPCC guidelines[16].

1.7.4.2 Gap filling of emissions in GHG inventory submissions 2020

Since 2011 GHG inventory estimates have been complete for all EU Member States, and therefore no gap filling has been needed.

1.7.4.3 Gap filling of activity data

In response to recommendations of the UNFCCC review team the EU elaborated and implemented a gap filling procedure for gaps in activity data (for further details on the methodology also see 4.3). Due to the large resource needs for gap filling the following rules apply:

- Only activity data for key categories will be gap-filled.
- If more than 75 % of the emissions are calculated on basis of consistent activity data.
- If the IEF has a reasonable degree of consistency (i.e. standard deviation divided by mean < 50 %).
- Only for the latest reporting year.

1.7.4.4 Gap filling of activity data in GHG inventory submissions 2022

Applying the rules mentioned above activity data of the following categories have been gap-filled in this inventory submission for the year 2020:

- Clinker Production 2A1
- Lime Production 2A2
- Ammonia Production 2B1

1.7.5 Geographical coverage of the European Union inventory

Table 1.19 shows the geographical coverage of the EU Member States' national inventories. Note that not all Member States have signed and ratified the UNFCCC and the Kyoto Protocol with the same geographical coverage. In addition, the EU territory of a country is not always equivalent to the territory of the Party to the UNFCCC or the Kyoto Protocol. For three countries/Member States there are differences in geographical coverage as UNFCCC Party, Kyoto Protocol Party and/or EU Member

[16] ETC ACC technical note on gap filling procedures, December 2006.

State (DK, FR and the UK). If there are differences in geographical coverage the respective country needs to prepare several inventories.

As the EU inventory is the sum of the Member States' inventories, the EU inventory covers the same geographical area as the inventories of the 27 Member States, Iceland and the United Kingdom for their respective EU territory. Note that Denmark, France and the United Kingdom submit GHG inventories to the UNFCCC that may differ from the GHG inventories used for the EU-28 inventory because these countries submit more than one inventory to the UNFCCC, which have different geographical coverages. However, the EU's submission under the Convention is fully consistent with MS GHG emissions by sources and sinks according to the EU territory. The EU's submission under the Kyoto Protocol is fully consistent with the joint ratification of the second commitment period of KP by the EU (see Table 1.19).

Table 1.19 Geographical coverage of the Union's GHG inventory

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second committment period)	EU-territory coverage (UNFCCC)	Party coverage (UNFCCC)	Country code
Austria	Austria	√	√	√	AUT
Belgium	Belgium consisting of Flemish Region, Walloon Region and Brussels Region	√	√	√	BEL
Bulgaria	Bulgaria	√	√	√	BGR
Croatia	Croatia	√	√	√	HRV
Cyprus	Area under the effective control of the Republic of Cyprus	√	√	√	CYP
Czechia	Czech Republic	√	√	√	CZE
Denmark	Denmark (excluding Greenland and the Faeroe Islands)	√	√		DNM
Estonia	Estonia	√	√	√	EST
Finland	Finland including Åland Islands	√	√	√	FIN
France	Metropolitan France, the overseas departments (Guadeloupe, Martinique, Guyana and Reunion) and the overseas communities (Saint-Martin and Mayotte), excluding the French overseas communities (French Polynesia, Wallis and Futuna, Saint-Pierre and Miquelon) and overseas territories (the French Southern and Antarctic Lands) and New Caledonia.	√	√		FRK
	Metropolitan France, the overseas departments (Guadeloupe, Martinique, Guyana and Reunion), the overseas communities (French Polynesia, Saint-Martin, Wallis and Futuna, Mayotte, Saint-Pierre and Miquelon) and overseas territories (the French Southern and Antarctic Lands) and New Caledonia.			√	FRA
Germany	Germany	√	√	√	DEU
Greece	Greece	√	√	√	GRC
Hungary	Hungary	√	√	√	HUN
Ireland	Ireland	√	√	√	IRE
Italy	Italy	√	√	√	ITA
Latvia	Latvia	√	√	√	LVA
Lithuania	Lithuania	√	√	√	LTU
Luxembourg	Luxembourg	√	√	√	LUX
Malta	Malta	√	√	√	MLT

Member State	Geographical coverage	EU and MS Party coverage (Kyoto Protocol, second committment period)	EU-territory coverage (UNFCCC)	Party coverage (UNFCCC)	Country code
Netherlands	The reported emissions are those that derive from the legal territory of the Netherlands. This includes a 12-mile zone out from the coastline and inland water bodies. It excludes Aruba, Curaçao and Sint Maarten, which are constituent countries of the Kingdom of the Netherlands. It also excludes Bonaire, Saba and Sint Eustatius, which since 10 October 2010 have been public bodies (openbare lichamen) with their own legislation that is not applicable to the European part of the Netherlands. Emissions from offshore oil and gas production on the Dutch part of the continental shelf are included	√	√	√	NLD
Poland	Poland	√	√	√	POL
Portugal	Mainland Portugal and the two Autonomous regions of Madeira and Azores Islands. Includes also emissions from air traffic and navigation bunkers realized between these areas.	√	√	√	PRT
Romania	Romania	√	√	√	ROU
Slovakia	Slovakia	√	√	√	SVK
Slovenia	Slovenia	√	√	√	SVN
Spain	Spanish part of Iberian mainland, Canary Islands, Balearic Islands, Ceuta and Melilla	√	√	√	ESP
Sweden	Sweden	√	√	√	SWE
European Union	EU-27+GBE		√	√	EUA
Iceland	Iceland	√		√	
United Kingdom	England, Scotland, Wales and Northern Ireland, and Gibraltar, excluding the UK Crown Dependencies (Jersey, Guernsey and the Isle of Man) and the UK Overseas Territories (except Gibraltar).		√		GBE
	England, Scotland, Wales and Northern Ireland and the UK Overseas Territories and UK Crown Dependencies to whom the UK's ratification of the Kyoto Protocol has been extended and whose emissions are included for the second commitment period (the Cayman Islands, the Falkland Islands, Gibraltar, Jersey, Guernsey and the Isle of Man).	√			GBK
	England, Scotland, Wales and Northern Ireland and the UK Overseas Territories and UK Crown Dependencies for whom the UK's ratification of the UN Framework Convention on Climate Change is extended (the Cayman Islands, the Falkland Islands, Gibraltar, Bermuda, Jersey, Guernsey and the Isle of Man).			√	GBR
European Union and Iceland	EU-27, Iceland and the relevant UK's Overseas Territories and Crown Dependencies (GBK).	√			EUC

1.7.6 Completeness of the European Union submission

1.7.6.1 National inventory report

The EU NIR follows – as far as possible - the annotated outline of the UNFCCC secretariat with the exception of the annexes. The main reason for this is the nature of the EU inventory being the sum of Member States' inventories. Therefore the main purpose of the annexes is to make transparent the EU emission estimates by providing the basic Member States tables for every CRF table. Table 1.20 provides information on what is included in the Annexes to the EU GHG inventory report and provides explanations where the EU does not follow the UNFCCC reporting guidelines.

Table 1.20 Annexes as outlined in the UNFCCC reporting guidelines and annexes included in the EU submission

Annex required in the UNFCCC reporting guidelines	Annex included in the EU submission
Annex I: Key categories	Included: Key category analyses Tier 1 including and excluding LULUCF
Annex II: Assessment of uncertainty	The uncertainty assessment is included in the NIR, section 1.6
Annex III: Detailed methodological descriptions for individual source or sink categories	Included: A summary description of the methodologies used by each Member State for the EU key categories
Annex IV: National energy balance of the most recent year	Not included: Due to the nature of the EU inventory being the sum of Member States' inventories there is no national energy balance which could be included in this annex.
Annex V: Additional information	Included: Summary Table 2 for all MS in order to make transparent the data basis of the EU inventory

1.7.6.2 Activity data in the EU CRF

The European Union cannot provide all data in the sectoral background tables. The main reasons for not completing all sectoral background data tables are: (1) limited data availability partly due to confidentiality issues; and (2) the use of different type of activity data by Member States. The latter is due to the fact that the Member States are responsible for calculating emissions. If they use country-specific methods they may also use different types of activity data. At EU-level these different types of activity data cannot be simply added up. It should be noted that at EU-level no emissions are calculated directly on the basis of activity data reported by MS. However, all the details for the calculation of MS emissions are documented in the Member States' CRF tables, as part of their national GHG inventories.

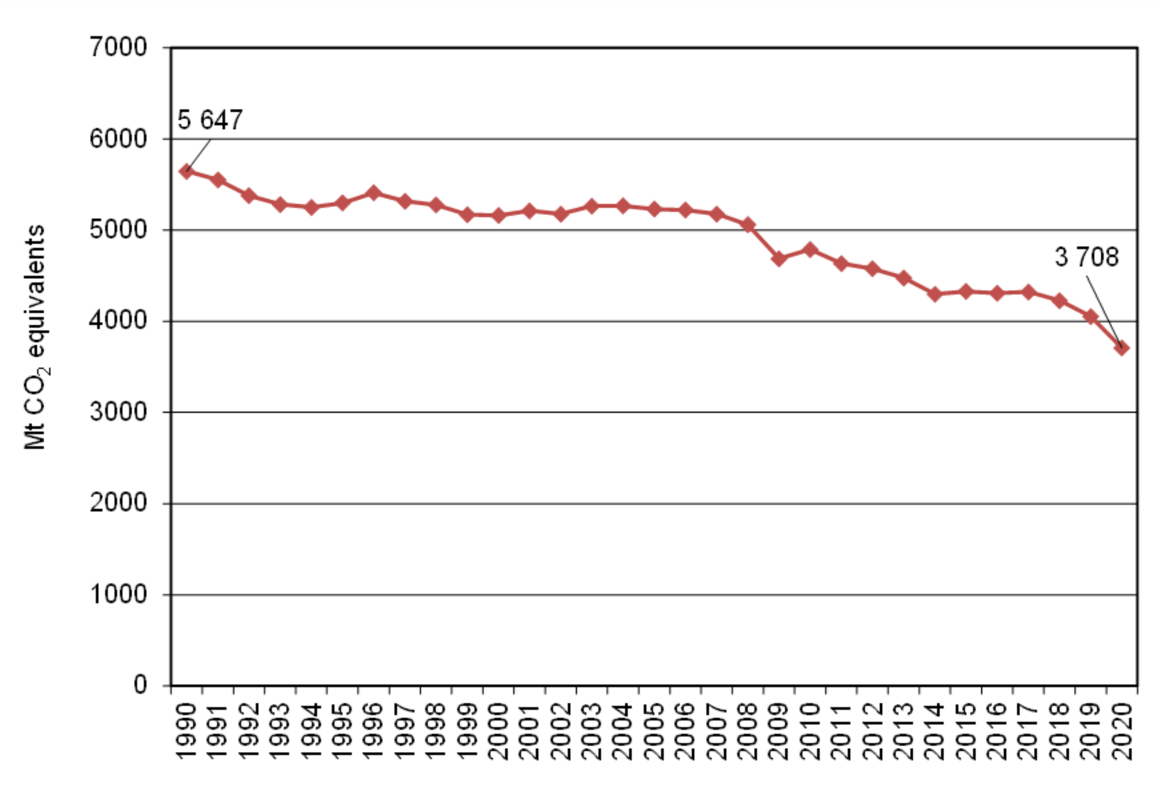
2 EU GREENHOUSE GAS EMISSION TRENDS

This chapter presents the main GHG emission trends in the EU-KP. Aggregated results are described as regards total GHG and emission trends are briefly analysed mainly at gas level. A short overview of countries contributions to total EU-KP GHG trends is given. Finally, the trends of indirect GHGs and SO_2 emissions are presented.

2.1 Aggregated greenhouse gas emissions

In 2020, total GHG emissions in the EU-KP, without LULUCF, were 34.3 % (-1 939 million tonnes CO_2 equivalents) below 1990 levels. Emissions decreased by 8.5 % (346 million tonnes CO_2 equivalents) between 2019 and 2020 (Figure 2.1).

Figure 2.1 EU-KP GHG emissions 1990–2020 (excl. LULUCF)



Notes: GHG emission data for the EU-KP as a whole refer to domestic emissions (i.e. within its territory), include indirect CO_2 and do not include emissions and removals from LULUCF; nor do they include emissions from international aviation and international maritime transport. CO_2 emissions from biomass with energy recovery are reported as a Memorandum item according to UNFCCC guidelines and are not included in national totals. In addition, no adjustments for temperature variations or electricity trade are considered. The global warming potentials are those from the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

2.1.1 Main trends by source category, 1990-2020

Total GHG emissions (excluding LULUCF and excluding international aviation) decreased by 1 939 Mt CO_2 eq. since 1990 (or 34.3 %) reaching their lowest level during this period in 2020 (3 708 Mt CO_2 eq.). There has been a progressive decoupling of gross domestic product (GDP) and GHG emission compared to 1990, with an increase in GDP by 54 % alongside a decrease in emissions of about 34 % over the period.

The reduction in GHG emissions over the 30-year period was due to a variety of factors, including the growing share in the use of renewables, the use of less carbon intensive fossil fuels and improvements in energy efficiency, as well as to structural changes in the economy. On top of these long-lasting changes, which account for the main share in the reduction in GHG emissions, the economic recession linked to the Covid-19 pandemic also played a role in 2020.

The long-lasting changes have resulted in a lower energy intensity of the economy and in a lower carbon intensity of energy production and consumption in 2020 compared to 1990. Demand for energy to heat households has also been lower, as Europe on average has experienced milder winters since 1990, which has also helped reduce emissions.

GHG emissions decreased in the majority of sectors between 1990 and 2020, with the notable exception of transport, and refrigeration and air conditioning. At the aggregate level, emission reductions were largest for manufacturing industries and construction, electricity and heat production, iron and steel production (including energy-related emissions) and residential combustion.

Besides the 2020 economic recession, a combination of factors explains lower emissions in industrial sectors, such as improved efficiency and lower carbon intensity as well as structural changes in the economy, with a higher share of services and a lower share of more-energy-intensive industry in total GDP.

Emissions from electricity and heat production decreased strongly since 1990. In addition to improved energy efficiency there has been a move towards less carbon intense fuels. Between 1990 and 2020, the use of solid and liquid fuels in thermal power stations decreased strongly whereas natural gas consumption more than doubled. Coal consumption in 1990 was three times higher than in 2020. The use of renewable energy sources in electricity and heat generation has increased substantially in the EU since 1990. Improved energy efficiency and a less carbon intensive fuel mix have resulted in reduced CO_2 emissions per unit of fossil energy generated.

Emissions in the residential sector also represented one of the largest reductions. Energy efficiency improvements from better insulation standards in buildings, and a less carbon-intensive fuel mix, can partly explain lower demand for space heating in the EU over the past 30 years.

In terms of the main GHGs, CO_2 was responsible for the largest reduction in emissions since 1990. Reductions in emissions from N_2O and CH_4 have been substantial, reflecting lower levels of mining activities, lower agricultural livestock, as well as lower emissions from managed waste disposal on land and from reduced adipic and nitric acid production.

A number of policies (both EU and country-specific) have contributed to the overall GHG emission reduction, including key agricultural and environmental policies in the 1990s and climate and energy policies in the past 15 years since 2005.

Almost all EU Member States reduced emissions compared to 1990 and thus contributed to the overall positive EU performance. The UK and Germany accounted for 47% of the total net reduction in the EU-KP of the past 30 years.

Table ES. 1 shows those sources that made the largest contribution to the change in total GHG emissions in the EU plus Iceland and UK between 1990 and 2020.

Table 2.1 Overview of EU source categories whose emissions increased or decreased by more than 20 Million tonnes CO_2 equivalent in the period 1990-2020

Source category	Million tonnes (CO_2 equivalents)
Refrigeration and Air conditioning (HFCs from 2.F.1)	80
Road Transportation (CO2 from 1.A.3.b)	53
Aluminium Production (PFCs from 2.C.3)	-21
Agricultural soils: Direct N2O emissions (N2O from 3.D.1)	-27
Fluorochemical Production (HFCs from 2.B.9)	-28
Cement Production (CO2 from 2.A.1)	-28
Enteric Fermentation: Cattle (CH4 from 3.A.1)	-42
Fugitive Emissions from Oil and Natural Gas (CH4 from 1.B.2)	-42
Nitric Acid Production (N2O from 2.B.2)	-47
Adipic Acid Production (N2O from 2.B.3)	-57
Fuels used Commercial/Institutional Sector (CO2 from 1.A.4.a)	-61
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-70
Fugitive Emissions from Solid Fuels (CH4 from 1.B.1)	-74
Managed Waste Disposal Sites (CH4 from 5.A1)	-77
Fuels used Residential Sector (CO2 from 1.A.4.b)	-138
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-144
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A.	-275
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-732
Total	**-1939**

Notes: As the table only presents sectors whose emissions have increased or decreased by at least 20 million tonnes CO_2 equivalent, the sum of the EU key categories in this table does not match the total change in emissions listed at the bottom of the table, which includes all emission sources in the EU inventory. Note that LULUCF categories or Memorandum items such as international aviation and international navigation are not included in this table.

2.1.2 Main trends by source category, 2019-2020

Total GHG emissions (excluding LULUCF and international aviation) decreased in 2020 by 346 million tonnes, or 8.5 % compared to 2019, to reach 3 708 million tonnes CO_2 equivalent in 2020. The reduction in GHG emissions in 2020 was the second largest in absolute terms and the highest in relative terms year-on-year in the EU since 1990. This was by and large due to the strong contraction in economic activity caused by the Covid-19 pandemic.

At EU level, almost 70 % of the net reduction in GHG emissions in 2020 took place in road transportation and public electricity and heat production. Almost all economic sectors saw significant emission reductions in 2020.

Road transport CO_2 emissions decreased by 123 million tonnes (or -14%) due to a drastic reduction in transport activity resulting from the lockdown measures during the Covid-19 pandemic. Passenger cars accounted for the bulk of emission reductions in road transportation, but emissions from light duty and heavy-duty vehicles also decreased sharply in 2020.

The second largest reduction in CO_2 emissions in 2020 came from electricity and heat production, with 118 million tonnes less compared to 2019 (or -14% year on year). Most of this reduction was linked to lower use of coal in power stations. Greenhouse gas emissions from stationary installations in the EU ETS also decreased 11.6%, which represents the largest drop in emissions since the ETS began operating in 2005. It is comparable only to the decrease observed in 2009 at the height of the financial crisis.

Based on Eurostat energy statistics, while total electricity production declined in the EU in 2020, the use of renewable energy sources in electricity generation increased, mostly from wind, solar and hydro. Higher use of renewables offset otherwise-higher emissions from fossil fuels, thus underpinning the ongoing decarbonisation trend in the sector.

Although less substantial than in road transportation and the power sector, GHG emissions in 2020 also decreased in manufacturing industries and construction, iron and steel, petroleum refining and commercial buildings, among others. HFC emissions from refrigeration and air conditioning continued the downtrend that started in 2014.

Table 2.2 Overview of EU-KP source categories whose emissions increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2019–2020

Source category	Million tonnes (CO_2 equivalents)
Cement Production (CO2 from 2.A.1)	-4
Manufacture of Solid Fuels and Other Energy Industries (CO2 from 1.A.1.c)	-6
Domestic Aviation (CO2 from 1.A.3.a)	-8
Refrigeration and Air conditioning (HFCs from 2.F.1)	-9
Fuels used Commercial/Institutional Sector (CO2 from 1.A.4.a)	-10
Petroleum Refining (CO2 from 1.A.1.b)	-11
Manufacturing industries (excl. Iron and steel) (Energy-related CO2 from 1.A.2 excl. 1.A	-17
Iron and Steel Production (CO2 from 1.A.2.a + 2.C.1)	-18
Public Electricity and Heat Production (CO2 from 1.A.1.a)	-118
Road Transportation (CO2 from 1.A.3.b)	-123
Total	**-346**

Notes: As the table only presents sectors whose emissions have increased or decreased by at least 3 million tonnes of CO_2 equivalent, the sum of the EU key categories in this table does not match the total change in emissions listed at the bottom of the table, which includes all emission sources in the EU inventory. Note that LULUCF categories or Memorandum items such as international aviation and international navigation are not included in this table.

Table 2.3 gives an overview on total GHG emissions by countries, illustrating where main changes occurred.

Table 2.3 Greenhouse gas emissions in CO_2 equivalent (excl. LULUCF)

	1990 (million tonnes)	2020 (million tonnes)	2019 - 2020 (million tonnes)	Change 2019 - 2020 (%)	Change 1990-2020 (%)
Austria	78.4	73.6	-6.1	-7.7%	-6.2%
Belgium	145.7	106.4	-10.0	-8.6%	-26.9%
Bulgaria	98.4	49.2	-10.3	-17.3%	-50.0%
Croatia	31.4	23.8	-0.9	-3.5%	-24.4%
Cyprus	5.6	8.9	0.0	-0.3%	59.0%
Czechia	198.8	113.3	-10.2	-8.3%	-43.0%
Denmark	71.1	41.7	-2.8	-6.2%	-41.3%
Estonia	40.2	11.6	-3.1	-21.0%	-71.2%
Finland	71.2	47.8	-5.0	-9.5%	-32.9%
France	544.1	393.0	-41.6	-9.6%	-27.8%
Germany	1241.9	728.7	-71.0	-8.9%	-41.3%
Greece	103.5	74.8	-10.8	-12.6%	-27.7%
Hungary	94.8	62.8	-1.8	-2.7%	-33.8%
Ireland	54.4	57.7	-2.1	-3.6%	6.1%
Italy	519.9	381.2	-37.1	-8.9%	-26.7%
Latvia	25.9	10.5	-0.7	-5.9%	-59.6%
Lithuania	47.9	20.2	-0.2	-0.9%	-57.8%
Luxembourg	12.7	9.1	-1.7	-15.5%	-28.8%
Malta	2.6	2.1	0.0	-0.5%	-18.4%
Netherlands	220.5	164.3	-15.9	-8.8%	-25.5%
Poland	475.9	376.0	-14.5	-3.7%	-21.0%
Portugal	58.5	57.6	-6.0	-9.5%	-1.5%
Romania	249.7	109.9	-4.0	-3.5%	-56.0%
Slovakia	73.5	37.0	-2.8	-7.0%	-49.6%
Slovenia	18.6	15.9	-1.2	-7.2%	-14.8%
Spain	290.1	274.7	-39.1	-12.5%	-5.3%
Sweden	71.4	46.3	-4.5	-8.9%	-35.2%
United Kingdom	793.4	402.1	-42.1	-9.5%	-49.3%
EU-27+UK	**5640.0**	**3700.3**	**-345.5**	**-8.5%**	**-34.4%**
Iceland	3.7	4.5	-0.2	-4.3%	22.7%
United Kingdom (KP)	796.2	404.8	-42.6	-9.5%	-49.2%
EU-KP	**5646.5**	**3707.6**	**-346.1**	**-8.5%**	**-34.3%**

2.2 Emission trends by gas

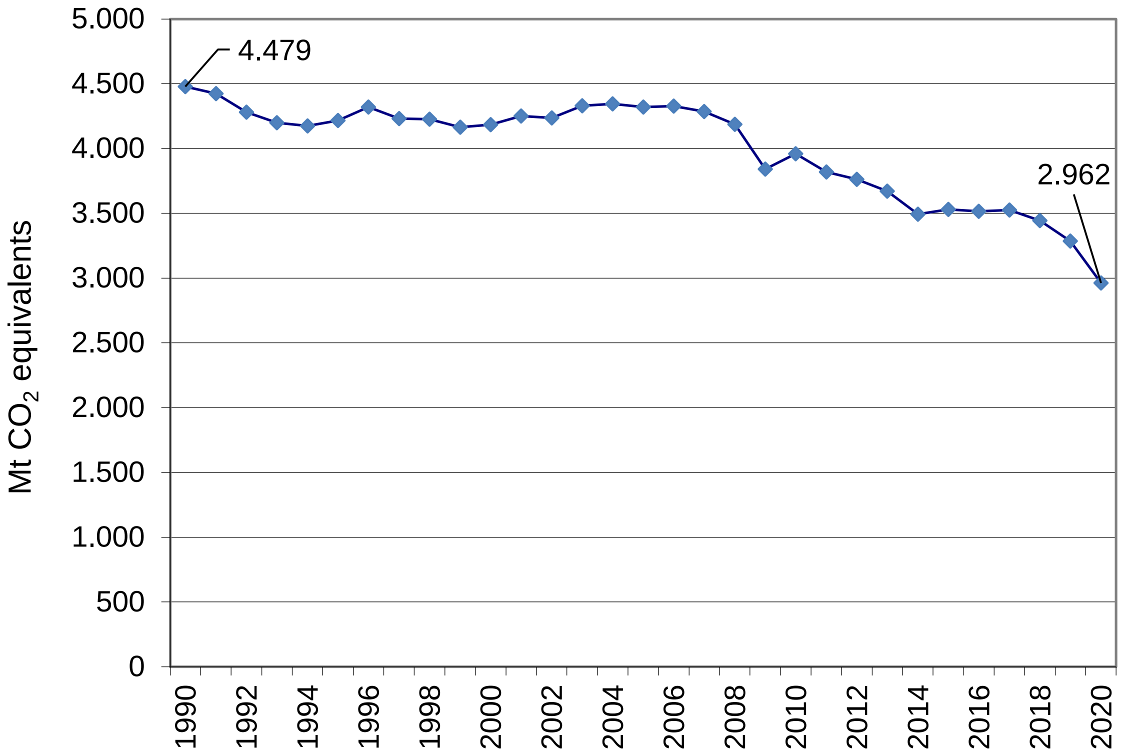
Table 2.4, Figure 2.2 and Figure 2.3 give an overview of the main trends in EU-KP GHG emissions and removals for 1990–2020. In the EU-KP the most important GHG is CO_2, accounting for 80 % of total EU-KP emissions in 2020 excluding LULUCF. In 2020, CO_2 emissions excluding LULUCF were 2 966 Mt, which was 34 % below 1990 levels. Compared to 2019, CO_2 emissions, N_2O emissions and CH_4 emissions decreased each by 9.9 %, 1.4 % and 1.3 % respectively.

Table 2.4 Overview of EU-KP GHG emissions and removals from 1990 to 2020 in CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Net CO2 emissions/removals	4256	3 910	3 872	3 996	3 622	3 481	3418	3 326	3 168	3 211	3 201	3 261	3177	3 033	2 716
CO2 emissions (without LULUCF)	4479	4 216	4 185	4 321	3 961	3 819	3763	3 670	3 494	3 531	3 515	3 526	3444	3 287	2 962
CH4	712	655	595	536	480	470	466	456	448	448	441	440	434	425	419
N2O	384	347	303	284	238	232	230	231	234	233	233	237	234	230	227
HFCs	29	43	53	73	99	103	106	109	112	106	108	108	104	100	89
PFCs	26	17	12	7	4	4	4	4	3	3	4	3	4	3	2
Unspecified mix of HFCs and PFCs	6	6	2	1	1	0	1	1	1	1	1	1	2	2	2
SF6	11	15	10	8	6	6	6	6	6	6	6	7	7	7	6
NF3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (with net CO2 emissions/removals)	**5456**	**5 026**	**4 880**	**4 936**	**4 480**	**4 326**	**4261**	**4 162**	**4 000**	**4 038**	**4 024**	**4 090**	**3990**	**3 830**	**3 491**
Total (without CO2 from LULUCF)	**5678**	**5 332**	**5 193**	**5 262**	**4 819**	**4 664**	**4607**	**4 505**	**4 327**	**4 358**	**4 338**	**4 355**	**4258**	**4 083**	**3 737**
Total (without LULUCF)	**5647**	**5 299**	**5 162**	**5 231**	**4 789**	**4 635**	**4576**	**4 477**	**4 298**	**4 329**	**4 308**	**4 322**	**4228**	**4 054**	**3 708**

Notes: CO_2 emissions include indirect CO_2

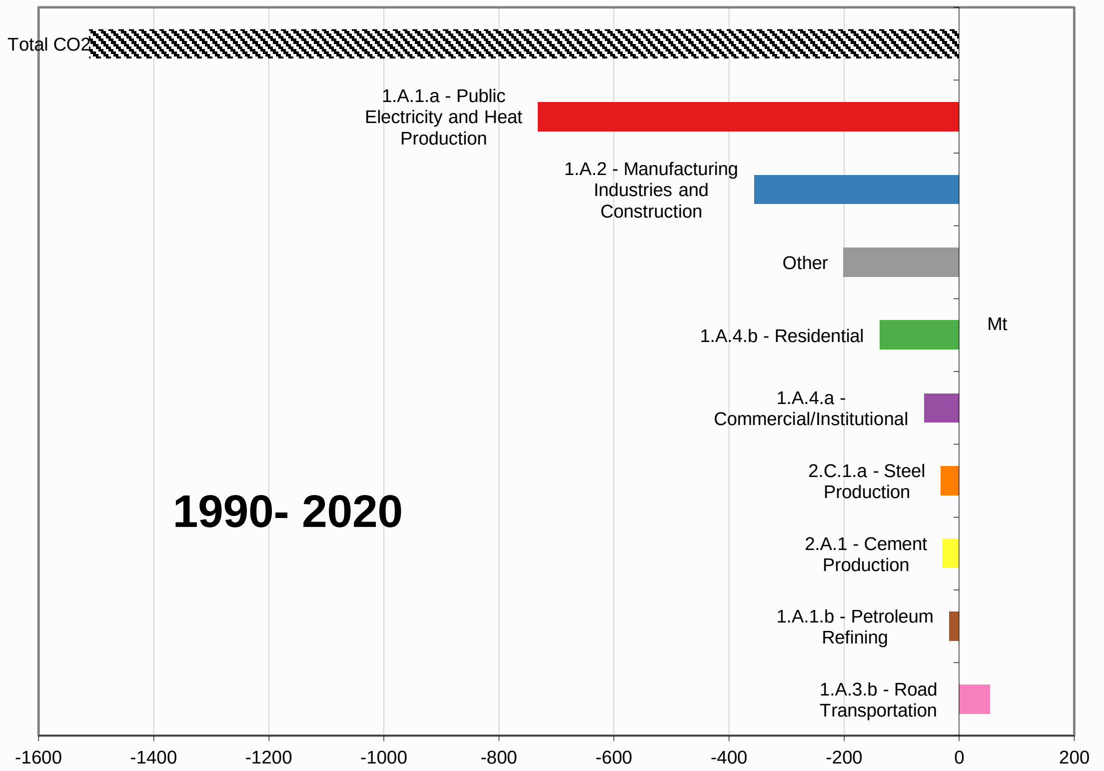
Figure 2.2 CO_2 emissions 1990 to 2020 (Mt)



Notes: CO_2 emissions include indirect CO_2

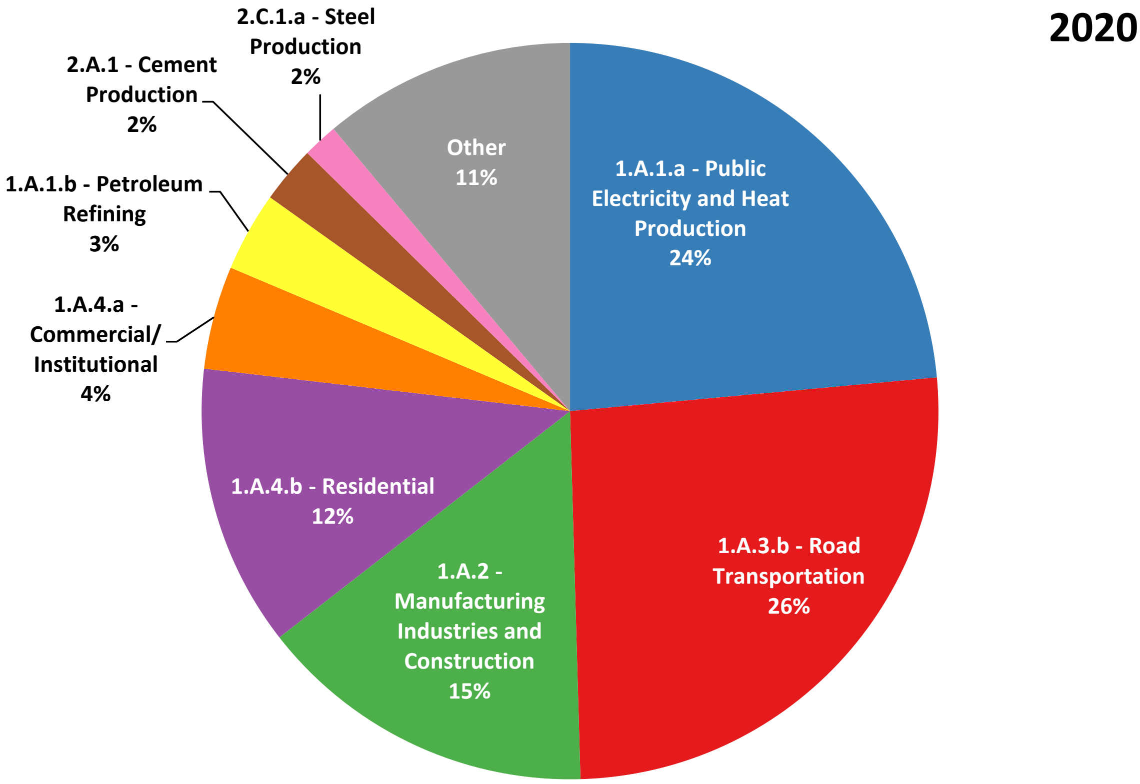
The largest key source categories for CO_2 emissions (Figure 2.3) have been reduced between 1990 and 2020 with the exception of 1.A.3.b Road transportation, which accounts for 26 % of CO_2 emissions in 2020.

Figure 2.3 Absolute change of CO_2 emissions by large key source categories 1990 to 2020 in CO_2 equivalents (Mt) for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.4 CO_2 emissions: Share of key source categories and all remaining categories in 2020 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

CH_4 emissions account for 12 % of total EU GHG emissions in 2020 and decreased by 40 % since 1990 to 434 Mt CO_2 equivalents in 2020 (Figure 2.5). The two largest key sources are enteric fermentation and anaerobic waste (Figure 2.7). They account for 54 % of CH_4 emissions in 2020.

Figure 2.5 CH_4 emissions 1990 to 2020 in CO_2 equivalents (Mt)

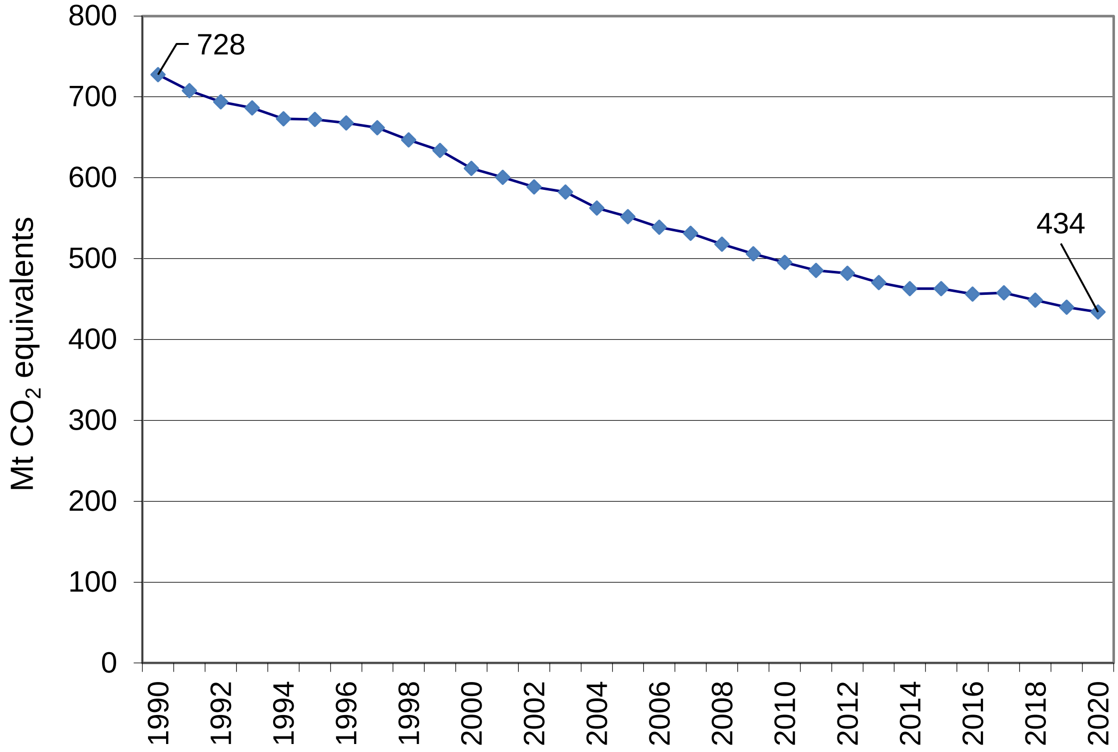
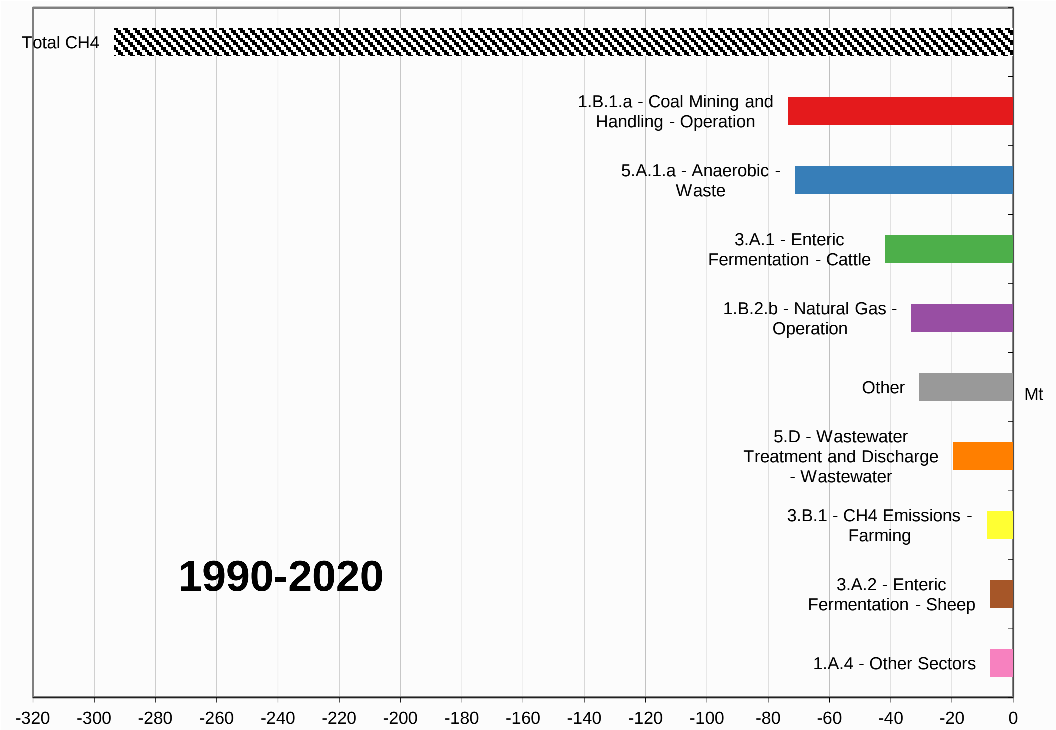


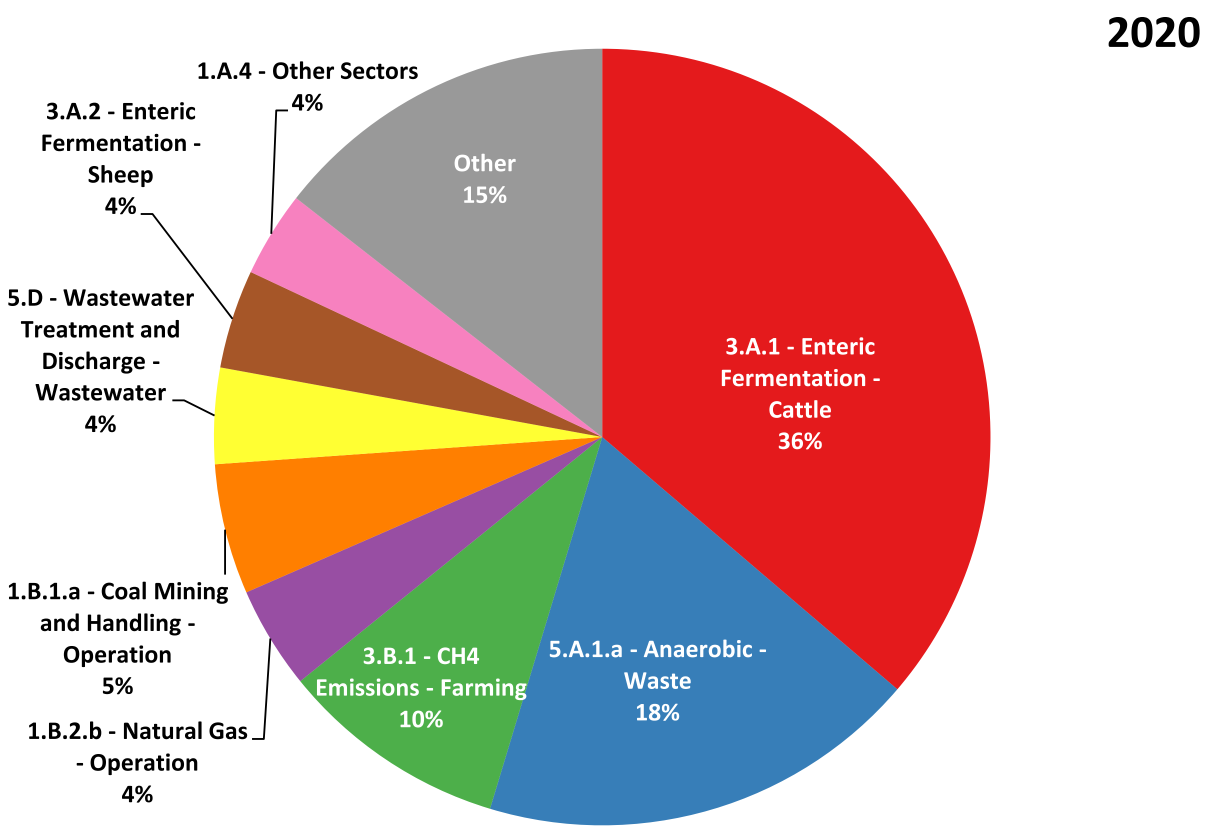
Figure 2.6 shows that the main reasons for declining CH_4 emissions were reductions in anaerobic waste and coal mining.

Figure 2.6 Absolute change of CH_4 emissions by large key source categories 1990 to 2020 in CO_2 equivalents (Mt) for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.7 CH_4 emissions: Share of key source categories and all remaining categories in 2020 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

N_2O emissions are responsible for 7 % of total EU GHG emissions and decreased by 39 % to 242 Mt CO_2 equivalents in 2020 (Figure 2.8). N_2O emissions derive mainly from the agriculture sector. The two largest key sources account for about 66 % of N_2O emissions in 2020 (Figure 2.10). Figure 2.9 shows that the main reason for large N_2O emission cuts were reductions in chemical industry and agricultural soils.

Figure 2.8 N₂O emissions 1990 to 2020 in CO₂ equivalents (Mt)

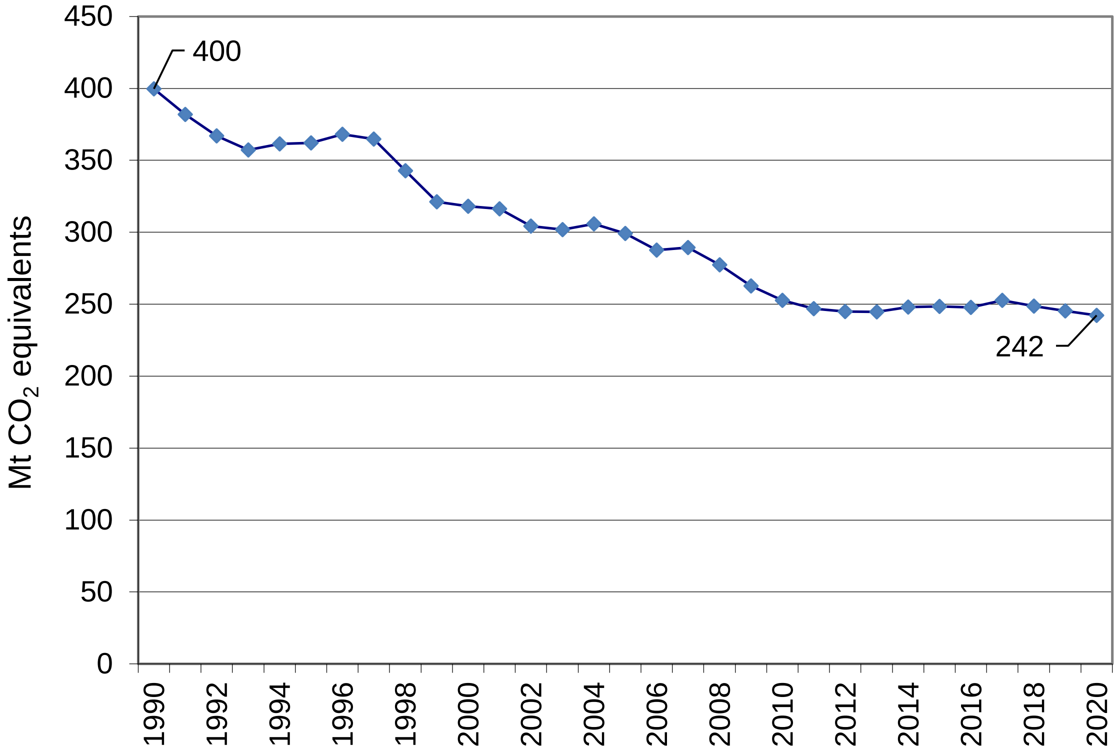
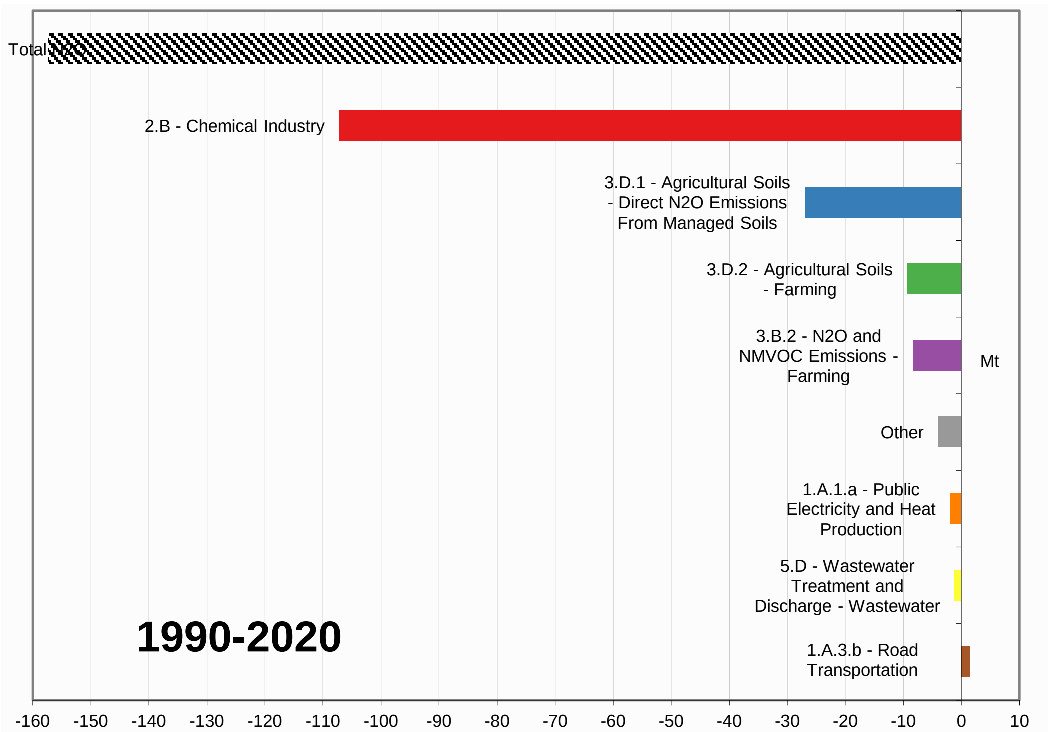
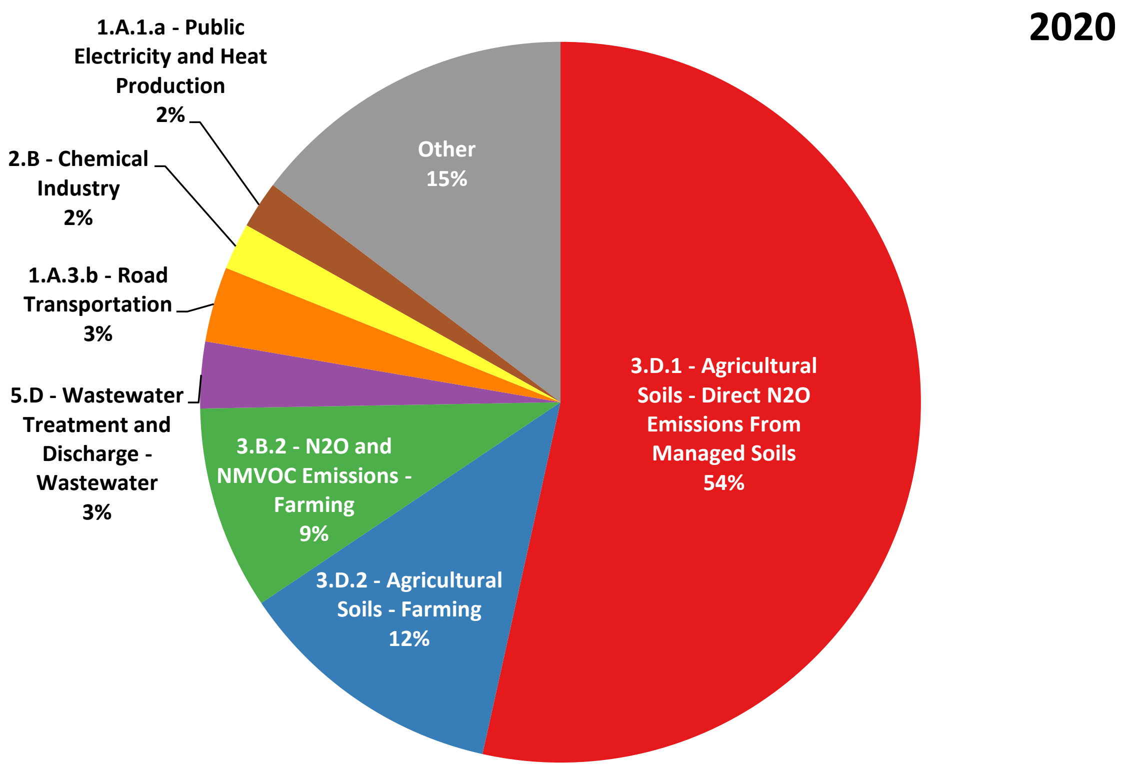


Figure 2.9 Absolute change of N_2O emissions by large key source categories 1990 to 2020 in CO_2 equivalents (Mt) for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.10 N_2O emissions: Share of key source categories and all remaining categories in 2020 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

Fluorinated gas emissions account for 2.7 % of total EU GHG emissions. In 2020, emissions amounted to 99 Mt CO_2 equivalents, which was 37 % above 1990 levels (Figure 2.11). Refrigeration and air conditioning, the largest key category, accounts for 81 % of fluorinated gas emissions in 2020. Figure 2.12 reveals that HFCs from refrigeration and air conditioning showed large increases between 1990 and 2020. The main reason for this is the phase-out of ozone-depleting substances such as chlorofluorocarbons under the Montreal Protocol and the replacement of these substances with HFCs (mainly in refrigeration, air conditioning, foam production and as aerosol propellants). On the other hand, the sum of HFC emissions from categories not presented individually in Figure 2.12 (Other in Figure 2.12) decreased substantially.

Figure 2.11 Fluorinated gas emissions 1990 to 2020 in CO_2 equivalents (Mt)

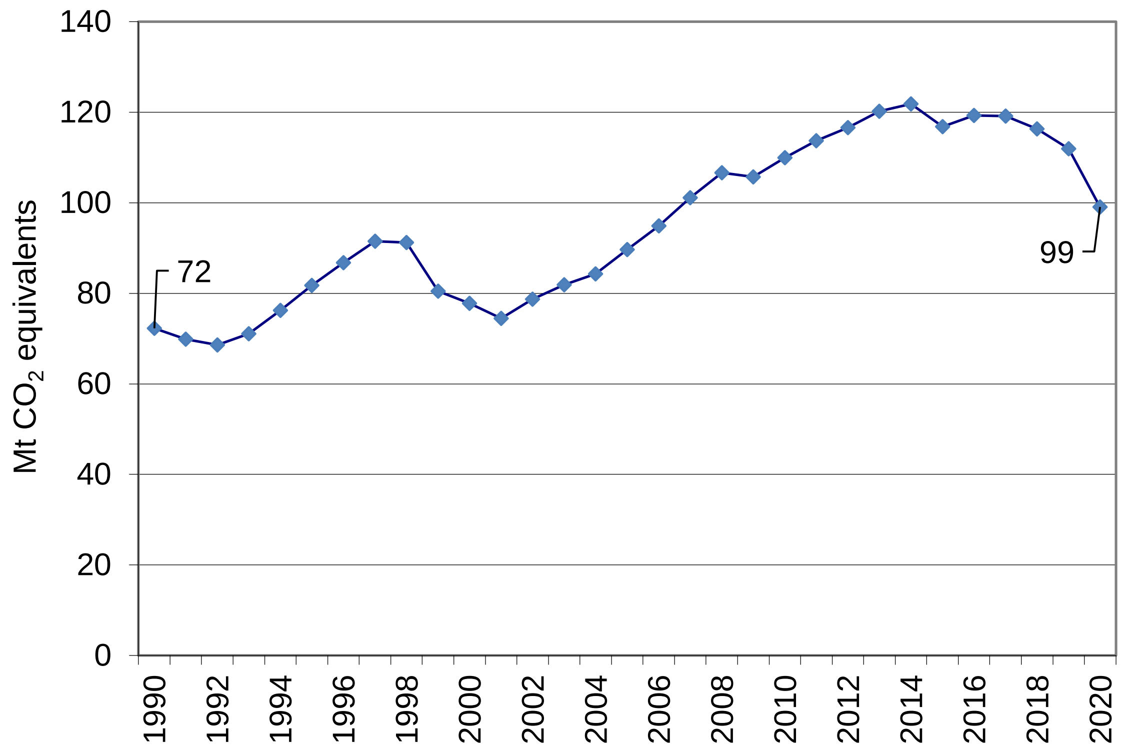
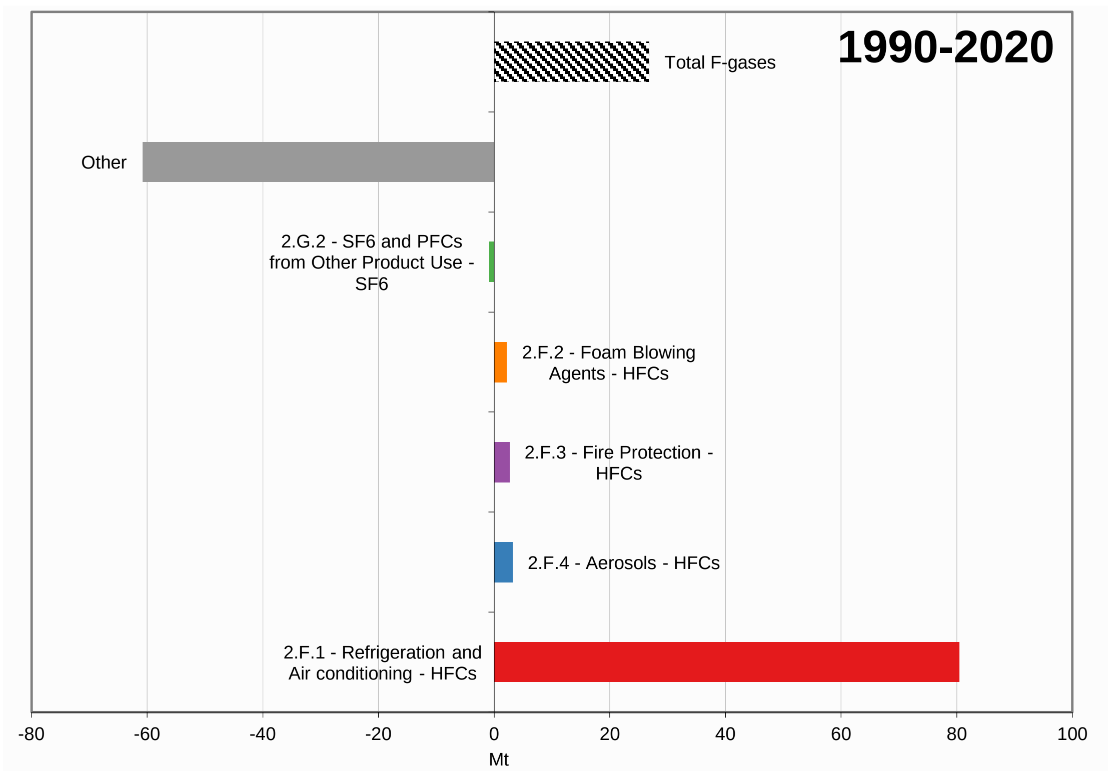
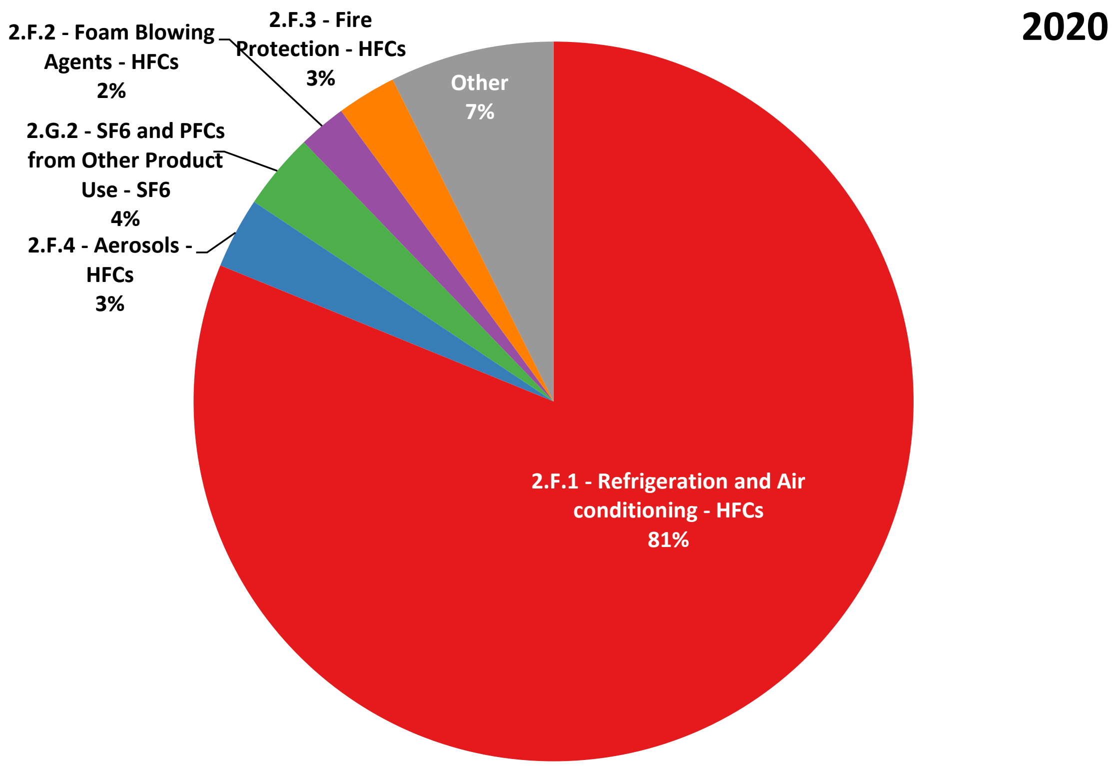


Figure 2.12 Absolute change of fluorinated gas emissions by large key source categories 1990 to 2020 in CO_2 equivalents (Mt) for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 2.13 Fluorinated gas: Share of key source categories and all remaining categories in 2020 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total
Percentages are rounded and may lead to a sum higher or lower than 100%

2.3 Emission trends by source

Table 2.5 gives an overview of EU-KP emissions in the main source categories for 1990–2020. The most important sector in terms of GHG emissions is energy (i.e. combustion and fugitive emissions), which accounted for 76 % of total emissions in 2020. The second largest sector is agriculture (11 %), followed by industrial processes (9 %). More detailed trend descriptions are included in the individual sector chapters (chapters 3-7) and chapter 9 on indirect CO_2 emissions.

Table 2.5 Overview of EU-KP GHG emissions (in million tonnes CO_2 equivalent) in the main source and sink categories for the period 1990 to 2020

GHG SOURCE AND SINK	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Energy	4 323	4 062	3 995	4 108	3 795	3 651	3 609	3 510	3 323	3 364	3 348	3 351	3 270	3 113	2 801
2. Industrial Processes	548	523	480	487	407	404	393	396	402	393	391	400	392	382	351
3. Agriculture	532	466	457	434	419	418	417	420	427	428	430	433	429	425	424
4. Land-Use, Land-Use Change and Forestry	-191	-272	-282	-295	-309	-308	-315	-315	-298	-290	-285	-232	-238	-224	-217
5. Waste	238	244	227	199	166	160	156	150	144	141	137	136	135	133	130
6. Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	4	4	3	3	2	2	2	2	2	2	2	2	2	2	1
Total (with net CO_2 emissions/removals)	**5 456**	**5 026**	**4 880**	**4 936**	**4 480**	**4 326**	**4 261**	**4 162**	**4 000**	**4 038**	**4 024**	**4 090**	**3 990**	**3 830**	**3 491**
Total (without LULUCF)	**5 647**	**5 299**	**5 162**	**5 231**	**4 789**	**4 635**	**4 576**	**4 477**	**4 298**	**4 329**	**4 308**	**4 322**	**4 228**	**4 054**	**3 708**

2.4 Emission trends by Member State

Table 2.6 gives an overview of EU countries contributions to the EU-KP emissions for 1990–2020. Countries show large variations in GHG emission trends.

Table 2.6 Overview of countries contributions to total EU GHG emissions, excluding LULUCF, including indirect CO_2 emissions, from 1990 to 2020 in million tonnes CO_2-equivalent

Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Austria	78	79	80	92	84	82	79	80	76	78	79	82	79	80	74
Belgium	146	154	149	146	134	123	120	120	115	119	117	117	118	116	106
Bulgaria	98	72	57	62	59	65	60	56	59	62	60	63	60	59	49
Croatia	31	22	25	30	28	28	26	25	24	24	25	25	24	25	24
Cyprus	5.6	7.0	8.3	9.2	9.5	9.2	8.6	7.9	8.3	8.3	8.8	9.0	8.9	8.9	8.9
Czechia	199	158	151	149	141	139	135	130	128	129	130	131	129	124	113
Denmark	71	79	71	67	64	59	54	56	52	49	51	49	48	45	42
Estonia	40	20	17	19	21	21	20	22	21	18	20	21	20	15	12
Finland	71	72	70	70	76	68	62	63	59	55	58	55	56	53	48
France	544	536	549	551	507	483	485	486	455	458	459	463	443	435	393
Germany	1242	1115	1037	987	936	911	917	934	894	898	901	886	851	800	729
Greece	103	109	127	136	119	116	112	103	99	95	92	96	92	86	75
Hungary	95	77	75	77	66	64	61	58	58	61	62	65	65	65	63
Ireland	54	59	68	70	62	58	59	59	58	60	63	62	62	60	58
Italy	520	534	557	591	518	505	486	450	429	442	439	433	430	418	381
Latvia	26	12	10	11	12	11	11	11	11	11	11	11	11	11	10
Lithuania	48	22	19	23	21	21	21	20	20	20	20	21	20	20	20
Luxembourg	13	10	10	13	12	12	12	11	11	10	10	10	11	11	9
Malta	2.6	2.7	2.8	3.0	2.9	2.9	3.1	2.8	2.8	2.1	1.8	2.0	2.0	2.1	2.1
Netherlands	221	230	218	213	212	198	193	194	186	193	194	191	186	180	164
Poland	476	447	397	405	413	412	404	400	387	389	400	414	413	391	376
Portugal	58	68	82	86	69	67	66	64	64	68	66	71	67	64	58
Romania	250	185	139	147	123	130	128	116	115	115	113	117	118	114	110
Slovakia	73	53	49	51	46	45	42	42	40	41	41	42	42	40	37
Slovenia	19	19	19	20	20	20	19	18	17	17	18	18	18	17	16
Spain	290	330	388	442	358	358	351	324	326	337	326	339	333	314	275
Sweden	71	73	68	67	65	60	58	56	54	54	54	53	52	51	46
United Kingdom	793	745	710	687	605	560	577	563	523	505	480	469	460	444	402
EU-27+UK	**5640**	**5292**	**5154**	**5224**	**4781**	**4627**	**4569**	**4469**	**4291**	**4321**	**4300**	**4314**	**4220**	**4046**	**3700**
Iceland	3.7	3.5	4.1	4.0	4.9	4.6	4.7	4.7	4.7	4.7	4.7	4.8	4.8	4.7	4.5
United Kingdom (KP)	796	748	714	690	608	563	580	566	526	508	483	472	463	447	405
EU-KP	**5647**	**5299**	**5162**	**5231**	**4789**	**4635**	**4576**	**4477**	**4298**	**4329**	**4308**	**4322**	**4228**	**4054**	**3708**

The overall EU-KP GHG emission trend is dominated by the three largest emitters Germany (20 %), the United Kingdom (11 %) and France (11 %), accounting for over forty percent of total EU-KP GHG emissions in 2020. Germany and the United Kingdom, the two countries with the highest absolute reductions, achieved total domestic GHG emission reductions of 905 million tonnes CO_2 equivalent compared to 1990, not counting carbon sinks and the use of Kyoto mechanisms.

The main reasons for the favourable trend in Germany were an increase in the efficiency of power and heating plants and the economic restructuring of the five new “Länder” after the German reunification, particularly in the iron and steel sector. Other important reasons include a reduction in the carbon intensity of fossil fuels (with the switch from coal to gas), a strong increase in renewable energy use and waste management measures that reduced the landfilling of organic waste.

Lower GHG emissions in the United Kingdom were primarily the result of liberalising energy markets and the subsequent fuel switch from oil and coal to gas in electricity production. Other reasons include the shift towards more efficient combined cycle gas turbine stations, decreasing iron and steel production and the implementation of methane recovery systems at landfill sites.

France's emissions were 28 % below 1990 levels in 2020. France achieved large reductions in N_2O emissions in the chemical industry; also emissions in the large energy-related categories were below 1990 levels in 2020. However, HFC emissions from electronics industry and product uses as substitutes of ODS increased considerably between 1990 and 2020.

Italy, Poland and Spain were the fourth, fifth and sixth largest emitters in the EU-KP with a share in total GHG emissions of 10 %, 10 % and 7 %, respectively.

Italy's GHG emissions were 27 % below 1990 levels in 2020. Italian emissions decreased significantly since 2007 with a significant drop in 2009, which was mainly due to the economic crisis and reductions in industrial output. Since 2010 emissions were decreasing continuously with one exemption in 2015.

Poland's GHG emissions were 21 % below 1990 levels in 2020. The main factors for decreasing emissions in Poland — as with other Member States — were the decline of energy-inefficient heavy industry and the overall restructuring of the economy in the late 1980s and early 1990s. The notable exception was transport (especially road transport), where emissions increased.

Spain's emissions were 5 % below 1990 levels in 2020. Emission increases from road transport and households and services where offset – in particular in 2020 – by emission reductions from electricity and heat production.

2.5 Emission trends for indirect greenhouse gases and sulphur dioxide

Emissions of CO, NO_x, NMVOC and SO_2 have to be reported to the UNFCCC Secretariat because they influence climate change indirectly: CO, NO_x and NMVOC are precursor substances for ozone which itself is a greenhouse gas. Sulphur emissions produce microscopic particles (aerosols) that can reflect sunlight back out into space and also affect cloud formation. Table 2.7 shows the total indirect GHG and SO_2 emissions in the EU-KP between 1990 and 2020. All emissions were reduced significantly from 1990 levels: the largest reduction was achieved in SO_2 (-94 %) followed by, CO (-75 %), NO_x (-68 %) and NMVOC (-65 %).

Table 2.7 Overview of EU-KP indirect GHG and SO_2 emissions for 1990–2020 (kt)

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
NO_X	17797	15476	13475	12375	9841	9468	9168	8760	8387	8243	7933	7830	6750	6390	5632
CO	65233	52747	41045	32183	27131	24758	24834	23855	21677	21960	21387	21078	17932	17453	16489
NMVOC	17882	14551	11954	9922	8303	7890	7736	7501	7271	7232	7172	7242	6453	6358	6186
SO_2	24074	15686	9603	7378	4336	4193	3919	3482	3233	3154	2691	2671	1928	1719	1436

Table 2.8 shows the NO_x emissions of the EU-KP countries between 1990 and 2020. The largest emitters, Germany, France, the United Kingdom and Spain made up 48 % of total NO_x emissions in 2020. All countries reduced their NO_x emissions between 1990 and 2020.

Table 2.9 shows the CO emissions between 1990 and 2020. The largest emitters, France, Germany, Italy, Romania and Spain that made up 61 % of the total CO emissions in 2020, reduced their emissions from 1990 levels substantially. Also all other countries with the exception of Iceland reduced CO emissions.

Table 2.10 shows the NMVOC emissions of the EU-KP countries between 1990 and 2020. The largest emitters France, Germany, Italy and the UK that made up 58 % of the total NMVOC emissions in 2020, reduced their emissions from 1990 levels, together with all countries except Malta.

Table 2.11 shows the SO_2 emissions of the EU-KP countries between 1990 and 2020. The largest emitters, Bulgaria, Germany, Spain and the UK that made up 53 % of the total SO_2 emissions in 2020, reduced their emissions from 1990 levels substantially, together with all other countries except Iceland.

Table 2.8 Overview of Member States' contributions to EU-KP NOx emissions for 1990–2020 (kt)

Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Austria	218	198	211	246	203	194	189	188	180	177	170	161	150	142	123
Belgium	422	411	357	325	242	225	214	205	195	195	183	172	166	154	133
Bulgaria	203	131	98	103	95	106	93	84	88	92	85	91	82	78	63
Croatia	111	82	91	90	73	69	61	60	57	58	58	58	53	52	49
Cyprus	18	21	22	22	18	21	20	15	16	13	13	13	12	14	11
Czechia	730	373	290	282	237	223	210	196	190	183	174	170	164	152	136
Denmark	297	286	221	201	147	138	127	122	113	112	111	109	103	96	89
Estonia	95	51	44	40	43	41	39	35	35	35	37	37	37	33	32
Finland	298	266	235	200	179	164	155	151	143	132	128	124	120	113	98
France	2133	1959	1792	1568	1217	1161	1130	1108	1018	990	939	911	855	810	683
Germany	2839	2186	1893	1632	1445	1419	1411	1410	1365	1342	1315	1264	1179	1106	978
Greece	315	320	350	401	315	293	243	243	236	233	230	250	241	234	206
Hungary	244	188	186	177	146	136	129	126	125	127	119	120	119	113	106
Ireland	168	170	181	175	120	107	109	111	110	112	112	110	110	102	94
Italy	2128	1992	1510	1294	941	903	853	781	757	719	704	662	662	642	573
Latvia	96	51	42	45	40	38	38	37	37	36	35	35	36	34	32
Lithuania	150	72	61	62	56	55	55	51	54	56	56	54	55	54	52
Luxembourg	40	34	41	56	39	39	37	33	31	28	25	22	20	19	15
Malta	7.0	8.5	8.4	9.8	10.3	9.0	9.6	7.7	7.7	6.5	5.8	5.4	5.1	5.6	5.2
Netherlands	591	493	409	358	299	285	273	264	250	250	240	229	221	208	190
Poland	1090	1053	852	869	888	872	836	796	747	725	742	804	NO,IE,N	NO,IE,N	NO,IE,N
Portugal	259	296	299	282	202	185	172	168	165	168	161	164	157	151	133
Romania	494	396	374	325	255	262	286	238	230	229	215	210	208	206	211
Slovakia	136	113	110	106	88	81	77	75	74	72	68	67	67	61	54
Slovenia	75	75	59	55	48	47	46	43	39	35	34	34	32	29	25
Spain	1396	1439	1463	1450	1033	1029	976	898	886	915	877	890	875	820	696
Sweden	291	260	224	195	171	164	157	153	151	147	144	139	135	127	118
United Kingdom	2905	2502	2005	1763	1252	1165	1186	1124	1050	1014	921	891	851	802	700
EU-27+UK	**17751**	**15426**	**13427**	**12332**	**9802**	**9431**	**9131**	**8724**	**8350**	**8203**	**7900**	**7795**	**6716**	**6358**	**5605**
Iceland	31	34	33	29	26	24	24	23	22	23	21	21	22	21	19
United Kingdom (KP)	2920	2517	2021	1778	1264	1179	1199	1136	1065	1031	932	905	864	814	708
EU-KP	**17797**	**15476**	**13475**	**12375**	**9841**	**9468**	**9168**	**8760**	**8387**	**8243**	**7933**	**7830**	**6750**	**6390**	**5632**

Table 2.9 Overview of Member States' contributions to EU-KP CO emissions for 1990–2020 (kt)

Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Austria	1253	971	724	625	578	560	560	563	527	537	532	523	482	496	474
Belgium	1508	1278	994	798	494	396	340	511	317	366	349	282	326	358	265
Bulgaria	272	193	103	102	87	102	89	86	72	77	88	92	82	73	65
Croatia	557	447	469	418	329	306	290	279	246	268	260	254	231	218	216
Cyprus	45	39	29	24	14	13	12	12	12	11	12	11	10	10	8.5
Czechia	2045	1547	1103	942	925	888	877	889	857	852	851	851	859	827	796
Denmark	718	644	473	424	349	306	288	275	251	256	246	237	220	205	192
Estonia	230	178	162	142	142	125	128	122	119	118	125	128	132	130	134
Finland	725	642	571	504	434	393	392	377	373	356	364	355	347	339	314
France	11060	9285	6664	5265	4143	3449	3158	3206	2683	2650	2684	2635	2513	2474	2179
Germany	13081	7100	5084	3837	3513	3429	3175	3134	2965	3069	2946	2961	2852	2753	2455
Greece	1276	1103	1050	897	633	618	683	572	577	551	490	487	456	444	411
Hungary	1414	946	823	671	526	536	552	545	465	450	436	427	364	347	333
Ireland	562	419	325	284	216	198	191	190	177	177	174	148	144	125	121
Italy	6796	7071	4750	3467	3073	2433	2697	2502	2256	2266	2191	2258	2049	2060	1873
Latvia	457	323	250	229	159	161	159	140	130	107	105	111	114	110	97
Lithuania	370	209	175	169	155	147	143	133	125	118	117	115	116	110	105
Luxembourg	469	213	46	39	29	27	28	27	25	21	22	22	20	21	16
Malta	20	20	14	11	14	13	12	11	11	10	9.3	10	7.6	7.2	5.7
Netherlands	1224	886	814	737	683	659	636	608	586	584	568	560	538	520	459
Poland	3641	4659	3356	3089	3077	2781	2787	2658	2387	2343	2456	2543	NO,IE,N	NO,IE,N	NO,IE,N
Portugal	793	823	678	520	398	366	352	332	314	322	308	324	282	291	261
Romania	2394	2342	3518	2502	2180	2116	2925	2056	2007	2128	1997	1710	1623	1742	2228
Slovakia	1035	657	542	550	447	415	428	404	331	374	388	379	327	283	279
Slovenia	292	284	206	183	143	140	134	133	114	122	121	116	105	97	87
Spain	4229	3217	2797	2135	1956	1931	1628	1936	1676	1817	1670	1668	1881	1625	1462
Sweden	1099	943	654	504	414	394	367	360	349	336	337	330	310	301	288
United Kingdom	7570	6230	4589	3044	1896	1735	1682	1673	1604	1553	1419	1418	1413	1366	1254
EU-27+UK	**65138**	**52665**	**40965**	**32111**	**27007**	**24638**	**24713**	**23733**	**21556**	**21837**	**21266**	**20953**	**17807**	**17333**	**16377**
Iceland	70	62	65	61	118	115	116	117	116	119	118	122	122	117	110
United Kingdom (KP)	7595	6250	4605	3056	1903	1740	1687	1678	1609	1557	1423	1421	1416	1369	1255
EU-KP	**65233**	**52747**	**41045**	**32183**	**27131**	**24758**	**24834**	**23855**	**21677**	**21960**	**21387**	**21078**	**17932**	**17453**	**16489**

Table 2.10 Overview of Member States' contributions to EU-KP NMVOC emissions for 1990–2020 (kt)

Member State	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Austria	334	247	180	156	137	132	130	124	117	112	111	112	109	108	111
Belgium	353	311	234	183	144	132	128	124	118	117	116	114	113	112	113
Bulgaria	95	82	66	67	61	61	62	59	59	67	62	63	65	65	63
Croatia	162	114	99	109	88	83	78	73	67	68	69	67	67	72	68
Cyprus	10	10	9.5	6.3	5.0	4.8	4.8	4.2	4.2	4.1	4.2	4.2	4.1	4.1	3.7
Czechia	496	350	282	239	221	210	204	201	196	195	191	191	190	182	161
Denmark	213	210	182	155	132	125	120	121	113	115	111	109	108	103	107
Estonia	48	33	29	26	23	22	23	23	23	24	24	26	27	27	29
Finland	232	203	177	147	113	105	101	97	95	89	90	87	86	85	84
France	2931	2533	2089	1608	1236	1165	1115	1107	1090	1063	1040	1028	1006	989	955
Germany	3892	2342	1806	1487	1362	1272	1257	1212	1174	1147	1141	1145	1099	1072	1036
Greece	267	250	251	238	181	173	174	166	164	164	153	156	154	146	151
Hungary	306	210	188	172	130	133	134	131	122	126	126	123	117	117	112
Ireland	150	139	124	123	113	110	111	113	110	111	113	116	117	116	113
Italy	1993	2058	1630	1340	1116	1025	1032	996	924	897	880	921	894	888	885
Latvia	89	65	55	52	41	41	40	39	39	36	35	35	39	36	34
Lithuania	133	91	67	70	68	62	65	63	59	60	59	64	59	63	54
Luxembourg	28	21	16	15	11	11	12	11	11	10	10	10	10	11	10
Malta	1.5	1.7	1.5	1.9	4.0	3.5	4.2	4.6	4.0	4.5	4.4	4.2	4.2	4.7	4.2
Netherlands	402	265	199	154	145	144	139	137	131	131	129	127	121	117	110
Poland	706	825	732	721	712	694	676	633	631	641	672	686	NO,IE,N	NO,IE,N	NO,IE,N
Portugal	249	238	237	195	158	147	140	138	144	146	143	145	144	147	158
Romania	220	173	231	241	240	226	234	221	219	216	215	216	211	211	207
Slovakia	265	181	155	152	127	124	120	118	100	115	116	113	105	102	98
Slovenia	65	62	55	48	39	37	35	35	32	32	33	32	32	31	30
Spain	1078	947	917	763	601	580	557	543	537	551	557	578	592	584	563
Sweden	368	279	223	204	176	173	165	157	153	154	147	140	135	136	133
United Kingdom	2778	2294	1707	1238	911	884	866	838	825	825	810	819	836	823	784
EU-27+UK	**17866**	**14536**	**11941**	**9911**	**8293**	**7881**	**7727**	**7492**	**7263**	**7223**	**7163**	**7233**	**6444**	**6350**	**6178**
Iceland	10	10	8.7	7.5	5.9	5.7	5.6	5.5	5.6	5.8	6.0	5.8	5.9	5.7	5.4
United Kingdom (KP)	2785	2300	1711	1242	915	887	870	842	828	828	813	823	839	826	787
EU-KP	**17882**	**14551**	**11954**	**9922**	**8303**	**7890**	**7736**	**7501**	**7271**	**7232**	**7172**	**7242**	**6453**	**6358**	**6186**

Table 2.11 Overview of Member States' contributions to EU-KP SO2 emissions for 1990–2020 (kt)

Member State	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Austria	74	47	32	26	16	15	15	14	14	14	13	13	11	11	10
Belgium	364	258	170	143	61	53	47	43	41	41	34	32	32	29	24
Bulgaria	444	378	334	372	411	493	429	369	393	428	379	410	360	324	258
Croatia	170	77	60	58	35	29	24	17	14	16	14	12	10	7.4	5.9
Cyprus	32	40	48	38	22	21	16	13	17	13	16	16	17	16	12
Czechia	1755	1059	233	208	164	168	160	145	135	129	115	110	97	80	67
Denmark	178	145	32	26	15	14	13	13	11	10	10	10	11	9.3	9.1
Estonia	218	102	81	67	76	66	33	29	34	28	32	34	32	21	16
Finland	250	105	81	69	67	60	51	48	43	42	40	35	33	29	23
France	1306	965	643	484	286	242	241	221	178	171	155	149	140	114	104
Germany	5460	1742	643	473	403	387	368	357	335	334	309	301	289	259	233
Greece	511	521	563	585	231	168	142	131	114	112	107	106	99	89	71
Hungary	829	613	427	43	30	34	30	29	26	24	23	28	23	17	16
Ireland	183	163	144	73	27	25	23	23	17	16	15	14	14	11	11
Italy	1784	1323	757	411	222	200	180	149	132	126	120	117	109	105	82
Latvia	100	49	18	8.7	4.3	4.3	4.4	3.9	3.9	3.6	3.4	3.6	3.8	3.7	3.5
Lithuania	202	77	39	27	18	19	17	14	13	15	15	13	13	12	11
Luxembourg	16	9.2	3.6	2.6	1.7	1.3	1.5	1.6	1.4	1.3	0.9	1.0	0.9	0.9	0.8
Malta	10	11	10	12	8.3	8.2	8.0	5.2	4.8	2.2	1.8	0.8	0.1	0.1	0.1
Netherlands	188	127	71	63	34	34	34	30	29	30	28	26	25	22	19
Poland	2652	2141	1411	1171	874	836	803	768	724	711	591	583	NO,IE,N	NO,IE,N	NO,IE,N
Portugal	318	322	295	190	63	57	52	48	43	46	46	47	45	44	38
Romania	847	709	498	602	367	347	285	221	195	158	102	86	80	96	73
Slovakia	140	120	117	86	68	67	57	52	45	67	26	28	20	16	13
Slovenia	202	124	93	39	10	11	10	9.2	7.3	5.1	4.2	4.4	4.3	3.8	3.4
Spain	2129	1823	1420	1230	262	297	300	234	253	271	229	236	214	167	127
Sweden	103	71	45	36	29	26	26	23	21	18	19	18	17	16	15
United Kingdom	3571	2530	1291	787	454	427	461	398	323	261	190	186	173	155	136
EU-27+UK	**24037**	**15651**	**9558**	**7331**	**4259**	**4108**	**3831**	**3409**	**3166**	**3091**	**2639**	**2620**	**1873**	**1660**	**1383**
Iceland	23	22	35	41	74	82	85	70	64	58	49	47	52	56	51
United Kingdom (KP)	3584	2543	1300	793	458	429	464	400	326	265	193	189	176	158	138
EU-KP	**24074**	**15686**	**9603**	**7378**	**4336**	**4193**	**3919**	**3482**	**3233**	**3154**	**2691**	**2671**	**1928**	**1719**	**1436**

3 ENERGY (CRF SECTOR 1)

This chapter starts with an overview on emission trends in CRF Sector 1 Energy. For each EU-KP key category as well as other important subsector specific categories, overview tables are presented including the countries' contributions to the category in terms of level and trend. This chapter includes also, the reference approach, and international bunkers.

3.1 Overview of sector

CRF Sector 1 Energy comprises of the three sectors Fuel combustion activities (1.A), Fugitive emissions from fuels (1.B) and CO_2 Transport and storage (1.C). The energy sector contributes 76% to total GHG emissions and is the largest emitting sector in the EU-KP. Total GHG emissions from this sector decreased by 35% from 4323 Mt in 1990 to 2801 Mt in 2020 (Figure 3.1). In 2020, due to the covid-19 pandemic, emissions decreased by 10 % compared to 2019.

The most important energy-related gas is CO_2 that makes up 73% of the total EU-KP greenhouse gas emissions (without LULUCF) in 2020. CH_4 of the energy sector is responsible for 2% and N_2O for 1% of the total GHG emissions.

Figure 3.1 CRF Sector 1 Energy: EU-KP GHG emissions in CO_2 equivalents (Mt) for 1990–2020

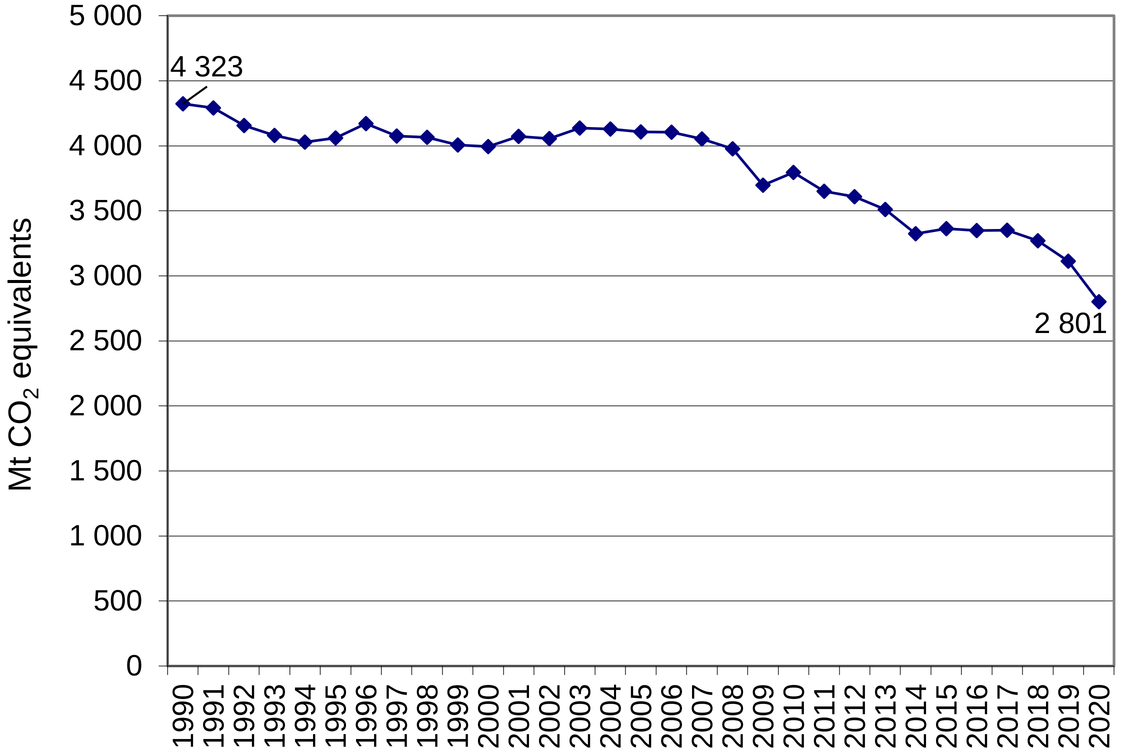
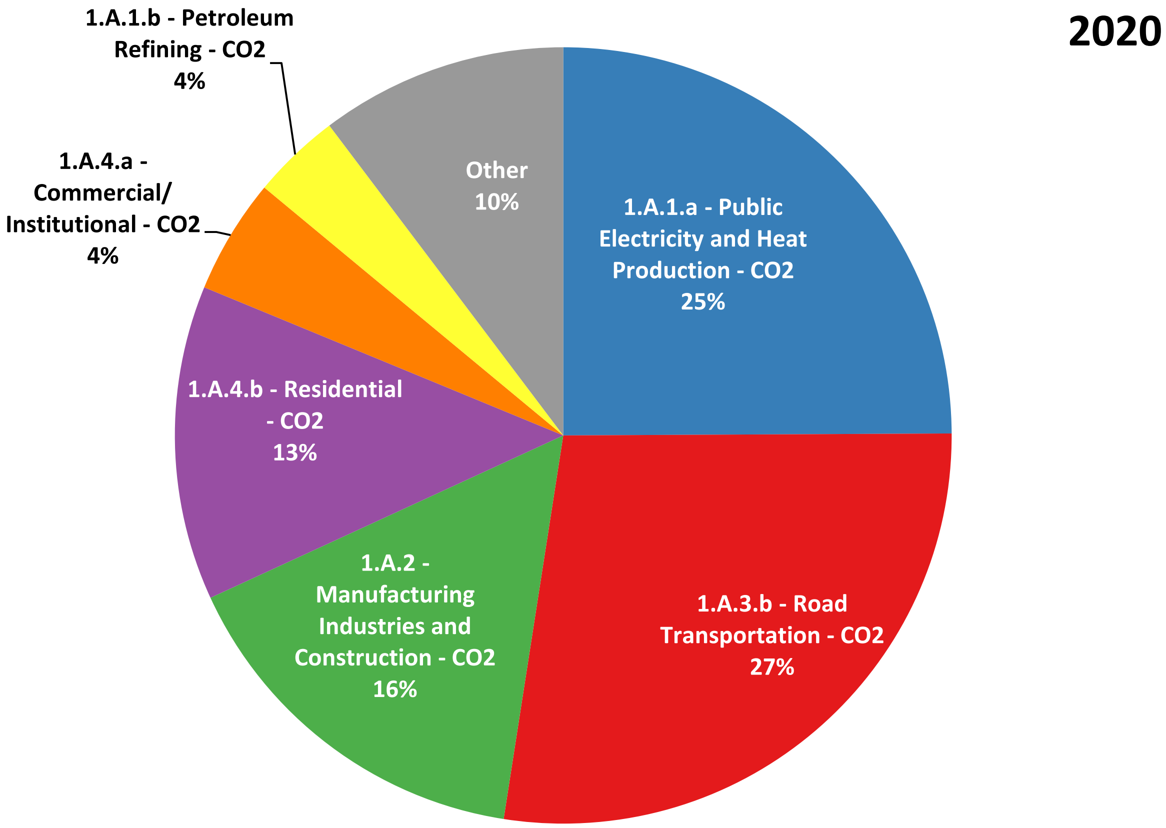


Figure 3.2 shows the share of the largest key categories in the sector Energy in 2020. The first chart illustrates that the three largest key categories account for 68 % and the largest six for 90 % of emissions in the whole sector 1. The two largest categories of the energy sector alone are responsible for 52 % of the total EU-KP emissions in 2020.

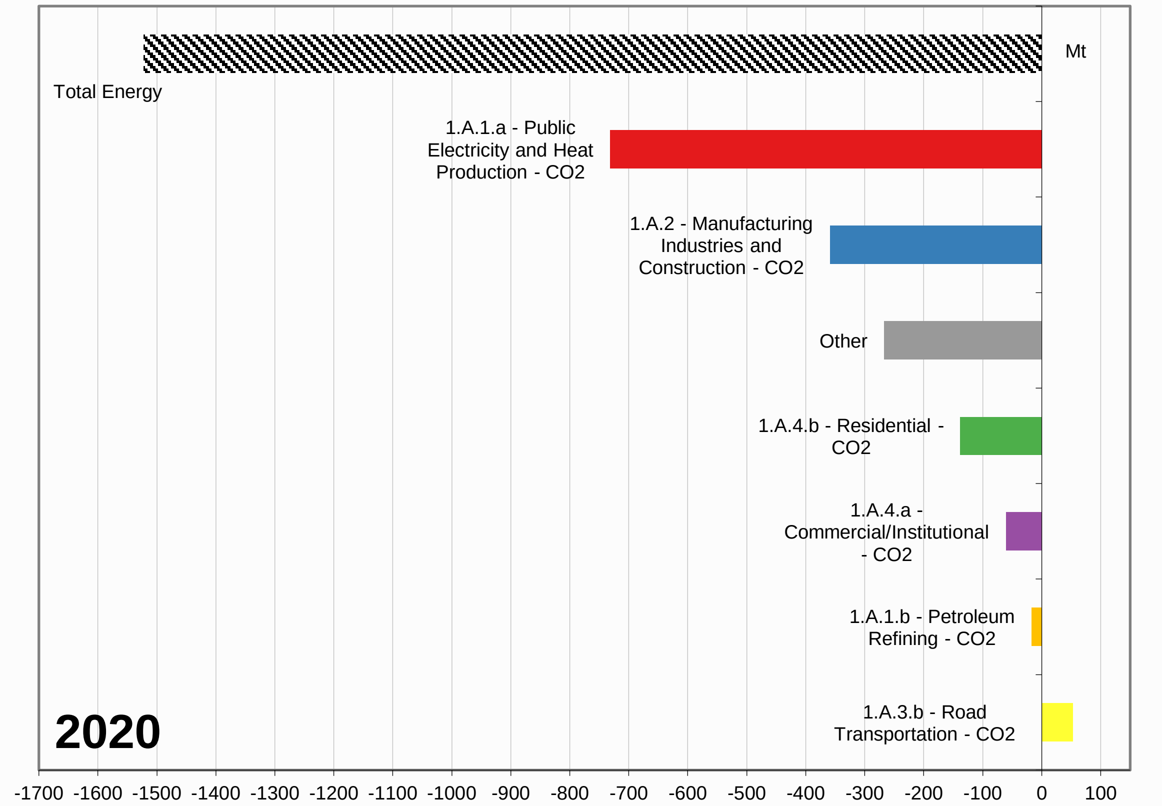
Figure 3.2 CRF Sector 1 Energy: Share of largest key source categories in 2020



Note: Remaining Energy categories is calculated by subtracting the presented categories (1.A.1.a, 1.A.1.b, 1.A.2, 1.A.3.b, 1.A.4.a and 1.A.4.b.) from the sector total

Furthermore, Figure 3.3 shows the absolute change of GHG emissions of these large key categories for the years 1990-2020. CO_2 emissions from 1.A.3.b Road Transportation had the highest increase in absolute terms of all energy-related emissions, while CO_2 emissions from 1.A.1.a Public Electricity and Heat Production as well as 1.A.2 Manufacturing Industries decreased substantially between 1990 and 2020. The decreases in Public Electricity and Heat Production and Manufacturing Industries as well as the increases in Road Transportation occurred in almost all countries. The decline of Fugitive Emissions from Fuels (CH_4) and decreasing CO_2 emissions from 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries are the main reasons for the large absolute emission reductions from “remaining Energy categories” in Figure 3.3.

Figure 3.3 CRF Sector 1 Energy: Absolute change of GHG emissions in CO_2 equivalents (Mt) by large key categories for 1990-2020



Note: Remaining Energy categories is calculated by subtracting the presented categories (1.A.1.a, 1.A.1.b, 1.A.2, 1.A.3.b, 1.A.4.a and 1.A.4.b.) from the sector total

The key categories in the energy sector are as follows:

- 1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)
- 1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)
- 1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)
- 1.A.1.a Public Electricity and Heat Production: Peat (CO_2)
- 1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)
- 1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)
- 1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)
- 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)
- 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)
- 1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)
- 1.A.2.a Iron and Steel: Liquid Fuels (CO_2)
- 1.A.2.a Iron and Steel: Solid Fuels (CO_2)
- 1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)
- 1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)
- 1.A.2.c Chemicals: Gaseous Fuels (CO_2)
- 1.A.2.c Chemicals: Liquid Fuels (CO_2)
- 1.A.2.c Chemicals: Solid Fuels (CO_2)
- 1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)
- 1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)

- 1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)
- 1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)
- 1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)
- 1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Other Fuels (CO_2)
- 1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)
- 1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)
- 1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)
- 1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)
- 1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)
- 1.A.3.b Road Transportation: Diesel Oil (CO_2)
- 1.A.3.b Road Transportation: Diesel Oil (N_2O)
- 1.A.3.b Road Transportation: Gaseous Fuels (CO_2)
- 1.A.3.b Road Transportation: Gasoline (CH_4)
- 1.A.3.b Road Transportation: Gasoline (CO_2)
- 1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)
- 1.A.3.c Railways: Liquid Fuels (CO_2)
- 1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)
- 1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)
- 1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)
- 1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)
- 1.A.4.a Commercial/Institutional: Other Fuels (CO_2)
- 1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)
- 1.A.4.b Residential: Biomass (CH_4)
- 1.A.4.b Residential: Gaseous Fuels (CO_2)
- 1.A.4.b Residential: Liquid Fuels (CO_2)
- 1.A.4.b Residential: Solid Fuels (CH_4)
- 1.A.4.b Residential: Solid Fuels (CO_2)
- 1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)
- 1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)
- 1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)
- 1.A.5.a Other Other Sectors: Solid Fuels (CO_2)
- 1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)
- 1.B.1.a Coal Mining and Handling: Operation (CH_4)
- 1.B.2.a Oil: Operation (CH_4)
- 1.B.2.a Oil: Operation (CO_2)
- 1.B.2.b Natural Gas: Operation (CH_4)
- 1.B.2.c Venting and Flaring: Operation (CO_2)

3.2 Source categories

3.2.1 Energy Industries (CRF Source Category 1.A.1)

Energy Industries (CRF 1.A.1) comprises emissions from fuels combusted by the fuel extraction or energy-producing industries and is subdivided in three categories: Public electricity and heat production (CRF 1.A.1.a), Petroleum-refining (CRF 1.A.1.b), and Manufacture of solid fuels and other energy industries (CRF 1.A.1.c). Each category is described in its own chapter.

Table 3.1 shows the nine key categories of sector 1.A.1, including information on whether the reasons for this categorization lie in their emission trend and/or level. Furthermore, it entails information on the share of higher tier methods used by the countries. In sector 1.A.1.a Germany, Poland, the United Kingdom and Italy have mainly been influencing this share of higher tier methods because of their weight of emissions. The same applies for Italy, Germany, the United Kingdom and Spain in sector 1.A.1.b and the United Kingdom, Germany, Italy and Czechia in sector 1.A.1.c.

Table 3.1: Key source categories for level and trend analyses and share of MS emissions using higher tier methods in sector 1.A.1

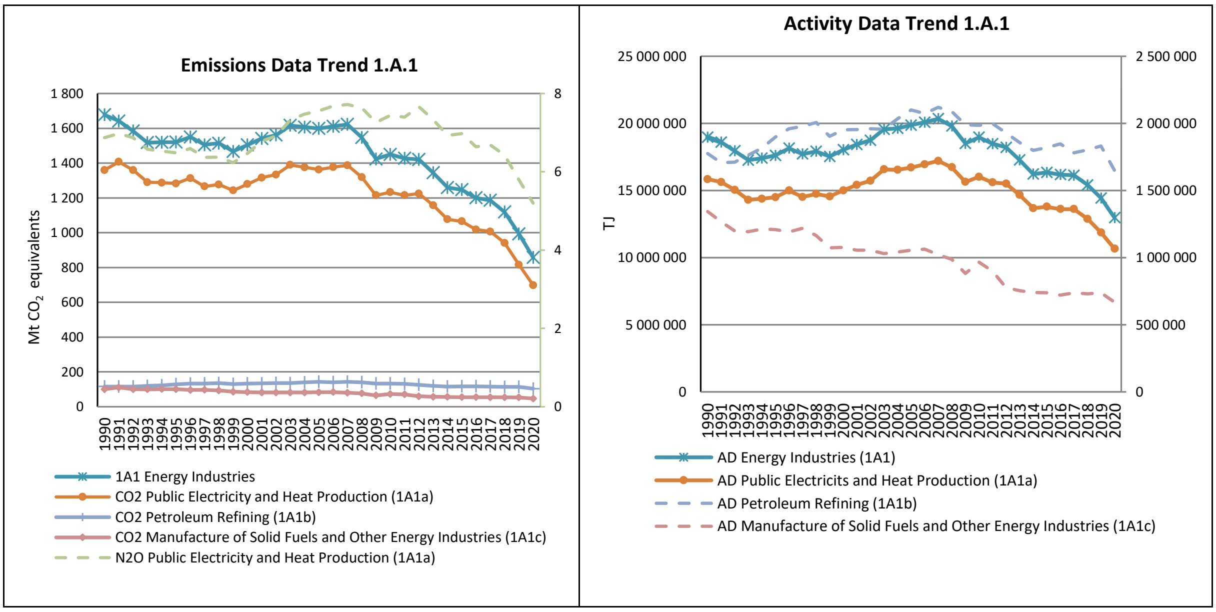
Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CO_2)	107640	235579	T	L	L	97.0 %
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CO_2)	176699	21927	T	L	L	98.1 %
1.A.1.a Public Electricity and Heat Production: Other Fuels (CO_2)	10744	43273	T	L	L	93.6 %
1.A.1.a Public Electricity and Heat Production: Peat (CO_2)	9162	5051	0	L	L	97.7 %
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CO_2)	1126033	392059	T	L	L	95.2 %
1.A.1.b Petroleum Refining: Gaseous Fuels (CO_2)	5277	25622	T	0	L	98.4%
1.A.1.b Petroleum Refining: Liquid Fuels (CO_2)	111002	75626	T	L	L	98.1%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CO_2)	20093	18155	T	L	L	92.3%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CO_2)	91155	25360	T	L	L	97.2%

Figure 3.4 shows the trends in emissions in Energy Industries for the EU-KP between 1990 and 2020, which was mainly dominated by CO_2 emissions from public electricity and heat production. Carbon dioxide from 1.A.1.a currently represents about 85% of greenhouse gas emissions in 1.A.1 in 1990 (i.e. including methane and nitrous oxide) with a drop to 81.4% in 2020 due to the large decrease of emissions from 1.A.1.a.

Total greenhouse gas emissions from 1.A.1 decreased by 48.9%, between 1990 and 2020. This was mainly due to a decrease of CO_2eq emission from Public Electricity and Heat Production (- 731.4 Mt CO_2eq) followed by -71 Mt CO_2eq of the manufacturing of solid fuels and -17.7 Mt CO_2eq from petroleum refining.

The decrease in fuel consumption since 2006 can be explained by the continuing effects of the economic downturn, the increased use of renewables, but also by enhanced energy efficiency in the newer EU Member States as well as mild winters. The reduction is particularly visible between 2019 and 2020 due to the COVID pandemic situation.

Figure 3.4 1.A.1 Energy Industries: Total GHG, CO_2 and N_2O emission trends and Activity Data



Note: Data displayed as dashed line refers to the secondary axis.

Table 3.2 breaks down the information by country. Between 1990 and 2020, greenhouse gas emissions from energy industries increased in two countries and fell in 27. The highest absolute increase was accounted for by Cyprus with 1.3 Mt CO_2e respectively 7%. Germany, the United Kingdom and Poland, followed by Italy and Romania account for the largest part of reductions (-581.8 Mt CO_2eq). The change in the EU-KP was a net decrease of about 820 Mt CO_2eq or 49% in 30 years. The table shows the emissions of GHG, N_2O and CH_4 separately expressed in CO_2eq. The latter two greenhouse gases only contribute a very small part (combined approximately 1%) of the total emissions in energy industries.

In terms of absolute contributions to EU-KP greenhouse gas emissions from energy industries, this sector is clearly dominated by Germany, Poland, Italy and the United Kingdom. The first two combined are responsible for 41%, all four countries represent 59.5% and the top six countries account for 70.2% of the EU-KP's greenhouse gas emissions from energy industries.

Table 3.2 1.A.1 Energy industries: Countries' contributions to CO_2, N_2O and CH_4 emissions

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt		N2O emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020	1990	2020
Austria	14 011	8 807	13 961	8 686	42	97	8	25
Belgium	29 746	19 015	29 547	18 834	179	144	20	37
Bulgaria	36 538	18 250	36 401	18 142	124	89	13	18
Croatia	7 089	3 696	7 066	3 659	17	26	5	11
Cyprus	1 767	3 033	1 761	3 023	4	7	2	3
Czechia	56 855	41 603	56 594	41 368	245	201	17	34
Denmark	26 257	7 351	26 156	7 191	86	76	15	84
Estonia	28 288	5 848	28 271	5 809	15	26	3	13
Finland	18 969	13 130	18 843	12 868	116	233	10	29
France	66 338	37 115	65 823	36 822	448	248	66	45
Germany	427 353	212 476	423 906	208 312	3 167	1 807	280	2 356
Greece	43 253	24 486	43 094	24 429	145	47	14	11
Hungary	20 872	12 338	20 795	12 261	67	53	9	24
Ireland	11 223	8 648	11 145	8 513	71	124	7	11
Italy	137 646	81 797	136 941	81 353	477	326	227	118
Latvia	6 318	1 368	6 302	1 329	11	24	5	15
Lithuania	13 553	2 648	13 522	2 584	21	39	10	24
Luxembourg	36	229	33	213	1	10	1	6
Malta	1 766	811	1 759	810	6	1	1	0
Netherlands	53 364	47 833	53 147	47 438	148	257	69	137
Poland	235 395	139 757	234 294	138 996	1 018	653	82	109
Portugal	16 420	10 387	16 366	10 251	49	124	6	13
Romania	71 189	18 339	70 967	18 263	183	65	38	12
Slovakia	18 966	6 447	18 893	6 404	65	29	8	14
Slovenia	6 377	4 517	6 349	4 492	25	22	2	3
Spain	78 881	43 556	78 541	43 018	289	400	51	138
Sweden	9 928	7 497	9 792	7 266	120	185	17	46
United Kingdom	238 637	75 858	236 971	74 781	1 434	697	232	380
EU-27+UK	**1 677 033**	**856 839**	**1 667 239**	**847 114**	**8 574**	**6 008**	**1 219**	**3 717**
Iceland	14	2	13	2	0	0	0	0
United Kingdom (KP)	239 329	76 610	237 660	75 529	1 436	699	233	381
EU-KP	**1 677 738**	**857 593**	**1 667 942**	**847 864**	**8 576**	**6 011**	**1 220**	**3 718**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Public heat and electricity production is the main source of emissions from energy industries. Furthermore, it is the largest source category in the EU-KP greenhouse gas inventory. Differences in the intensity of greenhouse gas emissions of heat and electricity production between the countries are to a large extent explained by the mix of fuels or technologies, which are used. Some countries rely more on coal than on gas. At the EU-KP level, 31.3% of the fuel used in energy industries comes from solid fuels. Its contribution has been declining in favour of the relatively cleaner natural gas, which is the first source of energy in 2020 with about 38.0% and biomass which has been constantly increasing with a share of 14.6% in 2020.

As can be seen in Figure 3.5 Germany, Poland, Italy and the United Kingdom contribute 59.5% of the total CO_2 emissions in sector 1.A.1 Energy industries in the year 2020. The relatively low share of greenhouse gas emissions from energy industries in France can be partly explained by the use of nuclear and hydro energy for power generation.

Figure 3.5 1.A.1 Energy Industries, all fuels: Emission trend and share for CO_2

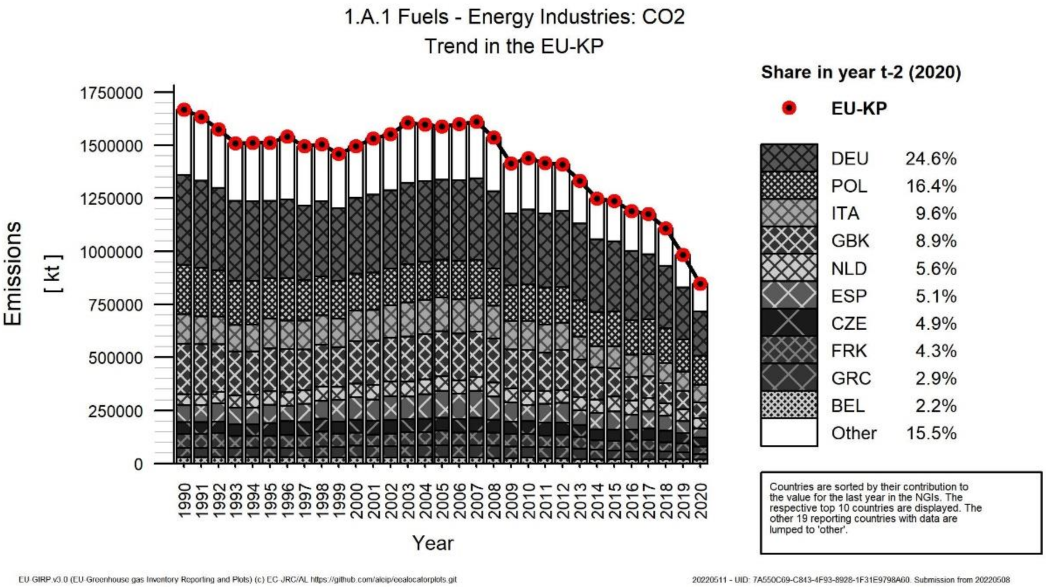


Table 3.3 provides information on the countries' contribution to EU-KP recalculations in CO_2 from 1.A.1 Energy Industries for 1990 and 2019 as well as the main explanations for the largest recalculations in absolute terms.

Table 3.3 1.A.1 Energy Industries: Contribution of countries to EU-KP recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	-111	-1.1	-	Revision of energy balance (mainly -109 kt from gaseous fuels)
Belgium	-313	-1.0	-269	-1.3	In Flemish region: no difference in emissions / Brussels region: -0.01 kt due to the correction of the emission factor for the turbojet/in Walloon region: -312.59 kt due to the reallocation of the emissions from a gas turbine power plant from the sector "energy industries" to the sector "Chemical industries".	In Flemish region: no difference in emissions / in Brussels region: + 107.03 kt due to the update of data for the incinerator, the update of the energy balance and the correction of the emission factor for the turbojet/in Walloon region: -377 kt due to the reallocation of the emissions from a gas turbine power plant from the sector "energy industries" to the sector "Chemical industries" and update of the energy balance.
Bulgaria	-1.6	-0.0	4.8	0.0	-	-
Croatia	-	-	-	-	-	-

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Cyprus	-	-	-	-	-	-
Czechia	0.0	0.0	0.4	0.0	-	-
Denmark	5.3	0.0	60	0.7	For stationary combustion plants, the emission estimates for the years 1990-2019 have been updated according to the latest energy statistics published by the Danish Energy Agency.	
Estonia	-0.0	-0.0	0.0	0.0	-	-
Finland	-	-	1.5	0.0	-	-
France	-12	-0.0	3 462	9.1	-	Transfer of fuel consumptions from autoproducers of heat and electricity selling their produced energy to manufacturing industries from 1A2 to 1A1a, from 2011 onwards. In 2019, there is also a difference relating to waste incineration with energy recovery (1A1a), due to the inclusion of the new national MODECOM 2017 survey. This leads to a change in the ratio of fossil carbon / biogenic. The share of fossil carbon in incinerated waste is higher and so are GHG emissions.
Germany	-	-	1 330	0.5	-	update of provisional 2019 energy balance data with actual ones
Greece	-	-	-	-	-	-
Hungary	0	0.0	119	1.0	-	Revised AD, no methodological change. For example, natural gas consumption in 1A1a was revised by +2PJ in 2019.
Ireland	-	-	-18	-0.2	-	-
Italy	-	-	97	0.1	-	Update of natural gas EF.
Latvia	-	-	-	-	-	-
Lithuania	-	-	-	-	-	-
Luxembourg	-	-	-0.7	-0.3	-	AD changes due to small revisions of energy balance, change of country-specific CO_2 emission factors for liquid fuels, revision of AD for MSW.
Malta	-	-	-	-	-	-
Netherlands	-	-	97	0.2	-	Final energy statistics and improved allocation biogenic part of natural gas
Poland	-	-	-7.5	-0.0	-	-
Portugal	-	-	-	-	-	-
Romania	244	0.3	710	3.3		Recalculation are due to the including of the activity data from reports monitoring of economic operators under EU ETS scheme for the fuels (Other Bituminous Coal, Sub-bituminous Coal, Lignite, Coke

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						Oven Coke, Refinery Gas, LPG, Transport Diesel, Residual Fuel Oil, Petroleum Coke, Heating and Other Gasoil and Natural Gas).
Slovakia	-	-	-49	-0.7	-	Recalculation of municipal waste incineration due to correction of activity data from the Statistical Office.
Slovenia	2.0	0.0	5.5	0.1	Improved CS CO_2 EF for natural gas.	
Spain	-	-	936	1.7	-	Correction of error: Error when putting the data in the database, Huelva regasification plant (0511) part 01
Sweden	-	-	-4.3	-0.1	-	Revision of waste fuel for one plant.
United Kingdom	2 250	1.0	-232	-0.3		Reallocations of some sites that had previously been considered upstream but are actually downstream.
EU27+UK	**2 175**	**0.1**	**6 131**	**0.6**		
Iceland	0.0	0.0	0	0.0	-	-
United Kingdom (KP)	2 250	1.0	-183	-0.2		
EU-KP	**2 176**	**0.1**	**6 181**	**0.6**		

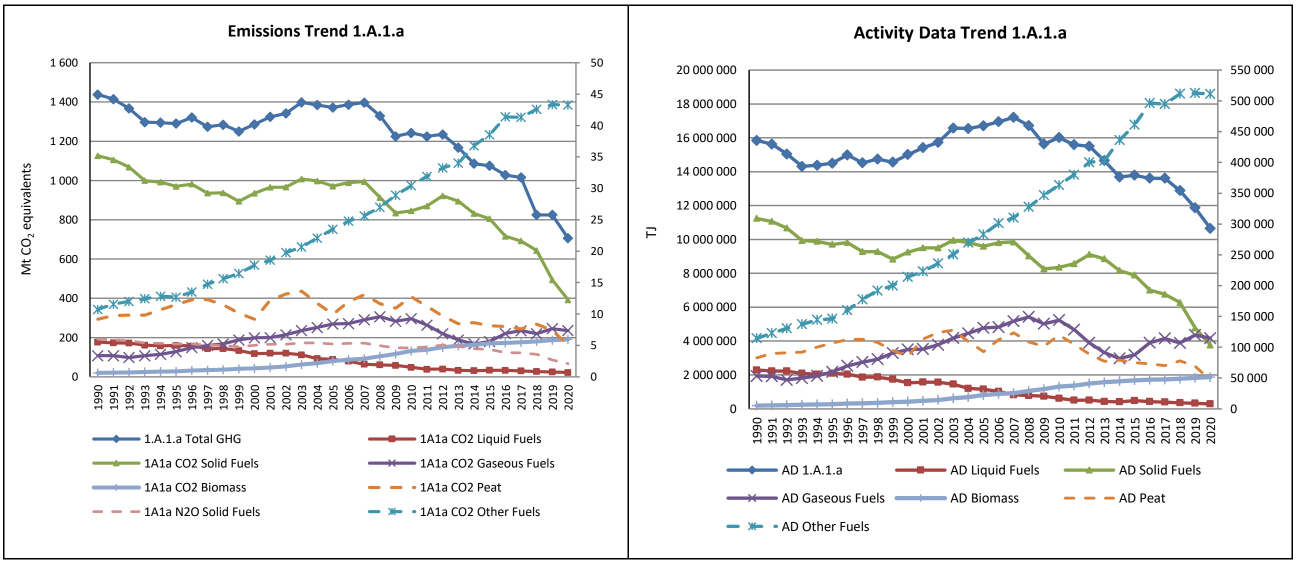
3.2.1.1 Public Electricity and Heat Production (1.A.1.a) (EU-KP)

According to the 2006 IPCC guidelines, emissions from public electricity and heat production (CRF 1.A.1.a) should include emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants. Main activity producers (i.e. public utilities) are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. Emissions from own on-site use of fuel should be included. Emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity that supports their primary activity) should be assigned to the sector where they were generated and not under 1.A.1.a. autoproducers may be in public or private ownership.

CO_2 emissions from electricity and heat production is the largest key category in the EU-KP accounting for 18.9% of total greenhouse gas emissions in 2020 and for 82% of greenhouse gas emissions of the Energy Industries Sector. Between 1990 and 2020, CO_2 emissions from electricity and heat production decreased by 51.2% in the EU-KP.

Figure 3.6 shows the trends in emissions originating from the production of public electricity and heat by fuel in the EU-KP between 1990 and 2020 as well as the underlying activity data[17].

Figure 3.6 1.A.1.a Public Electricity and Heat Production: Total, CO_2 and N_2O emission and activity data trends



Note: Data displayed as dashed line refers to the secondary axis.

Fuel used for public electricity and heat production decreased by 32.8% in the EU-KP between 1990 and 2020. Solid fuels represent 35.3% of the fuel used in public conventional thermal power plants; its combustion has been declining by 66.5% between 1990 and 2020. Gaseous fuels have increased very rapidly, by a factor of almost 3 between 1990 and 2010, declined until 2014 and now see a new increased use in the last years. 2020 is the first year for which natural gas consumptions are higher

[17] CO_2 emissions from the combustion of biomass fuels are reported as a memo item and are therefore not included in the emissions from public electricity and heat production. The biomass used as a fuel is however included in the national energy consumption (i.e. activity data). The fact that CO_2 emissions from biomass are treated differently from other fuel emissions does not imply emissions from the production of heat and electricity are due to fossil fuel combustion only. Biomass CO_2 emissions are just reported elsewhere. Non-CO_2 emissions from the combustion of biomass (CH_4 and N_2O) are reported under the energy sector.

than solid fuel consumptions with a share of 39.2% of all the fuels used for the production of heat and electricity in the EU-KP. Liquid fuels still account for some 2.7%, but its use has declined gradually during the past 30 years. The use of biomass has increased even more rapidly than the use of gas: its share in the fuel mix is now at 17.5%. Finally, other fossil fuels consumptions have been multiplied by 4.5 between 1990 and 2020 and represent 4.8% of total consumptions. Peat remains marginal with a share of 0.4% in 2020.

Table 3.4 shows emissions arising from the production of public heat and electricity by country. Carbon dioxide emissions amount to 98.8% of greenhouse gas emissions from public electricity and heat production. These emissions increased in two Countries and fell in 27 compared to 1990. Of the two countries where emissions were higher in 2020 than in 1990, 88% of the increase was accounted for by Cyprus alone. Of the countries, where emissions fell, 70.3% of the total reduction was accounted for by the United Kingdom (21.3%), Germany (21.9%), Poland (13.3%) and Romania (7.1%) and Italy (6.8%). The change in the EU-KP between 1990 and 2020 was a net decrease of 732.2 Mt CO_2 respectively of 51%.

Table 3.4 1.A.1.a Public Electricity and Heat Production: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	11 056	6 953	5 665	0.8%	-5 392	-49%	-1 288	-19%	T1,T2	CS,D
Belgium	23 224	14 982	13 867	2.0%	-9 357	-40%	-1 115	-7%	T1,T3	D,PS
Bulgaria	35 179	21 393	17 337	2.5%	-17 842	-51%	-4 056	-19%	T1,T2	CS,D
Croatia	3 729	2 645	2 622	0.4%	-1 107	-30%	-23	-1%	T1,T2	CS,D
Cyprus	1 676	3 282	3 004	0.4%	1 328	79%	-278	-8%	CS	CS
Czechia	54 585	42 955	36 729	5.3%	-17 856	-33%	-6 226	-14%	T1,T2	CS,D
Denmark	24 697	6 314	5 373	0.8%	-19 324	-78%	-941	-15%	T1,T2,T3	CS,D,PS
Estonia	28 192	6 557	4 249	0.6%	-23 943	-85%	-2 308	-35%	T1,T2,T3	CS,D,PS
Finland	16 453	13 963	11 038	1.6%	-5 416	-33%	-2 926	-21%	T3	CS,D,PS
France	49 149	32 279	29 604	4.2%	-19 545	-40%	-2 675	-8%	T2,T3	CS,PS
Germany	338 451	214 809	180 749	25.9%	-157 702	-47%	-34 060	-16%	CS	CS
Greece	40 617	27 243	19 946	2.9%	-20 670	-51%	-7 296	-27%	T1,T2	D,PS
Hungary	17 850	10 545	10 356	1.5%	-7 493	-42%	-189	-2%	T1,T2,T3	CS,D,PS
Ireland	10 876	8 819	8 121	1.2%	-2 756	-25%	-698	-8%	T1,T3	CS,D,PS
Italy	108 670	67 034	59 921	8.6%	-48 749	-45%	-7 114	-11%	T3	CS
Latvia	6 097	1 720	1 280	0.2%	-4 816	-79%	-439	-26%	T1,T2	CS,D
Lithuania	12 003	846	1 296	0.2%	-10 707	-89%	451	53%	T1,T2,T3	CS,D,PS
Luxembourg	33	223	213	0.0%	180	537%	-10	-5%	T2	CS
Malta	1 759	739	810	0.1%	-949	-54%	71	10%	T2	CS
Netherlands	40 026	44 248	35 415	5.1%	-4 611	-12%	-8 833	-20%	CS,T2	CS,D
Poland	227 279	141 949	131 205	18.8%	-96 074	-42%	-10 744	-8%	T1,T2	CS,D
Portugal	14 355	10 702	8 157	1.2%	-6 198	-43%	-2 545	-24%	T1,T3	D,PS
Romania	66 403	18 734	15 213	2.2%	-51 190	-77%	-3 521	-19%	T1,T2,T3	CS,D,PS
Slovakia	14 700	4 428	3 923	0.6%	-10 778	-73%	-506	-11%	T2	CS
Slovenia	6 096	4 556	4 492	0.6%	-1 605	-26%	-64	-1%	T1,T2	CS,D,PS
Spain	65 593	43 571	32 025	4.6%	-33 568	-51%	-11 545	-26%	T1,T2	S,D,OTH,PS
Sweden	7 714	5 716	5 172	0.7%	-2 542	-33%	-545	-10%	T2	CS
United Kingdom	203 114	57 930	49 578	7.1%	-153 536	-76%	-8 352	-14%	T1,T2	CS,D
EU-27+UK	**1 429 577**	**815 136**	**697 360**	**100%**	**-732 217**	**-51%**	**-117 776**	**-14%**	**-**	**-**
Iceland	13	5	2	0.0%	-12	-87%	-3	-64%	T1	D
United Kingdom (KP)	203 803	58 823	50 326	7.2%	-153 477	-75%	-8 497	-14%	T1,T2	CS,D
EU-KP	**1 430 279**	**816 034**	**698 110**	**100%**	**-732 169**	**-51%**	**-117 924**	**-14%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

N_2O emissions currently represent 0.7% of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2020, emissions decreased by 26% (Table 3.5). The largest decline in emissions from this source category was reported by Germany (-811 kt CO_2eq) and the United Kingdom (-721 kt CO_2eq) and. The biggest increase occurred in Spain (+120 kt CO_2eq).

Table 3.5 1.A.1.a Public Electricity and Heat Production: Countries' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	39	93	92	1.8%	53	133%	0	-1%	T1	D
Belgium	51	84	89	1.7%	38	74%	4	5%	T1,T3	D
Bulgaria	123	109	89	1.7%	-34	-28%	-20	-19%	T1	D
Croatia	13	24	25	0.5%	12	92%	1	3%	T1	D
Cyprus	4	8	7	0.1%	3	80%	-1	-8%	T1	D
Czechia	242	212	187	3.6%	-55	-23%	-25	-12%	T1	D
Denmark	79	72	70	1.3%	-9	-11%	-2	-3%	T1,T2,T3	CS,D
Estonia	15	23	24	0.5%	10	66%	1	4%	T1,T2	CS,D
Finland	100	249	213	4.1%	112	112%	-36	-14%	T3	CS
France	420	266	245	4.7%	-175	-42%	-22	-8%	T2,T3	D,PS
Germany	2 407	1 846	1 596	30.7%	-811	-34%	-250	-14%	T2	CS
Greece	142	76	43	0.8%	-99	-70%	-33	-43%	T1	D
Hungary	63	53	51	1.0%	-11	-18%	-2	-3%	T1	D
Ireland	71	139	123	2.4%	52	74%	-15	-11%	T1,T2	D
Italy	308	215	195	3.8%	-112	-37%	-20	-9%	T3	CR,D
Latvia	11	25	24	0.5%	13	118%	-1	-5%	T1	D
Lithuania	19	36	38	0.7%	19	102%	2	6%	T1	D
Luxembourg	1	7	10	0.2%	8	564%	3	37%	T1	D
Malta	6	0	1	0.0%	-5	-90%	0	25%	T1	D
Netherlands	133	231	231	4.5%	99	75%	0	0%	D,T1	D
Poland	1 002	682	644	12.4%	-358	-36%	-37	-5%	T1	D
Portugal	46	134	123	2.4%	77	169%	-11	-9%	T1	D
Romania	179	79	61	1.2%	-118	-66%	-18	-23%	T1	D
Slovakia	59	30	27	0.5%	-32	-55%	-4	-12%	T1	D
Slovenia	25	22	22	0.4%	-3	-14%	0	-2%	T1	D
Spain	274	455	394	7.6%	120	44%	-61	-13%	T1,T2	D,OTH
Sweden	118	230	184	3.5%	66	56%	-47	-20%	T2	CS
United Kingdom	1 110	391	388	7.5%	-722	-65%	-3	-1%	T1,T2	CS,D
EU-27+UK	**7 058**	**5 792**	**5 194**	**100%**	**-1 863**	**-26%**	**-598**	**-10%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-86%	0	-65%	T1	D
United Kingdom (KP)	1 112	394	390	7.5%	-721	-65%	-3	-1%	T1,T2	CS,D
EU-KP	**7 059**	**5 795**	**5 197**	**100%**	**-1 863**	**-26%**	**-598**	**-10%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Finally, CH_4 emissions currently represent 0.5% of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2020, emissions increased by 384%. The biggest increase was reported by Germany (2040 kt CO_2eq), which is also responsible for 66.7% of the EU-KP emissions in 2020.

Table 3.6 1.A.1.a Public Electricity and Heat Production: Countries' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	6	21	22	0.7%	16	263%	0	2%	T1,T2	CS,D
Belgium	11	33	33	1.0%	22	195%	0	1%	T1,T3	D
Bulgaria	12	20	18	0.5%	6	46%	-3	-12%	T1	D
Croatia	3	9	10	0.3%	7	197%	1	10%	T1	D
Cyprus	2	3	3	0.1%	1	78%	0	-8%	T1	D
Czechia	15	33	33	1.0%	17	112%	0	0%	T1	D
Denmark	15	113	83	2.5%	68	468%	-30	-27%	T1,T2,T3	CS,D
Estonia	3	10	12	0.3%	9	308%	1	12%	T1,T2	CS,D
Finland	9	30	28	0.9%	20	219%	-1	-4%	T3	CS
France	14	44	41	1.2%	27	201%	-4	-8%	T2	D
Germany	172	2 173	2 212	66.6%	2 040	1185%	39	2%	T2	CS
Greece	13	10	8	0.3%	-4	-33%	-2	-19%	T1	D
Hungary	7	24	23	0.7%	16	215%	-1	-2%	T1	D
Ireland	6	11	11	0.3%	4	63%	0	-1%	T1,T2	D
Italy	95	103	101	3.0%	6	7%	-2	-2%	T3	CR,D
Latvia	5	16	15	0.5%	10	222%	-1	-5%	T1	D
Lithuania	9	22	24	0.7%	15	165%	1	6%	T1	D
Luxembourg	1	4	6	0.2%	5	566%	2	37%	T1	D
Malta	1	0	0	0.0%	-1	-66%	0	15%	T1	D
Netherlands	39	101	112	3.4%	73	186%	11	11%	T1,T2	CS,D
Poland	75	100	104	3.1%	29	39%	4	4%	T1	D
Portugal	4	13	12	0.4%	8	201%	-1	-8%	T1	D
Romania	36	10	10	0.3%	-26	-73%	0	-4%	T1	D
Slovakia	6	13	12	0.4%	7	112%	-1	-5%	T1	D
Slovenia	2	3	3	0.1%	1	81%	0	0%	T1	D
Spain	21	60	50	1.5%	29	141%	-11	-17%	T1,T2	CR,CS,D
Sweden	16	47	46	1.4%	30	190%	-1	-3%	T2	CS
United Kingdom	88	279	287	8.7%	199	227%	9	3%	T1,T2	CS,D
EU-27+UK	**685**	**3 308**	**3 319**	**100%**	**2 634**	**384%**	**11**	**0%**	**-**	**-**
Iceland	0	0	0	0.0%	0	-86%	0	-65%	T1	D
United Kingdom (KP)	89	280	289	8.7%	200	225%	8	3%	T1,T2	CS,D
EU-KP	**686**	**3 309**	**3 320**	**100%**	**2 634**	**384%**	**11**	**0%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

1.A.1.a Electricity and Heat Production - Liquid Fuels (CO_2)

CO_2 emissions arising from the combustion of liquid fuels for public electricity and heat generation account for about 3.1% of all greenhouse gas emissions from 1.A.1.a. Within the EU-KP, emissions fell by 88% respectively by 153.5 Mt CO_2 between 1990 and 2020 (Table 3.7).

Table 3.7 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 229	42	65	0.3%	-1 164	-95%	22	53%		CS
Belgium	663	13	17	0.1%	-645	-97%	5	35%	T1, T3	D, PS
Bulgaria	3 245	49	38	0.2%	-3 207	-99%	-10	-21%	T1,T2	CS,D
Croatia	2 142	16	13	0.1%	-2 129	-99%	-3	-19%	T1	D
Cyprus	1 676	3 282	3 004	13.7%	1 328	79%	-278	-8%	CS	CS
Czechia	1 174	116	87	0.4%	-1 087	-93%	-29	-25%	T1	D, CS
Denmark	953	115	115	0.5%	-838	-88%	1	1%	T1,T2,T3	CS,D,PS
Estonia	3 519	105	108	0.5%	-3 411	-97%	3	3%	T2	CS
Finland	1 234	711	551	2.5%	-683	-55%	-160	-23%	T3	CS/PS/D
France	8 209	3 726	3 622	16.5%	-4 587	-56%	-104	-3%	T2,T3	CS,PS
Germany	8 637	1 340	1 012	4.6%	-7 625	-88%	-329	-25%	CS	CS
Greece	5 416	3 603	3 083	14.1%	-2 333	-43%	-520	-14%	T2	CS, PS
Hungary	1 443	44	32	0.1%	-1 410	-98%	-12	-27%	T1, T2	D, CS
Ireland	1 087	253	343	1.6%	-744	-68%	90	36%	T1,T3	CS,D,PS
Italy	64 597	916	805	3.7%	-63 792	-99%	-111	-12%	T3	CS
Latvia	3 079	3	4	0.0%	-3 075	-100%	1	38%	T1, T2	D, CS
Lithuania	6 021	45	73	0.3%	-5 948	-99%	28	63%	T1, T2, T3	CS, PS, D
Luxembourg	NO	1	1	0.0%	1	∞	0	-35%	T1/T2	D/CS
Malta	1 049	31	74	0.3%	-975	-93%	43	137%	T1, T2	CS, D
Netherlands	233	679	310	1.4%	77	33%	-369	-54%	CS,T2	CS,D
Poland	5 198	1 175	1 271	5.8%	-3 927	-76%	96	8%	T1/T2	D/CS
Portugal	6 434	729	641	2.9%	-5 794	-90%	-88	-12%	T1	D
Romania	20 387	331	324	1.5%	-20 064	-98%	-7	-2%	T1,T2,T3	D,CS,PS
Slovakia	1 033	9	6	0.0%	-1 027	-99%	-3	-33%	T2	CS
Slovenia	272	16	13	0.1%	-259	-95%	-3	-17%	T1	D
Spain	6 087	6 420	5 384	24.6%	-703	-12%	-1 036	-16%	T2	CS/PS
Sweden	1 277	C	C	-	-1 277	-100%	-	-	T2	CS
United Kingdom	19 716	589	461	2.1%	-19 255	-98%	-129	-22%	T1, T2	CS, D
EU-27+UK	**174 731**	**24 358**	**21 455**	**98%**	**-153 277**	**-88%**	**-2 904**	**-12%**		
Iceland	13	5	2	0.0%	-12	-87%	-3	-64%	T1	D
United Kingdom (KP)	20 393	1 194	932	4.2%	-19 461	-95%	-262	-22%	T1, T2	CS, D
EU-KP	**175 422**	**24 968**	**21 927**	**100%**	**-153 494**	**-88%**	**-3 041**	**-12%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Table 3.7 also shows that about 98.1 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.7 shows the contribution to the emission trend for liquid fuels by the main countries. In 2020 Spain, France, Greece and Cyprus are responsible for about 68.9% of emissions in this category. The strongest decrease in emissions took place in Italy because less oil is used as a fuel in the power sector. In 1990 Italy was responsible for 36.8% of the emissions in this category and now in 2020 only for 3.7%.

Figure 3.7 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Emission trend and share for CO_2

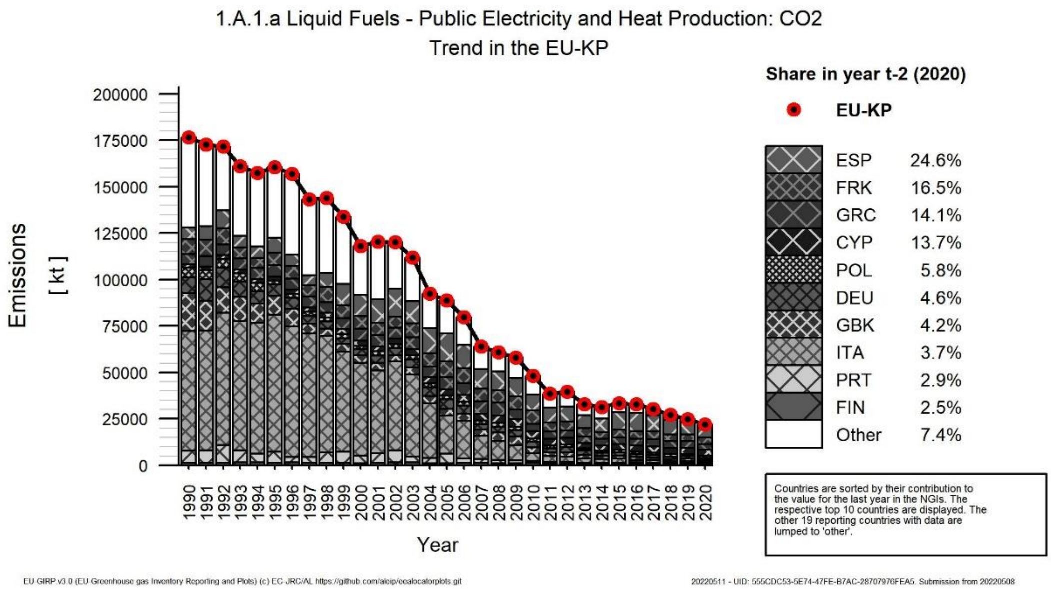
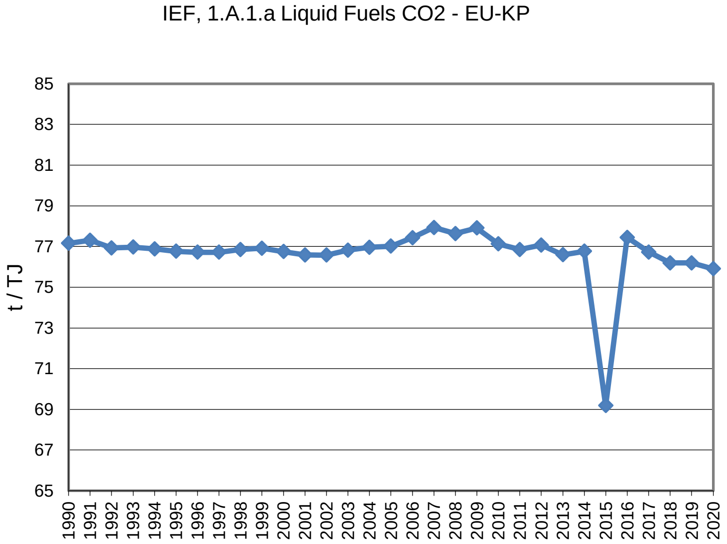
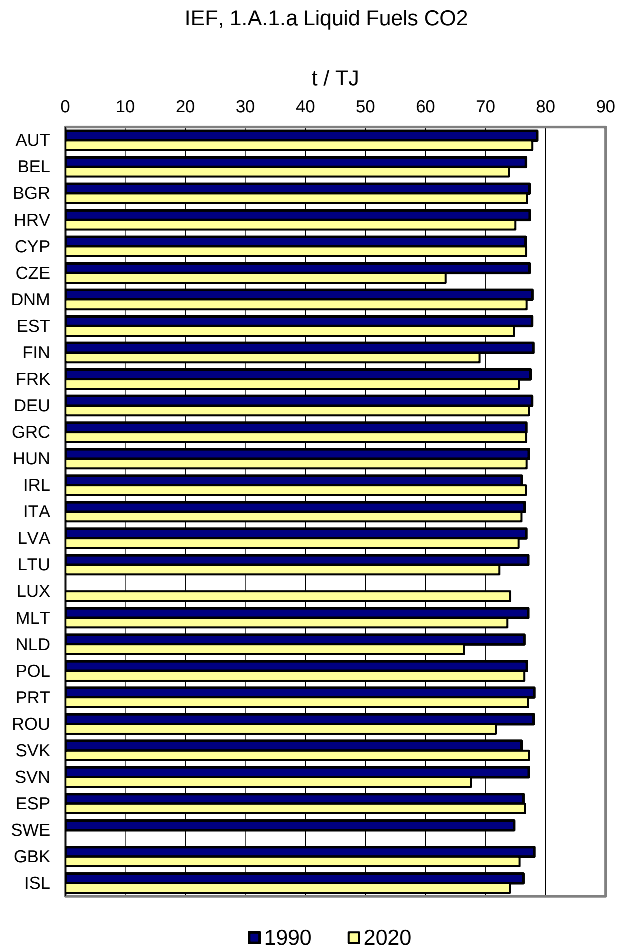


Figure 3.8 (continues on the next page) shows the implied emission factors for CO_2 emissions from liquid fuels used in public electricity and heat production. The IEFs in most countries range between 76 and 79 t/TJ on the entire time-series. The average IEF within the EU-KP is 75.9 t/TJ in 2020. The IEF from Netherlands is one of the lowest among the countries in the year 2020. The low IEF is caused by the high share of waste gas use in the liquid fuel mix, which has a comparatively low IEF (53.0 t/TJ). The same explanation can be given for Czechia which consumes a high share of Refinery gas with an EF of about 55 t CO_2/TJ).

Figure 3.8 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Implied Emission Factors for CO_2



N.B: the low IEF reported in 2015 is due to an error in the CRF from one country (Romania). However, this does not impact overall CO_2 emissions as the error is on AD reported but not on emission. This will be corrected for the next submission.



1.A.1.a Electricity and Heat Production - Solid Fuels (CO_2)

CO_2 emissions from the combustion of solid fuels represented about 55.5% of all greenhouse gas emissions from public electricity and heat production. Within the EU-KP, emissions fell by 65% between 1990 and 2020 (Table 3.8). A reason for the recent decline is that coal is being phased out of the fuel mix especially in the United Kingdom, Germany as well as in Poland. Over the past 30 years United Kingdom, Germany and Poland account for 61.8 % of the decline in the EU-KP.

Table 3.8 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	6 247	1 160	356	0.1%	-5 890	-94%	-803	-69%	T3	PS
Belgium	19 148	5 185	3 779	1.0%	-15 369	-80%	-1 406	-27%	T3	PS
Bulgaria	25 638	19 505	15 375	3.9%	-10 263	-40%	-4 129	-21%	T1,T2	CS,D
Croatia	595	1 306	987	0.3%	392	66%	-319	-24%	T2	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	52 368	39 207	32 953	8.4%	-19 415	-37%	-6 254	-16%	T1, T2	D, CS
Denmark	22 225	3 160	2 718	0.7%	-19 507	-88%	-441	-14%	T1,T2,T3	CS,D,PS
Estonia	22 017	5 862	3 613	0.9%	-18 404	-84%	-2 249	-38%	T2/T3	CS/PS
Finland	9 281	5 781	4 092	1.0%	-5 189	-56%	-1 690	-29%	T3	CS/PS/D
France	37 410	7 581	6 275	1.6%	-31 136	-83%	-1 306	-17%	T2,T3	CS,PS
Germany	307 246	165 282	129 795	33.1%	-177 451	-58%	-35 487	-21%	CS	CS
Greece	35 201	16 603	9 099	2.3%	-26 101	-74%	-7 503	-45%	T1,T2	D,PS
Hungary	12 266	5 513	5 127	1.3%	-7 139	-58%	-386	-7%	T1, T2, T3	D, CS, PS
Ireland	4 845	566	755	0.2%	-4 089	-84%	189	33%	T1,T3	CS,D,PS
Italy	27 756	17 199	12 581	3.2%	-15 175	-55%	-4 617	-27%	T3	CS
Latvia	211	10	3	0.0%	-208	-98%	-7	-66%	T1, T2	D, CS
Lithuania	174	7	5	0.0%	-169	-97%	-2	-28%	T1, T2, T3	CS, PS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	710	NO	NO	-	-710	-100%	-	-	NA	NA
Netherlands	25 862	18 947	11 292	2.9%	-14 571	-56%	-7 655	-40%	CS,T2	CS,D
Poland	220 132	133 455	121 675	31.0%	-98 457	-45%	-11 781	-9%	T1/T2	D/CS
Portugal	7 921	4 685	2 079	0.5%	-5 842	-74%	-2 606	-56%	T3	PS
Romania	25 215	13 216	9 450	2.4%	-15 765	-63%	-3 766	-28%	T2,T3	CS,PS
Slovakia	11 542	2 504	1 761	0.4%	-9 781	-85%	-743	-30%	T2	CS
Slovenia	5 712	4 232	4 158	1.1%	-1 554	-27%	-75	-2%	T3	PS
Spain	58 931	14 841	6 997	1.8%	-51 934	-88%	-7 844	-53%	T2	PS
Sweden	4 231	1 835	1 923	0.5%	-2 308	-55%	89	5%	T2	CS
United Kingdom	183 150	6 472	5 210	1.3%	-177 939	-97%	-1 262	-19%	T2	CS
EU-27+UK	**1 126 033**	**494 112**	**392 059**	**100%**	**-733 974**	**-65%**	**-102 053**	**-21%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	183 150	6 472	5 210	1.3%	-177 939	-97%	-1 262	-19%	T2	CS
EU-KP	**1 126 033**	**494 112**	**392 059**	**100%**	**-733 974**	**-65%**	**-102 053**	**-21%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.8 also shows that about 95.2 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.9 shows the trend of emissions for solid fuels for main contributing countries. In 2020 Germany has the largest share of emissions from solid fuels in the EU-KP (33.1%), followed by Poland (31.0%) and then by a clear margin Czechia (8.4%) and Bulgaria (3.9%).

Figure 3.9 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Emission trend and share for CO_2

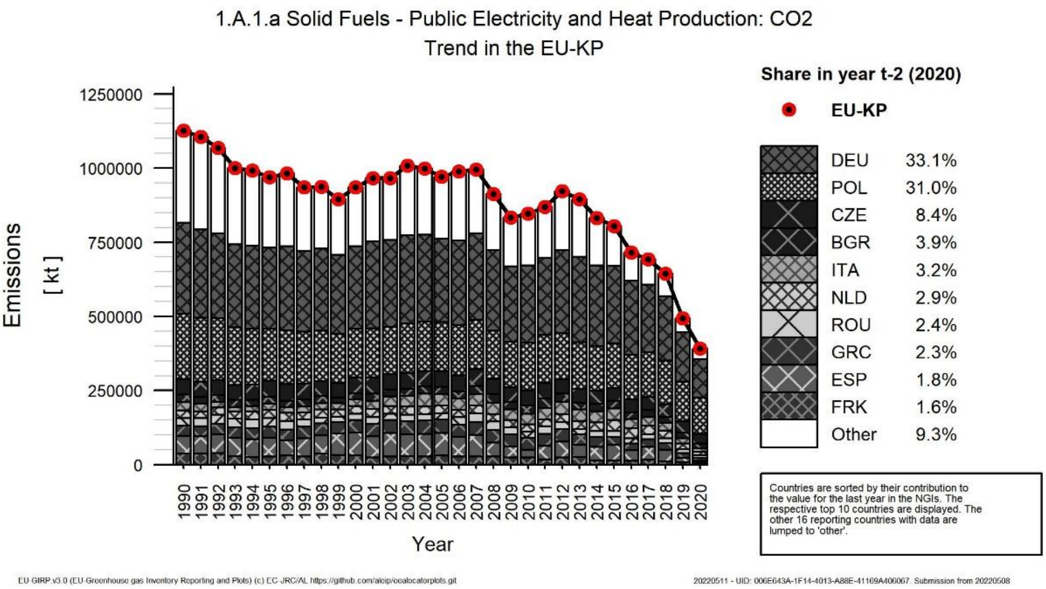
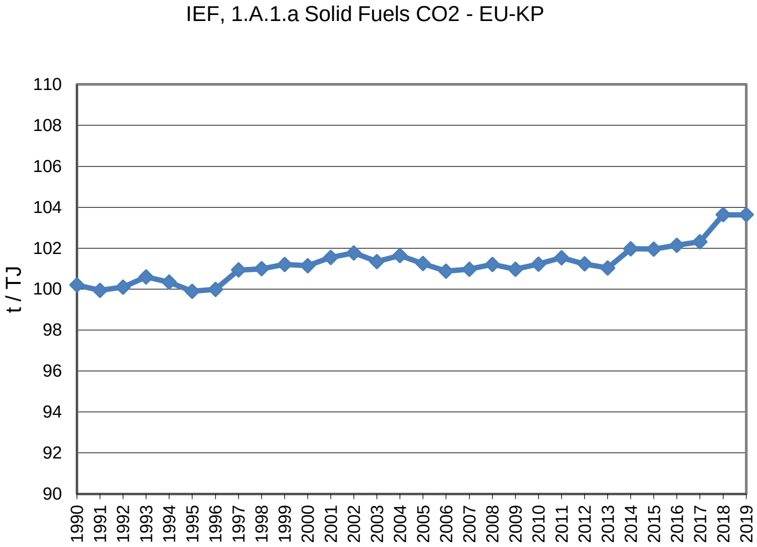
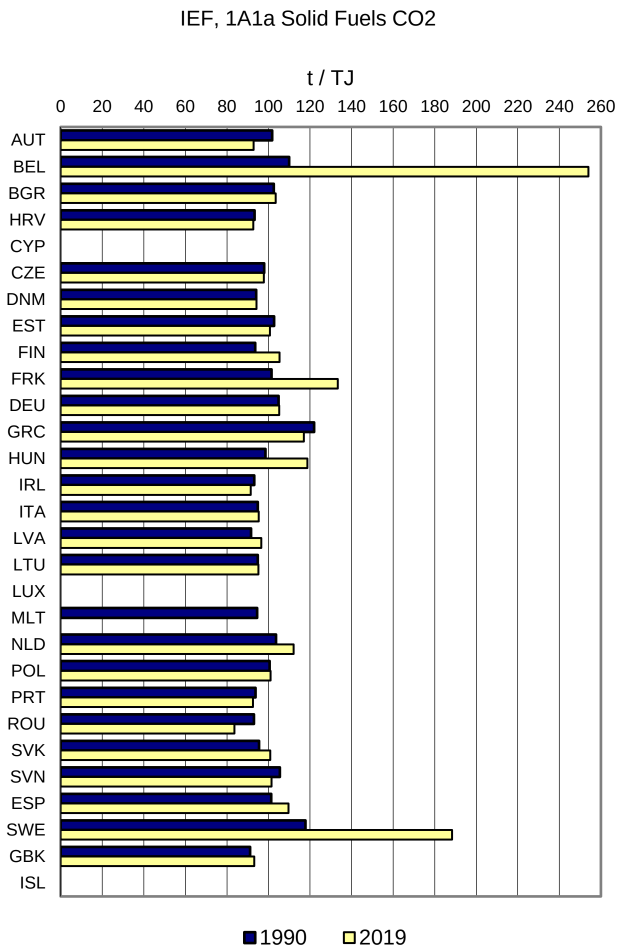


Figure 3.10 (on the next page) shows the relevant implied emission factors for solid fuels. The EU-KP implied emission factor has remained fairly stable between 100 t/TJ and 102 t/TJ on the entire time-series with a slight increase in the last years (around 104 t/TJ in 2020). The comparatively high IEF of Greece is due to the large importance of domestic lignite use for electricity production. The Greek IEF is based on verified EU-ETS reports, ranging from 33.74 to 35.37 tC/TJ. These values lie out of the range suggested by the 2006 IPCC Guidelines. However, given that the net calorific value of the Greek lignite is one of the lowest, a high value for the carbon content is expected. This is the same observation for Hungary which consumes domestic lignite with very low NCV as well as blast furnace gas. In Belgium, Sweden and France, the emission factors increased sharply since the late 1990s due to the use of blast furnace gas which has a much higher carbon content. A significant increase of the Belgian IEF since 2015 can be observed. The reason for this strong increase lies in the large decrease of the consumption of coals and at the same time an increase in energy consumption of blast furnace gas.

Figure 3.10 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Gaseous Fuels (CO_2)

CO_2 emissions from the combustion of gaseous fuels accounted for 33.3 % of all greenhouse gas emissions from public electricity and heat generation in 2020. Emissions increased by 120 % in the EU-KP between 1990 and 2020 (Table 3.9). The United Kingdom and Italy together were responsible for about 53 % of the increase in the last 30 years.

Table 3.9 1.A.1.a Electricity and heat production, Gaseous Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	3 294	4 719	4 227	1.8%	933	28%	-492	-10%	T2	CS
Belgium	2 739	7 648	8 034	3.4%	5 295	193%	386	5%	T1, T3	D, PS
Bulgaria	6 295	1 840	1 923	0.8%	-4 372	-69%	84	5%	T1,T2	CS,D
Croatia	991	1 323	1 622	0.7%	630	64%	299	23%	T2	CS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 019	3 379	3 425	1.5%	2 406	236%	46	1%	T1, T2	D, CS
Denmark	980	1 403	892	0.4%	-88	-9%	-511	-36%	T1,T2,T3	CS,D,PS
Estonia	1 815	360	258	0.1%	-1 557	-86%	-102	-28%	T2	CS
Finland	1 989	2 035	2 098	0.9%	109	5%	63	3%	T3	CS
France	973	13 974	12 871	5.5%	11 898	1223%	-1 103	-8%	T2,T3	CS,PS
Germany	18 447	33 824	35 496	15.1%	17 049	92%	1 672	5%	CS	CS
Greece	IE,NO	7 037	7 764	3.3%	7 764	∞	727	10%	T1,T2	D,PS
Hungary	4 111	4 787	5 000	2.1%	889	22%	214	4%	T1, T2	D, CS
Ireland	1 881	5 329	5 415	2.3%	3 534	188%	86	2%	T1,T3	CS,D,PS
Italy	16 173	48 755	46 357	19.7%	30 184	187%	-2 398	-5%	T3	CS
Latvia	2 658	1 707	1 273	0.5%	-1 385	-52%	-434	-25%	T1, T2	D, CS
Lithuania	5 797	592	909	0.4%	-4 888	-84%	316	53%	T1, T2	CS, D
Luxembourg	NO	115	114	0.0%	114	∞	-1	-1%	T1/T2	D/CS
Malta	NO	708	736	0.3%	736	∞	28	4%	T2	CS
Netherlands	13 329	21 899	21 104	9.0%	7 775	58%	-795	-4%	CS,T2	CS,D
Poland	1 197	6 322	7 282	3.1%	6 085	508%	961	15%	T2	CS
Portugal	NO	4 830	4 969	2.1%	4 969	∞	139	3%	T3/T2	PS/D
Romania	20 801	5 187	5 440	2.3%	-15 361	-74%	253	5%	T3	PS
Slovakia	2 089	1 756	1 992	0.8%	-97	-5%	237	13%	T2	CS
Slovenia	113	287	301	0.1%	188	166%	13	5%	T2	CS
Spain	447	20 672	18 124	7.7%	17 676	3950%	-2 549	-12%	T2	CS/PS
Sweden	486	C	C	-	-486	-100%	-	-	T2	CS
United Kingdom	16	44 923	37 741	16.0%	37 725	236409%	-7 182	-16%	T1, T2	CS, D
EU-27+UK	**107 155**	**245 410**	**235 366**	**100%**	**128 211**	**120%**	**-10 044**	**-4%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16	45 146	37 954	16.1%	37 938	237746%	-7 192	-16%	T1, T2	CS, D
EU-KP	**107 155**	**245 633**	**235 579**	**100%**	**128 425**	**120%**	**-10 054**	**-4%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Table 3.9 also shows that about 97 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

In eight EU-KP countries the consumption of gaseous fuels was lower in 2020 than in 1990. Cyprus and Iceland are not utilising gaseous fuels for public electricity and heat production. In the other 19 countries, gas consumption has increased in the last 30 years. From 1990 until 2008 the use of gaseous fuels shows a steep increasing trend, followed by strong decreasing trend from 2009 until 2014, which was mainly attributed to the increased prices for natural gas. After this steep decrease the emissions of gaseous fuels increased again by about 40% in 2020 compared to 2014. Figure 3.11 shows the trend of emissions from gaseous fuels by the main contributing countries which are Italy (19.7%), the United Kingdom (16.1%) and Germany (15.1%). One of the reasons for the recent increase is that coal is in the process of being phased out of the fuel mix and replaced by gaseous fuels in many countries.

Figure 3.11 1.A.1.a Public Electricity and Heat Production, Gaseous Fuels: Emission trend and share for CO_2

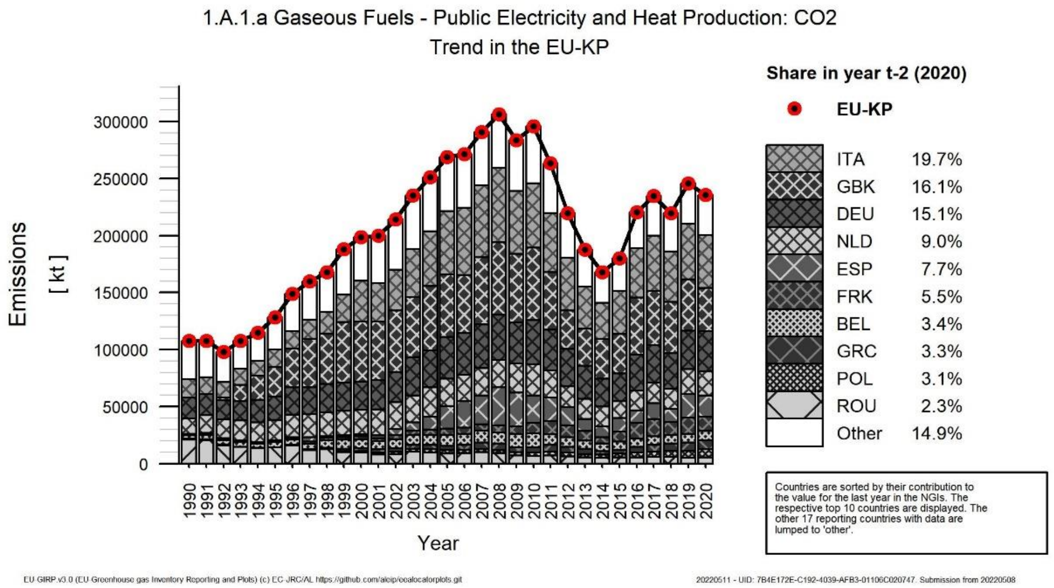
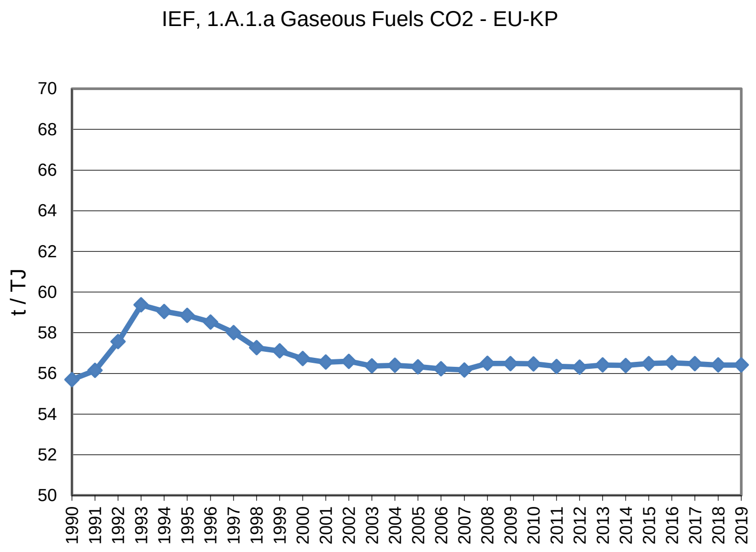
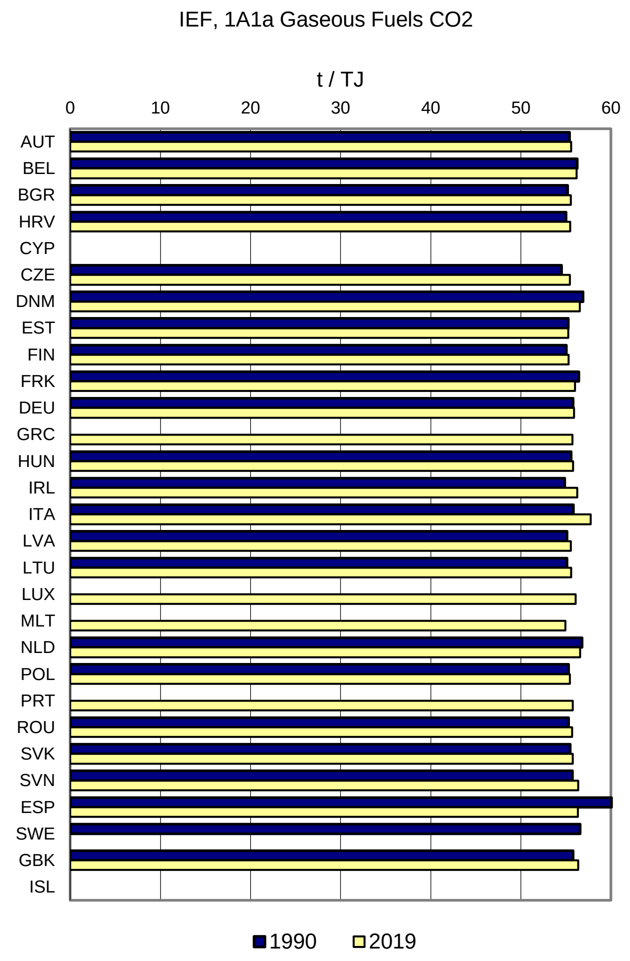


Figure 3.12 (on the next page) shows the implied emission factors from gaseous fuels for CO_2. The EU-KP implied emission factor has remained fairly stable (56.5 t/TJ in 2020) which is very close to the default emission factor of natural gas (56.1 t/TJ). The slight increase in the EU-KP factor observed in the early 1990s can be explained by the higher UK's gas share in the EU-KP and by an increase in the UK's implied emission factor. In the early 1990s, the IEF for Spain is also high. It is explained by the total CO_2 emissions allocation amongst fuels which does not impact total CO_2 emissions. The latter is the result of the commissioning of the Peterhead power station in Scotland, which uses sour gas, a fuel with a much higher factor than natural gas.

Figure 3.12 1.A.1.a Public Electricity and Heat Production, Gaseous Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Other Fuels (CO_2)

In 2020, the share of CO_2 emissions from other fuels amounts to 6.2 % of total greenhouse gas emissions from public electricity and heat generation. Other fuels cover mainly the fossil part of municipal solid waste incineration where there is energy recovery, including plastics, hazardous waste, bulky waste and waste sludge (Table 3.10). Emissions increased by 303 % at EU-KP level between 1990 and 2020 and increased in all countries except for Latvia. Germany alone is responsible for 31.7% of the increase in the whole EU-KP over the last 30 years.

Table 3.10 1.A.1.a Public Electricity and Heat Production, Other Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	286	1 031	1 016	2.3%	730	255%	-15	-1%	T2	CS
Belgium	674	2 136	2 036	4.7%	1 362	202%	-100	-5%	T3	PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	24	253	265	0.6%	240	1000%	12	5%	T1	D
Denmark	539	1 637	1 648	3.8%	1 109	206%	10	1%	T1,T2,T3	CS,D,PS
Estonia	NO	128	143	0.3%	143	∞	16	12%	T3	PS
Finland	1	628	601	1.4%	600	59911%	-27	-4%	T3	CS
France	2 557	6 999	6 837	15.8%	4 279	167%	-163	-2%	T2,T3	CS,PS
Germany	4 121	14 363	14 446	33.4%	10 326	251%	84	1%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	30	202	197	0.5%	167	557%	-5	-2%	T1, T2, T3	D, CS, PS
Ireland	NO	633	596	1.4%	596	∞	-37	-6%	T1,T3	CS,D,PS
Italy	143	164	178	0.4%	34	24%	14	8%	T3	CS
Latvia	3	NO	NO	-	-3	-100%	-	-	T1	D
Lithuania	NO	179	295	0.7%	295	∞	116	65%	T1, T2	CS, D
Luxembourg	33	107	99	0.2%	65	194%	-9	-8%	T1/T2	D/CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	601	2 723	2 709	6.3%	2 108	350%	-14	-1%	CS,T2	CS,D
Poland	753	998	978	2.3%	225	30%	-20	-2%	T1	D
Portugal	NO	459	469	1.1%	469	∞	10	2%	T2	D/CS
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	36	159	163	0.4%	128	359%	4	3%	T2	CS
Slovenia	NO	21	20	0.0%	20	∞	0	-2%	T1	D
Spain	128	1 637	1 521	3.5%	1 393	1092%	-117	-7%	T2	CS/PS
Sweden	570	2 875	2 827	6.5%	2 257	396%	-48	-2%	T2	CS
United Kingdom	232	5 946	6 166	14.2%	5 934	2558%	220	4%	T1, T2	CS, D
EU-27+UK	**10 732**	**43 279**	**43 210**	**100%**	**32 478**	**303%**	**-69**	**0%**		
Iceland	NO	NO	NO	-	-	-	-	-	T1	D
United Kingdom (KP)	244	6 011	6 230	14.4%	5 986	2451%	219	4%	T1, T2	CS, D
EU-KP	**10 744**	**43 343**	**43 273**	**100%**	**32 529**	**303%**	**-70**	**0%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.10 also shows that more than 93.6 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.13 illustrates clearly the strong increase of emissions caused by other fuels over the past 30 years. The largest emitters of other fuels in 2020 were Germany (33.4%), France (15.8%) and the United Kingdom (14.4%). Together these three countries accounted for 63.6% of the total EU-KP emissions in this category.

Figure 3.13 1.A.1.a Public Electricity and Heat Production, Other Fuels: Emission trend and share for CO_2

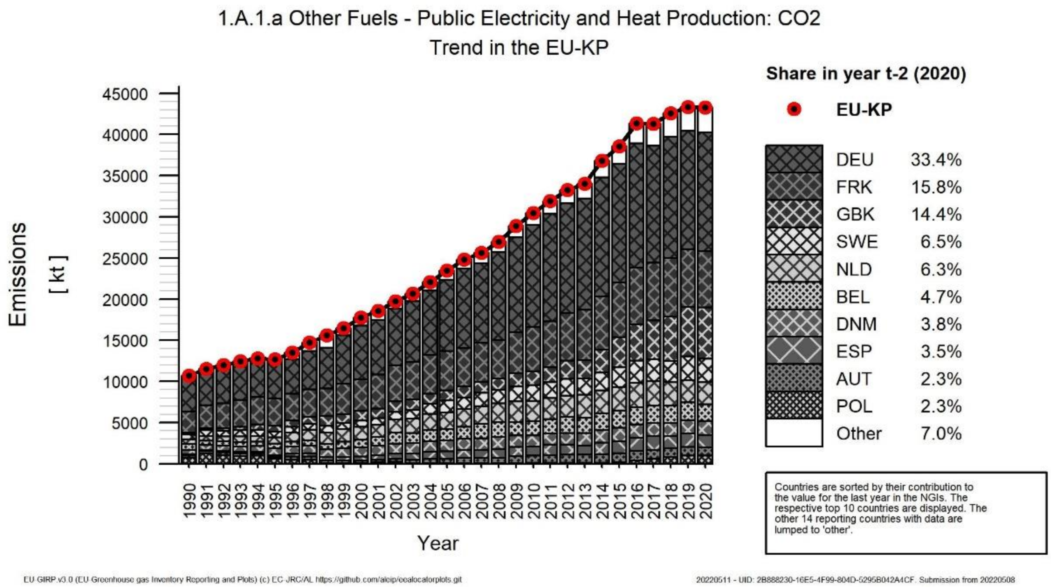
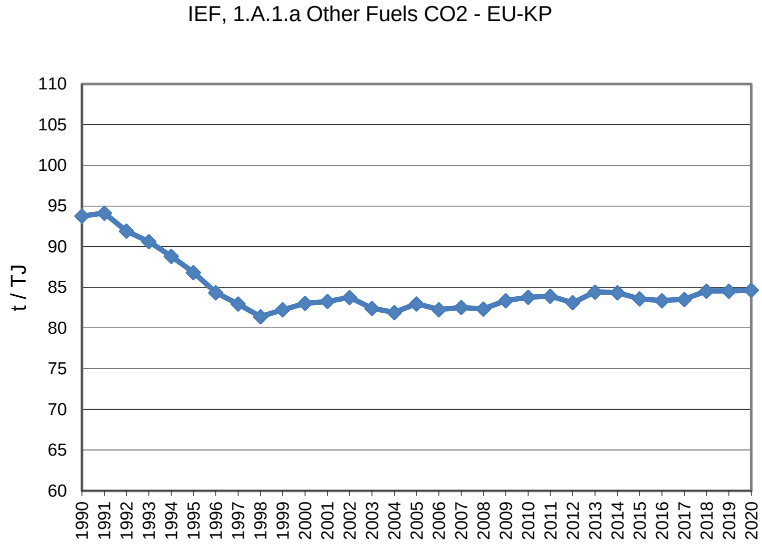
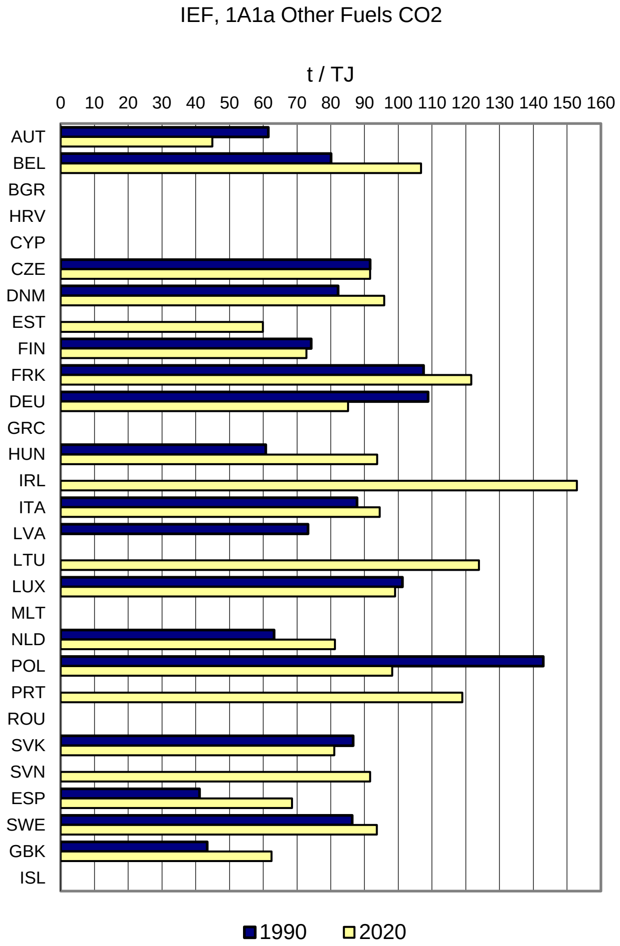


Figure 3.14 (on the next page) shows the implied emission factors from other fuels for CO_2. The EU-KP implied emission factor has gradually fallen until 1998, then levelled out between 80 and 85 t/TJ on the entire time-series. In Germany, the IEF declined continuously between 1990 and 2020 (from 109 to 85.1 t/TJ). This is because the combustion of industrial waste has been greatly reduced in the early 1990s whereas the combustion of residential waste for electricity and heat has increased in the complete reporting period; furthermore, the calorific value of the applied waste has increased due to a better national waste separation management. There is a large diversity in waste composition across countries leading to the differences in countries' IEFs.

Figure 3.14 1.A.1.a Public Electricity and Heat Production, Other Fuels: Implied Emission Factors for CO_2





1.A.1.a Electricity and Heat Production - Peat (CO_2)

CO_2 emissions from the combustion of peat represented 0.7% of all greenhouse gas emissions from public electricity and heat production. Peat in its raw state is a fossil sedimentary deposit of vegetal origin with high water content. Only 5 countries report emissions from peat combustion. Latvia did not consume Peat anymore in 2020. Within the EU-KP, emissions declined by 45% respectively 4.1 Mt CO_2 between 1990 and 2020 and by 32% between 2019 and 2020 (Table 3.11).

Table 3.11 1.A.1.a Public Electricity and Heat Production, Peat: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	841	102	127	2.5%	-715	-85%	24	24%	T1/T2	D/CS
Finland	3 950	4 808	3 697	73.2%	-253	-6%	-1 112	-23%	T3	CS
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	3 065	2 038	1 012	20.0%	-2 053	-67%	-1 026	-50%	T1,T3	CS,D,PS
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	146	NO	0	0.0%	-146	-100%	0	∞	T1, T2	CS, D
Lithuania	11	22	15	0.3%	4	34%	-7	-33%	T1, T2	CS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	-	-	-	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	1 150	418	202	4.0%	-948	-82%	-216	-52%	T2	CS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**9 162**	**7 388**	**5 051**	**100%**	**-4 111**	**-45%**	**-2 337**	**-32%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**9 162**	**7 388**	**5 051**	**100%**	**-4 111**	**-45%**	**-2 337**	**-32%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Note: Peat is not used as a fuel in the Netherlands. Nevertheless, the Netherlands did not report Peat as notation key

Table 3.11 also shows that about 97.7 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.15 illustrates the trend of peat emissions throughout the last 30 years, which is predominately influenced by the emission fluctuation over the years by Finland and Ireland. Several parameters such as weather conditions greatly influence the peat consumption: in Finland, peat represents 4% of electricity production and is the third most important energy source in district heat production (with 15% of the district heat produced). In 2020, the two largest emitters, Finland and Ireland, are responsible for 93.2% of the total emissions in this category.

Figure 3.15 1.A.1.a Public Electricity and Heat Production, Peat: Emission trend and share for CO_2

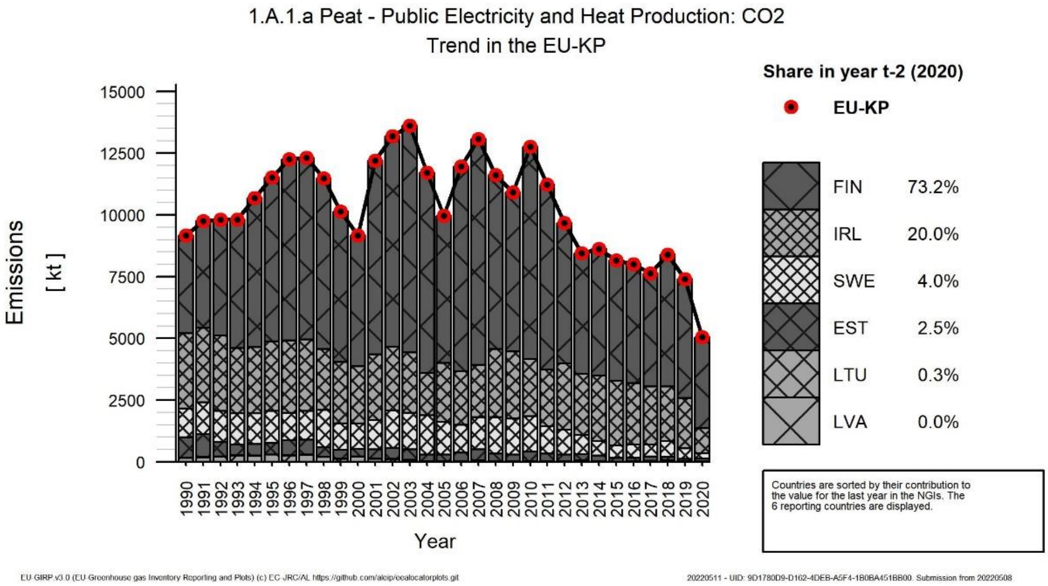
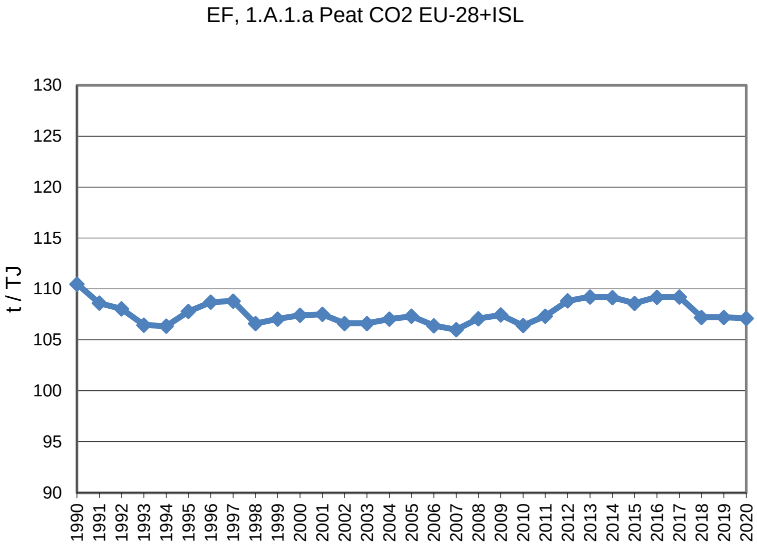
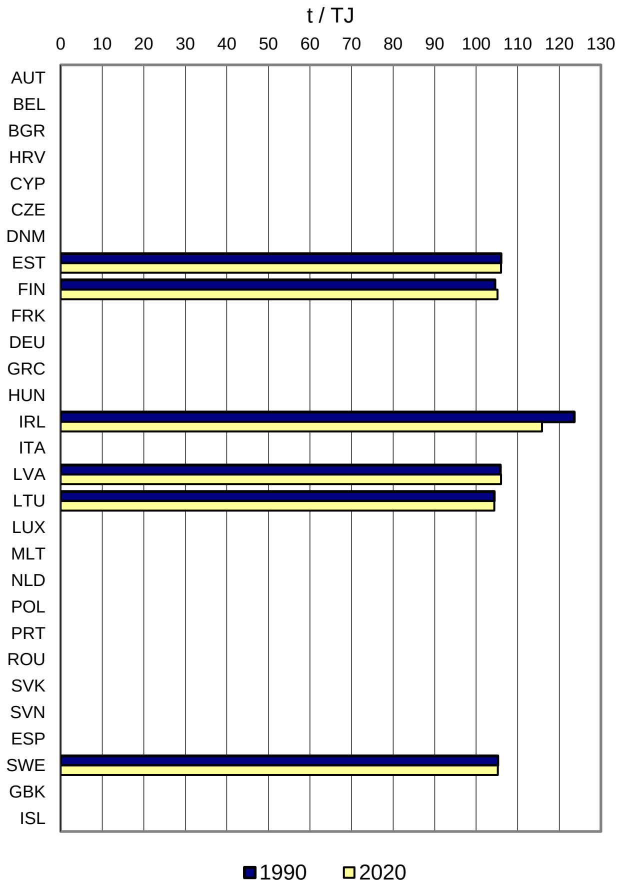


Figure 3.16 shows the implied emission factors of peat for CO_2. The EU-KP implied emission factor amounts to 107.1 t/TJ in 2020 and has been quite stable over the last 30 years. It is mainly influenced by the IEF of the two largest emitters (Finland and Ireland). The default emission factor for peat is 106 t/TJ according to the 2006 IPCC guidelines. Only Ireland has an IEF continuously above the default value. The reason for this is the use of the plant specific emission factor (112.9 t/TJ) for three milled peat power plants in use.

Figure 3.16 1.A.1.a Public Electricity and Heat Production, Peat: Implied Emission Factors for CO_2



IEF, 1.A.1.a Peat CO2



3.2.1.2 Petroleum Refining (1.A.1.b) (EU-KP)

According to the 2006 IPCC guidelines, Petroleum Refining (CRF 1.A.1.b) should include all combustion activities supporting the refining of petroleum products including on-site combustion for the generation of electricity and heat for own use. It does not include evaporative emissions occurring at the refinery. These emissions should be reported separately under 1.B.2.a as well as venting and flaring under 1.B.2.c.

Total emissions from Petroleum Refining are accounting for 2.8% of total greenhouse gas emissions in year 2020. Between 1990 and 2020, EU-KP CO_2 emissions decreased by 14% (Table 3.12). Emissions in 2020 were above 1990 levels in 8 countries, whereas they were decreasing in 16 and reported as not occurring for the whole time series in five countries. Poland, Greece and Italy had the largest emission increases. In contrast France and the United Kingdom report the largest decreases together accounting for 78.2% of the decrease in emissions in this period. The decrease at European level can be explained by the reduction of Liquid fuels consumptions (-29.2% for sector 1.A.1.b Liquid fuels between 1990 and 2020).

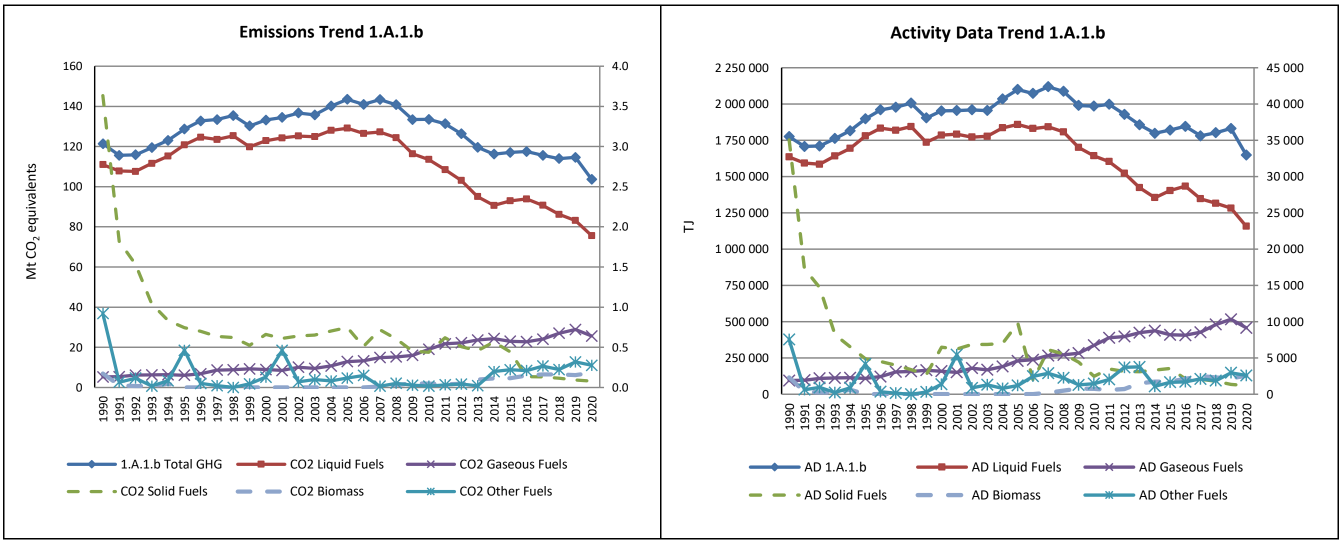
Table 3.12 1.A.1.b Petroleum Refining: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	2 394	2 791	2 732	2.6%	337	14%	-59	-2%	T2	CS
Belgium	4 299	5 611	4 826	4.7%	527	12%	-785	-14%	CS,T3	PS
Bulgaria	860	991	803	0.8%	-57	-7%	-188	-19%	T1,T2	CS,D
Croatia	2 425	991	836	0.8%	-1 589	-66%	-155	-16%	T1	D
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czechia	493	540	433	0.4%	-59	-12%	-107	-20%	T1,T2	CS,D
Denmark	908	958	916	0.9%	8	1%	-42	-4%	T1,T2,T3	CS,D,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2 042	1 693	1 560	1.5%	-483	-24%	-133	-8%	T3	CS,PS
France	11 935	6 239	5 116	5.0%	-6 819	-57%	-1 123	-18%	T2,T3	CS,PS
Germany	20 166	21 824	18 553	18.0%	-1 612	-8%	-3 271	-15%	CS	CS
Greece	2 375	4 600	4 448	4.3%	2 073	87%	-151	-3%	T2	PS
Hungary	2 376	1 558	1 611	1.6%	-765	-32%	52	3%	T2,T3	CS,PS
Ireland	168	274	301	0.3%	132	79%	26	10%	T3	CS,PS
Italy	15 817	18 986	17 448	16.9%	1 630	10%	-1 539	-8%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 324	1 222	1.2%	-287	-19%	-102	-8%	T2,T3	CS,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	11 010	10 022	9 373	9.1%	-1 637	-15%	-649	-6%	T2	CS,D
Poland	2 169	4 598	4 593	4.4%	2 424	112%	-5	0%	T1,T2	CS,D
Portugal	1 870	2 164	2 094	2.0%	223	12%	-70	-3%	T2	CR,D,PS
Romania	4 418	2 170	1 883	1.8%	-2 535	-57%	-287	-13%	T1,T2,T3	CS,D,PS
Slovakia	2 873	1 419	1 504	1.5%	-1 369	-48%	85	6%	T3	PS
Slovenia	171	NO	NO	-	-171	-100%	-	-	NA	NA
Spain	10 858	11 042	10 241	9.9%	-618	-6%	-801	-7%	T2,T3	PS
Sweden	1 778	1 755	1 735	1.7%	-43	-2%	-20	-1%	T2	CS
United Kingdom	17 831	12 628	11 110	10.8%	-6 721	-38%	-1 518	-12%	T2	CS
EU-27+UK	**120 833**	**114 179**	**103 337**	**100%**	**-17 496**	**-14%**	**-10 842**	**-9%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	17 831	12 628	11 110	10.8%	-6 721	-38%	-1 518	-12%	T2	CS
EU-KP	**120 833**	**114 179**	**103 337**	**100%**	**-17 496**	**-14%**	**-10 842**	**-9%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 3.17 shows the trends in activity data and the associated emissions originating from the refining of petroleum by fuel in the EU-KP between the years 1990 and 2020. Fuel used for petroleum refining decreased by 7.5% in the EU-KP between 1990 and 2020. In the year 2020, liquid fuels represent 70.4% of all fuel used in the refining of petroleum. Gaseous fuels almost fully account for the remaining part (27.5%) of the activity data. Gaseous fuels use is almost five times higher in 2020 compared to 1990. There remains a small amount of solid fuels used accounting for 0.07% in petroleum refining; in Germany (lignite and coke oven gas) and Poland (hard coal and lignite) as well as 0.16 of biomass and 1.88 % of other fuels use.

Figure 3.17 1.A.1.b Petroleum Refining: Total and CO_2 emission and activity trends



Note: Data displayed as dashed line refers to the secondary axis.

1.A.1.b Petroleum Refining - Liquid Fuels (CO_2)

CO_2 emissions from the combustion of liquid fuels used for petroleum refining accounted for 73% of all greenhouse gas emissions from petroleum refining in 2020. Emissions decreased by 31% between 1990 and 2020 (Table 3.13). Greece had the largest emission increase accounting for 59.6% of the whole increase between 1990 and 2020. In contrast, the United Kingdom and France report the largest decreases together accounting for 45.8% of the whole decrease in emissions in this period.

Table 3.13 1.A.1.b Petroleum Refining, Liquid Fuels: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 958	2 287	2 235	3.0%	277	14%	-53	-2%	T2	CS
Belgium	4 285	3 058	2 325	3.1%	-1 961	-46%	-733	-24%	CS,T3	PS
Bulgaria	791	888	701	0.9%	-90	-11%	-187	-21%	T1	D
Croatia	2 411	601	424	0.6%	-1 987	-82%	-177	-29%	T1	D
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czechia	176	317	246	0.3%	70	40%	-71	-22%	T1	CS,D
Denmark	908	940	881	1.2%	-27	-3%	-59	-6%	T1,T2,T3	CS,D,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 383	1 447	1 302	1.7%	-81	-6%	-145	-10%	T3	CS,PS
France	11 413	4 802	3 825	5.1%	-7 588	-66%	-977	-20%	T2,T3	CS,PS
Germany	15 417	16 363	14 859	19.6%	-558	-4%	-1 504	-9%	CS	CS
Greece	2 375	4 600	4 448	5.9%	2 073	87%	-151	-3%	T2	PS
Hungary	1 683	928	956	1.3%	-727	-43%	28	3%	T3	PS
Ireland	168	262	287	0.4%	118	70%	24	9%	T3	CS,PS
Italy	15 656	14 754	13 610	18.0%	-2 047	-13%	-1 144	-8%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 205	1 064	1.4%	-446	-30%	-141	-12%	T2,T3	CS,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 968	7 115	6 483	8.6%	-3 485	-35%	-633	-9%	T2	CS,D
Poland	1 326	2 153	2 266	3.0%	940	71%	113	5%	T1,T2	CS,D
Portugal	1 870	1 085	997	1.3%	-873	-47%	-88	-8%	T2	CR,D,PS
Romania	4 418	1 585	1 578	2.1%	-2 840	-64%	-8	0%	T2,T3	CS,PS
Slovakia	2 786	1 149	1 284	1.7%	-1 502	-54%	135	12%	T3	PS
Slovenia	43	NO	NO	-	-43	-100%	-	-	NA	NA
Spain	10 812	7 668	7 386	9.8%	-3 426	-32%	-282	-4%	T2,T3	PS
Sweden	1 778	C	C	-	-1 778	-100%	-	-	T2	CS
United Kingdom	17 782	9 944	8 471	11.2%	-9 311	-52%	-1 473	-15%	T2	CS
EU-27+UK	**109 224**	**83 152**	**75 626**	**100%**	**-33 598**	**-31%**	**-7 526**	**-9%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	17 782	9 944	8 471	11.2%	-9 311	-52%	-1 473	-15%	T2	CS
EU-KP	**109 224**	**83 152**	**75 626**	**100%**	**-33 598**	**-31%**	**-7 526**	**-9%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Table 3.13 also shows that 98 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.18 illustrates that Germany, Italy and the United Kingdom are the countries contributing most in terms of CO_2 emissions in 2020. It also can be seen that the trend for liquid fuels was continuously decreasing since the year 2008 with a stabilization between 2014 and 2016.

Figure 3.18 1.A.1.b Petroleum Refining, Liquid Fuels: Emission trend and share for CO_2

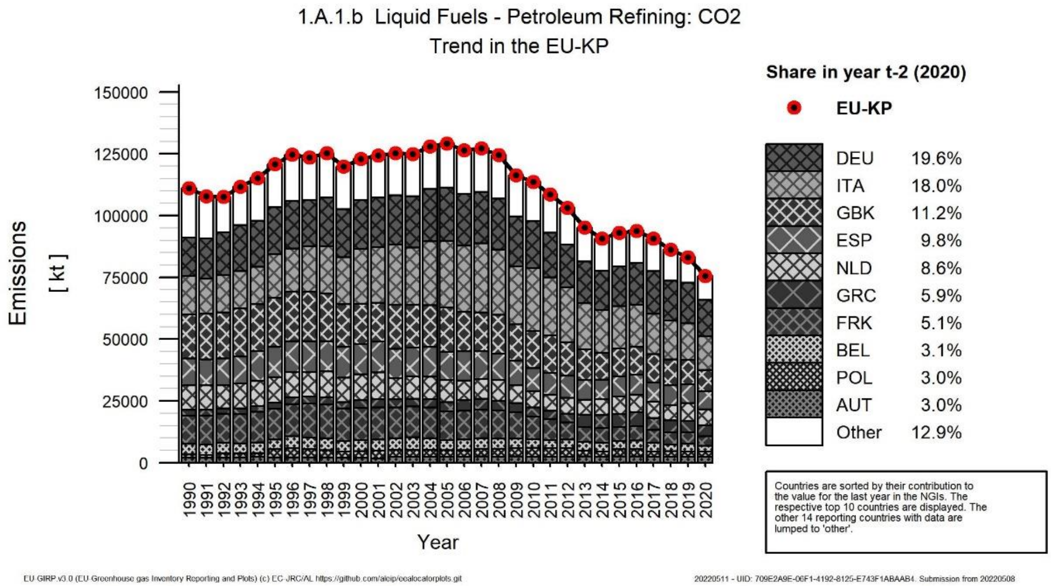
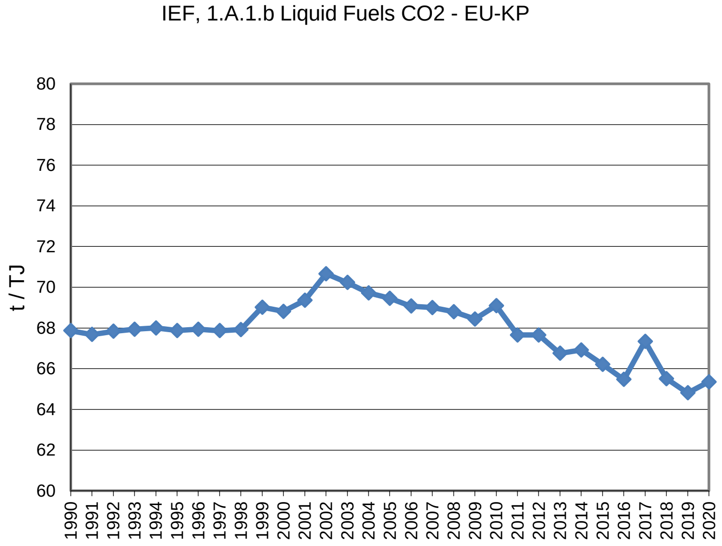
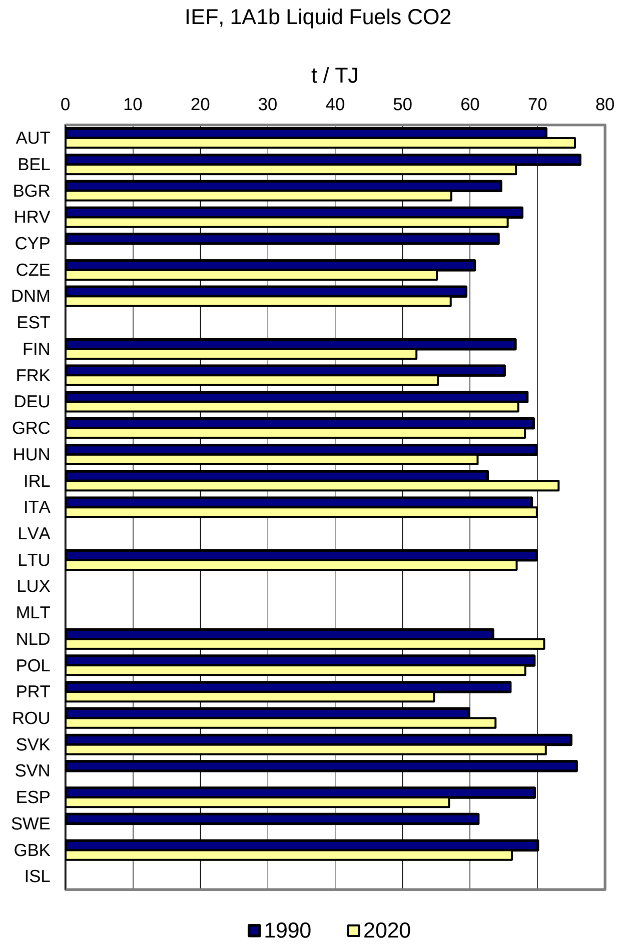


Figure 3.19 (on the next page) shows the emission factors for CO_2 emissions from liquid fuels. The EU-KP implied emission factor shows variations around 68 t/TJ over the time series and amounts 65.3 t/TJ in 2020. In general, the fluctuating IEF is due to the annual variations of fuel consumption with different carbon content. The IEF declining trend observed since 2002 is due to the higher share of refinery gas in the energy mix.

For example, in Italy the main fuels used are refinery gases, fuel oil and petroleum coke, which have very different emission factors, and every year the amount used changes resulting in an annual variation of the IEF. Ireland reports one of the highest IEF in 2020 which is due to differences in the data published in the national energy balance and the reported emissions under the EU ETS, concerning the single oil refinery in Ireland.

Figure 3.19 1.A.1.b Petroleum Refining, Liquid Fuels: Implied Emission Factors for CO_2





1.A.1.b Petroleum Refining - Solid Fuels (CO_2)

CO_2 emissions from the combustion of solid fuels in petroleum refining represented less than 0.1% of all greenhouse gas emissions from 1.A.1.b in 2020. There are only four countries reporting emissions in the EU-KP in 2020 (Belgium, Poland, Germany and Romania). Thereof only Poland reports increasing emissions between 1990 and 2020. However, emissions are decreasing between 2019 and 2020. Poland is responsible for 60.4% of emissions in 2020 in the EU-KP. Over the whole times series emissions fell by 98% on average (Table 3.14).

Table 3.14 1.A.1.b Petroleum Refining, Solid Fuels: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	0.02	0.02	0.02%	0.02	∞	0.002	16%	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	12	NO	NO	-	-12	-100%	-	-	NA	NA
France	486	NO	NO	-	-486	-100%	-	-	NA	NA
Germany	3 131	25	25	31.9%	-3 106	-99%	0	1%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	4	66	47	60.4%	43	1015%	-18	-28%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	4	6	7.7%	6	∞	2	71%	T3	PS
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**3 633**	**94**	**79**	**100%**	**-3 554**	**-98%**	**-15**	**-16%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**3 633**	**94**	**79**	**100%**	**-3 554**	**-98%**	**-15**	**-16%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 3.14 also shows that 93.9 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.20 illustrates the trend of emissions in 1.A.1.b for solid fuels for the past 30 years. The use of solid fuels in petroleum refining has declined drastically since 1990. Emissions are down by 98%. Germany is responsible for the strong declining trend in the 1990s and due to the recent overall trend, Poland is now responsible for 60.4% of the total emissions in the EU-KP for this category in 2020.

Figure 3.20 1.A.1.b Petroleum Refining, Solid Fuels: Emission trend and share for CO_2

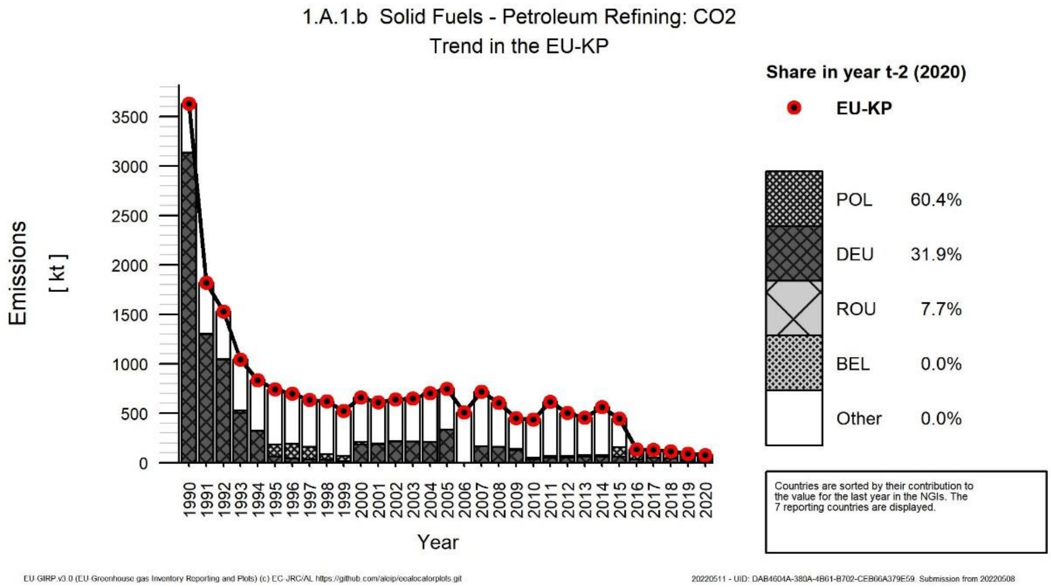
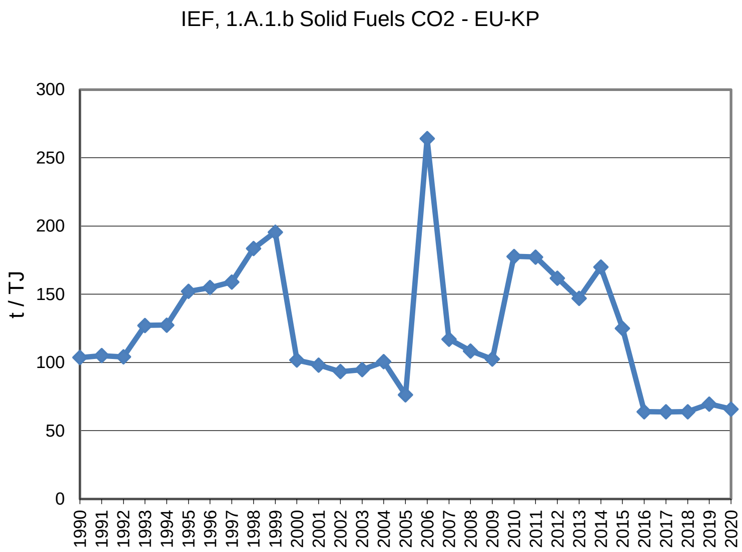
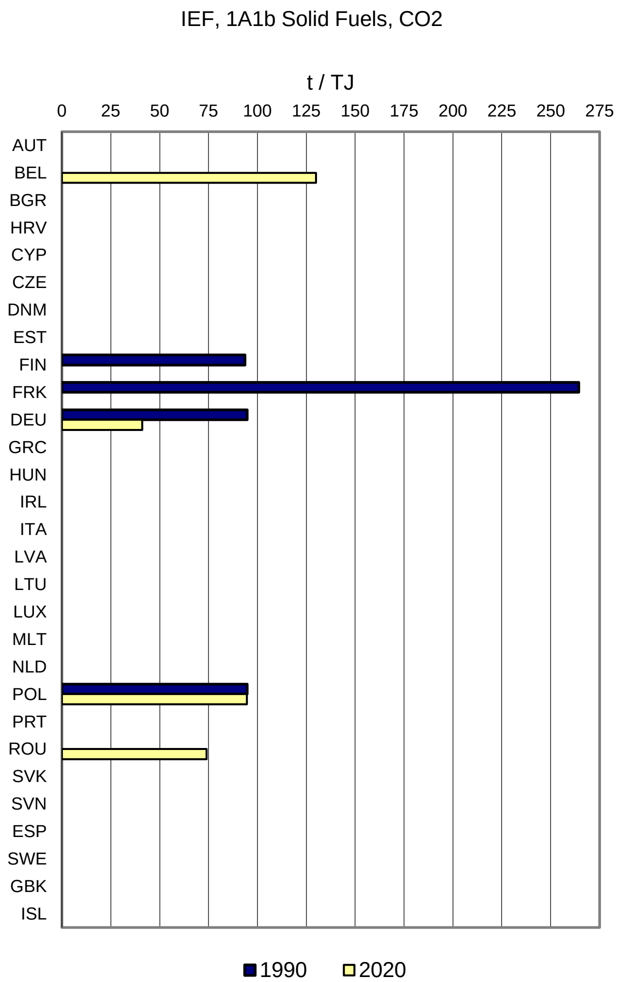


Figure 3.21 (on the next page) shows the relevant implied emission factors. The EU-KP implied emission factor showed strong fluctuations and amounts 65.8 t/TJ in 2020. One explanation for this is the low number of countries reporting this category. Apart from that, the variation in the EU-KP factor can be partly explained by the declining use of solid fuels in petroleum refining in Germany between 1990 and 1999. This explains the gradual increase of the EU-KP IEF up to 1999 through the growing weight of the much higher implied emission factor of France. The high emission factor in France was due to the use of blast furnace gas. In Germany, there was a decline in the IEF in the early 1990s compared to a rather stable IEF since the mid-1990s. The reason is that the use of - mainly - lignite has constantly been reduced in favour of coke oven gas. The increased EU-KP solid fuel combustion in 2000-2005 and 2007-2009 is due to an increase in fuel combustion in Germany in these years. The higher weight of the German IEF also explains the lower IEF at EU-KP level during these years. For 2006 Germany reports only negligible amounts of solid fuel use in petroleum refining. Therefore, the EU-KP IEF was almost entirely dominated by the high French IEF in this year. The drop in the implied emission factor since 2014 can be explained by the increased weight of Poland with their lower IEF (compared to France). Since there is no more solid fuel consumption in France since 2017, the average IEF is driven by Poland and Germany which have similar CO_2 EF.

Figure 3.21 1.A.1.b Petroleum Refining, Solid Fuels: Implied Emission Factors for CO_2





1.A.1.b Petroleum Refining - Gaseous Fuels (CO_2)

In 2020, CO_2 emissions from the combustion of gaseous fuels used for petroleum refining accounted for about 24.7% of total greenhouse gas emissions from 1.A.1.b. Emissions in the EU-KP increased by 386% between 1990 and 2020 (Table 3.15). Only four countries reduced their emissions: Czechia, Finland, Hungary and Slovenia over the whole time series. Belgium, Germany, Italy, Poland, Spain, the United Kingdom and Netherlands together account for 83.5% of the total increase between 1990 and 2020.

Table 3.15 1.A.1.b Petroleum Refining, Gaseous Fuels: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	437	504	497	1.9%	61	14%	-7	-1%	T2	CS
Belgium	14	2 305	2 283	8.9%	2 269	16334%	-21	-1%	CS,T3	PS
Bulgaria	69	103	102	0.4%	33	48%	-1	-1%	T2	CS
Croatia	14	390	412	1.6%	398	2852%	22	6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	317	223	187	0.7%	-130	-41%	-36	-16%	T2	CS
Denmark	NO	18	35	0.1%	35	∞	17	96%	T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	648	246	258	1.0%	-389	-60%	12	5%	T3	CS
France	36	1 436	1 291	5.0%	1 254	3466%	-146	-10%	T2,T3	CS,PS
Germany	1 444	5 436	3 669	14.3%	2 225	154%	-1 767	-33%	CS	CS
Greece	NO	IE	IE	-	-	-	-	-	NA	NA
Hungary	693	614	641	2.5%	-52	-7%	27	4%	T3	PS
Ireland	NO	12	14	0.1%	14	∞	2	16%	T3	CS,PS
Italy	161	4 232	3 838	15.0%	3 677	2288%	-394	-9%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	119	159	0.6%	159	∞	39	33%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 042	2 907	2 890	11.3%	1 848	177%	-17	-1%	T2	CS
Poland	92	2 380	2 280	8.9%	2 187	2366%	-100	-4%	T2	CS
Portugal	NO	1 078	1 096	4.3%	1 096	∞	18	2%	T2	CR,D,PS
Romania	NO	581	300	1.2%	300	∞	-282	-48%	T2,T3	CS,PS
Slovakia	88	270	220	0.9%	132	151%	-50	-19%	T3	PS
Slovenia	128	NO	NO	-	-128	-100%	-	-	NA	NA
Spain	46	3 322	2 811	11.0%	2 765	6013%	-511	-15%	T2,T3	PS
Sweden	NO	C	C	-	-	-	-	-	T2	CS
United Kingdom	49	2 684	2 639	10.3%	2 590	5251%	-45	-2%	T2	CS
EU-27+UK	**5 277**	**28 860**	**25 622**	**100%**	**20 344**	**386%**	**-3 239**	**-11%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	49	2 684	2 639	10.3%	2 590	5251%	-45	-2%	T2	CS
EU-KP	**5 277**	**28 860**	**25 622**	**100%**	**20 344**	**386%**	**-3 239**	**-11%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Table 3.15 also shows that about 98.4 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS.

Figure 3.22 illustrates the trend of increasing emissions from gaseous fuels in category 1.A.1.b in the last 30 years. As can be seen, the six largest contributors to CO_2 emissions in this sector account together for 70.8% of the total emissions in this category. Emissions have decreased by 11% between 2019 and 2020 after the peak observed in 2019.

Figure 3.22 1.A.1.b Petroleum Refining, Gaseous Fuels: Emission trend and share for CO_2

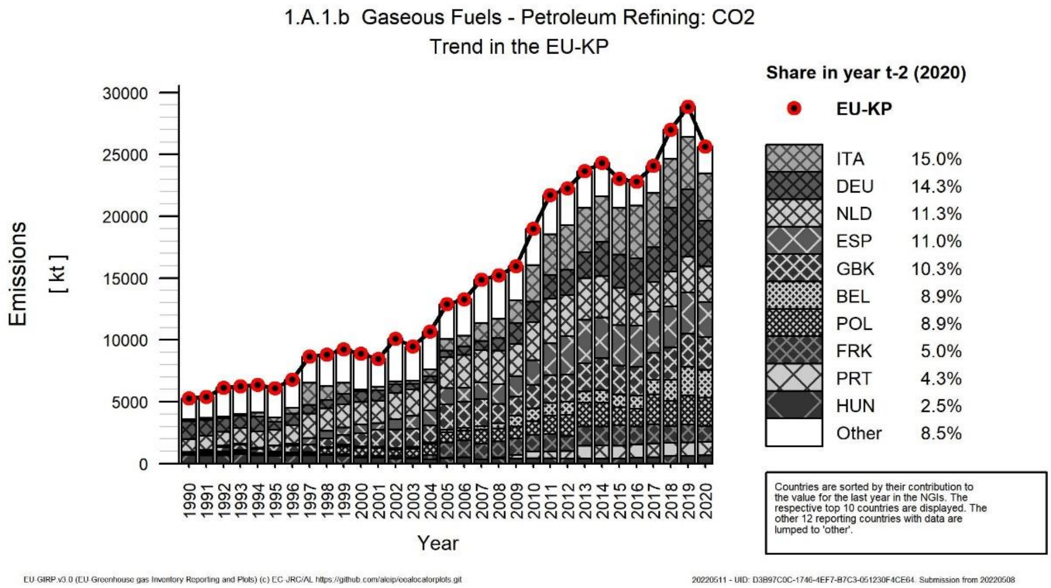
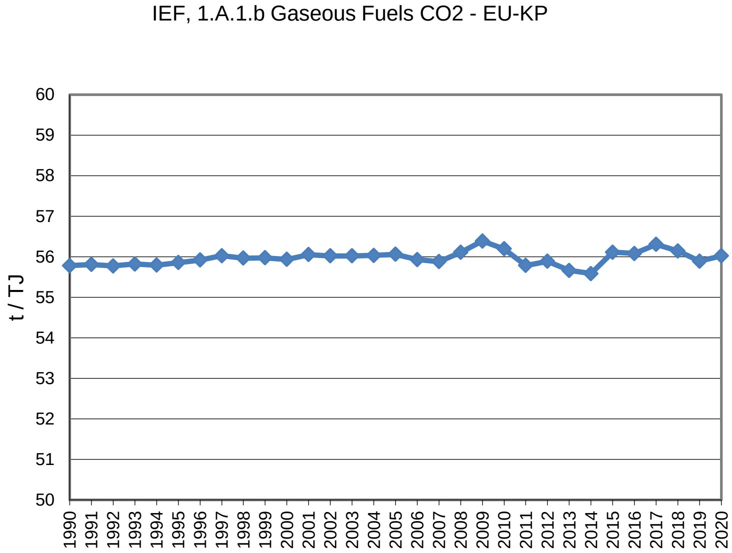
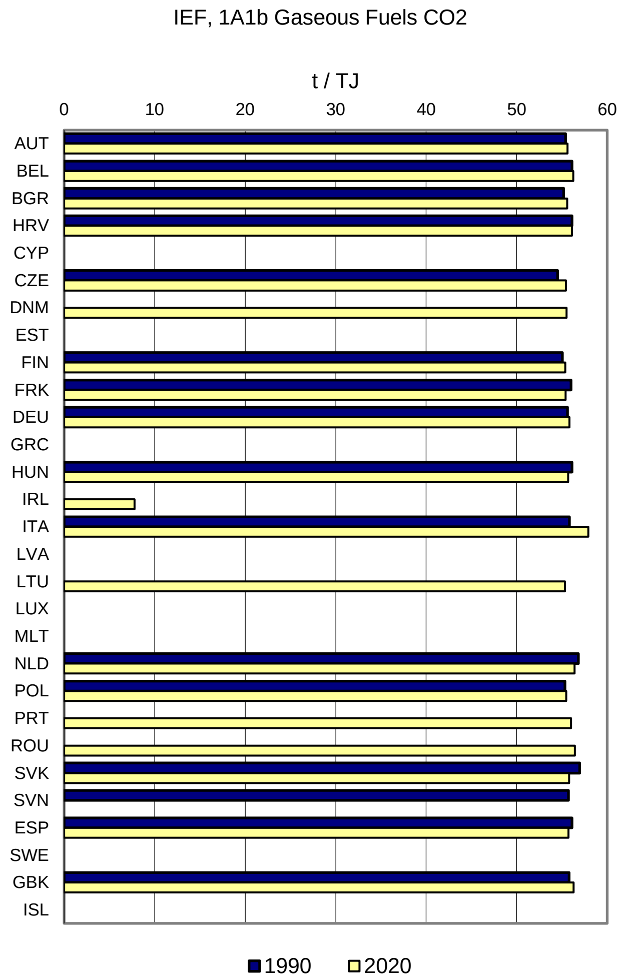


Figure 3.23 (on the next page) shows the implied emission factors for CO_2 emissions from gaseous fuels. The EU-KP implied emission factor has remained broadly stable around 56 t/TJ on the entire time-series. The very low IEF from Ireland is due to inconsistencies between CO_2 emissions originating from ETS data and activity data derived from the energy balance which aggregates different types of gases. This impacts only the IEF as total fuel reported under ETS is very similar to total fuel reported in the energy balance.

Figure 3.23 1.A.1.b Petroleum Refining, Gaseous Fuels: Implied Emission Factors for CO_2





3.2.1.3 Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c) (EU-KP)

According to the 2006 IPCC guidelines, the manufacture of solid fuels and other energy industries includes combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including production of charcoal. It comprises combustion emissions from the production of coke, brown coal briquettes and patent fuel. It can also cover the emissions from own-energy use in coal mining and gas extraction. Emissions from own on-site fuel use should be included. In addition, this category includes emissions from fuel combustion in oil and natural gas production.

Total emissions from this category accounted for 1.3% of total EU-KP greenhouse gas emissions in 2020. Between 1990 and 2020, CO_2 emissions fell by 60% in the EU-KP (Table 3.16). The United Kingdom, Germany, Czechia and Italy together are responsible for 67.4% of the total EU-KP emissions in 2020. Germany is responsible for 80% of the whole decrease in this category between 1990 and 2020.

Table 3.16 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Countries' contributions to CO_2 emissions

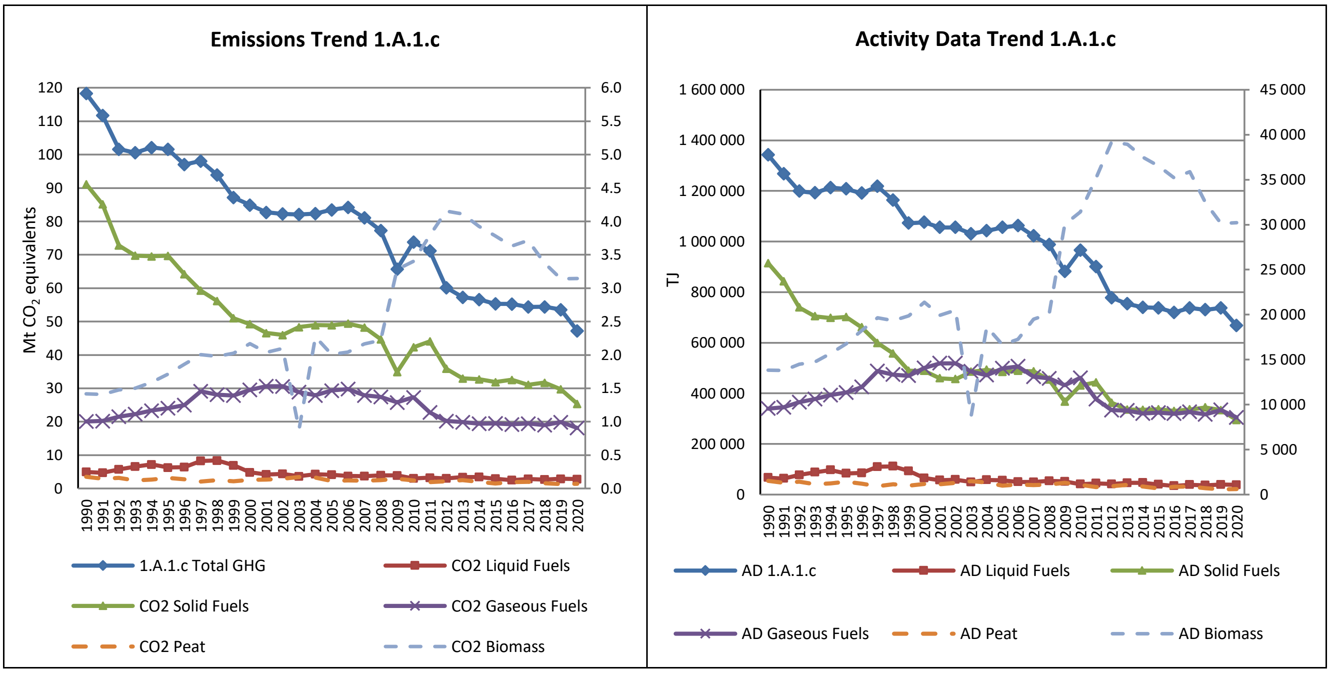
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	510	312	289	0.6%	-221	-43%	-23	-7%	T2	CS
Belgium	2 024	150.09	140.71	0.3%	-1 883.4	-93%	-9	-6%	T3	PS
Bulgaria	362	4	2	0.0%	-360	-99%	-1	-38%	T2	CS
Croatia	912	245	202	0.4%	-710	-78%	-43	-17%	T1	D
Cyprus	NO	NO	19	0.0%	19	∞	19	∞	T1	D
Czechia	1 516	5 438	4 206	9.1%	2 690	177%	-1 232	-23%	T1,T2	CS,D
Denmark	550	1 248	902	1.9%	352	64%	-346	-28%	T2,T3	CS,PS
Estonia	78	1 609	1 560	3.4%	1 481	1890%	-50	-3%	T3	PS
Finland	347	292	271	0.6%	-77	-22%	-22	-7%	T3	CS
France	4 738	2 841	2 101	4.5%	-2 637	-56%	-740	-26%	T2	CS
Germany	65 289	9 519	9 010	19.4%	-56 279	-86%	-509	-5%	CS	CS
Greece	102	43	34	0.1%	-68	-66%	-9	-21%	T2	PS
Hungary	570	401	294	0.6%	-276	-48%	-107	-27%	T1,T2,T3	CS,D,PS
Ireland	100	107	92	0.2%	-9	-9%	-15	-14%	T3	CS
Italy	12 454	5 389	3 985	8.6%	-8 470	-68%	-1 405	-26%	T3	CS
Latvia	205	64	48	0.1%	-157	-76%	-15	-24%	T2	CS
Lithuania	9	49	66	0.1%	57	606%	17	34%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2 110	2 464	2 650	5.7%	539	26%	186	8%	T2	CS,D
Poland	4 846	3 357	3 197	6.9%	-1 649	-34%	-160	-5%	T1,T2	CS,D
Portugal	141	NO	NO	-	-141	-100%	-	-	NA	NA
Romania	146	1 132	1 166	2.5%	1 020	698%	35	3%	T1,T2,T3	CS,D,PS
Slovakia	1 319	1 173	977	2.1%	-341	-26%	-196	-17%	T2	CS
Slovenia	82	0	0	0.0%	-82	-100%	0	-37%	T2	CS
Spain	2 089	1 740	752	1.6%	-1 338	-64%	-989	-57%	T1,T2	CS,D,PS
Sweden	300	387	360	0.8%	59	20%	-28	-7%	T2	CS
United Kingdom	16 026	14 613	14 093	30.4%	-1 933	-12%	-520	-4%	T1,T2	CS,D
EU-27+UK	**116 829**	**52 580**	**46 417**	**100%**	**-70 412**	**-60%**	**-6 162**	**-12%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16 026	14 613	14 093	30.4%	-1 933	-12%	-520	-4%	T1,T2	CS,D
EU-KP	**116 829**	**52 580**	**46 417**	**100%**	**-70 412**	**-60%**	**-6 162**	**-12%**	**-**	**-**

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 3.24 shows the trends in emissions from this source category by fuel in the EU-KP between 1990 and 2020. The largest share of greenhouse gas emissions from the manufacture of solid fuels can be accounted to CO_2 emissions from solid (53.7%) and gaseous (38.4%) fuels. Emissions from solid fuels fell markedly during the 1990s and then stabilized for a few years. Since 2006 they began to decrease again. The strong drop in 2009 was due to the drop-in coke production associated with the iron and steel production triggered by the economic downturn.

Fuel used for manufacturing solid fuels fell by 50.4% in the EU-KP between 1990 and 2020. The strongest decline was reported for solid fuels (-67.8%), followed by liquid fuels (-42.7%). Only biomass consumptions increased in the period from 1990 to 2020. Germany is responsible for the increase in energy use and emissions from biomass (according to the energy balance of Germany, biomass mainly consists of biogas that is used in gasification plants). In the year 2020, solid fuels and gaseous fuels represented 44.2% and 45.4% respectively of all fuel used. Biomass consumptions represent 4.5% of fuel consumptions. Almost no other fossil fuels and peat are used in this category; together accounting for less than 0.1% of the total fuel used in 2020.

Figure 3.24 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Total and CO_2 emission and activity trends



Note: Data displayed as dashed line refers to the secondary axis.

1.A.1.c Manufacture of Solid Fuels and Other Energy Industries – Solid Fuels (CO_2)

CO_2 emissions from the combustion of solid fuels used for the manufacture of solid fuels accounted for 53.7% of total greenhouse gas emissions from 1.A.1.c in 2020. Emissions in the EU-KP declined by 72% since 1990. This was mainly driven by a strong decline in emissions in Germany (-52 485 kt CO_2), which amounts to about 80% of the total decline in this category.

Table 3.17 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	2 017	150.09	140.71	0.6%	-1 876.3	-93%	-9	-6%	T3	PS
Bulgaria	274	1	0	0.0%	-274	-100%	-1	-85%	T1,T2	CS,D
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 352	5 414	4 185	16.5%	2 833	210%	-1 229	-23%	T1, T2	D, CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	78	1 609	1 560	6.2%	1 481	1890%	-50	-3%	T3	PS
Finland	347	292	271	1.1%	-77	-22%	-22	-7%	T3	CS
France	4 054	2 841	2 101	8.3%	-1 953	-48%	-740	-26%	T2	CS
Germany	61 101	8 925	8 616	34.0%	-52 485	-86%	-309	-3%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	220	247	148	0.6%	-72	-33%	-99	-40%	T1, T2, T3	D, CS, PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	10 891	4 500	3 031	12.0%	-7 860	-72%	-1 469	-33%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	T1, T2	D, CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	916	1 041	1 243	4.9%	327	36%	202	19%	T2	CS
Poland	4 009	2 190	1 853	7.3%	-2 156	-54%	-337	-15%	T1/T2	D/CS
Portugal	91	NO	NO	-	-91	-100%	-	-	T1	D
Romania	NO	0	NO	-	-	-	0	-100%	NA	NA
Slovakia	1 319	1 134	947	3.7%	-372	-28%	-187	-16%	T2	CS
Slovenia	37	NO	NO	-	-37	-100%	-	-	NA	NA
Spain	1 809	220	207	0.8%	-1 602	-89%	-13	-6%	T1/T2	D/CS/PS
Sweden	300	387	360	1.4%	59	20%	-28	-7%	T2	CS
United Kingdom	2 339	776	698	2.8%	-1 640	-70%	-77	-10%	T1, T2	CS, D
EU-27+UK	**91 155**	**29 729**	**25 360**	**100%**	**-65 795**	**-72%**	**-4 369**	**-15%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 339	776	698	2.8%	-1 640	-70%	-77	-10%	T1, T2	CS, D
EU-KP	**91 155**	**29 729**	**25 360**	**100%**	**-65 795**	**-72%**	**-4 369**	**-15%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Note: Austria includes the emissions from 1.A.1.c Solid fuels (occurring in coke ovens) in 1.A.2.a Iron and Steel Industries.

Table 3.17 also shows that than 97.2 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Solid fuels have fallen steadily to one third of the 1990 levels. The decline in emissions (see Figure 3.25 below) in Germany is mainly due to a large decline in lignite production in the 1990s. Lignite use decreased strongly in the new German Länder from usage levels of the industry of the former GDR. From raw lignite, a range of refined products used to be produced for industry, households and small commercial operations. A comprehensive transition from lignite to other fuels then took place until the end of the 1990s. The three largest emitters in 2020 were Germany, Czechia and Italy, jointly responsible for 62.5% of all EU-KP emissions in this category.

Figure 3.25 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Emission trend and share for CO_2

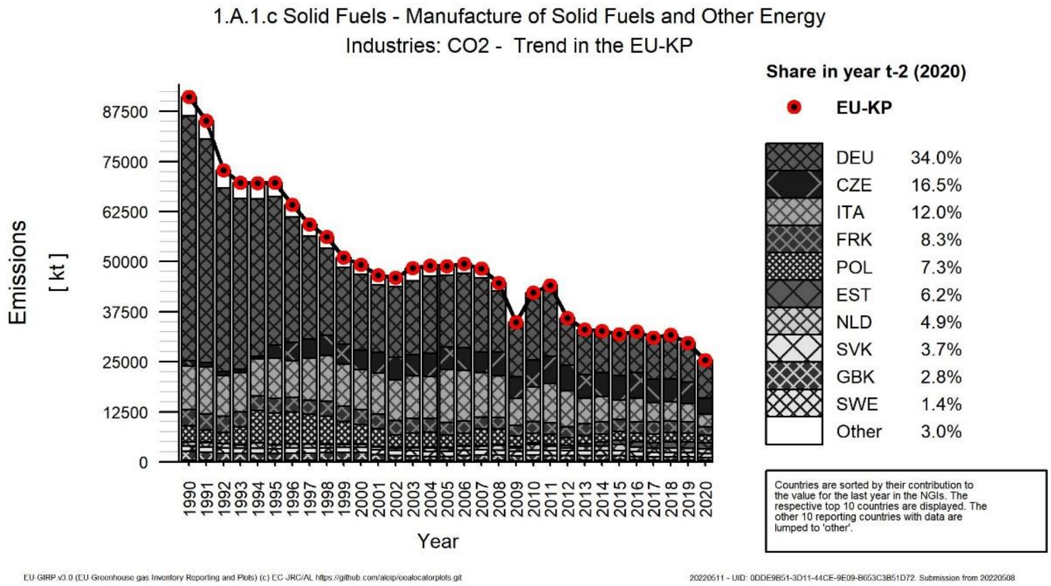
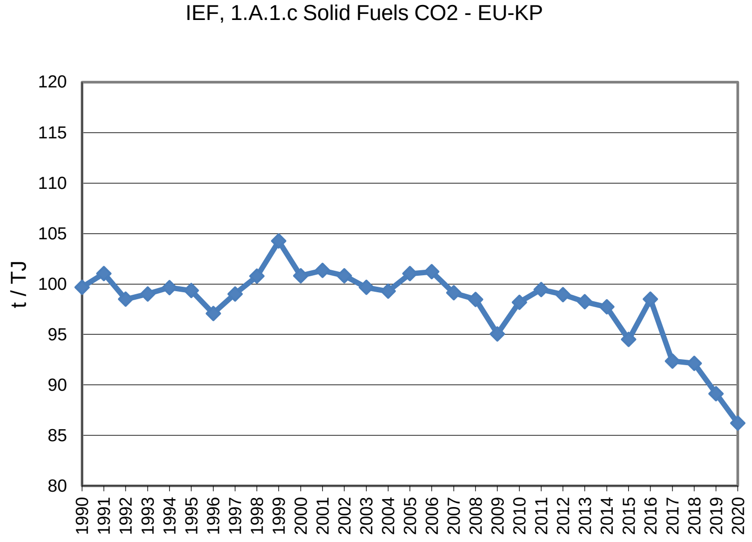
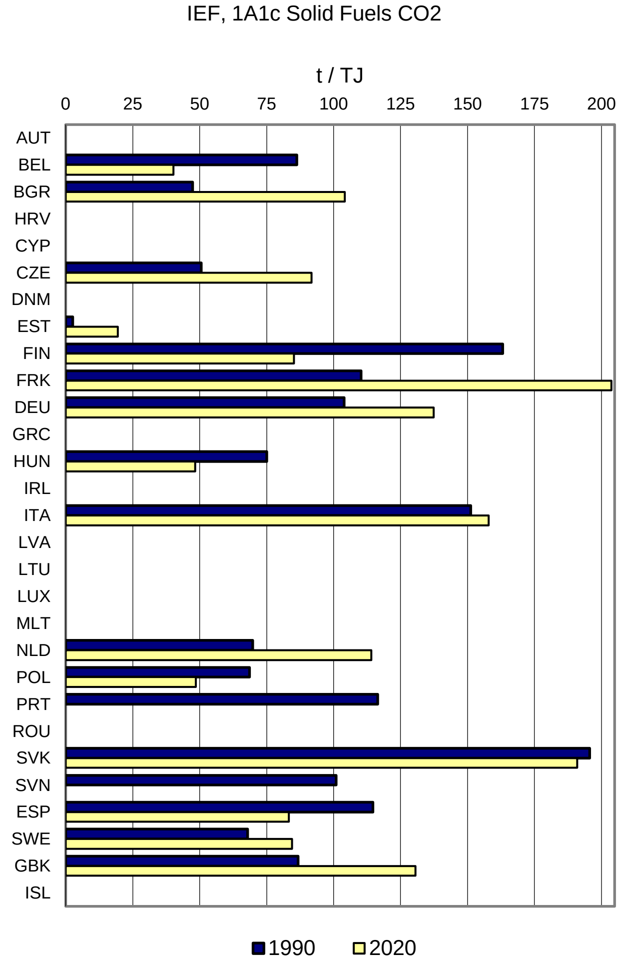


Figure 3.26 shows the relevant implied emission factors for solid fuels. The EU-KP implied emission factor amounted to 86.2 t/TJ in 2020: it is the lowest of the entire time-series. This drop can be partly explained by the 13 % decrease of IEF of Italy (third emitter with 12%) since 2016.

In general, the variation can be explained by the mix of different fuels and the shifts of their energy consumptions between years. The high implied emission factor for solid fuels in Slovakia and France can be explained with their use of blast furnace gas. Alike, the high implied emission factor for solid fuels in Italy is due to the large use of derived steel gases and in particular blast furnace gas to produce electricity in the iron and steel plant plants. Estonia has a low IEF, because the EF is calculated by using the carbon balance of the shale oil plant. The measured results are provided by the oil plants to the Estonian Ministry of Environment. To calculate the amount of carbon in flue gases into the atmosphere the carbon in the oil shale is subtracted from the carbon of shale oil, semi-coke gas, gasoil and black ash.

Figure 3.26 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Implied Emission Factors for CO_2





1.A.1.c Manufacture of Solid Fuels and Other Energy Industries – Gaseous Fuels (CO_2)

CO_2 emissions from the combustion of gaseous fuels used in category 1.A.1.c accounted for 38.4% of total greenhouse gas emissions from this category in 2020. Emissions in the EU-KP decreased by 10% (Table 3.18 below) between the years 1990 and 2020. After a strong increase in the 1990s and stabilisation in the 2000s there has been a significant reduction in the last few years. The top three countries (United Kingdom, Netherlands and Poland) together account for 79% of emissions in this category.

Table 3.18 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Countries' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	506	312	289	1.6%	-217	-43%	-23	-7%	T2	CS
Belgium	3	NO	NO	-	-2.6	-100%	-	-	NA	NA
Bulgaria	NO	1	1	0.0%	1	∞	0	4%	T1,T2	CS,D
Croatia	875	245	202	1.1%	-673	-77%	-43	-17%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	6	6	0.0%	6	∞	0	2%	T1, T2	D, CS
Denmark	545	1 211	877	4.8%	333	61%	-334	-28%	T3	CS,PS
Estonia	IE	IE	IE	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	531	NO	NO	-	-531	-100%	-	-	T2	CS
Germany	2 622	586	387	2.1%	-2 235	-85%	-200	-34%	CS	CS
Greece	102	43	34	0.2%	-68	-66%	-9	-21%	T2	PS
Hungary	311	153	145	0.8%	-165	-53%	-8	-5%	T1, T3	D, PS
Ireland	IE	44	22	0.1%	22	∞	-22	-50%	T3	CS
Italy	621	889	953	5.3%	333	54%	64	7%	T3	CS
Latvia	105	32	27	0.2%	-77	-74%	-4	-14%	T1, T2	CS, D
Lithuania	NO	37	53	0.3%	53	∞	16	43%	T1, T2	CS, D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 184	1 423	1 407	7.7%	222	19%	-16	-1%	T2	CS
Poland	684	1 030	1 247	6.9%	563	82%	217	21%	T2	CS
Portugal	NO	NO	NO	-	-	-	-	-	T1	D
Romania	NO	280	244	1.3%	244	∞	-36	-13%	T2,T3	CS,PS
Slovakia	NO	40	31	0.2%	31	∞	-9	-22%	T2	CS
Slovenia	42	0	0	0.0%	-42	-100%	0	-37%	T2	CS
Spain	89	1 478	537	3.0%	448	503%	-940	-64%	T2	CS
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom	11 874	12 072	11 691	64.4%	-183	-2%	-380	-3%	T1, T2	CS, D
EU-27+UK	**20 093**	**19 882**	**18 155**	**100%**	**-1 937**	**-10%**	**-1 727**	**-9%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	11 874	12 072	11 691	64.4%	-183	-2%	-380	-3%	T1, T2	CS, D
EU-KP	**20 093**	**19 882**	**18 155**	**100%**	**-1 937**	**-10%**	**-1 727**	**-9%**		

Abbreviations are explained in the Chapter 'Units and abbreviations'.

Note: Estonia includes the emissions from 1.A.1.c in 1A1a.
Sweden includes emissions from 1.A.1.c in 1.A.2.g

Table 3.18 also shows that about 92.3 % of EU-KP emissions are calculated using higher tier methods. Many countries are using country specific information from the EU ETS and apply default emission factors for emissions that are not covered by the EU ETS. Similarly, countries may use country specific emission factors for the most common fuels (for example hard coal and lignite) and use default emission factors for fuels of minor importance (for example brown coal briquettes). Therefore, countries might use apparently contradicting information such as "T1, T2" for Methods used and "CS, D" for Emission Factors applied. In such cases we assumed, that 90 % of emissions are calculated using a higher tier method and 10 % of emissions are calculated using the tier 1 method. When countries have reported country specific methods and emission factors it has been assumed, that a higher tier method has been used.

Figure 3.27 illustrates the emission trend for gaseous fuels split by countries over the last 30 years. Although the emissions in the year 2020 compared to 1990 decreased by 10% over the whole time series, there was a strong increase in the 1990s and a decline after 2009. The increase in EU-KP emissions between 1990 and 2002 and the decline in recent years were heavily influenced by the trend in the United Kingdom, which is responsible for 64.4% of the total EU-KP emissions in this category in 2020. Between 2000 and 2020, natural gas production was reduced by 65% in GBK.

Figure 3.27 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Emission trend and share for CO_2

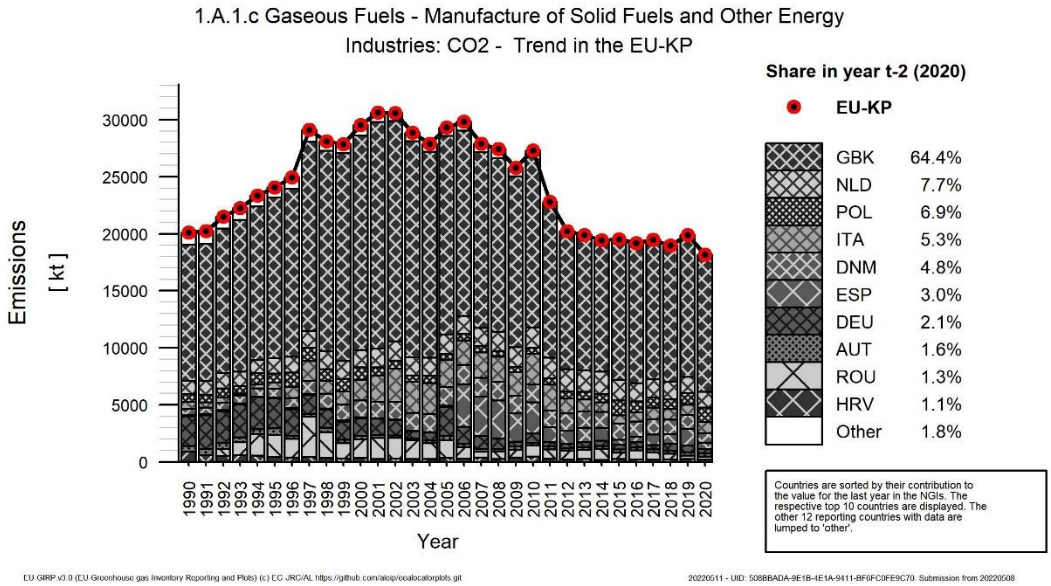
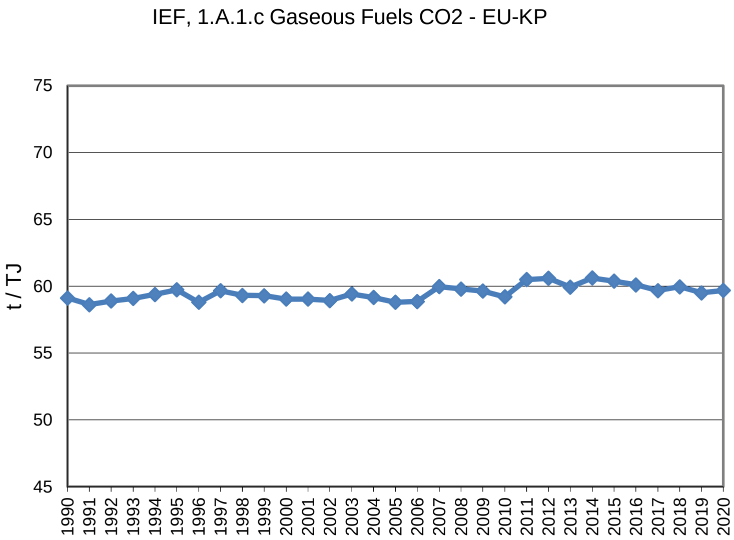
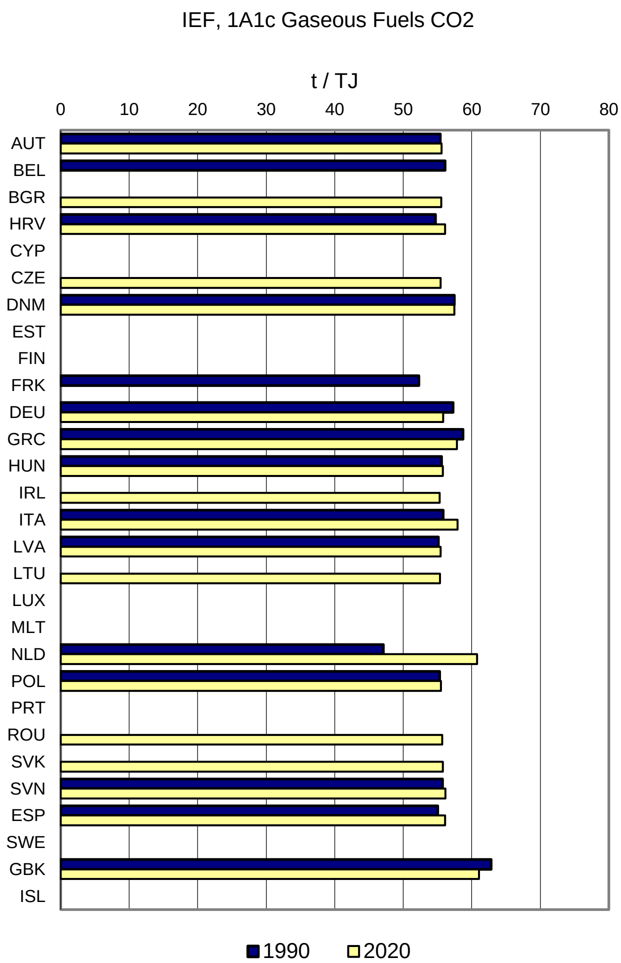


Figure 3.28 (on the next page) shows the implied emission factors for gaseous fuels. The EU-KP implied emission factor amounts 59.7 t/TJ in 2020 and remained fairly stable around 60 t/TJ over the last 30 years. The IPCC default values range between 54.3 t/TJ (lower) and 58.3 t/TJ (upper). The EU-KP IEF is dominated by the IEF of the United Kingdom and the Netherlands, which are comparatively high. In the United Kingdom emissions of gaseous fuels within this sector include colliery methane combustion and natural gas combustion, including offshore own gas use. The carbon emission factor for offshore own gas use is higher than the emission factor for other natural gas combustion. This higher emission factor is to be expected, as the unrefined gaseous fuels used in the upstream oil and gas sector will contain heavier hydrocarbons (which are removed in gas treatment prior to injection into natural gas supply infrastructure at onshore terminals). This source is responsible for the majority of the emissions within this sector in the United Kingdom and is therefore the main driver in the trend in the implied emission factor. The emission factor for this source is based on data supplied by the offshore operators. It decreases across the time series but remains higher than natural gas IEF in other sectors. The IEF of the Netherlands is comparatively high. The inter-annual variability in the EFs for CO_2 and CH_4 emissions from gas combustion is mainly due to a change in the statistics to estimate Activity Data which are not consistent with emissions reported in the AERs of individual companies. This leads to high IEF but it does not influence total emissions: this issue is under investigation.

Figure 3.28 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Implied Emission Factors for CO_2





3.2.2 Manufacturing industries and construction (CRF Source Category 1.A.2.)

Category 1A2. includes emissions from combustion of fuels in manufacturing industries and construction including fuel use of non-public electricity and heat generation (auto producers). According to the guidelines, emissions from fuel combustion in coke oven plants are reported under 1.A.1.c. Austria reports emissions from onsite coke ovens of integrated iron and steel plants under category 1.A.2.a. Some MS report emissions of blast furnace and coke oven gas combustion under categories 1.A.1.a public electricity and heat production or 1.A.4 other sectors and some MS are reporting emissions from refinery gas under 1.A.2. Emissions from category 1.A.2 are specified by the sum of subsectors that correspond to the International Standard Industrial Classification of All Economic Activities (ISIC, see listing below). Emissions from transport used by industry are reported under category 1.A.3 Transport. Most countries report emissions arising from off-road and other mobile machinery used in industry (e.g. construction machinery) under category 1.A.2.g. Emissions from non-energy fuel use (e.g. reducing agents used in blast furnaces or natural gas used for ammonia production) should be reported under category 2 Industrial Processes.

The following enumeration shows the correspondence of 1A2 subcategories and ISIC Rev 3.1 codes:

- 1 A 2 a Iron and Steel: ISIC Group 271 and Class 2731.
- 1 A 2 b Non-Ferrous Metals: ISIC Group 272 and Class 2732.
- 1 A 2 c Chemicals: ISIC Division 24.
- 1 A 2 d Pulp, Paper and Print: ISIC Divisions 21 and 22
- 1 A 2 e Food Processing, Beverages and Tobacco: ISIC Divisions 15 and 16.
- 1 A 2 f Non-metallic Minerals: ISIC Division 26
- 1 A 2 g Other manufacturing industries: ISIC Divisions 17 to 20, 25, 28 to 37 and 45.

The following table shows the share of specific tier methods used for each 1.A.2 category emission estimates. It can be seen that most countries use Tier 2 methodology for emission estimates.

Table 3.19 Share of Tier methods for 1.A.2 by type of reported method and method combinations.

Methods and method combinations	Share of emissions which are estimated by the specific Tier method'
CS	9.9%
T1	3.2%
T1,T2	7.5%
T1,T3	3.1%
T2	31.8%
T2,T3	7.2%
T3	2.3%
T1,T2,T3	13.3%
CS,T1	14.2%
CS,T1,T3	0.4%
Other combination	5.3%

Information about methodology used by countries for calculating emissions from category 1.A.2.g is not included in submission files for specific fuels but only as overall methodology information. Table 3.20 shows all key categories in 1A2 and the share of higher tiers.

Table 3.20 Key categories for sector 1.A.2.

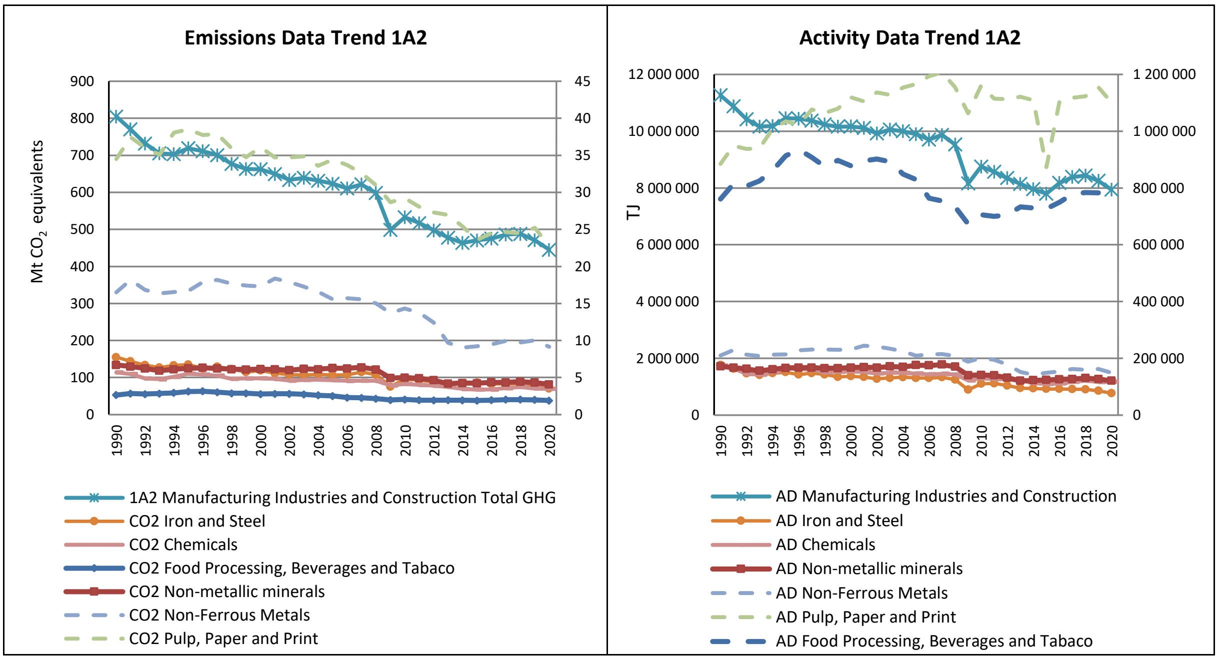
Source category gas	kt CO_2 equivalent		Trend	Level		Share of higher Tiers [%]
	1990	2020		1990	2020	
1.A.2.a Iron and Steel: Gaseous Fuels (CO_2)	31933	18636	0	L	L	99.86
1.A.2.a Iron and Steel: Liquid Fuels (CO_2)	9183	872	T	L	0	99.15
1.A.2.a Iron and Steel: Solid Fuels (CO_2)	113361	50941	T	L	L	99.95
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CO_2)	3835	6874	T	0	L	95.72
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	8066	1172	T	L	0	92.43
1.A.2.c Chemicals: Gaseous Fuels (CO_2)	55475	42257	T	L	L	99.25
1.A.2.c Chemicals: Liquid Fuels (CO_2)	40418	18714	T	L	L	92.74
1.A.2.c Chemicals: Solid Fuels (CO_2)	14761	7142	0	L	L	99.96
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CO_2)	13247	17903	T	L	L	92.06
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CO_2)	11544	1627	T	L	0	84.21
1.A.2.d Pulp, Paper and Print: Solid Fuels (CO_2)	8503	2083	T	L	0	94.89
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CO_2)	19432	31732	T	L	L	97.52
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CO_2)	20540	2579	T	L	0	62.90
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CO_2)	12812	3564	T	L	0	94.00
1.A.2.f Non-metallic minerals: Gaseous Fuels (CO_2)	27928	30278	T	L	L	98.69
1.A.2.f Non-metallic minerals: Liquid Fuels (CO_2)	45862	20479	T	L	L	94.87
1.A.2.f Non-metallic minerals: Other Fuels (CO_2)	1432	15169	T	0	L	70.87
1.A.2.f Non-metallic minerals: Solid Fuels (CO_2)	58631	15484	T	L	L	96.65
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CO_2)	92874	83694	T	L	L	98.87
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CO_2)	103954	46998	T	L	L	98.87
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CO_2)	92264	10487	T	L	L	98.87

In 2020, category 1.A.2. contributed to 444 955 kt CO_2 equivalents of which 98.7% share belongs to CO_2 emissions, 0.8% to N_2O emissions and 0.5% to CH_4 emissions.

Figure 3.29 shows the emission trends within source category 1.A.2, which is dominated by CO_2 from category 1.A.2.g Other which contributes to total kt CO_2 equivalents emissions by 33.5% followed by 1.A.2.f Non-metallic Minerals contributing by 18.4%, 1.A.2.a Iron and steel contributing by 16.2%, 1.A.2.c Chemicals by 16.1%, 1.A.2.e Food processing, beverages and tobacco by 8.6%, 1.A.2.d Pulp, paper and print by 5% and 1.A.2.b Non-ferrous metals by 2%. Some Member States do not allocate emissions to all sub-categories under 1.A.2., which is one reason for 1.A.2.g being the largest sub-category within 1.A.2. source category.

Greece reports the rest of industrial sector emissions in category 1.A.2.f instead of category 1.A.2.g for whole time series. Germany reports some fuels of subcategories 1.A.2.a-1.A.2.e as included elsewhere (Notation key 'IE') and reports the specific emissions and activity data under 1.A.2.g. For the years 2013 to 2020 Sweden makes excessive use of confidential reporting (Notation key 'C'), which implies that sub-categories include emissions without providing detailed fuel specific emissions. However, all Swedish confidential emissions are included in the total emissions of 1.A.2. and have been included in 'other fossil fuels' of the EU inventory.

Figure 3.29: 1.A.2. Manufacturing Industries and Construction: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Table 3-21 summarizes information by countries on GHG emissions and CO_2 emissions from 1.A.2 Manufacturing Industries and Construction in 1990 and 2020. The highest shares on total kt CO_2 equivalents emissions (above the average share calculated for EU-KP) are Germany (26%), Italy (10%), France (9.5%), Spain (9%), United Kingdom (9%), Poland (7%) and the Netherlands (6%). Together those countries contribute to 76% of total emissions from 1.A.2.

Table 3-21: 1.A.2. Manufacturing Industries and Construction: Member States, United Kingdom and Iceland contributions to total GHG and CO_2 emissions

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt	
	1990	2020	1990	2020
Austria	9 845	10 550	9 763	10 411
Belgium	23 536	13 073	23 388	12 937
Bulgaria	17 763	4 010	17 664	3 962
Croatia	5 235	2 394	5 209	2 382
Cyprus	515	923	512	915
Czechia	47 113	10 244	46 824	10 132
Denmark	5 580	3 577	5 511	3 500
Estonia	3 475	511	3 466	509
Finland	13 375	6 238	13 192	6 079
France	65 165	42 187	64 591	41 589
Germany	186 767	116 388	185 165	115 337
Greece	9 405	4 454	9 338	4 406
Hungary	13 400	4 973	13 364	4 927
Ireland	4 099	4 521	4 080	4 500
Italy	92 278	45 856	90 772	44 879
Latvia	3 971	660	3 910	608
Lithuania	6 165	1 187	6 108	1 168
Luxembourg	6 266	1 096	6 250	1 084
Malta	53	57	53	57
Netherlands	34 496	27 267	34 394	27 158
Poland	42 836	29 196	42 621	28 878
Portugal	9 012	7 628	8 854	7 465
Romania	51 599	14 782	51 476	14 714
Slovakia	16 097	5 933	16 027	5 882
Slovenia	3 097	1 715	3 066	1 690
Spain	45 286	40 211	44 933	39 178
Sweden	10 818	6 074	10 657	5 914
United Kingdom	77 397	39 252	76 967	38 867
EU-27+UK	**804 645**	**444 955**	**798 156**	**439 129**
Iceland	238	45	237	44
United Kingdom (KP)	77 474	39 329	77 044	38 945
EU-KP	**804 960**	**445 078**	**798 470**	**439 250**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The difference between EU-27+UK and EU-KP is not only Iceland but also the different geographical coverage of the UK included in the EU-27+UK submission (GBE). The EU-27+UK numbers are the numbers submitted under the UNFCCC and include the EU territory for the UK. The EU-KP numbers are the numbers submitted under the Kyoto Protocol and include the Kyoto Protocol territory of the UK (GBK).

1.A.2. Manufacturing Industries and Construction is the fourth largest sector in the EU-KP accounting for 16% of total GHG emissions from Energy sector in 2020. Between 1990 and 2020, CO_2 emissions from 1.A.2. Manufacturing Industries and Construction declined by 45%. Decrease of total emissions is caused by decrease of fossil fuel consumption in category 1.A.2. Manufacturing Industries and Construction.

A shift from solid and liquid fuels to mainly natural gas took place and an increase of biomass CO_2 emissions by 118% and an increase of other fossil fuels CO_2 emissions by 180% have been recorded in 2020 compared to 1990.

Between 1990 and 2020, CO_2 emissions were significantly reduced by Estonia (85%), Latvia (84%), Luxembourg (83%), Iceland (82%), Lithuania (81%) and Czechia and Bulgaria (78%) compared to the level of CO_2 emissions in 1990. Only Austria, Cyprus, Ireland and Malta report emission increases.

The main reason for the decline of emissions in Latvia for 1990 to 2001 could be explained with recession of Soviet Union and following reformations and reorganizations within Latvia after that. Decrease of emissions in 2006 to 2008 were influenced by the features of national economy development when in-country industrial production already started to diminish due to increasing costs of the production and dominance of imported products. Crisis in national economy in the second part of 2008 also caused a significant decrease in total emissions. The main reasons for the large decline in Czechia were the loss of markets and the energy saving behavior of newly privatized enterprises, following the political changes in the country in the early 1990s. Main reasons of the decline in Romania were the transition to a market economy and the reduction of energy intensive activities. The main reason for the decline of emissions in Germany (38%) was the restructuring of the industry and efficiency improvements after German reunification.

Table 3-22 provides information on countries recalculations in CO_2 from 1.A.2. Manufacturing Industries for 1990 and 2019 and explanations for the recalculations in absolute terms. The largest recalculations in 1990 were reported by Romania, Estonia, Iceland and United Kingdom. The largest recalculations in 2019 were reported by Iceland, United Kingdom and Romania. The reasons for year 2019 revisions are mostly changes in activity data/revised energy balances.

Table 3-22: 1.A.2. Manufacturing Industries and Construction: Recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	122	1.2		Revision of energy balance (mainly -92 kt from other fossil fuels, + 175 kt from liquid fuels). Also: -42 kt CO_2 from solid fuels have ben reallocated to category 2.C.1.
Belgium	313	1.4	372	2.8	no explanation provided	in Walloon region : reallocation of the emissions from a gaz turbine power plant from the sector "energy industries" to the sector "Chemical industries" and correction of a mistake in some stationary motors using biogas (the direct measurements are now taking into account).
Bulgaria	-2.2	-0.0	16	0.4	no explanation provided	
Croatia	-	-	-	-		
Cyprus	-	-	0.4	0.1		
Czechia	-	-	376	4.1		updated activity data in CzSO balance
Denmark	149	2.8	-26	-0.7	Revised estimates for combustion of gas-/diesel oil in mobile sources have resulted in revised split between stationary combustion and mobile sources. Further details about the	

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
					background for the recalculation is included in the mobile combustion chapter. The gas oil reallocated from mobile sources to stationary combustion is +5678 TJ for 1990 corresponding to +421 kt CO_2. For 2019, the recalculation is + 1126 TJ corresponding to 83 kton CO_2. This recal-culation is split between industrial plants (1A2) and agricultural plants (1A4c).	
Estonia	-742	-18	-27	-3.6	Emissions were recalculated due to using updated Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases and taking into account the number and fuel consmuption of other mobile emission sources, such as excavator, loeader, and road work machines in 1A2g.	no explanation provided
Finland	-54	-0.4	3	0.0		
France	-578	-0.9	-3 419	-7.2	update of activity data: Revision of the treatment of consumption of solid fuels and natural gas linked to the decentralized production of electricity and heat between 2011 and 2020 (transfer to 1A1a) and reallocation of part of the consumption from self-production to the tertiary sector (between 10 and 20%) over 1990-2020.	
Germany	-	-	-1 906	-1.5		update of provisional 2019 energy balance data with actual ones
Greece	-	-	-	-		
Hungary	-151	-1.1	-13	-0.3	no explanation provided	
Ireland	1.4	0.0	-0	-0.0		
Italy	-	-	119	0.2		
Latvia	-	-	0.3	0.1		
Lithuania	-	-	-1.9	-0.1		
Luxembourg	0.0	0.0	32	2.7		AD changes due to small revisions of energy balance, error corrections for AD, methodology revision for injected biogas
Malta	-	-	1.4	3.1		Update in activity data (Fuel consumption) /changes in Emissions factors/ changes in the methodology
Netherlands	-50	-0.1	-325	-1.2		Final energy statistics and improved allocation biogenic part of natural gas
Poland	-	-	0.5	0.0		
Portugal	1.2	0.0	24	0.3		
Romania	-16 608	-24	-884	-6	no explanation provided	"Recalculation are due to the including of the activity data from reports monitoring of economic operators under EU ETS scheme for the fuels (Other Bituminous Coal, Sub-bituminous Coal, Lignite, Coke Oven Coke, Refinery Gas, LPG, Transport Diesel, Residual Fuel Oil, Petroleum Coke, Heating and Other Gasoil and Natural Gas). "
Slovakia	-	-	-	-		

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Slovenia	9.4	0.3	29	1.7		Improved CS CO_2 EF for natural gas, Improved AD (other fuels in 1A2c)
Spain	-0.0	-0.0	-831	-1.8		- 2019 AD correction corresponding to the use of natural gas in combustion in boilers of less than 50 MWt - Error correction due to omission regarding some FE for several fuels and point years - Update of actual rate for "secondary zinc production" from 2015 onwards. - Update of actual rate for "secondary aluminium production" for the year 2019. - The balance sheet has generated movements in fuels. In addition, the non-specific combustion emission factors for the balance rubrics were completed in this 2022 edition.
Sweden	46	0.4	-135	-2.0	Updated activity data and emission factors for non-road mobile machinery >560kW.	Revision of emission factor for one plant
United Kingdom	-18 220	-19	-8 661	-17	Reallocation of 1A2a emissions to 2C1	
EU27+UK	**-35 886**	**-4.3**	**-15 134**	**-3.2**		
Iceland	-121	-34	-33	-39	Fuel used in Off road machinery moved from 1A2 to 1A3	
United Kingdom (KP)	-18 237	-19	-8 726	-17	see above	
EU-KP	**-36 025**	**-4.3**	**-15 231**	**-3.2**		

3.2.2.1 Iron and Steel (1.A.2.a)

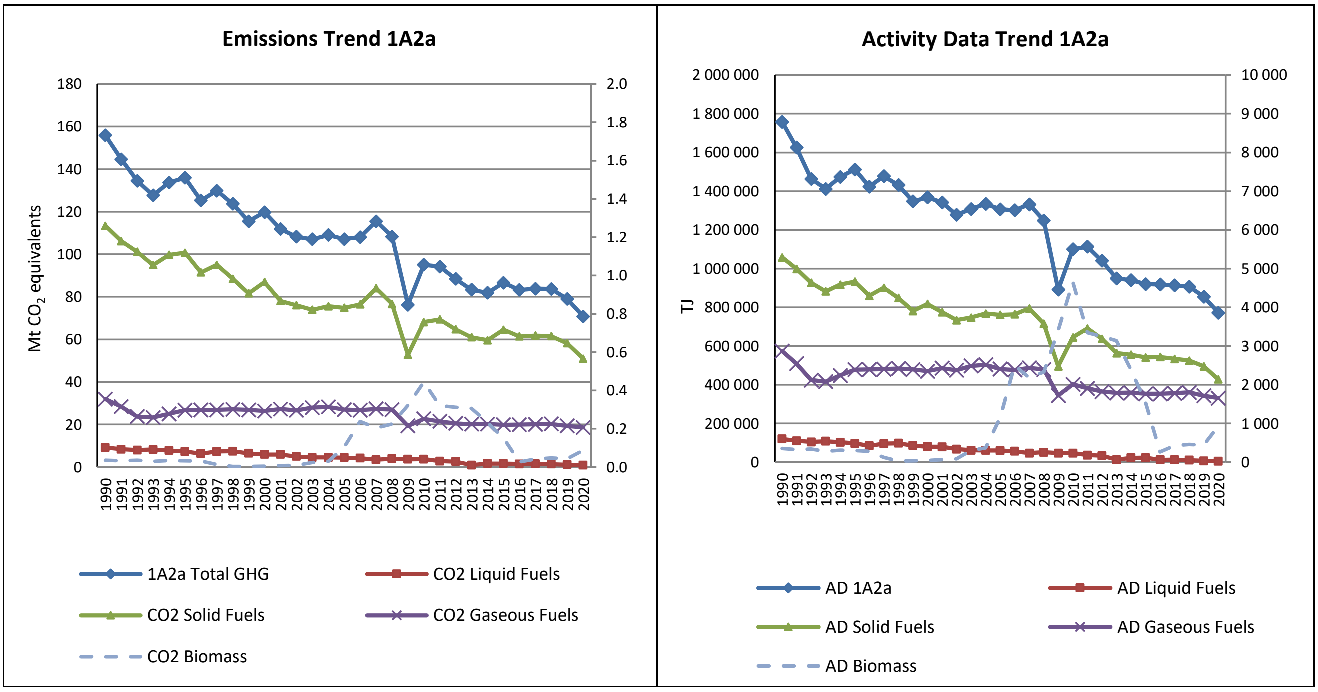
This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.a Iron and Steel.

Category 1.A.2.a (more specifically CO_2 emissions from use of gaseous, liquid and solid fuels) was identified as a key category by level and trend and thus the following description focuses only on CO_2 emissions. CO_2 emissions trend and activity data trends can be observed in *Figure 3.30*. Detailed data related to countries CO_2 emissions and percentage differences is depicted in Table 3-23. CO_2 emissions have almost 100% share on total emissions from 1.A.2.a. The strong increase of emissions (17%) observed between 2009 and 2010 correlates with crude steel production which was higher by 24% in 2010. Between 1990 and 2020 CO_2 emissions decreased by 57%. Between 2019 and 2020 CO_2 emissions decreased by 10%.

Total CO_2 emissions from 1.A.2.a amounted to 70 471 kt CO_2 eq. in 2020. The trend of total CO_2 emissions for 1990 to 2020 from category 1.A.2.a is depicted in *Figure 3.30*. Total CO_2 emissions decreased by 57% since 1990, mainly due to improved efficiency of restructured iron and steel plants and ongoing consequences of the economic crisis in 2009. Total CO_2 emissions decreased by 10% between 2019 and 2020. CO_2 emissions from 1.A.2.a Iron and Steel accounted for 16% of 1.A.2. source category. The share of liquid fuels on CO_2 emissions from 1.A.2.a decreased from 6% in 1990 to 1% in 2020. The share of solid fuels on CO_2 emissions from 1.A.2.a was 72% in 2020 and 73% in 1990. The share of gaseous fuels on CO_2 emissions from 1.A.2.a increased from 21% in 1990 to 26% in 2020.

Almost all countries reported lower level of CO_2 emissions in 2020 compared to 1990 except Iceland. Highest shares on total EU-KP emissions concern Germany (46%) followed by Italy (11%) and France (8%). Most rapid decrease of emissions compared to 1990 can be observed for Latvia (100%), Ireland (99%), Croatia (97%), Bulgaria (96%), Luxembourg (95%) Hungary (93%) and Romania (90%). Emissions are reported as ‘NO’ (not occurring) for Lithuania and Malta.

Figure 3.30: 1.A.2.a Iron and Steel: CO_2 emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

Table 3-23: 1.A.2.a Iron and Steel: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	2 063	1 831	1 848	2.6%	-214	-10%	17	1%	T1,T2	CS,D
Belgium	5 662	1 234	1 239.04	1.8%	-4 422	-78%	5	0%	T1,T3	D,PS
Bulgaria	2 705	121	115	0.2%	-2 590	-96%	-6	-5%	T2	CS
Croatia	1 062	41	34	0.0%	-1 029	-97%	-7	-18%	T1	D
Cyprus	NO,IE	0	0	0.0%	0	∞	0	133%	T1	D
Czechia	14 861	1 688	1 885	2.7%	-12 975	-87%	198	12%	T1,T2	CS,D
Denmark	132	98	94	0.1%	-38	-29%	-5	-5%	T1,T2,T3	CS,D
Estonia	NO	1	0	0.0%	0	∞	0	-51%	T2	CS
Finland	2 499	830	809	1.1%	-1 690	-68%	-21	-3%	T3	CS,PS
France	8 518	4 882	5 625	8.0%	-2 894	-34%	743	15%	T2,T3	CS,PS
Germany	35 269	36 374	32 590	46.2%	-2 680	-8%	-3 784	-10%	CS	CS
Greece	447	96	94	0.1%	-353	-79%	-2	-2%	T2	CS,PS
Hungary	2 490	193	173	0.2%	-2 317	-93%	-21	-11%	T1,T2	CS,D
Ireland	175	2	2	0.0%	-173	-99%	0	0%	T2	CS
Italy	25 255	9 827	8 004	11.4%	-17 251	-68%	-1 823	-19%	T2	CS
Latvia	389	0	0	0.0%	-389	-100%	0	16%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	5 404	297	264	0.4%	-5 140	-95%	-33	-11%	T1,T2,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	5 599	4 889	4 150	5.9%	-1 449	-26%	-739	-15%	T2	CS
Poland	16 247	4 537	3 710	5.3%	-12 538	-77%	-828	-18%	T1,T2	CS,D
Portugal	373	94	98	0.1%	-275	-74%	4	4%	T2	CR,D,PS
Romania	9 242	848	890	1.3%	-8 352	-90%	42	5%	T1,T2,T3	CS,D,PS
Slovakia	2 682	2 442	2 179	3.1%	-503	-19%	-263	-11%	T2	CS
Slovenia	423	218	197	0.3%	-226	-53%	-21	-10%	T1,T2	CS,D
Spain	8 341	5 583	4 341	6.2%	-4 000	-48%	-1 242	-22%	T1,T2,T3	CS,D,PS
Sweden	1 705	1 569	1 197	1.7%	-508	-30%	-371	-24%	T2	CS
United Kingdom	3 585	1 010	933	1.3%	-2 652	-74%	-77	-8%	T2	CS
EU-27+UK	**155 130**	**78 708**	**70 471**	**100%**	**-84 658**	**-55%**	**-8 236**	**-10%**	**-**	**-**
Iceland	0	2	1	0.0%	1	260%	0	-27%	T1	D
United Kingdom (KP)	3 585	1 010	933	1.3%	-2 652	-74%	-77	-8%	T2	CS
EU-KP	**155 130**	**78 709**	**70 473**	**100%**	**-84 657**	**-55%**	**-8 237**	**-10%**	**-**	**-**

Malta includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.a Iron and Steel - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.a amounted 872 kt in 2020 for EU-KP. CO_2 emissions decreased compared to the year 1990 by 90% and compared to 2019 by 21%. This category corresponds to 1.2% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 91% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-24. Czechia, Estonia, Hungary, Ireland, Latvia, Lithuania, Malta and Netherlands report emissions as 'NO' (not occurring). Three Member States and Iceland use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.a – Liquid Fuels (CO_2)). All countries reported lower level of emissions in 2020 than in 1990 (except of Iceland, but it should be noted that the share of Iceland on total EU-KP emissions is only 0.1%).

Table 3-24: 1.A.2.a Iron and Steel, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	76	5	7	0.8%	-69	-91%	2	39%	T2	CS
Belgium	885	14	12.56	1.4%	-872	-99%	-1	-10%	T1,T3	D,PS
Bulgaria	37	1	1	0.1%	-37	-99%	0	-4%	NA	NA
Croatia	208	4	4	0.5%	-204	-98%	0	0%	T1	D
Cyprus	IE	0	0	0.0%	0	∞	0	133%	T1	D
Czechia	427	NO	NO	-	-427	-100%	-	-	NA	NA
Denmark	21	2	2	0.3%	-19	-89%	0	7%	T1,T2	CS,D
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	305	21	20	2.3%	-285	-93%	-1	-6%	T3	CS
France	1 455	181	166	19.1%	-1 289	-89%	-15	-8%	T2,T3	CS,PS
Germany	916	16	14	1.5%	-902	-99%	-2	-16%	CS	CS
Greece	447	30	28	3.3%	-419	-94%	-1	-5%	T2	PS
Hungary	553	NO	NO	-	-553	-100%	-	-	NA	NA
Ireland	16	NO	NO	-	-16	-100%	-	-	NA	NA
Italy	156	6	2	0.2%	-154	-99%	-4	-69%	T2	CS
Latvia	92	NO	NO	-	-92	-100%	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	48	4	3	0.4%	-45	-93%	0	-9%	T1,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	19	NO	NO	-	-19	-100%	-	-	NA	NA
Poland	870	17	14	1.6%	-857	-98%	-3	-20%	T1,T2	CS,D
Portugal	109	0	0	0.0%	-109	-100%	0	34%	T2	CR,D,PS
Romania	NO	1	1	0.1%	1	∞	1	96%	T1,T2,T3	CS,D,PS
Slovakia	164	2	1	0.1%	-163	-99%	0	-29%	T2	CS
Slovenia	54	4	2	0.3%	-52	-96%	-2	-42%	T1	D
Spain	1 070	140	80	9.1%	-990	-93%	-60	-43%	T1,T2,T3	CS,D,PS
Sweden	831	610	454	51.9%	-377	-45%	-156	-26%	T2	CS
United Kingdom	421	50	60	6.9%	-361	-86%	10	20%	T2	CS
EU-27+UK	**9 183**	**1 107**	**872**	**100%**	**-8 311**	**-91%**	**-235**	**-21%**	**-**	**-**
Iceland	0	2	1	0.1%	1	260%	0	-27%	T1	D
United Kingdom (KP)	421	50	60	6.9%	-361	-86%	10	20%	T2	CS
EU-KP	**9 183**	**1 109**	**873**	**100%**	**-8 310**	**-90%**	**-235**	**-21%**	**-**	**-**

Cyprus reports an 'IE' for liquid fuels (included in 1.A.2.b).
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.31 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Sweden (52%), France (19%), Spain (9%) and United Kingdom (7%), which together represent 87% share on EU-KP emissions.

Figure 3.31: 1.A.2.a Iron and Steel, Liquid fuels: Emission trend and share for CO_2

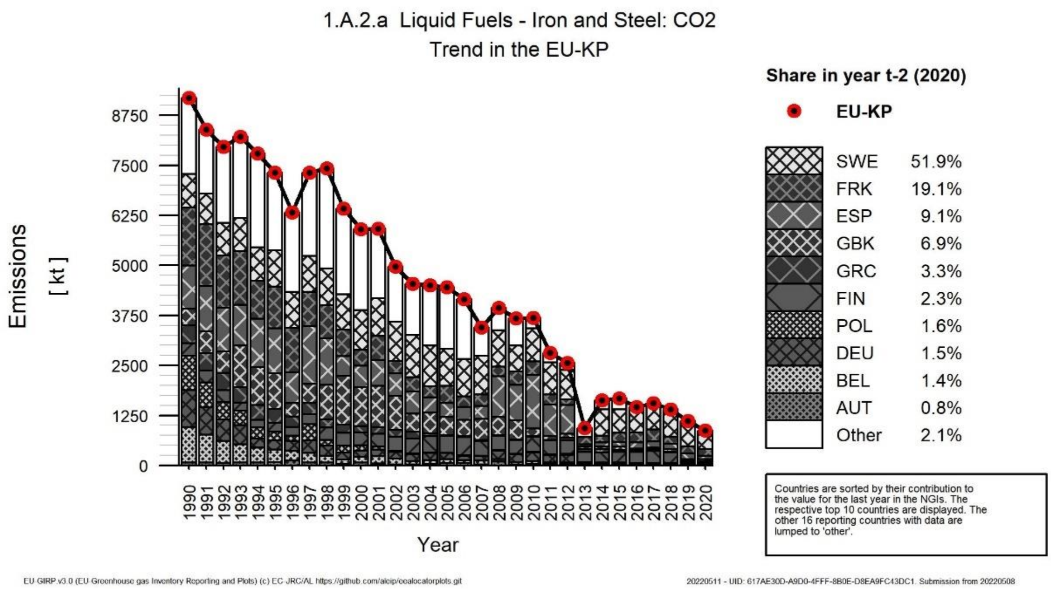
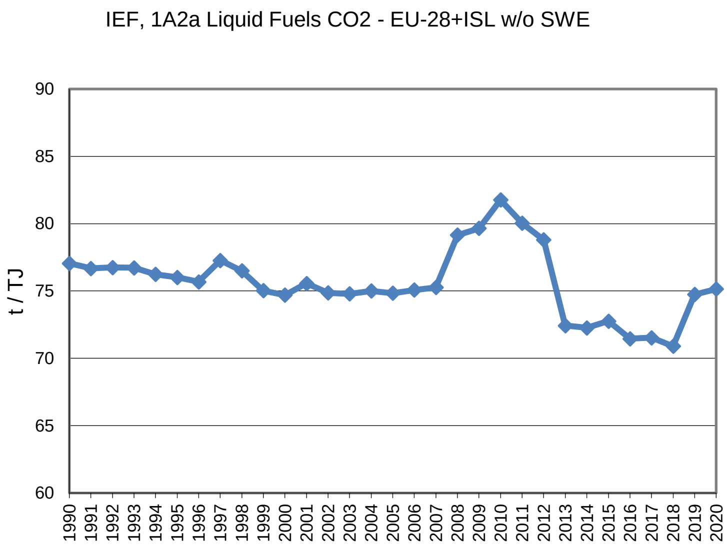


Figure 3.32 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. In the graph, data from Sweden aren't included due to reported confidential data. Nevertheless, Swedish emissions are included in the calculation of IEF in EU CRF.

The high CO_2 IEF reported for 2008–2012 is mainly due to the contribution of Spain's CO_2 emissions to the EU total (up to 5% between 2007 and 2008) and its high CO_2 IEF (ranging from 92.4 to 96.1 t/TJ) for those years. The EU CO_2 IEF equaled 75.14 t/TJ in 2020 excluding Sweden.

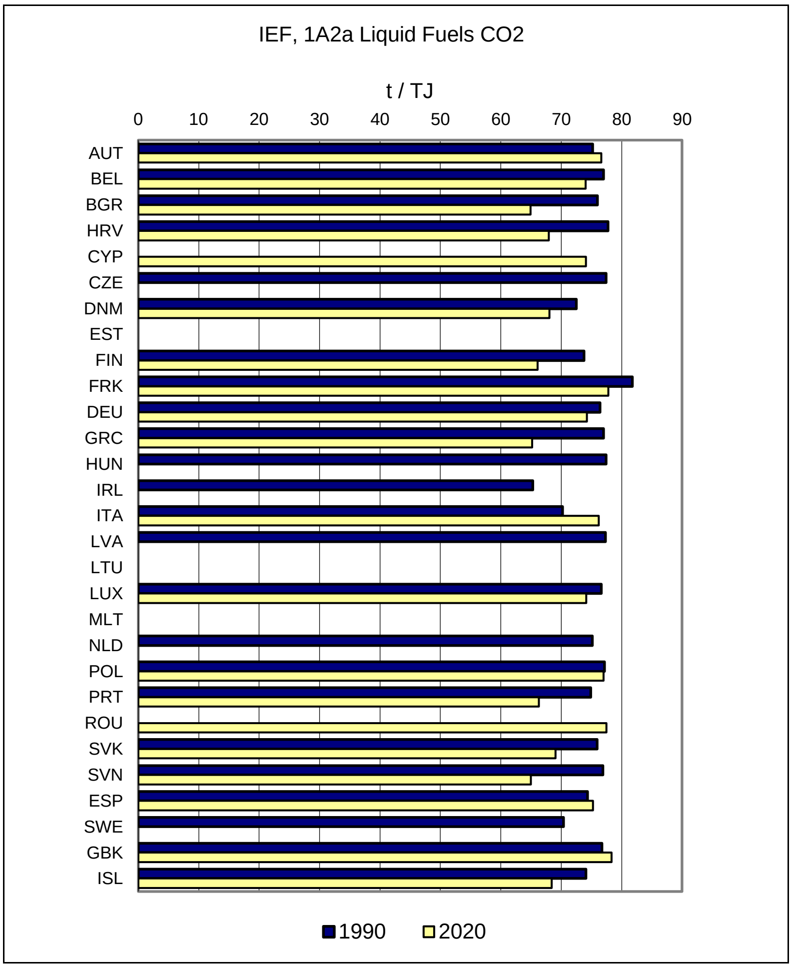
Figure 3.32: 1.A.2.a Iron and Steel, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



Note: The EU IEF for CO_2 emissions of category 1.A.2.a. liquid fuels displayed in this graph does not include data from SWE due to reported confidential data.

Figure 3.33 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. For the year 2020, Sweden reports activity data as C ('confidential') and thus CO_2 IEF is not depicted in Figure 3.33.

Figure 3.33: 1.A.2.a Iron and Steel, Liquid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1.A.2.a Iron and Steel - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.a amounted 50 941 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 55% and decreased compared to 2019 by 13%. This category represents 72% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 60% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-25. Cyprus, Denmark, Estonia, Greece, Ireland, Latvia, Lithuania, Luxembourg, Malta, Portugal and Iceland report emissions as 'NO' (not occurring). Two Member States use Tier 1 methodology for emission estimates, the rest of the Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99.9% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.a – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2020 than in 1990.

Table 3-25: 1.A.2.a Iron and Steel, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 337	679	770	1.5%	-566	-42%	91	13%	T2	CS
Belgium	3 284	18	15.46	0.0%	-3 268	-100%	-3	-15%	T3	PS
Bulgaria	1 631	0	0	0.0%	-1 631	-100%	0	-48%	NA	NA
Croatia	625	6	4	0.0%	-622	-99%	-2	-36%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	13 709	1 239	1 425	2.8%	-12 284	-90%	186	15%	T2	CS,D
Denmark	5	NO	NO	-	-5	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2 084	481	449	0.9%	-1 635	-78%	-32	-7%	T3	CS,PS
France	4 271	1 839	2 757	5.4%	-1 514	-35%	918	50%	T2,T3	CS,PS
Germany	29 912	33 421	29 561	58.0%	-351	-1%	-3 860	-12%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	625	64	46	0.1%	-579	-93%	-18	-27%	T1,T2	CS,D
Ireland	115	NO	NO	-	-115	-100%	-	-	NA	NA
Italy	20 762	5 898	4 253	8.3%	-16 509	-80%	-1 646	-28%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	4 959	NO	NO	-	-4 959	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	4 913	4 238	3 527	6.9%	-1 385	-28%	-711	-17%	T2	CS
Poland	11 870	3 344	2 509	4.9%	-9 361	-79%	-835	-25%	T1,T2	CS,D
Portugal	264	NO	NO	-	-264	-100%	-	-	NA	NA
Romania	2 578	75	182	0.4%	-2 395	-93%	108	145%	T1,T2	CS,D
Slovakia	2 296	2 280	2 024	4.0%	-273	-12%	-256	-11%	T2	CS
Slovenia	57	27	21	0.0%	-36	-64%	-6	-22%	T1	D
Spain	6 475	3 747	2 761	5.4%	-3 714	-57%	-987	-26%	T1,T2,T3	CS,PS
Sweden	849	795	558	1.1%	-291	-34%	-237	-30%	T2	CS
United Kingdom	741	85	79	0.2%	-662	-89%	-6	-7%	T2	CS
EU-27+UK	**113 361**	**58 236**	**50 941**	**100%**	**-62 420**	**-55%**	**-7 295**	**-13%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	741	85	79	0.2%	-662	-89%	-6	-7%	T2	CS
EU-KP	**113 361**	**58 236**	**50 941**	**100%**	**-62 420**	**-55%**	**-7 295**	**-13%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.34 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (58%), Italy (8%) and Netherlands (7%), which together represent 73% share of EU-KP emissions.

Figure 3.34: 1.A.2.a Iron and Steel, solid fuels: Emission trend and share for CO_2

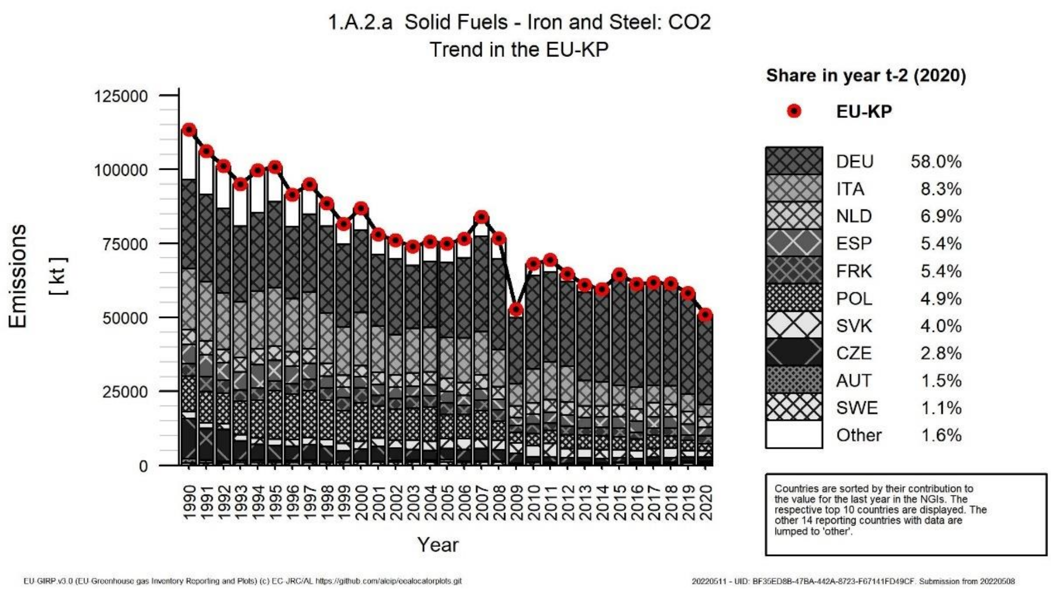


Figure 3.35 shows implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that CO_2 IEF fluctuate during the whole time series. Lowest CO_2 IEF was calculated for year 2011 and since that CO_2 IEF has increasing but still fluctuating trend. The main reason for the increase in the CO_2 IEF between 2012 and 2013 is Italy's decrease in CO_2 emissions. For these years, the share of Germany's CO_2 emissions in the EU total increased from 37% to 40%, and Germany's CO_2 IEF was one of the highest reported, increasing from 155.17 t/TJ in 2012 to 158.47 t/TJ in 2013. CO_2 IEF equalled to 119.00 t/TJ in 2020.

Figure 3.35: 1.A.2.a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

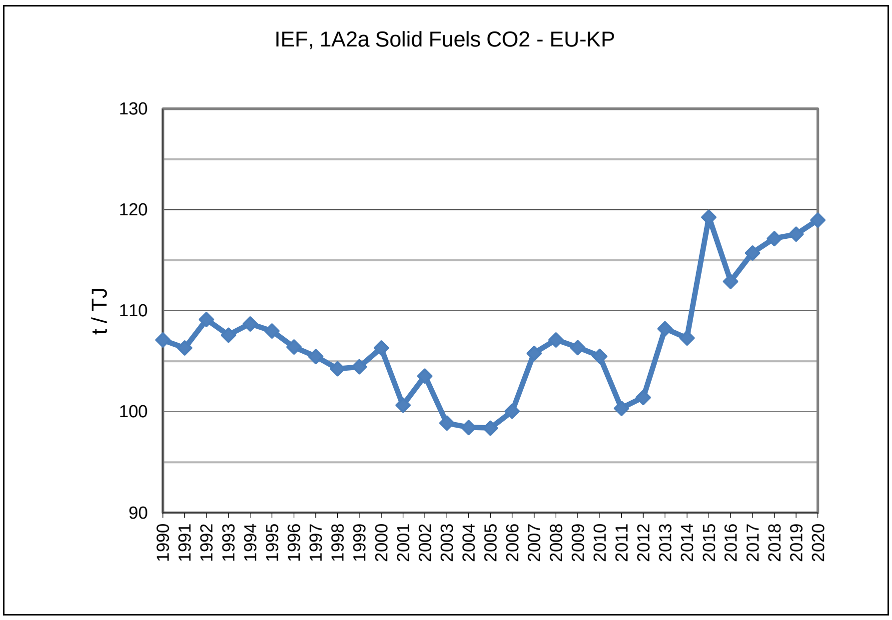
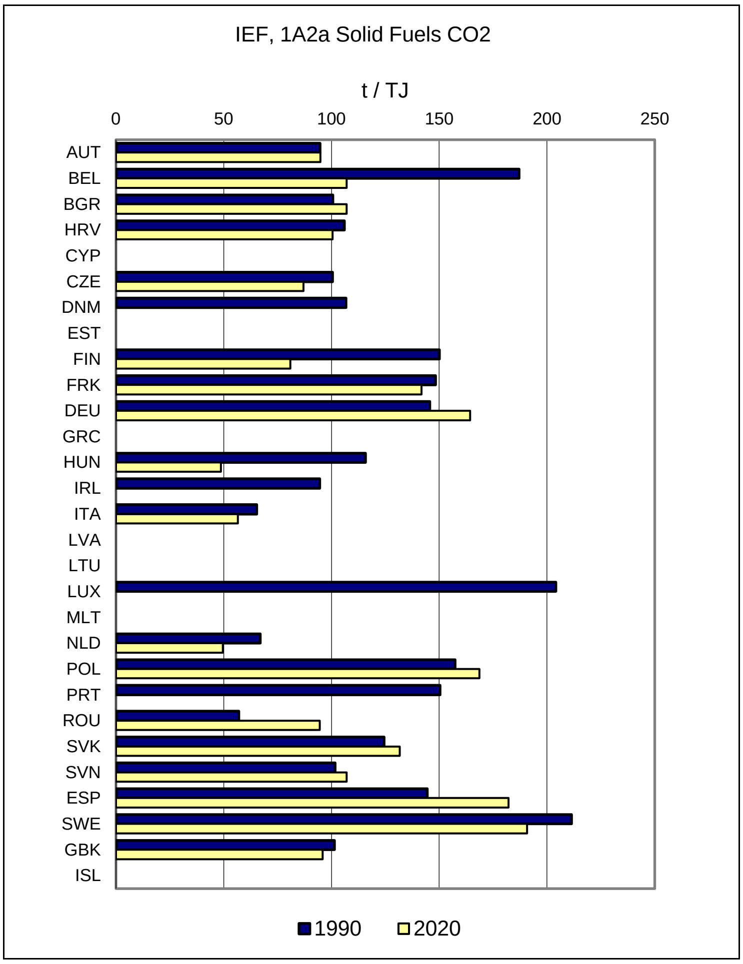


Figure 3.36 shows comparison of CO_2 IEF used by Member States, United Kingdom and Iceland for emission estimates in 1990 and 2020. The high variation of the CO_2 IEFs across MS is due to usage of

derived coal gases which have significant lower (coke oven gas) or higher carbon content (blast furnace gas) than coal.

Figure 3.36: 1.A.2.a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 by Member States and Iceland (in t/TJ)



1.A.2.a Iron and Steel - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.a amounted 18 636 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 42% and decreased compared to 2019 by 4%. This category represents 26% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 44% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-26. Cyprus, Lithuania, Malta and Iceland report emissions as 'NO' (not occurring). Croatia uses Tier 1 methodology for emission estimates, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99.8% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.a – Gaseous Fuels (CO_2)). Austria, Finland, France, Spain and Sweden report higher level of emissions in 2020 than in 1990. Highest increase of emissions (638%) is observed for Sweden with a 1% share on total EU-KP emissions in 2020.

Table 3-26: 1.A.2.a Iron and Steel, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	650	1 147	1 071	5.7%	421	65%	-76	-7%	T2	CS
Belgium	1 493	1 197	1 205.81	6.5%	-287	-19%	9	1%	T1,T3	D,PS
Bulgaria	1 037	120	114	0.6%	-923	-89%	-6	-5%	T2	CS
Croatia	229	32	26	0.1%	-202	-88%	-5	-17%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	724	449	461	2.5%	-264	-36%	12	3%	T2	CS
Denmark	106	96	91	0.5%	-15	-14%	-5	-5%	T3	CS
Estonia	NO	1	0	0.0%	0	∞	0	-51%	T2	CS
Finland	110	328	340	1.8%	230	210%	12	4%	T3	CS
France	2 784	2 849	2 686	14.4%	-98	-4%	-164	-6%	T2,T3	CS,PS
Germany	4 442	2 937	3 015	16.2%	-1 426	-32%	78	3%	CS	CS
Greece	NO	66	66	0.4%	66	∞	0	0%	T2	CS
Hungary	1 312	129	126	0.7%	-1 186	-90%	-3	-2%	T2	CS
Ireland	44	2	2	0.0%	-41	-95%	0	0%	T2	CS
Italy	4 338	3 923	3 750	20.1%	-588	-14%	-173	-4%	T2	CS
Latvia	236	0	0	0.0%	-235	-100%	0	16%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	397	293	260	1.4%	-137	-34%	-33	-11%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	667	651	622	3.3%	-45	-7%	-29	-4%	T2	CS
Poland	2 924	1 176	1 186	6.4%	-1 737	-59%	10	1%	T2	CS
Portugal	NO	94	98	0.5%	98	∞	4	4%	T2	CR,D,PS
Romania	6 665	769	705	3.8%	-5 960	-89%	-64	-8%	T2,T3	CS,PS
Slovakia	221	161	154	0.8%	-67	-30%	-7	-4%	T2	CS
Slovenia	312	188	174	0.9%	-138	-44%	-14	-7%	T2	CS
Spain	796	1 695	1 500	8.1%	704	88%	-195	-12%	T2,T3	CS,PS
Sweden	25	164	186	1.0%	161	638%	22	13%	T2	CS
United Kingdom	2 423	875	794	4.3%	-1 630	-67%	-81	-9%	T2	CS
EU-27+UK	**31 933**	**19 344**	**18 636**	**100%**	**-13 297**	**-42%**	**-708**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 423	875	794	4.3%	-1 630	-67%	-81	-9%	T2	CS
EU-KP	**31 933**	**19 344**	**18 636**	**100%**	**-13 297**	**-42%**	**-708**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.37 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Italy (20%), Germany (16%), France (14%), Spain (8%), Belgium (7%), Poland (6%), Austria (6%) and United Kingdom (4%) which together represent 82% share of EU-KP emissions.

Figure 3.37: 1.A.2.a Iron and Steel, Gaseous fuels: Emission trend and share for CO_2

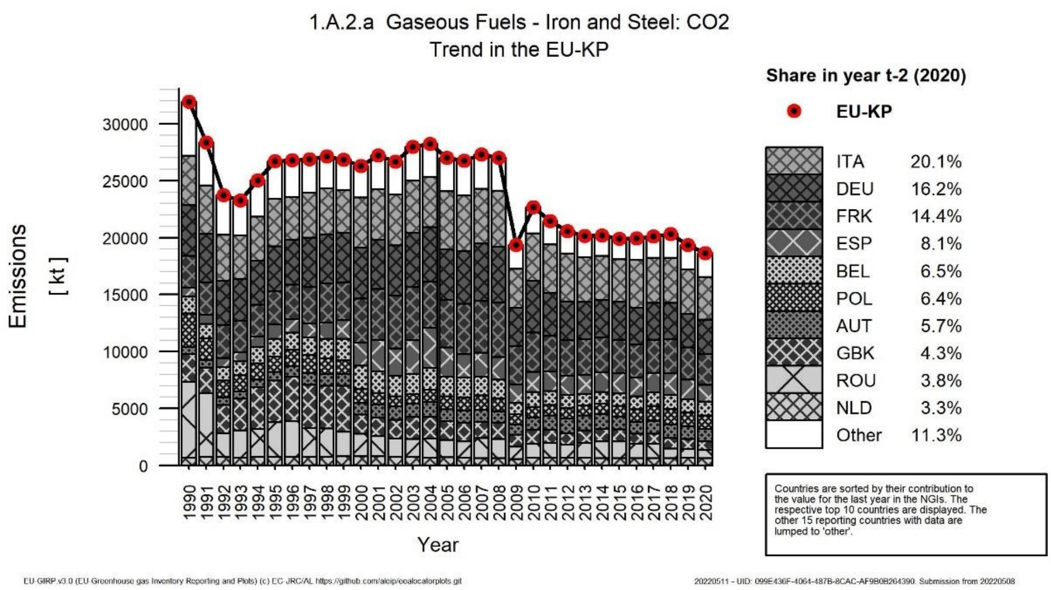


Figure 3.38 shows implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that the CO_2 IEF is fluctuating. The strong increase from 2011 to 2013 is caused by strong increase of Romania IEF in these years. Since 2016, CO_2 IEF has slightly decreasing trend. CO_2 IEF equalled to 56.30 t/TJ in 2020.

Figure 3.38: 1.A.2.a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

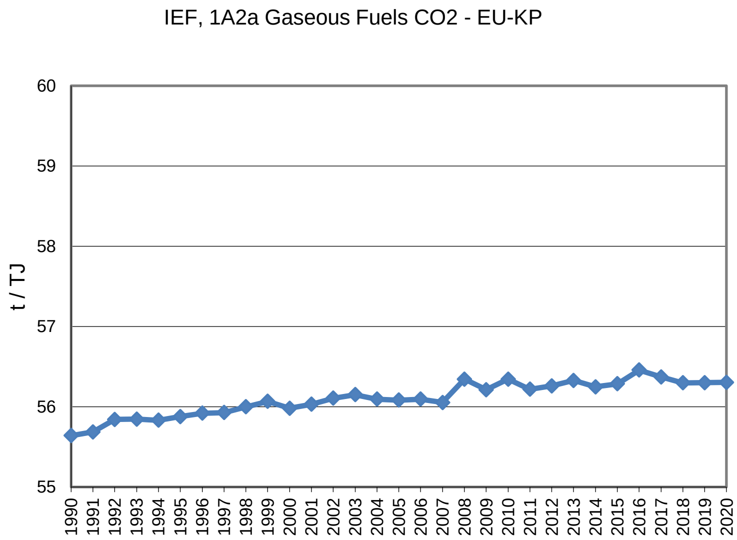
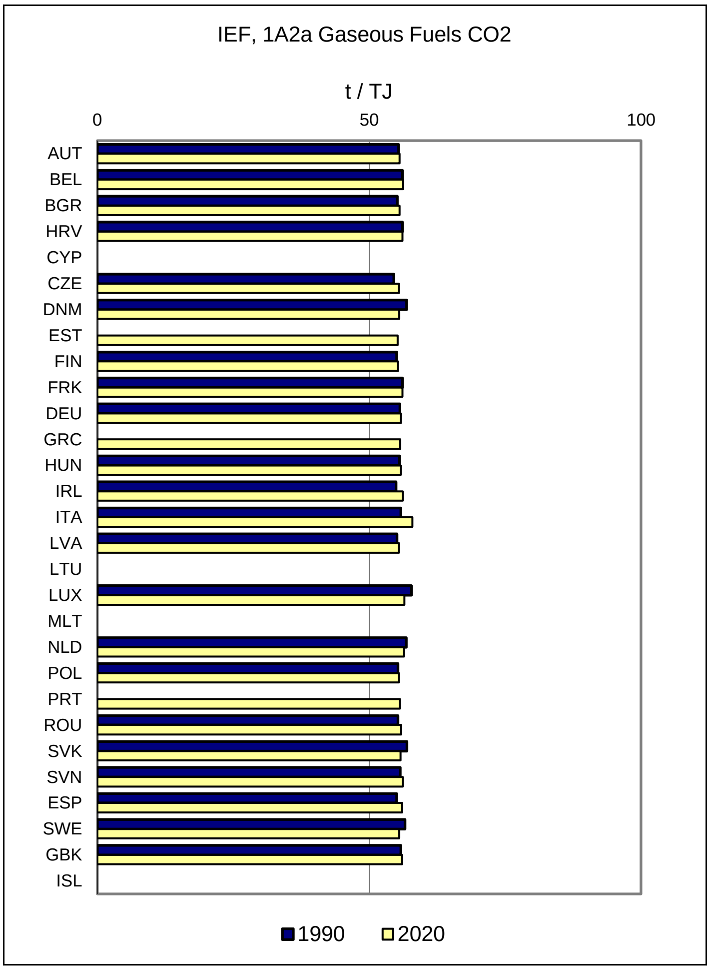


Figure 3.39 shows comparison of implied emission factors (CO_2 IEFs) used by countries for emission estimates in 1990 and 2020. No significant differences between CO_2 IEF used by EU-KP are not occurring as also no significant differences between CO_2 IEF used in 1990 and 2020 are occurring.

***Figure 3.39**: 1.A.2.a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)*



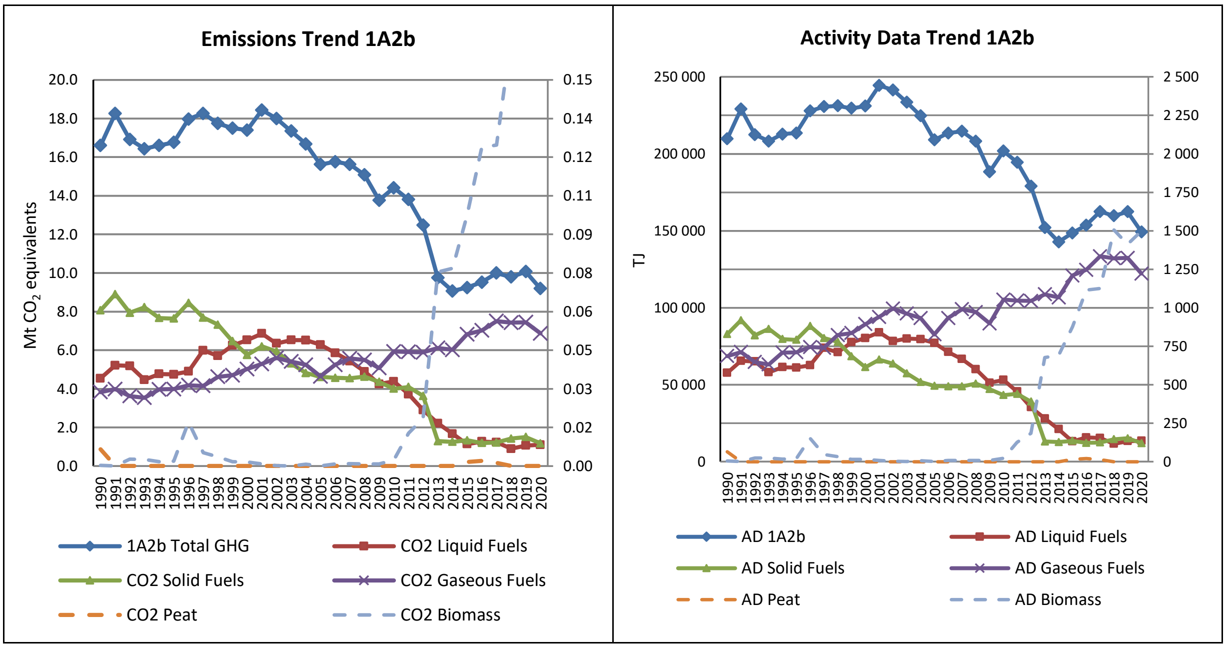
3.2.2.2 Non-Ferrous Metals (1.A.2.b)

This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.b Non-Ferrous Metals.

Total CO_2 emissions from 1.A.2.b amounted to 9 145 kt CO_2 eq. in 2020. The trend of total emissions for 1990 to 2020 from category 1.A.2.b is depicted in Figure 3.40. Total CO_2 emissions decreased by 44% since 1990 and decreased by 9% between 2019 and 2020. Total CO_2 emissions from 1.A.2.b Non-Ferrous Metals accounted for 2% of 1.A.2. source category.

Figure **3.40** shows the emission trend within the category 1.A.2.b, which is dominated by CO_2 emissions from gaseous fuels in 2020. The share of liquid fuels on CO_2 emissions from 1.A.2.b decreased from 27% in 1990 to 12% in 2020. The share of solid fuels on CO_2 emissions from 1.A.2.b decreased from 49% in 1990 to 13% in 2020. The share of gaseous fuels on CO_2 emissions from 1.A.2.b increased from 23% in 1990 to 75% in 2020.

Figure 3.40: 1.A.2.b Non-ferrous Metals: CO_2 emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table.3-27. Denmark, Lithuania, Malta and Portugal report emissions as ‘NO’ (not occurring) or ‘IE’ (included elsewhere). For Portugal, emissions from non-ferrous metals are included in 1.A.2.g Other. Nine Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emissions was reported by Romania (338%), with a 3.9% share on total EU-KP emissions in 2020.

Table.3-27: 1.A.2.b Non-ferrous Metals: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	132	301	263	2.9%	131	99%	-38	-13%	T1,T2	CS,D
Belgium	629	428	397.03	4.3%	-232	-37%	-31	-7%	T1	D
Bulgaria	299	251	249	2.7%	-50	-17%	-2	-1%	T1,T2	CS,D
Croatia	17	27	26	0.3%	8	49%	-1	-5%	T1	D
Cyprus	5	2	3	0.0%	-2	-33%	1	53%	T1	D
Czechia	102	148	142	1.6%	40	40%	-6	-4%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	1	1	0.0%	1	∞	0	25%	T2	CS
Finland	338	105	100	1.1%	-238	-71%	-6	-5%	T3	CS,D
France	2 473	1 053	1 081	11.8%	-1 392	-56%	28	3%	T2,T3	CS,PS
Germany	1 377	133	128	1.4%	-1 248	-91%	-5	-4%	CS	CS
Greece	582	358	335	3.7%	-247	-42%	-22	-6%	T2	CS,PS
Hungary	297	180	152	1.7%	-145	-49%	-28	-16%	T2	CS
Ireland	809	1 360	1 334	14.6%	526	65%	-26	-2%	T1,T2,T3	CS,D
Italy	735	1 114	1 036	11.3%	301	41%	-78	-7%	T2	CS
Latvia	NO	1	1	0.0%	1	∞	-1	-44%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	28	47	43	0.5%	15	52%	-4	-9%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	214	160	128	1.4%	-86	-40%	-32	-20%	T2	CS
Poland	1 053	1 330	1 067	11.7%	14	1%	-263	-20%	T1,T2	CS,D
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Romania	81	365	353	3.9%	273	338%	-11	-3%	T1,T2,T3	CS,D,PS
Slovakia	1 256	99	95	1.0%	-1 161	-92%	-4	-4%	T2	CS
Slovenia	440	101	119	1.3%	-321	-73%	18	18%	T1,T2	CS,D
Spain	1 192	1 631	1 346	14.7%	154	13%	-285	-17%	T1,T2,T3	CS,D,PS
Sweden	128	111	107	1.2%	-21	-16%	-4	-4%	T2	CS
United Kingdom	4 317	701	638	7.0%	-3 679	-85%	-63	-9%	T2	CS
EU-27+UK	**16 502**	**10 008**	**9 145**	**100%**	**-7 357**	**-45%**	**-863**	**-9%**	**-**	**-**
Iceland	14	8	6	0.1%	-7	-55%	-2	-27%	T1	D
United Kingdom (KP)	4 317	701	638	7.0%	-3 679	-85%	-63	-9%	T2	CS
EU-KP	**16 516**	**10 017**	**9 151**	**100%**	**-7 364**	**-45%**	**-865**	**-9%**	**-**	**-**

Malta and Portugal include emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.b Non-Ferrous Metals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.b amounted 1 098 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 75% and compared to 2019 increased by 4%. Category has 0.2% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 77% compared to 1990. The category was not identified as a key category for this submission but it was identified in previous submissions and thus the description of the category is still included in the reporting.

Detailed data related to the EU-KP submissions are depicted in *Table 3-28*. Czechia, Denmark, Estonia, Hungary, Latvia, Lithuania, Luxemburg, Malta and Netherlands report emissions as 'NO' (not occurring). Portugal reports emissions as 'IE' (included elsewhere). Four Member States and Iceland use Tier 1 methodology for emission estimates (approximately 92% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.b – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2020 than in 1990 (except Italy).

Table 3-28: 1.A.2.b Non-ferrous Metals, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	35	8	8	0.7%	-27	-76%	0	2%	T2	CS
Belgium	220	38	37.09	3.4%	-183	-83%	-1	-2%	T1	D
Bulgaria	199	49	40	3.7%	-159	-80%	-9	-18%	T1	D
Croatia	17	3	3	0.2%	-14	-84%	0	0%	T1	D
Cyprus	5	2	3	0.3%	-2	-33%	1	53%	T1	D
Czechia	3	NO	NO	-	-3	-100%	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	174	78	71	6.4%	-103	-59%	-7	-10%	T3	CS
France	770	279	358	32.4%	-413	-54%	78	28%	T2,T3	CS,PS
Germany	144	82	79	7.2%	-64	-45%	-2	-3%	CS	CS
Greece	582	22	20	1.8%	-562	-97%	-3	-11%	T2	PS
Hungary	202	NO	NO	-	-202	-100%	-	-	NA	NA
Ireland	766	32	27	2.5%	-739	-96%	-4	-13%	T1,T3	CS,D
Italy	18	33	34	3.1%	16	92%	1	4%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	15	NO	NO	-	-15	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	62	40	36	3.2%	-27	-43%	-4	-11%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	3	1	0.1%	1	∞	-2	-63%	T1,T2	CS,D
Slovakia	23	4	3	0.3%	-20	-87%	-1	-14%	T2	CS
Slovenia	120	4	3	0.3%	-118	-98%	-1	-20%	T1	D
Spain	931	287	282	25.5%	-649	-70%	-5	-2%	T1,T2,T3	CS,D,PS
Sweden	110	94	91	8.2%	-19	-17%	-3	-3%	T2	CS
United Kingdom	131	2	2	0.2%	-130	-99%	0	-17%	T2	CS
EU-27+UK	**4 529**	**1 059**	**1 098**	**99%**	**-3 431**	**-76%**	**39**	**4%**	**-**	**-**
Iceland	14	8	6	0.6%	-7	-55%	-2	-27%	T1	D
United Kingdom (KP)	131	2	2	0.2%	-130	-99%	0	-17%	T2	CS
EU-KP	**4 543**	**1 067**	**1 105**	**100%**	**-3 438**	**-76%**	**37**	**3%**	**-**	**-**

Portugal includes emissions under 1.A.2.g. Romania includes emissions under 1.A.2.a from 1990 to 2017 (except 2007). Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.41 shows CO_2 emissions trend as well as the share of the Member States with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to France (32%), Spain (26%), Sweden (8%), Germany (7%) and Finland (6%) which together represent 80% share of EU-KP emissions.

Figure 3.41: 1.A.2.b Non-ferrous Metals, liquid fuels: Emission trend and share for CO_2

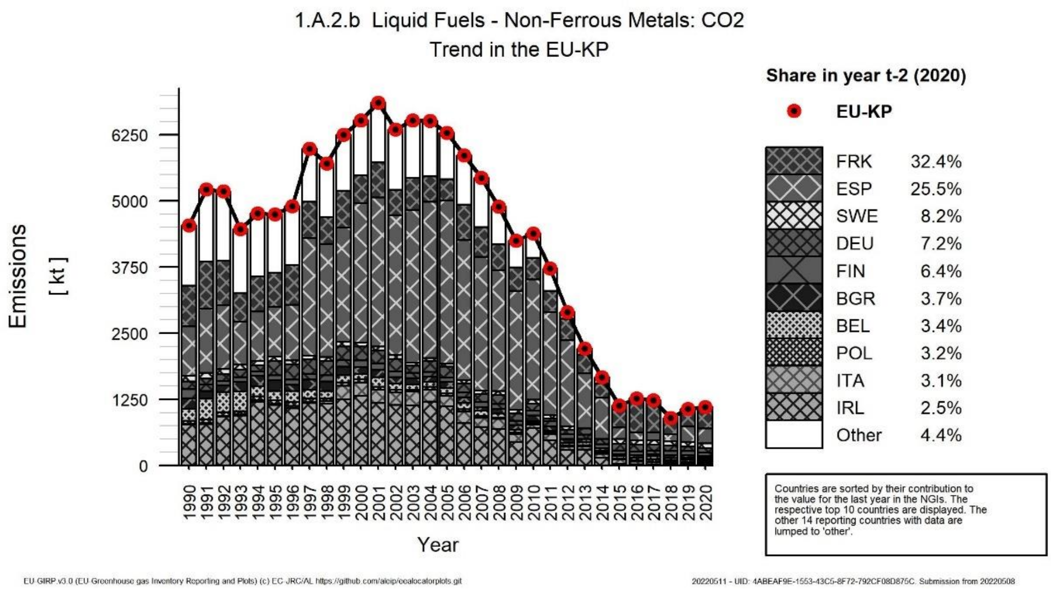


Figure 3.42 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that CO_2 IEF fluctuated at the beginning of the time series and since 2013 shows major fluctuations. The peak in the 2015 implied emission factor, as presented in the figure below, occurs because Sweden reported activity data as confidential. CO_2 IEF equalled to 81.74 t/TJ in 2020.

Figure 3.42: 1.A.2.b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

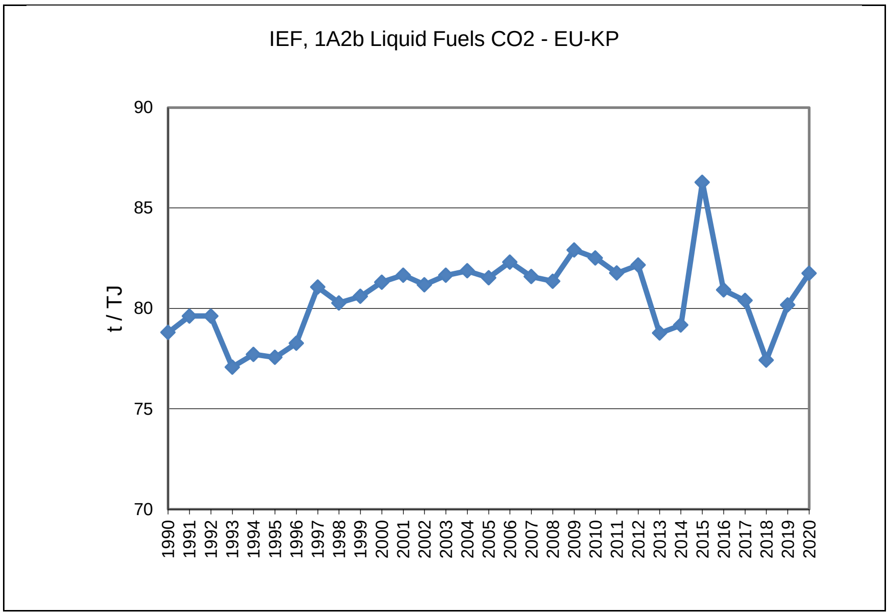
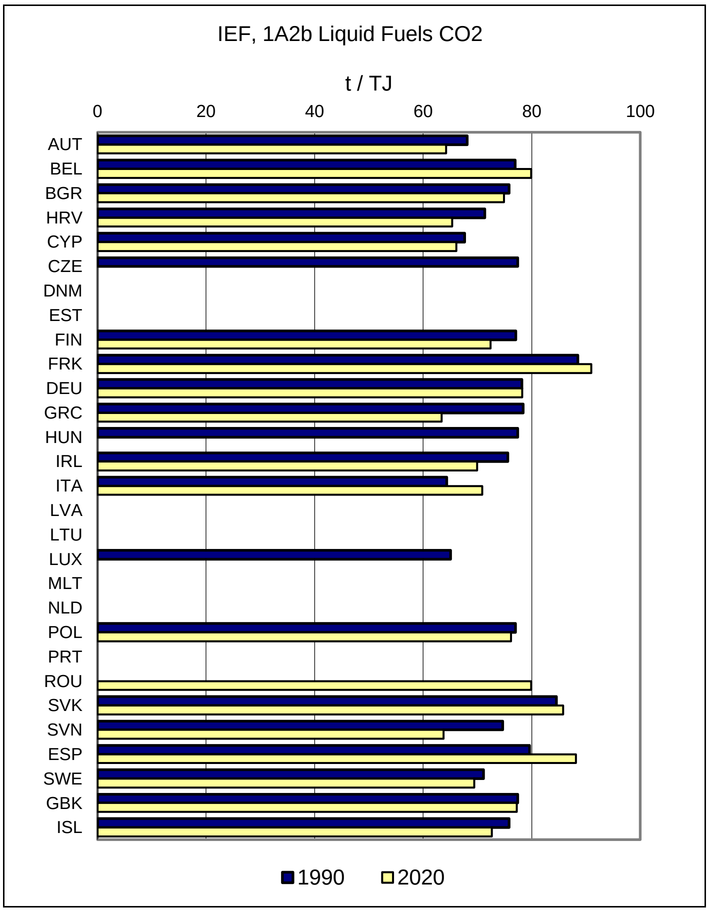


Figure 3.43 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. Particularly higher implied CO_2 emission factors are due to the use of petroleum coke, which has significantly higher carbon content than liquid oil products.

Figure 3.43: 1.A.2.b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.b Non-Ferrous Metals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.b amounted 1 172 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 85% and compared to 2019 decreased by 22%. Category has 0.3% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 60% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-29. Twelve member states and Iceland report emissions as 'NO' (not occurring). Greece, Portugal and Romania report emissions as 'IE' (included elsewhere). Belgium uses Tier 1 methodology for emission estimates, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 93% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.b – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2020 than in 1990 (except Bulgaria with an 8% share on total EU-KP emissions in subcategory 1.A2.b solid fuels in 2020).

Table 3-29: 1.A.2.b Non-ferrous Metals, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	22	13	13	1.1%	-9	-41%	0	-2%	T2	CS
Belgium	147	98	88.70	7.6%	-59	-40%	-10	-10%	T1	D
Bulgaria	76	89	93	7.9%	16	21%	3	4%	T1,T2	CS,D
Croatia	0	NO	NO	-	0	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	46	15	15	1.3%	-31	-67%	0	1%	T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	155	24	26	2.2%	-129	-83%	2	7%	T3	CS
France	954	2	2	0.2%	-952	-100%	0	-11%	T2,T3	CS,PS
Germany	1 233	52	49	4.2%	-1 184	-96%	-3	-6%	CS	CS
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	9	NO	NO	-	-9	-100%	-	-	NA	NA
Ireland	4	NO	NO	-	-4	-100%	-	-	NA	NA
Italy	152	122	61	5.2%	-90	-60%	-61	-50%	T2	CS
Latvia	NO	0	NO	-	-	-	0	-100%	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0	NO	NO	-	0	-100%	-	-	NA	NA
Poland	673	849	606	51.7%	-67	-10%	-243	-29%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	81	IE	IE	-	-81	-100%	-	-	NA	NA
Slovakia	798	28	24	2.1%	-774	-97%	-4	-14%	T2	CS
Slovenia	154	5	7	0.6%	-148	-96%	1	20%	T1,T2	CS,D
Spain	188	109	98	8.4%	-89	-48%	-11	-10%	T1,T2	CS,D
Sweden	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom	3 366	95	90	7.6%	-3 276	-97%	-5	-5%	T2	CS
EU-27+UK	**8 066**	**1 503**	**1 172**	**100%**	**-6 894**	**-85%**	**-330**	**-22%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 366	95	90	7.6%	-3 276	-97%	-5	-5%	T2	CS
EU-KP	**8 066**	**1 503**	**1 172**	**100%**	**-6 894**	**-85%**	**-330**	**-22%**	**-**	**-**

Portugal includes emissions under 1.A.2.g. From 1991, Romania includes emissions under 1.A.2.a.
Greece includes emissions in the Industrial processes sector (as non-energy use of fuels).
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure ***3.44*** shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Poland (52%), Sweden (8%) and Bulgaria (8%) which together have 68% share on EU-KP emissions.

The reason for the strong decrease of the emissions since 2013 is the reallocation of the UK power plant emissions to the sector 1.A.1.a.

Figure 3.44: 1.A.2.b Non-ferrous Metals, solid fuels: Emission trend and share for CO_2

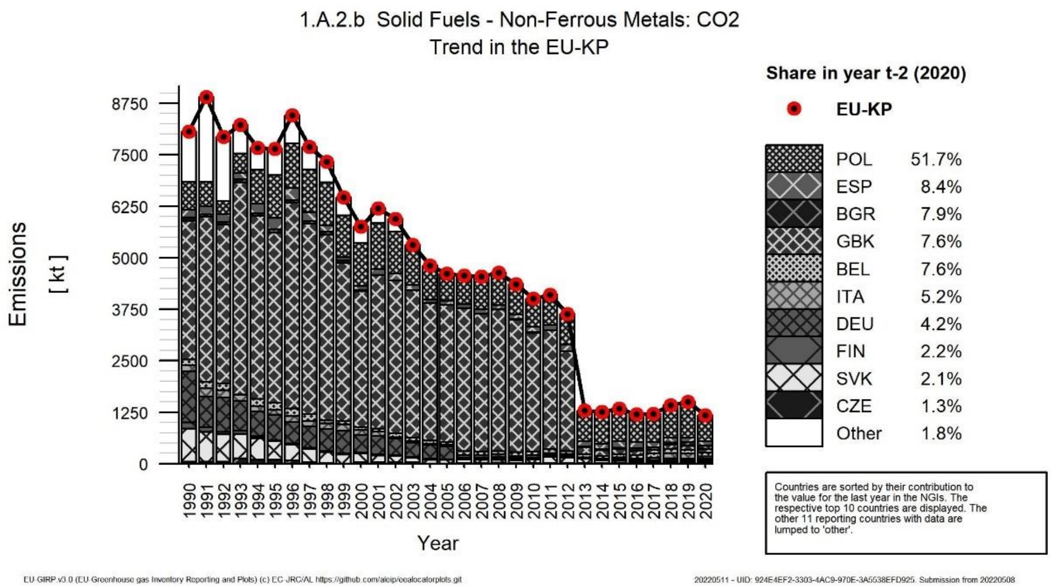


Figure 3.45 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. Since the beginning of the time series, the CO_2 IEF had relatively decreasing trend. In 2013 CO_2 IEF increased rapidly. The reason for the increase of the CO_2 IEF in 2013 is the reallocation of the UK power plant. As the UK IEF is lower than the EU average the declining weight of the UK in EU emissions leads to an increase in the IEF of the EU. CO_2 IEF equalled to 97.11 t/TJ in 2020.

Figure 3.45: 1.A.2.b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

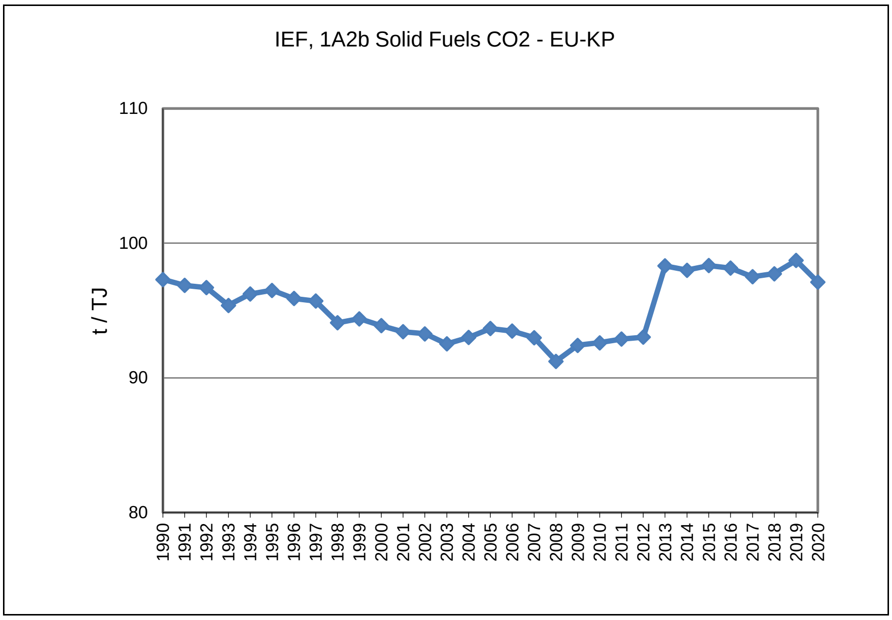
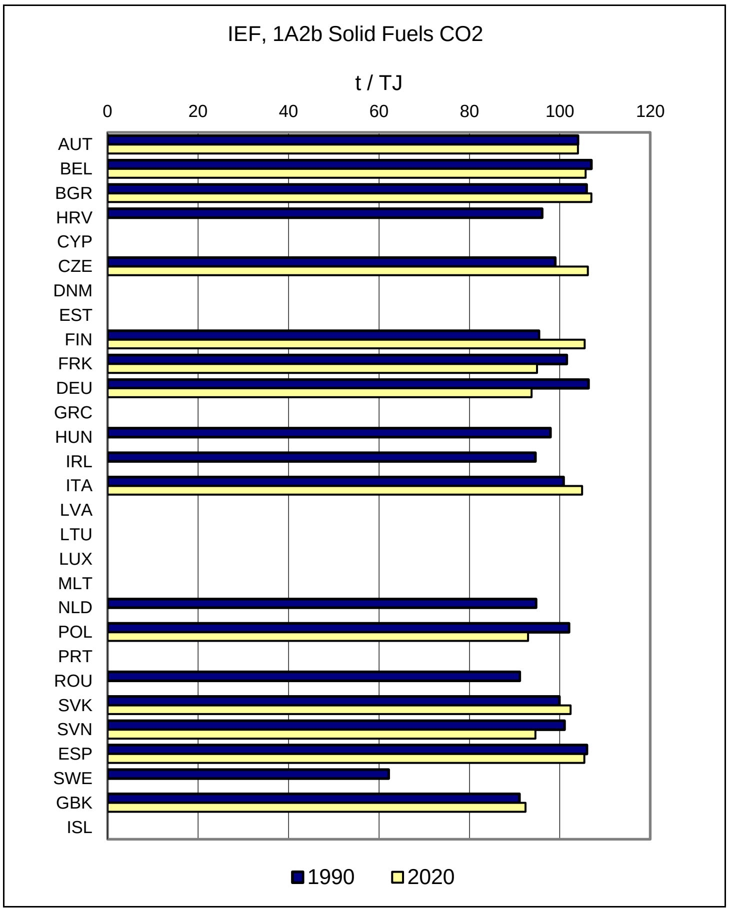


Figure 3.46 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020.

Figure 3.46: 1.A.2.b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.b Non-Ferrous Metals - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.b amounted 6 874 kt in 2020 for EU-KP. CO_2 emissions increased compared to year 1990 by 79% and compared to year 2019 decreased by less than 8%. This category represents 1.5% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 70% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-30. Cyprus, Denmark, Lithuania, Malta and Iceland report emissions as 'NO' (not occurring). Germany and Portugal report emissions as 'IE' (included elsewhere). For Germany, emissions from gaseous fuels from this category are reported in 1.A.2.g Other. Two Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 96% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.b – Gaseous Fuels (CO_2)). Five countries reported lower level of emissions in 2020 than in 1990. Most rapid increase of emissions was reported by Ireland (3289%); Ireland has also the highest share on total CO_2 emissions from 1.A.2.b – Gaseous Fuels (CO_2).

Table 3-30: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	75	278	241	3.5%	166	221%	-38	-13%	T2	CS
Belgium	261	292	271.23	3.9%	10	4%	-21	-7%	T1	D
Bulgaria	23	112	116	1.7%	93	396%	4	3%	T2	CS
Croatia	NO	24	23	0.3%	23	∞	-1	-6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	53	133	127	1.9%	74	140%	-6	-4%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	1	1	0.0%	1	∞	0	25%	T2	CS
Finland	NO	3	3	0.0%	3	∞	0	-2%	T3	CS
France	748	771	721	10.5%	-27	-4%	-50	-6%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	335	315	4.6%	315	∞	-20	-6%	T2	CS
Hungary	86	180	152	2.2%	66	76%	-28	-16%	T2	CS
Ireland	39	1 328	1 307	19.0%	1 268	3289%	-21	-2%	T2	CS
Italy	566	959	941	13.7%	375	66%	-18	-2%	T2	CS
Latvia	NO	1	1	0.0%	1	∞	-1	-39%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	13	47	43	0.6%	30	222%	-4	-9%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	213	160	128	1.9%	-86	-40%	-32	-20%	T2	CS
Poland	254	441	425	6.2%	171	67%	-16	-4%	T2	CS
Portugal	IE	IE	IE	-	-	-	-	-	NA	NA
Romania	IE	362	352	5.1%	352	∞	-10	-3%	T2,T3	CS,PS
Slovakia	435	67	68	1.0%	-367	-84%	1	1%	T2	CS
Slovenia	165	92	109	1.6%	-55	-34%	18	19%	T2	CS
Spain	73	1 235	966	14.1%	893	1217%	-270	-22%	T2,T3	CS,PS
Sweden	10	17	16	0.2%	6	54%	-1	-5%	T2	CS
United Kingdom	819	604	546	7.9%	-273	-33%	-58	-10%	T2	CS
EU-27+UK	**3 835**	**7 445**	**6 874**	**100%**	**3 038**	**79%**	**-572**	**-8%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	819	604	546	7.9%	-273	-33%	-58	-10%	T2	CS
EU-KP	**3 835**	**7 445**	**6 874**	**100%**	**3 038**	**79%**	**-572**	**-8%**	**-**	**-**

Portugal includes emissions under 1.A.2.g. From 1990 to 2017, Romania includes emissions under 1.A.2.a. Germany reported emissions under 1.A.2.g (unspecified industrial power plants) because of confidential data.

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.47 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Ireland (19%), Spain (14%), Italy (14%), France (10%) and United Kingdom (8%) which together have 65% share on EU-KP emissions.

Figure 3.47: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Emission trend and share for CO_2

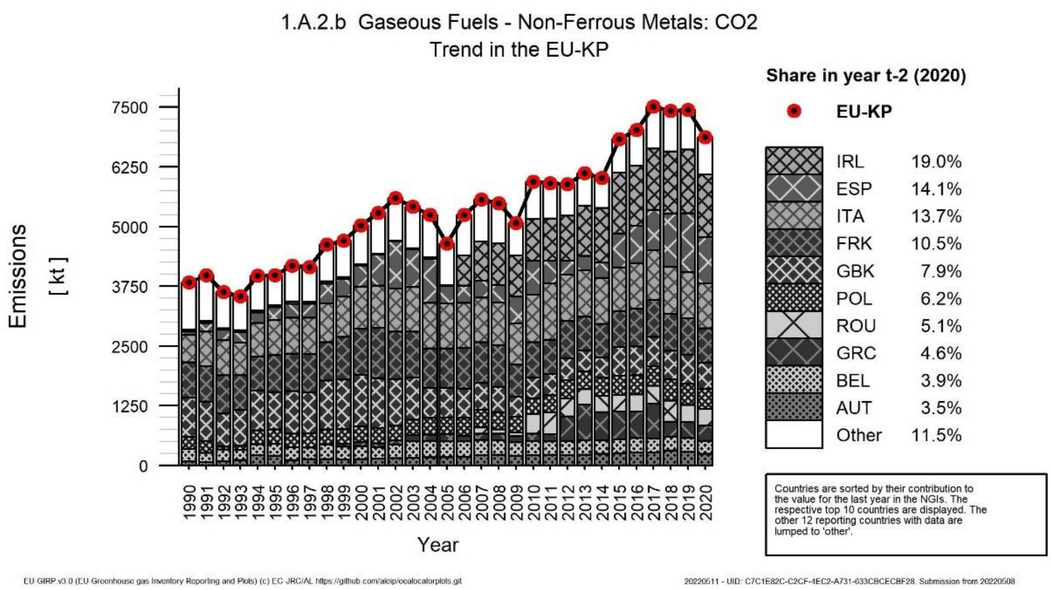


Figure 3.48 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that CO_2 IEF has stable trend for the period 1990-2017 bud since 2018 the trend has slightly changed. CO_2 IEF equalled to 56. t/TJ in 2020.

Figure 3.48: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

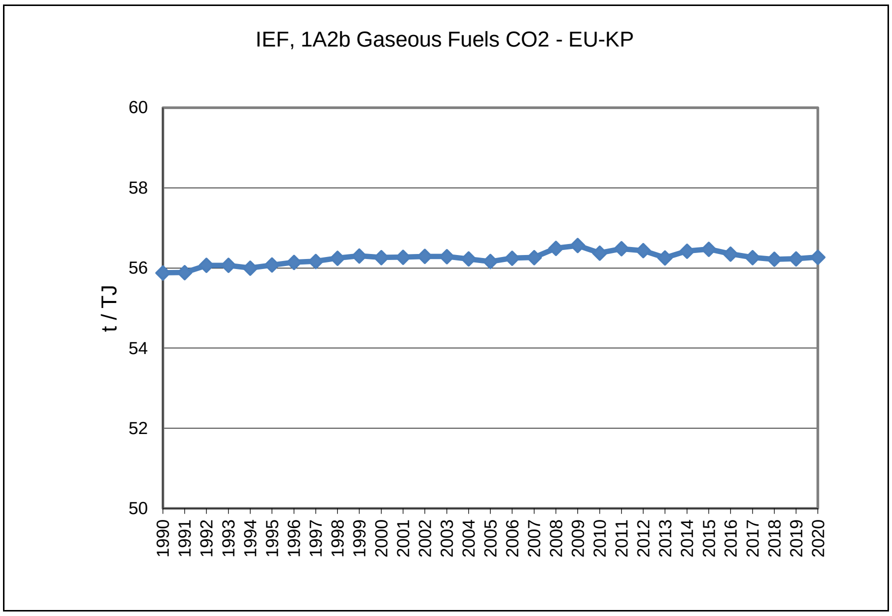
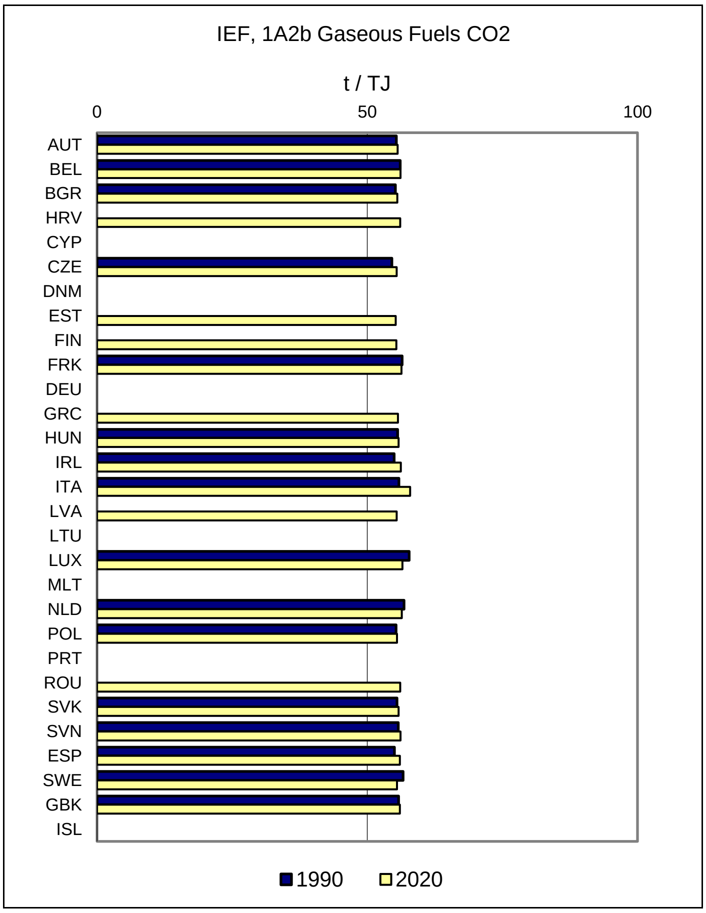


Figure 3.49 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020 No significant differences between CO_2 IEF used by EU-KP are occurring and also no significant differences between CO_2 IEF used in 1990 and 2020 are occurring.

Figure 3.49: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



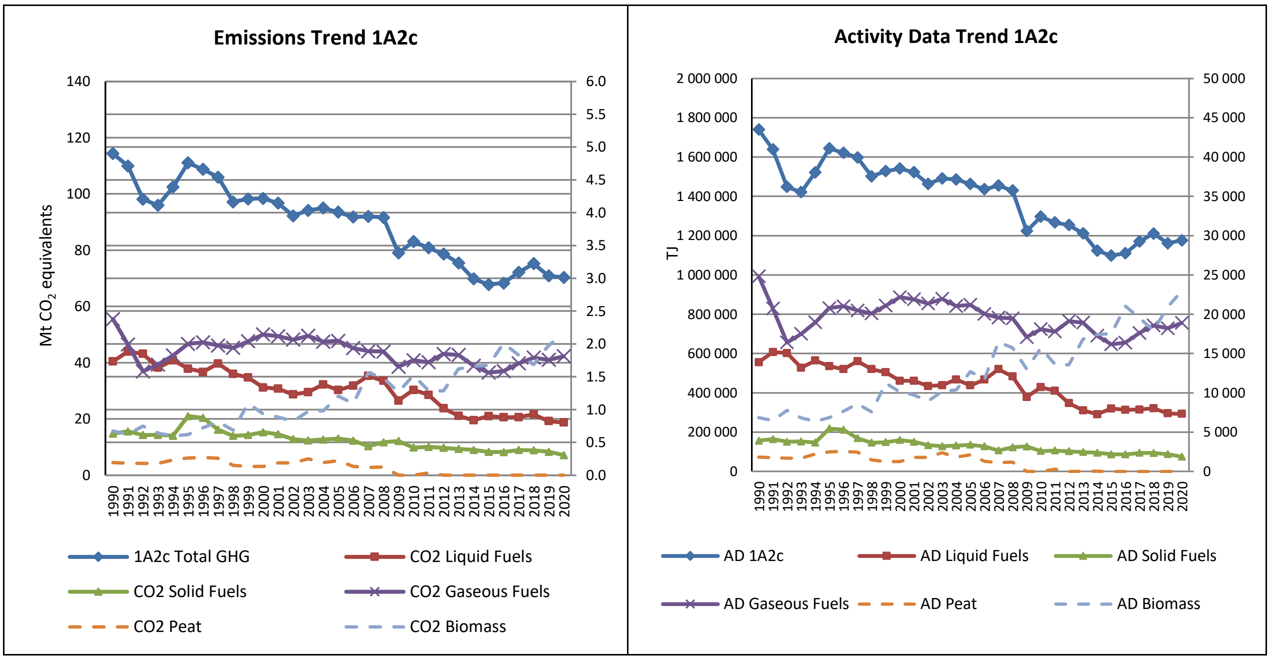
3.2.2.3 Chemicals (1.A.2.c)

This chapter provides information about European emission trend, Member States and United Kingdom contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.c Chemicals.

Total CO_2 emissions from 1.A.2.c amounted to 69 736 kt CO_2 eq. in 2020. The trend of total CO_2 emissions for 1990 to 2020 from category 1.A.2.c is depicted in Figure 3.50. CO_2 emissions decreased by 39% since 1990 and by 1% between 2019 and 2020. CO_2 emissions from 1.A.2.c Chemicals accounted for 16% of 1.A.2. source category.

Figure **3.50** shows the emission trend within the category 1.A.2.c, which is dominated by CO_2 emissions from gaseous fuels in 2020. The share of liquid fuels on CO_2 emissions from 1.A.2.c decreased from 117% in 1990 to 26% in 2020. The share of solid fuels on CO_2 emissions from 1.A.2.c slightly decreased from 43% in 1990 to 10% in 2020. The share of gaseous fuels on CO_2 emissions from 1.A.2.c decreased from 161% in 1990 to 62% in 2020.

Figure 3.50: 1.A.2.c Chemicals: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table 3-31. Germany, Malta and Iceland report emissions as ‘NO’ (not occurring) or ‘IE’ (included elsewhere). For Germany, emissions from this category are reported in 1.A.2.g Other. Six Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emissions was reported by Cyprus (but it should be noted that the share of Cyprus emissions on total EU-KP emissions is minor compared to for example Poland and Spain which reported significant increase of emissions and have also high share on total EU-KP emissions).

Table 3-31: 1.A.2.c Chemicals: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	847	1 462	1 404	2.0%	557	66%	-58	-4%	T1,T2	CS,D
Belgium	5 098	3 814	3 461.65	5.0%	-1 636	-32%	-352	-9%	T1,T3	D,PS
Bulgaria	966	1 427	1 338	1.9%	372	39%	-90	-6%	T1,T2	CS,D
Croatia	738	292	336	0.5%	-402	-54%	44	15%	T1	D
Cyprus	2	8	8	0.0%	6	258%	0	-4%	T1	D
Czechia	2 996	1 855	2 027	2.9%	-969	-32%	172	9%	T1,T2	CS,D
Denmark	328	231	204	0.3%	-124	-38%	-27	-12%	T1,T2,T3	CS,D
Estonia	390	20	11	0.0%	-379	-97%	-9	-46%	T1,T2	CS,D
Finland	1 191	726	704	1.0%	-487	-41%	-22	-3%	T3	CS,D
France	14 783	10 321	9 600	13.8%	-5 183	-35%	-721	-7%	T2,T3	CS,PS
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Greece	808	452	618	0.9%	-190	-24%	166	37%	T2	CS
Hungary	1 531	394	384	0.6%	-1 146	-75%	-10	-3%	T1,T2,T3	CS,D,PS
Ireland	410	427	416	0.6%	6	1%	-11	-3%	T2	CS
Italy	21 428	9 084	8 671	12.4%	-12 756	-60%	-412	-5%	T2	CS
Latvia	294	27	24	0.0%	-270	-92%	-3	-11%	T2	CS
Lithuania	399	314	280	0.4%	-119	-30%	-34	-11%	T2	CS
Luxembourg	170	122	114	0.2%	-56	-33%	-9	-7%	T1,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	17 275	12 926	14 740	21.1%	-2 535	-15%	1 814	14%	T2	CS,D
Poland	4 003	6 808	6 419	9.2%	2 416	60%	-389	-6%	T1,T2	CS,D
Portugal	1 412	1 335	1 232	1.8%	-180	-13%	-103	-8%	T1,T3	D,PS
Romania	17 929	3 087	3 603	5.2%	-14 326	-80%	516	17%	T1,T2,T3	CS,D,PS
Slovakia	2 652	473	473	0.7%	-2 178	-82%	1	0%	T2	CS
Slovenia	211	70	76	0.1%	-134	-64%	6	8%	T1,T2	CS,D
Spain	5 364	9 032	8 256	11.8%	2 892	54%	-776	-9%	T1,T2	CS,D,PS
Sweden	601	481	381	0.5%	-220	-37%	-100	-21%	T2	CS
United Kingdom	12 042	5 036	4 955	7.1%	-7 087	-59%	-80	-2%	T2	CS
EU-27+UK	**113 868**	**70 224**	**69 736**	**100%**	**-44 132**	**-39%**	**-488**	**-1%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	12 042	5 036	4 955	7.1%	-7 087	-59%	-80	-2%	T2	CS
EU-KP	**113 875**	**70 224**	**69 736**	**100%**	**-44 140**	**-39%**	**-488**	**-1%**	**-**	**-**

Emissions of Germany and Malta are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.c Chemicals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.c amounted 18 714 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 54% and compared to 2019 by 3%. Category has 4% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 47% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-32. Malta and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Seven Member States use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 93% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.c – Liquid Fuels (CO_2)). Cyprus, Czechia, Netherlands and Poland reported higher level of emissions in 2020 than in 1990.

Table 3-32: 1.A.2.c Chemicals, Liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	97	42	76	0.4%	-21	-21%	34	80%	T2	CS
Belgium	1 852	296	229	1.2%	-1 623	-88%	-67	-23%	T1	D
Bulgaria	855	1 002	832	4.4%	-23	-3%	-171	-17%	T1	D
Croatia	291	6	6	0.0%	-285	-98%	0	0%	T1	D
Cyprus	2	8	8	0.0%	6	258%	0	-4%	T1	D
Czechia	175	204	280	1.5%	105	60%	76	37%	T1	D
Denmark	212	3	3	0.0%	-209	-99%	0	6%	T1,T2	CS,D
Estonia	229	8	4	0.0%	-225	-98%	-5	-57%	T1,T2	CS,D
Finland	677	632	600	3.2%	-77	-11%	-33	-5%	T3	CS
France	5 470	2 505	2 488	13.3%	-2 982	-55%	-17	-1%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	639	41	37	0.2%	-602	-94%	-3	-9%	T2	CS
Hungary	380	3	3	0.0%	-377	-99%	0	0%	T1	D
Ireland	131	69	50	0.3%	-81	-62%	-19	-27%	T2	CS
Italy	13 125	3 866	3 398	18.2%	-9 727	-74%	-467	-12%	T2	CS
Latvia	270	10	10	0.1%	-260	-96%	0	2%	T2	CS
Lithuania	69	4	4	0.0%	-65	-94%	0	6%	T2	CS
Luxembourg	112	5	5	0.0%	-107	-95%	0	1%	T1,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6 493	6 944	7 621	40.7%	1 128	17%	677	10%	T2	CS,D
Poland	308	1 100	1 167	6.2%	859	279%	67	6%	T1,T2	CS,D
Portugal	1 373	752	704	3.8%	-669	-49%	-47	-6%	T1,T3	D,PS
Romania	NO	1 052	970	5.2%	970	∞	-81	-8%	T1,T2,T3	CS,D,PS
Slovakia	51	2	2	0.0%	-49	-96%	0	-13%	T2	CS
Slovenia	32	9	9	0.0%	-23	-72%	0	-1%	T1	D
Spain	2 852	254	162	0.9%	-2 690	-94%	-92	-36%	T1,T2	CS,D
Sweden	341	310	C	-	-341	-100%	-310	-100%	T2	CS
United Kingdom	4 377	96	45	0.2%	-4 332	-99%	-51	-53%	T2	CS
EU-27+UK	**40 070**	**18 913**	**18 714**	**100%**	**-21 356**	**-53%**	**-199**	**-1%**	**-**	**-**
Iceland	7	NO	NO	-	-7	-100%	-	-	NA	NA
United Kingdom (KP)	4 377	96	45	0.2%	-4 332	-99%	-51	-53%	T2	CS
EU-KP	**40 077**	**18 913**	**18 714**	**100%**	**-21 363**	**-53%**	**-199**	**-1%**	**-**	**-**

From 1990 to 2000 Croatia includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Figure 3.51 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen, that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Netherlands (41%), Italy (18%), France (13%), Poland (6%), Romania (5%) and Bulgaria (4%) which together have 87% share on EU-KP emissions.

Figure 3.51: 1.A.2.c Chemicals, Liquid fuels: Emission trend and share for CO_2

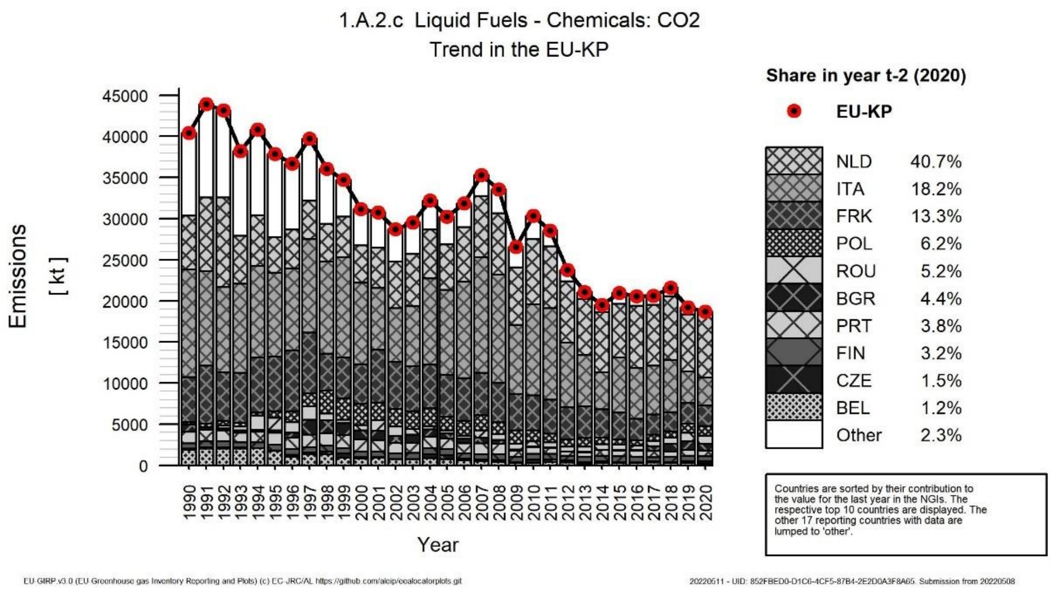


Figure 3.52 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that CO_2 IEF fluctuates over the time period with decreasing trend. CO_2 IEF equaled to 63.90 t/TJ in 2020. The main reason for the declining trend of the IEF is the growing weight of the Netherlands (with a lower IEF) and the decreasing weight of Italy (with a higher IEF) in total EU-KP emissions.

Figure 3.52: 1.A.2.c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

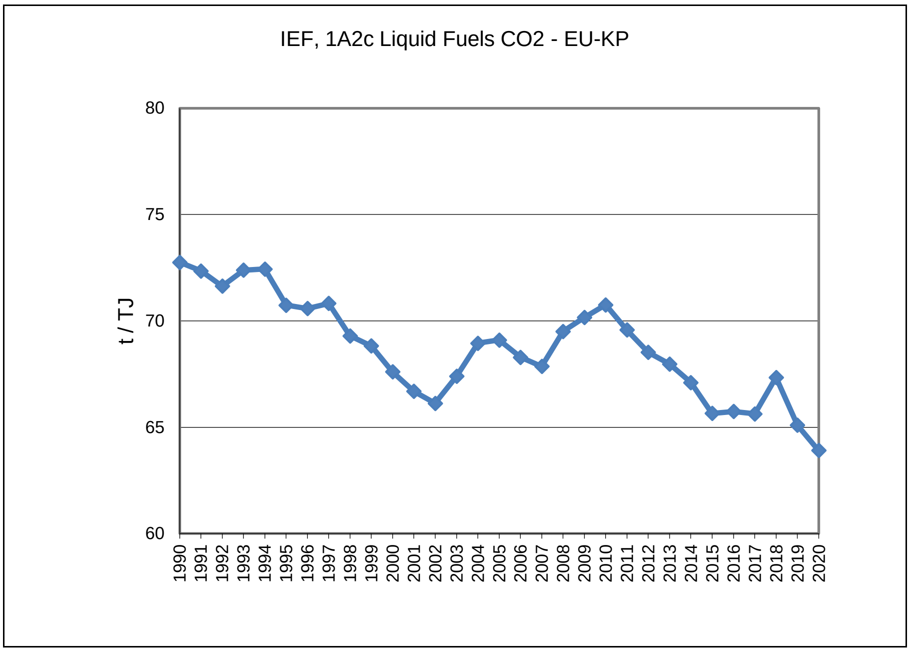
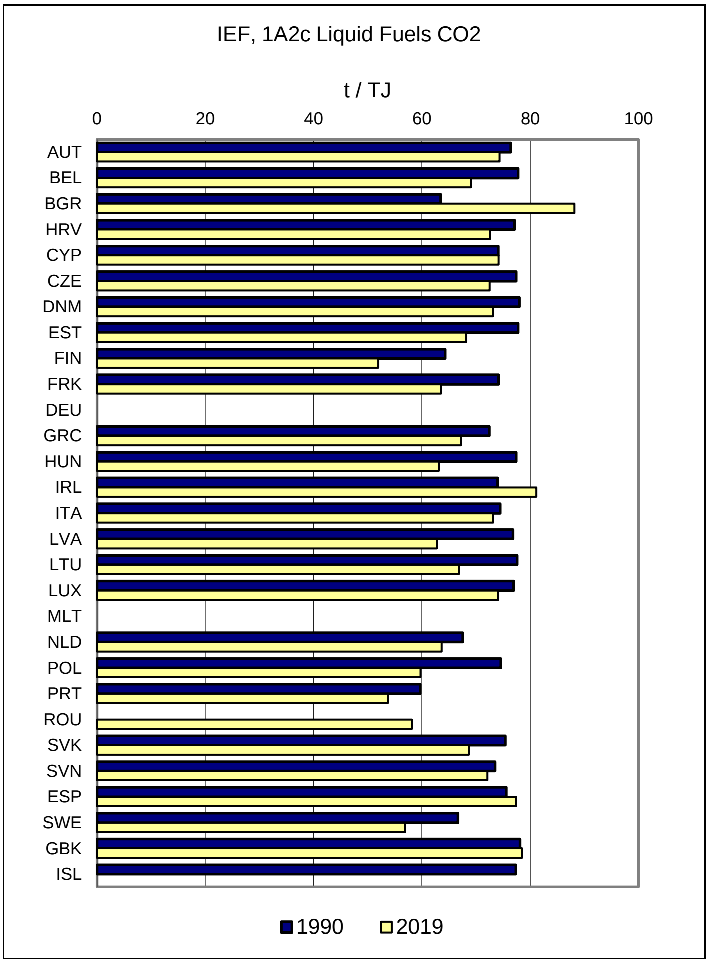


Figure 3.53 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. The main reason for the differences of IEFs across countries is differences in the fuel mix. Bulgaria has higher IEF compared to other countries which is caused by high share of petroleum coke.

Figure 3.53: 1.A.2.c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.c Chemicals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.c amounted 7 142 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 52% and compared to 2019 by 14%. Category has 2% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 52% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-33. Sixteen Member States and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Belgium uses for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99.9% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.c – Solid Fuels (CO_2)). Bulgaria and Poland reported higher level of emissions in 2020 than in 1990. Poland has the highest share on total EU-KP emissions.

Table 3-33: 1.A.2.c Chemicals, Solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	106	58	38	0.5%	-68	-64%	-20	-34%	T2	CS
Belgium	688	3	3	0.0%	-685	-100%	0	-1%	T1	D
Bulgaria	80	169	227	3.2%	146	182%	58	35%	NA	NA
Croatia	101	NO	NO	-	-101	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	2 487	1 016	966	13.5%	-1 521	-61%	-50	-5%	T2	CS,D
Denmark	6	NO	NO	-	-6	-100%	-	-	NA	NA
Estonia	5	NO	NO	-	-5	-100%	-	-	NA	NA
Finland	214	NO	NO	-	-214	-100%	-	-	NA	NA
France	2 149	1 290	936	13.1%	-1 213	-56%	-354	-27%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	169	NO	NO	-	-169	-100%	-	-	NA	NA
Hungary	96	NO	NO	-	-96	-100%	-	-	NA	NA
Ireland	72	NO	NO	-	-72	-100%	-	-	NA	NA
Italy	640	79	NO	-	-640	-100%	-79	-100%	NA	NA
Latvia	NO	NO	0	0.0%	0	∞	0	∞	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 087	NO	NO	-	-1 087	-100%	-	-	NA	NA
Poland	1 012	4 822	4 260	59.6%	3 248	321%	-562	-12%	T1,T2	CS,D
Portugal	39	NO	NO	-	-39	-100%	-	-	NA	NA
Romania	639	98	NO	-	-639	-100%	-98	-100%	NA	NA
Slovakia	1 584	49	49	0.7%	-1 534	-97%	1	2%	T2	CS
Slovenia	1	NO	NO	-	-1	-100%	-	-	NA	NA
Spain	691	593	542	7.6%	-148	-21%	-50	-9%	T1,T2	CS,D,PS
Sweden	100	C	C	-	-100	-100%	-	-	T2	CS
United Kingdom	2 796	129	120	1.7%	-2 676	-96%	-9	-7%	T2	CS
EU-27+UK	**14 661**	**8 304**	**7 142**	**100%**	**-7 519**	**-51%**	**-1 163**	**-14%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 796	129	120	1.7%	-2 676	-96%	-9	-7%	T2	CS
EU-KP	**14 661**	**8 304**	**7 142**	**100%**	**-7 519**	**-51%**	**-1 163**	**-14%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Figure 3.54 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland (60%), Czechia (14%) and France (13%) which together represent 87% share on EU-KP emissions.

Figure 3.54: 1.A.2.c Chemicals, Solid fuels: Emission trend and share for CO_2

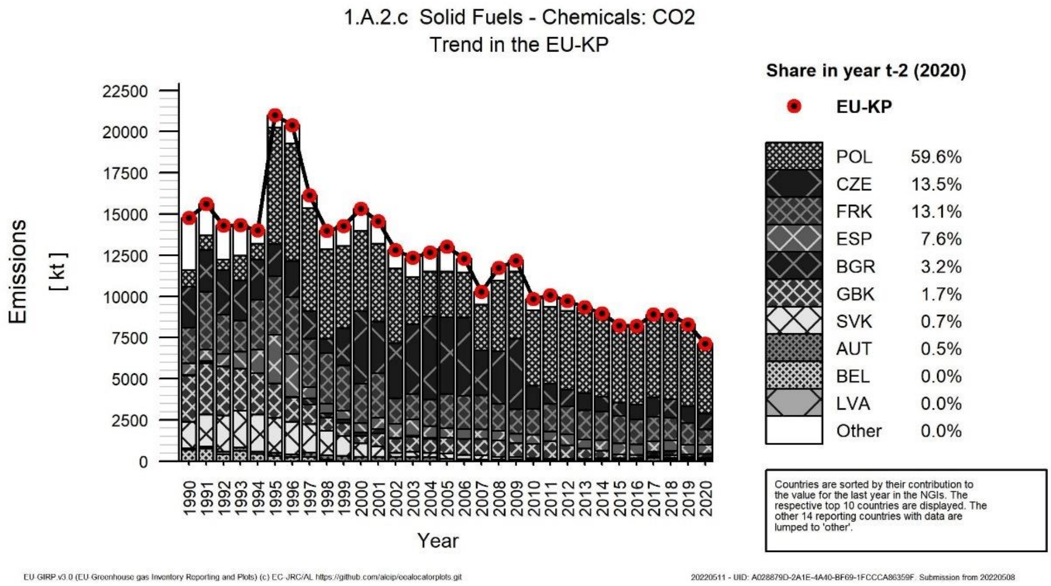


Figure 3.55 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that since 2010, the CO_2 IEF fluctuates only slightly. CO_2 IEF equalled to 95.35 t/TJ in 2020.

Figure 3.55: 1.A.2.c Chemicals, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

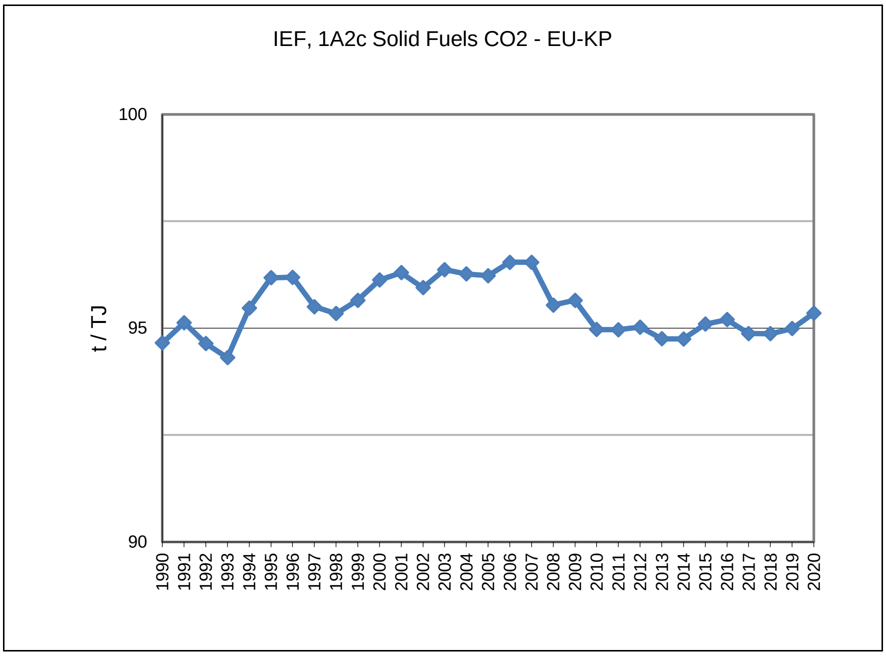
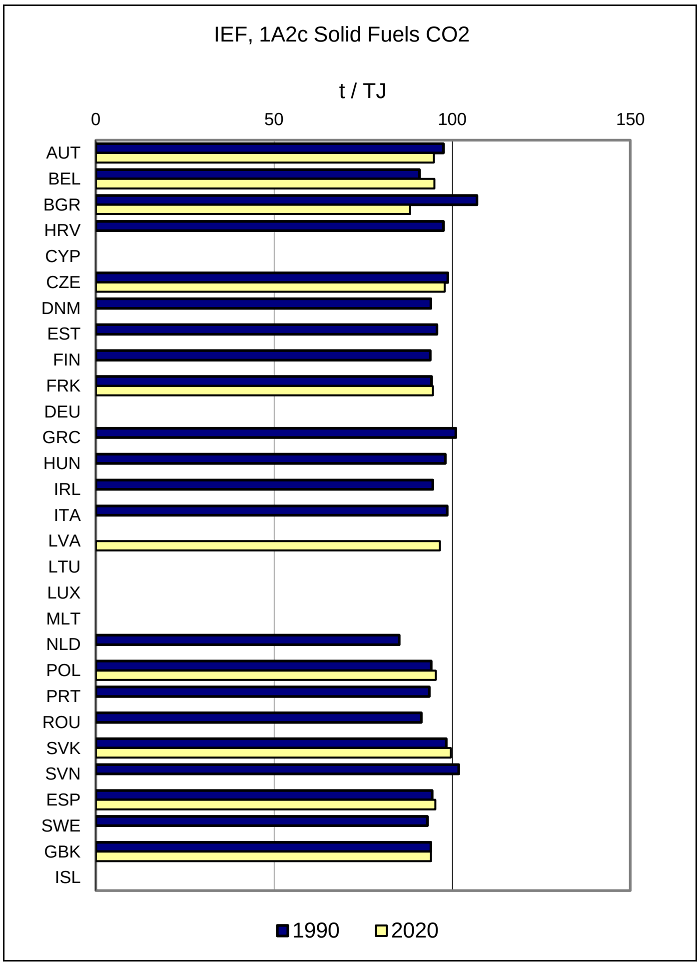


Figure 3.56 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020.

Figure 3.56: 1.A.2.c Chemicals, Solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.c Chemicals – Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.c amounted 42 257 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 24% and compared to 2019 CO_2 emissions increased by 3%. This category represents 10% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 25% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-34. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Croatia uses for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.c –Gaseous Fuels (CO_2)). Nine Member States reported higher level of emissions in 2020 than in 1990. Noticeable higher level of emissions in 2020 compared to 1990 was reported by Bulgaria (823%) and Spain (314%).

Table 3-34: 1.A.2.c Chemicals, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	519	1 182	1 108	2.6%	590	114%	-73	-6%	T2	CS
Belgium	2 559	3 499	3 222.43	7.6%	664	26%	-277	-8%	T1,T3	D,PS
Bulgaria	30	256	279	0.7%	249	823%	23	9%	T2	CS
Croatia	346	286	330	0.8%	-16	-5%	44	15%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	334	634	780	1.8%	446	134%	146	23%	T2	CS
Denmark	110	229	201	0.5%	91	83%	-27	-12%	T3	CS
Estonia	157	12	7	0.0%	-150	-95%	-4	-38%	T2	CS
Finland	99	88	98	0.2%	-1	-1%	10	11%	T3	CS
France	6 695	5 303	5 138	12.2%	-1 556	-23%	-165	-3%	T2,T3	CS,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	412	581	1.4%	581	∞	169	41%	T2	CS
Hungary	1 055	390	378	0.9%	-677	-64%	-12	-3%	T2	CS
Ireland	207	358	366	0.9%	159	76%	8	2%	T2	CS
Italy	7 663	5 139	5 273	12.5%	-2 390	-31%	134	3%	T2	CS
Latvia	24	17	13	0.0%	-10	-43%	-3	-19%	T2	CS
Lithuania	331	310	276	0.7%	-55	-17%	-34	-11%	T2	CS
Luxembourg	57	117	108	0.3%	51	89%	-9	-8%	T3	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 695	5 982	7 119	16.8%	-2 576	-27%	1 137	19%	T2	CS
Poland	293	830	945	2.2%	653	223%	115	14%	T2	CS
Portugal	NO	583	527	1.2%	527	∞	-56	-10%	T1,T3	D,PS
Romania	17 290	1 878	2 631	6.2%	-14 659	-85%	754	40%	T3	PS
Slovakia	989	408	412	1.0%	-578	-58%	3	1%	T2	CS
Slovenia	177	53	56	0.1%	-121	-68%	3	6%	T2	CS
Spain	1 822	8 186	7 552	17.9%	5 730	314%	-634	-8%	T2	CS
Sweden	155	74	64	0.2%	-91	-59%	-11	-14%	T2	CS
United Kingdom	4 870	4 811	4 791	11.3%	-79	-2%	-20	0%	T2	CS
EU-27+UK	**55 475**	**41 035**	**42 257**	**100%**	**-13 218**	**-24%**	**1 222**	**3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 870	4 811	4 791	11.3%	-79	-2%	-20	0%	T2	CS
EU-KP	**55 475**	**41 035**	**42 257**	**100%**	**-13 218**	**-24%**	**1 222**	**3%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.57 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Spain (18%), Netherlands (17%), France (12.5%), Italy (12%), United Kingdom (11%), Belgium (8%) and Romania (6%) which together represent 84.5% share on EU-KP emissions.

Figure 3.57: 1.A.2.c Chemicals, Gaseous fuels: Emission trend and share for CO_2

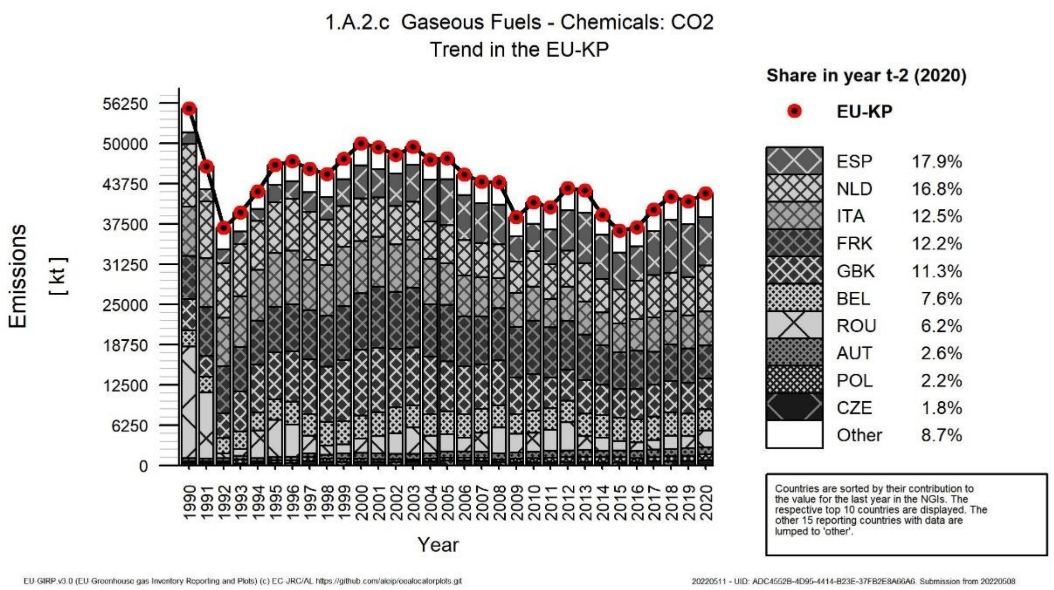


Figure 3.58 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. CO_2 IEF shows stable trend for the whole time series. CO_2 IEF equaled to 55.90 t/TJ in 2020.

Figure 3.58: 1.A.2.c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

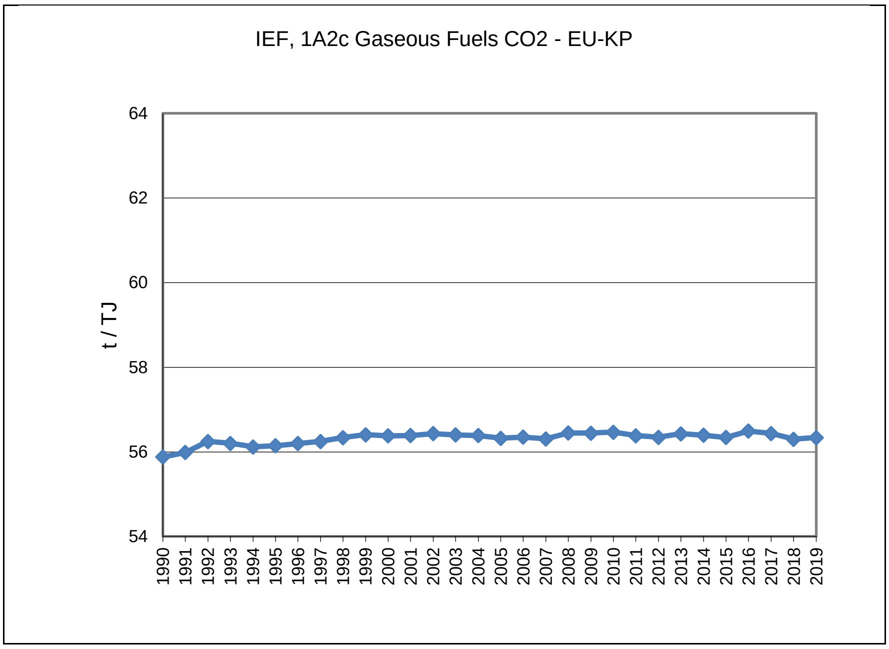
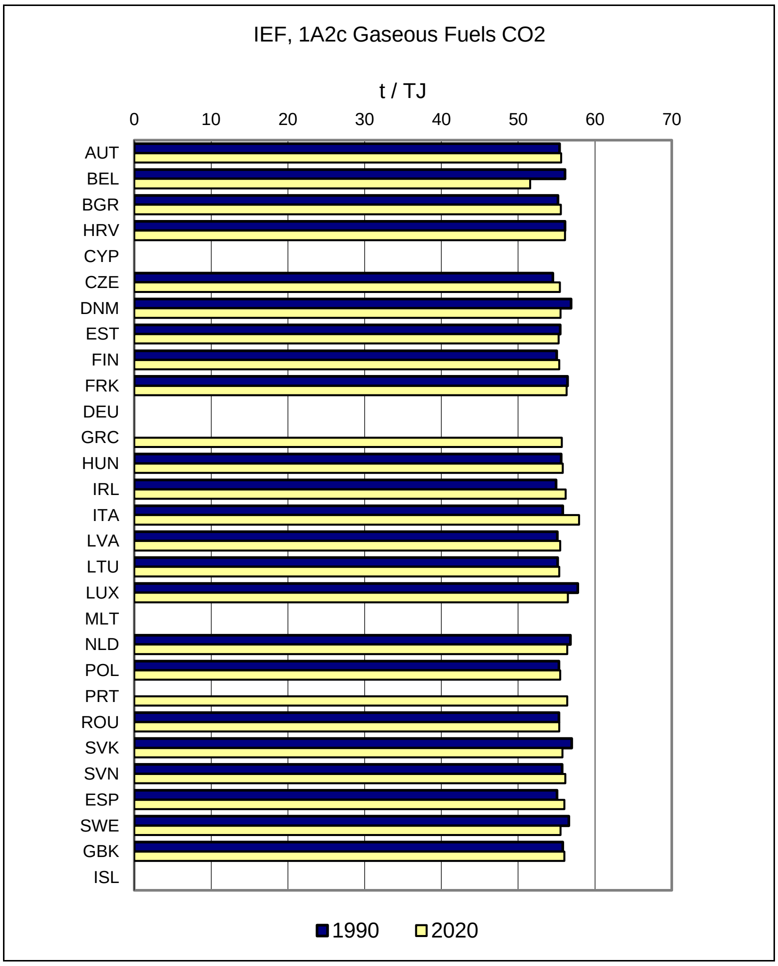


Figure 3.59 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. No significant differences between CO_2 IEF used by EU-KP are occurring as also no significant differences between CO_2 IEF used in 1990 and 2020 are occurring.

Figure 3.59: 1.A.2.c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



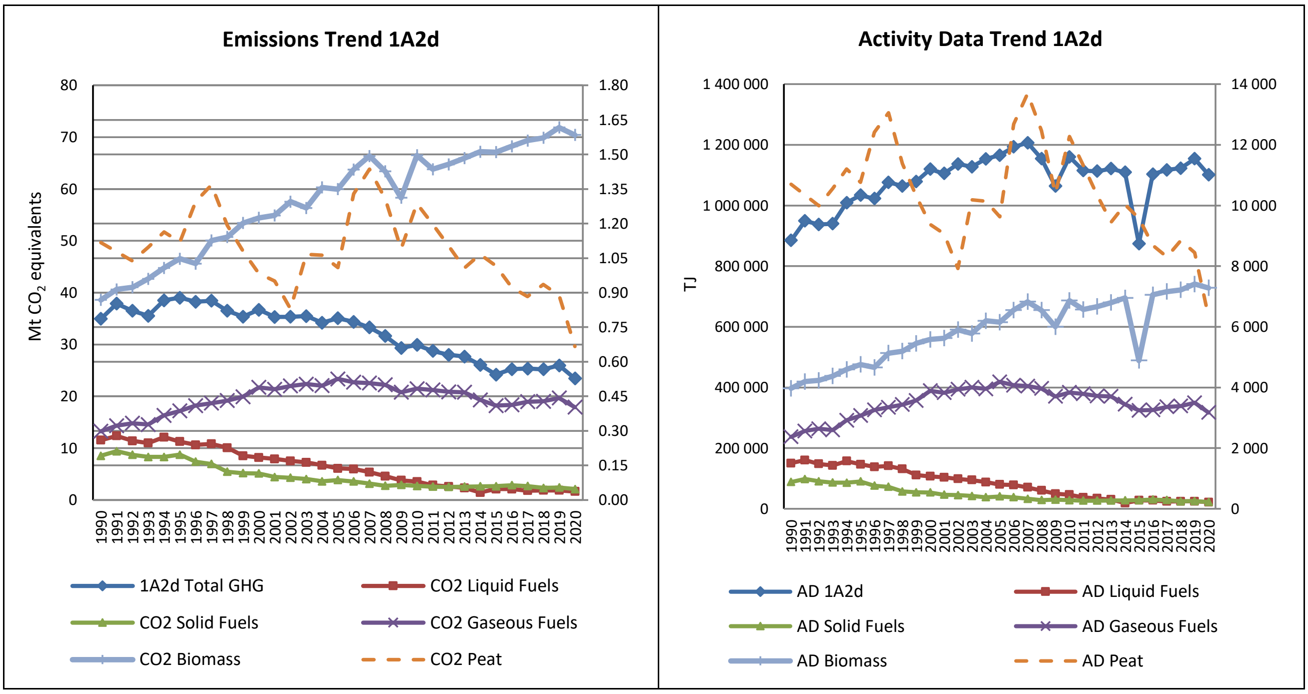
3.2.2.4 Pulp, Paper and Print (1.A.2.d)

This chapter provides information about European emission trend, Member States and United Kingdom contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.d Pulp, Paper and Print.

Total CO_2 emissions from 1.A.2.d amounted to 22 730 kt CO_2 eq. in 2020. The trend of total emissions for 1990 to 2020 from category 1.A.2.d is depicted in Figure **3.60**. Total CO_2 emissions decreased by 34% since 1990 and by 10% between 2019 and 2020. CO_2 emissions from 1.A.2.d Pulp, Paper and Print accounted for 5% of 1.A.2. source category.

Figure **3.60** shows the emission trend within the category 1.A.2.d, which is dominated by CO_2 emissions from gaseous fuels in 2020. The share of liquid fuels on CO_2 emissions from 1.A.2.d decreased from 33% in 1990 to 7% in 2020. The share of solid fuels on CO_2 emissions from 1.A.2.d decreased from 25% in 1990 to 9% in 2020. The share of gaseous fuels on CO_2 emissions from 1.A.2.d increased from 38% in 1990 to 79% in 2020. This sector includes a high amount of biomass consumption which is also gradually increasing since 1990. The activity data shows a strong switch from liquid and solid fuels to gaseous fuels and biomass.

Figure 3.60: 1.A.2.d Pulp, Paper and Print: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Note that total CO_2 emissions in the figure on the left side do not include CO_2 from biomass whereas total activity data in the figure on the right side includes AD biomass.

Detailed data related to the EU-KP submissions are depicted in Table 3-35. Malta and Iceland report emissions as 'NO' (not occurring). Seven Member States report increase of CO_2 emissions compared to level of emissions in 1990. The most significant increase of CO_2 emissions was reported by Bulgaria, Germany, Hungary and Poland (which together represent 18% share on total EU-KP emissions).

Table 3-35: 1.A.2.d Pulp, Paper and Print: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	2 208	1 970	1 772	7.8%	-436	-20%	-198	-10%	T1,T2	CS,D
Belgium	644	532	556.22	2.4%	-88	-14%	24	5%	T1,T3	D,PS
Bulgaria	16	102	95	0.4%	79	509%	-7	-7%	T1,T2	CS,D
Croatia	303	111	115	0.5%	-188	-62%	5	4%	T1	D
Cyprus	5	3	3	0.0%	-2	-35%	0	2%	T1	D
Czechia	2 285	444	472	2.1%	-1 813	-79%	28	6%	T1,T2	CS,D
Denmark	338	67	55	0.2%	-283	-84%	-11	-17%	T1,T2,T3	CS,D
Estonia	145	62	63	0.3%	-82	-57%	1	1%	T1,T2	CS,D
Finland	5 330	2 458	2 136	9.4%	-3 194	-60%	-323	-13%	T3	CS,D
France	4 457	2 350	2 224	9.8%	-2 233	-50%	-126	-5%	T2	CS
Germany	4	4	8	0.0%	4	114%	3	79%	CS	CS
Greece	306	93	84	0.4%	-222	-72%	-9	-9%	T2	CS
Hungary	74	469	417	1.8%	343	465%	-52	-11%	T1,T2,T3	CS,D,PS
Ireland	28	19	19	0.1%	-9	-33%	0	2%	T2	CS
Italy	3 108	4 975	4 665	20.5%	1 557	50%	-310	-6%	T2	CS
Latvia	168	6	5	0.0%	-164	-97%	-1	-16%	T2	CS
Lithuania	255	39	32	0.1%	-224	-88%	-7	-18%	T2	CS
Luxembourg	NO,IE	2	2	0.0%	2	∞	0	-21%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 668	924	846	3.7%	-823	-49%	-78	-8%	T2	CS
Poland	284	1 474	1 337	5.9%	1 052	370%	-137	-9%	T1,T2	CS,D
Portugal	754	1 363	1 235	5.4%	481	64%	-128	-9%	T1	D
Romania	NO	232	204	0.9%	204	∞	-28	-12%	T1,T2,T3	CS,D,PS
Slovakia	2 329	434	390	1.7%	-1 939	-83%	-44	-10%	T2	CS
Slovenia	381	316	274	1.2%	-106	-28%	-42	-13%	T1,T2,T3	CS,D,PS
Spain	2 602	4 669	3 799	16.7%	1 197	46%	-869	-19%	T1,T2,T3	CS,D,PS
Sweden	2 189	691	605	2.7%	-1 584	-72%	-86	-13%	T2	CS
United Kingdom	4 620	1 394	1 318	5.8%	-3 303	-71%	-77	-6%	T2	CS
EU-27+UK	**34 502**	**25 202**	**22 730**	**100%**	**-11 772**	**-34%**	**-2 472**	**-10%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 620	1 394	1 318	5.8%	-3 303	-71%	-77	-6%	T2	CS
EU-KP	**34 502**	**25 202**	**22 730**	**100%**	**-11 772**	**-34%**	**-2 472**	**-10%**	**-**	**-**

Emissions of Luxembourg from 1990 to 1999 are included in 1.A.2.g. Emissions of Malta are reported in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.d Pulp, Paper and Print – Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.d amounted 1 627 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 86% and compared to 2019 by 12%. Category has 0.4% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 86% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-36. Malta, Netherlands and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Six Member States use Tier 1 methodology for emission estimates, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 84% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.d – Liquid Fuels (CO_2)). All Member States reported lower level of emissions in 2020 than in 1990 (except of Poland, which has 7% share on total EU-KP emissions in 2020).

Table 3-36: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	853	17	13	0.8%	-839	-98%	-4	-23%	T2	CS
Belgium	235	10	18	1.1%	-216	-92%	8	75%	T1,T3	D,PS
Bulgaria	16	3	1	0.1%	-14	-91%	-1	-50%	NA	NA
Croatia	58	3	2	0.2%	-56	-96%	0	-11%	T1	D
Cyprus	5	3	3	0.2%	-2	-35%	0	2%	T1	D
Czechia	461	3	11	0.6%	-450	-98%	7	221%	T1	CS,D
Denmark	89	4	4	0.2%	-85	-95%	0	8%	T1,T2	CS,D
Estonia	145	1	1	0.0%	-145	-100%	0	-32%	T1,T2	CS,D
Finland	1 138	474	374	23.0%	-763	-67%	-100	-21%	T3	CS
France	1 352	95	94	5.8%	-1 258	-93%	-1	-1%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	302	49	51	3.1%	-252	-83%	1	2%	T2	CS
Hungary	19	3	3	0.2%	-16	-84%	0	0%	T1	D
Ireland	28	3	3	0.2%	-25	-89%	0	3%	T2	CS
Italy	1 017	18	15	0.9%	-1 001	-98%	-2	-13%	T2	CS
Latvia	16	0	0	0.0%	-15	-98%	0	0%	T2	CS
Lithuania	69	4	1	0.0%	-68	-99%	-4	-82%	T2	CS
Luxembourg	IE	0	0	0.0%	0	∞	0	-16%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2	NO	NO	-	-2	-100%	-	-	NA	NA
Poland	106	129	114	7.0%	8	8%	-15	-11%	T1,T2	CS,D
Portugal	754	239	239	14.7%	-514	-68%	0	0%	T1	D
Romania	NO	3	1	0.1%	1	∞	-2	-58%	T1,T2	CS,D
Slovakia	985	3	3	0.2%	-982	-100%	0	4%	T2	CS
Slovenia	98	3	1	0.1%	-97	-99%	-2	-67%	T1	D
Spain	1 247	188	155	9.5%	-1 092	-88%	-34	-18%	T1,T2,T3	CS,D,PS
Sweden	1 786	578	513	31.5%	-1 273	-71%	-65	-11%	T2	CS
United Kingdom	766	7	6	0.4%	-760	-99%	-1	-14%	T2	CS
EU-27+UK	**11 544**	**1 841**	**1 627**	**100%**	**-9 917**	**-86%**	**-214**	**-12%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	766	7	6	0.4%	-760	-99%	-1	-14%	T2	CS
EU-KP	**11 544**	**1 841**	**1 627**	**100%**	**-9 917**	**-86%**	**-214**	**-12%**	**-**	**-**

Emissions of Germany are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.61 shows CO_2 emissions trend as well as the share of countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Sweden (32%), Finland (23%), Portugal (15%), Spain (10%), Poland (7%) and France (6%) which together represent 92% share on EU-KP emissions.

Figure 3.61: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Emission trend and share for CO_2

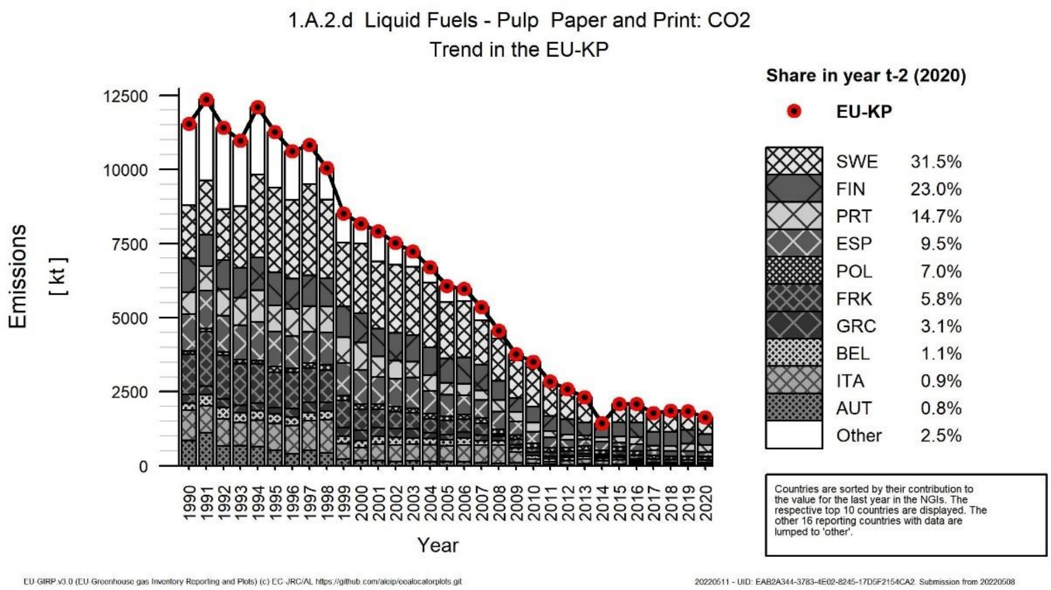


Figure.3.62 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that CO_2 IEF is decreasing during whole time period, which is caused by increasing consumption of Liquified Petroleum Gas with lower CO_2 IEF and decreasing consumption of Heavy Fuel Oil with higher CO_2 IEF. Slight fluctuation occurred during few last years. CO_2 IEF equaled to 75.11 t/TJ in 2020.

Figure.3.62: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

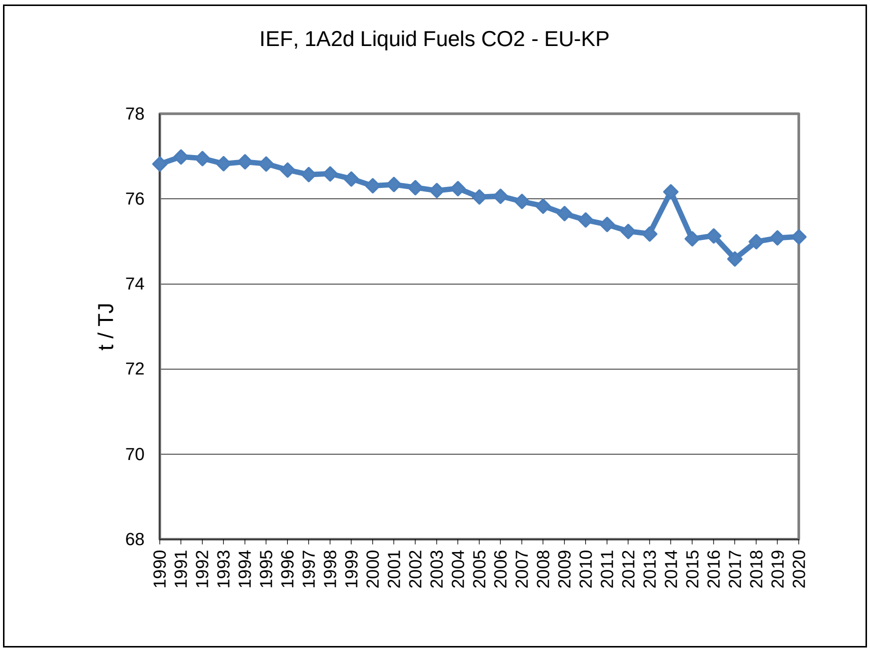
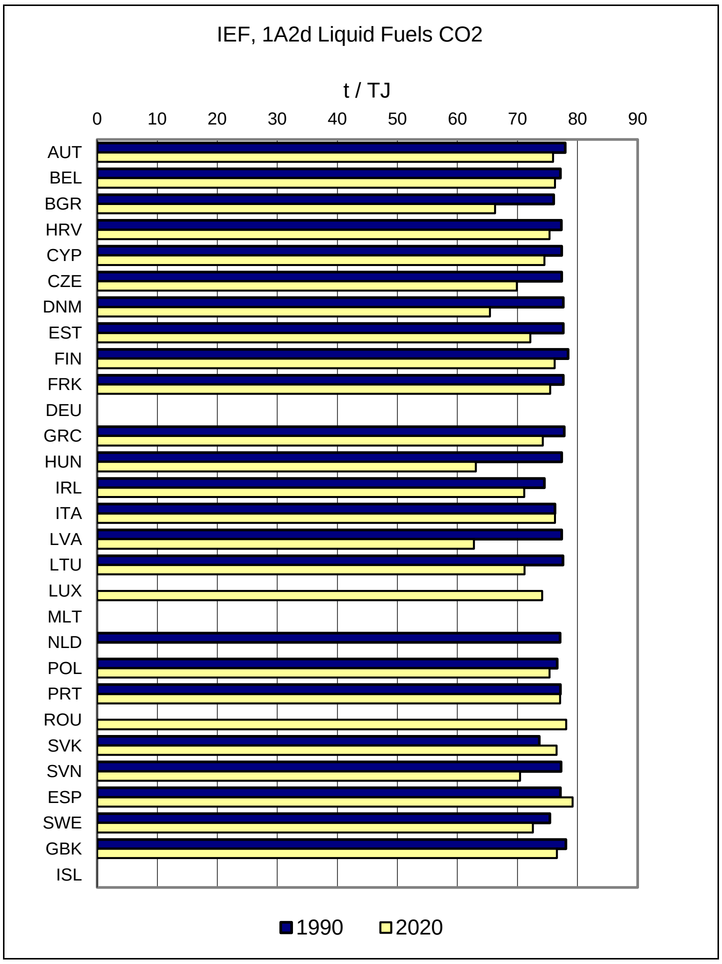


Figure.3.63 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. No major differences between countries CO_2 IEF occur.

Figure.3.63: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.d Pulp, Paper and Print - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.d amounted 2 083 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 75% and by 12% compared to 2019. This category represents 0.5% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 75% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table **3-37**. Fifteen Member States and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Belgium uses for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 95% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.d – Solid Fuels (CO_2)). All Member States reported lower level of emissions in 2020 than in 1990 (except for Hungary and Poland which together have 39% share on EU-KP emissions).

Table 3-37: 1.A.2.d Pulp, Paper and Print, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	398	366	298	14.3%	-101	-25%	-68	-19%	T2	CS
Belgium	128	88	106	5.1%	-21	-16%	18	21%	T1	D
Bulgaria	NO	4	4	0.2%	4	∞	0	1%	T1,T2	CS,D
Croatia	68	NO	NO	-	-68	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 646	163	169	8.1%	-1 477	-90%	6	4%	T2	CS,D
Denmark	125	NO	NO	-	-125	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 318	171	164	7.9%	-1 154	-88%	-7	-4%	T3	CS
France	1 034	NO	28	1.3%	-1 006	-97%	28	∞	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	4	NO	NO	-	-4	-100%	-	-	NA	NA
Hungary	6	270	189	9.1%	183	3295%	-81	-30%	T3	PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	6	NO	NO	-	-6	-100%	-	-	NA	NA
Latvia	3	NO	NO	-	-3	-100%	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	8	NO	NO	-	-8	-100%	-	-	NA	NA
Poland	173	733	630	30.2%	457	264%	-103	-14%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	1 142	206	205	9.8%	-937	-82%	-2	-1%	T2	CS
Slovenia	172	108	64	3.1%	-108	-63%	-44	-41%	T3	PS
Spain	277	NO	NO	-	-277	-100%	-	-	NA	NA
Sweden	265	25	C	-	-265	-100%	-25	-100%	T2	CS
United Kingdom	1 733	252	226	10.9%	-1 506	-87%	-26	-10%	T2	CS
EU-27+UK	**8 238**	**2 362**	**2 083**	**100%**	**-6 155**	**-75%**	**-279**	**-12%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 733	252	226	10.9%	-1 506	-87%	-26	-10%	T2	CS
EU-KP	**8 238**	**2 362**	**2 083**	**100%**	**-6 155**	**-75%**	**-279**	**-12%**	**-**	**-**

Emissions of Germany are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.

Figure 3.64 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland (30%), Austria (14%), United Kingdom (11%) and Slovakia (10%) which together represent 65% share on EU-KP emissions.

Figure 3.64: 1.A.2.d Pulp, Paper and Print, Solid fuels: Emission trend and share for CO_2

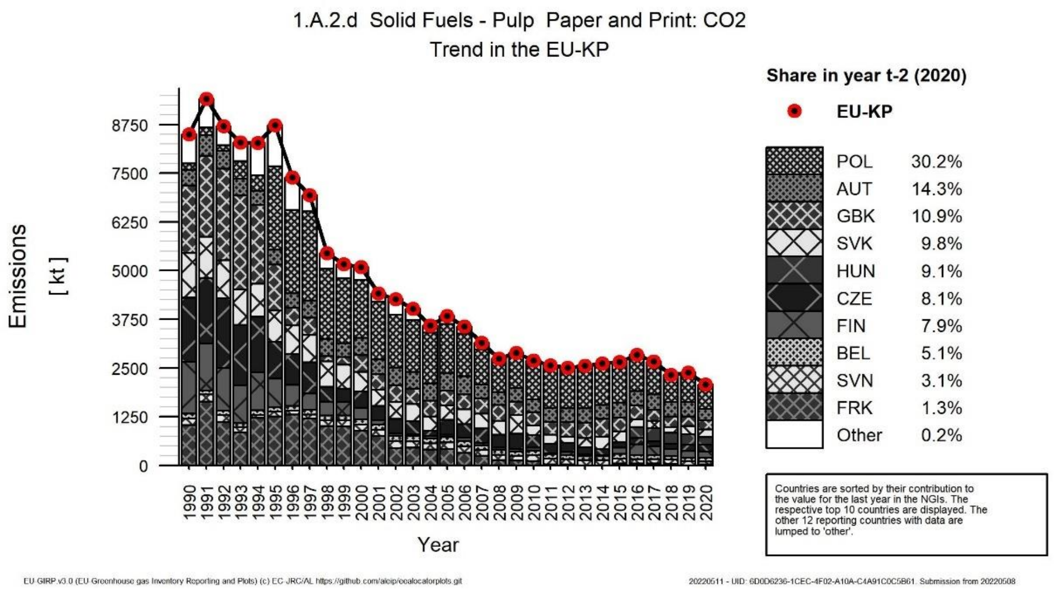


Figure 3.65 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. CO_2 IEF equalled to 94.17 t/TJ in 2020.

Figure 3.65: 1.A.2.d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

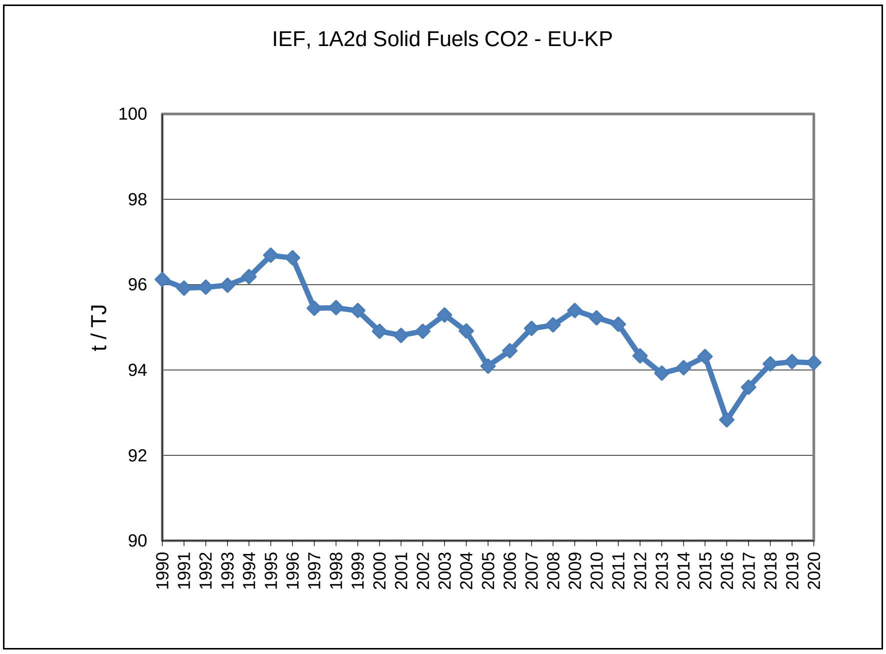
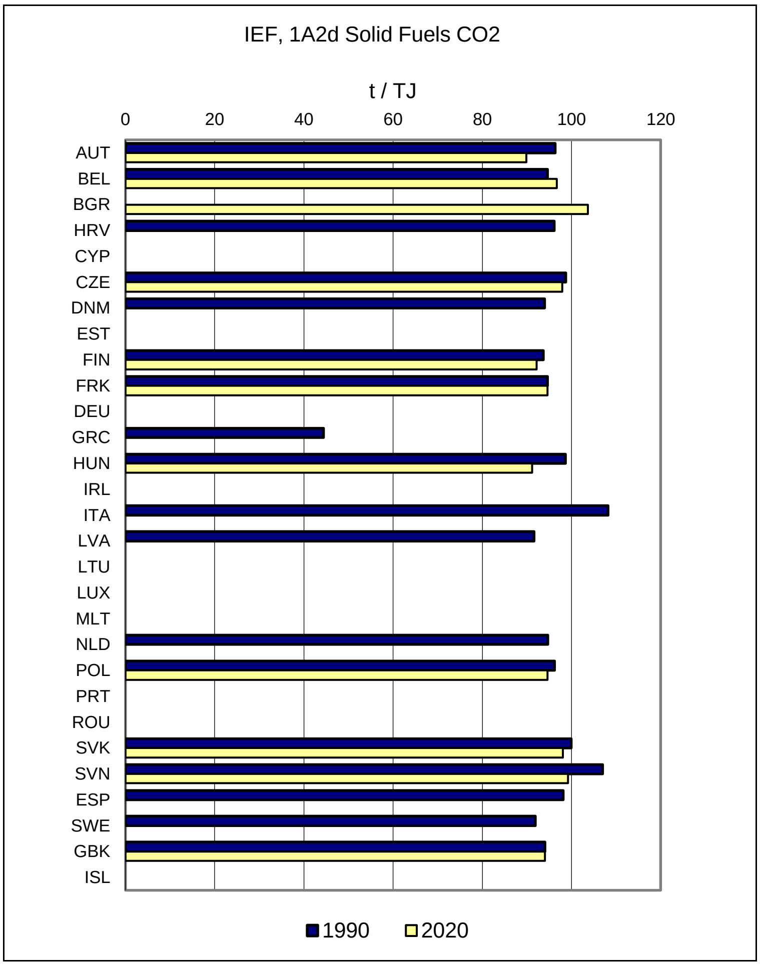


Figure 3.66 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020.

Figure 3.66: 1.A.2.d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.d Pulp, Paper and Print - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.d amounted 17 903 kt in 2020 for EU-KP. CO_2 emissions increased compared to year 1990 by 35% and compared to 2019 decreased by 9%. This category has 5% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 30% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-38. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Germany reports emissions as 'IE' (include elsewhere) and reports them in 1.A.2.g Other. Belgium, Croatia and Portugal use Tier 1 methodology for emission estimates, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 92% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.d – Gaseous Fuels (CO_2)). Six Member States and United Kingdom reported lower level of emissions in 2020 than in 1990, the rest of Member States reported increase of emissions compared to 1990. Most rapid increase of emissions compared to 1990 was reported by Poland, Spain, Hungary and Italy (which together have 50% share on total EU-KP emissions).

Table 3-38: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	943	1 580	1 452	8.1%	509	54%	-128	-8%	T2	CS
Belgium	282	327	314	1.8%	32	11%	-13	-4%	T1	D
Bulgaria	NO	95	89	0.5%	89	∞	-6	-6%	T2	CS
Croatia	177	108	113	0.6%	-64	-36%	5	5%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	179	278	293	1.6%	114	64%	15	5%	T2	CS
Denmark	124	63	51	0.3%	-73	-59%	-12	-18%	T3	CS
Estonia	NO	61	62	0.3%	62	∞	1	2%	T2	CS
Finland	1 757	834	856	4.8%	-901	-51%	22	3%	T3	CS
France	2 071	2 228	2 082	11.6%	11	1%	-145	-7%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	44	34	0.2%	34	∞	-10	-23%	T2	CS
Hungary	50	117	127	0.7%	78	157%	10	9%	T2	CS
Ireland	NO	16	16	0.1%	16	∞	0	2%	T2	CS
Italy	2 085	4 957	4 649	26.0%	2 565	123%	-308	-6%	T2	CS
Latvia	150	5	4	0.0%	-146	-97%	-1	-17%	T2	CS
Lithuania	187	34	31	0.2%	-156	-84%	-4	-10%	T2	CS
Luxembourg	IE	2	1	0.0%	1	∞	0	-21%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 659	924	846	4.7%	-813	-49%	-78	-8%	T2	CS
Poland	6	551	517	2.9%	511	9167%	-34	-6%	T2	CS
Portugal	NO	1 124	996	5.6%	996	∞	-128	-11%	T1	D
Romania	NO	216	190	1.1%	190	∞	-27	-12%	T2,T3	CS,PS
Slovakia	203	222	183	1.0%	-19	-10%	-39	-18%	T2	CS
Slovenia	110	206	209	1.2%	99	90%	4	2%	T2	CS
Spain	1 078	4 480	3 645	20.4%	2 566	238%	-836	-19%	T2,T3	CS,PS
Sweden	66	74	58	0.3%	-8	-12%	-16	-21%	T2	CS
United Kingdom	2 122	1 135	1 085	6.1%	-1 037	-49%	-50	-4%	T2	CS
EU-27+UK	**13 247**	**19 680**	**17 903**	**100%**	**4 656**	**35%**	**-1 777**	**-9%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	2 122	1 135	1 085	6.1%	-1 037	-49%	-50	-4%	T2	CS
EU-KP	**13 247**	**19 680**	**17 903**	**100%**	**4 656**	**35%**	**-1 777**	**-9%**	**-**	**-**

Emissions of Germany are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.67 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Italy (26%), Spain (20%), France (12%), Austria (8%), United Kingdom (6%), Portugal (6%), Netherlands (5%) and Finland (5%) which together have 87% share on EU-KP emissions.

Figure 3.67: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Emission trend and share for CO_2

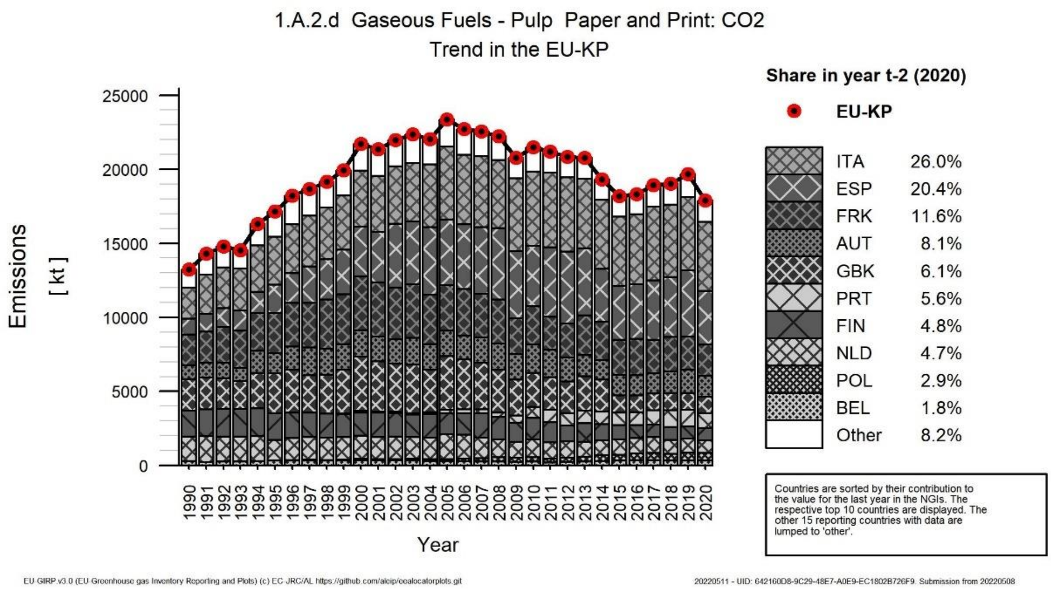


Figure 3.68 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. CO_2 IEF shows relatively stable slightly increasing trend without major fluctuations for whole time series. The main reason for increasing trend of the CO_2 IEF is the growing share of Italy and Spain on total EU-KP emissions; their CO_2 IEFs have been slightly growing since 1990. CO_2 IEF equalled to 56.71 t/TJ in 2020.

Figure 3.68: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

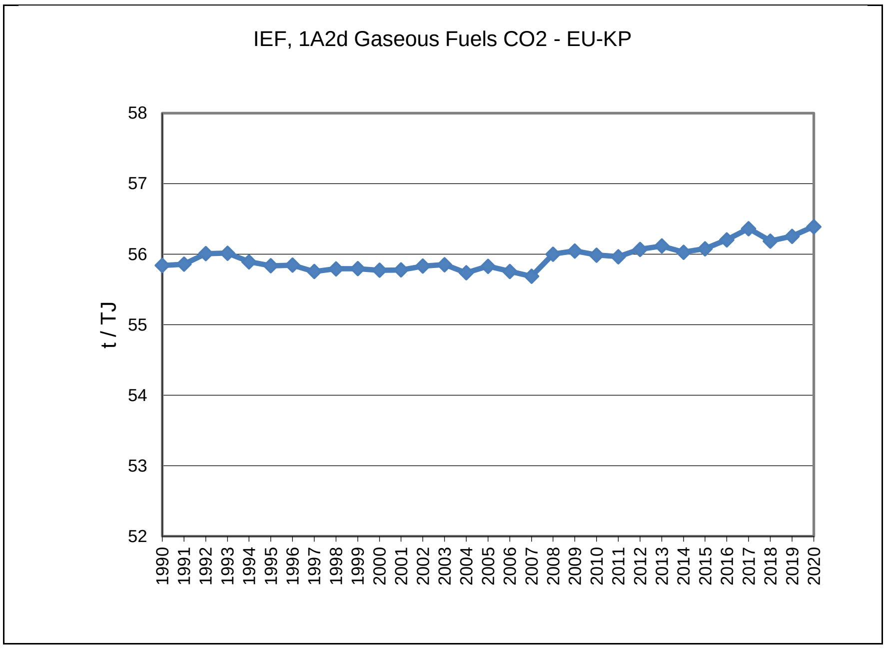
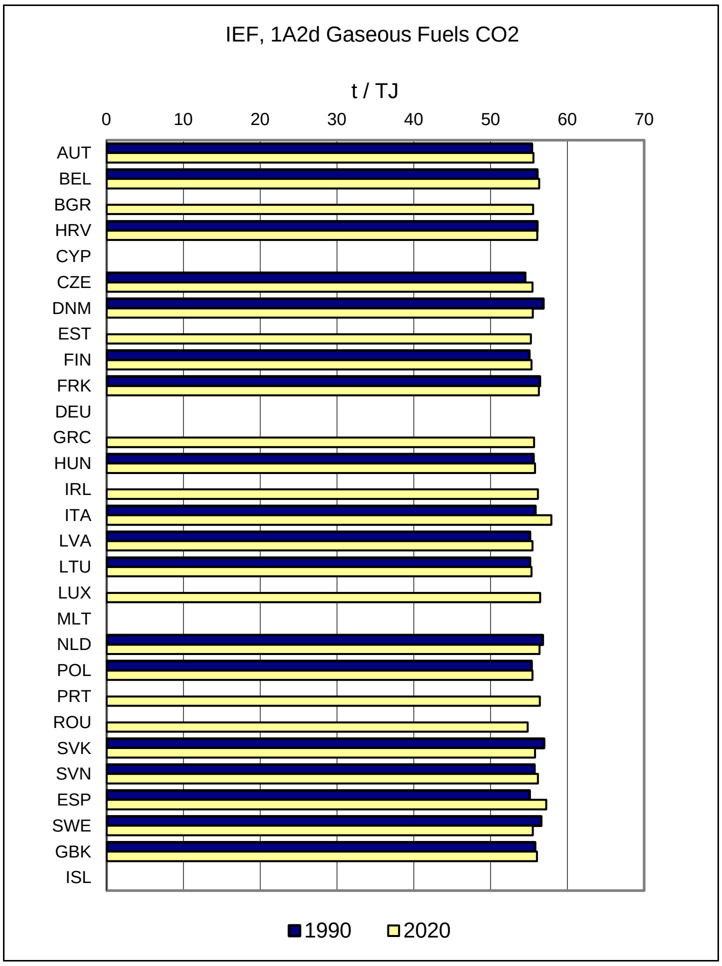


Figure 3.69 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between 1990 and 2020 CO_2 IEFs occur.

Figure 3.69: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



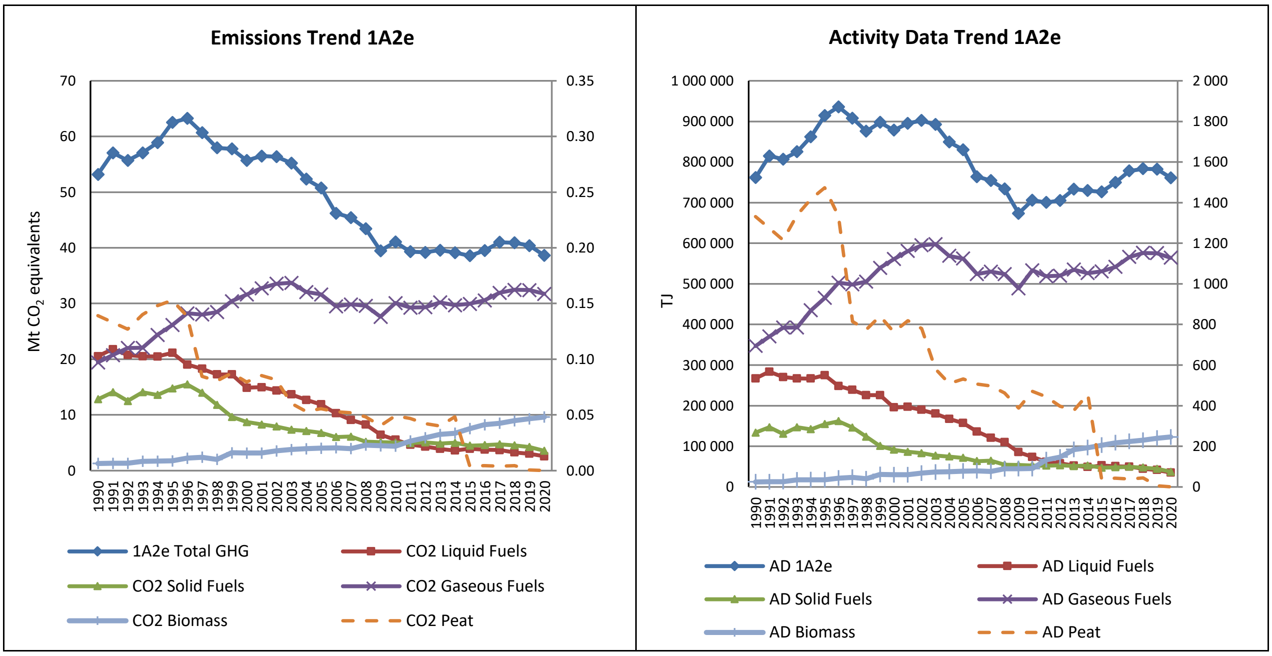
3.2.2.5 Food Processing, Beverages and Tobacco (1.A.2.e)

This chapter provides information about European emission trend, Member States, Iceland and United Kingdom contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.e Food Processing, Beverages and Tobacco.

Total CO_2 emissions from 1.A.2.e amounted to 37 980 kt CO_2 eq. in 2020. The trend of total CO_2 emissions for 1990 to 2020 from category 1.A.2.e is depicted in Figure 3.70. Total CO_2 emissions decreased by 28% since 1990 and by 4% between 2019 and 2020. CO_2 emissions from 1.A.2.e Food Processing, Beverages and Tobacco accounted for 9% of 1.A.2. source category.

Figure 3.70 shows the emission trend within the category 1.A.2.e, which is dominated by CO_2 emissions from gaseous fuels in 2020. The share of liquid fuels on CO_2 emissions from 1.A.2.e decreased from 39% in 1990 to 7% in 2020. The share of solid fuels on CO_2 emissions from 1.A.2.e decreased from 24% in 1990 to 9% in 2020. The share of gaseous fuels on CO_2 emissions from 1.A.2.e increased from 37% in 1990 to 84% in 2020.

Figure 3.70: 1.A.2.e Food Processing, Beverages and Tobacco: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table 3-39. Malta reports emissions as ‘NO’ (not occurring). Four Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emissions was reported by Romania which represent 2% share on total EU-KP emissions.

Table 3-39: 1.A.2.e Food Processing, Beverages and Tobacco: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	870	759	776	2.0%	-94	-11%	17	2%	T1,T2	CS,D
Belgium	3 023	2 479	2 445	6.4%	-578	-19%	-34	-1%	T1,T3	D,PS
Bulgaria	454	228	223	0.6%	-230	-51%	-5	-2%	T1,T2	CS,D
Croatia	729	336	295	0.8%	-435	-60%	-41	-12%	T1	D
Cyprus	73	67	62	0.2%	-11	-15%	-5	-7%	T1	D
Czechia	2 988	882	995	2.6%	-1 993	-67%	113	13%	T1,T2	CS,D
Denmark	1 607	943	869	2.3%	-738	-46%	-74	-8%	T1,T2,T3	CS,D
Estonia	695	94	98	0.3%	-597	-86%	4	4%	T1,T2	CS,D
Finland	828	146	126	0.3%	-701	-85%	-20	-13%	T3	CS,D
France	8 538	8 155	7 234	19.0%	-1 304	-15%	-921	-11%	T2	CS
Germany	2 016	195	188	0.5%	-1 828	-91%	-7	-3%	CS	CS
Greece	917	581	555	1.5%	-362	-39%	-26	-4%	T1,T2	CS,D
Hungary	2 029	798	837	2.2%	-1 192	-59%	39	5%	T1,T2	CS,D
Ireland	1 017	989	1 012	2.7%	-5	-1%	23	2%	T1,T2	CS,D
Italy	3 891	3 455	3 472	9.1%	-419	-11%	18	1%	T2	CS
Latvia	840	89	88	0.2%	-752	-90%	-1	-1%	T1,T2	CS,D
Lithuania	676	233	242	0.6%	-434	-64%	9	4%	T2	CS
Luxembourg	8	33	31	0.1%	22	274%	-2	-7%	T1,T2,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	4 009	3 484	3 434	9.0%	-575	-14%	-50	-1%	T2	CS
Poland	3 715	4 437	4 235	11.1%	520	14%	-202	-5%	T1,T2	CS,D
Portugal	830	756	740	1.9%	-91	-11%	-16	-2%	T1	CR,D
Romania	119	952	930	2.4%	810	680%	-22	-2%	T1,T2,T3	CS,D,PS
Slovakia	1 140	345	342	0.9%	-798	-70%	-3	-1%	T2	CS
Slovenia	221	99	91	0.2%	-130	-59%	-7	-7%	T1,T2	CS,D
Spain	3 005	4 737	4 401	11.6%	1 396	46%	-335	-7%	T1,T2	CS,D
Sweden	948	283	275	0.7%	-673	-71%	-7	-3%	T2	CS
United Kingdom	7 614	4 182	3 982	10.5%	-3 633	-48%	-200	-5%	T2	CS
EU-27+UK	**52 803**	**39 735**	**37 980**	**100%**	**-14 823**	**-28%**	**-1 755**	**-4%**	**-**	**-**
Iceland	128	15	16	0.0%	-113	-88%	0	2%	T1	D
United Kingdom (KP)	7 614	4 182	3 982	10.5%	-3 633	-48%	-200	-5%	T2	CS
EU-KP	**52 931**	**39 751**	**37 996**	**100%**	**-14 936**	**-28%**	**-1 755**	**-4%**	**-**	**-**

Emissions of Malta are included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.e Food Processing, Beverages and Tobacco - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.e amounted 2 565 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 87% and compared to 2019 by 12%. This category represents 0.6% share of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 87% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-40. Malta reports emissions as 'NO' (not occurring). Nine Member States and Iceland use for emission estimates Tier 1 methodology, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 61% of countries emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.e – Liquid Fuels (CO_2)). All countries reported lower level of emissions in 2020 than in 1990 (except for Luxembourg which has 0.8% share on EU-KP emissions).

Table 3-40: 1.A.2.e Food Processing, Beverages and Tobacco, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	345	35	29	1.1%	-315	-91%	-5	-16%	T2	CS
Belgium	1 689	54	69	2.7%	-1 620	-96%	14	27%	T1	D
Bulgaria	409	27	25	1.0%	-384	-94%	-1	-6%	T1	D
Croatia	342	51	44	1.7%	-299	-87%	-7	-14%	T1	D
Cyprus	73	67	62	2.4%	-11	-15%	-5	-7%	T1	D
Czechia	472	19	21	0.8%	-451	-95%	2	10%	T1	CS,D
Denmark	742	183	192	7.4%	-550	-74%	9	5%	T1,T2	CS,D
Estonia	695	37	28	1.1%	-667	-96%	-9	-24%	T1,T2	CS,D
Finland	365	53	69	2.7%	-295	-81%	16	30%	T3	CS
France	2 995	184	174	6.7%	-2 821	-94%	-10	-5%	T2	CS
Germany	908	35	34	1.3%	-874	-96%	-1	-2%	CS	CS
Greece	863	474	443	17.2%	-420	-49%	-31	-7%	T2	CS
Hungary	616	23	32	1.2%	-584	-95%	9	38%	T1	D
Ireland	433	191	189	7.3%	-244	-56%	-2	-1%	T1,T2	CS,D
Italy	1 424	39	50	1.9%	-1 374	-96%	11	29%	T2	CS
Latvia	565	13	9	0.4%	-556	-98%	-4	-30%	T2	CS
Lithuania	174	36	36	1.4%	-138	-79%	0	0%	T2	CS
Luxembourg	4	24	22	0.8%	17	398%	-2	-9%	T1,T3	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	165	0	0	0.0%	-164	-100%	0	389%	NA	NA
Poland	232	207	175	6.8%	-57	-25%	-31	-15%	T1,T2	CS,D
Portugal	829	200	171	6.6%	-659	-79%	-29	-15%	T1	CR,D
Romania	NO	130	118	4.6%	118	∞	-11	-9%	T1,T2,T3	CS,D,PS
Slovakia	359	1	1	0.0%	-358	-100%	0	1%	T2	CS
Slovenia	146	24	19	0.7%	-127	-87%	-5	-22%	T1	D
Spain	2 251	780	539	20.9%	-1 712	-76%	-241	-31%	T1	D
Sweden	596	117	C	-	-596	-100%	-117	-100%	T2	CS
United Kingdom	2 720	20	13	0.5%	-2 707	-100%	-7	-36%	T2	CS
EU-27+UK	**19 815**	**2 906**	**2 565**	**99%**	**-17 251**	**-87%**	**-342**	**-12%**	**-**	**-**
Iceland	128	13	15	0.6%	-114	-89%	1	10%	T1	D
United Kingdom (KP)	2 720	20	13	0.5%	-2 707	-100%	-7	-36%	T2	CS
EU-KP	**19 943**	**2 919**	**2 579**	**100%**	**-17 364**	**-87%**	**-340**	**-12%**	**-**	**-**

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.71 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Spain (21%), Greece (17%), Denmark (7%), Ireland (7%), France (7%), Poland (7%), Portugal (7%) and Romania (5%) which together represent 78% share on EU-KP emissions.

Figure 3.71: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Emission trend and share for CO_2

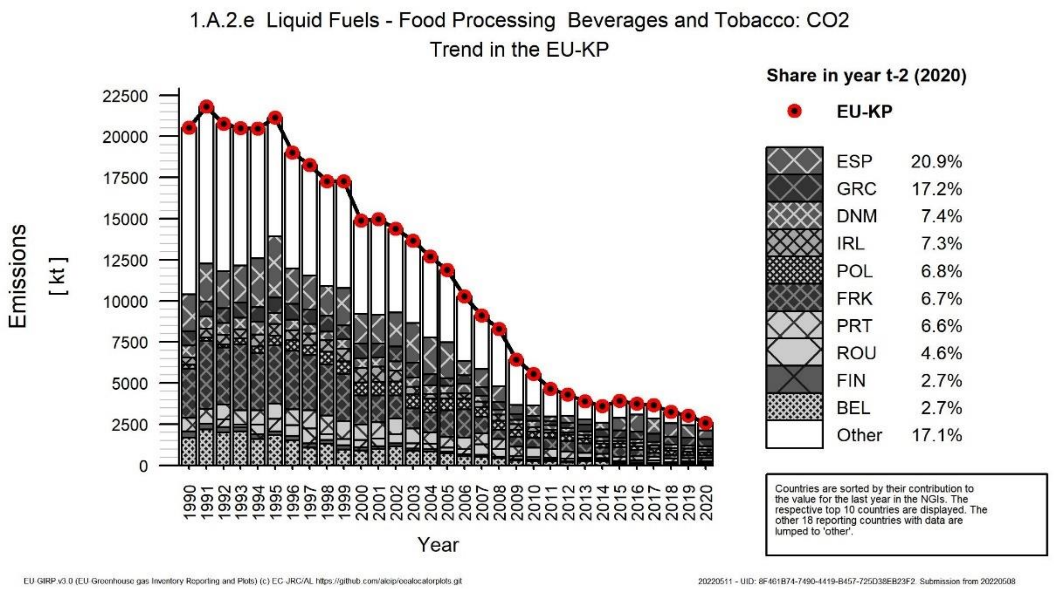


Figure 3.72 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that whole time series CO_2 IEF has decreasing trend with minor fluctuation between 2014 and 2018. CO_2 IEF equalled to 72.30 t/TJ in 2020.

Figure 3.72: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

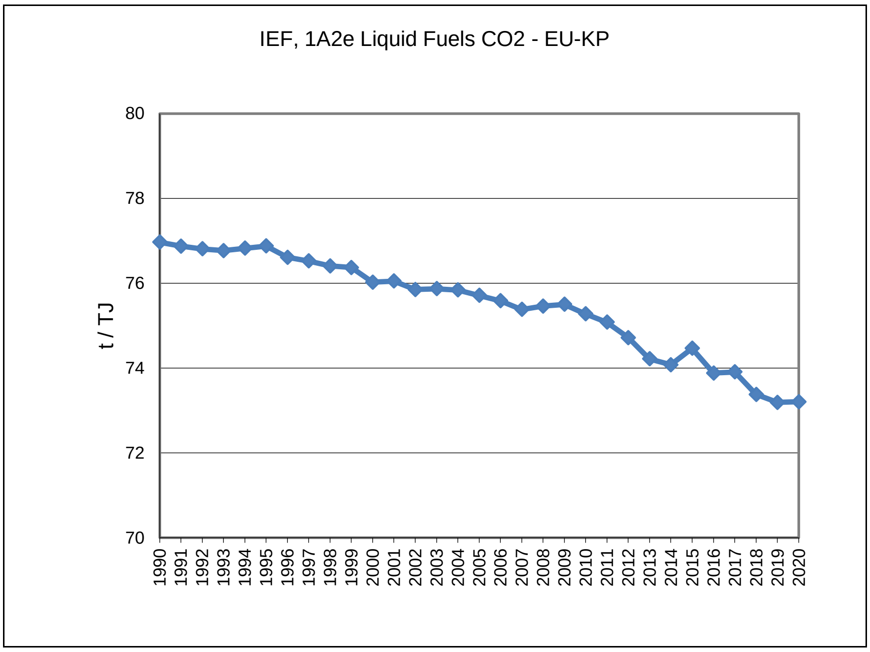
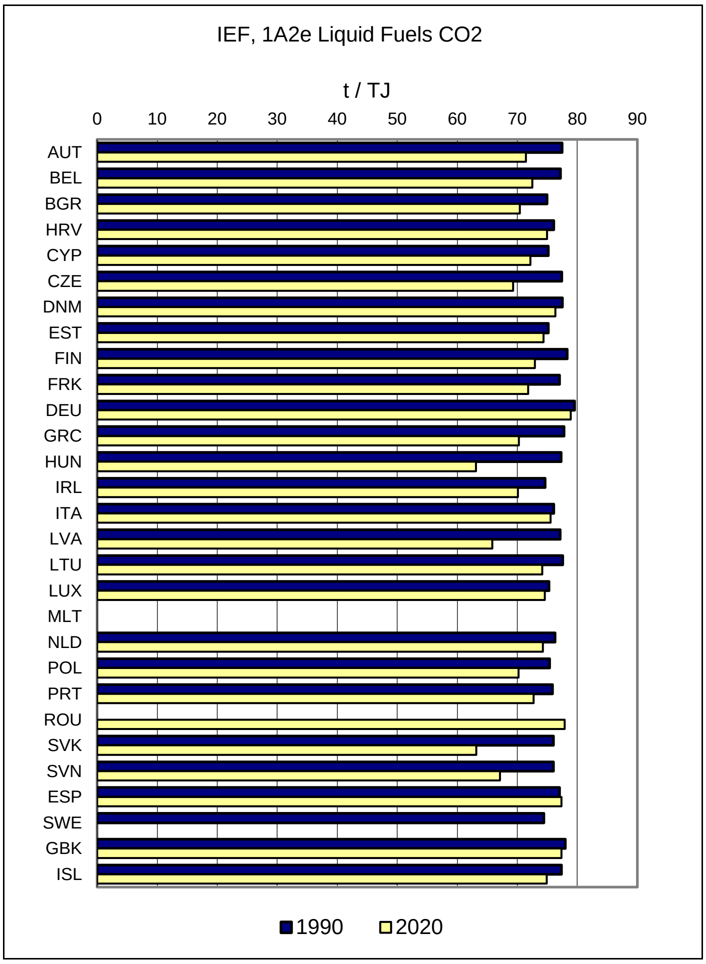


Figure 3.73 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. It can be seen that no major differences between CO_2 IEF used by countries occur. Also, no major differences between CO_2 IEF calculated in 1990 and 2020 occur.

Figure 3.73: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emissions for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.e Food Processing Beverages and Tobacco - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.e amounted 3 564 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 72% and compared to 2019 by 16%. This category represents 0.8% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 72% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-41. Nine Member States and Iceland report emissions as 'NO' (not occurring). Belgium, Croatia and Denmark use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 94% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.e – Solid Fuels (CO_2)). All countries reported lower level of emissions in 2020 than in 1990.

Table 3-41: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	18	13	12	0.3%	-6	-34%	-1	-7%	T2	CS
Belgium	651	118	88	2.5%	-562	-86%	-30	-25%	T1	D
Bulgaria	33	6	4	0.1%	-29	-89%	-2	-33%	T1,T2	CS,D
Croatia	207	49	32	0.9%	-174	-84%	-17	-34%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 789	175	180	5.0%	-1 609	-90%	5	3%	T2	CS,D
Denmark	399	110	93	2.6%	-306	-77%	-17	-16%	T1	D
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	257	75	36	1.0%	-221	-86%	-39	-52%	T3	CS
France	2 083	923	489	13.7%	-1 594	-77%	-434	-47%	T2	CS
Germany	1 108	159	154	4.3%	-954	-86%	-6	-4%	CS	CS
Greece	54	NO	NO	-	-54	-100%	-	-	NA	NA
Hungary	185	6	6	0.2%	-179	-97%	0	0%	T1,T2	CS,D
Ireland	292	NO	NO	-	-292	-100%	-	-	NA	NA
Italy	87	NO	NO	-	-87	-100%	-	-	NA	NA
Latvia	100	1	2	0.0%	-99	-98%	0	21%	T2	CS
Lithuania	33	7	10	0.3%	-23	-69%	3	47%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	227	96	71	2.0%	-156	-69%	-26	-27%	T2	CS
Poland	3 374	2 267	2 158	60.6%	-1 216	-36%	-108	-5%	T1,T2	CS,D
Portugal	1	NO	NO	-	-1	-100%	-	-	NA	NA
Romania	119	6	5	0.1%	-114	-96%	-1	-13%	T2,T3	CS,PS
Slovakia	312	48	47	1.3%	-265	-85%	-1	-2%	T2	CS
Slovenia	9	NO	NO	-	-9	-100%	-	-	NA	NA
Spain	94	23	23	0.6%	-71	-76%	0	0%	T1,T2	CS,D
Sweden	90	9	11	0.3%	-79	-88%	2	17%	T2	CS
United Kingdom	1 289	154	143	4.0%	-1 146	-89%	-10	-7%	T2	CS
EU-27+UK	**12 812**	**4 246**	**3 564**	**100%**	**-9 247**	**-72%**	**-682**	**-16%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 289	154	143	4.0%	-1 146	-89%	-10	-7%	T2	CS
EU-KP	**12 812**	**4 246**	**3 564**	**100%**	**-9 247**	**-72%**	**-682**	**-16%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.74 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland (61%) and France (14%) which together represent 75% share on EU-KP emissions.

Figure 3.74: 1.A.2.e Food Processing, Beverages and Tobacco, solid fuels: Emission trend and share for CO_2

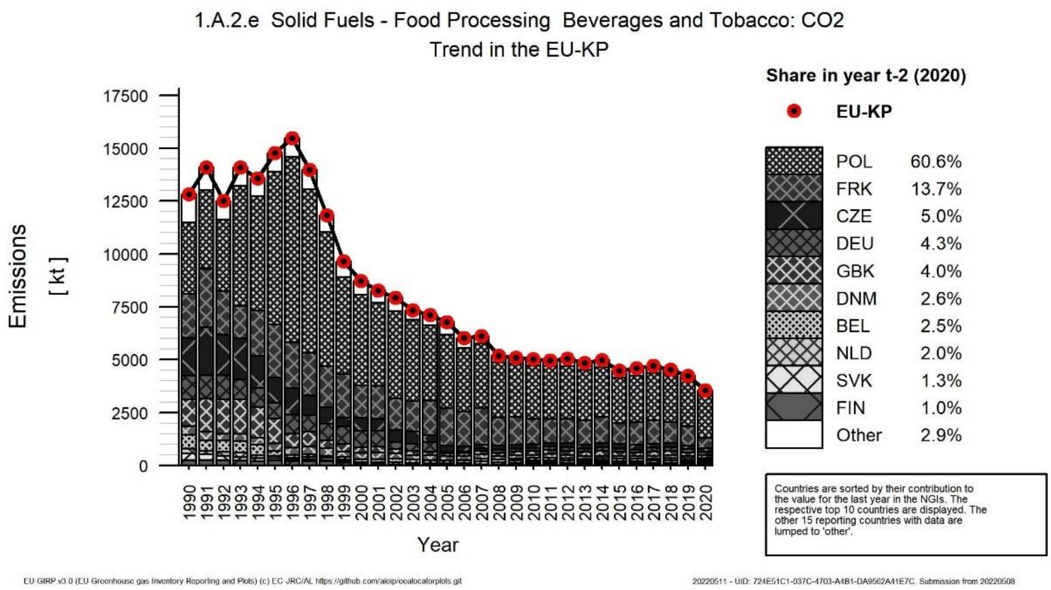


Figure 3.75 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that CO_2 IEF is relatively stable during whole time period with slightly increasing trend since 2006. CO_2 IEF equalled to 95.41 t/TJ in 2020.

Figure 3.75: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

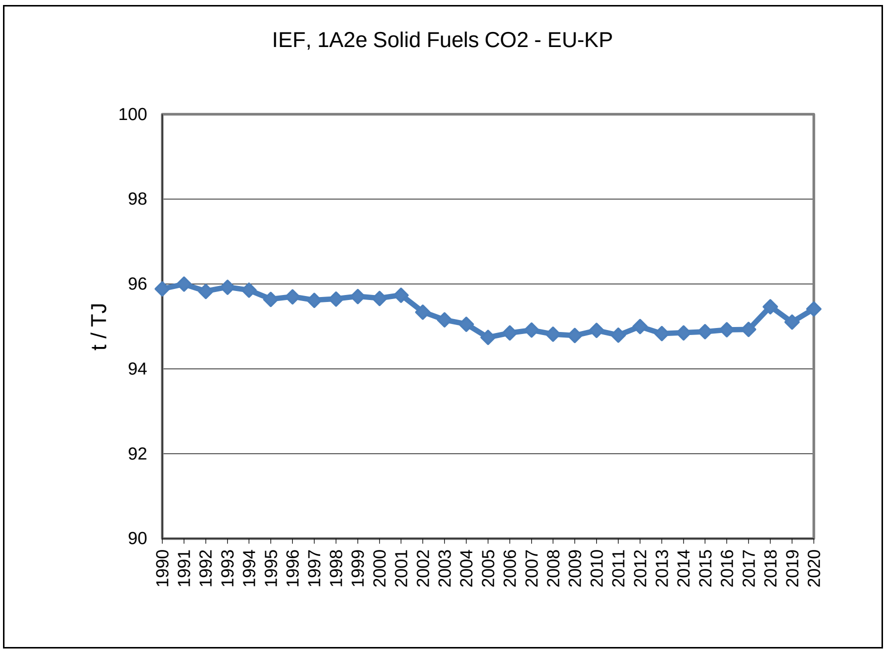
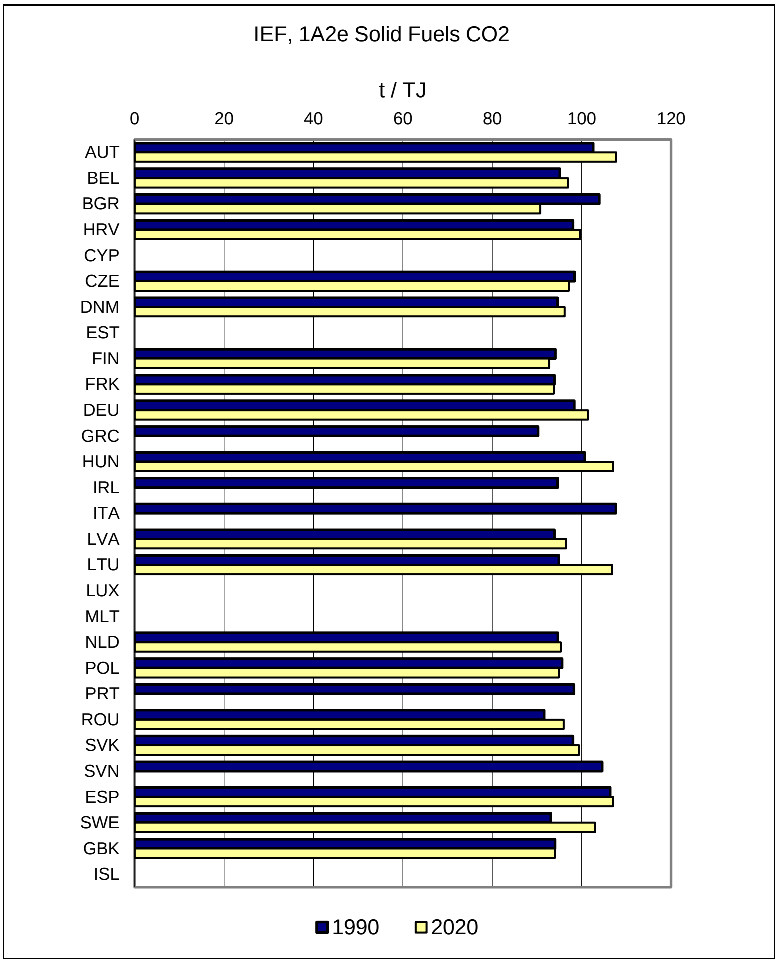


Figure 3.76 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020.

Figure 3.76: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.e Food Processing Beverages and Tobacco - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.e amounted 31 732 kt in 2020 for EU-KP. CO_2 emissions increased compared to year 1990 by 63% and decreased by 2% compared to 2019. This category represents 7.1% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 62% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-42. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). For confidentiality reasons Germany reports emissions in 1.A.2.g. Croatia and Portugal use Tier 1 methodology for emission estimates, the rest of Member States use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 98% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.e – Gaseous Fuels (CO_2)). Seven Member States reported lower level of emissions in 2020 than in 1990, the rest of countries reported increase of emissions.

Table 3-42: 1.A.2.e Food Processing, Beverages and Tobacco, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	507	712	735	2.3%	228	45%	23	3%	T2	CS
Belgium	684	2 307	2 288	7.2%	1 604	234%	-18	-1%	T1,T3	D,PS
Bulgaria	11	196	194	0.6%	183	1600%	-1	-1%	T2	CS
Croatia	180	236	219	0.7%	38	21%	-17	-7%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	727	687	794	2.5%	67	9%	106	15%	T2	CS
Denmark	466	650	584	1.8%	119	25%	-65	-10%	T3	CS
Estonia	NO	57	70	0.2%	70	∞	13	22%	T2	CS
Finland	67	17	21	0.1%	-46	-69%	4	21%	T3	CS
France	3 460	7 026	6 571	20.7%	3 112	90%	-454	-6%	T2	CS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	107	112	0.4%	112	∞	5	5%	T2	CS
Hungary	1 228	769	799	2.5%	-429	-35%	30	4%	T2	CS
Ireland	293	798	824	2.6%	530	181%	25	3%	T2	CS
Italy	2 380	3 416	3 422	10.8%	1 042	44%	6	0%	T2	CS
Latvia	175	74	77	0.2%	-98	-56%	3	4%	T2	CS
Lithuania	469	190	196	0.6%	-273	-58%	6	3%	T2	CS
Luxembourg	4	9	9	0.0%	5	132%	0	-4%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 617	3 387	3 363	10.6%	-254	-7%	-25	-1%	T2	CS
Poland	109	1 963	1 901	6.0%	1 792	1645%	-62	-3%	T2	CS
Portugal	NO	557	569	1.8%	569	∞	13	2%	T1	D
Romania	NO	792	782	2.5%	782	∞	-11	-1%	T2,T3	CS,PS
Slovakia	470	296	294	0.9%	-176	-37%	-2	-1%	T2	CS
Slovenia	66	74	72	0.2%	6	10%	-2	-2%	T2	CS
Spain	661	3 934	3 840	12.1%	3 179	481%	-94	-2%	T2	CS
Sweden	254	157	171	0.5%	-83	-33%	14	9%	T2	CS
United Kingdom	3 605	4 007	3 825	12.1%	221	6%	-182	-5%	T2	CS
EU-27+UK	**19 432**	**32 418**	**31 732**	**100%**	**12 300**	**63%**	**-686**	**-2%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 605	4 007	3 825	12.1%	221	6%	-182	-5%	T2	CS
EU-KP	**19 432**	**32 418**	**31 732**	**100%**	**12 300**	**63%**	**-686**	**-2%**	**-**	**-**

Emissions of Germany included in 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.77 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to France (21%), Spain (12%), United Kingdom (12%), Italy (10%), Netherland (10%), Belgium (7%) and Poland (6%) which together represent 79% share on EU-KP emissions.

Figure 3.77: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Emission trend and share for CO_2

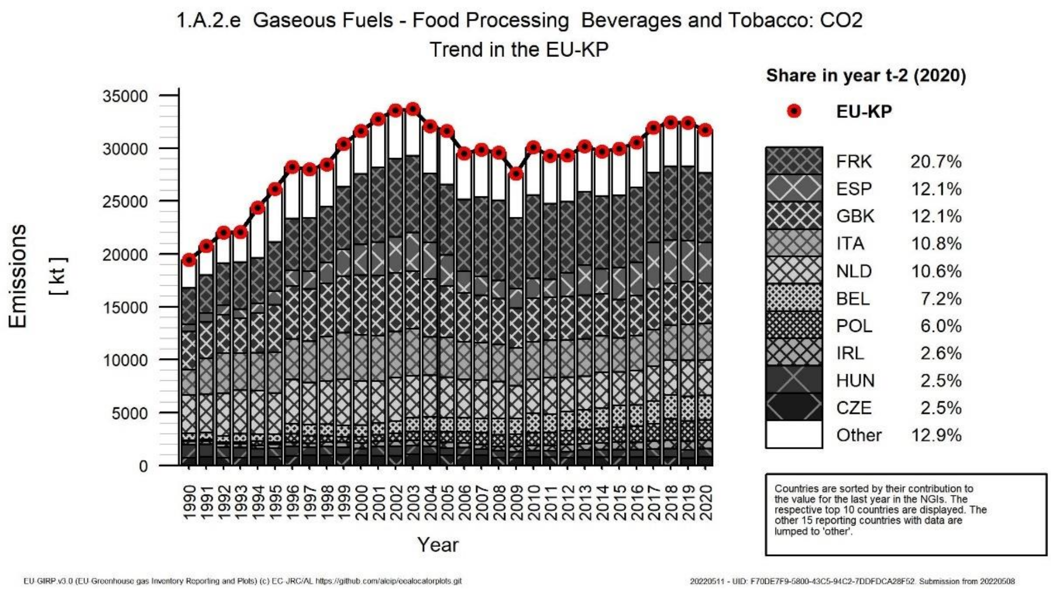


Figure 3.78 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020 which is stable during whole time period. CO_2 IEF equalled to 56.25 t/TJ in 2020.

Figure 3.78: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

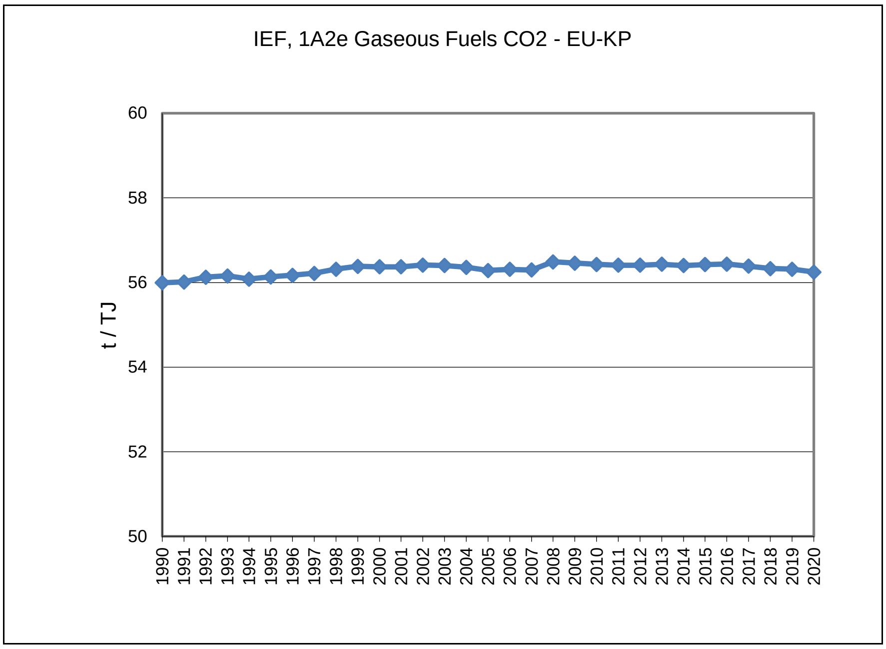
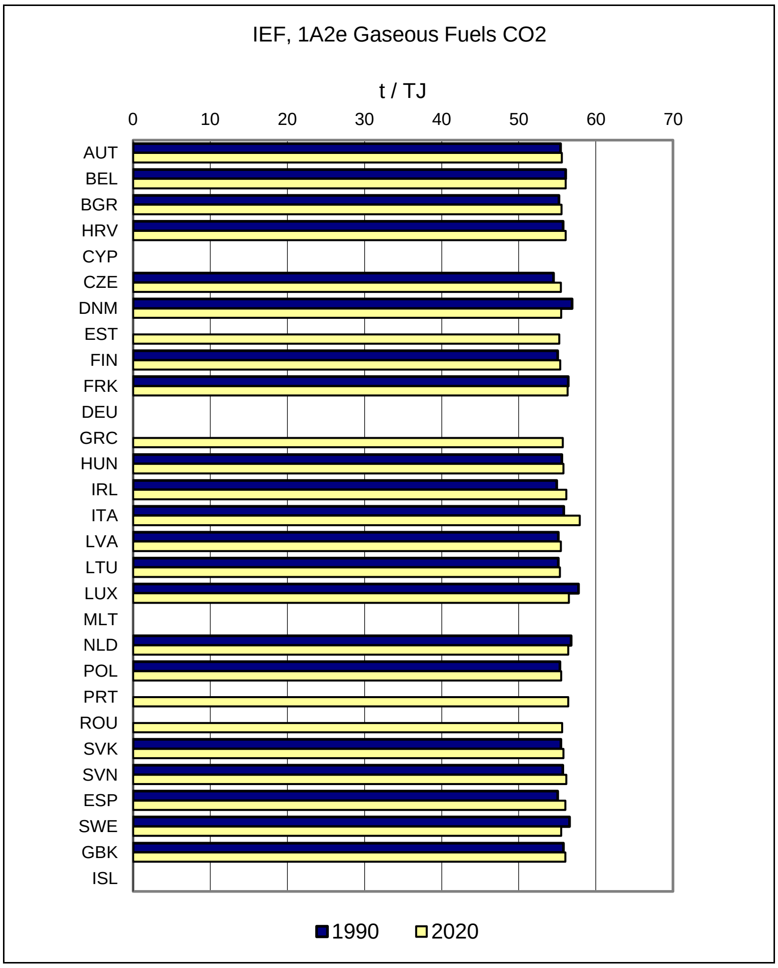


Figure 3.79 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2020 occur.

Figure 3.79: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



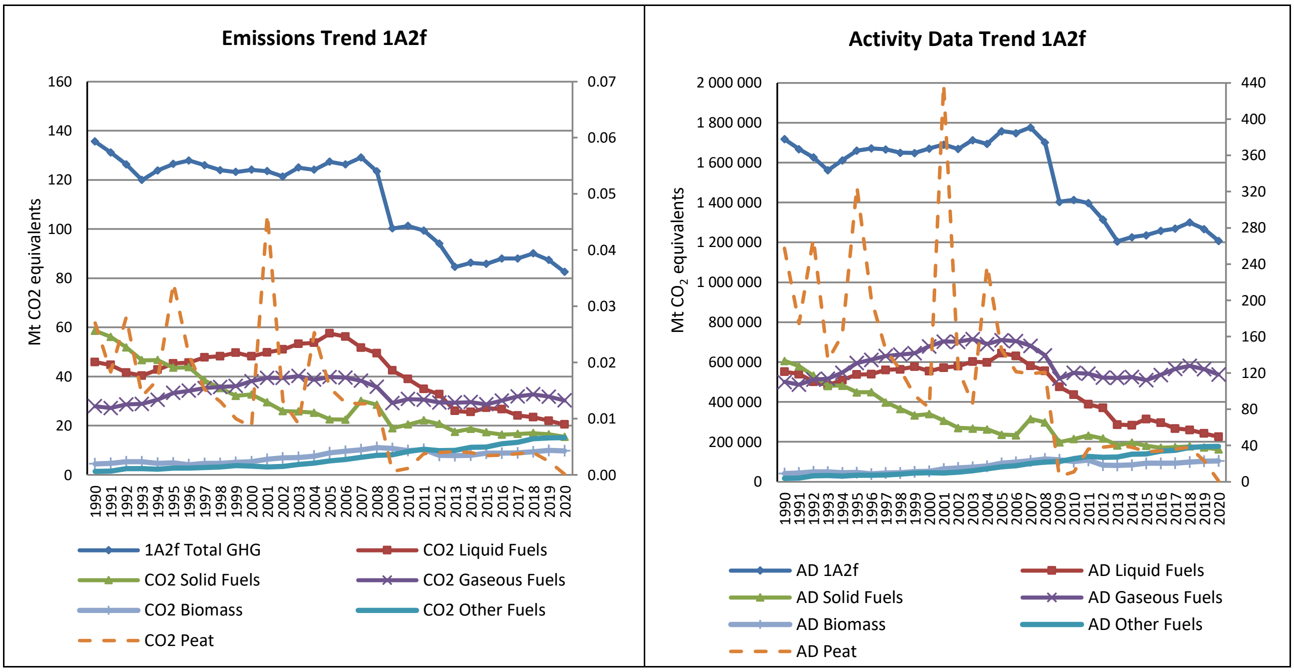
3.2.2.6 Non-metallic Minerals (1.A.2.f)

This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.f Non-metallic Minerals.

Total CO_2 emissions from 1.A.2.f amounted to 81 410 kt CO_2 eq. in 2020. The trend of total emissions for 1990 to 2020 from category 1.A.2.f is depicted in Figure 3.80. Total CO_2 emissions decreased by 39% since 1990 and by 6% between 2019 and 2020. The sharp decline in 2009 is due to the economic crisis and sharp decline in building activity. CO_2 emissions from 1.A.2.f Non-metallic Minerals accounted for 18% of 1.A.2. source category.

Figure 3.80 shows the emission trend within the category 1.A.2.f, which is dominated by CO_2 emissions from gaseous fuels in 2020. The share of liquid fuels on CO_2 emissions from 1.A.2.f decreased from 34% in 1990 to 25% in 2020. The share of solid fuels on CO_2 emissions from 1.A.2.f decreased from 44% in 1990 to 19% in 2020. The share of gaseous fuels on CO_2 emissions from 1.A.2.f increased from 21% in 1990 to 37% in 2020.

Figure 3.80: 1.A.2.f Non-metallic Minerals: Activity data and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table.3-43. Malta reports emissions as 'NO' (not occurring). Five Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emission was reported by Romania (1 243%) which represents 4.5% share on total EU-KP emissions.

Table.3-43: 1.A.2.f Non-metallic Minerals: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 669	1 664	1 654	2.0%	-15	-1%	-9	-1%	T1,T2	CS,D
Belgium	5 525	3 442	3 053	3.8%	-2 472	-45%	-389	-11%	T1,T3	D,PS
Bulgaria	2 646	1 030	1 011	1.2%	-1 635	-62%	-19	-2%	T1,T2	CS,D
Croatia	1 924	1 280	1 257	1.5%	-667	-35%	-22	-2%	T1	D
Cyprus	380	413	431	0.5%	51	14%	18	4%	CS,T1	CS,D
Czechia	4 527	2 730	2 628	3.2%	-1 899	-42%	-101	-4%	T1,T2	CS,D
Denmark	1 325	1 501	1 519	1.9%	194	15%	18	1%	T1,T2,T3	CS,D,PS
Estonia	1 053	311	114	0.1%	-939	-89%	-197	-63%	T1,T2,T3	CS,D,PS
Finland	1 368	578	568	0.7%	-800	-58%	-10	-2%	T3	CS,D
France	15 223	9 499	8 752	10.8%	-6 471	-43%	-747	-8%	T2,T3	CS,PS
Germany	18 507	12 856	12 587	15.5%	-5 920	-32%	-269	-2%	CS	CS
Greece	6 278	2 989	2 719	3.3%	-3 560	-57%	-271	-9%	T1,T2	CS,D,PS
Hungary	2 341	1 268	1 092	1.3%	-1 249	-53%	-176	-14%	T1,T2,T3	CS,D,PS
Ireland	819	1 207	1 162	1.4%	343	42%	-44	-4%	T1,T2,T3	CS,D,PS
Italy	21 045	10 915	10 347	12.7%	-10 699	-51%	-569	-5%	T2	CS
Latvia	599	305	292	0.4%	-307	-51%	-12	-4%	T1,T2	CS,D,PS
Lithuania	3 210	489	414	0.5%	-2 796	-87%	-75	-15%	T2	CS,OTH
Luxembourg	537	428	373	0.5%	-164	-31%	-56	-13%	T1,T2,T3	CS,D,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2 298	1 077	1 008	1.2%	-1 289	-56%	-69	-6%	T2	CS
Poland	10 340	9 573	9 223	11.3%	-1 117	-11%	-350	-4%	T1,T2	CS,D
Portugal	3 289	2 629	2 605	3.2%	-684	-21%	-24	-1%	T1,T3	D,PS
Romania	271	3 194	3 643	4.5%	3 372	1243%	450	14%	T1,T2,T3	CS,D,PS
Slovakia	3 408	1 446	1 408	1.7%	-2 000	-59%	-38	-3%	T2	CS
Slovenia	297	468	435	0.5%	138	46%	-33	-7%	T1,T2,T3	CS,D,PS
Spain	16 529	11 149	9 756	12.0%	-6 773	-41%	-1 394	-12%	T1,T2	CS,D,PS
Sweden	1 826	1 151	1 083	1.3%	-743	-41%	-68	-6%	T1,T2	CS
United Kingdom	6 599	2 573	2 275	2.8%	-4 324	-66%	-298	-12%	T2	CS
EU-27+UK	**133 834**	**86 165**	**81 410**	**100%**	**-52 424**	**-39%**	**-4 755**	**-6%**	**-**	**-**
Iceland	47	0	0	0.0%	-47	-99%	0	-2%	T1	D
United Kingdom (KP)	6 599	2 573	2 275	2.8%	-4 324	-66%	-298	-12%	T2	CS
EU-KP	**133 881**	**86 166**	**81 411**	**100%**	**-52 471**	**-39%**	**-4 755**	**-6%**	**-**	**-**

Malta includes emissions under 1.A.2.g.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1.A.2.f Non-metallic Minerals - Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.f amounted 20 479 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 55% and compared to 2019 by 7%. Category has 4.6% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 59% compared to 1990. One of the reasons for the decline is increase in the use of waste as a fuel.

Detailed data related to the EU-KP submissions are depicted in Table **3-44**. Sweden reports emissions as 'C' (confidential) since 2016 in order to comply with the Public Access to Information and Secrecy Act of the Swedish law. This decision was made based on the results of the internal review. Malta reports emissions as 'NO' (not occurring). Four Member States and Iceland use Tier 1 methodology for emission estimates, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 95% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Liquid Fuels (CO_2)). Four Member States reported higher level of emissions in 2020 than in 1990.

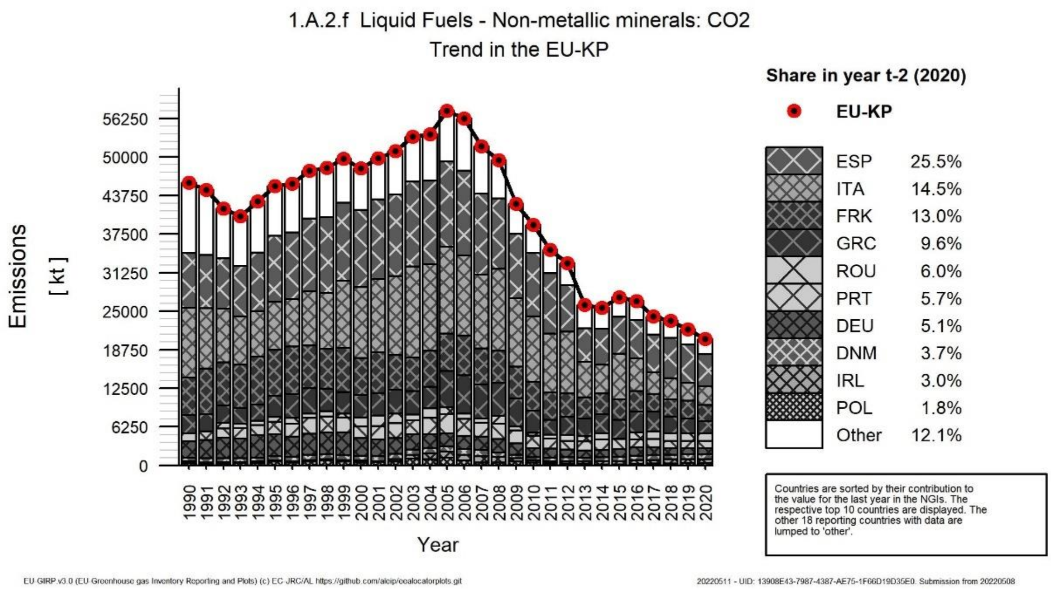
Table 3-44: 1.A.2.f Non-metallic Minerals , liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	508	106	79	0.4%	-429	-84%	-27	-25%	T2	CS
Belgium	1 509	316	288	1.4%	-1 221	-81%	-28	-9%	T1,T3	D,PS
Bulgaria	666	247	241	1.2%	-426	-64%	-6	-2%	T1	D
Croatia	745	512	354	1.7%	-391	-53%	-158	-31%	T1	D
Cyprus	148	219	215	1.0%	67	45%	-4	-2%	CS	CS
Czechia	1 029	19	44	0.2%	-986	-96%	25	132%	T1	CS,D
Denmark	514	749	764	3.7%	250	49%	14	2%	T1,T2	CS,D
Estonia	448	1	0	0.0%	-448	-100%	-1	-85%	T1,T2	CS,D
Finland	437	247	263	1.3%	-173	-40%	16	7%	T3	CS
France	6 080	2 842	2 654	13.0%	-3 426	-56%	-188	-7%	T2,T3	CS,PS
Germany	2 663	1 041	1 038	5.1%	-1 625	-61%	-3	0%	CS	CS
Greece	2 914	2 393	1 968	9.6%	-946	-32%	-425	-18%	T2	PS
Hungary	453	390	294	1.4%	-159	-35%	-95	-24%	T1,T2	CS,D
Ireland	312	635	615	3.0%	303	97%	-19	-3%	T1,T2	CS,D
Italy	11 359	2 878	2 974	14.5%	-8 385	-74%	97	3%	T2	CS
Latvia	267	0	6	0.0%	-261	-98%	6	1470%	T2	CS
Lithuania	2 750	10	10	0.0%	-2 740	-100%	0	3%	T2	CS
Luxembourg	23	17	16	0.1%	-7	-30%	-1	-7%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	468	0	0	0.0%	-468	-100%	0	50%	-	-
Poland	394	368	367	1.8%	-28	-7%	-1	0%	T1,T2	CS,D
Portugal	1 319	1 145	1 176	5.7%	-142	-11%	31	3%	T1,T3	D,PS
Romania	NO	1 278	1 220	6.0%	1 220	∞	-59	-5%	T1,T2,T3	CS,D,PS
Slovakia	1 219	219	219	1.1%	-1 001	-82%	0	0%	T2	CS
Slovenia	63	118	135	0.7%	72	114%	17	15%	T1	D
Spain	8 819	6 221	5 230	25.5%	-3 589	-41%	-991	-16%	T1,T2	CS,D
Sweden	625	C	266	1.3%	-360	-57%	266	∞	T1	CS
United Kingdom	127	56	44	0.2%	-83	-65%	-12	-22%	T2	CS
EU-27+UK	**45 860**	**22 025**	**20 479**	**100%**	**-25 382**	**-55%**	**-1 547**	**-7%**	**-**	**-**
Iceland	2	0	0	0.0%	-2	-80%	0	-2%	T1	D
United Kingdom (KP)	127	56	44	0.2%	-83	-65%	-12	-22%	T2	CS
EU-KP	**45 862**	**22 026**	**20 479**	**100%**	**-25 383**	**-55%**	**-1 547**	**-7%**	**-**	**-**

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure.3.81 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) has Spain (25.5%), Italy (14.5%), France (13%), Greece (10%), Romania (6%), Portugal (6%) and Germany (5%) which together have 83% share on EU-KP emissions.

Figure.3.81: 1.A.2.f Non-metallic Minerals, liquid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden.

Figure.3.82 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that CO_2 IEF increased significantly compared to CO_2 IEF calculated for 1990. The high CO_2 IEF in recent years is caused mainly due to the increased consumption of petrol coke in cement kilns. Between the years 2012 to 2017 strong fluctuation of EU-KP CO_2 IEF. CO_2 IEF equalled to 90.75 t/TJ in 2020.

Figure.3.82: 1.A.2.f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

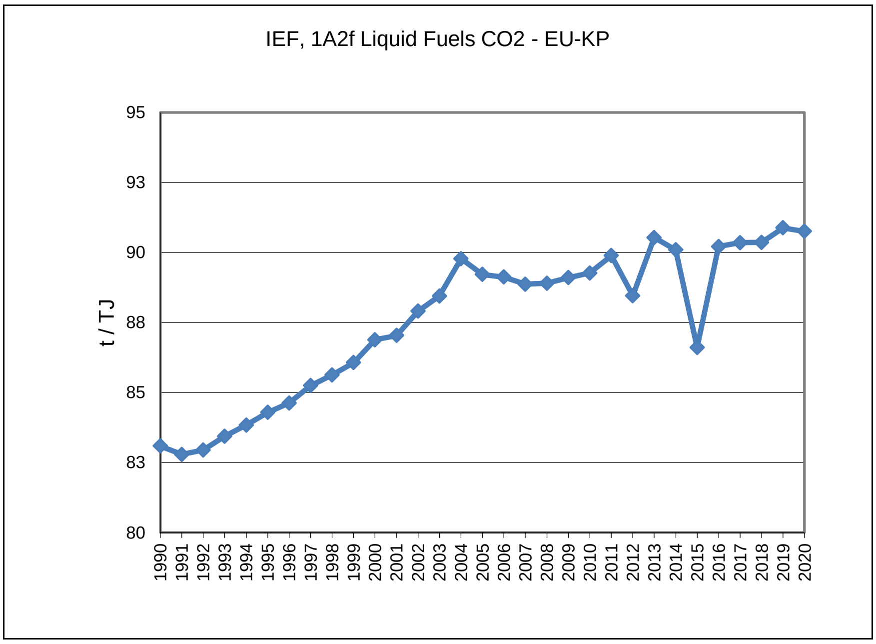
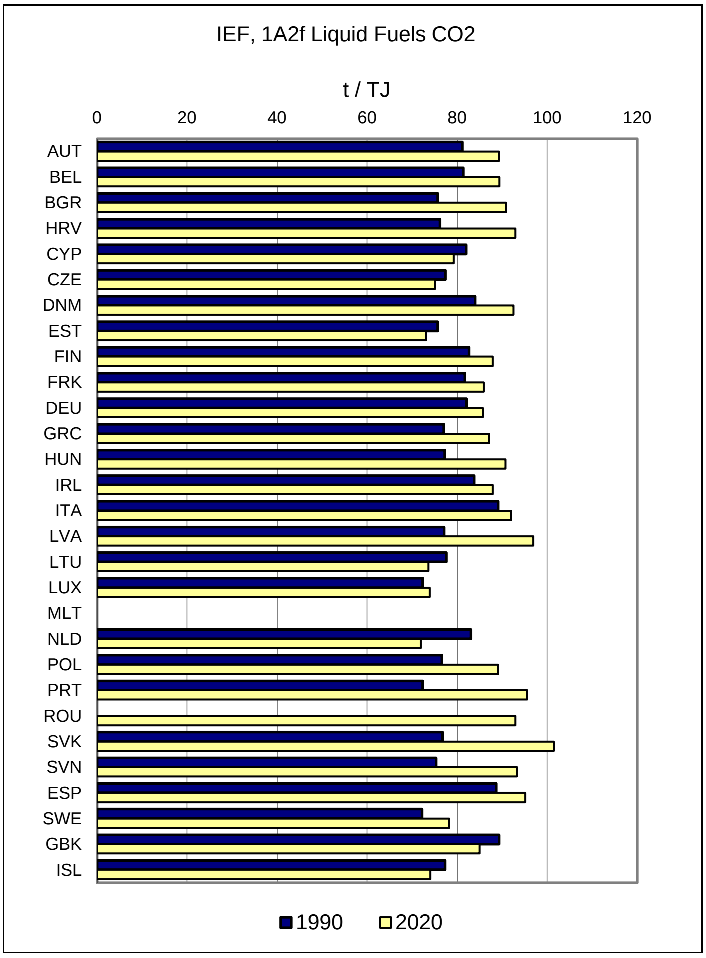


Figure 3.83 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. The CO_2 IEF is in many cases higher in 2020 than in 1990 which reflects reasons for relatively high CO_2 IEF mentioned above.

Figure 3.83: 1.A.2.f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.f Non-metallic Minerals - Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.f amounted 15 049 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 74% and compared to 2019 by 9%. This category represents 3.5% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 73% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-45. Malta and Iceland report emissions as 'NO' (not occurring). Sweden reports emissions as 'C' (confidential). Croatia and Luxembourg use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 97% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Solid Fuels (CO_2)). Latvia, Lithuania and Romania reported higher level of emissions in 2020 than in 1990 (it should be noted that the share of their emissions on total EU-KP emissions is together only 7%).

Table 3-45: 1.A.2.f Non-metallic Minerals, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	535	234	311	2.1%	-225	-42%	76	32%	T2	CS
Belgium	2 466	1 477	1 200	8.0%	-1 266	-51%	-277	-19%	T1,T3	D,PS
Bulgaria	295	177	111	0.7%	-184	-62%	-66	-37%	T1,T2	CS,D
Croatia	535	303	388	2.6%	-146	-27%	85	28%	T1	D
Cyprus	232	68	68	0.5%	-164	-71%	0	0%	CS	CS
Czechia	2 209	737	592	3.9%	-1 617	-73%	-145	-20%	T2	CS,D
Denmark	574	297	319	2.1%	-255	-44%	22	7%	T1,T3	D,PS
Estonia	595	188	25	0.2%	-570	-96%	-163	-87%	T2,T3	CS,PS
Finland	806	222	191	1.3%	-615	-76%	-31	-14%	T3	CS
France	4 970	845	704	4.7%	-4 266	-86%	-141	-17%	T2,T3	CS,PS
Germany	12 053	4 290	4 269	28.4%	-7 785	-65%	-21	0%	CS	CS
Greece	3 364	273	306	2.0%	-3 059	-91%	33	12%	T2	PS
Hungary	230	106	105	0.7%	-125	-55%	-1	-1%	T1,T2	D,PS
Ireland	375	313	301	2.0%	-73	-20%	-12	-4%	T2	CS
Italy	3 690	881	642	4.3%	-3 048	-83%	-239	-27%	T2	CS
Latvia	16	114	76	0.5%	60	372%	-39	-34%	T2	CS
Lithuania	60	416	348	2.3%	288	484%	-68	-16%	T2	CS
Luxembourg	312	158	129	0.9%	-184	-59%	-29	-18%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	346	134	119	0.8%	-227	-66%	-15	-11%	T2	CS
Poland	8 576	2 237	2 116	14.1%	-6 461	-75%	-122	-5%	T1,T2	CS,D
Portugal	1 958	11	18	0.1%	-1 940	-99%	7	66%	T1,T3	D,PS
Romania	271	699	710	4.7%	439	162%	11	2%	T2,T3	CS,PS
Slovakia	1 474	507	475	3.2%	-999	-68%	-32	-6%	T2	CS
Slovenia	113	47	47	0.3%	-66	-59%	-1	-1%	T1,T3	D,PS
Spain	5 221	181	117	0.8%	-5 104	-98%	-64	-35%	T1,T2	CS,D
Sweden	1 135	C	436	2.9%	-700	-62%	436	∞	T2	CS
United Kingdom	6 174	1 577	1 363	9.1%	-4 811	-78%	-214	-14%	T2	CS
EU-27+UK	**57 451**	**16 495**	**15 049**	**100%**	**-42 402**	**-74%**	**-1 446**	**-9%**	**-**	**-**
Iceland	45	NO	NO	-	-45	-100%	-	-	NA	NA
United Kingdom (KP)	6 174	1 577	1 363	9.1%	-4 811	-78%	-214	-14%	T2	CS
EU-KP	**57 496**	**16 495**	**15 049**	**100%**	**-42 447**	**-74%**	**-1 446**	**-9%**	**-**	**-**

EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.84 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (28%), Poland (14%), United Kingdom (9%), Belgium (8%), Romania (5%), France (5%) and Italy (4%) which together represent 73% share on EU-KP emissions.

Figure 3.84: 1.A.2.f Non-metallic Minerals, solid fuels: Emission trend and share for CO_2

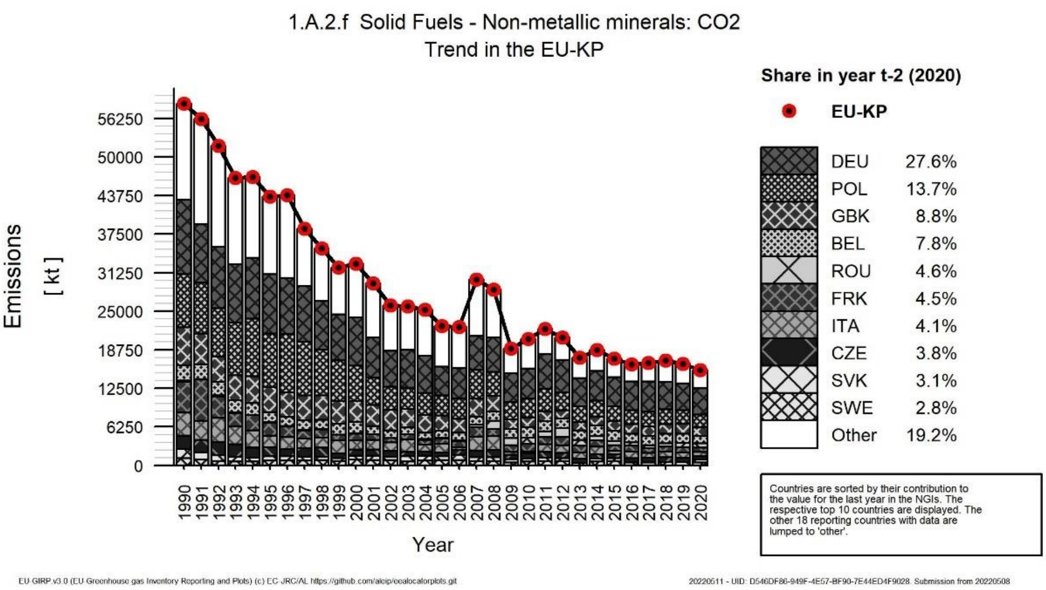


Figure 3.85 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. The IEF has slightly decreasing trend with minor fluctuations. CO_2 IEF equalled to 95.49 t/TJ in 2020.

Figure 3.85: 1.A.2.f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

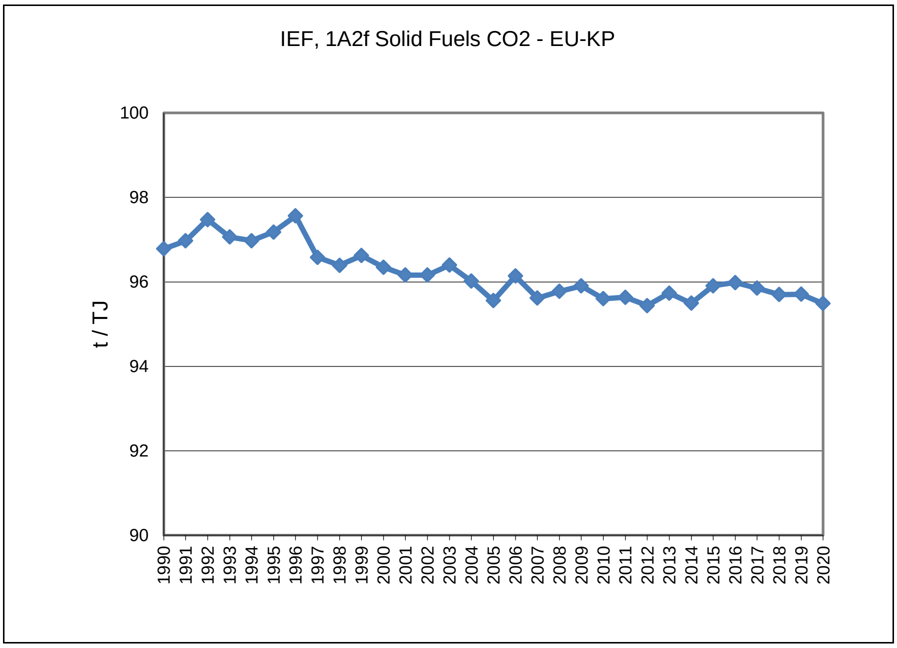
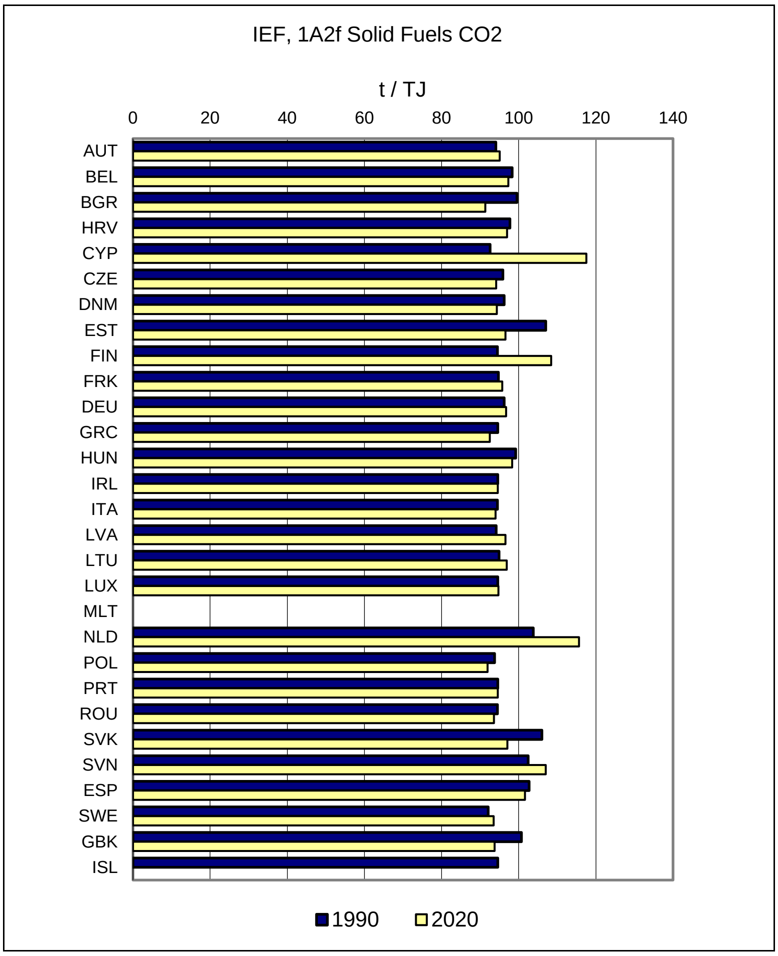


Figure 3.86 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2020 occur. Except for Netherlands where strong increase in 2019 IEF is caused by change in fuel composition; lignite consumption decreased by 92% and this resulted in bigger share of cokes with IEF 120 t/TJ in 2019.

Figure 3.86: 1.A.2.f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.f Non-metallic Minerals - Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.f amounted 30 278 kt in 2020 for EU-KP. CO_2 emissions increased compared to year 1990 by 8% and decreased compared to 2019 by 5%. This category represents 6.8% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 5% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-46. Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Two Member States use Tier 1 methodology for emission estimates, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 99% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Gaseous Fuels (CO_2)). Nine Member States reported higher level of emissions in 2020 than in 1990.

Table 3-46: 1.A.2.f Non-metallic Minerals, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	559	701	699	2.3%	140	25%	-2	0%	T2	CS
Belgium	1 364	1 221	1 153	3.8%	-211	-15%	-68	-6%	T1,T3	D,PS
Bulgaria	1 684	606	659	2.2%	-1 025	-61%	53	9%	T2	CS
Croatia	645	304	282	0.9%	-362	-56%	-21	-7%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 289	1 323	1 412	4.7%	123	10%	89	7%	T2	CS
Denmark	237	267	232	0.8%	-6	-2%	-35	-13%	T3	CS
Estonia	NO	26	22	0.1%	22	∞	-4	-14%	T2	CS
Finland	126	58	56	0.2%	-69	-55%	-2	-4%	T3	CS
France	3 840	4 664	4 355	14.4%	515	13%	-308	-7%	T2,T3	CS,PS
Germany	3 265	4 536	4 289	14.2%	1 023	31%	-248	-5%	CS	CS
Greece	NO	145	259	0.9%	259	∞	114	78%	T2	CS
Hungary	1 658	486	453	1.5%	-1 205	-73%	-33	-7%	T2	CS
Ireland	132	60	61	0.2%	-71	-54%	1	2%	T2	CS
Italy	5 996	6 607	6 258	20.7%	262	4%	-349	-5%	T2	CS
Latvia	316	70	71	0.2%	-245	-77%	2	2%	T2	CS
Lithuania	382	53	50	0.2%	-332	-87%	-3	-5%	T2	CS
Luxembourg	201	164	120	0.4%	-82	-41%	-45	-27%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 484	944	889	2.9%	-594	-40%	-55	-6%	T2	CS
Poland	1 359	2 569	2 461	8.1%	1 102	81%	-107	-4%	T2	CS
Portugal	NO	1 195	1 096	3.6%	1 096	∞	-98	-8%	T1,T3	D,PS
Romania	NO	770	735	2.4%	735	∞	-35	-5%	T2,T3	CS,PS
Slovakia	542	391	387	1.3%	-155	-29%	-4	-1%	T2	CS
Slovenia	116	184	146	0.5%	31	26%	-37	-20%	T2	CS
Spain	2 370	4 059	3 763	12.4%	1 393	59%	-296	-7%	T2	CS
Sweden	65	115	114	0.4%	49	75%	-1	-1%	T1	CS
United Kingdom	297	267	255	0.8%	-42	-14%	-13	-5%	T2	CS
EU-27+UK	**27 928**	**31 783**	**30 278**	**100%**	**2 350**	**8%**	**-1 504**	**-5%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	297	267	255	0.8%	-42	-14%	-13	-5%	T2	CS
EU-KP	**27 928**	**31 783**	**30 278**	**100%**	**2 350**	**8%**	**-1 504**	**-5%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.87 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Italy (21%), France (14%), Germany (14%), Spain (12%), Poland (8%) and Czechia (5%) which together represent 74% share on EU-KP emissions.

Figure 3.87: 1.A.2.f Non-metallic Minerals, gaseous fuels: Emission trend and share for CO_2

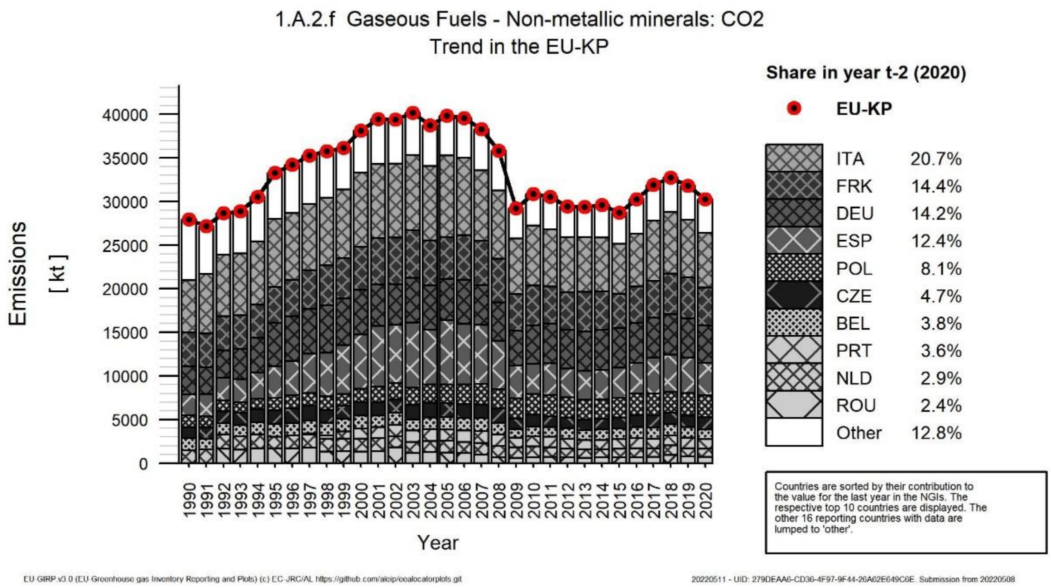


Figure 3.88 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. CO_2 IEF is stable during whole time period with slightly increasing trend. CO_2 IEF equalled to 56.31 t/TJ in 2020.

Figure 3.88: 1.A.2.f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

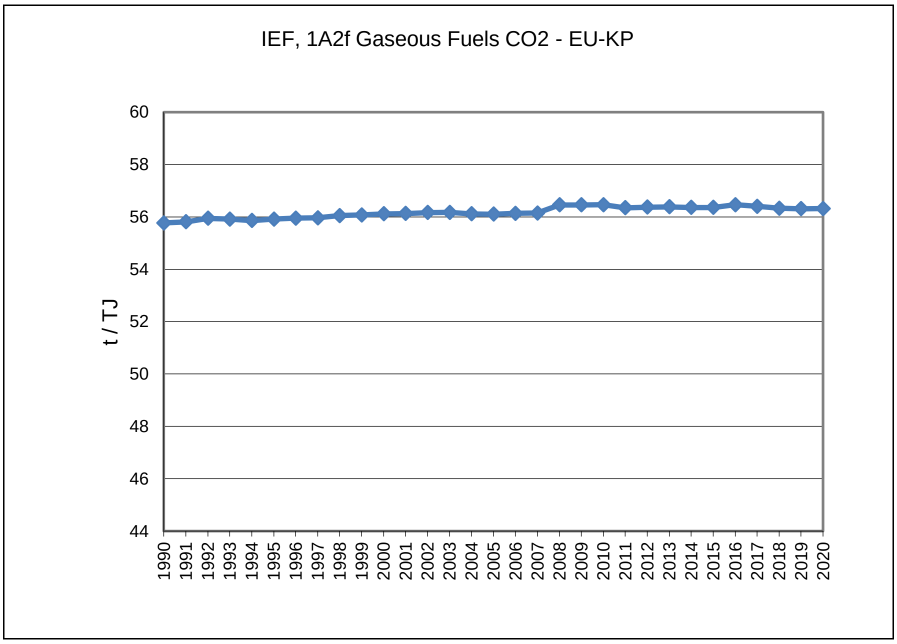
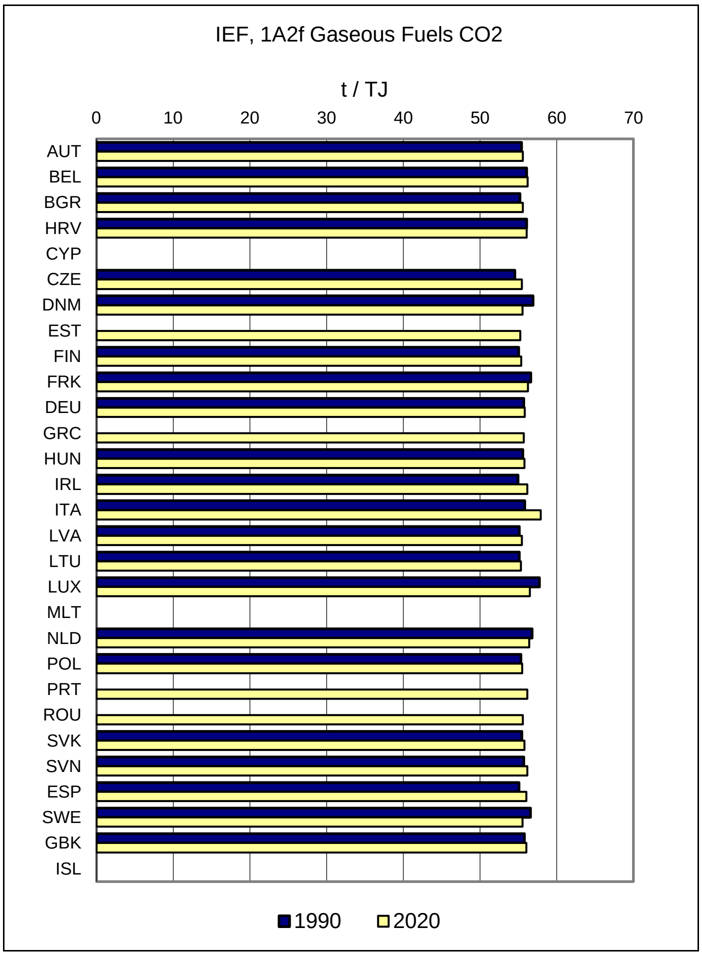


Figure 3.89 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2020 occur.

Figure 3.89: 1.A.2.f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.f Non-metallic Minerals – Other Fossil Fuels (CO_2)

CO_2 emissions from the use of other fossil fuels in category 1.A.2.f amounted 15 169 kt in 2020 for EU-KP. CO_2 emissions increased compared to year 1990 by 959% and compared to 2019 by 1%. This category represents 3.5% of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 962% compared to 1990.

Detailed data related to the EU-KP submissions are depicted in Table 3-47. Bulgaria, Malta, Netherlands and Iceland report emissions as 'NO' (not occurring). Three Member States use for emission estimates Tier 1 methodology, the rest of countries use higher tiers or combination of tiers (as it is calculated in chapter 3.2.1 approximately 70% of EU-KP emissions were calculated by using higher Tier methods or combination of methods in category 1.A.2.f – Other Fossil Fuels (CO_2)). All countries reported higher level of emissions in 2020 than in 1990. Most countries report emissions from industrial waste (co-) incineration and particularly incineration of municipal waste (e.g. Spain) under this category, especially from cement kilns. Examples of industrial wastes could be waste tires, waste oil/lubricants, solvents, plastics waste and paper waste.

Table 3-47: 1.A.2.f Non-metallic Minerals, other fossil fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	67	623	566	3.7%	499	742%	-57	-9%	T2	CS
Belgium	186	428	412	2.7%	226	121%	-16	-4%	T1,T3	D,PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	161	233	1.5%	233	∞	72	44%	T1	D
Cyprus	NO	127	148	1.0%	148	∞	22	17%	T1	D
Czechia	NO	651	581	3.8%	581	∞	-70	-11%	T2	CS
Denmark	NO	187	204	1.3%	204	∞	17	9%	T2	CS
Estonia	NO	97	66	0.4%	66	∞	-30	-31%	T3	PS
Finland	NO	50	57	0.4%	57	∞	7	14%	T3	CS
France	333	1 148	1 039	6.9%	706	212%	-109	-9%	T2,T3	CS,PS
Germany	526	2 988	2 992	19.7%	2 466	469%	4	0%	CS	CS
Greece	NO	178	186	1.2%	186	∞	8	4%	T2	PS
Hungary	NO	286	240	1.6%	240	∞	-46	-16%	T3	PS
Ireland	NO	198	184	1.2%	184	∞	-14	-7%	T3	PS
Italy	NO	550	473	3.1%	473	∞	-77	-14%	T2	CS
Latvia	NO	120	139	0.9%	139	∞	19	16%	T2	PS
Lithuania	NO	7	6	0.0%	6	∞	-2	-20%	T2	OTH
Luxembourg	NO	89	108	0.7%	108	∞	19	21%	T1,T3	D,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	10	4 400	4 280	28.2%	4 270	43912%	-120	-3%	T1	D
Portugal	12	278	314	2.1%	302	2470%	36	13%	T1,T3	D,PS
Romania	NO	446	978	6.4%	978	∞	532	119%	T2	CS
Slovakia	173	329	328	2.2%	155	90%	-2	-1%	T2	CS
Slovenia	5	119	106	0.7%	101	2166%	-13	-11%	T1,T3	D,PS
Spain	120	688	645	4.3%	526	440%	-43	-6%	T2	CS,PS
Sweden	NO	260	268	1.8%	268	∞	8	3%	T2	CS
United Kingdom	1	673	613	4.0%	612	61153%	-59	-9%	T2	CS
EU-27+UK	**1 432**	**15 083**	**15 169**	**100%**	**13 737**	**959%**	**86**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1	673	613	4.0%	612	61153%	-59	-9%	T2	CS
EU-KP	**1 432**	**15 083**	**15 169**	**100%**	**13 737**	**959%**	**86**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 3.90 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland (28%), Germany (20%), France (7%), Romania (6%) and Spain (4%) which together represent 69% share on EU-KP emissions.

Figure 3.90: 1.A.2.f Non-metallic Minerals, other fossil fuels: Emission trend and share for CO_2

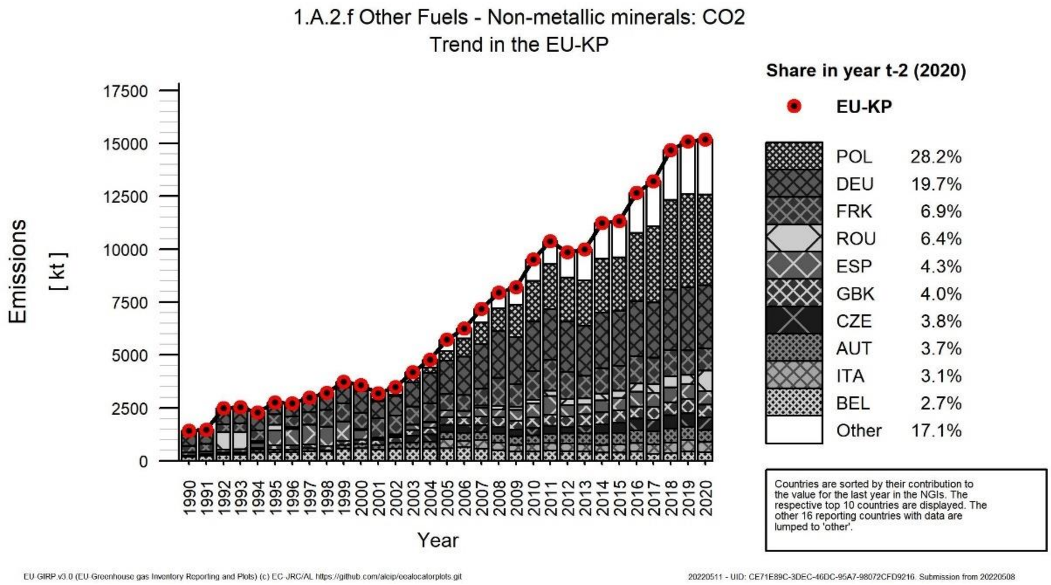


Figure 3.91 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. It can be seen that CO_2 IEF is fluctuating during whole time period, the lowest CO_2 IEF was calculated for 2002. Another low CO_2 IEF is observed for the year 2019. Industrial waste as a fuel that has an EF below the IPCC default EF for industrial waste combusted in manufacturing industries and constructions (2006 IPCC Guidelines, vol.2, chap. 2, table 2.3). The EFs for industrial waste components are typically around 80 t fossil CO_2/TJ fossil energy and for year 2020 the CO_2 IEF equalled to 85.38 t/TJ.

Figure 3.91: 1.A.2.f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)

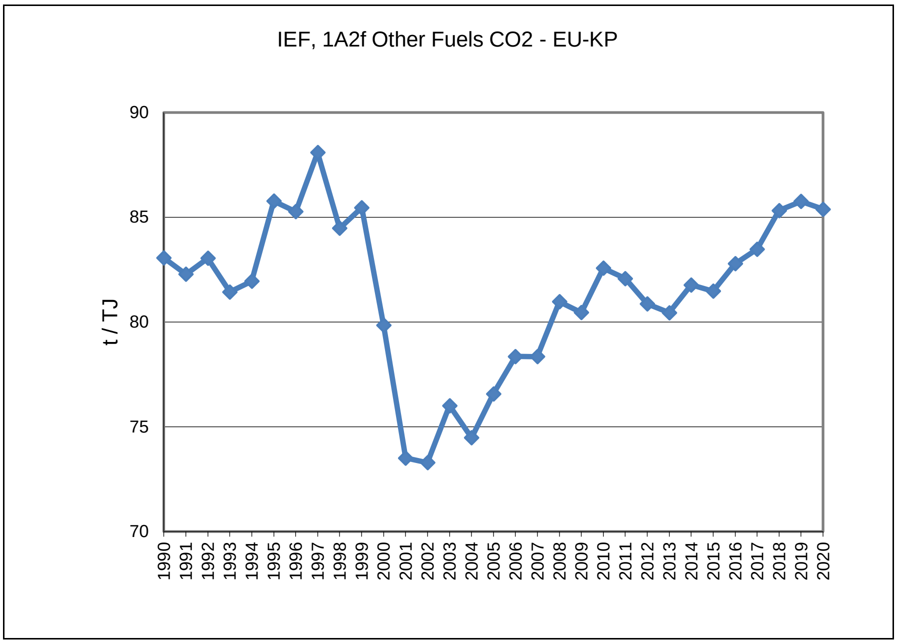
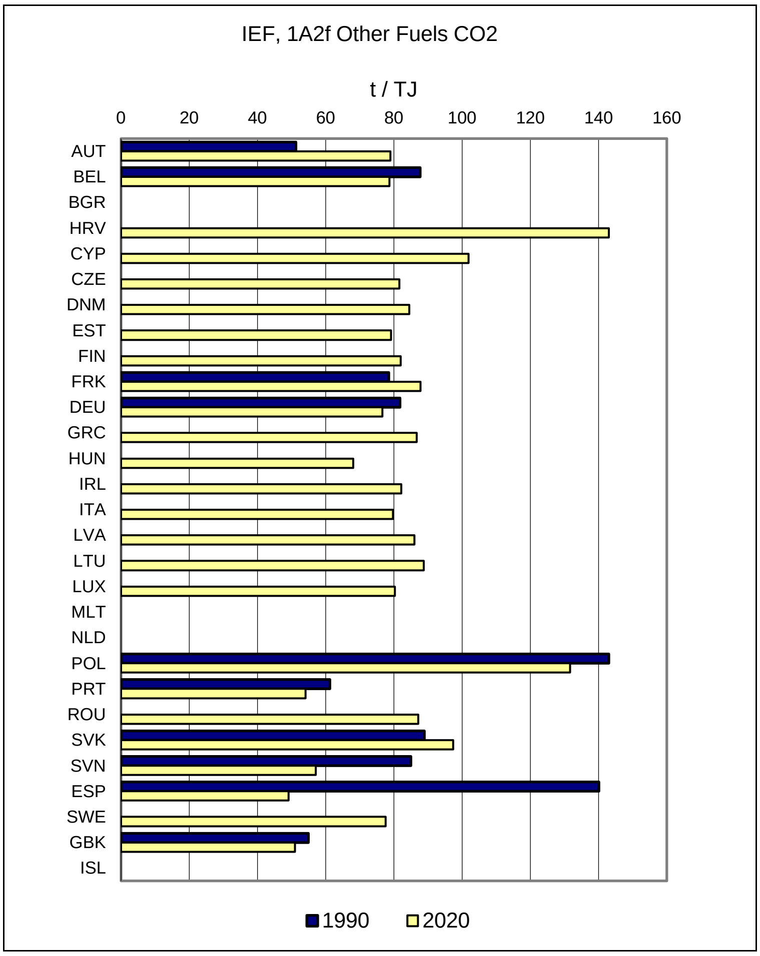


Figure 3.92 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. Croatia and Poland apply the default IPCC CO_2 emission factor (or a factor which is close to it) which is significantly higher than the country specific values used by almost all other countries. The

comparatively low implied emission factor reported by almost all countries is mainly due to incineration of industrial waste. Industrial waste as a fuel that has an EF below the IPCC default EF for industrial waste combusted in manufacturing industries and constructions (2006 IPCC Guidelines, vol.2, chap. 2, table 2.3). The EFs for industrial waste components are typically around 80 t fossil CO_2/TJ fossil energy.

Figure 3.92: 1.A.2.f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



3.2.2.7 Other (1.A.2.g)

This chapter provides information about European emission trend, Member States, United Kingdom and Iceland contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.g Other.

This category includes emissions from stationary combustion but also may include emissions from mobile sources (e.g. construction machinery). Some countries use this category to report emissions which cannot be allocated to the categories 1.A.2.a to 1.A.2.f due to lack of detailed data, e.g. IEA data provides fuel consumption of Industrial Auto-producers (Electricity, CHP, Heat) for total industry only. This category is dominated by Germany; Germany reports all emissions from power and heat production in industry under this category. Emissions for category 1.A.2.g other (manufacturing industries and construction) include those from stationary combustion, but may also include emissions from mobile sources (e.g. construction machinery), and that some member States use this category to report emissions that cannot be allocated to categories 1.A.2.a–1.A.2.f owing to a lack of detailed data. The following **Table 3.49** presents 1.A.2.g GHG emissions and the share of mobile machinery (off road vehicles) by Member State in year 2020. Greece reports emissions of 1A2g together with category 1A2f. Ireland presumably includes it in the transport sector (1A3). Cyprus, Czechia, Estonia, France, Malta and Slovakia report data from 1.A.2.g.vii together with agricultural mobile sources under the category 1A4cii while Italy and Poland report data under residential or commercial under categories 1A4 or 1A5.

Table 3-48: 1.A.2.g Other: CO_2, CH_4 and N_2O emissions

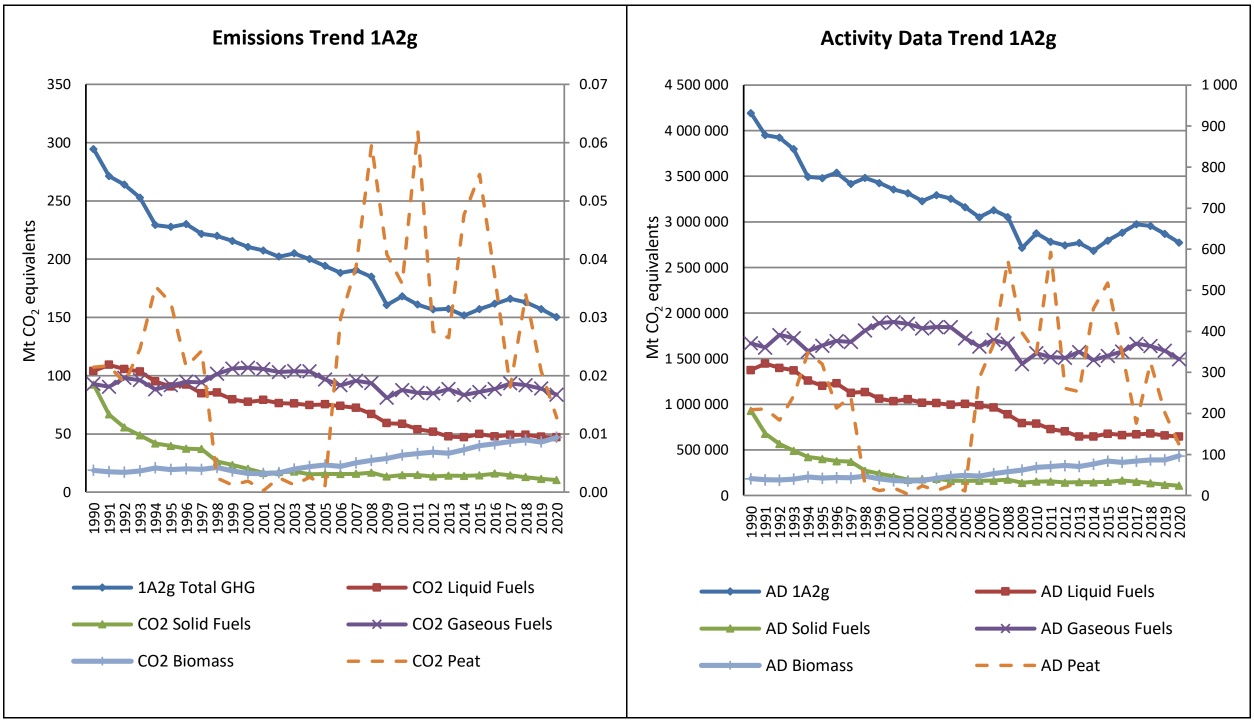
MS		Emissions 2020 in kt CO_2 eq.		
		CO_2	CH_4	N_2O
AUT	g. Other	2,694	5.8	67
	1.A.2.g.vii Off-road vehicles and other machinery	1,238	0.0	0.1
BEL	g. Other	1,784	7.4	17
	1.A.2.g.vii Off-road vehicles and other machinery	547	0.1	0.0
BGR	g. Other	931	5.1	18
	1.A.2.g.vii Off-road vehicles and other machinery	88	0.0	0.0
HRV	g. Other	319	0.3	0.8
	1.A.2.g.vii Off-road vehicles and other machinery	319	0.0	0.0
CYP	g. Other	408	0.1	0.1
	1.A.2.g.vii Off-road vehicles and other machinery	NO, IE	NO, IE	NO, IE
CZE	g. Other	1,982	8	13
	1.A.2.g.vii Off-road vehicles and other machinery	NO, IE	NO, IE	NO, IE
DNM	g. Other	759	2.2	15
	1.A.2.g.vii Off-road vehicles and other machinery	542	0.0	0.0
EST	g. Other	221	0.1	0.6
	1.A.2.g.vii Off-road vehicles and other machinery	NO, IE	NO, IE	NO, IE
FIN	g. Other	1,636	11	14
	1.A.2.g.vii Off-road vehicles and other machinery	1,164	0.1	0.0
FRK	g. Other	7,073	22	355
	1.A.2.g.vii Off-road vehicles and other machinery	NO, IE	NO, IE	NO, IE
DEU	g. Other	69,836	199	550
	1.A.2.g.vii Off-road vehicles and other machinery	88	0.1	0.0
GRC	g. Other	IE	IE	IE
	1.A.2.g.vii Off-road vehicles and other machinery	IE	IE	IE
HUN	g. Other	1,872	3.1	14
	1.A.2.g.vii Off-road vehicles and other machinery	760	0.0	0.0
IRL	g. Other	554	3.7	6
	1.A.2.g.vii Off-road vehicles and other machinery	NO, IE	NO, IE	NO, IE
ITA	g. Other	8,683	5.2	155
	1.A.2.g.vii Off-road vehicles and other machinery	NO, IE	NO, IE	NO, IE
LVA	g. Other	198	12	32
	1.A.2.g.vii Off-road vehicles and other machinery	119	0.0	0.0
LTU	g. Other	200	2.4	8.5
	1.A.2.g.vii Off-road vehicles and other machinery	44	0.0	0.0
LUX	g. Other	259	0.2	6.5
	1.A.2.g.vii Off-road vehicles and other machinery	178	0.0	0.0
MLT	g. Other	57	0.1	0.1

MS		Emissions 2020 in kt CO_2 eq.		
		CO_2	CH_4	N_2O
	1.A.2.g.vii Off-road vehicles and other machinery	NO, IE	NO, IE	NO, IE
NLD	g. Other	2,853	17	25
	1.A.2.g.vii Off-road vehicles and other machinery	1,668	0.0	0.0
POL	g. Other	2,887	32	52
	1.A.2.g.vii Off-road vehicles and other machinery	NO, IE	NO, IE	NO, IE
PRT	g. Other	1,556	2.8	34
	1.A.2.g.vii Off-road vehicles and other machinery	172	0.0	0.1
ROU	g. Other	6,046	8.7	14
	1.A.2.g.vii Off-road vehicles and other machinery	NO	NO	NO
SVK	g. Other	994	2.4	3.6
	1.A.2.g.vii Off-road vehicles and other machinery	IE	IE	IE
SVN	g. Other	498	2.2	14
	1.A.2.g.vii Off-road vehicles and other machinery	92	0.0	0.0
ESP	g. Other	7,279	204	66
	1.A.2.g.vii Off-road vehicles and other machinery	1,978	0.0	0.1
SWE	g. Other	2,266	7.3	49
	1.A.2.g.vii Off-road vehicles and other machinery	1,223	0.0	0.1
GBK	g. Other	24,767	117	214
	1.A.2.g.vii Off-road vehicles and other machinery	5,029	0.9	0.2
ISL	g. Other	20	0.0	1.4
	1.A.2.g.vii Off-road vehicles and other machinery	11.8	0.0	0.0

Total CO_2 emissions from 1.A.2.g amounted to 147 656 kt CO_2 eq. in 2020. The trend of total CO_2 emissions for 1990 to 2020 from category 1.A.2.g is depicted in Figure 3.93. Total CO_2 emissions decreased by 49% since 1990 and by 4% between 2019 and 2020. CO_2 emissions from 1.A.2.g Other accounted for 33% of 1.A.2. source category.

Figure 3.93 shows the emission trend within the category 1.A.2.g, which is mainly dominated by CO_2 emissions from gaseous, liquid and solid fuels; the decrease in the early 1990s was mainly due to a decline of solid fuel consumption.

Figure 3.93: 1.A.2.g Other: Activity data and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU-KP submissions are depicted in Table **3-49**. Greece report data as 'IE' (included elsewhere). Four Member States reported increase of CO_2 emissions compared to level of emissions in 1990. The highest increase of CO_2 emission was reported by Cyprus (752%), but it should be noted that Cyprus has minor share (approximately 0.3%) on total EU-KPs emissions.

Table 3-49: 1.A.2.g Other: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 974	2 726	2 694	1.8%	720	36%	-32	-1%	T1,T2,T3	CS,D
Belgium	2 807	1 828	1 784	1.2%	-1 022	-36%	-44	-2%	CS,T1,T3	D
Bulgaria	10 579	908	931	0.6%	-9 648	-91%	24	3%	T1,T2	CS,D
Croatia	435	335	319	0.2%	-116	-27%	-16	-5%	T1	D
Cyprus	48	67	408	0.3%	360	752%	341	513%	T1	D
Czechia	19 064	1 907	1 982	1.3%	-17 082	-90%	74	4%	T1,T2	CS,D
Denmark	1 781	792	759	0.5%	-1 022	-57%	-34	-4%	M,T1,T2,T3	CS,D
Estonia	1 183	223	221	0.1%	-961	-81%	-1	-1%	T1,T2	CS,D
Finland	1 639	1 571	1 636	1.1%	-3	0%	65	4%	T3	CS,D
France	10 598	7 543	7 073	4.8%	-3 525	-33%	-470	-6%	T2	CS
Germany	127 992	72 845	69 836	47.3%	-58 156	-45%	-3 009	-4%	CS,T1	CS,D
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	4 603	1 799	1 872	1.3%	-2 731	-59%	73	4%	T1,T2	CS,D
Ireland	821	564	554	0.4%	-267	-32%	-10	-2%	T1,T2	CS,D
Italy	15 310	9 587	8 683	5.9%	-6 627	-43%	-904	-9%	T2	CS
Latvia	1 620	199	198	0.1%	-1 421	-88%	0	0%	T1,T2	CS,D
Lithuania	1 567	207	200	0.1%	-1 367	-87%	-6	-3%	T1,T2	CS,D
Luxembourg	103	268	259	0.2%	156	151%	-9	-3%	T1,T2	CS,D
Malta	53	47	57	0.0%	4	8%	10	20%	T1	D
Netherlands	3 331	3 007	2 853	1.9%	-479	-14%	-155	-5%	T2	CS
Poland	6 979	2 898	2 887	2.0%	-4 092	-59%	-12	0%	T1,T2	CS,D
Portugal	2 196	1 531	1 556	1.1%	-640	-29%	25	2%	T1	D
Romania	23 834	4 919	5 091	3.4%	-18 743	-79%	173	4%	T1,T2,T3	CS,D,PS
Slovakia	2 560	1 039	994	0.7%	-1 566	-61%	-45	-4%	T2	CS
Slovenia	1 094	461	498	0.3%	-596	-54%	37	8%	T1,T2	CS,D
Spain	7 899	8 353	7 279	4.9%	-621	-8%	-1 074	-13%	CR,T1,T2,T3	R,CS,D,PS
Sweden	3 260	2 420	2 266	1.5%	-994	-30%	-154	-6%	T1,T2	CS
United Kingdom	38 190	26 436	24 767	16.8%	-13 423	-35%	-1 669	-6%	T1,T2,T3	CS,D
EU-27+UK	**291 517**	**154 479**	**147 656**	**100%**	**-143 861**	**-49%**	**-6 823**	**-4%**	**-**	**-**
Iceland	41	26	20	0.0%	-20	-50%	-5	-21%	T1	D
United Kingdom (KP)	38 266	26 511	24 844	16.8%	-13 422	-35%	-1 666	-6%	T1,T2,T3	CS,D
EU-KP	**291 634**	**154 579**	**147 754**	**100%**	**-143 881**	**-49%**	**-6 826**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
Greece includes emissions of 1.A.2.g in category 1.A.2.f

1.A.2.g Other – Liquid Fuels (CO_2)

CO_2 emissions from the use of liquid fuels in category 1.A.2.g amounted 46 900 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 53% and compared to 2019 by 1%. This category represents 11% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU-KP submissions are depicted in Table.3-50. Sweden reports emissions as 'C' (confidential). Five Member States reported higher level of emissions (it should be noted that these countries have together 8% share on EU-KP emissions).

Table.3-50: 1.A.2.g Other, liquid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	866	1 494	1 387	3.0%	521	60%	-107	-7%		
Belgium	1 569	739	761	1.6%	-809	-52%	22	3%		
Bulgaria	8 632	312	328	0.7%	-8 304	-96%	17	5%		
Croatia	435	335	319	0.7%	-116	-27%	-16	-5%	T1	D
Cyprus	48	67	408	0.9%	360	752%	341	513%		
Czechia	2 935	70	128	0.3%	-2 806	-96%	58	83%		
Denmark	1 167	572	586	1.2%	-581	-50%	14	2%		
Estonia	702	149	166	0.4%	-537	-76%	16	11%	T2	CS
Finland	1 480	1 261	1 313	2.8%	-167	-11%	52	4%	T3	CS
France	5 905	3 713	3 500	7.4%	-2 405	-41%	-212	-6%		
Germany	30 374	14 689	14 185	30.2%	-16 189	-53%	-504	-3%		
Greece	IE	IE	IE	-	-	-	-	-		
Hungary	1 498	763	822	1.7%	-676	-45%	59	8%	T1, T2	D, CS
Ireland	649	314	306	0.7%	-343	-53%	-9	-3%		
Italy	5 707	2 245	2 203	4.7%	-3 504	-61%	-42	-2%		
Latvia	1 066	126	130	0.3%	-937	-88%	4	3%	T1, T2	CS, D
Lithuania	812	72	68	0.1%	-744	-92%	-4	-6%	T2	CS
Luxembourg	59	225	219	0.5%	160	270%	-5	-2%		
Malta	53	47	57	0.1%	4	8%	10	20%	TI	D
Netherlands	1 580	1 616	1 668	3.5%	88	6%	53	3%		
Poland	1 028	707	792	1.7%	-236	-23%	85	12%	T1/T2	D/CS
Portugal	2 147	547	550	1.2%	-1 597	-74%	3	1%		
Romania	4 812	1 539	1 358	2.9%	-3 453	-72%	-181	-12%	T1,T2,T3	D,CS,PS
Slovakia	66	12	11	0.0%	-55	-83%	-1	-7%	T2	CS
Slovenia	585	143	154	0.3%	-431	-74%	11	8%	T1	D
Spain	5 788	2 763	2 311	4.9%	-3 477	-60%	-452	-16%	T1, T2, T3	CS, D, M, PS
Sweden	3 053	C	C	-	-3 053	-100%	-	-		
United Kingdom	20 821	12 879	13 172	28.0%	-7 650	-37%	293	2%	T2, T3	CS
EU-27+UK	**100 784**	**47 396**	**46 900**	**100%**	**-53 884**	**-53%**	**-496**	**-1%**		
Iceland	41	26	20	0.0%	-20	-50%	-5	-21%		
United Kingdom (KP)	20 898	12 954	13 249	28.2%	-7 649	-37%	295	2%	T2, T3	CS
EU-KP	**100 901**	**47 497**	**46 998**	**100%**	**-53 904**	**-53%**	**-499**	**-1%**		

Greece includes emissions of 1.A.2.g in category 1.A.2.f
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level. Additional information is provided in Annex III of the EU NIR and in MS NIRs, which are also part of the EU submission.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.94 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (30%), United Kingdom (28%), France (7%), Spain (5%), Italy (5%) and Romania (3%) which together represent 77% share on EU-KP emissions.

Figure 3.94: 1.A.2.g Other, liquid fuels: Emission trend and share for CO_2

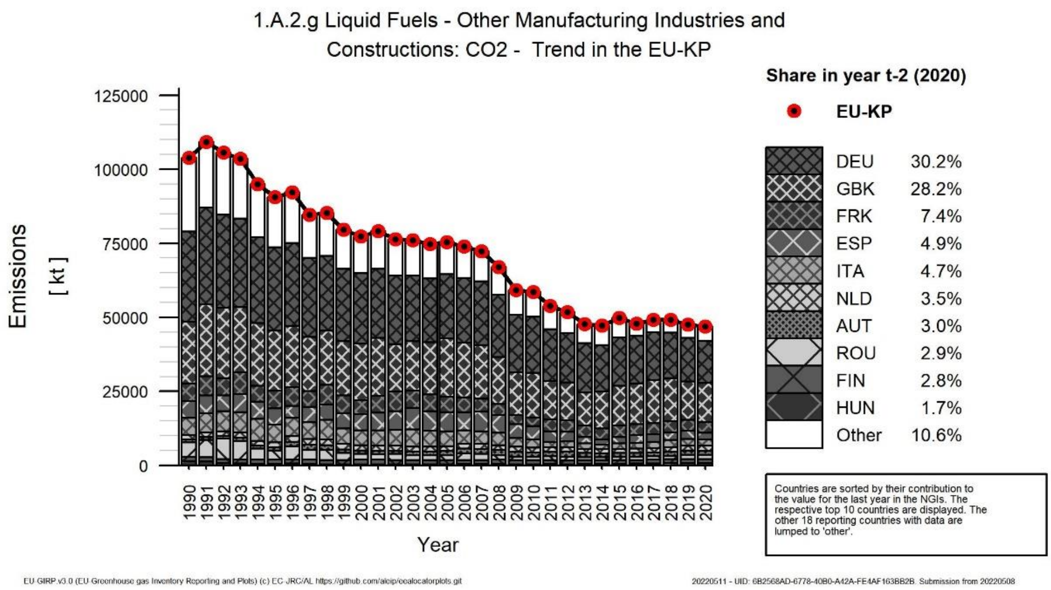


Figure 3.95 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. The CO_2 IEF shows a decreasing trend with minor fluctuations since 2008. This trend is driven mainly by Germany and is caused by changes in fuel mix. CO_2 IEF equaled to 90.75 t/TJ in 2020.

Figure 3.95: 1.A.2.g Other, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

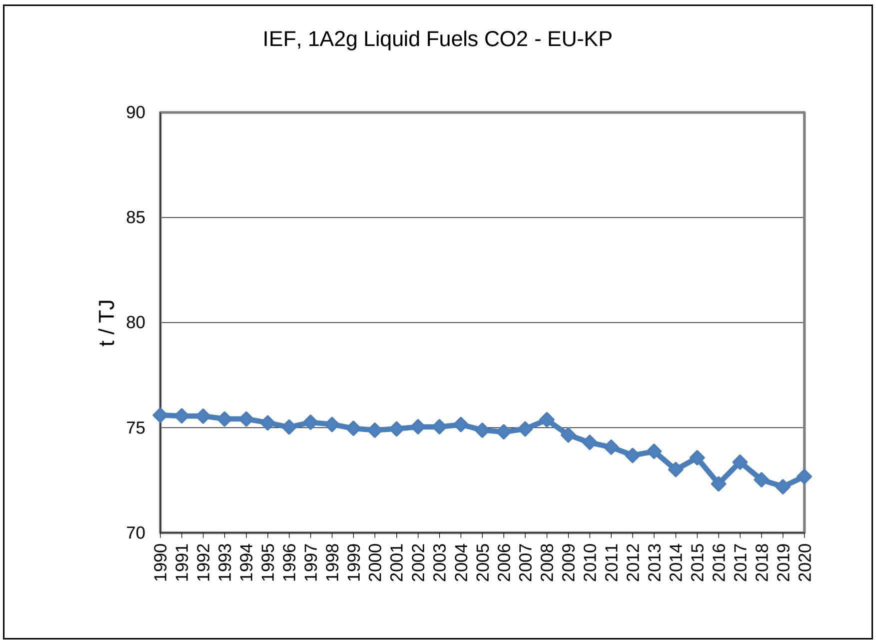
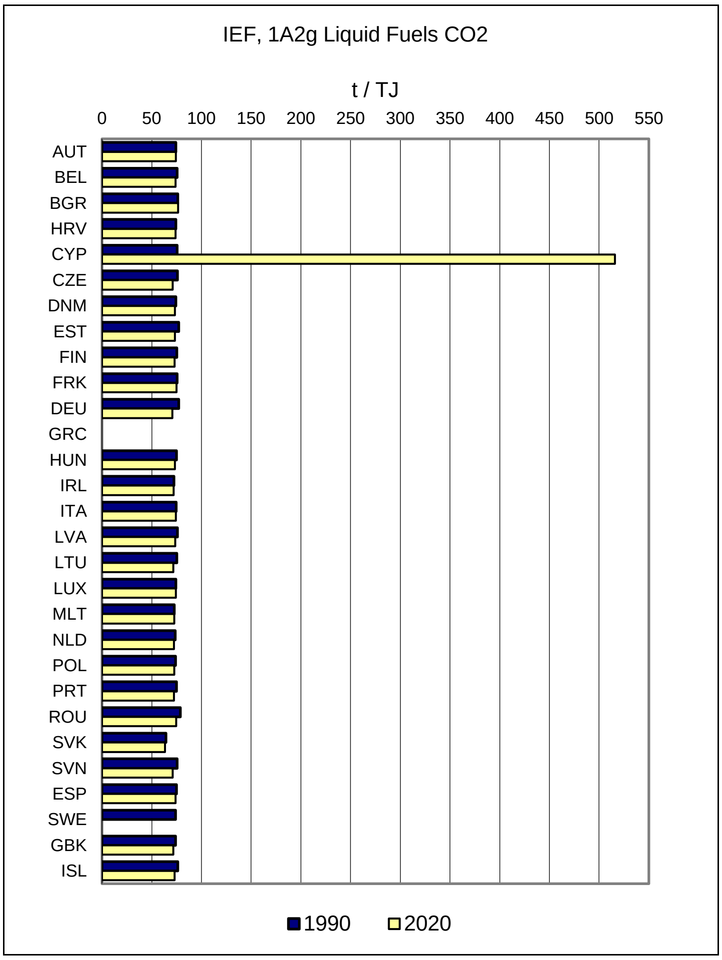


Figure 3.96 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. There is huge difference of Cyprus CO_2 IEF and CO_2 IEF of other Member States in year 2020. The most probable explanation of this difference is very likely a mistake in emissions or in AD. Cyprus did not provide any data for a control during the review process which caused that this issue was nor noticed neither questioned and does not have any explanation.

Figure 3.96: 1.A.2.g Other, liquid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.g Other – Solid Fuels (CO_2)

CO_2 emissions from the use of solid fuels in category 1.A.2.g amounted 10 487 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 89% and compared to 2019 by 8%. This category represents 2.4% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU-KP submissions are depicted in Table 3-51. Nine Member States and Iceland report emissions as 'NO' (not occurring). Sweden reports emissions as 'C' (confidential). All countries reported lower level of emissions in 2020 than in 1990.

Table 3-51: 1.A.2.g Other, solid fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	91	NO	0.01	0.0%	-91	-100%	0	∞		
Belgium	33	14	13	0.1%	-20	-61%	-1	-7%		
Bulgaria	1 858	33	48	0.5%	-1 810	-97%	15	46%		
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-		
Czechia	13 750	73	68	0.6%	-13 683	-100%	-5	-7%		
Denmark	324	NO	NO	-	-324	-100%	-	-		
Estonia	194	1	0	0.0%	-194	-100%	-1	-89%	T2	CS
Finland	8	NO	NO	-	-8	-100%	-	-	T3	CS
France	664	NO	NO	-	-664	-100%	-	-		
Germany	57 580	8 580	8 113	77.4%	-49 468	-86%	-467	-5%		
Greece	IE	IE	IE	-	-	-	-	-		
Hungary	677	12	13	0.1%	-664	-98%	1	11%	T1, T2	D, CS
Ireland	14	NO	NO	-	-14	-100%	-	-		
Italy	396	115	30	0.3%	-366	-92%	-85	-74%		
Latvia	27	1	1	0.0%	-26	-97%	-1	-54%	T1, T2	CS, D
Lithuania	79	4	2	0.0%	-77	-98%	-2	-56%	T2	CS
Luxembourg	20	10	11	0.1%	-9	-46%	1	11%		
Malta	NO	NO	NO	-	-	-	-	-	NO	NO
Netherlands	42	87	33	0.3%	-9	-21%	-55	-62%		
Poland	5 082	637	564	5.4%	-4 517	-89%	-73	-11%	T1/T2	D/CS
Portugal	49	23	16	0.2%	-33	-68%	-7	-31%		
Romania	5 379	10	3	0.0%	-5 376	-100%	-7	-69%	T1,T2	D,CS
Slovakia	1 422	344	312	3.0%	-1 110	-78%	-32	-9%	T2	CS
Slovenia	89	0	NO	-	-89	-100%	0	-100%	T1	D
Spain	248	NO	NO	-	-248	-100%	-	-	T1, T2, T3	CS, D, PS
Sweden	94	C	C	-	-94	-100%	-	-		
United Kingdom	4 144	1 397	1 260	12.0%	-2 884	-70%	-137	-10%	T2	CS
EU-27+UK	**92 170**	**11 342**	**10 487**	**100%**	**-81 683**	**-89%**	**-855**	**-8%**		
Iceland	NO	NO	NO	-	-	-	-	-		
United Kingdom (KP)	4 144	1 397	1 260	12.0%	-2 884	-70%	-137	-10%	T2	CS
EU-KP	**92 170**	**11 342**	**10 487**	**100%**	**-81 683**	**-89%**	**-855**	**-8%**		

Greece includes emissions of 1.A.2.g in category 1.A.2.f
EU trends in this table do not include Sweden for confidentiality reasons and to preserve time series consistency for the EU. This also explains the differences between the numbers in this table and the CRF.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level. Additional information is provided in Annex III of the EU NIR and in MS NIRs, which are also part of the EU submission
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure.3.97 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (77%) and United Kingdom (12%) which together represent 89% share on EU-KP emissions.

Figure.3.97: 1.A.2.g Other, solid fuels: Emission trend and share for CO_2

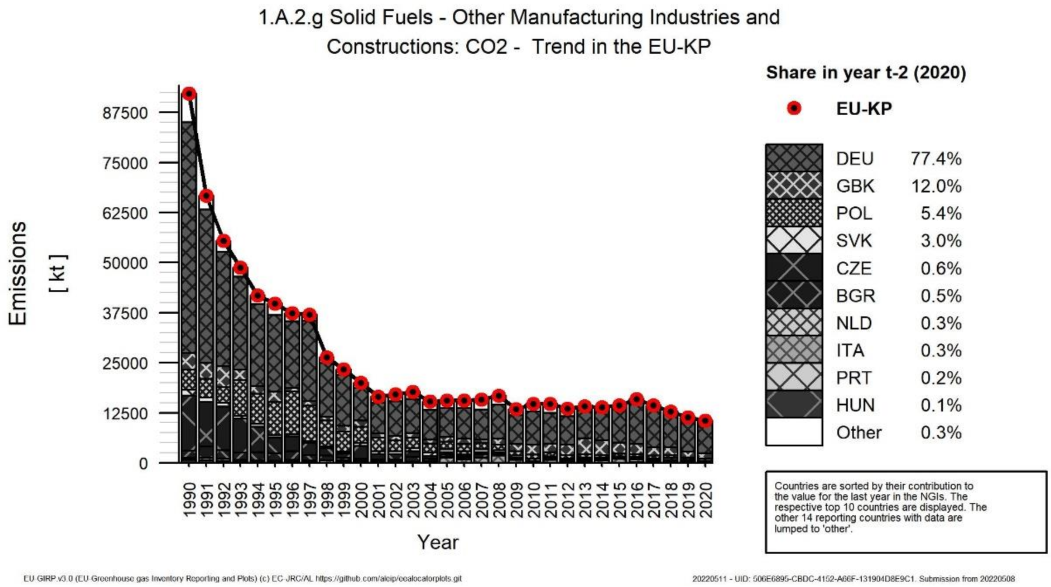


Figure 3.98 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020 which is fluctuating with slightly decreasing trend. CO_2 IEF equaled to 96.5 t/TJ in 2020.

Figure 3.98: 1.A.2.g Other, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

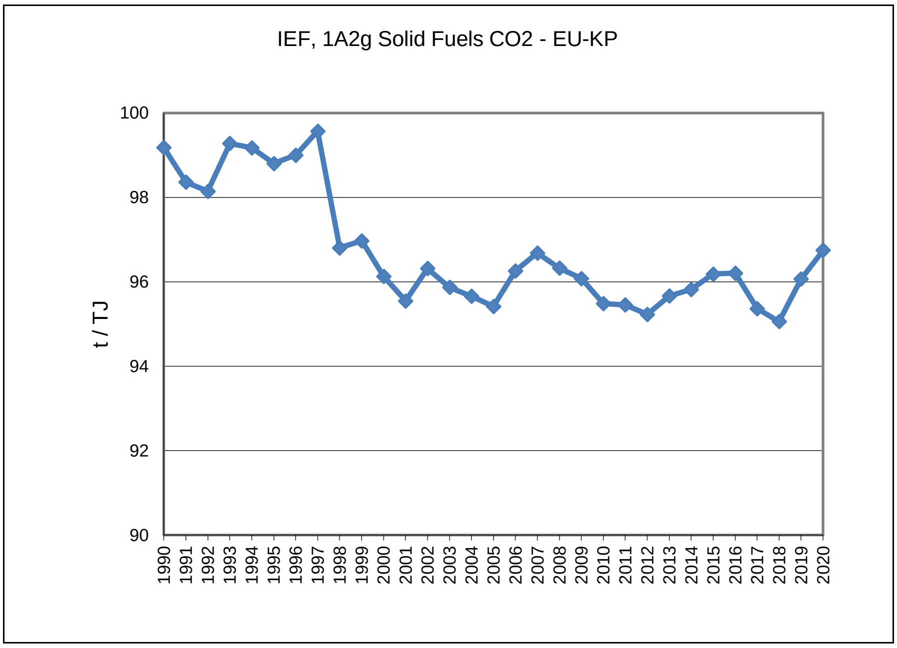
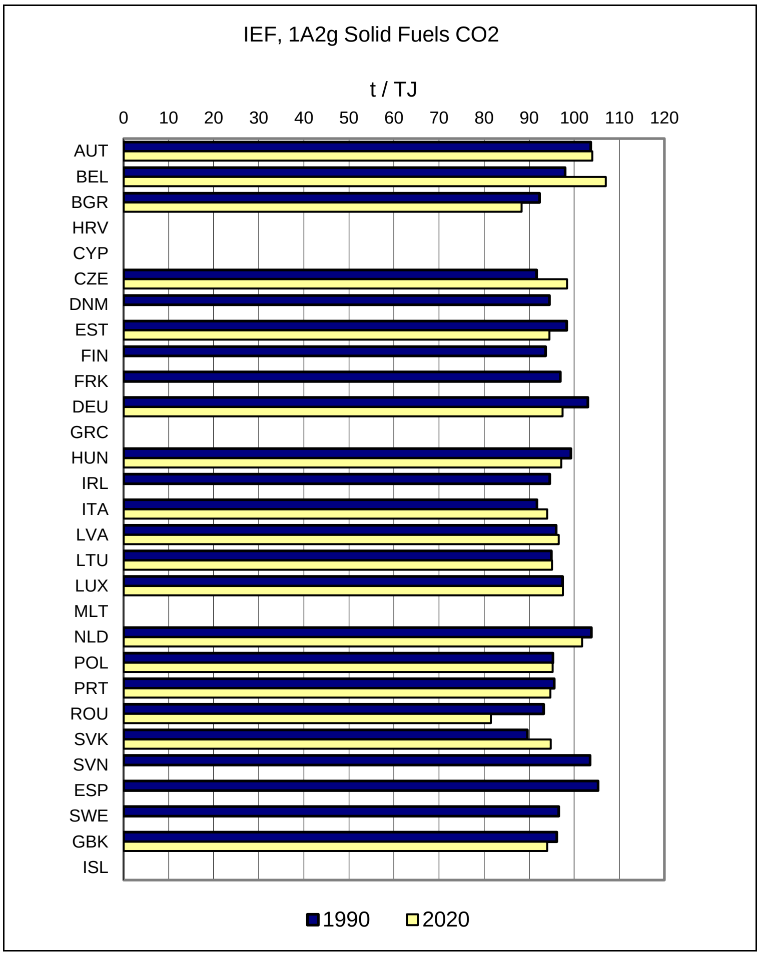


Figure **3.99** shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020.

Figure 3.99: 1.A.2.g Other, solid fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.g Other – Gaseous Fuels (CO_2)

CO_2 emissions from the use of gaseous fuels in category 1.A.2.g amounted 83 694 kt in 2020 for EU-KP. CO_2 emissions decreased compared to year 1990 by 10% and compared to 2019 by 6%. This category represents 19% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU-KP submissions are depicted in Table 3-52. Croatia, Cyprus, Malta and Iceland report emissions as 'NO' (not occurring). Eight Member States reported higher level of emissions in 2020 than in 1990.

Table 3-52: 1.A.2.g Other, gaseous fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 014	1 198	1 271	1.5%	257	25%	73	6%		
Belgium	1 204	1 058	997	1.2%	-207	-17%	-62	-6%		
Bulgaria	89	354	335	0.4%	246	276%	-19	-5%		
Croatia	NO	NO	NO	-	-	-	-	-	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-		
Czechia	2 379	1 764	1 786	2.1%	-593	-25%	21	1%		
Denmark	289	209	173	0.2%	-116	-40%	-36	-17%		
Estonia	286	73	56	0.1%	-230	-80%	-17	-23%	T2	CS
Finland	41	35	42	0.1%	1	3%	7	19%	T3	CS
France	4 018	3 807	3 557	4.3%	-460	-11%	-250	-7%		
Germany	37 693	45 808	43 802	52.3%	6 109	16%	-2 006	-4%	CS	CS
Greece	IE	IE	IE	-	-	-	-	-		
Hungary	2 428	1 024	1 037	1.2%	-1 392	-57%	13	1%	T2	CS
Ireland	158	249	248	0.3%	90	57%	-1	0%		
Italy	9 207	7 227	6 450	7.7%	-2 757	-30%	-776	-11%	T2	CS
Latvia	527	70	67	0.1%	-460	-87%	-3	-4%	T2	CS
Lithuania	677	120	120	0.1%	-557	-82%	0	0%	T2	CS
Luxembourg	24	33	28	0.0%	4	18%	-5	-14%		
Malta	NO	NO	NO	-	-	-	-	-	NO	NO
Netherlands	1 710	1 305	1 152	1.4%	-558	-33%	-153	-12%		
Poland	865	1 547	1 524	1.8%	659	76%	-23	-1%	T2	CS
Portugal	NO,IE	956	987	1.2%	987	∞	31	3%		
Romania	13 643	3 368	3 730	4.5%	-9 914	-73%	362	11%	T3	T1,T2
Slovakia	1 071	684	671	0.8%	-400	-37%	-13	-2%	T2	CS
Slovenia	420	308	334	0.4%	-86	-20%	26	8%	T2	CS
Spain	1 863	5 590	4 968	5.9%	3 105	167%	-622	-11%	T1, T2	CS, PS
Sweden	113	70	59	0.1%	-54	-48%	-10	-15%		
United Kingdom	13 155	12 121	10 300	12.3%	-2 855	-22%	-1 821	-15%	T2	CS
EU-27+UK	**92 874**	**88 978**	**83 694**	**100%**	**-9 181**	**-10%**	**-5 285**	**-6%**		
Iceland	NO	NO	NO	-	-	-	-	-		
United Kingdom (KP)	13 155	12 121	10 300	12.3%	-2 855	-22%	-1 821	-15%	T2	CS
EU-KP	**92 874**	**88 978**	**83 694**	**100%**	**-9 181**	**-10%**	**-5 285**	**-6%**		

Greece includes emissions of 1.A.2.g in category 1.A.2.f
Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries. Additional information is provided in Annex III of the EU NIR and in MS NIRs, which are also part of the EU submission.

Figure 3.100 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany (52%), United Kingdom (12%), Italy (8%), Spain (6%) Romania (5%) and France (4%) which together represent 87% share on EU-KP emissions.

Figure 3.100: 1.A.2.g Other, gaseous fuels: Emission trend and share for CO_2

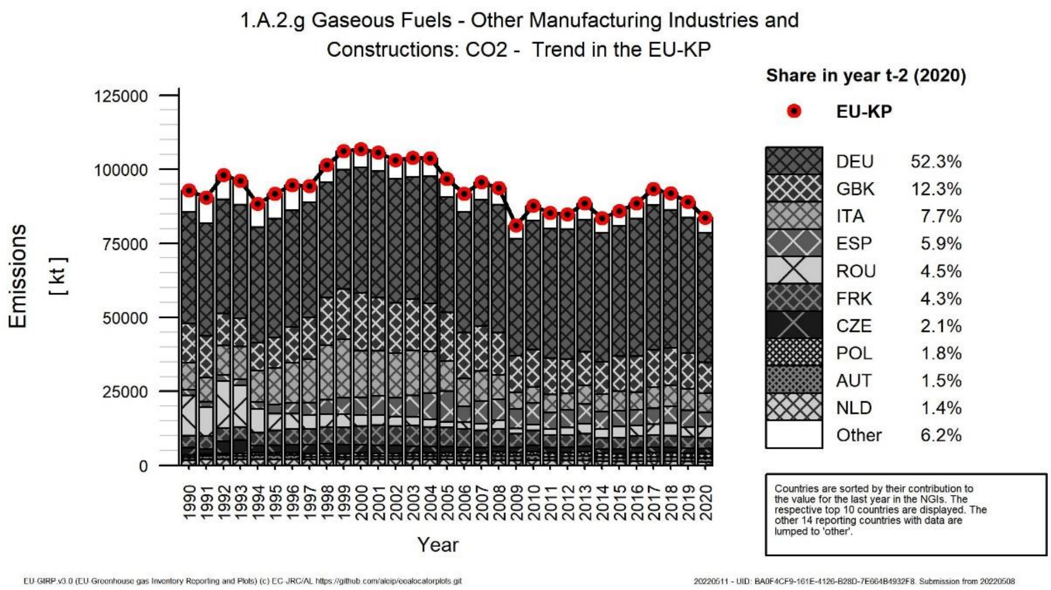


Figure 3.101 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. CO_2 IEF is relatively stable during reporting period. CO_2 IEF equaled to 56.03 t/TJ in 2020.

Figure 3.101: 1.A.2.g Other, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)

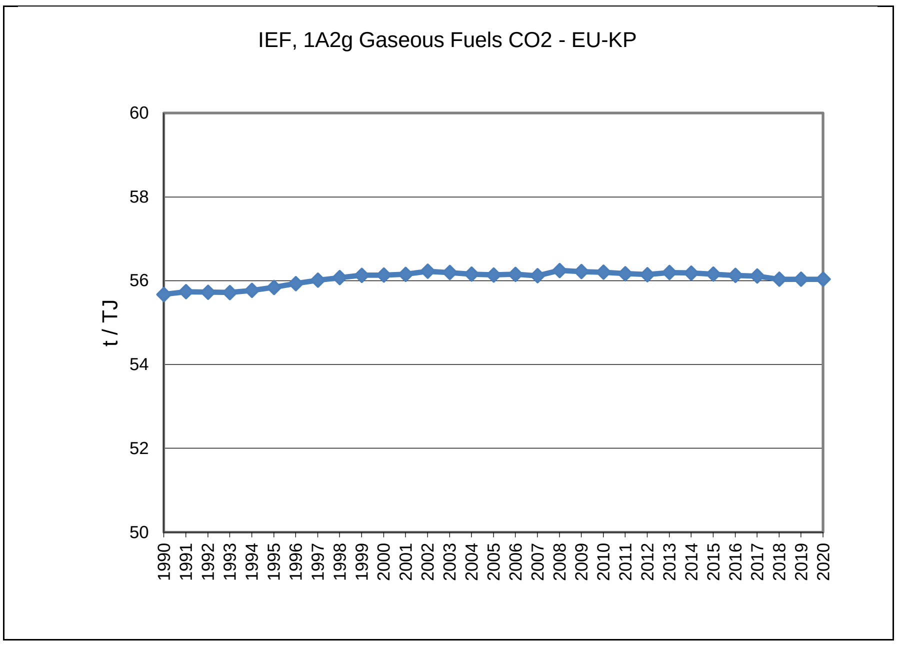
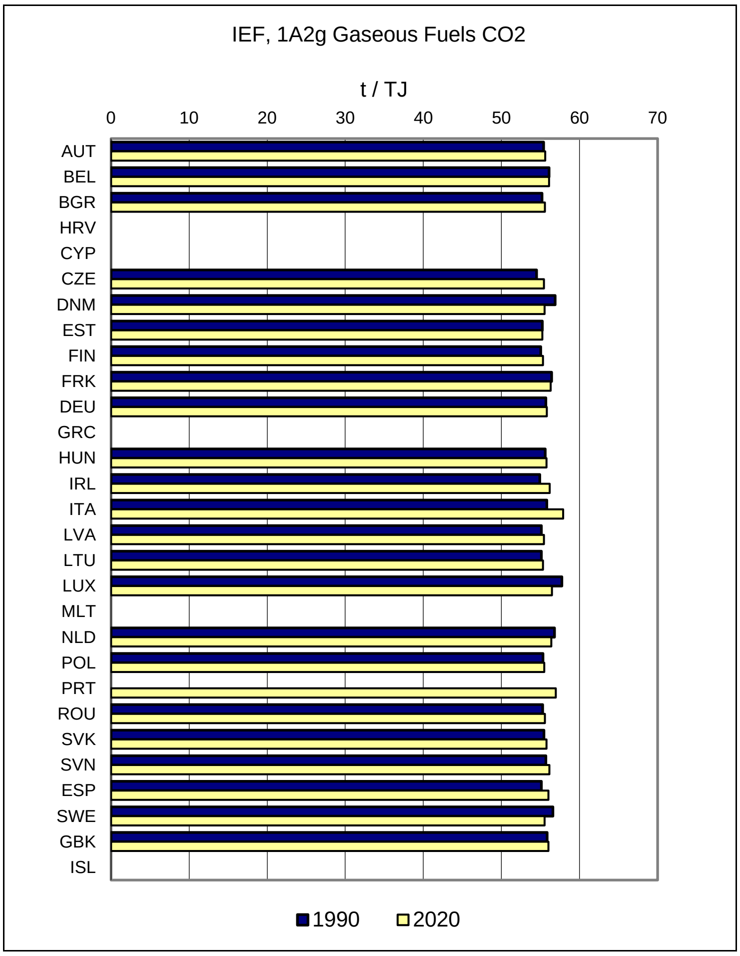


Figure 3.102 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. It can be seen that no major differences between CO_2 IEF used by countries occur, also no major differences between CO_2 IEF calculated by countries for 1990 and 2020 occur.

Figure 3.102: 1.A.2.g Other, gaseous fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



1.A.2.g Other – Other fossil fuels (CO_2)

CO_2 emissions from the use of other fossil fuels in category 1.A.2.g amounted 4 357 kt in 2020 for EU-KP. CO_2 emissions increased compared to year 1990 by 73% and compared to 2019 decreased by 1%. This category represents 1% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU-KP submissions are depicted in Table 3-53. Thirteen Member States and Iceland report emissions as 'NO' (not occurring). All Member States reported higher level of emissions in 2020 than in 1990, only United Kingdom and Denmark reported lower level of emissions.

Table 3-53: 1.A.2.g Other, other fossil fuels: Member States, United Kingdom and Iceland contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	3	34	36	0.8%	33	947%	2	5%
Belgium	NO	17	14	0.3%	14	∞	-3	-19%
Bulgaria	NO	209	220	5.1%	220	∞	11	5%
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	1	11	NO	-	-1	-100%	-11	-100%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	88	256	269	6.2%	181	206%	13	5%
France	11	23	15	0.3%	4	35%	-8	-34%
Germany	2 344	3 768	3 736	85.8%	1 392	59%	-32	-1%
Greece	-	-	-	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	NO	NO	NO	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	10	11	0.2%	11	∞	1	8%
Luxembourg	NO	1	1	0.0%	1	∞	0	1%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	3	7	6	0.1%	3	95%	-1	-15%
Portugal	NO,IE	5	3	0.1%	3	∞	-2	-32%
Romania	NO	2	0	0.0%	0	∞	-2	-91%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	9	10	0.2%	10	∞	1	9%
Spain	NO	NO	NO	-	-	-	-	-
Sweden	NO	C	C	-	-	-	-	-
United Kingdom	70	39	35	0.8%	-34	-49%	-3	-9%
EU-27+UK	**2 521**	**4 391**	**4 357**	**100%**	**1 836**	**73%**	**-34**	**-1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	70	39	35	0.8%	-34	-49%	-3	-9%
EU-KP	**2 521**	**4 391**	**4 357**	**100%**	**1 836**	**73%**	**-34**	**-1%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

Figure **3.31**Figure 3.103 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions. It can be seen that the highest share on total CO_2 emissions correspond to Germany (86%) for 2020.

Figure 3.103: 1.A.2.g Other, other fossil fuels: Emission trend and share for CO_2

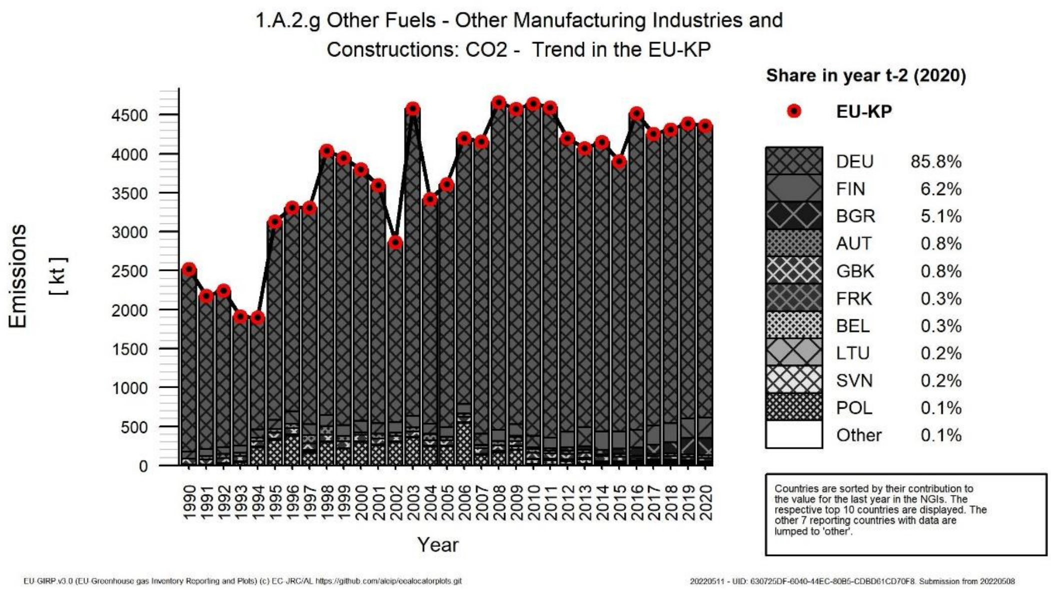


Figure 3.104 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU-KP submissions for 1990-2020. CO_2 IEF equaled to 74.12 t/TJ in 2020.

Figure 3.104: 1.A.2.g Other, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)

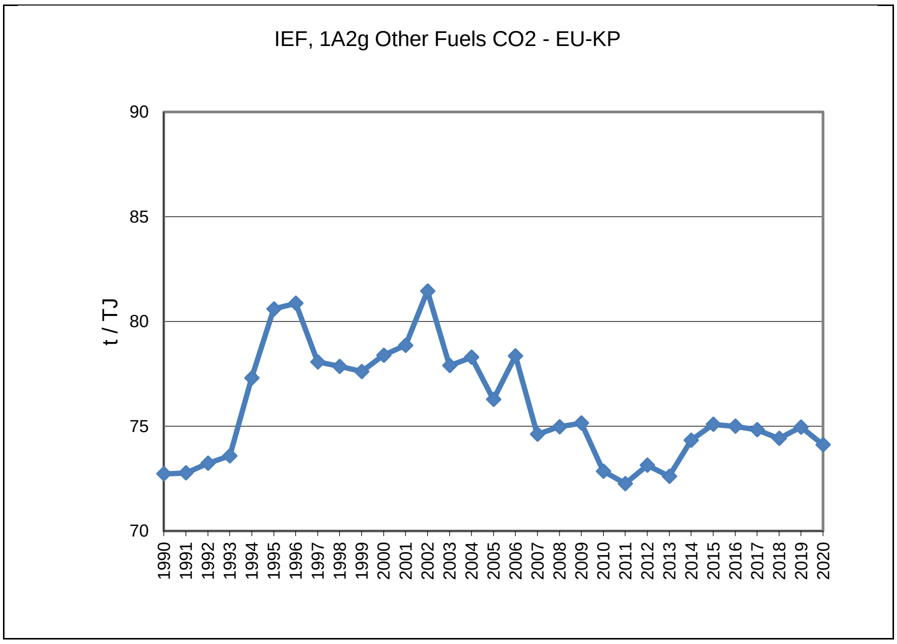
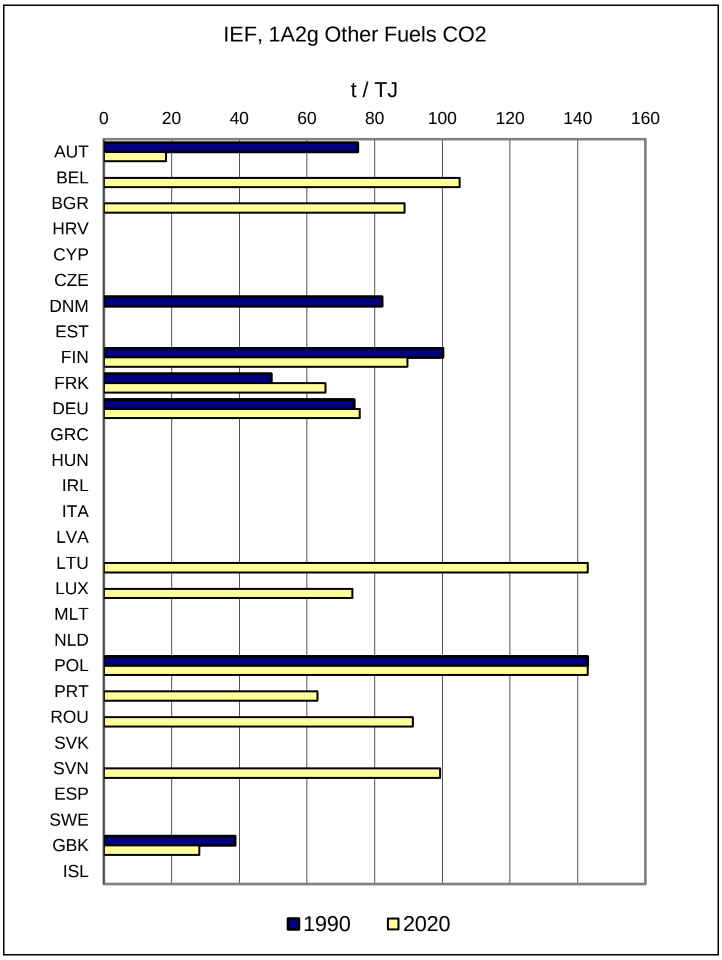


Figure 3.105 shows comparison of CO_2 IEF used by countries for emission estimates in 1990 and 2020. The comparatively low implied emission factor of Austria is mainly due to reporting of industrial waste where carbon content is taken into consideration. In the United Kingdom, low implied emission factor is mainly due to the use of waste solvents.

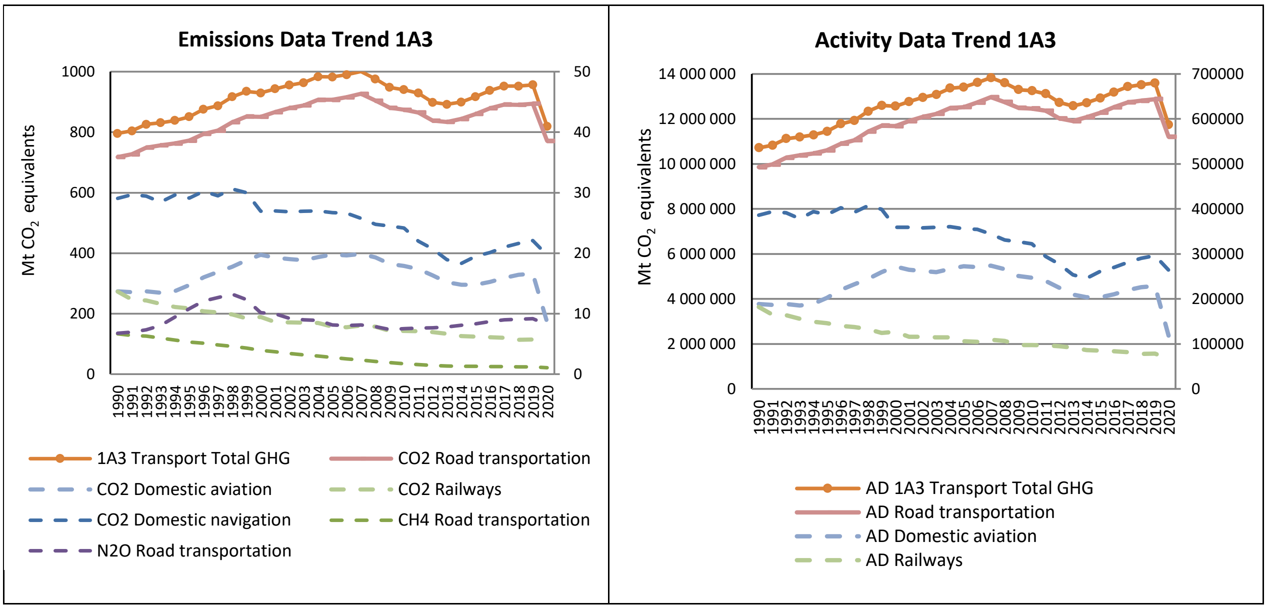
Figure 3.105: 1.A.2.g Other, other fossil fuels: Implied Emission Factors for CO_2 by Member States, United Kingdom and Iceland (in t/TJ)



3.2.3 Transport (CRF Source Category 1A3) (EU-KP)

Greenhouse gas emissions from 1A3 Transport are shown in Figure **3.106**. CO_2 emissions from this source category account for 21.8 %, CH_4 for 0.03 %, N_2O for 0.24 % of total GHG emissions (without LULUCF). Between 1990 and 2020, GHG from transport increased by 1 % in the EU-KP.

Figure 3.106 1A3 Transport: Greenhouse gas emissions in CO_2 equivalents (Mt) and Activity Data in TJ



Data displayed as dashed line refers to the secondary axis.

Table 3-54 summarizes the share of countries using higher tier methods for calculating emissions for the key categories of the transport categories. If the information on tier methods used is not available in the following tables of each subsector, the countries NIRs were reviewed so as to calculate the share of higher tiers. As presented, most countries use higher tiers, whereas the lower percentage is observed for 1A3d Domestic navigation: residual fuel oil, where most countries use T1 method for calculating corresponding emissions. It should be mentioned that as high tiers methods are categorised all used methods expect for the cases where only T1 method was used. In all cases, France, Germany, Italy, Spain and United Kingdom are mainly influencing the share of higher tiers.

Table 3-54: Key category analysis for the EU (1A3 sector excerpt): Key source categories for level and trend analyses and share of countries emissions using higher tier methods

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
1.A.3.a Domestic Aviation: Jet Kerosene (CO_2)	13188	8468	0	L	L	96.3%
1.A.3.b Road Transportation: Diesel Oil (CO_2)	303434	549167	T	L	L	88.3%
1.A.3.b Road Transportation: Diesel Oil (N_2O)	1817	6942	T	0	L	89.3%
1.A.3.b Road Transportation: Gaseous Fuels (CO_2)	508	4302	T	0	0	78.5%
1.A.3.b Road Transportation: Gasoline (CH_4)	6077	708	T	0	0	91.1%
1.A.3.b Road Transportation: Gasoline (CO_2)	406396	200889	T	L	L	92.4%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7346	13844	T	0	L	98.5%
1.A.3.c Railways: Liquid Fuels (CO_2)	13007	4822	T	L	0	
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CO_2)	17757	12444	0	L	L	92.3%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CO_2)	9632	5322	0	L	L	77.8%

Table 3-55 shows total GHG, CO_2, CH_4 and N_2O emissions from 1A3 Transport.

Table 3-55 1A3 Transport: Countries' contributions to CO_2 emissions, CH_4 and N_2O emissions

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt		N2O emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020	1990	2020
Austria	13 957	21 183	13 756	20 919	127	245	74	19
Belgium	20 926	21 661	20 611	21 406	176	240	140	16
Bulgaria	6 522	9 351	6 345	9 241	108	91	68	19
Croatia	3 896	5 802	3 787	5 732	67	61	42	9
Cyprus	1 249	1 924	1 218	1 901	24	21	7	3
Czechia	11 347	17 785	11 087	17 562	182	200	78	23
Denmark	10 787	12 032	10 609	11 892	98	130	79	9
Estonia	2 482	2 233	2 421	2 205	39	24	22	3
Finland	12 095	10 443	11 821	10 345	161	86	113	12
France	122 293	109 469	120 341	108 179	975	1 147	977	143
Germany	164 503	147 151	161 504	145 264	1 411	1 673	1 589	215
Greece	14 520	15 358	14 137	15 098	273	201	110	59
Hungary	8 913	12 585	8 721	12 425	124	140	69	20
Ireland	5 145	10 296	5 030	10 169	67	119	49	7
Italy	102 191	85 436	100 319	84 462	968	808	904	166
Latvia	3 040	3 109	2 940	3 069	81	37	20	3
Lithuania	5 816	6 145	5 685	6 065	91	73	40	7
Luxembourg	2 617	4 677	2 589	4 621	16	53	13	3
Malta	318	571	313	566	3	4	3	1
Netherlands	28 016	26 329	27 711	26 040	109	229	197	60
Poland	20 757	63 238	20 277	62 474	319	674	160	90
Portugal	10 820	14 831	10 618	14 666	102	147	99	18
Romania	12 451	18 401	12 069	18 123	288	246	94	32
Slovakia	6 824	7 069	6 693	6 990	100	74	30	4
Slovenia	2 738	4 581	2 673	4 523	37	54	28	4
Spain	58 670	74 256	57 739	73 354	520	807	411	95
Sweden	20 046	15 391	19 690	15 155	192	190	164	46
United Kingdom	121 343	96 770	118 655	95 728	1 432	966	1 256	76
EU-27+UK	**794 282**	**818 077**	**779 358**	**808 175**	**8 088**	**8 740**	**6 836**	**1 161**
Iceland	724	887	699	876	20	10	6	1
United Kingdom (KP)	122 162	97 373	119 458	96 325	1 440	971	1 264	77
EU-KP	**795 826**	**819 567**	**780 860**	**809 649**	**8 116**	**8 755**	**6 850**	**1 163**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3-56 provides information on the contribution of countries to EU-KP recalculations in CO_2 from 1A3 Transport for 1990 and 2019 and main explanations for the largest recalculations in absolute terms.

Table 3-56 1A3 Transport: Contribution of countries to EU-KP recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Main Explanations for 1990	Main Explanations for 2020
	kt CO_2	%	kt CO_2	%		
Austria	-0.0	-0.0	-0.2	-0.0	-	-
Belgium	-15	-0.1	23	0.1	Use of other COPERT version: during submission 2021 COPERT 5.4.36 was used, during this submission COPERT 5.5.1 is used.	Use of other COPERT version: during submission 2021 COPERT 5.4.36 was used, during this submission COPERT 5.5.1 is used.
Bulgaria	4.3	0.1	1.3	0.0	A detailed review of the activity data and parameters used in the COPERT model was undertaken.	A detailed review of the activity data and parameters used in the COPERT model was undertaken.
Croatia	0.0	0.0	-0.0	-0.0	-	-
Cyprus	1.5	0.1	2.9	0.1	Road Transport recalculations due to new activity data (fleet).	Road Transport recalculations due to new activity data (fleet).
Czechia	-131	-1.2	-27	-0.1	Updated activity data in COPERT database.	Updated activity data in COPERT database.
Denmark	17	0.2	-21	-0.2	The emission estimates for the years 1990-	The emission estimates for the years 1990-

	1990		2019		Main Explanations for 1990	Main Explanations for 2020
	kt CO_2	%	kt CO_2	%		
					2019 have been updated according to the latest energy statistics published by the Danish Energy Agency.	2019 have been updated according to the latest energy statistics published by the Danish Energy Agency.
Estonia	10	0.4	8.6	0.4	Emissions were recalculated due to using updated Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, and updated data in COPERT model.	Emissions were recalculated due to using updated Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, and updated data in COPERT model.
Finland	-2.2	-0.0	-13	-0.1	-	1.A.3b: CO_2 emission factor of fossil diesel was updated 1.A.3c: RAILI model renewed due to activity data changes 1.A.3e: data reallocated to 1.A.5 due to confidentiality"
France	99	0.1	-593	-0.5	-	-
Germany	-423	-0.3	-236	-0.1	-	-
Greece	12	0.1	25	0.1	-	Updated activity data and correction of small errors.
Hungary	0.0	0.0	6.4	0.0	-	-
Ireland	-0.2	-0.0	19	0.2	Revision of fuel data in the most recent energy statistics.	Revision of fuel data in the most recent energy statistics.
Italy	0.1	0.0	-144	-0.1	Update of COPERT model version for road transport estimates (5.5.1).	Update of diesel fuel consumption for agriculture and fishing categories and of road transport model COPERT (version 5.5.1).
Latvia	-0.0	-0.0	-0.3	-0.0	Recalculations have been done due to switch from COPERT 5.3 model version to COPERT 5.5 model version (corrected EF for EU standards (Convention, Euro 1-3).	Recalculations have been done due to switch from COPERT 5.3 model version to COPERT 5.5 model version (corrected EF for EU standards (Convention, Euro 1-3). In addition, GHG emissions for buses have been recalculates for 2015-2019, as the distribution of buses by group (Urban Buses Midi <=15 t, Urban Buses Standard 15 - 18 t, Urban Buses Articulated >18 t) has been clarified.
Lithuania	-	-	2.6	0.0	-	Recalculation in road transport was done for PC diesel cars due to the correction of previously made mistake. Recalculations in Natural gas transportation in pipelines (CRF 1.A.3.e.i) were done due to updated activity data in Fugitive emissions.
Luxembourg	0.0	0.0	0.2	0.0	-	Changes of country-specific CO_2 emission factors for liquid fuels, reallocation of LPG in energy balance.
Malta	-13	-4.0	-34	-4.5	Update in activity data (Fuel consumption) /changes in Emissions factors/ changes in the methodology.	Update in activity data (Fuel consumption) /changes in Emissions factors/ changes in the methodology.
Netherlands	-0.3	-0.0	-134	-0.4	Model update for fossil part in biofuels.	Final energy statistics and improved allocation biogenic part of natural gas.
Poland	1.8	0.0	33	0.1	-	in 1A3b - AD data and the method of calculation from COPERT 5.4 to COPERT 5.5 was changed.
Portugal	-	-	-1.6	-0.0	-	[1.A.3.b] Update of Activity Data in Road Transport; [1.A.3.c] Biofuel incorporation in Diesel.
Romania	10	0.1	1.2	0.0	Recalculations have been made for the year 1989, because of the update of the activity data, the update of the net calorific values, and the update of the country specific emission factors on 1A3c category - Railways and on 1A3d category - Domestic navigation.	Recalculations have been made because of the update of the activity data, the update of the net calorific values, and the update of the country specific emission factors on 1A3c category - Railways, on 1A3d category

	1990		2019		Main Explanations for 1990	Main Explanations for 2020
	kt CO_2	%	kt CO_2	%		
						- Domestic navigation and on 1A3e category - Other transportation.
Slovakia	-	-	60	0.7	-	Recalculations of road transportation using new version of model COPERT.
Slovenia	0.1	0.0	0.0	0.0	Use of the new Copert version (5.5.1)	Use of the new Copert version (5.5.1)
Spain	-3.5	-0.0	234	0.3	Activity data (stock of vehicles, mileage, etc.) has been updated including new data sources. The methodology of emission estimations (EF and equations) has been updated according to guidebook EMEP/EEA (2019).	Activity data (stock of vehicles, mileage, etc.) has been updated including new data sources. The methodology of emission estimations (EF and equations) has been updated according to guidebook EMEP/EEA (2019).
Sweden	994	5.3	560	3.5	Recalculation of fuel consumption assigned to working machinery.	Recalculation of fuel consumption assigned to working machinery.
United Kingdom	-4.5	-0.0	193	0.2	Reallocation from 1A2a to 2C1.	No significant recalculations.
EU27+UK	**557**	**0.1**	**-34**	**-0.0**	-	-
Iceland	94	15.5	39	3.8	Fuel used in Off road machinery moved from 1A2 to 1A3. Reallocation of fuel by the NEA from 1A3d to 1A4cii and 1D1b.	Fuel used in Off road machinery moved from 1A2 to 1A3. Also, the NEA reallocated fuel from 1A4 to 1A3.
United Kingdom (KP)	-1.4	-0.0	184	0.2	Reallocation from 1A2a to 2C1.	No significant recalculations.
EU-KP	**654**	**0.1**	**-4.6**	**-0.0**	-	-

Table 3-58 provides information on the contribution of countries to EU-KP recalculations in CH_4 from 1A3 Transport for 1990 and 2019.

Table 3-57 1A3 Transport: Contribution of countries to EU-KP recalculations in CH_4 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Main explanations for 1990	Main explanations for 2020
	kt CO_2 equiv.	%	kt CO_2 equiv.	%		
Austria	0.0	0.0	-0.0	-0.0	-	-
Belgium	-1.3	-0.9	-3.8	-17	Use of other COPERT version: during submission 2021 COPERT 5.4.36 was used, during this submission COPERT 5.5.1 is used.	Use of other COPERT version: during submission 2021 COPERT 5.4.36 was used, during this submission COPERT 5.5.1 is used.
Bulgaria	-	-	-0.4	-1.8	A detailed review of the activity data and parameters used in the COPERT model was undertaken.	A detailed review of the activity data and parameters used in the COPERT model was undertaken.
Croatia	0.8	1.8	-0.1	-1.4	Changes due to the use of new COPERT model version.	New version of COPERT model was used.
Cyprus	0.2	2.9	-0.0	-1.1	Road Transport recalculations due to new activity data (fleet).	Road Transport recalculations due to new activity data (fleet).
Czechia	3.5	4.7	2.4	10	Updated activity data in COPERT database.	Updated activity data in COPERT database.
Denmark	0.3	0.3	-0.1	-0.7	The emission estimates for the years 1990-2019 have been updated according to the latest energy statistics published by the Danish Energy Agency.	The emission estimates for the years 1990-2019 have been updated according to the latest energy statistics published by the Danish Energy Agency.
Estonia	-0.9	-4.1	-1.1	-23	Emissions were recalculated due to using updated Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, and updated data in COPERT model. Estonia developed	Emissions were recalculated due to using updated Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, and updated data in COPERT model. Estonia developed

	1990		2019		Main explanations for 1990	Main explanations for 2020
	kt CO_2 equiv.	%	kt CO_2 equiv.	%		
					Tier 3 country-specific CH_4 and N_2O emission factors for CNG and bio-CNG for passenger cars and buses. Emissions were recalculated for the whole time series.	Tier 3 country-specific CH_4 and N_2O emission factors for CNG and bio-CNG for passenger cars and buses. Emissions were recalculated for the whole time series.
Finland	-0.0	-0.0	0.0	0.0	-	1.A.3c: RAILI model renewed due to activity data changes 1.A.3e: data reallocated to 1.A.5 due to confidentiality.
France	1.6	0.2	9.0	5.7	-	-
Germany	15	0.9	-4.1	-1.7	-	-
Greece	0.0	0.0	0.3	0.5	-	Updated activity data and correction of small errors.
Hungary	0.0	0.0	-0.0	-0.0	-	-
Ireland	-0.6	-1.2	-0.8	-8.0	-	-
Italy	-0.0	-0.0	0.0	0.0	-	Update of diesel fuel consumption for agriculture and fishing categories and of road transport mdel COPERT (version 5.5.1).
Latvia	-0.2	-1.1	0.1	1.6	Recalculations have been done due to switch from COPERT 5.3 model version to COPERT 5.5 model version (corrected EF for EU standards (Convention, Euro 1-3).	Recalculations have been done due to switch from COPERT 5.3 model version to COPERT 5.5 model version (corrected EF for EU standards (Convention, Euro 1-3). In addition, GHG emissions for buses have been recalculates for 2015-2019, as the distribution of buses by group (Urban Buses Midi <=15 t, Urban Buses Standard 15 - 18 t, Urban Buses Articulated >18 t) has been clarified.
Lithuania	-	-	-0.0	-0.0	-	Recalculations in Natural gas transportation in pipelines (CRF 1.A.3.e.i) were done due to updated activity data in Fugitive emissions.
Luxembourg	-	-	0.0	0.0	-	-
Malta	-0.0	-1.2	-3.3	-73	Update in activity data (Fuel consumption) and changes in methodology (Updated emission factors: Domestic Navigation and Domestic Aviation).	Update in activity data (Fuel consumption) and changes in methodology (Updated emission factors: Domestic Navigation and Domestic Aviation).
Netherlands	1.8	0.9	0.4	0.6	Model update for fossil part in biofuels.	Final energy statistics and improved allocation biogenic part of natural gas.
Poland	0.3	0.2	-32	-24	-	in 1A3b - AD data and the method of calculation from COPERT 5.4 to COPERT 5.5 was changed.
Portugal	-	-	0.3	1.2	-	[1.A.3.b] Update of Activity Data in Road Transport.
Romania	0.0	0.0	0.0	0.0	-	Recalculations have been made because of the update of the activity data on 1A3c category - Railways, on 1A3d category - Domestic navigation and on 1A3e category - Other transportation.
Slovakia	-	-	-2.1	-28	-	Recalculations of road transportation using new version of model COPERT.
Slovenia	-0.1	-0.5	-0.0	-0.9	Use of the new Copert version (5.5.1)	Use of the new Copert version (5.5.1)
Spain	28	7.4	24	25	Activity data (stock of vehicles, mileage, etc.) has been updated including new data sources. The methodology of emission estimations (EF and equations) has been updated according to guidebook EMEP/EEA (2019).	Activity data (stock of vehicles, mileage, etc.) has been updated including new data sources. The methodology of emission estimations (EF and equations) has been updated according to guidebook EMEP/EEA (2019).
Sweden	1.8	1.1	-0.3	-0.7	Recalculation of fuel consumption assigned to working machinery.	Recalculation of fuel consumption assigned to working

	1990		2019		Main explanations for 1990	Main explanations for 2020
	kt CO_2 equiv.	%	kt CO_2 equiv.	%		
						machinery.Recalculation of activity data. New activity data.
United Kingdom	7.5	0.6	-8.4	-8.0	No significant recalculations.	Lower emissions from petrol cars due to no longer incorporating an ANPR correction.
EU27+UK	**58**	**0.8**	**-20**	**-1.5**	-	-
Iceland	0.1	1.9	0.1	3.6	Fuel used in Off road machinery moved from 1A2 to 1A3. Reallocation of fuel by the NEA from 1A3d to 1A4cii and 1D1b.	Fuel used in Off road machinery moved from 1A2 to 1A3. Also, the NEA reallocated fuel from 1A4 to 1A3.
United Kingdom (KP)	7.4	0.6	-8.7	-8.2	No significant recalculations.	Lower emissions from petrol cars due to no longer incorporating an ANPR correction.
EU-KP	**58**	**0.8**	**-20**	**-1.5**	-	-

Table 3-58 provides information on the contribution of countries to EU-KP recalculations in N_2O from 1A3 Transport for 1990 and 2019.

Table 3-58 1A3 Transport: Contribution of countries to EU-KP recalculations in N_2O for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Main explanations for 1990	Main explanations for 2020
	kt CO_2 equiv.	%	kt CO_2 equiv.	%		
Austria	0.0	0.0	0.1	0.0	-	-
Belgium	-2	-0.9	-7.7	-2.8	Use of other COPERT version: during submission 2021 COPERT 5.4.36 was used, during this submission COPERT 5.5.1 is used.	Use of other COPERT version: during submission 2021 COPERT 5.4.36 was used, during this submission COPERT 5.5.1 is used.
Bulgaria	-18	-14.4	-46	-32	A detailed review of the activity data and parameters used in the COPERT model was undertaken.	A detailed review of the activity data and parameters used in the COPERT model was undertaken.
Croatia	-0.8	-1.2	-4.7	-7.0	Changes due to the use of new COPERT model version.	New version of COPERT model was used.
Cyprus	-6.8	-21.8	-0.6	-2.6	Road Transport recalculations due to new activity data (fleet).	Road Transport recalculations due to new activity data (fleet).
Czechia	-5.6	-3.0	11	5.7	Updated activity data in COPERT database.	Updated activity data in COPERT database.
Denmark	0.3	0.3	0.1	0.1	The emission estimates for the years 1990-2019 have been updated according to the latest energy statistics published by the Danish Energy Agency.	The emission estimates for the years 1990-2019 have been updated according to the latest energy statistics published by the Danish Energy Agency.
Estonia	0.2	0.6	-0.4	-1.7	Emissions were recalculated due to using updated Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, and updated data in COPERT model. Estonia developed Tier 3 country-specific CH_4 and N_2O emission factors for CNG and bio-CNG for passenger cars and buses. Emissions were recalculated for the whole time series.	Emissions were recalculated due to using updated Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, and updated data in COPERT model. Estonia developed Tier 3 country-specific CH_4 and N_2O emission factors for CNG and bio-CNG for passenger cars and buses. Emissions were recalculated for the whole time series.
Finland	-0.0	-0.0	-0.0	-0.0	-	1.A.3c: RAILI model renewed due to activity data changes 1.A.3e: data reallocated to 1.A.5 due to confidentiality"
France	38	4.0	130	10.4	-	-
Germany	-12	-0.9	-8.6	-0.5	-	-

	1990		2019		Main explanations for 1990	Main explanations for 2020
	kt CO_2 equiv.	%	kt CO_2 equiv.	%		
Greece	0.1	0.0	-0.7	-0.3	-	Updated activity data and correction of small errors.
Hungary	-3.2	-2.5	-4.1	-2.5	-	-
Ireland	-2.7	-3.8	-7.4	-5.2	-	-
Italy	-24	-2.4	-48	-4.7	Update of COPERT model version for road transport estimates (5.5.1) and in particular N_2O emissions from LPG and LNG vehicles.	Update of diesel fuel consumption for agriculture and fishing categories and of road transport model COPERT (version 5.5.1) in particular N_2O emissions from LPG and LNG vehicles.
Latvia	-0.7	-0.8	0.1	0.3	Recalculations have been done due to switch from COPERT 5.3 model version to COPERT 5.5 model version (corrected EF for EU standards (Convention, Euro 1-3).	Recalculations have been done due to switch from COPERT 5.3 model version to COPERT 5.5 model version (corrected EF for EU standards (Convention, Euro 1-3). In addition, GHG emissions for buses have been recalculates for 2015-2019, as the distribution of buses by group (Urban Buses Midi <=15 t, Urban Buses Standard 15 - 18 t, Urban Buses Articulated >18 t) has been clarified.
Lithuania	-	-	-0.0	-0.0	-	Recalculations in Natural gas transportation in pipelines (CRF 1.A.3.e.i) were done due to updated activity data in Fugitive emissions.
Luxembourg	-	-	0.0	0.0	-	-
Malta	-0.1	-2.5	-0.0	-0.2	Update in activity data (Fuel consumption) and changes in methodology (Updated emission factors: Domestic Navigation and Domestic Aviation).	Update in activity data (Fuel consumption) and changes in methodology (Updated emission factors: Domestic Navigation and Domestic Aviation).
Netherlands	3.6	3.4	11	4.2	Model update for fossil part in biofuels.	Final energy statistics and improved allocation biogenic part of natural gas.
Poland	-0.4	-0.1	26	3.9	-	in 1A3b - AD data and the method of calculation from COPERT 5.4 to COPERT 5.5 was changed.
Portugal	-	-	0.8	0.5	-	[1.A.3.b] Update of Activity Data in Road Transport.
Romania	2.4	0.8	0.0	0.0	Recalculations have been made for the year 1989, because of the update of the activity data, the update of the net calorific values, and the update of the country specific emission factors on 1A3c category – Railways.	Recalculations have been made because of the update of the activity data on 1A3c category - Railways, on 1A3d category - Domestic navigation and on 1A3e category - Other transportation.
Slovakia	-	-	0.4	0.5	-	Recalculations of road transportation using new version of model COPERT.
Slovenia	1.5	4.2	-3.6	-5.4	Use of the new Copert version (5.5.1)	Use of the new Copert version (5.5.1)
Spain	-3.8	-0.7	-4.6	-0.5	Activity data (stock of vehicles, mileage, etc.) has been updated including new data sources. The methodology of emission estimations (EF and equations) has been updated according to guidebook EMEP/EEA (2019).	Activity data (stock of vehicles, mileage, etc.) has been updated including new data sources. The methodology of emission estimations (EF and equations) has been updated according to guidebook EMEP/EEA (2019).
Sweden	15	8.7	-0.4	-0.2	Recalculation of fuel consumption assigned to working machinery.	Recalculation of fuel consumption assigned to working machinery.Recalculation of activity data. New activity data.
United Kingdom	-12	-0.8	-92	-7.5	No significant recalculations.	Revision to fleet turnover model.
EU27+UK	**-31**	**-0.4**	**-49**	**-0.5**	-	-
Iceland	13	202	2	19	Fuel used in Off road machinery moved from 1A2 to 1A3. Reallocation of fuel by the NEA from 1A3d to 1A4cii and 1D1b.	Fuel used in Off road machinery moved from 1A2 to 1A3. Also, the NEA reallocated fuel from 1A4 to 1A3.
United Kingdom (KP)	-12	-0.8	-93	-7.4	No significant recalculations.	Revision to fleet turnover model

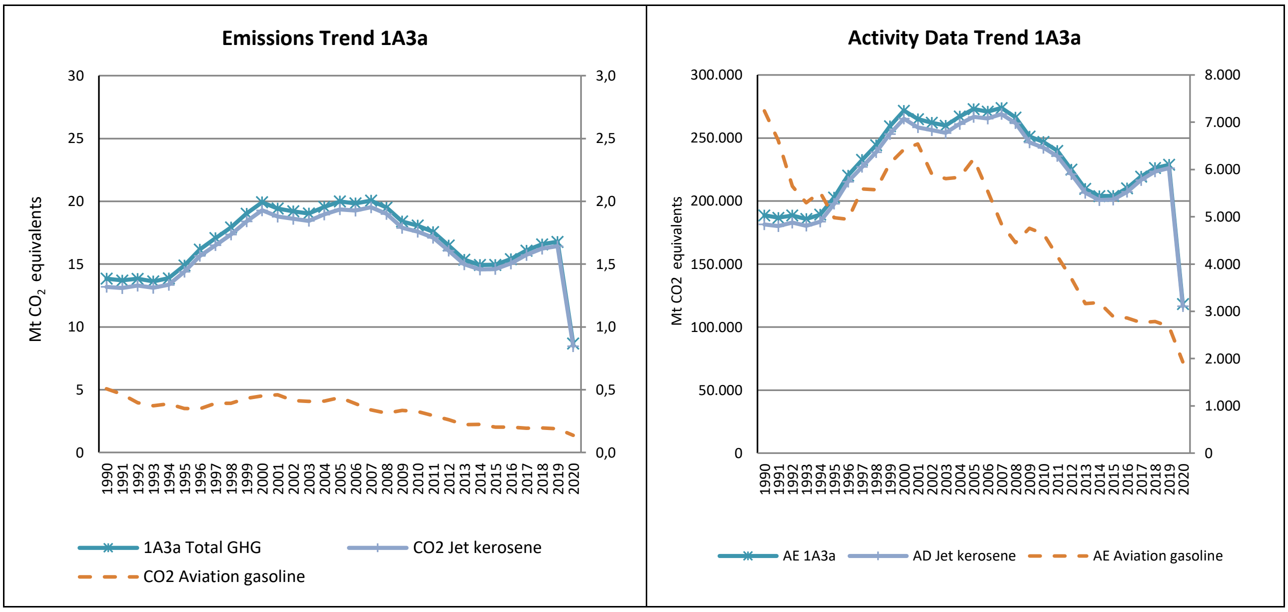
	1990		2019		Main explanations for 1990	Main explanations for 2020
	kt CO_2 equiv.	%	kt CO_2 equiv.	%		
EU-KP	-18	-0.2	-48	-0.5	-	-

3.2.3.1 Domestic Aviation (1A3a) (EU-KP)

This source category includes emissions from civil domestic passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.), including take-offs and landings for these flight stages. It should be noted that emissions from military aviation should be reported under category 1A5b Other Mobile, which is the case for most countries. However, Poland, have stated that all military activities are reported and included in the country's energy balance. For confidentiality reasons, the military share is not reported separately. The corresponding explanation is also included in the NIR submission. Furthermore, Iceland does not report emissions under category 1A5b in the CRF. During the ESD checks Iceland informed the EU that there is no military in Iceland, thus emissions from military aviation are not occurring.

CO_2 emissions from 1A3a Domestic Aviation account for 1 % of total transport related GHG emissions in 2020. Between 1990 and 2020, CO_2 emissions from domestic aviation decreased by 37 % in the EU-KP. CO_2 emissions from Jet Kerosene account for 99 % of total CO_2 emissions from 1A3a Domestic Aviation. Between 2019 and 2020, CO_2 emissions from domestic aviation decreased by 48 % in the EU-KP (Figure **3.107**, Table 3-59).

*Figure **3**.107 1A3a Civil Aviation: CO_2 Emissions in CO_2 equivalents (Mt) and Activity data in TJ*



Data displayed as dashed line refers to the secondary axis.

The countries France, Germany, Italy and Spain alone contributed 79.1 % to the emissions from this source. Twenty countries in total decreased emissions from civil aviation between 1990 and 2020 (Table 3-59). Based on the following table Germany and Italy used also T1 method for calculation emissions, but they used higher tier method for calculating emissions from jet kerosene, which contributes the most to this category. Thus, the total percentage of the share of higher tier methods amounts to 96.3%.

Table 3-59 1A3a Civil Aviation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	38	46	23	0.3%	-15	-39%	-23	-50%	T2,T3	CS
Belgium	15	10	9	0.1%	-6	-39%	-1	-13%	T1	D
Bulgaria	49	21	12	0.1%	-37	-75%	-9	-41%	T1,T2	D
Croatia	7	32	17	0.2%	10	152%	-15	-48%	T1	D
Cyprus	26	0	0	0.0%	-26	-100%	0	-75%	T1	D
Czechia	9	15	10	0.1%	1	17%	-5	-31%	T2	M
Denmark	226	148	78	0.9%	-148	-65%	-70	-47%	CR,M,T2	CS
Estonia	6	4	4	0.0%	-2	-35%	0	-8%	T2	D
Finland	385	206	86	1.0%	-299	-78%	-120	-58%	T1,T2	CS
France	4 134	4 980	3 051	35.5%	-1 083	-26%	-1 929	-39%	T3	M
Germany	2 411	2 229	1 038	12.1%	-1 373	-57%	-1 191	-53%	CS,T1,T2	CS,D,M
Greece	336	410	213	2.5%	-122	-36%	-197	-48%	T2,T3	D
Hungary	4	8	4	0.0%	0	12%	-4	-46%	T1,T2	CS,D
Ireland	48	17	13	0.2%	-35	-72%	-4	-24%	M,T3	CS
Italy	1 493	2 379	1 195	13.9%	-298	-20%	-1 184	-50%	T1,T2	CS
Latvia	0	2	1	0.0%	1	2179%	0	-9%	T1	D
Lithuania	8	2	2	0.0%	-6	-76%	0	-4%	T1	CS
Luxembourg	0	1	0	0.0%	0	130%	0	-3%	T1	D
Malta	1	0	0	0.0%	-1	-88%	0	-44%	T1	D
Netherlands	85	32	24	0.3%	-61	-72%	-8	-25%	T1	CS,D
Poland	63	128	73	0.9%	10	16%	-54	-42%	T1	D
Portugal	178	496	257	3.0%	79	45%	-238	-48%	T1,T3	D
Romania	25	194	116	1.3%	91	365%	-78	-40%	T1,T2	D,OTH
Slovakia	4	2	1	0.0%	-3	-76%	-1	-52%	T3	D
Slovenia	1	2	2	0.0%	0	46%	0	-20%	T1	D
Spain	1 655	3 127	1 516	17.6%	-139	-8%	-1 611	-52%	T3	D
Sweden	673	470	195	2.3%	-478	-71%	-275	-58%	T1	D
United Kingdom	1 531	1 438	576	6.7%	-955	-62%	-862	-60%	T3	CS
EU-27+UK	**13 410**	**16 396**	**8 517**	**99%**	**-4 893**	**-36%**	**-7 879**	**-48%**	**-**	**-**
Iceland	33	28	13	0.2%	-20	-61%	-15	-53%	T1	D
United Kingdom (KP)	1 784	1 630	649	7.5%	-1 135	-64%	-981	-60%	T3	CS
EU-KP	**13 696**	**16 616**	**8 603**	**100%**	**-5 093**	**-37%**	**-8 013**	**-48%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3a Domestic Aviation – Jet Kerosene (CO_2)

In 2020 CO_2 emissions resulting from jet kerosene within the category 1A3a were responsible for 99 % of CO_2 emissions in 1A3a. Within the EU-KP the emissions decreased between 1990 and 2020 by 36% (Table 3-60). The largest absolute decrease occurred in Germany. Between 2019 and 2020, EU-KP emissions decreased by 48 %.

Table 3-60 1A3a Civil Aviation, jet kerosene: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	31	39	18	0.2%	-13	-43%	-22	-55%	T3	CS
Belgium	12	9	8	0.1%	-4	-34%	-1	-12%	T1	D
Bulgaria	28	20	12	0.1%	-16	-58%	-8	-41%	T2	D
Croatia	6	31	15	0.2%	9	145%	-15	-50%	T1	D
Cyprus	26	0	0	0.0%	-26	-100%	0	-75%	T1	D
Czechia	8	6	5	0.1%	-4	-46%	-2	-27%	T2	M
Denmark	218	145	75	0.9%	-143	-66%	-70	-48%	CR,M,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	377	204	84	1.0%	-293	-78%	-120	-59%	T2	CS
France	4 043	4 931	3 015	35.6%	-1 028	-25%	-1 916	-39%	T3	M
Germany	2 276	2 209	1 024	12.1%	-1 252	-55%	-1 184	-54%	CS,T2	CS,M
Greece	311	403	208	2.5%	-104	-33%	-196	-49%	T3	D
Hungary	1	2	1	0.0%	0	4%	0	-30%	T2	CS
Ireland	45	15	12	0.1%	-33	-74%	-4	-24%	M,T3	CS
Italy	1 459	2 367	1 184	14.0%	-276	-19%	-1 184	-50%	T1,T2	CS
Latvia	0	1	1	0.0%	1	1610%	0	-32%	T1	D
Lithuania	7	1	1	0.0%	-7	-91%	0	13%	T1	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	0	0	0.0%	-1	-92%	0	-49%	T1	D
Netherlands	73	30	21	0.3%	-52	-71%	-8	-28%	T1	D
Poland	38	115	62	0.7%	24	63%	-53	-46%	T1	D
Portugal	176	495	256	3.0%	80	46%	-238	-48%	T3	D
Romania	25	188	112	1.3%	88	352%	-76	-40%	T2	OTH
Slovakia	4	2	1	0.0%	-3	-78%	-1	-54%	T3	D
Slovenia	NO	0	0	0.0%	0	∞	0	-53%	T1	D
Spain	1 628	3 115	1 506	17.8%	-122	-7%	-1 609	-52%	T3	D
Sweden	658	467	192	2.3%	-466	-71%	-275	-59%	T1	D
United Kingdom	1 462	1 414	570	6.7%	-892	-61%	-844	-60%	T3	CS
EU-27+UK	**12 914**	**16 210**	**8 382**	**99%**	**-4 532**	**-35%**	**-7 828**	**-48%**	**-**	**-**
Iceland	28	27	13	0.1%	-16	-55%	-14	-53%	T1	D
United Kingdom (KP)	1 707	1 605	643	7.6%	-1 064	-62%	-962	-60%	T3	CS
EU-KP	**13 188**	**16 427**	**8 468**	**100%**	**-4 720**	**-36%**	**-7 960**	**-48%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

France, Germany, Italy, Spain and the UK account for 87.1 % of CO_2 emissions from jet kerosene in 2020 (Figure **3.108**). Table 3-60 shows that the majority of emissions from Domestic Aviation jet kerosene were calculated using a higher tier method (96.3%) as presented in Table 6.1. Based on the table above, Italy, which is one of the major contributors to this category, mentions to use also T1 method. As stated in the NIR, T1 method is used for calculating emissions for N_2O and not CO_2 emissions. Thus, it was included in the share of the high tier methods calculation for CO_2 emissions. In Figure **3.109** the IEF is depicted, showing a mean value of around 73 t/TJ.

*Figure **3**.108 1A3a Civil Aviation, Jet Kerosene: Emission trend and share for CO_2*

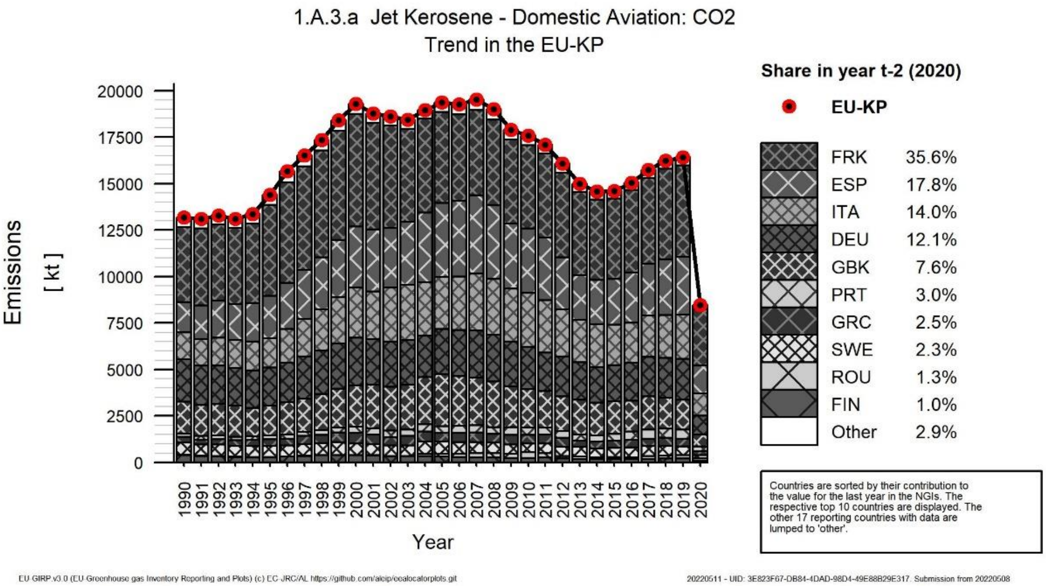
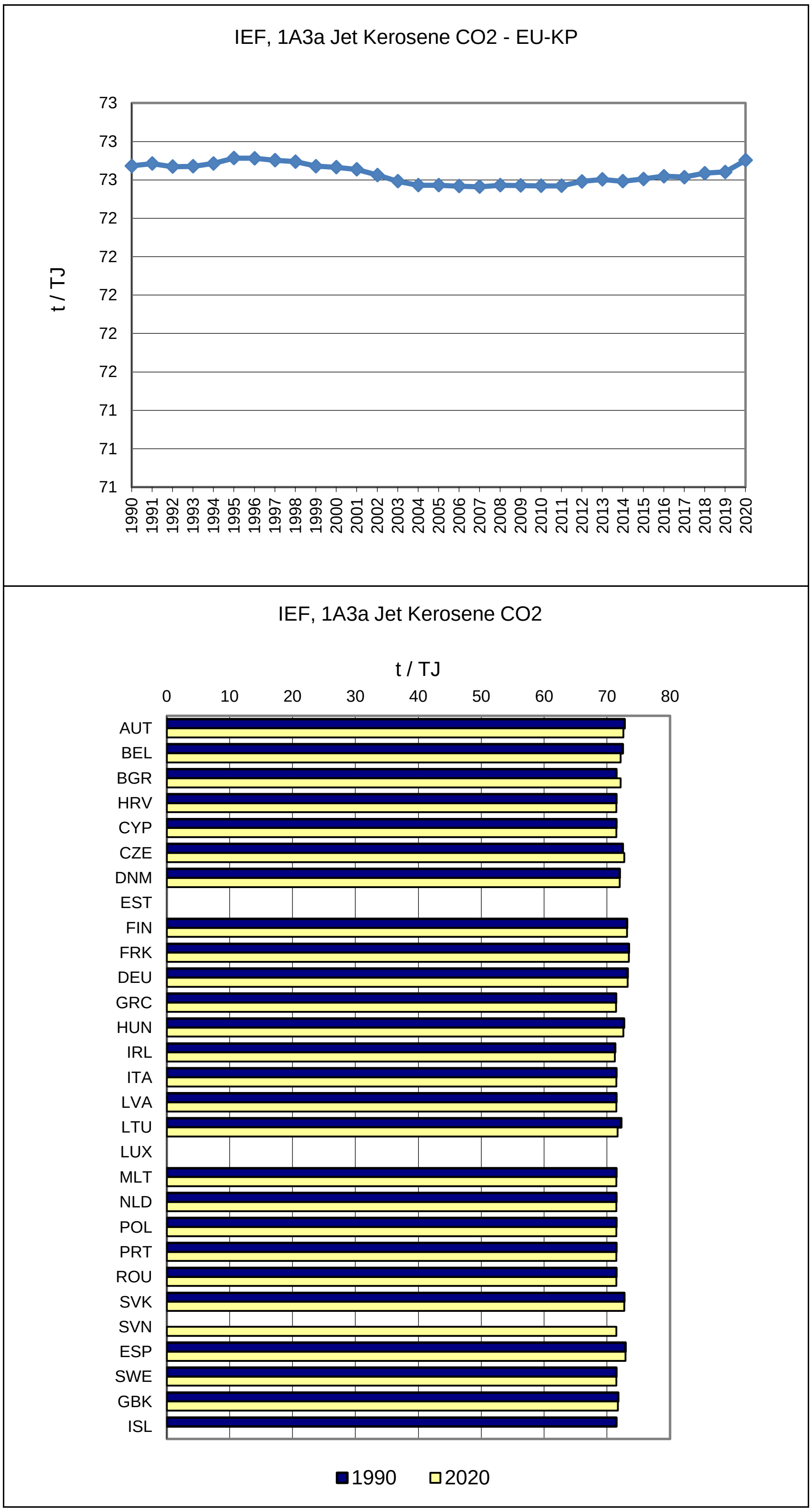


*Figure **3**.109 1A3a Civil Aviation, Jet Kerosene: Implied Emission Factors for CO_2 (in t/TJ)*



3.2.3.2 Road Transportation (1A3b) (EU-KP)

CO_2 emissions from 1A3b Road Transportation

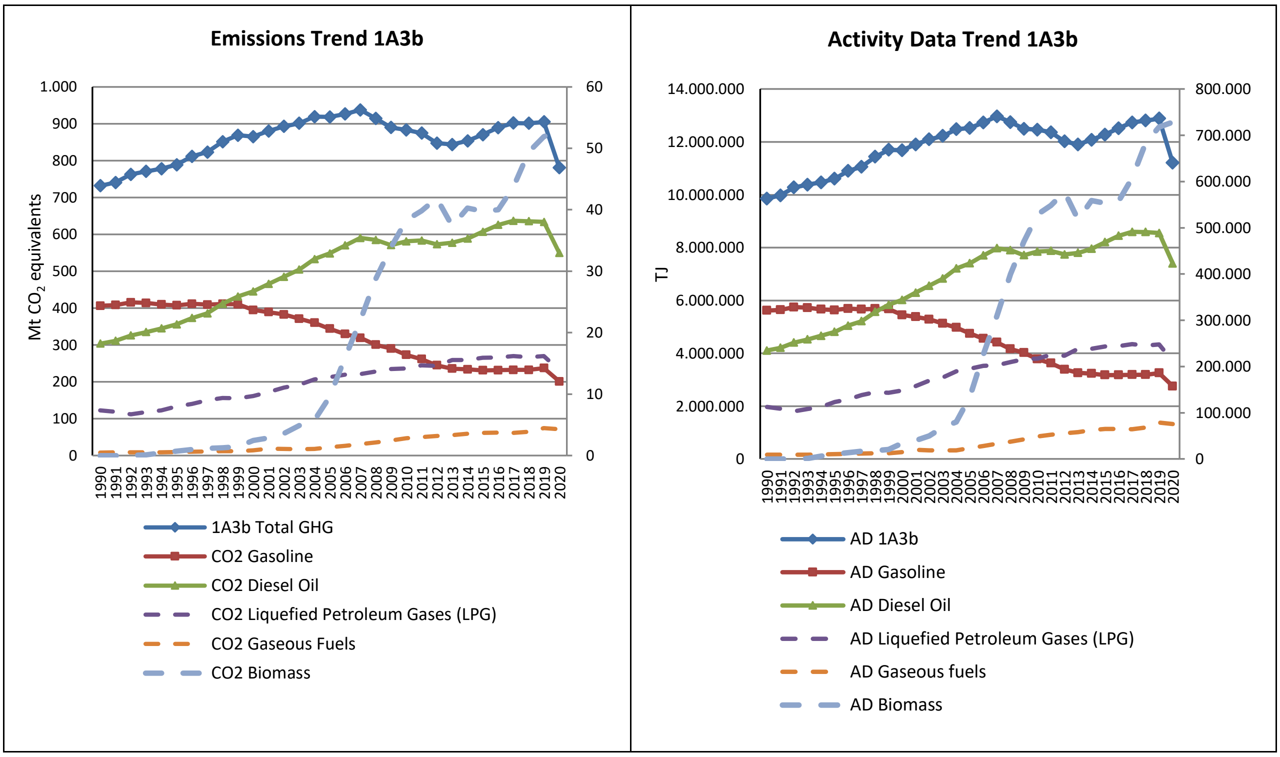
The mobile source category Road Transportation includes all types of light-duty vehicles such as passenger cars and light commercial trucks, and heavy-duty vehicles such as tractors, trailers and buses, and two and three-wheelers (including mopeds, scooters, and motorcycles). These vehicles operate on many types of gaseous and liquid fuels.

CO_2 emissions from 1A3b Road Transportation is the second largest key source of all categories in the EU-KP accounting for 21 % of total GHG emissions in 2020. Between 1990 and 2020, CO_2 emissions from road transportation increased by 7 % in the EU-KP (The **countries** Germany, France, Italy, Spain and the United Kingdom contributed most to the CO2 emissions from this source (62.3 %). All countries, except Estonia (-4%), Finland (-9%), France (-9%), Germany (-7%), Italy (-16%), Netherlands (-5%), Sweden (-20%) and United Kingdom (-18%), show decreased emissions from road transportation between 1990 and 2020. In the case of Sweden, the decreased emissions are explained by the total use of liquid biofuels (ethanol and FAME), which has increased by more than 850% since 2003. Ethanol is used by passenger cars, by ethanol buses and E85 vehicles. The total use of FAME has increased by 33-49% each year starting 2011 in the EU. The countries with the highest increases in absolute terms were Poland, Spain, Austria and Czechia. The countries with the lowest increase in relative terms were United Kingdom, Italy, France and Germany (Table 3-61).

Table 3-61). It is obvious that emissions dropped between 2007 and 2013 and the corresponding activity data, except for biomass, show a similar trend. This can be attributed to the economic crisis that Europe has gone through these years but also to the increased use of biofuels. The emissions from this key source are due to fossil fuel consumption in road transport, which increased by 10 % between 1990 and 2020.

Figure **3.110** gives an overview of the CO_2 trend caused by different fuels. The trend is mainly dominated by emissions resulting from the combustion of gasoline and diesel oil. The decline of gasoline and the increase of diesel show the gradual switch from gasoline to diesel passenger cars in several EU-KP countries.

*Figure **3**.110 1A3b Road Transport: CO_2 Emission Trend and Activity Data*



Data displayed as dashed line refers to the secondary axis.

The countries Germany, France, Italy, Spain and the United Kingdom contributed most to the CO_2 emissions from this source (62.3 %). All countries, except Estonia (-4%), Finland (-9%), France (-9%), Germany (-7%), Italy (-16%), Netherlands (-5%), Sweden (-20%) and United Kingdom (-18%), show decreased emissions from road transportation between 1990 and 2020. In the case of Sweden, the decreased emissions are explained by the total use of liquid biofuels (ethanol and FAME), which has increased by more than 850% since 2003. Ethanol is used by passenger cars, by ethanol buses and E85 vehicles. The total use of FAME has increased by 33-49% each year starting 2011 in the EU. The countries with the highest increases in absolute terms were Poland, Spain, Austria and Czechia. The countries with the lowest increase in relative terms were United Kingdom, Italy, France and Germany (Table 3-61).

Table 3-61 1A3b Road Transport: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	13 283	23 429	20 313	2.6%	7 031	53%	-3 115	-13%	T1,T2	CS,D
Belgium	19 677	24 752	20 542	2.7%	865	4%	-4 211	-17%	M,T2	CS,M
Bulgaria	5 785	9 618	9 108	1.2%	3 323	57%	-510	-5%	T1,T2	CR,D
Croatia	3 506	6 284	5 546	0.7%	2 040	58%	-738	-12%	T1	D
Cyprus	1 190	2 124	1 899	0.2%	710	60%	-225	-11%	T1,T2	D,M
Czechia	10 251	18 485	17 215	2.2%	6 964	68%	-1 270	-7%	T2	M
Denmark	9 371	12 116	11 140	1.4%	1 769	19%	-976	-8%	CR,M,T2	CS
Estonia	2 235	2 319	2 151	0.3%	-84	-4%	-169	-7%	T1,T2	CS,D
Finland	10 804	10 446	9 845	1.3%	-959	-9%	-600	-6%	T2	CS
France	113 896	123 073	103 240	13.4%	-10 656	-9%	-19 833	-16%	T3	M
Germany	151 886	157 437	141 283	18.3%	-10 604	-7%	-16 154	-10%	CS,M,T2,T3	CS,D
Greece	11 793	15 031	13 193	1.7%	1 400	12%	-1 839	-12%	T1,T2,T3	CS,D
Hungary	7 826	14 203	12 181	1.6%	4 355	56%	-2 022	-14%	T1,T2	CS,D
Ireland	4 690	11 509	9 592	1.2%	4 901	104%	-1 917	-17%	T2,T3	CS,M
Italy	92 332	96 604	77 832	10.1%	-14 500	-16%	-18 772	-19%	T2	CS,M
Latvia	2 402	3 133	2 979	0.4%	577	24%	-154	-5%	T1,T2	CS,D
Lithuania	5 247	5 996	5 854	0.8%	607	12%	-141	-2%	T1,T2	CS,D
Luxembourg	2 563	6 088	4 613	0.6%	2 051	80%	-1 475	-24%	T1,T2	CS,D
Malta	300	657	529	0.1%	229	77%	-128	-20%	T1,T2	CS,D,M
Netherlands	26 450	29 463	25 175	3.3%	-1 275	-5%	-4 288	-15%	T1,T2	CS
Poland	18 440	64 096	61 362	8.0%	42 922	233%	-2 734	-4%	T2	D
Portugal	10 001	16 756	14 181	1.8%	4 181	42%	-2 575	-15%	T2	OTH
Romania	10 366	17 923	17 505	2.3%	7 140	69%	-417	-2%	T1,T3	D,OTH
Slovakia	4 503	7 550	6 744	0.9%	2 241	50%	-806	-11%	T2	CS,D
Slovenia	2 607	5 537	4 504	0.6%	1 897	73%	-1 033	-19%	M	M
Spain	50 429	83 748	69 116	9.0%	18 687	37%	-14 632	-17%	CR	CR,CS
Sweden	17 409	15 211	13 940	1.8%	-3 469	-20%	-1 271	-8%	T2	CS
United Kingdom	107 892	109 305	88 421	11.5%	-19 471	-18%	-20 885	-19%	OTH,T1,T3	CS,OTH
EU-27+UK	**717 133**	**892 893**	**770 003**	**100%**	**52 870**	**7%**	**-122 890**	**-14%**	**-**	**-**
Iceland	512	940	817	0.1%	305	60%	-123	-13%	T1,T2	CS,D
United Kingdom (KP)	108 369	109 851	88 903	11.5%	-19 466	-18%	-20 948	-19%	OTH,T1,T3	CS,OTH
EU-KP	**718 122**	**894 379**	**771 303**	**100%**	**53 181**	**7%**	**-123 077**	**-14%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

In Table 3-62 the fuel share is presented per country. It is clear that diesel oil accounts for around 66.2 % for EU-KP and gasoline for 24.7 %. The highest LPG consumption is observed in Bulgaria (13.3 %) and Poland (8.9 %). The share of biomass is around 6.5 % for EU-KP with Sweden having the highest percentage (23.1 %).

Table 3-62 1A3b Road Transport: Countries' share of different fuel in the total consumption

Member State	Gasoline (%)	Diesel oil (%)	LPG (%)	Gaseous fuels (%)	Biomass (%)
Austria	18.4%	76.4%	0.0%	0.3%	4.9%
Belgium	20.2%	69.9%	0.7%	0.3%	8.9%
Bulgaria	14.7%	63.7%	13.3%	2.8%	5.5%
Croatia	21.8%	71.4%	3.1%	0.2%	3.5%
Cyprus	47.0%	49.2%	0.1%	NO	3.7%
Czech Republic	23.7%	67.8%	1.3%	1.3%	5.9%
Denmark	30.0%	63.5%	0.0002%	0.2%	6.3%
Estonia	27.9%	63.6%	1.3%	1.1%	6.0%
Finland	31.0%	57.8%	NO,NA	0.2%	11.0%
France	18.5%	73.3%	0.1%	0.5%	7.5%
Germany	31.0%	61.2%	0.7%	0.4%	6.7%
Greece	41.0%	50.0%	4.5%	0.4%	4.2%
Hungary	30.7%	62.4%	0.3%	0.2%	6.3%
Ireland	17.6%	77.4%	0.03%	NO	5.0%
Italy	22.2%	65.1%	5.3%	2.6%	4.8%
Latvia	16.6%	74.6%	4.3%	0.05%	4.2%
Lithuania	11.6%	78.2%	4.8%	0.4%	4.7%
Luxembourg	16.2%	76.4%	0.01%	NO	7.4%
Malta	37.5%	55.1%	0.4%	NO	7.0%
Netherlands	39.1%	53.6%	0.9%	0.8%	5.7%
Poland	19.8%	65.2%	8.9%	0.1%	5.9%
Portugal	19.1%	75.3%	0.6%	0.3%	4.6%
Romania	22.2%	67.5%	1.6%	0.001%	8.7%
Slovakia	21.5%	70.5%	1.5%	0.1%	6.3%
Slovenia	20.7%	72.8%	0.6%	0.2%	5.7%
Spain	17.3%	75.6%	0.3%	1.3%	5.5%
Sweden	30.9%	45.8%	NO	0.2%	23.1%
United Kingdom	30.2%	64.2%	0.2%	0.1%	5.2%
EU-27+UK	**24.7%**	**66.2%**	**1.9%**	**0.7%**	**6.5%**
Iceland	33.8%	60.3%	NO	NO	5.9%
EU-KP	**24.7%**	**66.2%**	**1.9%**	**0.7%**	**6.5%**

1A3b Road Transportation – Gaseous Fuels (CO_2)

CO_2 emissions from Gaseous fuels account for 5 % of CO_2 emissions from 1A3b Road Transport in 2020 (Figure **3.110**). Between 2019 and 2020 CO_2 emissions from Gaseous fuels have increased by 4 %, between 1990 and 2019 emissions show an increase of 748% in EU-KP. Most countries showed increased emissions in comparison with 2019 year, whereas five countries reported emissions as "Not occurring" or "Included elsewhere". United Kingdom includes the small amount of natural gas used for road transport with LPG consumption.

Table 3-63 1A3b Road Transport, gaseous fuels: countries contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	NO	42	44	1.0%	44	∞	3	6%
Belgium	NO,IE	54	53	1.2%	53	∞	-1	-2%
Bulgaria	NO	205	202	4.7%	202	∞	-3	-2%
Croatia	NO	9	7	0.2%	7	∞	-2	-23%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	175	177	4.1%	177	∞	3	2%
Denmark	0	17	16	0.4%	16	104524%	-1	-7%
Estonia	NO	11	20	0.5%	20	∞	9	85%
Finland	NO,NA	13	20	0.5%	20	∞	6	49%
France	0	383	454	10.5%	453	127296%	71	19%
Germany	NA	365	505	11.7%	505	∞	140	38%
Greece	NO	35	37	0.9%	37	∞	2	7%
Hungary	0	22	18	0.4%	18	5938%	-3	-16%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	487	2 316	1 669	38.8%	1 182	243%	-647	-28%
Latvia	17	0	1	0.0%	-16	-93%	1	175%
Lithuania	NO	17	19	0.5%	19	∞	2	12%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	151	159	3.7%	159	∞	8	5%
Poland	NO	41	47	1.1%	47	∞	6	14%
Portugal	NO	42	37	0.9%	37	∞	-5	-13%
Romania	NO	0	0	0.0%	0	∞	0	0%
Slovakia	NO	9	8	0.2%	8	∞	-1	-12%
Slovenia	NO	11	8	0.2%	8	∞	-2	-21%
Spain	NO	507	721	16.8%	721	∞	214	42%
Sweden	3	21	22	0.5%	19	652%	1	5%
United Kingdom	NO	32	57	1.3%	57	∞	25	77%
EU-27+UK	**508**	**4 478**	**4 302**	**100%**	**3 795**	**748%**	**-176**	**-4%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	NO	32	57	1.3%	57	∞	25	77%
EU-KP	**508**	**4 478**	**4 302**	**100%**	**3 795**	**748%**	**-176**	**-4%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

The countries Germany, France, Italy and Spain contributed most to the CO_2 emissions from this source (77.8%). All countries, except for Latvia, show increased emissions from road transportation between 1990 and 2020. The countries with the highest increases in absolute terms were Italy, Germany, France and Spain (Table 3-63).

Figure **3.111** it is depicted that the share of gaseous fuels is constantly increasing from 1990 to 2020. The reason for this increase is the increasing activity data and corresponing emissions of Italy, which is a high contributor to this source category. In Figure **3.112** the IEF is depicted and the mean value is around 56 t/TJ until 2007, and 57t/TJ until 2020. The increase in the IEF value is mainly due to the correspodning increase in the IEF of Italy. As already mentioned, Italy dominates EU emissions, thus the IEF of EU almost follows the increasing trend of the IEF of Italy from 1990 to 2020.

*Figure **3**.111: 1A3b Road Transport, gaseous fuels: Emission trend and share for CO_2*

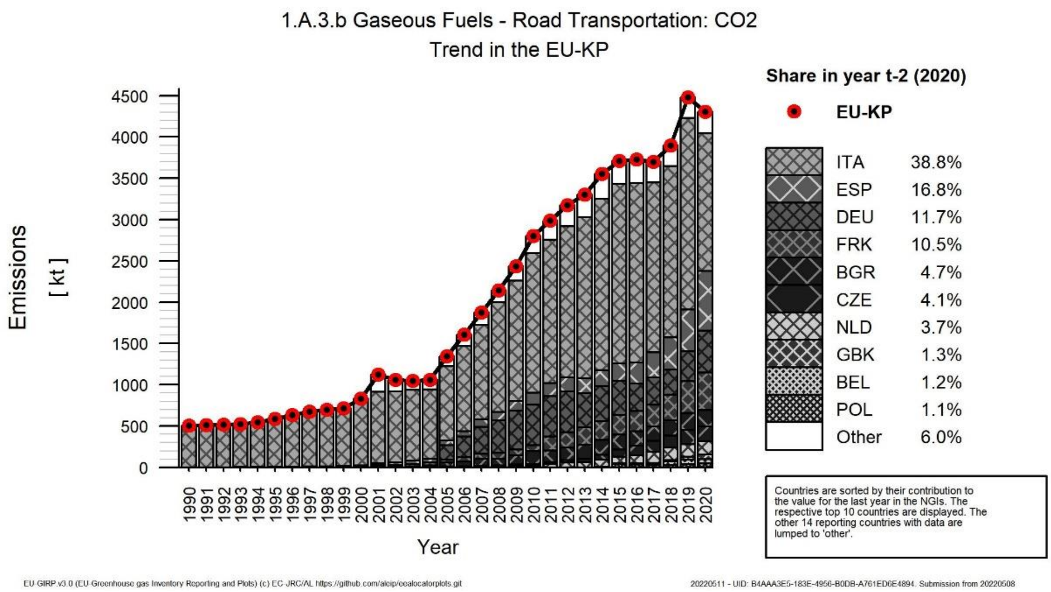
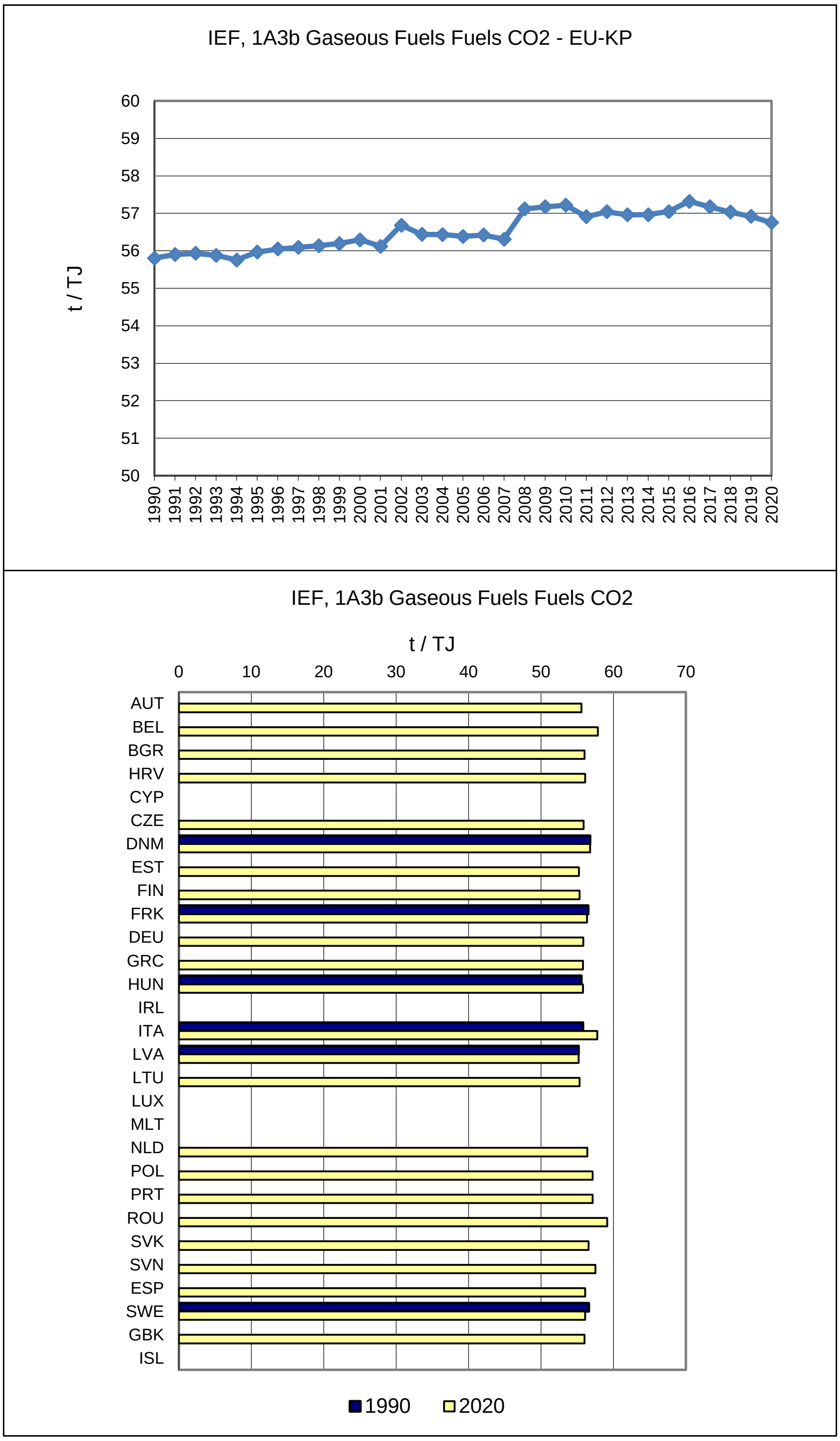


*Figure **3**.112 1A3b Road Transport, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)*



1A3b Road Transportation – Diesel Oil (CO_2)

CO_2 emissions from Diesel oil account for 70 % of CO_2 emissions from 1A3b Road Transport in 2020 (CO2 emissions from 1A3b Road Transportation

The mobile source category Road Transportation includes all types of light-duty vehicles such as passenger cars and light commercial trucks, and heavy-duty vehicles such as tractors, trailers and buses, and two and three-wheelers (including mopeds, scooters, and motorcycles). These vehicles operate on many types of gaseous and liquid fuels.

CO2 emissions from 1A3b Road Transportation is the second largest key source of all categories in the EU-KP accounting for 21 % of total GHG emissions in 2020. Between 1990 and 2020, CO2 emissions from road transportation increased by 7 % in the EU-KP (The **countries** Germany, France, Italy, Spain and the United Kingdom contributed most to the CO2 emissions from this source (62.3 %). All countries, except Estonia (-4%), Finland (-9%), France (-9%), Germany (-7%), Italy (-16%), Netherlands (-5%), Sweden (-20%) and United Kingdom (-18%), show decreased emissions from road transportation between 1990 and 2020. In the case of Sweden, the decreased emissions are explained by the total use of liquid biofuels (ethanol and FAME), which has increased by more than 850% since 2003. Ethanol is used by passenger cars, by ethanol buses and E85 vehicles. The total use of FAME has increased by 33-49% each year starting 2011 in the EU. The countries with the highest increases in absolute terms were Poland, Spain, Austria and Czechia. The countries with the lowest increase in relative terms were United Kingdom, Italy, France and Germany (Table 3-61).

Table 3-61). It is obvious that emissions dropped between 2007 and 2013 and the corresponding activity data, except for biomass, show a similar trend. This can be attributed to the economic crisis that Europe has gone through these years but also to the increased use of biofuels. The emissions from this key source are due to fossil fuel consumption in road transport, which increased by 10 % between 1990 and 2020.

Figure **3.110** gives an overview of the CO2 trend caused by different fuels. The trend is mainly dominated by emissions resulting from the combustion of gasoline and diesel oil. The decline of gasoline and the increase of diesel show the gradual switch from gasoline to diesel passenger cars in several EU-KP countries.

Figure **3.110**). All countries show increased emissions from Diesel oil between 1990 and 2020 (Table 3-64). Countries with the highest increase in per cent were Slovenia, Iceland, Ireland and Poland. Some of these increases are due to fuel bought in the respective countries but consumed abroad (fuel tourism).

Table 3-64 1A3b Road Transport, diesel oil: countries contributions to CO_2 emissions

Member State	CO_2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Information
	1990	2019	2020		kt CO_2	%	kt CO_2	%		
Austria	5 360	18 464	16 238	3.0%	10 878	203%	-2 226	-12%		
Belgium	11 027	19 039	15 782	2.9%	4 755	43%	-3 257	-17%		
Bulgaria	1 539	6 705	6 311	1.1%	4 772	310%	-394	-6%		
Croatia	1 159	4 632	4 179	0.8%	3 020	261%	-453	-10%	T1	D
Cyprus	669	1 042	983	0.2%	314	47%	-60	-6%	T1	D
Czechia	6 655	13 365	12 552	2.3%	5 897	89%	-814	-6%		
Denmark	4 442	8 110	7 571	1.4%	3 129	70%	-538	-7%		
Estonia	693	1 488	1 475	0.3%	782	113%	-13	-1%	T2	CS
Finland	4 923	6 774	6 450	1.2%	1 526	31%	-325	-5%	T2	CS
France	54 661	97 933	81 617	14.9%	26 956	49%	-16 317	-17%		
Germany	54 478	102 959	91 908	16.7%	37 431	69%	-11 051	-11%		
Greece	4 264	7 266	6 837	1.2%	2 573	60%	-429	-6%		
Hungary	2 388	9 623	8 205	1.5%	5 817	244%	-1 418	-15%	T2	CS
Ireland	1 914	9 191	7 870	1.4%	5 956	311%	-1 321	-14%		
Italy	47 808	66 127	53 877	9.8%	6 069	13%	-12 250	-19%		
Latvia	623	2 476	2 352	0.4%	1 730	278%	-123	-5%	T2	CS
Lithuania	2 134	4 961	4 854	0.9%	2 720	127%	-108	-2%	T2	CS
Luxembourg	1 269	5 024	3 803	0.7%	2 534	200%	-1 221	-24%		
Malta	119	411	322	0.1%	203	170%	-89	-22%	T1	D
Netherlands	13 012	16 372	14 268	2.6%	1 256	10%	-2 104	-13%		
Poland	8 769	44 420	43 205	7.87%	34 436	393%	-1 215	-3%	T2	D
Portugal	5 625	13 266	11 289	2.1%	5 663	101%	-1 977	-15%		
Romania	3 648	13 713	13 586	2.5%	9 937	272%	-127	-1%	T3	OTH
Slovakia	3 123	5 792	5 147	0.9%	2 025	65%	-644	-11%	T2	CS
Slovenia	867	4 266	3 504	0.6%	2 638	304%	-762	-18%	T3	M
Spain	24 706	66 594	55 173	10.0%	30 467	123%	-11 421	-17%	CR	CS
Sweden	4 524	8 936	8 282	1.5%	3 758	83%	-654	-7%		
United Kingdom	32 772	73 718	60 780	11.1%	28 008	85%	-12 938	-18%	T3	CS
EU-27+UK	**303 171**	**632 668**	**548 418**	**100%**	**245 247**	**81%**	**-84 249**	**-13%**		
Iceland	116	571	532	0.1%	416	360%	-40	-7%		
United Kingdom (KP)	32 920	73 948	60 997	11.1%	28 077	85%	-12 951	-18%	T3	CS
EU-KP	**303 434**	**633 468**	**549 167**	**100%**	**245 733**	**81%**	**-84 302**	**-13%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries. Additional information is provided in Annex III of the EU NIR and in MS NIRs, which are also part of the EU submission.

France, Germany, Italy, Spain and the UK account for 62.5 % of CO_2 emissions from diesel oil in 2020. In Figure 3.113 the IEF is depicted and the mean value is around 74 t/TJ. For some countries the values of the IEF is outside the range of the upper and lower IPCC default value. This is due to the fact that in most cases these IEF are country specific. The case of Romania was investigated and it was concluded that the value of the IEF depends also on the country specific values for the Net Calorific Value (NCV).

*Figure **3**.114 1A3b Road Transport, Diesel Oil: Emission trend and share for CO_2*

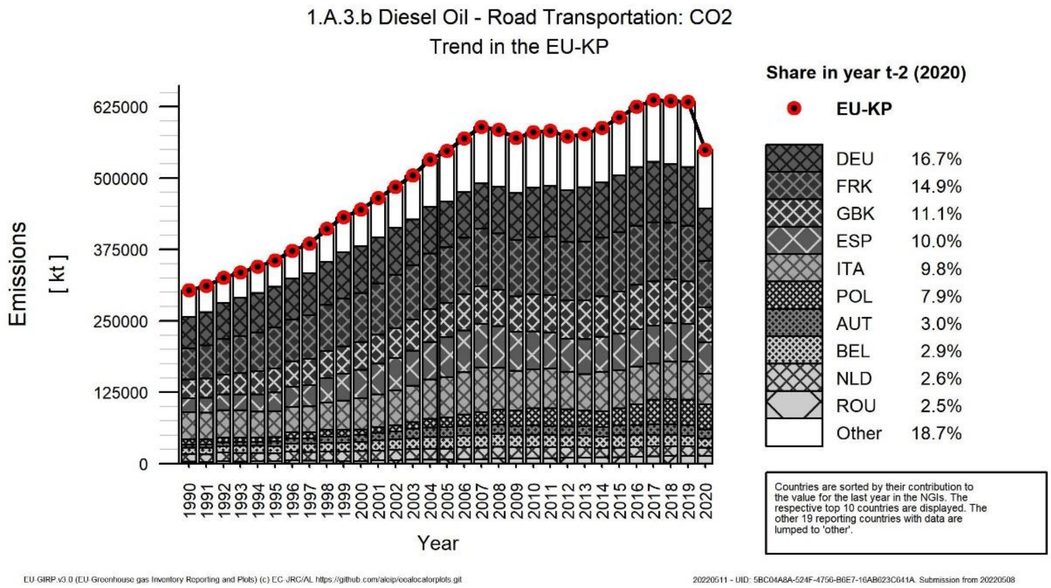
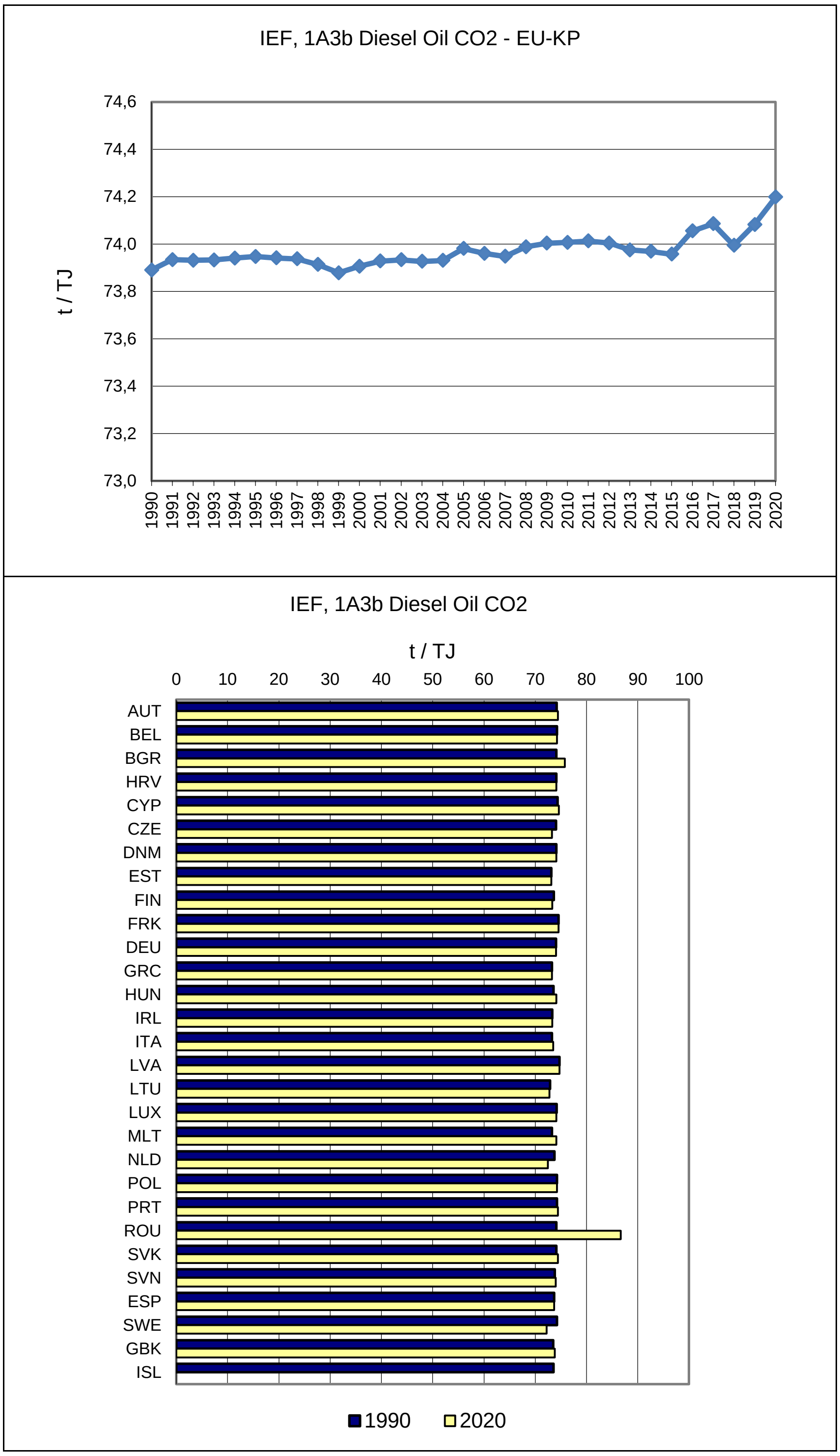


*Figure **3**.115 1A3b Road Transport, Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)*



1A3b Road Transportation – Gasoline (CO_2)

Between 1990 and 2010, CO_2 emissions from gasoline decreased by 51% in the EU-KP (Table 3-65

Table 3-65 1A3b Road Transport, gasoline: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Information
	1990	2019	2020		kt CO_2	%	kt CO_2	%		
Austria	7 896	4 835	3 962	2.0%	-3 934	-50%	-873	-18%		
Belgium	8 461	5 403	4 438	2.2%	-4 023	-48%	-965	-18%		
Bulgaria	4 241	1 477	1 428	0.7%	-2 814	-66%	-49	-3%		
Croatia	2 347	1 438	1 193	0.6%	-1 154	-49%	-244	-17%	T1	D
Cyprus	520	1 078	911	0.5%	391	75%	-167	-15%	T1	D
Czechia	3 596	4 638	4 217	2.1%	621	17%	-421	-9%		
Denmark	4 919	3 957	3 522	1.8%	-1 397	-28%	-434	-11%		
Estonia	1 542	789	623	0.3%	-919	-60%	-166	-21%	T2	CS
Finland	5 880	3 658	3 376	1.7%	-2 504	-43%	-282	-8%	T2	CS
France	59 074	23 423	19 998	10.0%	-39 076	-66%	-3 425	-15%		
Germany	97 217	52 686	47 418	23.6%	-49 798	-51%	-5 268	-10%		
Greece	7 438	7 002	5 609	2.8%	-1 830	-25%	-1 393	-20%		
Hungary	5 404	4 479	3 886	1.9%	-1 518	-28%	-593	-13%	T2	CS
Ireland	2 758	2 285	1 693	0.8%	-1 065	-39%	-593	-26%		
Italy	39 949	22 943	18 121	9.0%	-21 829	-55%	-4 823	-21%		
Latvia	1 722	520	500	0.2%	-1 223	-71%	-20	-4%	T2	CS
Lithuania	3 053	712	696	0.3%	-2 357	-77%	-16	-2%	T2	CS
Luxembourg	1 282	1 045	796	0.4%	-486	-38%	-249	-24%		
Malta	180	244	205	0.1%	25	14%	-39	-16%	T1	D
Netherlands	10 799	12 603	10 483	5.2%	-316	-3%	-2 120	-17%		
Poland	9 671	13 727	12 791	6.37%	3 120	32%	-935	-7%	T2	D
Portugal	4 370	3 336	2 771	1.4%	-1 599	-37%	-565	-17%		
Romania	6 591	3 951	3 687	1.8%	-2 903	-44%	-264	-7%	T3	OTH
Slovakia	1 380	1 609	1 469	0.7%	89	6%	-140	-9%	T2/T3	CS
Slovenia	1 740	1 206	952	0.5%	-789	-45%	-254	-21%	T3	M
Spain	25 639	16 166	12 819	6.4%	-12 819	-50%	-3 346	-21%	CR	CS
Sweden	12 882	6 196	5 576	2.8%	-7 305	-57%	-619	-10%		
United Kingdom	75 118	35 148	27 198	13.5%	-47 919	-64%	-7 949	-23%	T3	CS
EU-27+UK	**405 669**	**236 550**	**200 337**	**100%**	**-205 332**	**-51%**	**-36 213**	**-15%**		
Iceland	396	369	285	0.1%	-111	-28%	-84	-23%		
United Kingdom (KP)	75 448	35 465	27 464	13.7%	-47 984	-64%	-8 000	-23%	T3	CS
EU-KP	**406 396**	**237 236**	**200 889**	**100%**	**-205 507**	**-51%**	**-36 347**	**-15%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries. Additional information is provided in Annex III of the EU NIR and in MS NIRs, which are also part of the EU submission.

France, Germany, Italy, Spain and the United Kingdom account for 62.7 % for CO_2 emissions from gasoline in 2020. In Figure **3**.116 the IEF is depicted and the mean value is around 72.5 t/TJ. The increase of the IEF from 2014 to 2015 is due to an increase in the IEF of Germany, which has a share of

23.6% of emissions in this sector. After communiucation with Germany, it was explained that in order to keep inventory data consistent with the NEB, the NCV of gasoline was decreased, thus the energy related emission factor increased. For some countries the values of the IEF are outside the range of the upper IPCC default value (such as Austria and the Netherlands). This is due to the fact that in most cases these IEF are country specific.

*Figure **3**.117 1A3b Road Transport, Gasoline: Emission trend and share for CO_2*

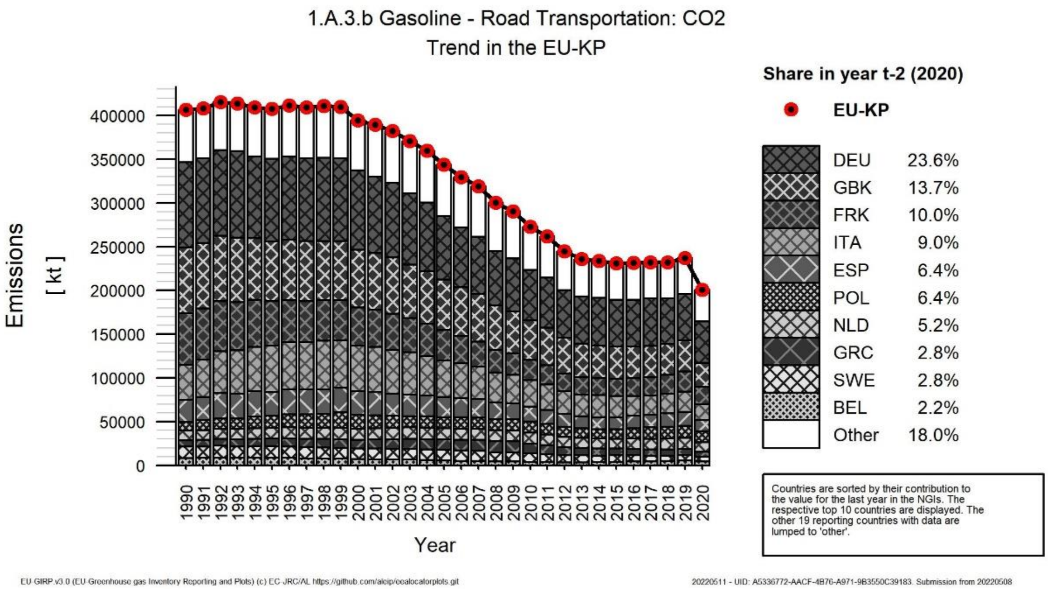
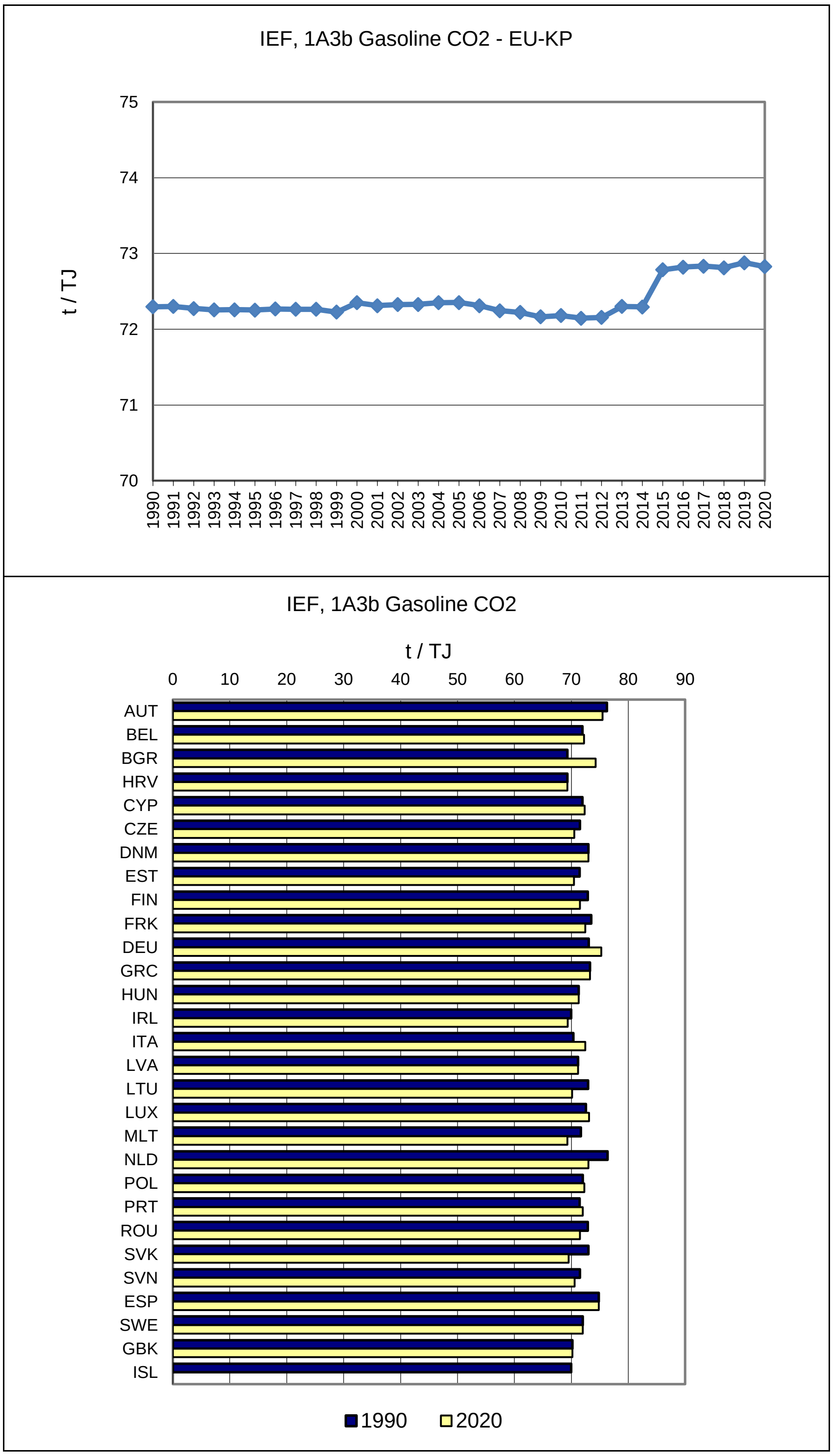


*Figure **3**.118 1A3b Road Transport, Gasoline: Implied Emission Factors for CO_2 (in t/TJ)*



1A3b Road Transportation – LPG (CO_2)

Between 1990 and 2020, CO_2 emissions from LPG increased by 88 % in the EU-KP. Three countries report emissions as 'Not occurring'. Between 2019 and 2020 EU-KP emissions decreased by 14 % (Table 3-66). Italy accounts for 28.6 % and Poland for 37.4 % of CO_2 emissions from LPG in 2020 whereas France, Germany, Spain and the United Kingdom account for only 9.9 % of CO_2 emissions,

Table 3-66 1A3b Road Transport, LPG: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO_2	%	kt CO_2	%		
Austria	26	14	8	0.1%	-18	-69%	-6	-42%		
Belgium	188	153	131	0.9%	-57	-30%	-21	-14%		
Bulgaria	NO	1 207	1 144	8.3%	1 144	∞	-63	-5%		
Croatia	NO	195	156	1.1%	156	∞	-39	-20%	T1	D
Cyprus	NO	1	1	0.0%	1	∞	0	-16%	T1	D
Czechia	NO	266	224	1.6%	224	∞	-42	-16%		
Denmark	9	0	0	0.0%	-9	-100%	0	-1%		
Estonia	1	29	27	0.2%	26	4463%	-2	-6%	T2	CS
Finland	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
France	150	158	107	0.8%	-44	-29%	-51	-33%		
Germany	9	969	907	6.5%	898	9921%	-62	-6%		
Greece	91	661	534	3.9%	443	488%	-128	-19%		
Hungary	NO	52	38	0.3%	38	∞	-15	-28%	T1	D
Ireland	19	4	2	0.0%	-16	-88%	-2	-49%		
Italy	4 026	5 003	3 962	28.6%	-64	-2%	-1 040	-21%		
Latvia	37	127	115	0.8%	78	210%	-12	-10%	T2	CS
Lithuania	60	294	271	2.0%	211	350%	-23	-8%	T2	CS
Luxembourg	11	1	1	0.0%	-11	-95%	0	-41%		
Malta	NO	2	2	0.0%	2	∞	0	-10%	T1	D
Netherlands	2 640	282	222	1.6%	-2 418	-92%	-61	-21%		
Poland	NO,IE	5 780	5 184	37.44%	5 184	∞	-596	-10%	T2	D
Portugal	0	111	84	0.6%	84	132055%	-27	-25%		
Romania	NO	259	233	1.7%	233	∞	-27	-10%	T3	OTH
Slovakia	NO	118	99	0.7%	99	∞	-20	-17%	T2	D
Slovenia	NO	39	25	0.2%	25	∞	-14	-36%	T3	M
Spain	79	260	200	1.4%	121	154%	-60	-23%	CR	CS
Sweden	0	NO,IE	NO,IE	-	0	-100%	-	-		
United Kingdom	NO	185	170	1.2%	170	∞	-15	-8%	T3	CS
EU-27+UK	**7 346**	**16 171**	**13 844**	**100%**	**6 498**	**88%**	**-2 327**	**-14%**		
Iceland	NO	NO	NO	-	-	-	-	-		
United Kingdom (KP)	NO	185	170	1.2%	170	∞	-15	-8%	T3	CS
EU-KP	**7 346**	**16 171**	**13 844**	**100%**	**6 498**	**88%**	**-2 327**	**-14%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries. Additional information is provided in Annex III of the EU NIR and in MS NIRs, which are also part of the EU submission.

1.A.3.b Road Transportation: Other Fuels (CO_2)

This category covers the CO_2 emissions from the fossil part of biofuels. According to the 2006 IPCC GLs (volume 2, chapter 3, section ' CO_2 emissions from biofuels' in page 3.17*): it is important to assess the* *biofuel origin so as to identify and separate fossil from biogenic feedstocks".* In other words, a part of the carbon of biofuels (and the associated CO_2 emissions) may have a fossil origin. The IPCC GLs provide some examples about biofuels' fossil part: *"biodiesel made from coal methanol with animal feedstocks has a non-zero fossil fuel fraction and is therefore not fully carbon neutral. Ethanol from the fermentation of agricultural products will generally be purely biogenic (carbon neutral), except in some cases, such as fossil-fuel derived methanol. Products which have undergone further chemical transformation may contain substantial amounts of fossil carbon ranging from about 5-10 percent in the fossil methanol used for biodiesel production upwards to 46 percent in ethyl-tertiary-butyl-ether (ETBE) from fossil isobutene (ADEME/DIREM, 2002). Some processes may generate biogenic by-products such as glycol or glycerine, which may then be used elsewhere."*

For this reason, all countries are encouraged to calculate these emissions and include them in the CRF under "Other fossil fuels". Based on Table 3-67 five countries report these emissions as 'Not occurring' or 'Not applicable' or 'Included Elsewhere'. France, Germany, Italy, Spain and United Kingdom contribute the most to this category, with a share of 72.2%.

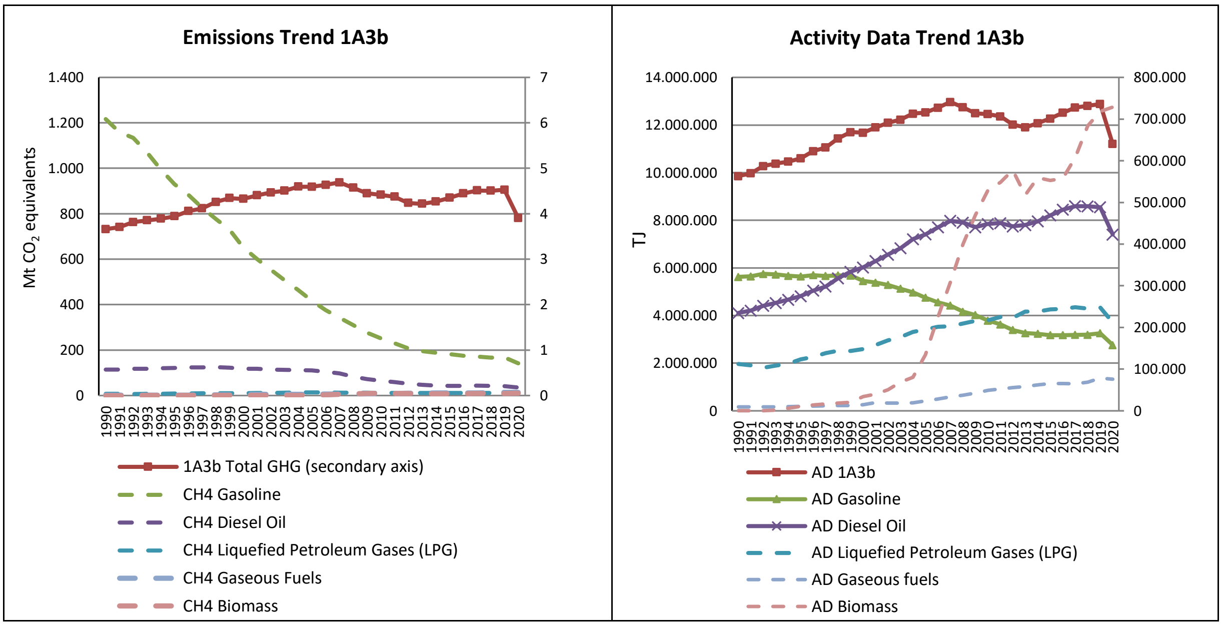
Table 3-67: 1A3b Road Transport, other fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	NO	74	61	2.0%	61	∞	-14	-18%
Belgium	NO	103	137	4.5%	137	∞	34	33%
Bulgaria	4	24	23	0.8%	19	446%	-1	-2%
Croatia	NO	10	10	0.3%	10	∞	0	5%
Cyprus	1	2	4	0.1%	4	589%	2	110%
Czechia	NO	41	46	1.5%	46	∞	5	12%
Denmark	NO	32	30	1.0%	30	∞	-2	-6%
Estonia	NO	4	6	0.2%	6	∞	2	64%
Finland	NA	NA	NA	-	-	-	-	-
France	NO	1 170	1 061	34.8%	1 061	∞	-109	-9%
Germany	NA	453	539	17.7%	539	∞	86	19%
Greece	NO	67	176	5.8%	176	∞	109	162%
Hungary	NO	27	33	1.1%	33	∞	7	25%
Ireland	NO	28	26	0.9%	26	∞	-1	-4%
Italy	NO	195	185	6.1%	185	∞	-9	-5%
Latvia	NO	4	5	0.2%	5	∞	1	19%
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	19	14	0.5%	14	∞	-5	-25%
Malta	NO	0	0	0.0%	0	∞	0	-38%
Netherlands	NO	55	44	1.4%	44	∞	-11	-20%
Poland	NO	129	135	4.4%	135	∞	6	5%
Portugal	NO	NO,IE	NO,IE	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	22	21	0.7%	21	∞	-1	-5%
Slovenia	NO	15	14	0.5%	14	∞	-1	-6%
Spain	NO	216	200	6.6%	200	∞	-16	-8%
Sweden	NO	58	60	2.0%	60	∞	2	3%
United Kingdom	NO	222	215	7.0%	215	∞	-7	-3%
EU-27+UK	**5**	**2 969**	**3 046**	**100%**	**3 041**	**62119%**	**77**	**3%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	NO	222	215	7.0%	215	∞	-7	-3%
EU-KP	**5**	**2 969**	**3 046**	**100%**	**3 041**	**62119%**	**77**	**3%**

CH_4 emissions from 1A3b Road Transportation

CH_4 emissions from 1A3b Road Transportation account for 0.12 % of total EU-KP GHG emissions in 2020. Figure **3.119** gives an overview of the CH_4 trend caused by different fuels, as well as the activity data trend, where it is clear that the gasoline share is decreasing, whereas the diesel oil is increasing.

*Figure **3**.119 1A3b Road Transport: CH_4 Emissions Trend and Activity Data Trend*



Data displayed as dashed line refers to the secondary axis.

CH_4 emissions decreased between 1990 and 2020 by 84 % (Table 3-71). All countries showed a decrease in CH_4 emissions from 1990 to 2020. Between 2019 and 2020, CH_4 emissions decreased by 14 % in EU-KP. In the same time period, the largest decrease in relative terms was reported by Ireland, and Cyprus.

Table 3-68 1A3b Road Transport: Member States' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	73	21	18	1.7%	-55	-75%	-3	-12%	T3	CS
Belgium	139	18	15	1.4%	-124	-89%	-3	-18%	M,T3	CS,M
Bulgaria	68	21	19	1.8%	-49	-72%	-2	-10%	T2	CR
Croatia	41	9	9	0.8%	-33	-79%	-1	-6%	T1,T3	CR,D
Cyprus	7	3	3	0.2%	-4	-63%	-1	-24%	T1,T2	D,M
Czechia	77	25	23	2.2%	-54	-70%	-3	-10%	T3	M
Denmark	79	9	8	0.7%	-71	-90%	-1	-10%	CR,M,T3	CR
Estonia	22	4	3	0.3%	-19	-86%	-1	-18%	T1,T3	CS,D
Finland	107	9	8	0.7%	-99	-93%	-1	-7%	T3	CR
France	956	141	120	11.4%	-836	-87%	-21	-15%	T3	M
Germany	1 561	224	209	19.7%	-1 352	-87%	-16	-7%	CS,M,T2,T3	CS,M
Greece	107	66	56	5.3%	-51	-48%	-10	-15%	M,T1,T2	D,M
Hungary	67	24	20	1.9%	-47	-70%	-4	-15%	T1,T3	D,M
Ireland	48	8	6	0.6%	-42	-88%	-2	-28%	T3	M
Italy	867	186	148	14.0%	-719	-83%	-39	-21%	T3	M
Latvia	19	3	3	0.3%	-16	-84%	0	-6%	T1,T3	CR,D,M
Lithuania	39	6	7	0.6%	-33	-83%	1	14%	T1,T3	CR,D
Luxembourg	12	4	3	0.3%	-9	-76%	-1	-18%	T3	M
Malta	3	1	1	0.1%	-2	-72%	0	-19%	T3	M
Netherlands	195	64	57	5.4%	-138	-71%	-7	-11%	T1,T2,T3	CS
Poland	158	101	89	8.4%	-69	-43%	-11	-11%	T3	D
Portugal	97	21	17	1.6%	-80	-83%	-4	-20%	T3	OTH
Romania	90	32	31	2.9%	-59	-66%	-1	-2%	T1,T3	D,OTH
Slovakia	29	5	4	0.4%	-25	-85%	-1	-17%	T3	D
Slovenia	27	5	4	0.4%	-24	-86%	-1	-22%	M	M
Spain	398	109	88	8.3%	-310	-78%	-21	-19%	CR	CR
Sweden	159	22	21	2.0%	-138	-87%	-1	-6%	M,T2	CS,D
United Kingdom	1 244	86	67	6.4%	-1 176	-95%	-18	-21%	T3	CS
EU-27+UK	**6 690**	**1 227**	**1 057**	**100%**	**-5 634**	**-84%**	**-171**	**-14%**	**-**	**-**
Iceland	6	1	1	0.1%	-5	-82%	0	-19%	T3	D
United Kingdom (KP)	1 251	87	68	6.5%	-1 182	-95%	-19	-21%	T3	CS
EU-KP	**6 703**	**1 230**	**1 059**	**100%**	**-5 644**	**-84%**	**-171**	**-14%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3b Road Transportation – Gasoline (CH_4)

Between 1990 and 2020, CH_4 emissions from gasoline decreased by 88 % in the EU-KP. All countries reported decreasing emissions. Between 2019 and 2020 EU-KP emissions decreased by 16 % (Table 3-69). The largest decreases in per cent were reported by Spain (-27 %) and Ireland (-26 %).

Table 3-69 1A3b Road Transport, gasoline: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	69	8	7	1.0%	-62	-90%	-1	-13%
Belgium	115	14	11	1.5%	-104	-91%	-3	-21%
Bulgaria	64	6	6	0.8%	-58	-91%	0	-6%
Croatia	39	6	6	0.9%	-32	-84%	0	-4%
Cyprus	6	3	2	0.3%	-4	-62%	-1	-19%
Czechia	59	17	15	2.1%	-44	-74%	-2	-11%
Denmark	69	7	6	0.9%	-63	-91%	-1	-12%
Estonia	20	3	2	0.3%	-18	-89%	-1	-23%
Finland	93	6	6	0.8%	-87	-94%	0	-8%
France	858	100	84	11.9%	-773	-90%	-16	-16%
Germany	1 514	149	138	19.5%	-1 376	-91%	-11	-7%
Greece	97	49	39	5.5%	-58	-60%	-10	-20%
Hungary	61	17	14	2.0%	-47	-77%	-3	-17%
Ireland	43	6	5	0.6%	-39	-89%	-2	-26%
Italy	733	129	103	14.6%	-630	-86%	-26	-20%
Latvia	16	1	1	0.2%	-15	-92%	0	-6%
Lithuania	33	2	2	0.3%	-30	-93%	0	3%
Luxembourg	12	1	1	0.1%	-11	-93%	0	-21%
Malta	3	1	1	0.1%	-2	-74%	0	-18%
Netherlands	159	52	45	6.3%	-114	-72%	-7	-14%
Poland	138	48	43	6.06%	-95	-69%	-5	-10%
Portugal	84	15	12	1.7%	-72	-86%	-3	-20%
Romania	81	20	20	2.8%	-61	-76%	-1	-3%
Slovakia	21	3	3	0.4%	-18	-87%	0	-11%
Slovenia	25	4	3	0.4%	-22	-89%	-1	-23%
Spain	342	83	61	8.6%	-282	-82%	-23	-27%
Sweden	155	13	11	1.6%	-144	-93%	-1	-10%
United Kingdom	1 158	77	60	8.5%	-1 098	-95%	-17	-22%
EU-27+UK	**6 066**	**840**	**706**	**100%**	**-5 360**	**-88%**	**-135**	**-16.0%**
Iceland	5	1	1	0.1%	-5	-85%	0	-24%
United Kingdom (KP)	1 164	78	61	8.6%	-1 103	-95%	-17	-22%
EU-KP	**6 077**	**843**	**708**	**100%**	**-5 370**	**-88%**	**-135**	**-16.0%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

France, Germany, Italy, Spain and the United Kingdom account for 63.2 % of CH_4 emissions from gasoline in 2020 (Figure **3.120**).

In Figure **3.121** the IEF is depicted and the IEF decreased from 43 kg/TJ in 1990 to 10 kg/TJ in 2020. All countries show a similar trend in both the IEF and emission values, which is also linked to the decreasing trend of the corresponding activity data. CH_4 emissions and consequently CH_4 IEF have reduced along the time series due to the introduction of abatement devices on vehicles, in agreement with the legislation emission limits.

*Figure **3**.120   1A3b Road Transport, gasoline: Emission trend and share for CH_4 emission*

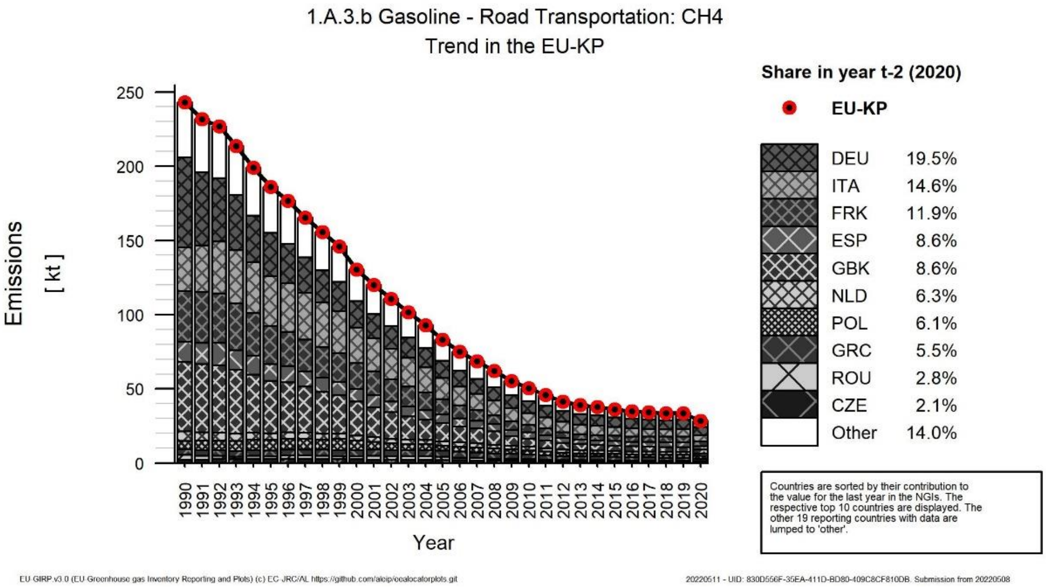
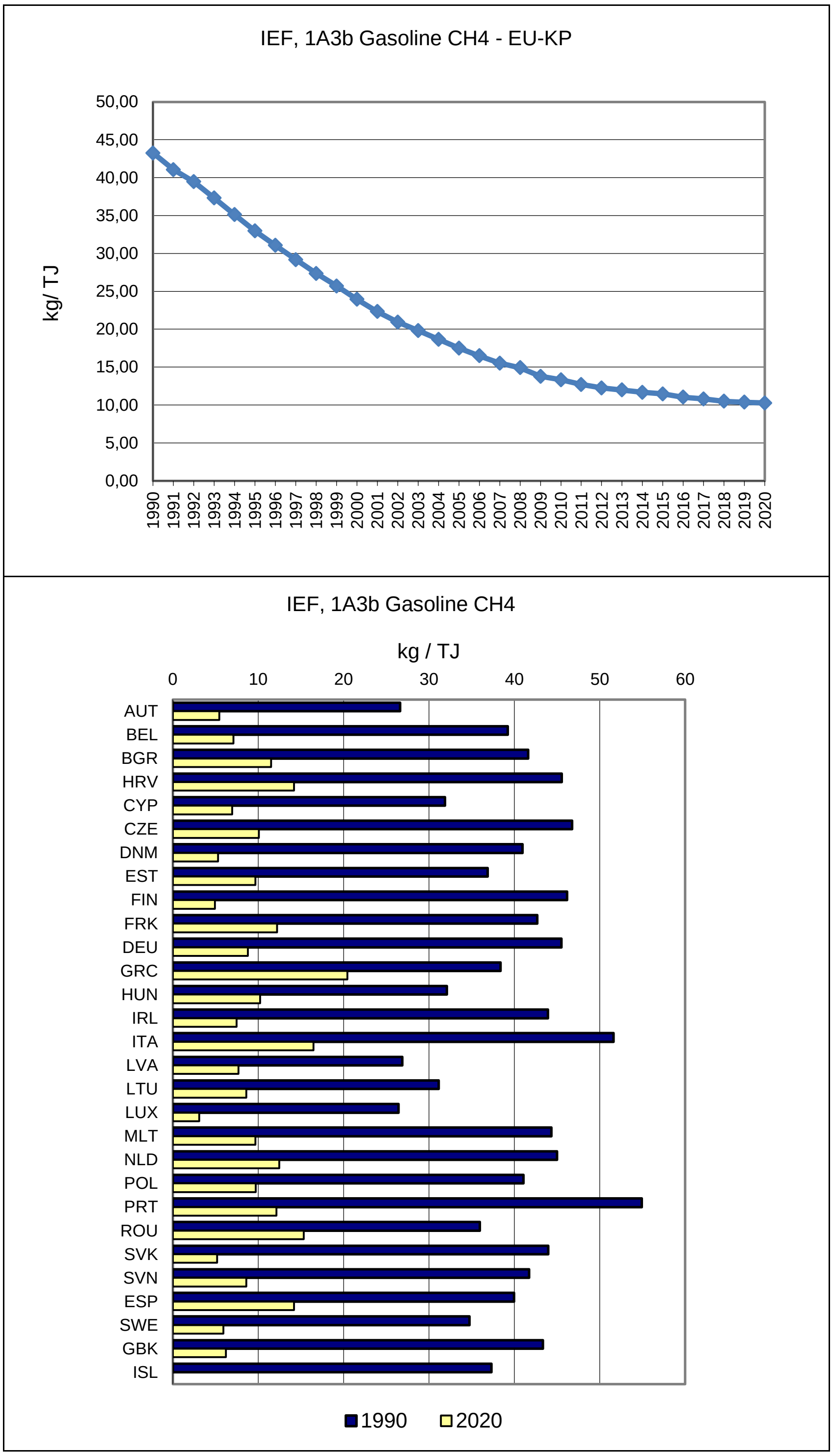


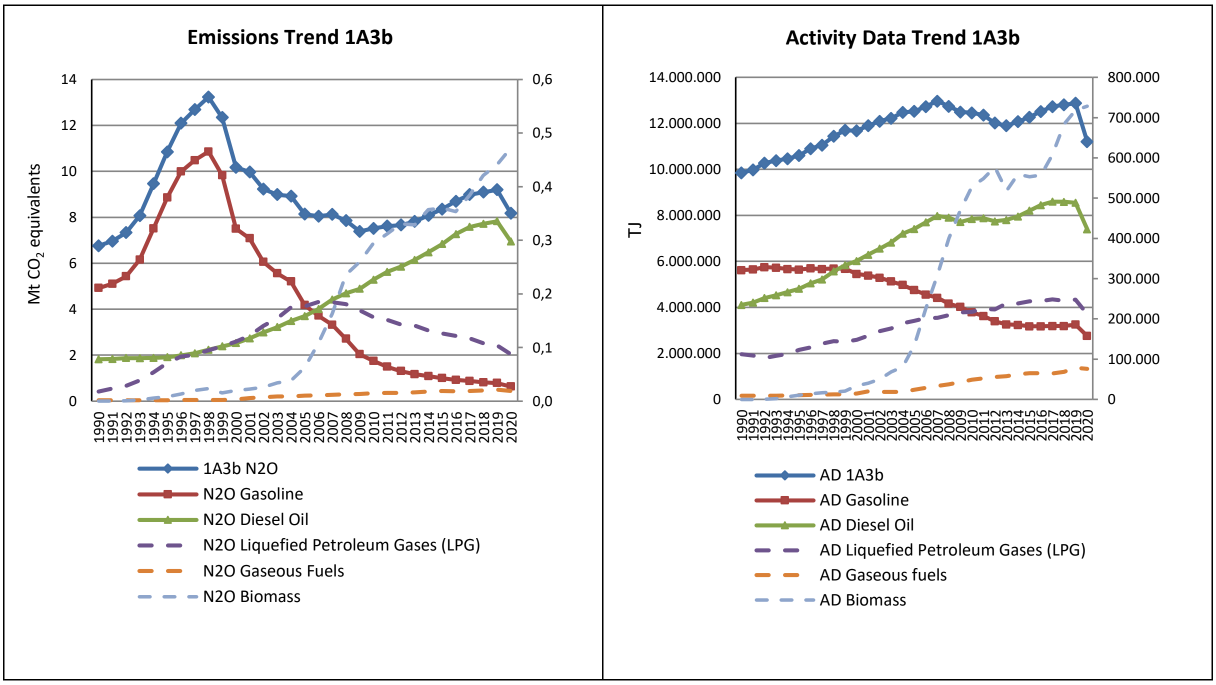
*Figure **3**.121 1A3b Road Transport, Gasoline: Implied Emission Factors for CH_4 (in kg/TJ)*



N_2O emissions from 1A3b Road Transportation

N_2O emissions from 1A3b Road Transportation account for 1% of total EU-KP Transport GHG emissions in 2020. Figure **3.122** gives an overview of the N_2O trend caused by different fuels. The trend is mainly dominated by emissions resulting from diesel oil, LPG and biomass in the recent years.

*Figure **3**.122 1A3b Road Transport: N_2O Emissions Trend*



Data displayed as dashed line refers to the secondary axis.

N_2O emissions increased between 1990 and 2020 by 21 % (Table 3-71). N_2O emissions increased in the 1990s due to the implementation of the catalytic converter in the early Euro vehicles (mainly Euro 1) but decreased thereafter (for post Euro 2 vehicles). The reason for the existing various trends in N_2O emission are different estimates of N_2O emission factors. In principle, two different models/emission factor sources are being used in EU-KP countries to estimate N_2O emissions: (1) HBEFA - Handbook of emissions factors, (2) COPERT. The Emission Factors Handbook (Austria, Germany, the Netherlands and Sweden) estimates that the N_2O emission factors decrease for every technology generation (Euro 1, Euro 2 etc.). The emission factors included in COPERT are in line with the EMEP/EEA Guidebook 2016 and they decrease for every technology generation (similar approach as the HBEFA).

The treatment of N_2O emission factors in the COPERT model was as follows: N_2O emission factors were fully updated for passenger cars and light commercial vehicles with the launch of the first official COPERT 4 version 3.0 (November 2006) and were introduced in the rt070100 chapter of the emissions inventory guidebook dated September 2006. These emission factors introduced reductions in N_2O as the emission technology improved. In particular for gasoline vehicles, these emission factors also introduced an increase in the emission level as the vehicle grows older and a decrease as the fuel sulphur decreased. All emission factors were based on an extensive literature review and synthesis of the findings that was conducted in 2005. Use of the new emission factors over COPERT III should in general lead to reductions of the national N_2O levels.

In 2007, the HDV N_2O emission factors were updated based on a relevant report that was published by the Dutch Institute TNO (Report TNO 03.OR.VM.006.1/IJR). These emission factors were sensitive to vehicle size and driving conditions (urban, rural, highway). Depending on the national stock details, use of the emission factors could lead to both slight increases or slight decreases compared to the previous set. The new emission factors were introduced in COPERT 4 v5.0 (December 2007) but were then introduced in the AEIG with the original GB2009 revision (Technical report 9/2009 – June 2009).

Since June 2009 this basic methodology of N_2O calculation has remained without changes.

The COPERT 4 implementation of the methodology introduced some calculation errors that were fixed in the subsequent software versions. Also, a number of slight updates (extension of the methodology to other categories) have been incorporated. A summary of these updates and software fixes is provided in Table 3-70

Table 3-70: N_2O and CH_4 relevant changes in the COPERT 4 and COPERT 5 methodology

Version: 4.3.0	Date: November 2006
METHODOLOGY: Update of the gasoline and diesel passenger car and light duty vehicle N_2O emission factors. Introduction of impact of vehicle technology, vehicle age and fuel sulphur.	
Reference: http://emisia.com/products/copert/versions	
Version: 4.5.0	Date: December2007
METHODOLOGY: Update of the diesel HDV emission factors based on Dutch study	
Reference: http://emisia.com/products/copert/versions	
Version: 4.5.1	Date: February 2008
SOFTWARE CORRECTION: Use of the cumulative mileage instead of annual mileage to calculate N_2O degradation. The correction should lead to an increase in emissions	
Reference: http://emisia.com/products/copert/versions	
Version: 4.6.1	Date: February 2009
METHODOLOGY: The Euro 5 and 6 passenger car and light duty trucks emission factors of CH_4, N_2O, NH_3 have been inherited by default from Euro 4. They were zero in the previous version. The revision will slightly increase total N_2O emissions.	
Reference: http://emisia.com/products/copert/versions	
Version: 4.7.0	Date: December 2009
SOFTWARE CORRECTION: There was a software bug during the calculation of N_2O, NH_3 and CH_4 hot and cold emissions. Because of this bug there was a misallocation between the hot and cold emissions of these pollutants. Furthermore, the N_2O cold emissions were stored in place of NH_3 cold emissions and vice versa. This is now corrected. The corrections are expected to lead to MS specific changes.	
Reference: http://emisia.com/sites/default/files/COPERT4_v7_0.pdf	
Version: 4.8.1	Date: May 2011
METHODOLOGY: N_2O hot and cold emission factors parameters for Euro 5 and Euro 6 LPG passenger cars are set equal to Euro 5 and Euro 6 gasoline ones. This is estimated to slightly increase N_2O in some MS were LPG vehicles are widespread.	
Reference: http://emisia.com/sites/default/files/COPERT4_v8_1.pdf	
Version: 4.9.0	Date: October 2011
METHODOLOGY: Bioethanol was introduced as a fuel. N_2O emissions are now split to a fossil and a non-fossil (biomass) part (for exporting to CRF).	
Reference: http://emisia.com/sites/default/files/COPERT4_v9_0.pdf	
Version: 4.10.0	Date: November 2012
METHODOLOGY: CH_4 emission factors for Euro 4, 5 and 6 gasoline passenger cars have been updated. This is estimated to slightly increase total CH_4 emissions.	
Reference: http://emisia.com/sites/default/files/COPERT4_v10_0.pdf	
Version: 4.11.0	Date: September 2014
METHODOLOGY: Updated N_2O emission factors for Euro 5/V and Euro 6/VI vehicles. The corrections are expected to lead to MS specific changes.	
Reference: http://www.emisia.com/sites/default/files/files/COPERT4_v11_0.pdf	
Version: 4.11.2	Date: January 2015
METHODOLOGY: Minor bug fixes to N_2O emission factors for Euro 5/V and Euro 6/VI vehicles. The corrections are expected to lead to MS specific changes.	
Reference: http://emisia.com/products/copert/versions	
Version: 5.1.0	Date: December 2017
METHODOLOGY: Corrected CH_4 Heavy Duty Trucks Hot Highway and Rural reduction factor to avoid negative results. Corrected CH_4 Hot-Cold emission factors for Diesel Passenger Cars Euro 5 and on. Corrected N_2O Hot Factors for LPG	

Passenger Cars Euro 5 and on. The corrections are expected to lead to MS specific changes.	
Reference: http://emisia.com/products/copert/versions	
Version: 5.2.0	Date: August 2018
METHODOLOGY: New L-category vehicles added (ATVs and diesel mini cars) with corresponding CH_4 and N_2O emission factors.	
Reference: http://emisia.com/products/copert/versions	
Version: 5.3.0	Date: September 2019
METHODOLOGY: Corrected CH_4 Hot Emission Factor for PC, LCV vehicles and revised Euro 6 LCV NOx emissions factors.	
Reference: http://emisia.com/products/copert/versions	
Version: 5.4.30	Date: September 2020
METHODOLOGY: Updated emission factors for Euro 6 PCs and LCVs. New vehicle categories and emission factors added (Petrol PHEV, Diesel PHEV, Busses Hybrid).	
Reference: http://emisia.com/products/copert/versions	
Version: 5.4.52	Date: May 2021
METHODOLOGY: Correction in the calculation of N_2O and NH3 emissions for PC LPG & CNG and Urban Buses CNG.	
Reference: http://emisia.com/products/copert/versions	

Table 3-71 1A3b Road Transport: Member States' contributions to N_2O emissions and information on method applied and emission factor

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	105	264	238	2.9%	132	126%	-27	-10%	T3	CS
Belgium	155	257	229	2.8%	74	48%	-28	-11%	M,T3	CS,M
Bulgaria	55	91	86	1.1%	31	57%	-5	-5%	T2	CR
Croatia	53	56	55	0.7%	2	5%	-1	-1%	T1,T3	CR,D
Cyprus	24	21	21	0.3%	-3	-13%	0	-1%	T1,T2	D,M
Czechia	93	180	173	2.1%	80	86%	-7	-4%	T3	M
Denmark	87	131	124	1.5%	36	42%	-7	-6%	CR,M,T3	CR
Estonia	22	21	21	0.3%	-1	-5%	0	-1%	T3	CS
Finland	154	83	82	1.0%	-71	-46%	0	0%	T3	CR
France	921	1 323	1 108	13.6%	187	20%	-215	-16%	T3	M
Germany	1 343	1 743	1 642	20.1%	299	22%	-101	-6%	CS,M,T2,T3	CS,M
Greece	117	122	108	1.3%	-9	-8%	-14	-11%	M,T1,T2	D,M
Hungary	61	146	128	1.6%	67	111%	-19	-13%	T1,T3	D,M
Ireland	50	120	105	1.3%	55	110%	-14	-12%	T3	M
Italy	838	900	737	9.0%	-101	-12%	-163	-18%	T3	M
Latvia	20	28	26	0.3%	7	36%	-2	-6%	T1,T3	CR,D,M
Lithuania	50	52	52	0.6%	3	5%	0	1%	T1,T3	CR,D
Luxembourg	15	67	53	0.7%	38	245%	-13	-20%	T3	M
Malta	2	4	3	0.0%	1	38%	-1	-17%	T3	M
Netherlands	102	259	223	2.7%	121	119%	-36	-14%	T1,T2	CS
Poland	164	659	643	7.9%	479	292%	-16	-2%	T3	D
Portugal	79	165	140	1.7%	62	79%	-25	-15%	OTH,T3	CR,OTH
Romania	227	203	206	2.5%	-21	-9%	3	1%	T1,T3	D,OTH
Slovakia	56	82	65	0.8%	9	16%	-16	-20%	T3	D
Slovenia	30	61	52	0.6%	22	73%	-10	-16%	M	M
Spain	464	920	775	9.5%	311	67%	-145	-16%	CR	CR
Sweden	154	177	173	2.1%	19	12%	-4	-2%	M,T1,T2	CS,D
United Kingdom	1 308	1 050	888	10.9%	-419	-32%	-161	-15%	T3	CR,CS
EU-27+UK	**6 750**	**9 186**	**8 160**	**100%**	**1 410**	**21%**	**-1 026**	**-11%**	**-**	**-**
Iceland	5	8	7	0.1%	2	33%	-1	-11%	T3	D
United Kingdom (KP)	1 312	1 053	892	10.9%	-420	-32%	-161	-15%	T3	CR,CS
EU-KP	**6 760**	**9 197**	**8 170**	**100%**	**1 410**	**21%**	**-1 027**	**-11%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3b Road Transportation – Diesel Oil (N_2O)

N_2O emissions from Diesel oil account for 87.5 % of N_2O emissions from 1A3b "Road Transportation" in 2020. Between 1990 and 2020 N_2O emissions from Diesel oil increased in all countries, except for Finland (decrease by 5 %), and in particular within the EU-KP the emission increased by 282%. The largest increase in absolute terms was reported by France and Germany. Between 2019 and 2020, EU-KP emissions decreased by 11 % (Table 3-72).

Table 3-72 1A3b Road Transport, diesel oil: Member States' contributions to N_2O emissions

Member State	N_2O Emissions in kt CO_2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor information
	1990	2019	2020		kt CO_2 equiv.	%	kt CO_2 equiv.	%		
Austria	12	237	215	3.1%	203	1681%	-22	-9%		
Belgium	58	229	195	2.8%	136	233%	-35	-15%		
Bulgaria	14	63	59	0.9%	46	329%	-4	-6%		
Croatia	11	47	47	0.7%	36	318%	0	0%	T3	CR
Cyprus	9	15	15	0.2%	6	63%	0	0%		
Czechia	52	149	143	2.1%	91	174%	-6	-4%		
Denmark	30	112	106	1.5%	76	251%	-5	-5%		
Estonia	7	17	18	0.3%	11	151%	1	3%	T3	M
Finland	65	61	62	0.9%	-3	-5%	1	2%	T3	CR
France	232	1 110	927	13.3%	695	299%	-183	-16%		
Germany	145	1 544	1 425	20.5%	1 280	882%	-118	-8%		
Greece	39	62	60	0.9%	20	52%	-3	-5%		
Hungary	21	115	98	1.4%	77	364%	-16	-14%	T3	M
Ireland	14	107	95	1.4%	81	576%	-12	-12%		
Italy	343	733	598	8.6%	256	75%	-135	-18%		
Latvia	7	24	22	0.3%	16	230%	-2	-6%	T3	M
Lithuania	23	47	48	0.7%	25	111%	0	1%	T3	CR
Luxembourg	3	61	47	0.7%	45	1774%	-13	-22%		
Malta	0	3	2	0.0%	2	475%	-1	-20%	T3	M
Netherlands	27	200	175	2.5%	148	546%	-25	-13%		
Poland	72	504	503	7.25%	431	599%	-1	0%	T3	D
Portugal	29	127	110	1.6%	80	276%	-17	-13%		
Romania	31	155	156	2.3%	126	407%	1	1%	T3	OTH
Slovakia	41	69	54	0.8%	13	31%	-14	-21%	T3	D
Slovenia	10	53	45	0.6%	35	362%	-8	-16%	T3	M
Spain	190	859	729	10.5%	540	285%	-130	-15%	CR	CR
Sweden	14	163	161	2.3%	147	1049%	-2	-1%		
United Kingdom	315	955	817	11.8%	502	159%	-137	-14%	T3	CR
EU-27+UK	**1 815**	**7 820**	**6 933**	**100%**	**5 118**	**282%**	**-887**	**-11%**		
Iceland	1	6	6	0.1%	5	520%	0	-6%		
United Kingdom (KP)	316	957	820	11.8%	503	159%	-138	-14%	T3	CR
EU-KP	**1 817**	**7 829**	**6 942**	**100%**	**5 124**	**282%**	**-887**	**-11%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level Only information from major emitters have been included to the table as well as voluntarily provided information by countries. Additional information is provided in Annex III of the EU NIR and in MS NIRs, which are also part of the EU submission.

France, Germany, Italy, Spain and the United Kingdom account for 64.8 % of N_2O emissions from diesel oil in 2020 (Figure **3.123**). In Figure **3.124** the IEF is depicted and the EU IEF increased from 1.5 kg/TJ in 1990 to about 3.2 kg/TJ in 2020. A similar situation, increase in the values of the IEF, is observed for almost all countries. In most cases the IEF is country specific, thus a variation in the values of the IEF through the timeseries is observed. These IEF depend on the vehicle age, on the vehicle size and on driving conditions. In the case of Cyprus, during the initial checks of 2021, a question was raised to the country in order to give an explanation concerning the high value of N_2O IEF in the year 1990. Cyprus is still investigating the issue. Thus, the issue is considered partly resolved and we will evaluate it in the next annual checks. Additionally, N_2O IEF for certain categories, such as heavy duty trucks and buses, have been increasing with more recent Euro standards (Euro IV-VI). All the above can lead to increased emission factors over the years.

*Figure **3**.123 1A3b Road Transport, diesel oil: Emission trend and share for N_2O emission*

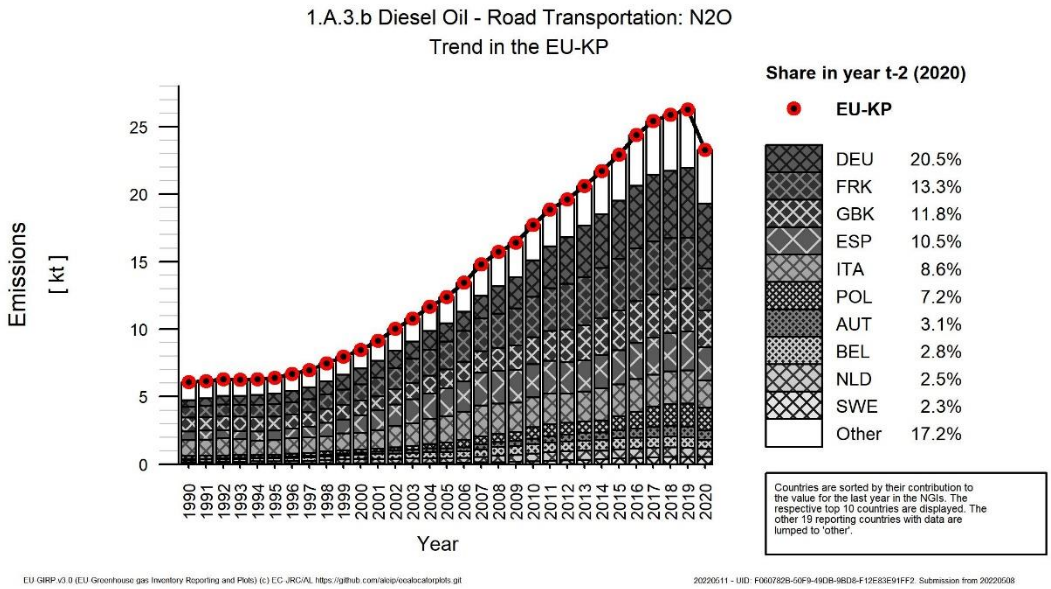
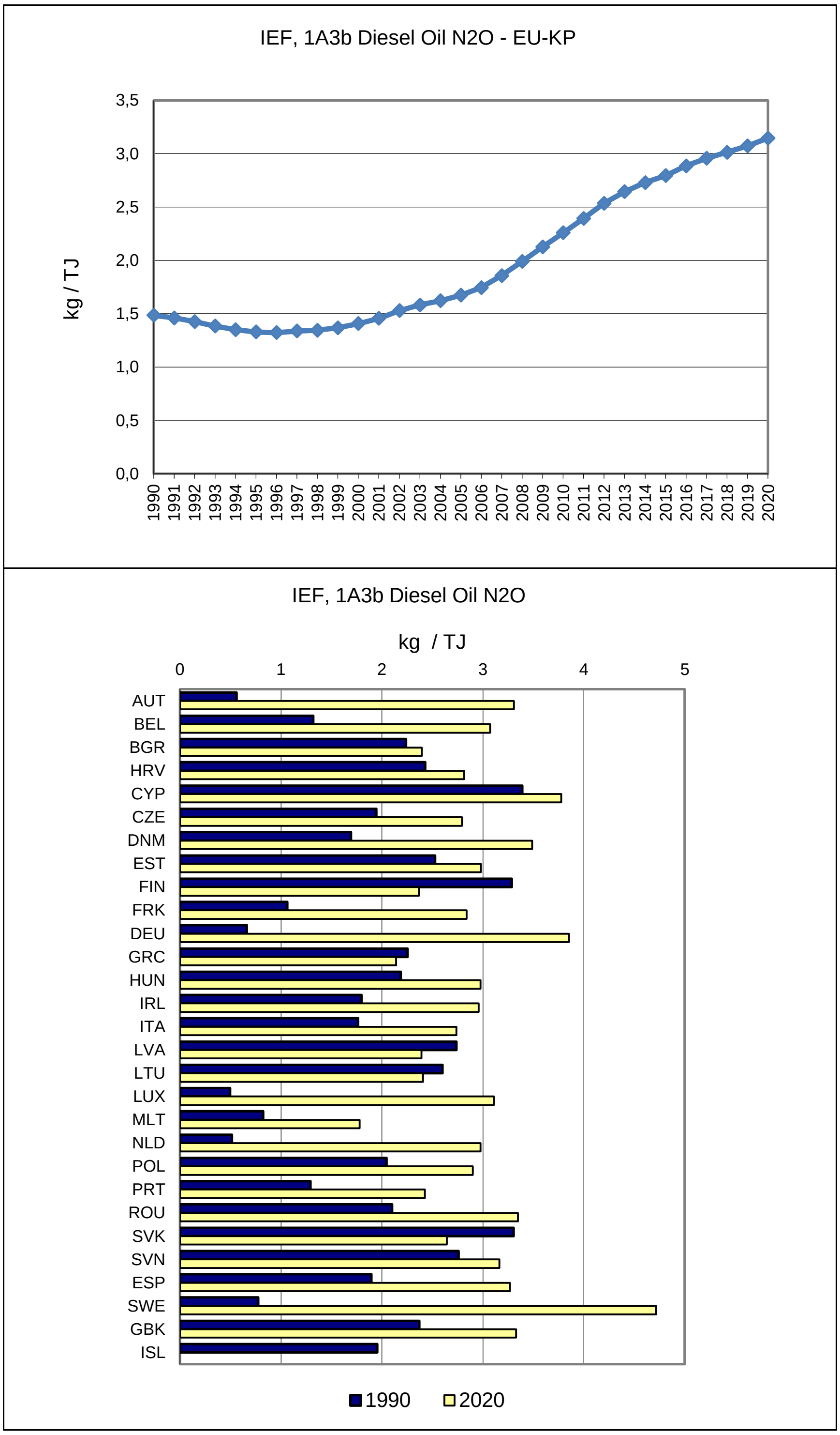


*Figure **3**.124 1A3b Road Transport, Diesel Oil: Implied Emission Factors for N_2O (in kg/TJ)*



1A3b Road Transportation – Gasoline (N_2O)

N_2O emissions from Gasoline account for 6 % of N_2O emissions from 1A3b Road Transportation in 2020. Between 1990 and 2020, N_2O emissions from gasoline decreased by 87 % in the EU-KP with a peak in 1998. As explained above, this peak is due to the implementation of the catalytic converter in the early Euro vehicles and mainly Euro 1. Emissions decreased thereafter with the introduction of Euro 2 and later vehicle technologies. Between 2019 and 2020, all countries showed a decreasing trend. The EU-KP total N_2O emissions dropped by 19 % (Table 3-73).

Table 3-73 1A3b Road Transport, gasoline: Member States' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	93	9	8	1.2%	-85	-92%	-2	-18%
Belgium	97	11	9	1.3%	-88	-91%	-2	-22%
Bulgaria	41	9	8	1.3%	-33	-79%	-1	-7%
Croatia	41	8	7	1.1%	-34	-83%	-1	-9%
Cyprus	15	5	4	0.7%	-11	-71%	-1	-20%
Czechia	41	17	15	2.3%	-26	-64%	-2	-14%
Denmark	57	11	9	1.5%	-48	-84%	-2	-16%
Estonia	15	3	2	0.4%	-12	-83%	-1	-24%
Finland	88	11	10	1.7%	-78	-88%	-1	-7%
France	689	99	78	12.3%	-611	-89%	-21	-21%
Germany	1 198	102	89	14.1%	-1 109	-93%	-12	-12%
Greece	78	49	38	6.0%	-40	-51%	-11	-22%
Hungary	39	24	19	3.0%	-21	-52%	-5	-21%
Ireland	36	7	5	0.8%	-31	-87%	-2	-29%
Italy	494	94	72	11.4%	-422	-85%	-22	-23%
Latvia	12	2	2	0.3%	-11	-86%	0	-13%
Lithuania	27	2	2	0.3%	-25	-93%	0	-5%
Luxembourg	13	2	1	0.2%	-12	-90%	0	-25%
Malta	2	1	1	0.1%	-1	-63%	0	-20%
Netherlands	58	38	32	5.0%	-26	-44%	-6	-17%
Poland	92	59	50	7.9%	-42	-45%	-9	-15%
Portugal	49	21	16	2.5%	-33	-68%	-6	-26%
Romania	196	25	24	3.8%	-172	-88%	-1	-6%
Slovakia	15	6	5	0.8%	-10	-66%	-1	-17%
Slovenia	20	4	3	0.5%	-17	-85%	-1	-27%
Spain	274	60	45	7.1%	-229	-84%	-15	-25%
Sweden	140	10	8	1.2%	-132	-95%	-2	-21%
United Kingdom	993	95	71	11.2%	-922	-93%	-24	-25%
EU-27+UK	**4 915**	**785**	**633**	**100%**	**-4 282**	**-87%**	**-151**	**-19%**
Iceland	4	1	1	0.1%	-3	-80%	0	-29%
United Kingdom (KP)	996	95	71	11.3%	-924	-93%	-24	-25%
EU-KP	**4 923**	**787**	**635**	**100%**	**-4 288**	**-87%**	**-152**	**-19%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

France, Germany, Italy, Spain and the United Kingdom accounted for 56.2 % of N_2O emissions (Figure **3.125**. Figure **3.126** the IEF is depicted and it is clear that high variability exists for all countries through the whole time series. In the case of Romania, the high value of N_2O IEF is an issue still under investigation.

*Figure **3**.125 1A3b Road Transport, Gasoline: Emission trend and share for N_2O emissions*

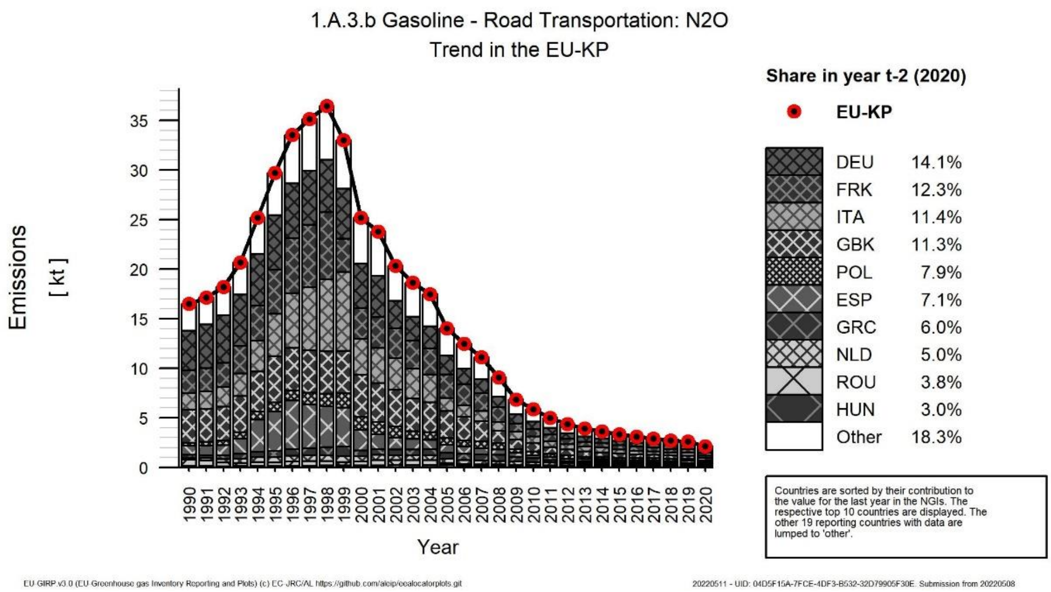
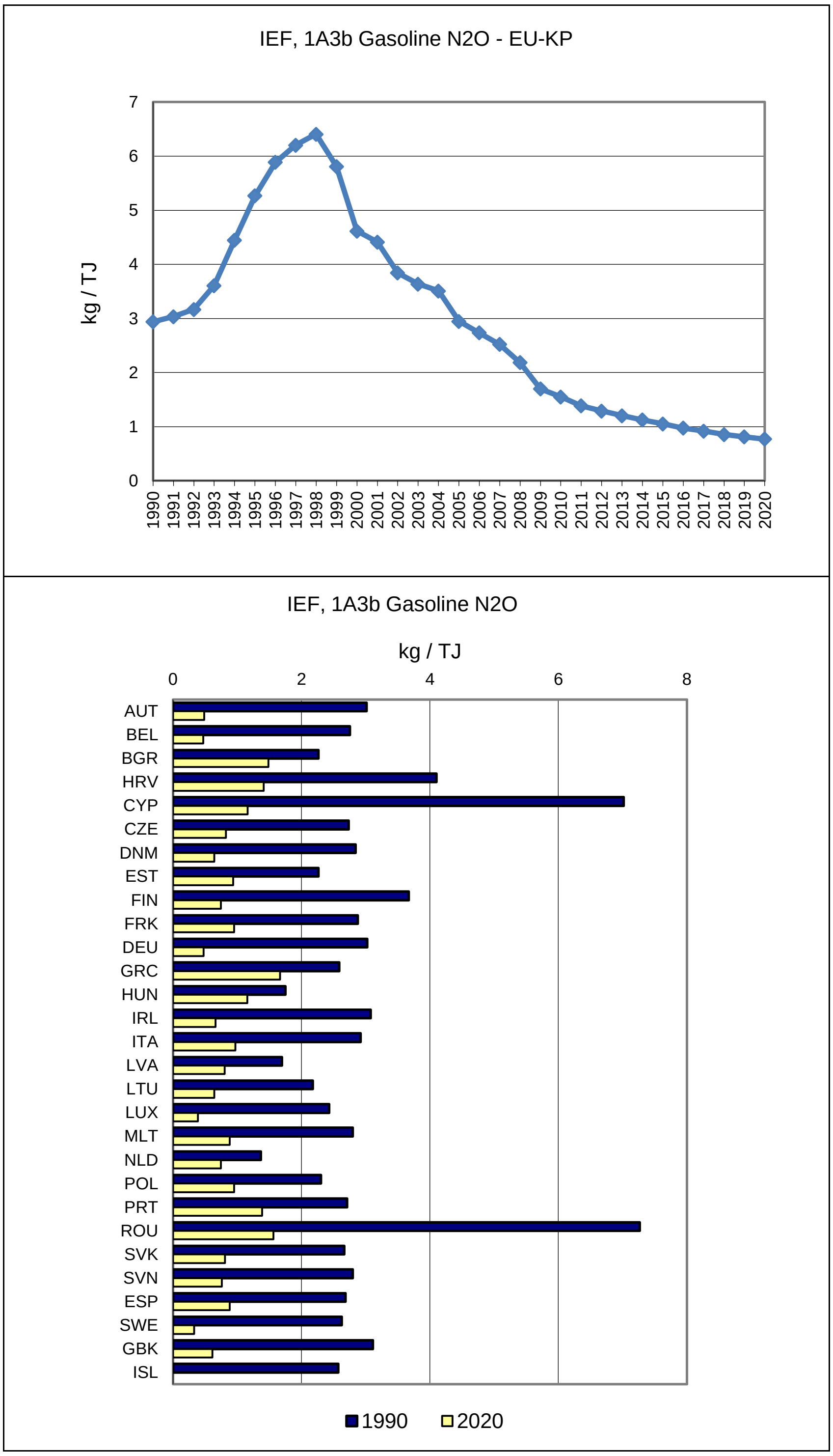


*Figure **3**.126 1A3b Road Transport, Gasoline: Implied Emission Factors for N_2O (in kg/TJ)*

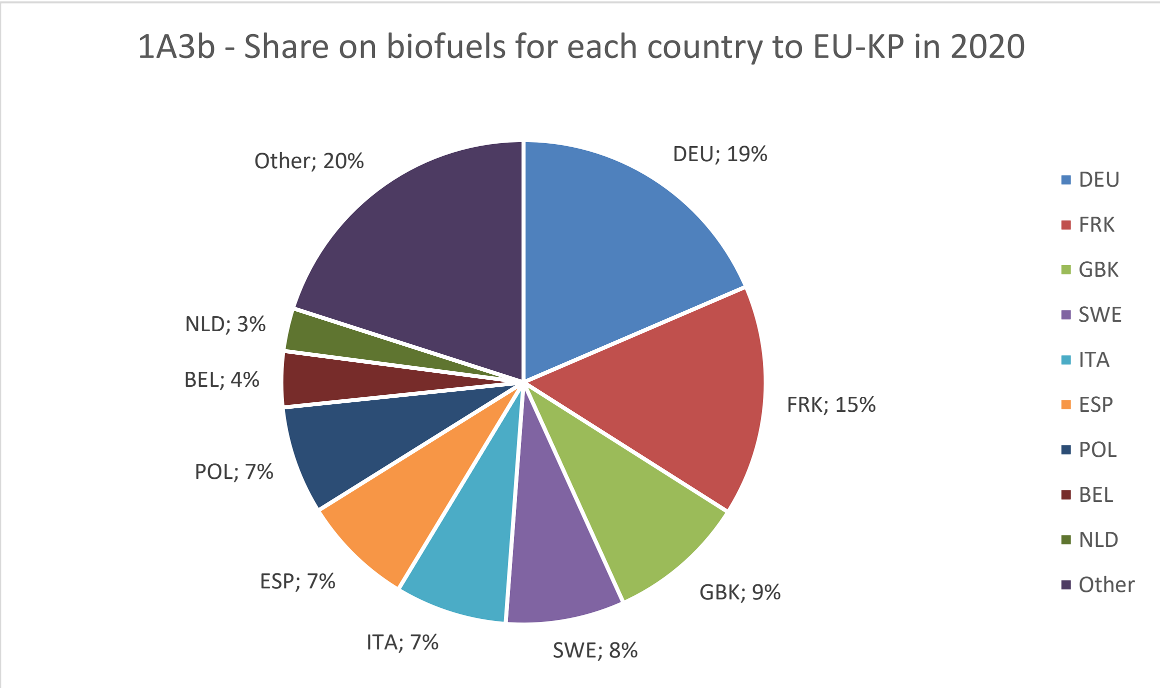


1A3b Road Transportation – Activity Data Biofuels

According to the European Directive on the promotion of the use of biofuels or other renewable fuels for transport (2003/30/EG), countries should ensure that a minimum proportion of biofuels and other renewable fuels is placed on their markets, and, to that effect, shall set national indicative targets, to reduce greenhouse gas emissions. Countries brought into force the laws, regulations and administrative provisions necessary to comply with this Directive by 31 December 2004. A reference value for these targets shall be 2 %, calculated on the basis of energy content, of all petrol and diesel for transport purposes placed on their markets by 31 December 2005. A reference value for these targets shall be 5.8 %, calculated on the basis of energy content, of all petrol and diesel for transport purposes placed on their markets by 31 December 2010. Due to the possibility of different national implementation the MS need to approach partly different targets.

Figure 3.127 shows the share on biofuels for each country to EU-KP in 2020. In this figure only the 9 countries, which contribute the most, are presented, whereas all remaining countries are presented together in category "Other" in this figure. Denmark reports most of total amount of biofuels (19 % of total EU-KP activity in 2020), followed by France (15 %). All countries report biofuels activity under 1A3b for 2020.

Figure 3.127 1A3b Road Transport, Biofuels: Share on biofuels for each country



Furthermore, during the ESD checks the ERT recommends that the European Union provide summary information on how each member State has reported the emissions from use of lubricants under the transport (1.A.3) and/or lubricant use (2.D.1) categories and work with the member States to report emissions from lubricants combusted in two-stroke engines under the transport category in accordance with the 2006 IPCC Guidelines. Based on that the following table provides information on the status of the recommendation for all the Member States.

Table 74: 1A3b, Road Transport, Emissions from the use of lubricants combusted in two-engine stroke engines.

Member State	Are the emissions from lubricants combusted in two-stroke engines reported under the transport category?	Main explanation
Austria	No	Lubricants used for 2-stroke engines were not reported separately due to lack of data.
Belgium	Yes	Apart from 0.2-0.3% which is used in 2-stroke motor vehicles – emissions are in 1A3b.
Bulgaria	Yes	Emissions reported in CRF under the transport category.
Cyprus	No	Spilt is not available in sub-categories (i.e. 1A3bii, 1A3biii etc.). The emissions related to lubricants are reported in 1.AD and 2.D.1 sections
Czech Republic	Yes	Emissions from lubricants combusted in 2-stroke moped and motorcycle engines are reported within 1.A.3.b iv subcategory according IPCC Guidelines 2006 and based on EIG 2019 and COPERT methodology.
Germany	Yes	Emissions reported in CRF under the transport category.
Denmark	No	Emissions from lubricants during use are reported under 2D3 as per the UNFCCC reporting guidelines. Two-stroke engines in road transport are only relevant for mopeds and motorcycles (and the odd veteran vehicle) and even in these categories four-stroke engines have gained popularity in part due to environmental considerations. The Danish energy statistics only include lubricants for non-energy purposes and any consumption in two-stroke mopeds/motorcycles will be negligible and fall far below the threshold of significance
Spain	Yes	Emissions reported in CRF under the transport category.
Estonia	No	It was concluded that the use of lubricants in 2-stroke engines is marginal.
Finland	No	There are no data on sales of 2-stroke oil separetely. The emissions are not separated from the use of 4 stroke oil and other lubricants.
France	Yes	Emissions reported in CRF under the transport category.
United Kingdom	Yes	Emissions reported in CRF under the transport category.
Greece	No	There are no 2-stroke motorcycles in Greece
Croatia	Yes	Emissions reported in CRF under the transport category.
Hungary	Yes	Emissions reported in CRF under the transport category.
Iceland	No	Currently available activity data does not allow to separate lubricants mixed in with other fuel in 2-stroke engines from lubricants used for their lubricating properties. Additionally, the amount of lubricant used as 2-stroke engine fuel is likely to be very small.
Ireland	No	The CO2 emissions from lubricants within transport is captured under the non energy use of fuels in category 2.D.1.
Italy	Yes	Emissions reported in CRF under the transport category.
Lithuania	No	Emissions from two-stroke engines are considered as insignificant, as these emissions do not exceed the threshold of significance. Based on these proportions, lubricants use in two-stroke engines in 2016 amounts only to 0,74-1,48 TJ, consequently emissions do not exceed threshold of significance.
Luxembourg	No	Emissions from lubricants reported exclusively under category 2.D.1. The activity data obtained from the national statistics institute (Statec) does not allow for a disaggregation of the lubricants consumption between 2-stroke engines and other applications. Furthermore, the number of 2-stroke engines in Luxembourg is very low; the consumption is below the threshold of significance.
Latvia	Yes	Emissions reported in CRF under the transport category.
Malta	No	The issue is under investigation.
Netherlands	Yes	Emissions reported in CRF under the transport category.
Poland	Yes	Emissions reported in CRF under the transport category.
Portugal	Yes	Emissions reported in CRF under the transport category.
Romania	No	Romania is considering reporting the emissions under the Energy Sector-Road Transportation category; The issue is under investigation.
Slovakia	Yes	Emissions reported in CRF under the transport category.
Slovenia	Yes	Emissions reported in CRF under the transport category. Emissions from combustion of lubricants in two-stroke engines are included in those of gasoline of 1A3b.
Sweden	No	The emissions from lubricants are still considered insignificant and not estimated separately.

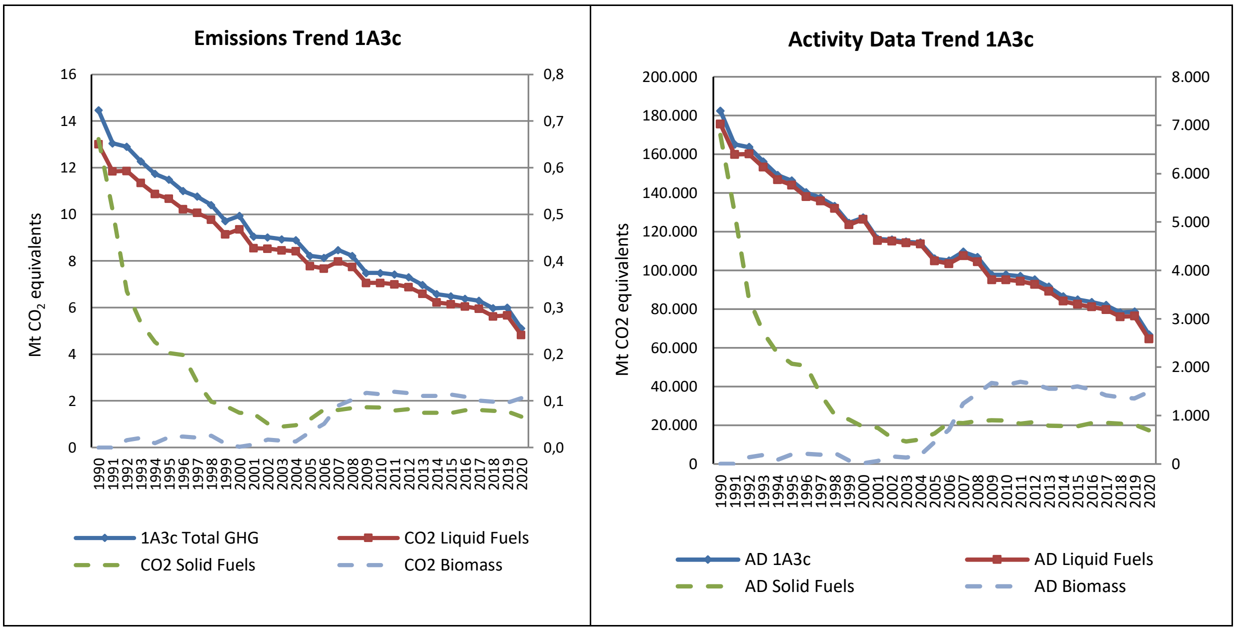
Furthermore, according to the 2006 IPCC Guidelines, Member States are recommended to estimate and provide in their emission inventories, the CO_2 emissions from the fossil part of biofuels (biodiesel and/or biogasoline). It is suggested to be reported under “1A3b Other fossil fuels” of the CRF report. Based on this, all countries of the European Union provide sufficient information concerning the CO_2 emissions from the fossil part of biofuels. Exemption to this are Romania and Iceland. Romania is in the process of investigating the issue, so next year the issue will be reviewed again by ERT. Iceland stated that “all of the biogasoline in Iceland is bioethanol and therefore does not include any fossil carbon (Sempos, 2018). The team for chemicals at the EA, which is responsible for monitoring reporting under the Quality Directive (Directive 2009/30/EC of the European Parliament and of the Council), has confirmed that no FAME biodiesel has been imported to Iceland, only HVO. Therefore, there is no carbon of fossil origin in biodiesel for which CO_2 emissions would need to be accounted for in this inventory”.

3.2.3.3 Railways (1A3c) (EU-KP)

Railway locomotives generally are one of these types: diesel, coal, electric, or steam. Diesel locomotives generally use diesel engines in combination with an alternator or generator to produce the electricity required to power their traction motors. Emissions from Railways arise from the combustion of liquid and solid fuels.

CO_2 emissions from 1A3c Railways account for 0.6% of total EU-KP GHG emissions in 2020.Between 1990 and 2020, CO_2 emissions from rail transportation decreased by 64 % in the EU-KP. The total trend is dominated by CO_2 emissions from liquid fuels (Figure **3.128**). The emissions from this key category are due to fossil fuel consumption in rail transport, which decreased by 61 % between 1990 and 2020.

*Figure **3**.128 1A3c Railways: CO_2 Emission Trend and Activity Data*



Data displayed as dashed line refers to the secondary axis.

The countries, France, Germany, Spain and the United Kingdom contributed most to the emissions from this source (55 %). Between 1990 and 2020, Germany had by far the highest decreases in absolute terms (Table 3-75).

Table 3-75 1A3c Railways: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	178	93	81	1.6%	-97	-55%	-12	-13%	T1,T2	CS,D
Belgium	222	78	69	1.4%	-153	-69%	-9	-12%	T3	CS,D
Bulgaria	323	31	34	0.7%	-289	-89%	3	10%	T1	D
Croatia	140	45	42	0.9%	-98	-70%	-3	-7%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	768	262	233	4.8%	-535	-70%	-29	-11%	T1	D
Denmark	297	224	197	4.0%	-100	-34%	-27	-12%	CR,T2	CS
Estonia	159	34	31	0.6%	-128	-80%	-3	-8%	T2	CS
Finland	191	69	64	1.3%	-127	-67%	-6	-8%	T2	CS
France	1 078	365	304	6.2%	-774	-72%	-60	-17%	T1	OTH
Germany	3 122	832	783	16.0%	-2 339	-75%	-49	-6%	CS,M,T1	CS,D,M
Greece	199	33	23	0.5%	-176	-89%	-10	-30%	T2	CS
Hungary	533	121	105	2.1%	-428	-80%	-16	-13%	T1,T2	CS,D
Ireland	133	122	97	2.0%	-36	-27%	-25	-20%	T2	CS
Italy	613	135	136	2.8%	-477	-78%	1	1%	T2	CS
Latvia	537	137	81	1.7%	-456	-85%	-56	-41%	T1,T2	CS,D
Lithuania	350	169	162	3.3%	-188	-54%	-7	-4%	T1,T2	CS,D
Luxembourg	25	7	7	0.1%	-18	-72%	0	2%	T1,T2	CS,D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	60	61	1.2%	-30	-33%	1	1%	T2	CS
Poland	1 624	268	258	5.3%	-1 365	-84%	-10	-4%	T1	D
Portugal	177	29	26	0.5%	-151	-85%	-3	-12%	T1	D
Romania	473	394	360	7.4%	-113	-24%	-34	-9%	T1,T2	CS,D
Slovakia	372	81	73	1.5%	-300	-81%	-8	-10%	T1	CS
Slovenia	65	23	17	0.3%	-48	-74%	-6	-26%	T1	D
Spain	422	245	170	3.5%	-252	-60%	-75	-31%	T1	D
Sweden	103	45	44	0.9%	-59	-57%	-1	-3%	T2	CS
United Kingdom	1 472	1 845	1 436	29.3%	-36	-2%	-409	-22%	T1,T2	CS
EU-27+UK	**13 668**	**5 748**	**4 894**	**100%**	**-8 775**	**-64%**	**-855**	**-15%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 472	1 845	1 436	29.3%	-36	-2%	-409	-22%	T1,T2	CS
EU-KP	**13 668**	**5 748**	**4 894**	**100%**	**-8 775**	**-64%**	**-855**	**-15%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3c Railways –Liquid Fuels (CO_2)

Between 1990 and 2020, CO_2 emissions from liquid fuels decreased by 63 % in the EU-KP. Between 2019 and 2020, EU-KP emissions decreased by 15 % (Table 3-76). France, Germany, Poland, Romania and the United Kingdom account for 63.8 % of CO_2 emissions from liquid fuels in 2020 (Figure **3.130**).

Table 3-76 1A3c Railways, liquid fuels: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	171	92	80	1.7%	-91	-53%	-12	-13%	T2	CS
Belgium	222	78	69	1.4%	-153	-69%	-9	-12%	T3	CS,D
Bulgaria	323	31	34	0.7%	-289	-89%	3	10%	T1	D
Croatia	119	45	42	0.9%	-77	-65%	-3	-7%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	768	261	232	4.8%	-536	-70%	-29	-11%	T1	D
Denmark	297	224	197	4.1%	-100	-34%	-27	-12%	CR,T2	CS
Estonia	142	34	31	0.6%	-111	-78%	-3	-8%	T2	CS
Finland	191	69	64	1.3%	-127	-67%	-6	-8%	T2	CS
France	1 078	363	303	6.3%	-775	-72%	-60	-17%	T1	OTH
Germany	2 847	796	751	15.6%	-2 096	-74%	-45	-6%	CS,M	CS,M
Greece	199	33	23	0.5%	-176	-89%	-10	-30%	T2	CS
Hungary	528	121	105	2.2%	-424	-80%	-16	-13%	T2	CS
Ireland	133	122	97	2.0%	-36	-27%	-25	-20%	T2	CS
Italy	613	135	136	2.8%	-477	-78%	1	1%	T2	CS
Latvia	537	137	81	1.7%	-456	-85%	-56	-41%	T2	CS
Lithuania	350	169	162	3.4%	-188	-54%	-7	-4%	T1,T2	CS,D
Luxembourg	25	7	7	0.1%	-18	-72%	0	2%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	60	60	1.3%	-30	-33%	1	1%	T2	CS
Poland	1 319	268	258	5.4%	-1 061	-80%	-10	-4%	T1	D
Portugal	177	29	26	0.5%	-151	-85%	-3	-12%	T1	D
Romania	441	394	360	7.5%	-81	-18%	-34	-9%	T1,T2	CS,D
Slovakia	372	81	73	1.5%	-300	-81%	-8	-10%	T1	CS
Slovenia	65	23	17	0.4%	-48	-74%	-6	-26%	T1	D
Spain	422	245	170	3.5%	-252	-60%	-75	-31%	T1	D
Sweden	103	45	44	0.9%	-59	-57%	-1	-3%	T2	CS
United Kingdom	1 472	1 804	1 400	29.0%	-72	-5%	-404	-22%	T2	CS
EU-27+UK	**13 007**	**5 667**	**4 822**	**100%**	**-8 185**	**-63%**	**-844**	**-15%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 472	1 804	1 400	29.0%	-72	-5%	-404	-22%	T2	CS
EU-KP	**13 007**	**5 667**	**4 822**	**100%**	**-8 185**	**-63%**	**-844**	**-15%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3c Railways –Liquid Fuels (CO2)

Between 1990 and 2020, CO2 emissions from liquid fuels decreased by 63 % in the EU-KP. Between 2019 and 2020, EU-KP emissions decreased by 15 % (Table 3-76). France, Germany, Poland, Romania and the United Kingdom account for 63.8 % of CO2 emissions from liquid fuels in 2020 (Figure **3.130**).

Table 3-76 shows that the majority of CO_2 emissions from the combustion of liquid fuels in railways were calculated using a higher tier method. From the calculation of the higher tier methods, countries that use only T1 method were excluded. Romania, states that the IEF values for the calculation of CO_2 emissions are country specific, thus Romania was included in the calculation of the higher tier methods. In Figure **3**.129 the IEF is depicted where the mean value is around 74 t/TJ. In 2016 and 2017 the IEF showed a slight increase, mainly due to the increased value of the IEF of Romania. The fluctuations in the IEF of Romania, is due to the fact that country specific EFs for CO_2 emissions have been determined.

*Figure **3**.130 1A3c Railways, Liquid Fuels: Emission trend and share for CO_2*

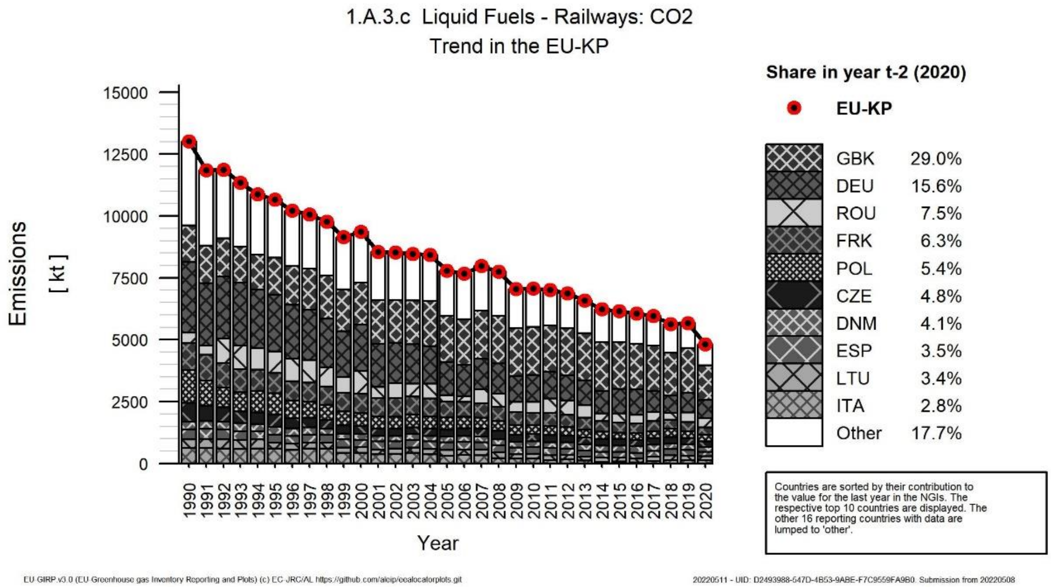
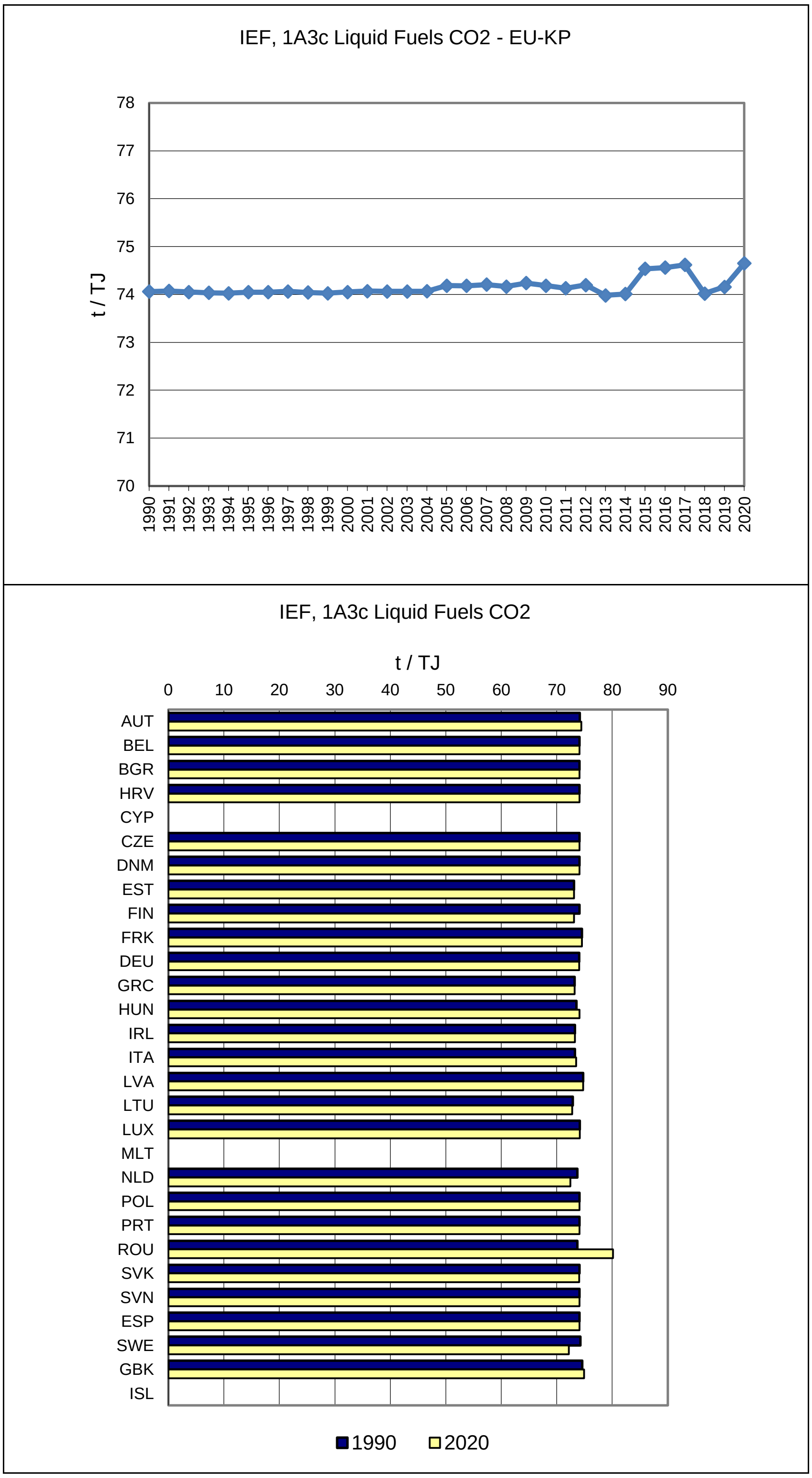


*Figure **3**.131 1A3c Railways, Liquid Fuels: Implied Emission Factors for CO_2 (in t/TJ)*



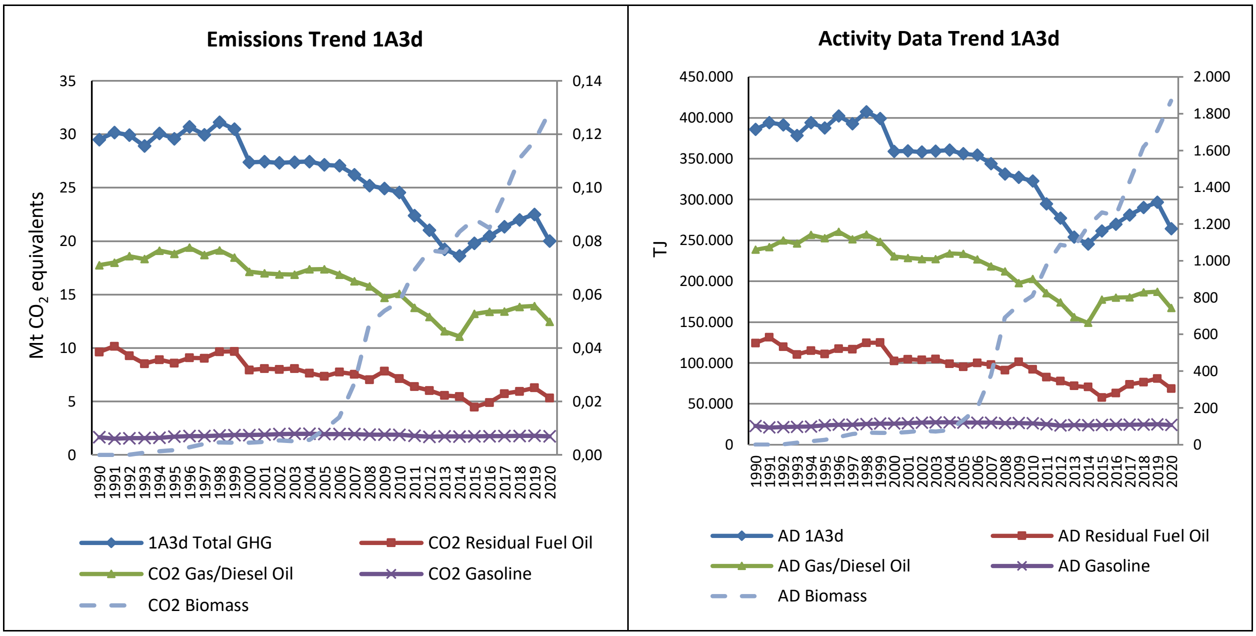
3.2.3.4 Domestic Navigation (1A3d) (EU-KP)

This source category covers all water-borne transport from recreational craft to large ocean-going cargo ships that are driven primarily by large, slow and medium speed diesel engines and occasionally by steam or gas turbines. Emissions arise from gas/diesel oil, residual oil or other.

CO_2 emissions from 1A3d Navigation account for 2.5% of total EU-KP GHG emissions in 2020. Between 1990 and 2020, CO_2 emissions from navigation decreased by 32 % in the EU-KP (Table 3-77).

The emissions from this key category are due to fossil fuel consumption in navigation. The total CO_2 emission trend is dominated by emissions from gas/diesel oil and residual oil (Figure **3.132**).

*Figure **3**.132 1A3d Domestic Navigation: CO_2 Emission Trend and Activity Data*



Data displayed as dashed line refers to the secondary axis.

Five countries (Germany, Greece, Italy, Spain and the United Kingdom) contributed the most to the emissions from this source (75.7 %). Most countries (21 in total) had decreasing emissions from navigation between 1990 and 2020. The countries with the highest decreases in absolute terms were Germany, United Kingdom and Spain (Table 3-77).

Table 3-77 1A3d Domestic Navigation: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	28	84	23	0.1%	-5	-17%	-60	-72%	T1,T2	CS,D
Belgium	362	374	371	1.9%	9	2%	-4	-1%	T1,T3	CS,D
Bulgaria	56	6	5	0.0%	-52	-91%	-2	-24%	T1	D
Croatia	134	156	127	0.6%	-7	-5%	-28	-18%	T1	D
Cyprus	2	3	1	0.0%	-1	-41%	-2	-54%	T1	D
Czechia	54	16	13	0.1%	-41	-76%	-3	-20%	T1	D
Denmark	715	478	478	2.4%	-237	-33%	0	0%	CR,M,T2	CS
Estonia	22	16	20	0.1%	-2	-8%	3	21%	T2	CS
Finland	441	429	350	1.8%	-91	-21%	-78	-18%	T2	CS
France	1 021	1 303	1 274	6.5%	253	25%	-30	-2%	T1	CS
Germany	3 001	1 568	1 393	7.1%	-1 609	-54%	-175	-11%	CS	CS,M
Greece	1 809	2 068	1 669	8.5%	-139	-8%	-399	-19%	T1	CS
Hungary	209	16	10	0.0%	-200	-95%	-6	-40%	T1	D
Ireland	85	274	319	1.6%	234	276%	45	16%	T2	CS
Italy	5 470	4 343	4 624	23.5%	-846	-15%	281	6%	T1,T2	CS
Latvia	1	10	7	0.0%	6	627%	-3	-27%	T1,T2	CS,D
Lithuania	15	16	12	0.1%	-4	-25%	-5	-28%	T1	CS
Luxembourg	1	1	0	0.0%	-1	-70%	-1	-60%	T1,T2	CS,D
Malta	12	51	37	0.2%	25	208%	-14	-28%	D,T1	CS,D
Netherlands	743	909	691	3.5%	-51	-7%	-217	-24%	T2	CS
Poland	151	10	15	0.1%	-135	-90%	6	58%	T1	D
Portugal	263	270	202	1.0%	-61	-23%	-68	-25%	T2	D
Romania	1 140	135	137	0.7%	-1 002	-88%	2	1%	T2	CS
Slovakia	0	4	5	0.0%	5	23700%	1	28%	T1	CS
Slovenia	0	0	0	0.0%	0	678%	0	-3%	T1	D
Spain	5 214	3 284	2 453	12.5%	-2 761	-53%	-831	-25%	T1	D
Sweden	452	671	624	3.2%	171	38%	-48	-7%	T2	CS
United Kingdom	7 536	5 485	4 736	24.1%	-2 800	-37%	-749	-14%	T2	CS
EU-27+UK	**28 937**	**21 979**	**19 597**	**100%**	**-9 340**	**-32%**	**-2 382**	**-11%**	**-**	**-**
Iceland	33	53	25	0.1%	-8	-24%	-28	-53%	T2	CS
United Kingdom (KP)	7 608	5 564	4 777	24.3%	-2 831	-37%	-786	-14%	T2	CS
EU-KP	**29 042**	**22 111**	**19 663**	**100%**	**-9 379**	**-32%**	**-2 448**	**-11%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

1A3d Domestic Navigation – Residual Fuel Oil (CO_2)

CO_2 emissions from residual oil account for 25 % of CO_2 emissions from 1A3d Navigation in 2020. Between 1990 and 2020, CO_2 emissions from residual fuel oil decreased by 45 % in the EU-KP. The countries with the highest decrease in absolute terms were Romania and United Kingdom. 18 countries reported emissions as 'Not Occurring' (Table 3-78) for 2020, whereas Belgium reported emissions as 'Included Elsewhere' and specifically, the aforementioned emissions are included in gas/diesel oil, since the amounts of residual fuel oil are very small.

Table 3-78 1A3d Navigation, residual fuel oil: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	IE	IE	IE	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	7	NO	NO	-	-7	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	357	118	133	2.5%	-224	-63%	15	13%	CR,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	123	37	19	0.3%	-105	-85%	-18	-50%	T2	CS
France	159	68	61	1.1%	-99	-62%	-7	-10%	T1	CS
Germany	247	31	29	0.6%	-218	-88%	-2	-6%	CS	CS,M
Greece	746	1 142	977	18.4%	231	31%	-165	-14%	T1	CS
Hungary	3	NO	NO	-	-3	-100%	-	-	NA	NA
Ireland	63	NO	NO	-	-63	-100%	-	-	NA	NA
Italy	2 576	1 980	2 126	40.0%	-449	-17%	146	7%	T1,T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	5	NO	NO	-	-5	-100%	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	70	NO	NO	-	-70	-100%	-	-	NA	NA
Portugal	190	195	146	2.7%	-44	-23%	-49	-25%	T2	D
Romania	1 027	NO	NO	-	-1 027	-100%	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1 254	1 834	1 119	21.0%	-135	-11%	-715	-39%	T1	D
Sweden	195	273	221	4.1%	26	13%	-52	-19%	T2	CS
United Kingdom	2 581	557	486	9.1%	-2 094	-81%	-71	-13%	T2	CS
EU-27+UK	**9 601**	**6 235**	**5 316**	**100%**	**-4 286**	**-45%**	**-919**	**-15%**	**-**	**-**
Iceland	12	15	NO	-	-12	-100%	-15	-100%	NA	NA
United Kingdom (KP)	2 599	584	492	9.2%	-2 107	-81%	-92	-16%	T2	CS
EU-KP	**9 632**	**6 277**	**5 322**	**100%**	**-4 310**	**-45%**	**-955**	**-15%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Greece, Italy and Spain account for 79.4 % of CO_2 emissions from residual fuel oil in 2020 (Figure 3.133).

Table 3-78 shows that the majority of CO_2 emissions from the combustion of residual fuel oil in navigation were calculated using a higher tier method (77.8%). Spain was not included in this calculation, since they use T1 to calculate these emissions. Specifically, Spain was asked in the 2022 review about this issue, and they stated that "Work will continue with the aim of finding a CS emission factor for fuel oil in the shortest possible time''. The issue is still under investigation by Spain and it was recommended that Spain should continue to put effort in moving to a higher tier methodology.

On the other hand, Italy stated that country specific IEF were used, thus they were considered in the calculation and Greece also includes in the NIR that country specific EF for CO_2 emissions were used. Figure **3**.134 the IEF is depicted where the mean value is around 77.5 t/TJ.

*Figure **3**.133 1A3d Navigation, Residual Fuel Oil: Emission trend and share for CO_2*

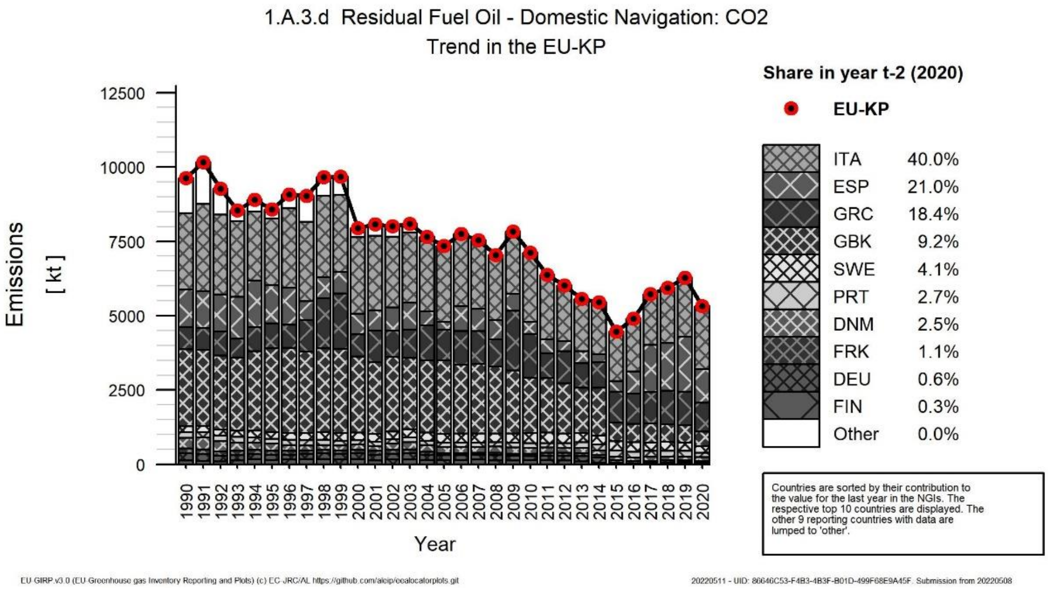
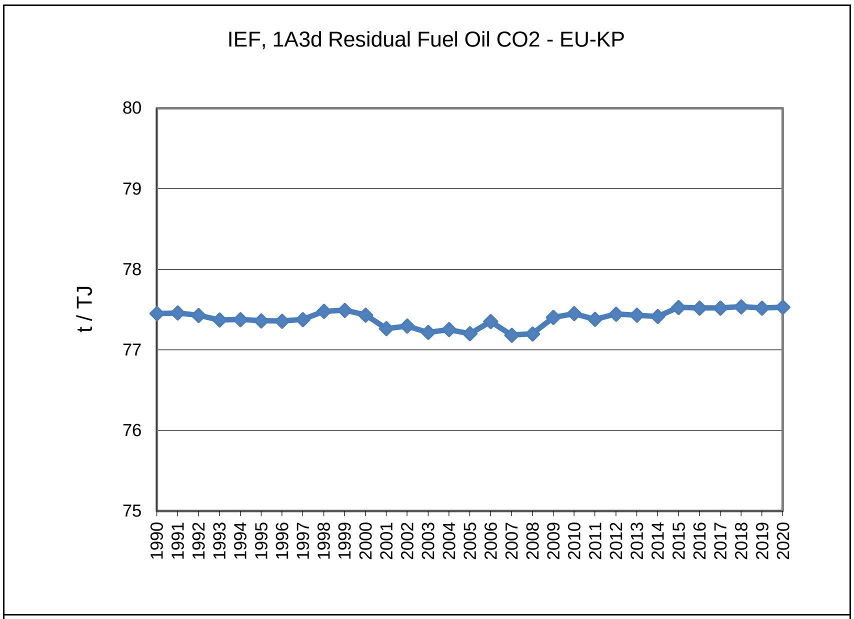
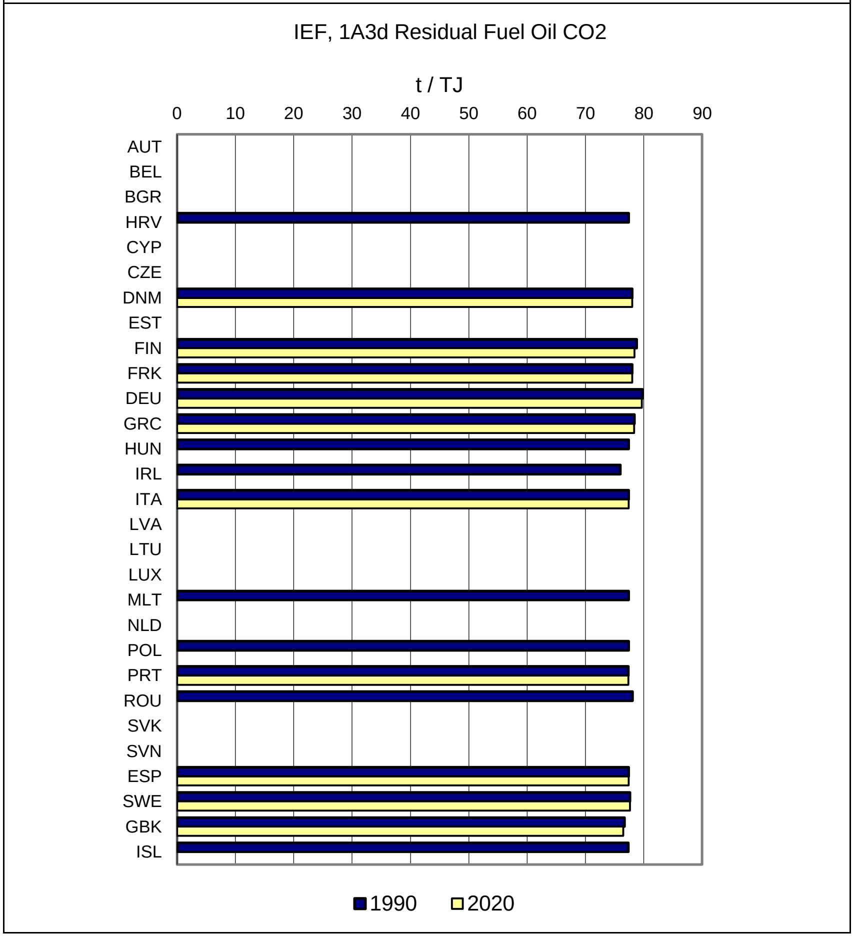


*Figure **3**.134 1A3d Navigation, Residual Fuel Implied Emission Factors for CO_2 (in t/TJ)*





1A3d Navigation – Gas/Diesel Oil (CO_2)

CO_2 emissions from Gas/Diesel oil account for 65 % of CO_2 emissions from 1A3d Navigation in 2020 (Table 3-79). The CO_2 emissions from Gas/Diesel oil decreased by 30 % between 1990 and 2020.

Table 3-79 1A3d Navigation, gas/diesel oil: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	18	77	17	0.1%	-2	-10%	-60	-78%	T2	CS
Belgium	362	374	371	3.0%	9	2%	-4	-1%	T1,T3	CS,D
Bulgaria	56	6	5	0.0%	-52	-91%	-2	-24%	T1	D
Croatia	128	155	127	1.0%	0	0%	-28	-18%	T1	D
Cyprus	2	3	1	0.0%	-1	-41%	-2	-54%	T1	D
Czechia	54	16	13	0.1%	-41	-76%	-3	-20%	T1	D
Denmark	358	356	341	2.7%	-18	-5%	-15	-4%	CR,M,T2	CS
Estonia	22	16	20	0.2%	-2	-8%	3	21%	T2	CS
Finland	186	261	182	1.5%	-4	-2%	-78	-30%	T2	CS
France	324	387	375	3.0%	50	15%	-12	-3%	T1	CS
Germany	2 754	1 536	1 363	11.0%	-1 390	-50%	-173	-11%	CS	CS,M
Greece	1 063	926	692	5.6%	-370	-35%	-233	-25%	T1	CS
Hungary	28	16	10	0.1%	-19	-67%	-6	-40%	T1	D
Ireland	22	274	319	2.6%	297	1337%	45	16%	T2	CS
Italy	2 326	2 084	2 217	17.8%	-109	-5%	133	6%	T1,T2	CS
Latvia	1	10	7	0.1%	6	735%	-3	-29%	T2	CS
Lithuania	15	16	12	0.1%	-4	-25%	-5	-28%	T1	CS
Luxembourg	1	1	0	0.0%	-1	-62%	0	-57%	T2	CS
Malta	6	50	36	0.3%	29	456%	-14	-28%	T1	D
Netherlands	697	844	628	5.0%	-69	-10%	-216	-26%	T2	CS
Poland	81	10	15	0.1%	-66	-81%	6	58%	T1	D
Portugal	73	75	56	0.5%	-17	-23%	-19	-25%	T2	D
Romania	112	132	134	1.1%	23	20%	2	2%	T2	CS
Slovakia	0	4	5	0.0%	5	23700%	1	28%	T1	CS
Slovenia	0	0	0	0.0%	0	625%	0	3%	T1	D
Spain	3 960	1 450	1 334	10.7%	-2 626	-66%	-116	-8%	T1	D
Sweden	181	245	223	1.8%	42	24%	-22	-9%	T2	CS
United Kingdom	4 851	4 513	3 880	31.2%	-971	-20%	-633	-14%	T2	CS
EU-27+UK	**17 682**	**13 837**	**12 383**	**100%**	**-5 299**	**-30%**	**-1 454**	**-11%**	**-**	**-**
Iceland	20	38	25	0.2%	5	23%	-13	-34%	T2	CS
United Kingdom (KP)	4 905	4 565	3 915	31.5%	-990	-20%	-649	-14%	T2	CS
EU-KP	**17 757**	**13 926**	**12 444**	**100%**	**-5 313**	**-30%**	**-1 483**	**-11%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Germany, Greece, Italy, Netherlands, Spain and the United Kingdom account for 81.6 % of the CO2 emissions from gas/diesel oil in 2020 (Figure **3**.135). Table 3-79 shows that the majority of CO_2 emissions from the combustion of gas/diesel oil in navigation were calculated using a higher tier method (92.3%). Spain was also taken into account since in 2022 review, Spain stated that they use country specific EFs. Whereas Italy, using country specific emission factors, was included in the calculation of higher tier methods and Greece also includes in the NIR that country specific EF for CO_2 emissions were used. the IEF is depicted where the mean value is around 74 t/TJ.

*Figure **3**.135 1A3d Navigation, Gas/Diesel Oil: Emission trend and share for CO_2*

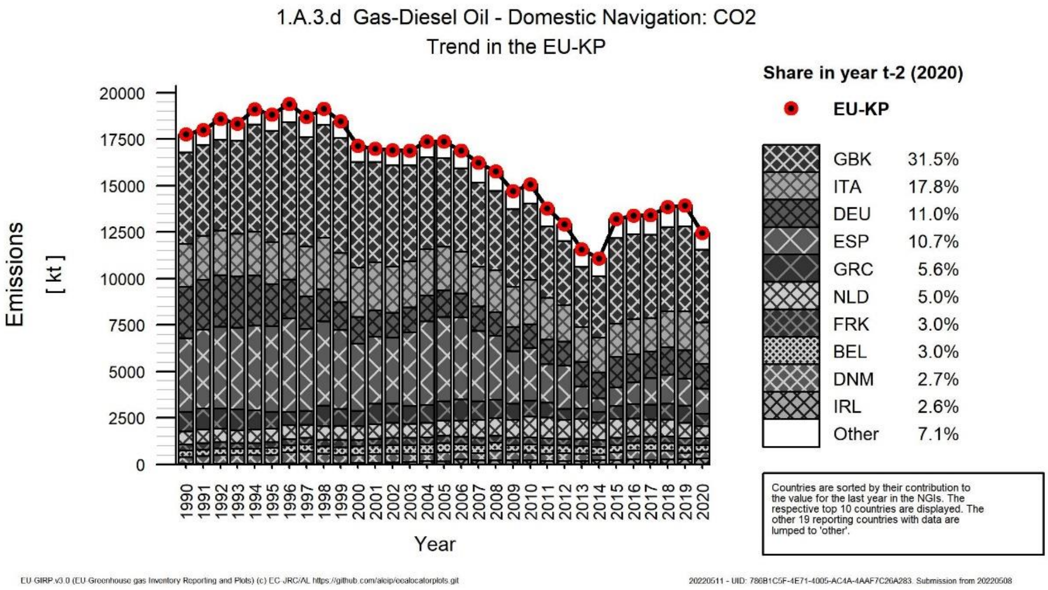
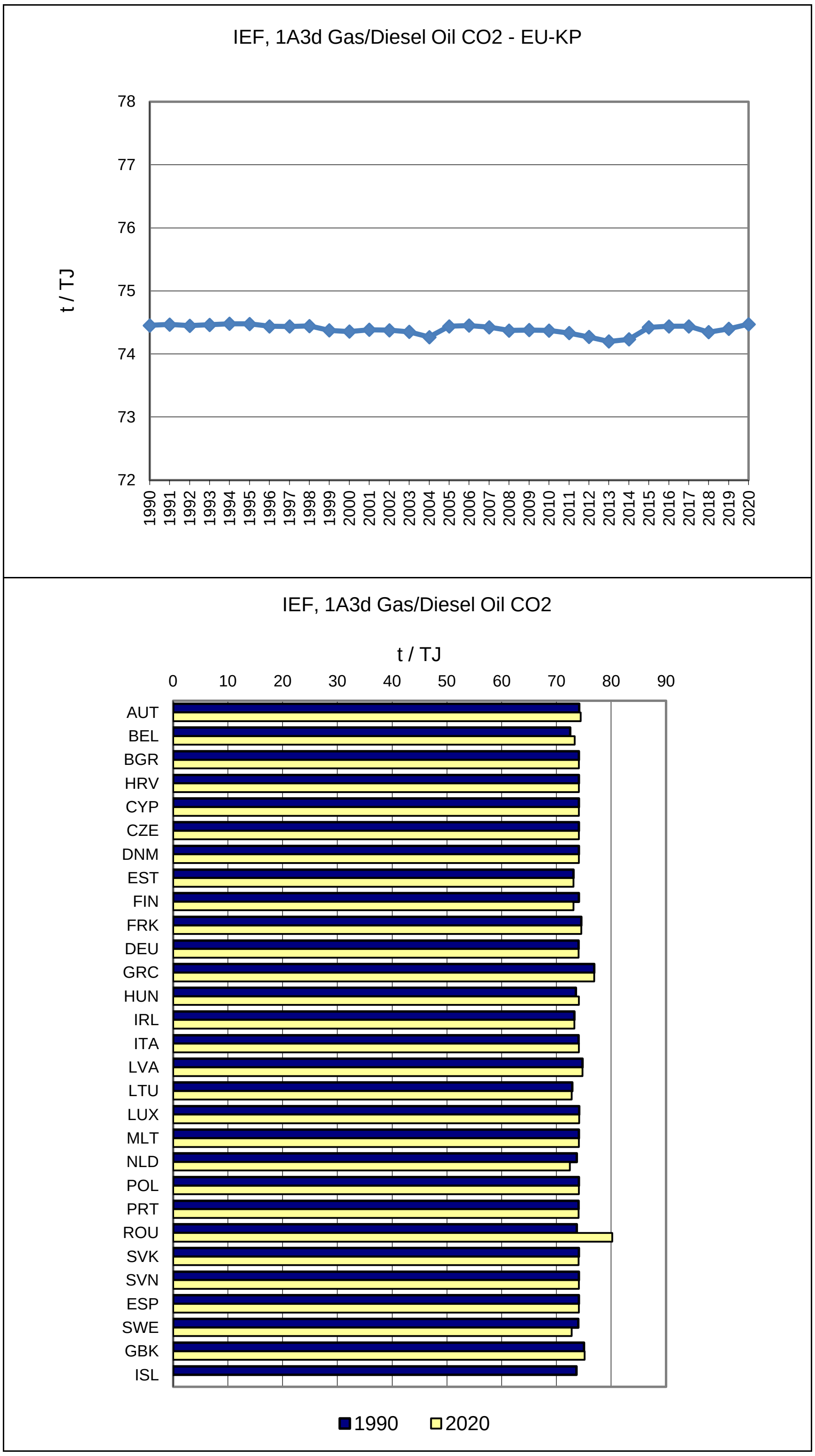


Figure 3.136 1A3d Navigation, Gas/Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)



3.2.3.5 Other (1A3e) (EU-KP)

CO_2 emissions from 1A3e Other account for only 0.14 % of total EU-KP GHG emissions in 2020. This source includes mainly pipeline transport and ground activities in airports and harbours. The emissions from this key source are due to fossil fuel consumption in other transportation, which increased by 18 % between 1990 and 2020.

Germany contributed 14.8 % and Poland 14.8 % to the EU-KP emissions from this source in 2020 (Table 3-80). Between 1990 and 2020 the EU-KP emissions decreased by 18%. Ten countries report emissions as 'Not occurring' or 'Included Elsewhere'. Iceland reports emissions as "Included elsewhere" and more specifically, these emissions are reported under 1A2gvii Industry and Construction since fuel sales statistics does not allow to disaggregate between fuel sold for airport and harbour ground-based activities and construction/off-road machinery. For Portugal, fuel consumption for 1.A.3.e.ii - Off-road activities is included in the category Commercial/Institutional (under Other Sectors – 1.A.4) because is not possible to separate the fuel consumption for these sectors in the Energy Balance.

Table 3-80 1A3e Other: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	229	556	479	9.2%	249	109%	-78	-14%	T1,T2	CS,D
Belgium	334	475	416	8.0%	81	24%	-59	-12%	CS,T3	D
Bulgaria	132	126	82	1.6%	-50	-38%	-44	-35%	T2	CS
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	5	50	90	1.7%	85	1561%	40	79%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
France	212	460	310	6.0%	98	46%	-150	-33%	T2	CS
Germany	1 083	1 194	768	14.8%	-316	-29%	-426	-36%	CS	CS
Greece	NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	149	172	125	2.4%	-24	-16%	-47	-27%	T2	CS
Ireland	73	142	148	2.8%	75	102%	6	4%	T2	CS
Italy	411	678	675	13.0%	264	64%	-3	0%	T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	64	30	35	0.7%	-29	-45%	6	19%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	342	85	89	1.7%	-253	-74%	5	5%	T2	CS
Poland	NO	858	765	14.8%	765	∞	-93	-11%	T1	D
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Romania	66	6	4	0.1%	-61	-93%	-2	-26%	T1,T2	CS,D
Slovakia	1 814	398	168	3.2%	-1 646	-91%	-230	-58%	T2	CS
Slovenia	NO	1	1	0.0%	1	∞	0	48%	T2	CS
Spain	19	131	99	1.9%	79	415%	-32	-25%	T1	CS,D
Sweden	1 053	357	352	6.8%	-700	-67%	-5	-1%	T2	CS
United Kingdom	225	595	560	10.8%	335	149%	-35	-6%	T3	CS
EU-27+UK	**6 211**	**6 315**	**5 165**	**100%**	**-1 046**	**-17%**	**-1 150**	**-18%**	**-**	**-**
Iceland	121	39	21	0.4%	-100	-82%	-18	-46%	T1	D
United Kingdom (KP)	225	595	560	10.8%	335	149%	-35	-6%	T3	CS
EU-KP	**6 332**	**6 354**	**5 186**	**100%**	**-1 145**	**-18%**	**-1 168**	**-18%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviation' Presented methods and emission factor information refer to the last inventory year.

3.2.4 Other Sectors (CRF Source Category 1.A.4.)

Category 1.A.4. mainly includes emissions from 'small scale fuel combustion' used for space heating and hot water production in commercial and institutional buildings, households, agriculture and forestry. It includes also emissions from mobile machinery used within these categories (e.g. mowers, harvesters, tractors, chain saws, motor pumps) as well as fuel used for grain drying, horticultural greenhouse heating or CO_2 fertilisation and stall heating. Category 1.A.4.c includes emissions from domestic inland, coastal, deep sea and international fishing. Emissions from transportation of agricultural goods are reported under category 1.A.3 Transport. The emissions reported under 1.A.4 can be generally defined as heat production processes for internal consumption.

The main driving force for CO_2 emissions in the 1.A.4 in energy consumption is the combustion for purposes of space heating. The fluctuations in consumption can be ascribed to difference in cold winter periods. The trend in eventually decreasing CO_2 emissions is a result of higher standards for new buildings and of successful execution of energy-efficiency-oriented modernization of existing buildings.

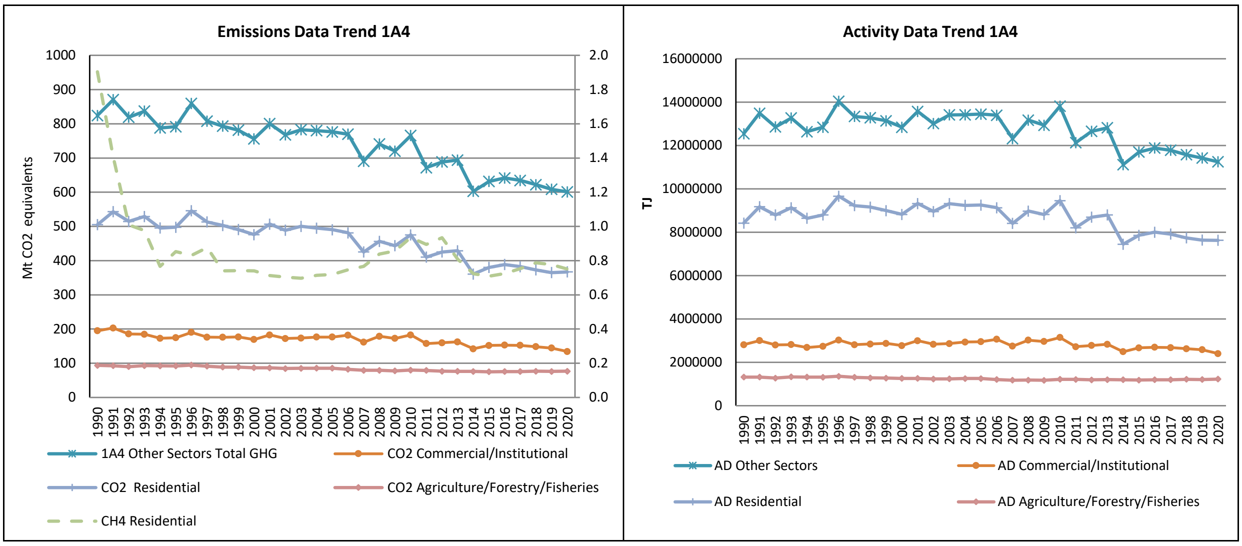
The following enumeration shows the correspondence of 1.A.4 subcategories and ISIC 3.1 rev codes:

- 1.A.4.a Commercial/Institutional: ISIC categories 4103, 42, 6, 719, 72, 8, and 91-96
- 1.A.4.b Residential: All emissions from fuel combustion in households
- 1.A.4.c Agriculture/Forestry/Fishing: ISIC categories 05, 11, 12, 1302

In 2020 category 1.A.4 contributed to 601 117 kt CO_2 equivalents of which 96.1% CO_2, 2.6% CH_4 and 1.3% N_2O.

Figure **3.137** shows the trend of total GHG emissions within source category 1.A.4 and the dominating sources which are CO_2 emissions from 1.A.4.b Residential and from 1.A.4.a Commercial/Institutional. The emission trends of the large key sources show larger fluctuations between 1990 and 2020. Between 1990 and 2020, emissions from 1.A.4 decreased by 27%. From 2019 to 2020 emissions decreased by 1% (-7.6 Mt CO_2 equivalents) which is mainly due to a decrease of category 1.A.4.a CO_2 emissions which decreased by 7%. The trend of 1.A.4.a CO_2 emissions between 1990 and 2020 is mostly influenced by Germany (-36.5 Mt CO_2). The decrease of 1.A.4.b CO_2 emissions between 1990 and 2020 is mostly influenced by Germany (-38.9 Mt CO_2) and France (-15.3 Mt CO_2).

Figure 3.137 1.A.4. Other Sectors: Total, CO_2 and CH_4 emission trends



Data displayed as dashed line refers to the secondary axis.

In 2020 GHG emissions from source category 1.A.4. accounted for nearly 18% of total GHG emissions. This source category includes twelve key sources which contributed to 95% of total 1.A.4. GHG emissions in 2020. The following list shows the key sources and their contribution to total 1.A.4 GHG emissions for the year 2020:

1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2) - 16.1%

1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2) - 4.7%

1.A.4.a Commercial/Institutional: Other Fuels (CO_2) - 1%

1.A.4.a Commercial/Institutional: Solid Fuels (CO_2) - 0.5%

1.A.4.b Residential: Biomass (CH_4) - 1.6%

1.A.4.b Residential: Gaseous Fuels (CO_2) - 39.9%

1.A.4.b Residential: Liquid Fuels (CO_2) - 16.2%

1.A.4.b Residential: Solid Fuels (CH_4) - 0.4%

1.A.4.b Residential: Solid Fuels (CO_2) - 4.8%

1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2) - 1.9%

1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2) - 10.3%

1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2) - 0.5%

The following table shows the share of higher tier methods used for each key source of category 1.A.4. It comprises all methods and method combinations as reported by countries for any of the 1.A.4 key sources.

Table 3.81: Key source categories for level and trend analyses and share of EU-KP emissions using higher tier methods for sector 1.A.4. (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		Share of higher Tier
	1990	2019		1990	2020	
1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2)	65963	96550	T	L	L	89%
1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2)	79450	28441	T	L	L	80%
1.A.4.a Commercial/Institutional: Other Fuels (CO_2)	748	6210	T	0	L	98%
1.A.4.a Commercial/Institutional: Solid Fuels (CO_2)	48484	3027	T	L	0	98%
1.A.4.b Residential: Biomass (CH_4)	9434	9420	T	L	L	50%
1.A.4.b Residential: Gaseous Fuels (CO_2)	184731	239788	T	L	L	91%
1.A.4.b Residential: Liquid Fuels (CO_2)	181315	97173	T	L	L	83%
1.A.4.b Residential: Solid Fuels (CH_4)	9227	2292	T	L	0	8%
1.A.4.b Residential: Solid Fuels (CO_2)	135130	29119	T	L	L	98%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2)	12472	11582	T	L	L	88%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2)	71359	61776	T	L	L	77%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2)	9735	3211	0	L	0	97%

The following table shows the share of specific tier methods used for each 1.A.4 category emission estimates. It can be seen that most countries use combination of T1 and T2 method for emission estimates.

Table 3.82: Share of Tier methods for 1.A.4 by type of reported method and method combinations.

Methods and method combinations	Share of emissions which are estimated by specific Tier method
CS	0.3%
T1	3.0%
T1,T2	28.5%
T1,T3	0.02%
T2	23.4%
T2,T3	0.5%
T3	0.01%
T1,T2,T3	21.2%
CS,T1,T2	14.3%
CS,T1,T3	2.4%
CS,T1,T2,T3	4.4%
Other combination	1.9%

Table 3.83 shows total GHG, CO_2 and CH_4 emissions from 1.A.4. Other sectors. Between 1990 and 2020 CO_2 emissions from 1.A.4. Other Sectors decreased by 27%, CH_4 decreased by 32% and N_2O emissions decreased by 4%.

Table 3.83 1.A.4. Other Sectors: Member States' contributions to total GHG, CO_2 and CH_4 emissions

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt		N2O emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020	1990	2020
Austria	14 253	9 027	13 543	8 617	192	148	518	262
Belgium	28 155	22 543	27 808	22 028	90	107	256	408
Bulgaria	8 133	1 816	7 654	1 396	193	90	286	330
Croatia	4 218	3 182	3 719	2 727	141	124	358	331
Cyprus	434	510	430	498	1	2	2	10
Czechia	33 807	12 314	31 954	11 263	178	144	1 676	907
Denmark	9 104	3 700	8 888	3 529	59	73	157	98
Estonia	1 904	851	1 790	700	13	23	100	128
Finland	7 741	3 430	7 490	3 202	87	59	163	170
France	97 974	71 267	91 855	68 903	1 470	1 373	4 649	990
Germany	208 090	124 901	202 925	123 414	977	447	4 188	1 041
Greece	8 653	6 585	8 066	6 285	349	99	239	201
Hungary	22 209	12 600	21 250	12 057	101	89	858	454
Ireland	10 448	9 601	9 894	9 365	104	79	451	157
Italy	78 924	79 178	76 042	74 583	1 740	2 357	1 141	2 238
Latvia	5 918	1 528	5 493	1 299	157	85	268	143
Lithuania	7 300	1 376	6 903	1 184	186	40	210	152
Luxembourg	1 360	1 617	1 343	1 604	6	4	11	10
Malta	265	160	264	158	1	1	1	1
Netherlands	39 535	31 817	38 916	30 308	50	52	568	1 457
Poland	56 922	51 773	53 441	47 746	676	1 101	2 805	2 926
Portugal	4 111	4 536	3 463	4 152	217	167	431	218
Romania	11 325	12 077	10 861	10 760	47	278	418	1 039
Slovakia	11 502	4 666	11 067	4 379	46	63	389	224
Slovenia	1 891	1 342	1 686	1 194	44	44	161	104
Spain	26 347	37 109	25 308	36 052	211	253	828	803
Sweden	11 158	2 312	10 872	2 163	167	89	118	59
United Kingdom	111 312	88 216	109 303	87 423	396	182	1 614	610
EU-27+UK	**822 993**	**600 032**	**792 229**	**576 989**	**7 900**	**7 572**	**22 864**	**15 471**
Iceland	797	545	789	537	6	7	2	1
United Kingdom (KP)	111 924	88 756	109 907	87 959	400	185	1 617	612
EU-KP	**824 403**	**601 117**	**793 623**	**578 062**	**7 910**	**7 582**	**22 870**	**15 474**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.84 provides information on the contribution of Member States to EU-KP recalculations in CO_2 from 1.A.4 Other sectors for 1990 and 2019 and explanations for the recalculations.

Table 3.84 1.A.4. Other Sectors: Contribution of MS to EU-KP recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	-61	-0.7		Revision of energy balance (mainly -91 kt from liquid fuels, + 29 kt from gaseous fuels)
Belgium	-0.5	-0.0	-431	-1.8	Optimalization of calculation model, update of activity data	in Flemish region: emissions decreased in 1A4 with 312 kt CO_2 mainly caused in the category 1A4b 'residential'/stationary_revision AD liquid fuels / in Brussels region: +0,91 kt due to the update of the energy balance/in

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						Walloon region: -119 kt due to the update of the energy balance
Bulgaria	-	-	6	0.4		Update and revision of activity data, EF and other parameters used for all sectors
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	-138	-1.2		updated activity data in CzSO balance
Denmark	-154	-1.7	43	1.1	Revised estimates for combustion of gas-/diesel oil and LPG in mobile sources have resulted in revised split between stationary combustion and mobile sources. The former CO_2 emission factor for LPG, 63.1 kg/GJ, referred to IPCC Guide lines (2006). The CO_2 emission factor 64.8 kg/GJ is now applied for all years	
Estonia	3.9	0.2	17	2.4	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance.	
Finland	6.5	0.1	4.5	0.1	1.A.4c/Liquid: LPG use in agricultural buildings was added to the inventory. Corresponding amount was deduced from 1.A.5a/Liquid.	
France	1 203	1.3	721	1.0	Change in consumption linked to the treatment of the national energy balance, general increase in all emissions; Correction of two industrial establishments whose source sector has been corrected (switch to industrial combustion (1A2)	
Germany	-29	-0.0	-2 154	-1.7	The energy inputs in high-seas fisheries were revised, for all years.x	Update of provisional 2019 energy balance data with actual ones. The energy inputs in high-seas fisheries were revised, for all years.
Greece	-	-	-	-		
Hungary	151	0.7	23	0.2	Reallocation of autoproducers had an effect, especially in the 1.A.4.a Commercial/Institutional source category and to a lesser extent in 1.A.4.c Agriculture/Forestry/Fishing.	Revised AD based on the latest IEA/Eurostat Annual Questionnaires
Ireland	-1.4	-0.0	46	0.5	In the Commercial/Institutional sector 1.A.4.a, there was a slight reallocation of oil in the sector over the entire time series from 1990-2019. There was an average recalculation of 0.44 per cent for the entire time series. • In the Residential sector 1.A.4.b, there was a slight decrease in oil use throughout the time series. From 1990-2019 there was an average recalculation of -0.16 per cent for the entire time series.	
Italy	-	-	-634	-0.8		Update of the amount of waste for energy and heat production in the commercial sector.
Latvia	-	-	-0	-0.0		
Lithuania	-	-	-	-		
Luxembourg	0	0.0	-32	-1.9		AD changes due to small revisions of energy balance, change of country-specific CO_2 emission factors for liquid fuels, methodology revision for injected biogas
Malta	-0	-0.0	10	7.5		Update in activity data (Fuel consumption).
Netherlands	51	0.1	90	0.3	Model update for NRMM	Final energy statistics and improved allocation biogenic part of natural gas
Poland	-	-	-1 068	-2.2		Update of the activity data according to Eurostat database.
Portugal	-	-	-	-		
Romania	14	0.1	-23	-0.2	Recalculation are due to the updated the activity data (Net Calorific Value and National Emission Factors).	
Slovakia	-	-	-	-		

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Slovenia	0	0.0	9	0.8		Improved CS CO_2 EF for natural gas
Spain	17	0.1	-111	-0.3	1A4ai, 1A4bi and 1A4ci. Stationary combustion in the institutional and commercial sector). Update of fuel-rubric allocation for the whole series.	1A4cii and 1A4ciii. AD update for year "n-1" (Forest Statistical Yearbook, consumption year: "n-1") and emission factor correction. 1A4ai, 1A4bi and 1A4ci. Stationary combustion in the institutional and commercial sector). Update of fuel-rubric allocation for the whole series. Update of wood and landfill gas consumption since 2016.
Sweden	6	0.1	-148	-6.1	1A4a: Revision of emission factors for other biomass. 1A4b: Revision of emission factors for other biomass and revision of activity data for charcoal. 1A4c: Revised activity data and revised emission factors for biomass (Harvest residues och Other biomass). 1.A.4.a.ii, 1.A.4.b.ii: Activity data and other parameters for emission calculation from lawn mowers have been revised, affecting emissions for the entire time series. The default fuel for fishing has been changed from diesel oil to domestic heating oil.	
United Kingdom	-304	-0.3	-3 519	-3.9	Any revisions to DUKES and other input data have been incorporated into the inventory.	Revisions to DUKES.
EU27+UK	**963**	**0.1**	**-7 349**	**-1.2**		
Iceland	14	1.8	-10	-1.8	Recalculations in 1A4ai are due to a change in the NEA data on fuel allocation.	The NEA reallocated fuel from 1A4 to 1A3. CS carbon content for Marine Gas Oil.
United Kingdom (KP)	-210	-0.2	-3 673	-4.0	see above	see above
EU-KP	**1 071**	**0.1**	**-7 513**	**-1.3**		

Table 3.85 provides information on the contribution of Member States to EU-KP recalculations in CH_4 from 1.A.4. Other sectors for 1990 and 2019.

Table 3.85 1.A.4. Other Sectors: Contribution of MS to EU-KP recalculations in CH_4 for 1990 and 2018 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	0.3	0.1	-2.4	-0.9	Updated heating stock data and newly allocated shares of combustion technologies per energy carrier.	Revision of energy balance (mainly -91 kt from liquid fuels, + 29 kt from gaseous fuels)
Belgium	0.2	0.1	-3.7	-0.9	Optimalization of calculation model, update of activity data	
Bulgaria	-	-	0	0.0		
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	-11	-1.2		updated activity data in CzSO balance
Denmark	-0.5	-0.3	-1.2	-1.1	Revised estimates for combustion of gas-/diesel oil and LPG in mobile sources have resulted in revised split between stationary combustion and mobile sources.	
Estonia	-13	-12	-3.0	-2.4	Emissions were recalculated due to using updated Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases. Estonia developed Tier 2 country-specific CH_4 and N_2O emission factors for 1-50MW combustion plants for natural gas, light fuel oil, residual fuel oil, peat, solid biomass, and biogas in 1A4a and	

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
					1A4c subsectors. Estonia has developed CH_4 and N_2O Tier 3 emission factors for diesel oil and gasoline for off-road vehicles (tractors, harvesters, and forestry machines) used in 1A4c Agriculture subsector and updated the number and fuel consumption for these vehicles. Emission were recalculated for the whole time series in 1A4a, 1A4b, and 1A4c.	
Finland	-5.4	-3.2	-0.1	-0.0	1A4ai, 1A4bi and 1A4ci/Biomass: there were minor updates in CH_4 and N_2O emission factors; the reason was updated shares of different combustion equipment in small scale wood combustion air emission calculation system maintained by SYKE.	
France	3.4	0.1	48	4.6	Transfer of a small share of autoproducer consumptions from industry (1A2) to tertiary sector (1A4a).	
Germany	0.3	0.0	28	2.7	The energy inputs in high-seas fisheries were revised, for all years.x	Update of provisional 2019 energy balance data with actual ones. The energy inputs in high-seas fisheries were revised, for all years.
Greece	-	-	-	-		
Hungary	0	0.0	0.3	0.1		Revised AD based on the latest IEA/Eurostat Annual Questionnaires.
Ireland	-0.0	-0.0	3.5	2.4	In the Commercial/Institutional sector 1.A.4.a, there was a slight reallocation of oil in the sector over the entire time series from 1990-2019. There was an average recalculation of 0.44 per cent for the entire time series. • In the Residential sector 1.A.4.b, there was a slight decrease in oil use throughout the time series. From 1990-2019 there was an average recalculation of -0.16 per cent for the entire time series.	
Italy	-	-	-1.0	-0.0		Update of the amount of waste for energy and heat production in the commercial sector.
Latvia	-	-	-0.0	-0.0		
Lithuania	-	-	-	-		
Luxembourg	-	-	-0.1	-1.0		AD changes due to small revisions of energy balance.
Malta	0.0	0.2	0.1	6.6		Update in activity data (Fuel consumption).
Netherlands	-0.1	-0.0	13	0.8	Model update for NRMM	Final energy statistics and new CH_4 EF for stoves
Poland	-	-	-83	-2.9		Update of the activity data according to Eurostat database.
Portugal	-	-	-	-		
Romania	1.1	0.3	0.0	0.0	Recalculation are due to the updated the activity data (Net Calorific Value and National Emission Factors).	
Slovakia	-	-	-3	-1.5		An improvement in biomass consumption was included in current submission. The activity data were modified for years 2014 – 2019.
Slovenia	0.0	0.0	0.0	0.0		
Spain	0.1	0.0	-222	-22	1A4ai, 1A4bi and 1A4ci. Stationary combustion in the institutional and commercial sector). Update of fuel-rubric allocation for the whole series.	1A4cii and 1A4ciii. AD update for year "n-1" (Forest Statistical Yearbook, consumption year: "n-1") and emission factor correction. 1A4ai, 1A4bi and 1A4ci. Stationary combustion in the institutional and commercial sector). Update of fuel-rubric allocation for the whole series. Update of wood and landfill gas consumption since 2016.
Sweden	3.7	3.2	-1.4	-2.2	1A4c: Revised activity data for biomass (Harvest residues of Other biomass).	

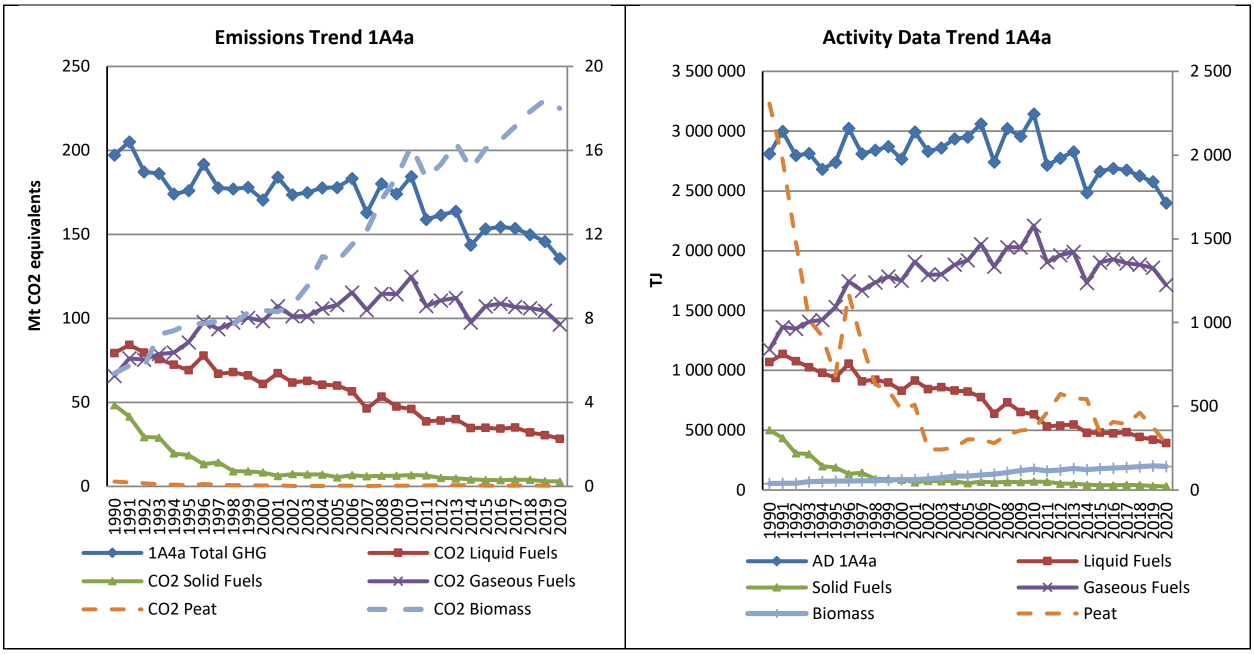
	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
					1.A.4.a.ii, 1.A.4.b.ii: Activity data and other parameters for emission calculation from lawn mowers have been revised, affecting emissions for the entire time series. The default fuel for fishing has been changed from diesel oil to domestic heating oil.	
United Kingdom	25	1.6	-441	-42	Revision to DUKES residential wood combustion	
EU27+UK	**15**	**0.1**	**-681**	**-4.2**		
Iceland	0.0	2.2	-0.0	-0.7	CH_4 and N_2O emissions in previous submission of the NIR had been interchanged for waste burning.	
United Kingdom (KP)	26	1.6	-442	-42	See above.	
EU-KP	**16**	**0.1**	**-682**	**-4.2**		

3.2.4.1 Commercial/Institutional (1.A.4.a)

CO_2 emissions from 1.A.4.a Commercial/Institutional accounted for 5% of total GHG emissions from 1.A Fuel Combustion in 2020. The subcategory 1.A.4.a. includes all combustion sources that utilize heat combustion for heating production halls and operational buildings in institutions, commercial facilities, services and trade.

Figure 3.138 shows the emission trend within the category 1.A.4.a, which is mainly dominated by CO_2 emissions from gaseous and liquid fuels. Between 1990 and 2020 CO_2 emissions decreased by 31% (see also the Table **3.86**), mainly due to decreases in CO_2 emissions from solid (-94%) and liquid (-64%) fuels while CO_2 emissions from gaseous fuels increased by 46% and show a fluctuating trend since 2006. Between 2019 and 2020 the GHG emissions decreased by 7%, mainly driven by the decrease in gaseous fuels.

Figure 3.138 1.A.4.a Commercial/Institutional: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Main factors influencing CO_2 emissions from this source category are (1) outdoor temperature, (2) number and size of offices, (3) building codes, (4) thermal properties of building stock, (5) fuel split for heating and warm water, (6) use of renewable energy sources, e.g. biomass or solar panels, and (7) use of district heating. Fuel consumption in 1.A.4.a decreased by 15% between 1990 and 2020 and biomass consumption increased by 266%.

Germany, Italy, France and the United Kingdom contributed the most to the EU-KP CO_2 emissions from this source (66% together). Member States with the highest increases in absolute terms were Spain and Italy. The Member State with the highest reduction in absolute terms was Germany (Table 3.86).

Table 3.86 1.A.4.a Commercial/Institutional: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	2 292	1 367	1 307	1.0%	-985	-43%	-60	-4%	T1,T2	CS,D
Belgium	4 289	5 683	5 172	3.9%	883	21%	-511	-9%	T1	D
Bulgaria	3 117	312	317	0.2%	-2 800	-90%	4	1%	T1,T2	CS,D
Croatia	855	612	571	0.4%	-284	-33%	-41	-7%	T1	D
Cyprus	75	118	86	0.1%	11	14%	-32	-27%	T1	D
Czechia	9 907	2 942	2 677	2.0%	-7 230	-73%	-264	-9%	T1,T2	CS,D
Denmark	1 578	740	708	0.5%	-870	-55%	-32	-4%	M,T1,T2,T3	CS,D
Estonia	165	253	256	0.2%	91	55%	3	1%	T1,T2	CS,D
Finland	2 473	1 166	1 065	0.8%	-1 408	-57%	-101	-9%	T1,T2,T3	CS,D
France	26 620	21 637	19 824	14.8%	-6 796	-26%	-1 813	-8%	T1,T2	CS,D
Germany	64 111	29 711	27 616	20.6%	-36 496	-57%	-2 095	-7%	CS,T1,T2,T3	CS,D
Greece	519	734	583	0.4%	64	12%	-151	-21%	T1,T2	CS,D
Hungary	2 898	2 769	2 781	2.1%	-117	-4%	12	0%	T1,T2	CS,D
Ireland	2 097	1 814	1 821	1.4%	-276	-13%	7	0%	T2	CS
Italy	11 902	24 305	23 443	17.5%	11 541	97%	-861	-4%	T2	CS
Latvia	2 726	359	399	0.3%	-2 327	-85%	40	11%	T1,T2	CS,D
Lithuania	3 059	316	261	0.2%	-2 798	-91%	-55	-17%	T2	CS
Luxembourg	639	657	551	0.4%	-87	-14%	-106	-16%	T1,T2	CS,D
Malta	165	82	95	0.1%	-69	-42%	13	16%	T1	D
Netherlands	8 347	7 008	6 375	4.7%	-1 972	-24%	-633	-9%	T2	CS,D
Poland	9 715	6 328	5 876	4.38%	-3 839	-40%	-452	-7%	T1,T2	CS,D
Portugal	704	1 134	961	0.7%	256	36%	-173	-15%	T1,T2	CS,D
Romania	NO	2 207	2 053	1.5%	2 053	∞	-154	-7%	T1,T2	CS,D
Slovakia	4 148	1 335	1 150	0.9%	-2 998	-72%	-185	-14%	T2	CS
Slovenia	624	340	334	0.2%	-289	-46%	-6	-2%	T1,T2	CS,D
Spain	3 811	10 546	9 038	6.7%	5 227	137%	-1 508	-14%	CR,T2	,CS,D,OTH
Sweden	2 775	656	606	0.5%	-2 169	-78%	-51	-8%	T1,T2	CS
United Kingdom	25 173	19 223	18 277	13.6%	-6 895	-27%	-946	-5%	T2	CS
EU-27+UK	**194 782**	**144 353**	**134 203**	**100%**	**-60 579**	**-31%**	**-10 150**	**-7%**	**-**	**-**
Iceland	8	4	3	0.0%	-5	-64%	-1	-24%	T1	D
United Kingdom (KP)	25 261	19 278	18 327	13.7%	-6 934	-27%	-950	-5%	T2	CS
EU-KP	**194 879**	**144 411**	**134 256**	**100%**	**-60 623**	**-31%**	**-10 155**	**-7%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4. a Commercial/Institutional – Liquid Fuels (CO_2)

In 2020 CO_2 emissions from liquid fuels had a share of 21% within source category 1.A.4.a (compared to 41% in 1990). Between 1990 and 2020, CO_2 emissions decreased by 64% (Table 3.87). Only three Member States increased the use of liquid fuels in the time series, the highest absolute increase is noted for Poland. It is important to note, however, that Poland hasn't been using the liquid fuels at the beginning of 90's. The highest absolute decreases were achieved in Germany and France. Generally, in number of Member States, there is apparent strong decrease from 2006 to 2007 due to low gasoil sales to end consumers. Many end consumers did not restock their oil tanks in 2007 because of high outdoor temperatures and rising oil prices. Additionally, end consumer gasoil stocks were comparatively high in 2007 due to a mild winter 2006. Between 2019 and 2020 EU-KP CO_2 emissions increased by 7%. According to the methodology as described in chapter 3.2.4 about 80% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.87 1.A.4.a Commercial/Institutional, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 420	465	469	1.6%	-951	-67%	4	1%	T2	T2
Belgium	2 315	1 203	976	3.4%	-1 339	-58%	-227	-19%	T1	T1
Bulgaria	2 986	89	73	0.3%	-2 913	-98%	-16	-18%	T1	T1
Croatia	526	122	111	0.4%	-415	-79%	-11	-9%	T1	T1
Cyprus	75	118	86	0.3%	11	14%	-32	-27%	T1	T1
Czechia	2 000	40	49	0.2%	-1 951	-98%	9	23%	T1	T1
Denmark	1 173	297	310	1.1%	-863	-74%	13	4%	T1,T2	T1,T2
Estonia	140	79	78	0.3%	-62	-45%	-1	-2%	-	-
Finland	2 423	1 091	1 000	3.5%	-1 423	-59%	-90	-8%	T2	T2
France	16 555	7 169	7 037	24.7%	-9 518	-57%	-132	-2%	-	-
Germany	28 138	9 371	8 773	30.8%	-19 365	-69%	-598	-6%	CS	CS
Greece	499	361	252	0.9%	-247	-49%	-109	-30%	T2	T2
Hungary	1 124	92	104	0.4%	-1 020	-91%	12	13%	T1	T1
Ireland	1 735	816	806	2.8%	-929	-54%	-10	-1%	T2	T2
Italy	1 530	1 459	1 440	5.1%	-90	-6%	-18	-1%	-	-
Latvia	1 017	65	110	0.4%	-908	-89%	45	69%	T2	T2
Lithuania	1 166	7	8	0.0%	-1 159	-99%	1	7%	T2	T2
Luxembourg	469	406	371	1.3%	-98	-21%	-35	-9%	T2	T2
Malta	165	82	95	0.3%	-69	-42%	13	16%	T1	T1
Netherlands	488	444	417	1.5%	-72	-15%	-27	-6%	T2	T2
Poland	IE,NO	1 229	1 078	3.8%	1 078	∞	-151	-12%	T1,T2	T1,T2
Portugal	704	387	318	1.1%	-387	-55%	-69	-18%	T1	T1
Romania	NO	314	268	0.9%	268	∞	-46	-15%	T1,T2	T1,T2
Slovakia	384	25	22	0.1%	-362	-94%	-3	-13%	T2	T2
Slovenia	391	271	278	1.0%	-113	-29%	7	3%	T1	T1
Spain	3 284	3 572	3 211	11.3%	-73	-2%	-361	-10%	T2	T2
Sweden	2 689	404	378	1.3%	-2 311	-86%	-27	-7%	-	-
United Kingdom	5 959	505	275	1.0%	-5 684	-95%	-230	-46%	T2	T2
EU-27+UK	**79 354**	**30 481**	**28 389**	**100%**	**-50 965**	**-64%**	**-2 092**	**-7%**		
Iceland	8	4	3	0.0%	-5	-64%	-1	-24%	T1	T1
United Kingdom (KP)	6 046	558	324	1.1%	-5 722	-95%	-234	-42%	T2	T2
EU-KP	**79 450**	**30 538**	**28 441**	**100%**	**-51 009**	**-64%**	**-2 097**	**-7%**		

Notes: From 1990 to 1993 Poland does not report any liquid fuels for stationary sources and reports liquid fuels from 'Off-road vehicles and other machinery' under category 1A3 and therefore the notation key 'IE, NO' is reported. Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.139 and Figure **3.140** show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany, France, Spain, Italy, Poland and Finland; together they cause 79% of the CO_2 emissions from liquid fuels in 1.A.4.a. Fuel consumption decreased by 63% between 1990 and 2020. The CO_2 implied emission factor for liquid fuels was 72.59 t/TJ in 2020.

Figure 3.139 1.A.4.a Commercial/Institutional, liquid fuels: Emission trend and share for CO_2

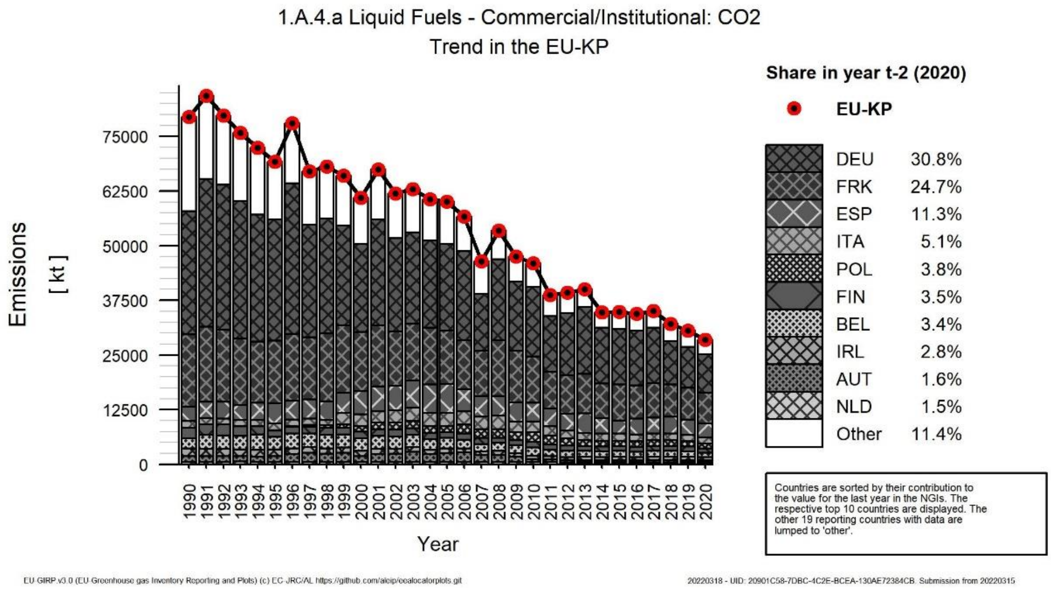
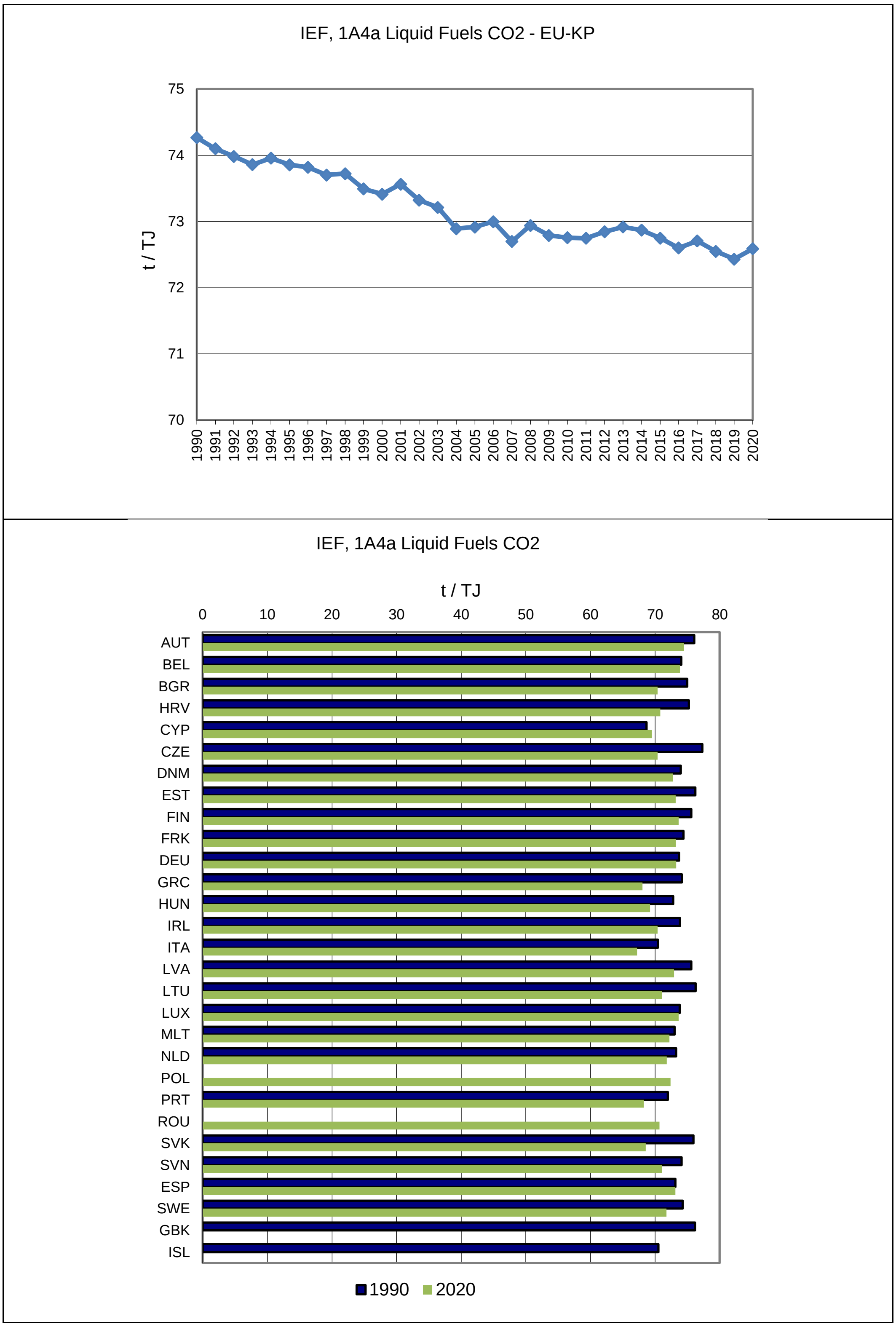


Figure 3.140 1.A.4.a Commercial/Institutional, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.a Commercial/Institutional – Solid Fuels (CO_2)

In 2020, CO_2 from solid fuels had a share of 2% within source category 1.A.4.a (compared to 25% in 1990). Between 1990 and 2020 CO_2 emissions decreased by 94% (Table 3.88). Twelve Member States and Iceland report emissions as 'Not occurring' or 'Included elsewhere' in 2020; all other Member States reduced emissions between 1990 and 2020 except Spain, Estonia and Romania. Between 2019 and 2020 CO_2 emissions decreased by 3%. According to the methodology as described in chapter 3.2.1 about 98% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.88 1.A.4.a Commercial/Institutional, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	91	NO	NO	-	-91	-100%	-	-	NA	NA
Belgium	9	0	0	0.0%	-9	-100%	0	0%	T1	T1
Bulgaria	89	15	13	0.4%	-77	-86%	-2	-16%	T1,T2	T1,T2
Croatia	88	NO,IE	NO,IE	-	-88	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	6 237	110	83	2.8%	-6 154	-99%	-27	-25%	T2	T2
Denmark	8	NO	NO	-	-8	-100%	-	-	-	-
Estonia	NO	4	4	0.1%	4	∞	0	8%	-	-
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	1 938	144	127	4.2%	-1 811	-93%	-17	-12%	-	-
Germany	22 426	6	6	0.2%	-22 420	-100%	0	3%	CS	CS
Greece	20	NO,IE	NO,IE	-	-20	-100%	-	-	NA	NA
Hungary	475	6	5	0.2%	-470	-99%	-1	-21%	T1,T2	T1,T2
Ireland	3	2	2	0.1%	-1	-22%	0	0%	T2	T2
Italy	NO	NO	NO	-	-	-	-	-	-	-
Latvia	1 366	13	7	0.2%	-1 360	-100%	-6	-48%	T2	T2
Lithuania	1 173	113	75	2.5%	-1 098	-94%	-38	-34%	T2	T2
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	101	9	2	0.1%	-99	-98%	-6	-74%	T2	T2
Poland	8 881	1 950	2 008	66.4%	-6 873	-77%	59	3%	T1,T2	T1,T2
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	1	0	0.0%	0	∞	-1	-80%	T1,T2	T1,T2
Slovakia	1 729	323	213	7.0%	-1 516	-88%	-110	-34%	T2	T2
Slovenia	203	NO	NO	-	-203	-100%	-	-	NA	NA
Spain	147	350	395	13.1%	249	170%	45	13%	T2	T2
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	3 498	87	86	2.8%	-3 412	-98%	-1	-1%	T2	T2
EU-27+UK	**48 483**	**3 133**	**3 026**	**100%**	**-45 458**	**-94%**	**-107**	**-3%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 499	87	87	2.9%	-3 412	-98%	-1	-1%	T2	T2
EU-KP	**48 484**	**3 134**	**3 027**	**100%**	**-45 458**	**-94%**	**-107**	**-3%**		

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.141 and Figure 3.142 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland, Spain and Slovakia; together they cause 86% of the CO_2 emissions from solid fuels in 1.A.4.a. Fuel consumption in the EU27+UK decreased by 94% between 1990 and 2020. The CO_2 implied emission factor for solid fuels was 96.54 t/TJ in 2020. The comparatively low IEFs of Spain and Greece in 1990 are due to a high share of gas works gas consumption in the 1990s.

Figure 3.141 1.A.4.a Commercial/Institutional, solid fuels: Emission trend and share for CO_2

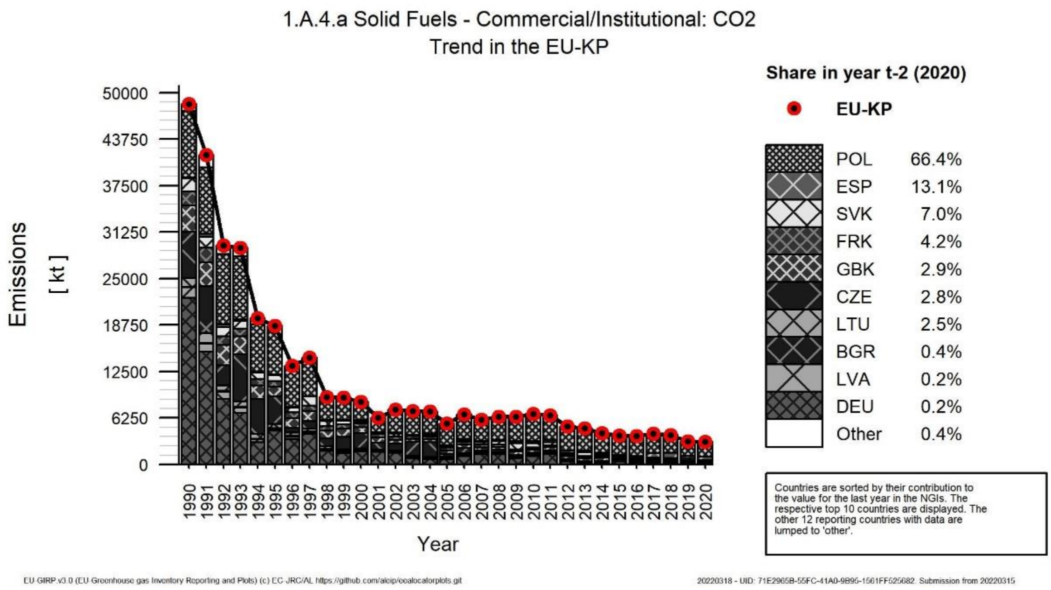
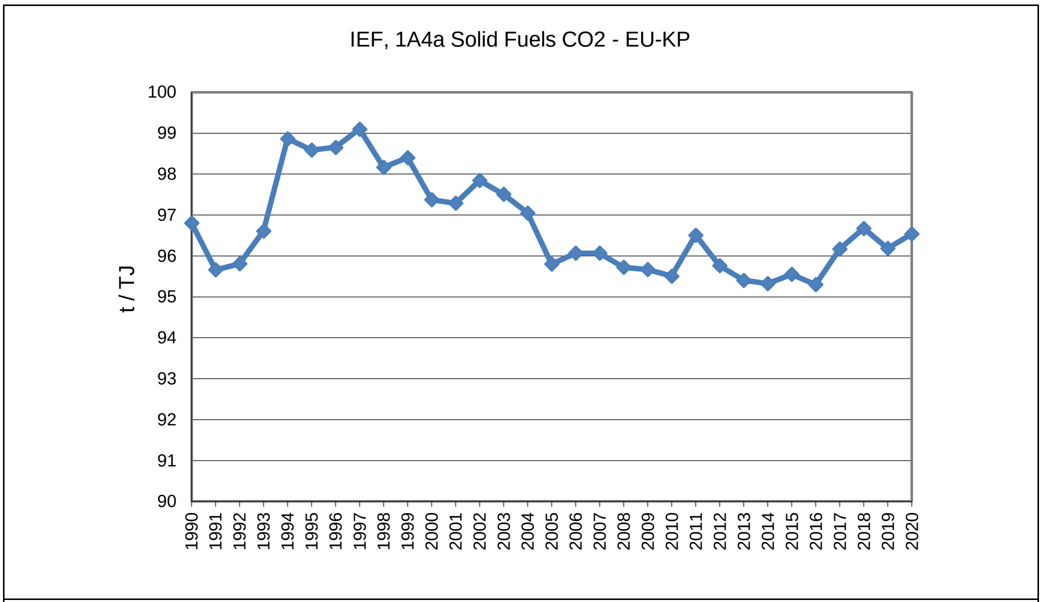
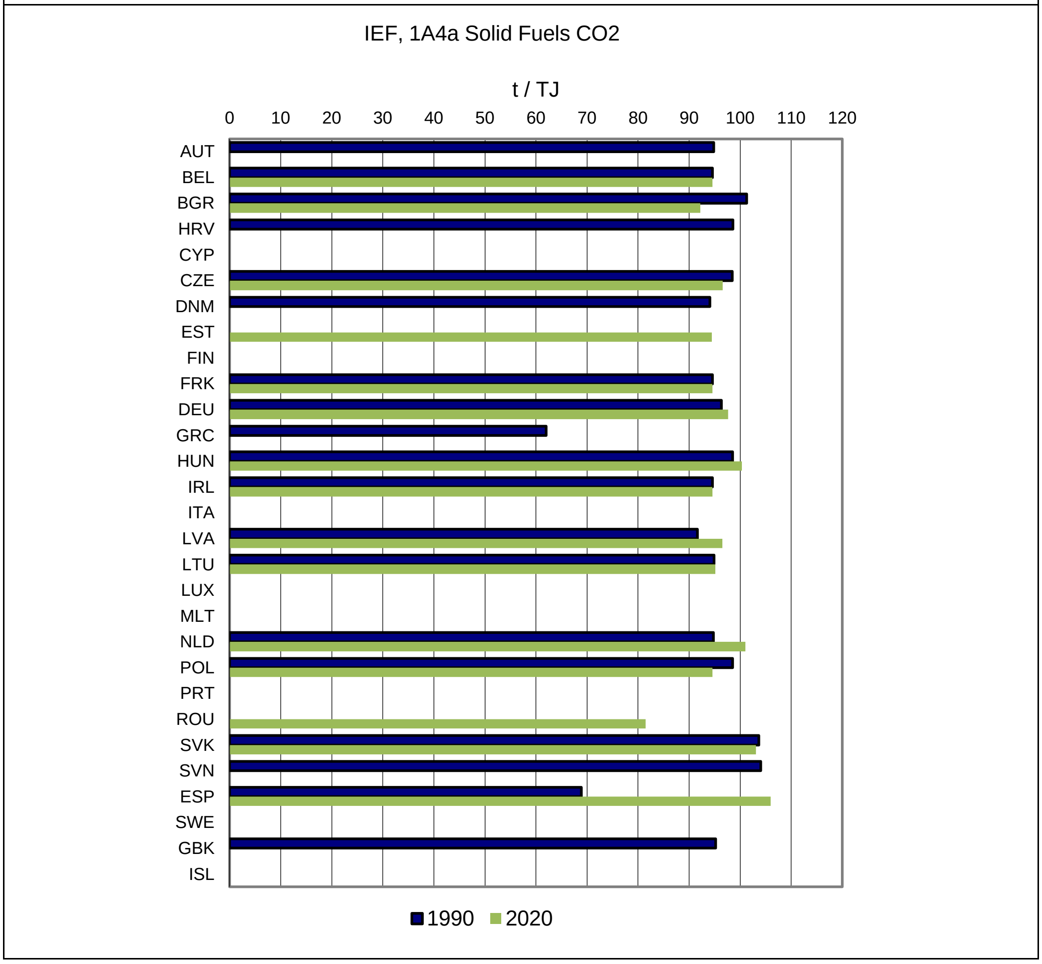


Figure 3.142 1.A.4.a Commercial/Institutional, solid fuels: of Implied Emission Factors for CO_2 (in t/TJ)





1.A.4.a Commercial/Institutional – Gaseous Fuels (CO_2)

In 2020 CO_2 from gaseous fuels had a share of 72% within source category 1.A.4.a (compared to 34% in 1990). Between 1990 and 2020, the emissions increased by 46% (Table 3.89). All Member States except Lithuania, the Netherlands and Slovakia reported increasing emissions. The highest absolute increases occurred in Italy, Germany and Spain. Between 2019 and 2020 CO_2 emissions decreased by

8%. According to the methodology as described in chapter 3.2.4 about 89% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.89 1.A.4.a Commercial/Institutional, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	698	896	838	0.9%	140	20%	-57	-6%	T2	T2
Belgium	1 936	4 368	4 077	4.2%	2 141	111%	-291	-7%	T1	T1
Bulgaria	42	209	231	0.2%	189	450%	23	11%	T2	T2
Croatia	241	490	460	0.5%	220	91%	-30	-6%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 670	2 791	2 545	2.6%	875	52%	-246	-9%	T2	T2
Denmark	363	443	398	0.4%	35	10%	-45	-10%	T3	T3
Estonia	19	170	174	0.2%	155	833%	4	2%	-	-
Finland	37	65	55	0.1%	18	47%	-10	-15%	T2	T2
France	8 127	14 319	12 655	13.1%	4 528	56%	-1 664	-12%	-	-
Germany	13 547	20 333	18 835	19.5%	5 288	39%	-1 498	-7%	CS	CS
Greece	IE,NO	373	331	0.3%	331	∞	-42	-11%	T2	T2
Hungary	1 299	2 513	2 515	2.6%	1 216	94%	2	0%	T2	T2
Ireland	223	996	1 013	1.0%	789	353%	17	2%	T2	T2
Italy	9 842	17 135	16 225	16.8%	6 383	65%	-910	-5%	-	-
Latvia	276	279	281	0.3%	5	2%	2	1%	T2	T2
Lithuania	708	169	161	0.2%	-547	-77%	-8	-5%	T2	T2
Luxembourg	170	251	180	0.2%	11	6%	-71	-28%	T2	T2
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 758	6 554	5 955	6.2%	-1 802	-23%	-599	-9%	T2	T2
Poland	762	3 124	2 653	2.7%	1 892	248%	-471	-15%	T2	T2
Portugal	NO	747	643	0.7%	643	∞	-104	-14%	T2	T2
Romania	NO	1 881	1 776	1.8%	1 776	∞	-105	-6%	T2	T2
Slovakia	2 035	987	915	0.9%	-1 120	-55%	-71	-7%	T2	T2
Slovenia	29	70	57	0.1%	28	94%	-13	-19%	-	#NV
Spain	381	6 624	5 432	5.6%	5 051	1327%	-1 192	-18%	T2	T2
Sweden	86	251	227	0.2%	141	164%	-24	-10%	-	-
United Kingdom	15 716	18 632	17 917	18.6%	2 201	14%	-715	-4%	T2	T2
EU-27+UK	**65 963**	**104 669**	**96 550**	**100%**	**30 587**	**46%**	**-8 119**	**-8%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	15 716	18 632	17 917	18.6%	2 201	14%	-715	-4%	T2	T2
EU-KP	**65 963**	**104 669**	**96 550**	**100%**	**30 587**	**46%**	**-8 119**	**-8%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.143 and Figure 3.144 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany, the United Kingdom, Italy, France, the Netherlands, Spain and Belgium; together they cause 84% of the CO_2 emissions from gaseous fuels in 1.A.4.a. Fuel combustion increased by 45% between 1990 and 2020. The CO_2 implied emission factor for gaseous fuels was 56.32 t/TJ in 2020.

Figure 3.143 1.A.4.a Commercial/Institutional, gaseous fuels: Emission trend and share for CO_2

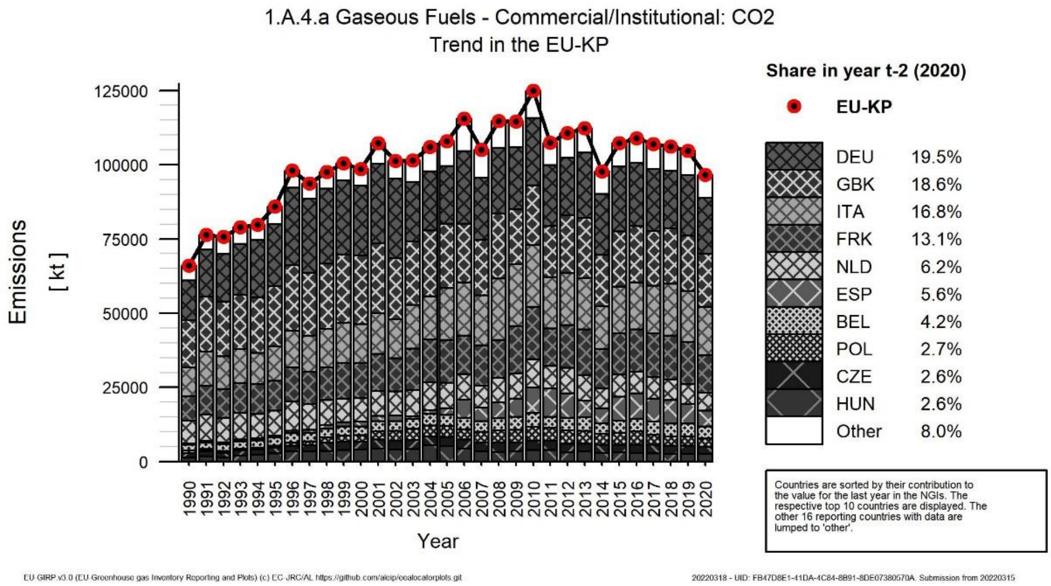
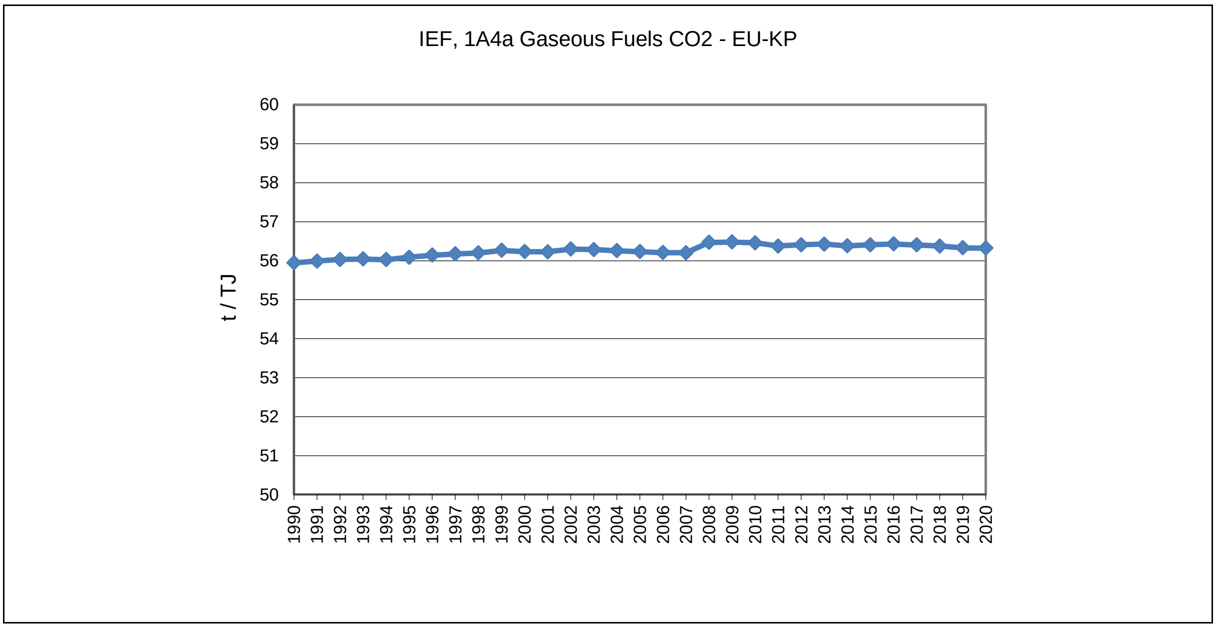
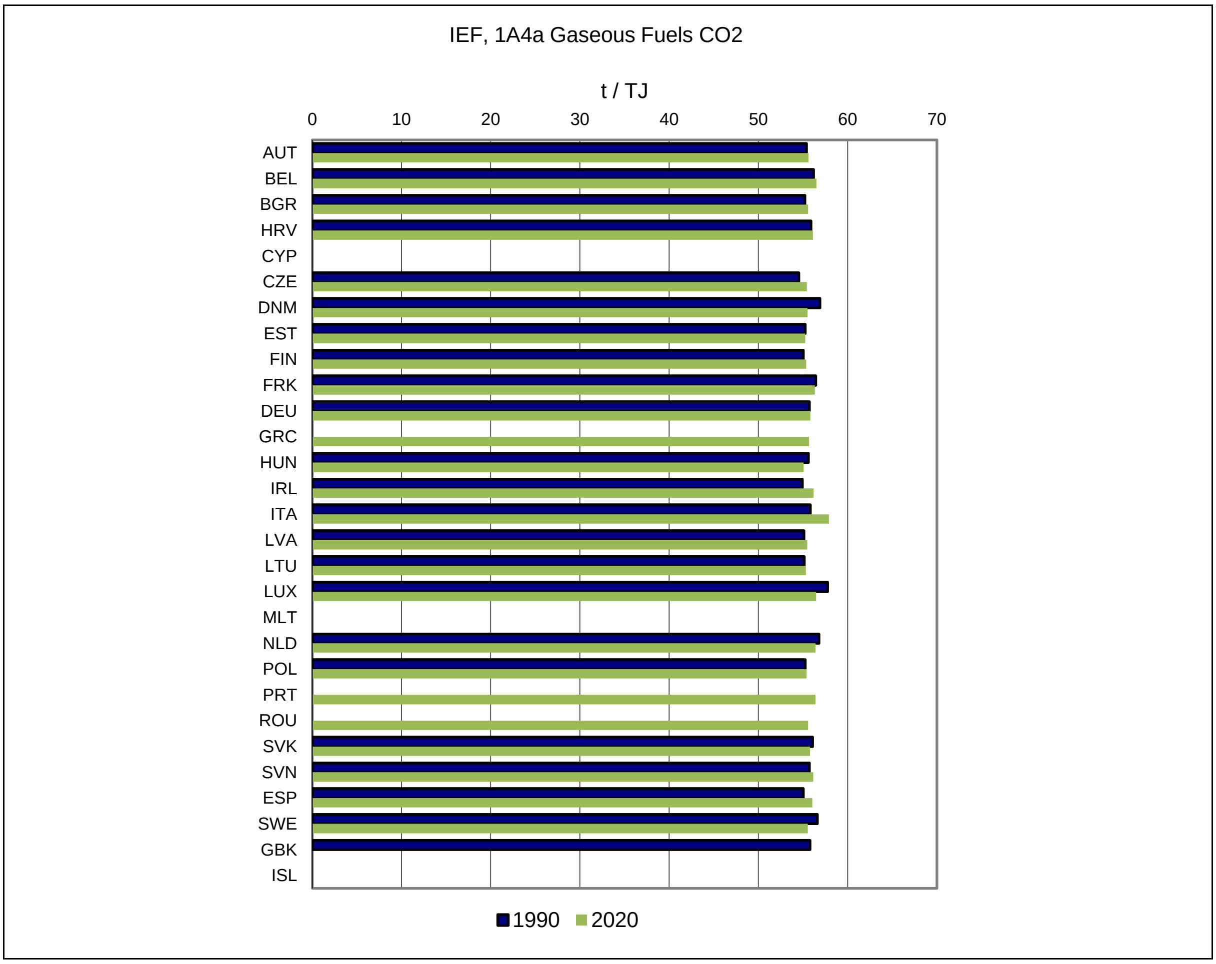


Figure 3.144 1.A.4.a Commercial/Institutional, gaseous fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)





1.A.4.a Commercial/Institutional – Other Fossil Fuels (CO_2)

Under this key category Member States report CO_2 emissions from waste incineration plants with energy recovery, whose main economic activity is the treatment of waste (as opposed to waste incineration plants with energy recovery whose main economic activity is power and heat production; these are reported under 1A1a).

In 2020, CO_2 from other fossil fuels had a share of 5% within category 1.A.4.a. Between 1990 and 2020 CO_2 emissions increased by 730% (Table 3.90). Sixteen Member States, the United Kingdom and Iceland report emissions as 'Not occurring' or 'Included elsewhere' in 2020; between 2019 and 2020 CO_2 increased by 3%. Level of emissions is strongly driven by Italy. In this category, Italy includes all emissions due to the non-renewable part of wastes used in electricity generation. According to the methodology as described in chapter 3.2.4 about 98% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.90: 1.A.4.a Commercial/Institutional, other fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	83	7	0.4	0.0%	-83	-100%	-7	-95%	T2	T2
Belgium	29	112	119	1.9%	90	309%	7	6%	T1	T1
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	34	NO	NO	-	-34	-100%	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-	-	-
Finland	0	NO	NO	-	0	-100%	-	-	NA	NA
France	NO	5	5	0.1%	5	∞	1	11%	-	-
Germany	NO	1	2	0.0%	2	∞	1	45%	NA	NA
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	NO	157	157	2.5%	157	∞	0	0%	T2	T2
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	530	5 712	5 778	93.1%	5 248	991%	67	1%	-	-
Latvia	NO	0.1	0.2	0.0%	0	∞	0	50%	T1	T1
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	1	1	0.0%	1	∞	0	-15%	NA	NA
Poland	72	25	136	2.2%	64	89%	111	447%	T1	T1
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	NO	10	9	0.2%	9	∞	-1	-9%	T2	T2
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	NO	1	1	0.0%	1	∞	0	4%	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**748**	**6 032**	**6 210**	**100%**	**5 461**	**730%**	**178**	**3%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**748**	**6 032**	**6 210**	**100%**	**5 461**	**730%**	**178**	**3%**		

Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'

Figure 3.146 shows CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) corresponds to Italy; it causes 93% of the CO_2 emissions from other fossil fuels in 1.A.4.a. The CO_2 implied emission factor for other fossil fuels was 95.16 t/TJ in 2020. The comparatively high implied emission factor is a calculated value from a mass balance calculation method and data from energy statistics.

Figure 3.145   1.A.4.a Commercial/Institutional, other fuels: Emission trend and share for CO_2

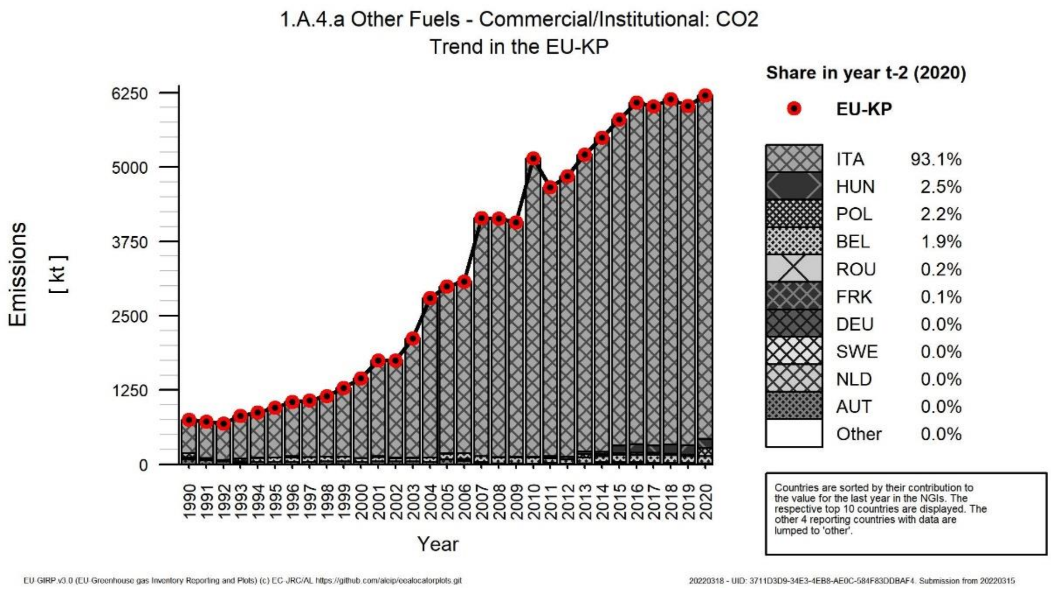
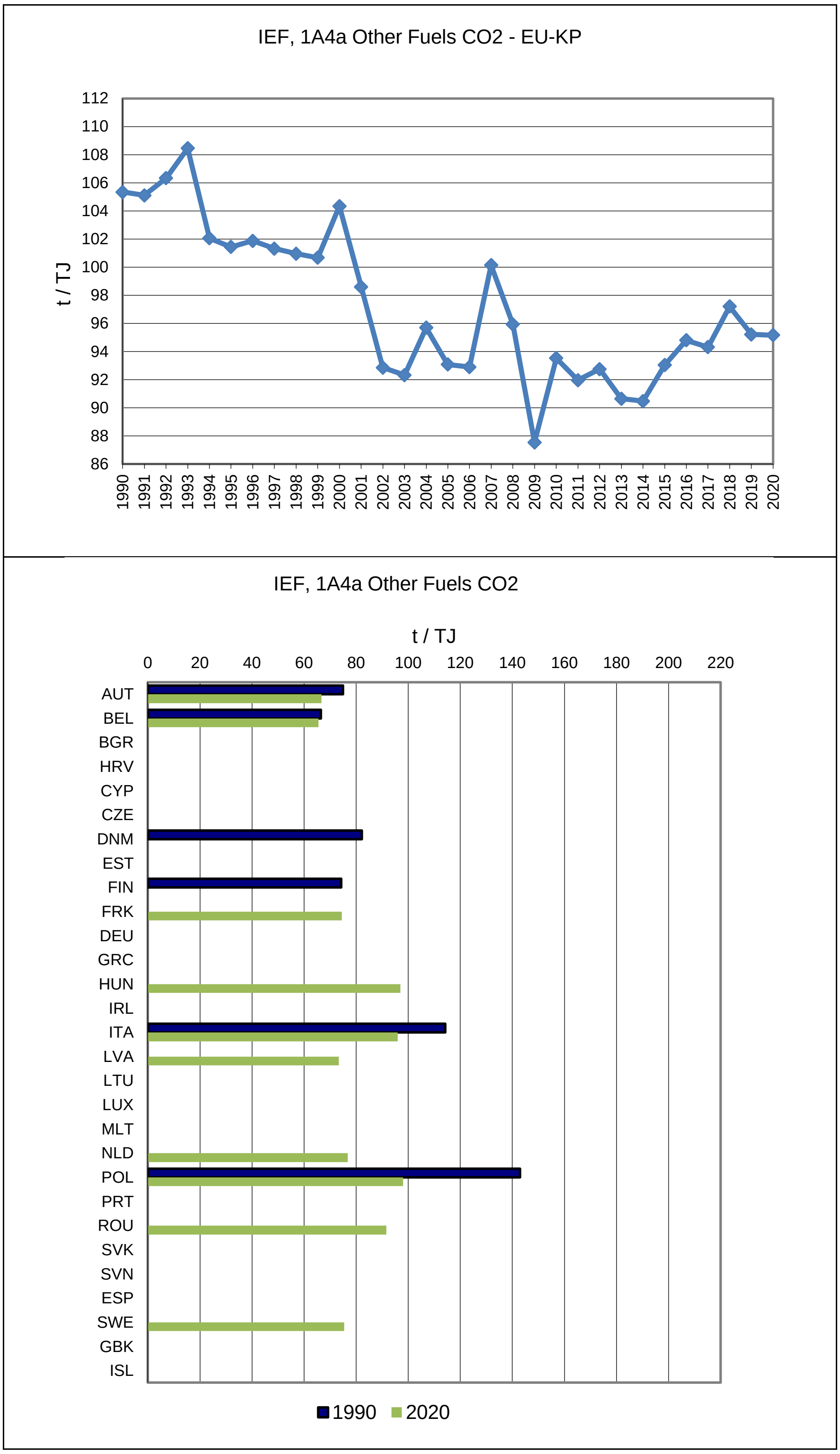


Figure 3.146 1.A.4.a Commercial/Institutional, other fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)



3.2.4.2 Residential (1.A.4.b)

CO_2 emissions from 1.A.4.b Residential account for 13% of total GHG emissions from 1.A Fuel Combustion in 2020.

Figure 3.147 shows the emission trend within the category 1.A.4.b, which is mainly dominated by CO_2 emissions from gaseous and liquid fuels. Total GHG emissions decreased by 28% since 1990, although CO_2 emissions from gaseous fuels increased strongly (+30%) which was counterbalanced by decreasing emissions from liquid and solid fuels. From 2019 to 2020, CO_2 emissions increased by 0.5% and energy consumption decreased by less than 0.5% which doesn't correlate very much with the trend in EU-27 heating degree days (-5%). Nevertheless this could be explained by the fact, that in 2020 people were staying at their homes more than usually due to COVID-19 pandemic. Biomass consumption reached a share of 22% in the year 2020 while the share of solid fossil fuels consumption dropped to 4%.

Trend in fuel consumption is in most Member States rather increasing, although some of the Member States have a strong decrease for 1.A.4.b in 2020 (e. g. Finland). On the contrary more than half of the Member States experienced decreasing trend in heating degree days. Nevertheless, for most of the Member States trend in fuel consumption correlates with trend in heating degree days, this does not apply only for seven Member States. The following Table **3.91: EU-27 heating degree days 2019 and** 2020 and 1.A.4.b trend in total fuel consumption. presents the (15°/18°) heating degree days in 2019 and 2020 for Member States and trend in 1.A.4.b total fuel consumption.

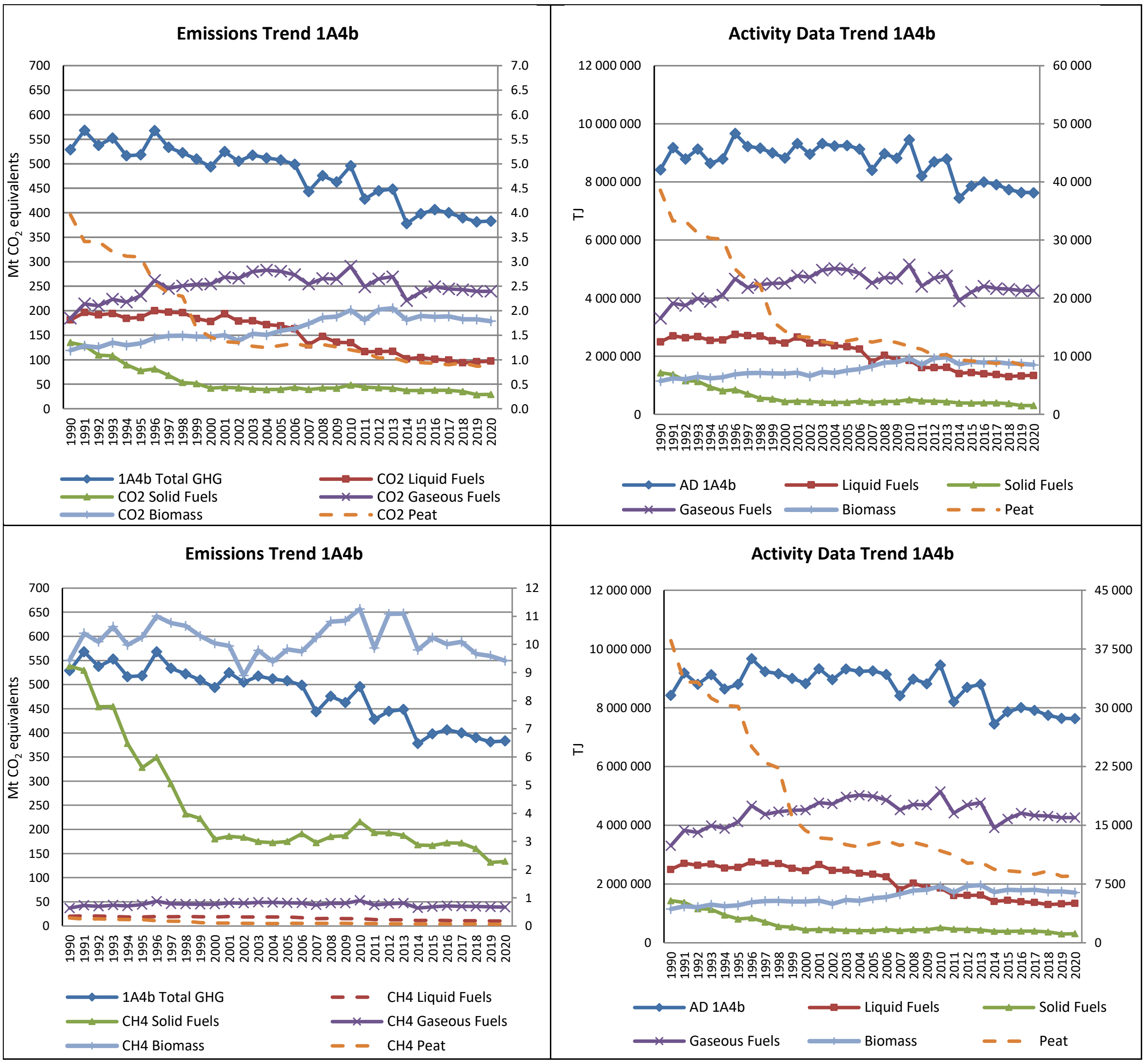
Table 3.91: EU-27 heating degree days 2019 and 2020 and 1.A.4.b trend in total fuel consumption.

	2019	**2020**	**Trend 2019 – 2020 [%]**	**Trend fuel consumption 1.A.4.b [%]**
Austria	3280	3323	1	0
Belgium	2532	2340	-8	-6
Bulgaria	2153	2247	4	17
Croatia	2076	2138	3	3
Cyprus	693	630	-9	-2
Czechia	2998	3079	3	2
Denmark	3027	2921	-4	-6
Estonia	3883	3553	-8	3
Finland	5483	4871	-11	-9
France	2247	2038	-9	-5
Germany	2801	2741	-2	-1
Greece	1449	1489	3	7
Hungary	2381	2547	7	5
Ireland	2707	2744	1	9
Italy	1814	1750	-4	-2
Latvia	3623	3404	-6	-9
Lithuania	3391	3306	-3	-1
Luxembourg	2754	2567	-7	8
Malta	515	402	-22	-4
Netherlands	2514	2386	-5	-4
Poland	2952	3006	2	4
Portugal	1109	1008	-9	3
Romania	2568	2666	4	3
Slovakia	2899	3047	5	3
Slovenia	2601	2691	3	-2
Spain	1671	1554	-7	7

	2019	2020	Trend 2019 – 2020 [%]	Trend fuel consumption 1.A.4.b [%]
Sweden	5120	4593	-10	0
EU27 (weighted)	2909	2759	-5	0

Source: Eurostat and EEA 2022

Figure 3.147 1.A.4.b Residential: Total, CO_2 and CH_4 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

CO_2 emissions from 1.A.4.b Residential

Between 1990 and 2020, CO_2 emissions from households decreased by 27% in the EU-KP (Table 3.92). Main factors influencing CO_2 emissions from this source category are (1) outdoor temperature, (2) number and size of dwellings, (3) building codes, (4) thermal properties of building stock, (5) fuel split for heating and warm water, (6) use of renewable energy sources, e.g. biomass or solar panels, and (7) the use of district heating. Fuel consumption of households decreased by 9% between 1990 and 2020, with a fuel shift from coal and oil to natural gas and biomass. Overall, the recently mild winters are apparent on the lower amount of fuel combustion.

Between 1990 and 2020, the largest CO_2 reduction in absolute terms was reported by Germany. Only five Member States show increases in their emissions. One reason for the performance of the Nordic countries is increased use of district heating. As district heating replaces heating boilers in households, an increase in the share of district heating reduces CO_2 emissions from households (but increases emissions from energy industries if fossil fuels are used). In Germany, efficiency improvements and the fuel switch in eastern German households are two reasons for the emission reductions. Between 2019 and 2020 the largest absolute increase in the emissions is reported by Poland which contributes to total EU-KP emissions with 8%.

Table 3.92 1.A.4.b Residential: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	10 000	6 393	6 426	1.8%	-3 574	-36%	33	1%	T1,T2	CS,D
Belgium	20 483	15 341	14 434	3.9%	-6 049	-30%	-907	-6%	CS,T1,T3	D
Bulgaria	2 887	623	658	0.2%	-2 229	-77%	35	6%	T1,T2	CS,D
Croatia	2 029	1 401	1 477	0.4%	-552	-27%	76	5%	T1	D
Cyprus	300	328	324	0.1%	24	8%	-4	-1%	T1	D
Czechia	18 375	7 348	7 362	2.0%	-11 013	-60%	14	0%	T1,T2	CS,D
Denmark	4 990	1 770	1 543	0.4%	-3 447	-69%	-227	-13%	M,T1,T2,T3	CS,D
Estonia	1 024	179	163	0.0%	-861	-84%	-15	-9%	T1,T2	CS,D
Finland	3 148	1 024	914	0.2%	-2 234	-71%	-110	-11%	T1,T2,T3	CS,D
France	54 018	40 352	38 700	10.5%	-15 318	-28%	-1 652	-4%	T1,T2	CS,D
Germany	128 636	89 449	89 771	24.5%	-38 865	-30%	322	0%	CS,T1,T2	CS
Greece	4 654	4 461	4 999	1.4%	345	7%	538	12%	T1,T2	CS,D
Hungary	15 700	7 153	7 637	2.1%	-8 064	-51%	484	7%	T1,T2	CS,D
Ireland	7 049	6 373	6 950	1.9%	-100	-1%	577	9%	T2	CS
Italy	55 788	44 735	44 075	12.0%	-11 713	-21%	-661	-1%	T2	CS
Latvia	1 182	435	419	0.1%	-763	-65%	-16	-4%	T1,T2	CS,D
Lithuania	2 361	735	704	0.2%	-1 658	-70%	-32	-4%	T2	CS
Luxembourg	670	941	1 030	0.3%	360	54%	89	9%	T1,T2	CS,D
Malta	95	42	41	0.0%	-54	-57%	-1	-2%	T1	D
Netherlands	20 733	15 780	15 034	4.1%	-5 700	-27%	-746	-5%	T1,T2	CS,D
Poland	35 222	29 887	31 176	8.50%	-4 047	-11%	1 288	4%	T1,T2	CS,D
Portugal	1 640	1 816	1 905	0.5%	265	16%	89	5%	T1,T2	CS,D
Romania	8 866	6 808	7 218	2.0%	-1 648	-19%	411	6%	T1,T2	CS,D
Slovakia	6 773	2 841	2 894	0.8%	-3 879	-57%	53	2%	T2	CS
Slovenia	896	625	649	0.2%	-248	-28%	23	4%	T1,T2	CS,D
Spain	12 802	14 157	15 364	4.2%	2 562	20%	1 206	9%	T2	CS,D,OTH
Sweden	6 301	453	435	0.1%	-5 865	-93%	-18	-4%	T1,T2	CS
United Kingdom	78 152	63 439	64 339	17.5%	-13 813	-18%	899	1%	T1,T2,T3	CS,D
EU-27+UK	**504 775**	**364 889**	**366 637**	**100%**	**-138 138**	**-27%**	**1 748**	**0%**	**-**	**-**
Iceland	28	4	5	0.0%	-23	-81%	1	23%	T1	D
United Kingdom (KP)	78 482	63 775	64 664	17.6%	-13 818	-18%	889	1%	T1,T2,T3	CS,D
EU-KP	**505 133**	**365 229**	**366 967**	**100%**	**-138 166**	**-27%**	**1 738**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.b Residential – Liquid Fuels (CO_2)

In 2020 CO_2 from liquid fuels had a share of 26% CO_2 emissions within source category 1.A.4.b (compared to 36% in 1990). Between 1990 and 2020, emissions decreased by 46% (Table 3.93). Italy, Germany and France show the highest absolute decreases. Only three Member States and the United Kingdom reported increasing emissions since 1990. Between 2019 and 2020 EU-KP CO_2 emissions increased by 1.5%. The strong decrease from 2006 to 2007 for Germany is due to low gasoil sales to end consumers. Many end consumers did not restock their oil tanks in 2007 because of high outdoor temperatures and rising oil prices. Additionally, end consumer gasoil stocks were comparatively high in 2007 due to a mild winter 2006. It is assumed that the circumstances were similar for other MS (e.g. Austria). According to the methodology as described in chapter 3.2.4 about 83% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.93 1.A.4.b Residential, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	5 633	3 007	3 044	3.1%	-2 589	-46%	38	1%	T2	T2
Belgium	12 805	7 492	7 003	7.2%	-5 802	-45%	-490	-7%	T1	T1
Bulgaria	158	52	56	0.1%	-101	-64%	4	7%	T1	T1
Croatia	1 137	313	329	0.3%	-808	-71%	15	5%	T1	T1
Cyprus	300	328	324	0.3%	24	8%	-4	-1%	-	-
Czechia	239	130	139	0.1%	-100	-42%	9	7%	T1	T1
Denmark	3 930	455	390	0.4%	-3 540	-90%	-65	-14%	-	-
Estonia	247	40	30	0.0%	-217	-88%	-11	-26%	-	-
Finland	3 024	949	845	0.9%	-2 179	-72%	-104	-11%	T2	T2
France	30 915	13 487	13 376	13.8%	-17 539	-57%	-112	-1%	-	-
Germany	56 382	36 437	37 446	38.5%	-18 936	-34%	1 009	3%	CS	CS
Greece	4 565	3 549	3 955	4.1%	-610	-13%	407	11%	T2	T2
Hungary	3 540	214	228	0.2%	-3 311	-94%	15	7%	T1	T1
Ireland	1 173	3 446	3 963	4.1%	2 790	238%	518	15%	T2	T2
Italy	28 444	5 741	5 435	5.6%	-23 009	-81%	-306	-5%	T2	T2
Latvia	332	158	158	0.2%	-174	-52%	1	1%	T2	T2
Lithuania	397	172	157	0.2%	-240	-61%	-15	-9%	T2	T2
Luxembourg	474	364	423	0.4%	-51	-11%	59	16%	T2	T2
Malta	95	42	41	0.0%	-54	-57%	-1	-2%	T1	T1
Netherlands	778	177	175	0.2%	-603	-77%	-2	-1%	T2	T2
Poland	110	1 745	1 662	1.7%	1 552	1405%	-83	-5%	T1,T2	T1,T2
Portugal	1 640	1 143	1 209	1.2%	-431	-26%	67	6%	T1	T1
Romania	922	862	744	0.8%	-177	-19%	-117	-14%	T1,T2	T1,T2
Slovakia	93	17	17	0.0%	-75	-81%	0	0%	T2	T2
Slovenia	527	376	400	0.4%	-127	-24%	24	7%	T1	T1
Spain	9 855	6 798	7 016	7.2%	-2 839	-29%	218	3%	T2	T2
Sweden	6 215	400	387	0.4%	-5 828	-94%	-13	-3%	T1	T1
United Kingdom	7 058	7 587	7 945	8.2%	887	13%	358	5%	T2	T2
EU-27+UK	**180 986**	**95 480**	**96 898**	**100%**	**-84 089**	**-46%**	**1 417**	**1.5%**		
Iceland	28	4	5	0.0%	-23	-81%	1	23%	T1	T1
United Kingdom (KP)	7 359	7 868	8 215	8.5%	856	12%	347	4%	T2	T2
EU-KP	**181 315**	**95 765**	**97 173**	**100%**	**-84 142**	**-46%**	**1 407**	**1.5%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.148 and Figure 3.149 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States and UK with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Germany, France, United Kingdom, Spain and Belgium; together they cause 89% of the CO_2 emissions from liquid fuels in 1.A.4.b. Fuel consumption in the EU-KP decreased by 46% between 1990 and 2020. The CO_2 implied emission factor for liquid fuels was 72.25 t/TJ in 2020. Within the MS there is variation of specific fuels used, which is causing also the fluctuation of the IEF. Most often Residual fuel oil, LPG and other kerosene are used.

Figure 3.148 1.A.4.b Residential, liquid fuels: Emission trend and share for CO_2

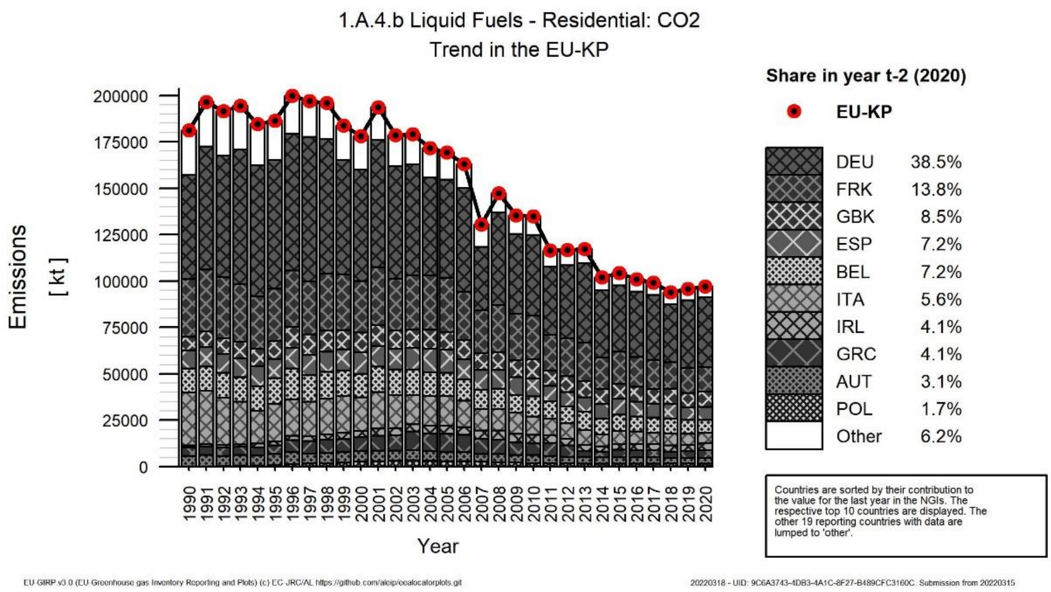
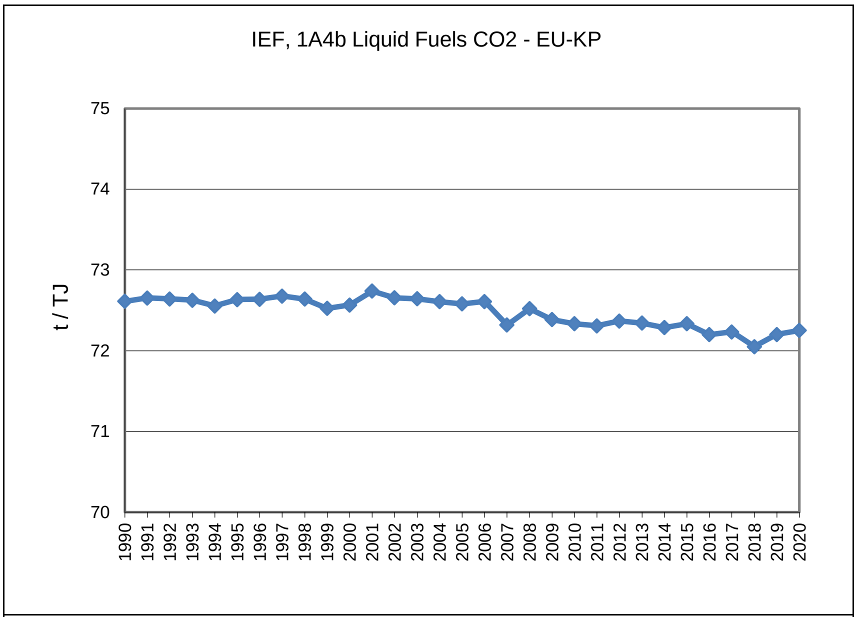
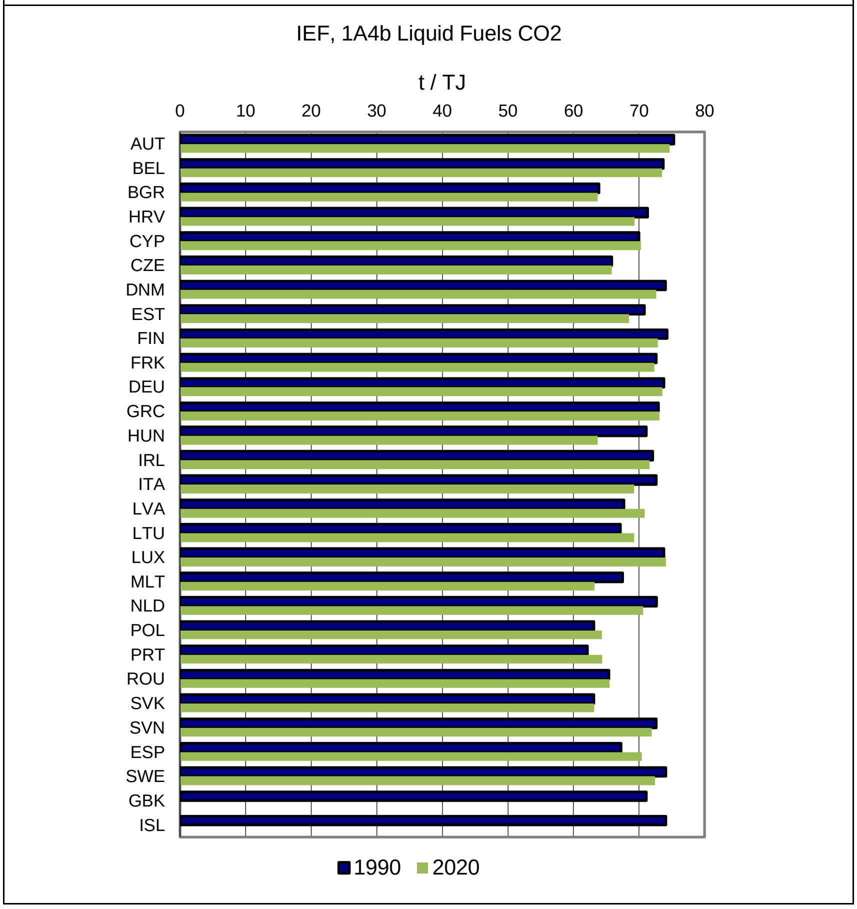


Figure 3.149 1.A.4.b Residential, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)





1.A.4.b Residential –Solid Fuels (CO_2)

In 2020, CO_2 from solid fuels had a share of 8% CO_2 emissions within source category 1.A.4.b (compared to 27% in 1990). Between 1990 and 2020 CO_2 emissions decreased by 78% (Table 3.94). All Member States reported decreasing emissions with the highest reductions in absolute terms in Germany, the United Kingdom and Czechia. Between 2019 and 2020 CO_2 emissions increased by 1%. Six Member States and Iceland report emissions as 'Not occurring' in 2020. According to the methodology as described in chapter 3.2.4 98% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.94 1.A.4.b Residential, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	2 511	79	80	0.3%	-2 431	-97%	1	1%	T2	T2
Belgium	1 796	82	76	0.3%	-1 720	-96%	-6	-7%	T1	T1
Bulgaria	2 730	387	378	1.3%	-2 351	-86%	-9	-2%	T1,T2	T1,T2
Croatia	436	9	8	0.03%	-428	-98%	-1	-14%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	16 038	3 042	2 904	10.0%	-13 134	-82%	-138	-5%	T2	T2
Denmark	72	NO	NO	-	-72	-100%	-	-	-	-
Estonia	337	5	4	0.01%	-333	-99%	-1	-19%	-	-
Finland	33	1	0	0.000%	-33	-100%	-0.4	-73%	T2	T2
France	1 969	97	82	0.3%	-1 887	-96%	-15	-15%	-	-
Germany	40 661	1 426	1 306	4.5%	-39 355	-97%	-120	-8%	CS	CS
Greece	89	16	13	0.0%	-76	-86%	-3	-20%	T2	T2
Hungary	8 107	302	239	0.8%	-7 868	-97%	-63	-21%	T1,T2	T1,T2
Ireland	2 483	753	788	2.7%	-1 695	-68%	35	5%	T2	T2
Italy	899	NO	NO	-	-899	-100%	-	-	NA	NA
Latvia	587	19	5	0.0%	-581	-99%	-14	-72%	T2	T2
Lithuania	1 440	126	98	0.3%	-1 342	-93%	-28	-22%	T2	T2
Luxembourg	26	1	1	0.004%	-25	-96%	0.07	7%	T1	T1
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	61	5	1	0.00%	-60	-98%	-3.3	-69%	T2	T2
Poland	28 362	19 712	20 605	70.8%	-7 758	-27%	892	5%	T1,T2	T1,T2
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	2 717	131	147	0.5%	-2 569	-95%	16	12%	T1,T2	T1,T2
Slovakia	5 122	261	244	0.8%	-4 878	-95%	-17	-7%	T2	T2
Slovenia	345	0.26	0.24	0.001%	-344	-100%	-0.02	-7%	T1	T1
Spain	2 035	327	234	0.8%	-1 801	-89%	-93	-29%	T2	T2
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	16 247	1 980	1 906	6.5%	-14 340	-88%	-74	-4%	T2	T2
EU-27+UK	**135 100**	**28 759**	**29 119**	**100%**	**-105 981**	**-78%**	**360**	**1%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	16 276	1 980	1 906	6.5%	-14 370	-88%	-74	-4%	T2	T2
EU-KP	**135 130**	**28 759**	**29 119**	**100%**	**-106 011**	**-78%**	**360**	**1%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.150 and Figure 3.151 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Poland, Czechia and United Kingdom; together they cause 87% of the CO_2 emissions from solid fuels in 1.A.4.b. Fuel consumption in the EU-KP decreased by 79% between 1990 and 2020. The CO_2 implied emission factor for solid fuels was 94.61 t/TJ in 2020. The comparatively low IEFs of Italy and Spain in 1990 are due to a high share of gas works gas consumption in the 1990s.

Figure 3.150 1.A.4.b Residential, solid fuels: Emission trend and share for CO_2

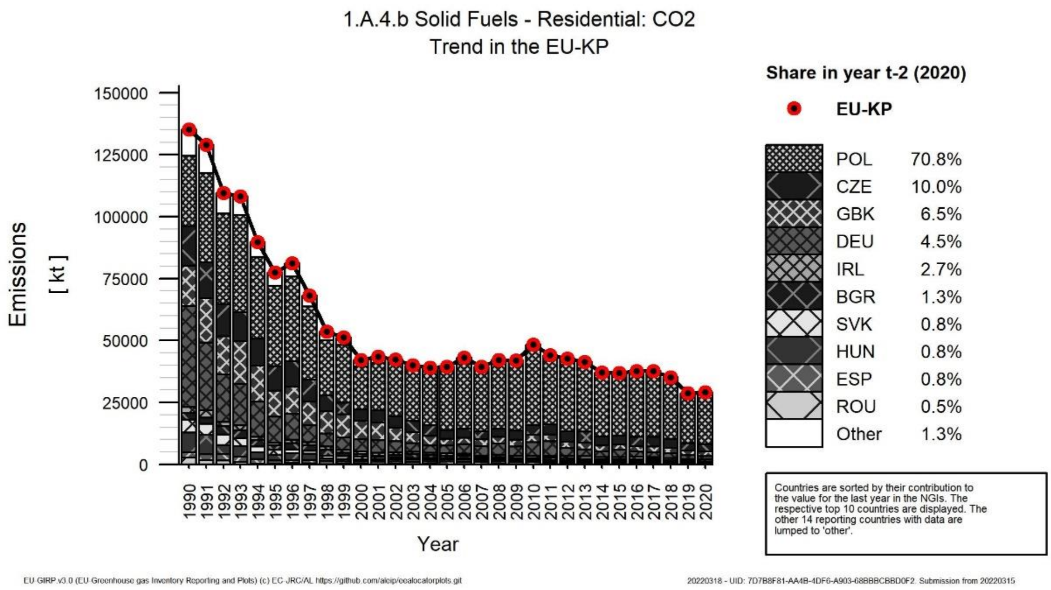
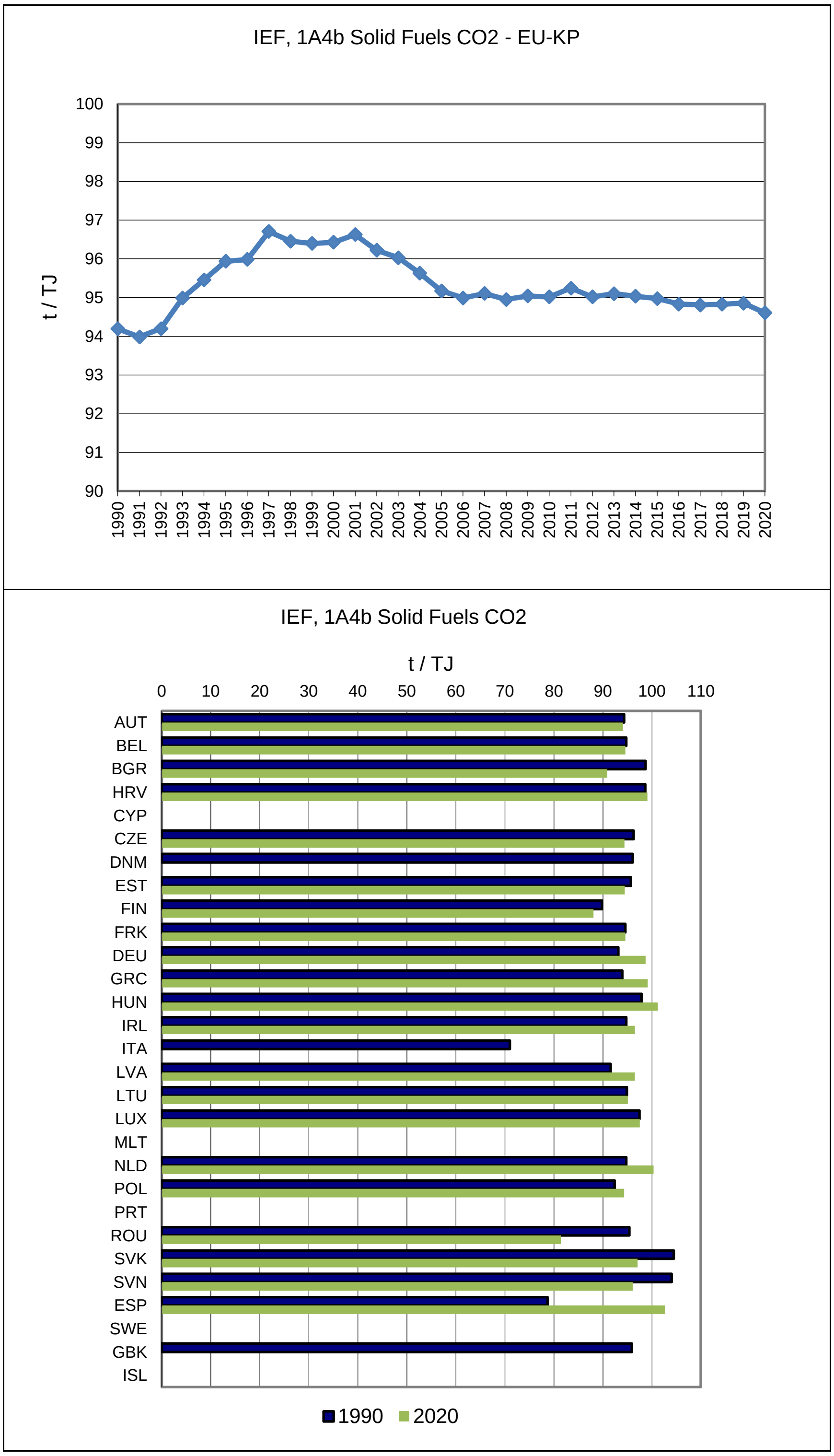


Figure 3.151 1.A.4.b Residential, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.b Residential – Gaseous Fuels (CO_2)

In 2020, CO_2 from gaseous fuels had a share of 65% CO_2 emissions within source category 1.A.4.b (compared to 37% in 1990). Between 1990 and 2020, the emissions increased by 30% (Table 3.95). All Member States except Estonia, Lithuania, the Netherlands and Sweden reported increasing emissions from the gaseous fuels combustion. The highest absolute increase occurred in Germany and Italy. Between 2019 and 2020 EU-KP emissions decreased by less than 0.5%. According to the methodology as described in chapter 3.2.4 about 91% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.95 1.A.4.b Residential, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 856	3 308	3 302	1.4%	1 446	78%	-6	0%	T2	T2
Belgium	5 882	7 767	7 355	3.1%	1 474	25%	-412	-5%	T1	T1
Bulgaria	NO	183	223	0.1%	223	∞	40	22%	T2	T2
Croatia	456	1 078	1 141	0.5%	685	150%	62	6%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	2 098	4 176	4 318	1.8%	2 220	106%	142	3%	T2	T2
Denmark	988	1 315	1 153	0.5%	165	17%	-162	-12%	T3	T3
Estonia	132	134	130	0.1%	-2	-1%	-4	-3%	-	-
Finland	25	60	55	0.02%	29	116%	-5	-8%	T2	T2
France	21 134	26 757	25 232	10.5%	4 098	19%	-1 526	-6%	-	-
Germany	31 564	51 585	51 018	21.3%	19 454	62%	-567	-1%	CS	CS
Greece	IE,NO	897	1 031	0.4%	1 031	∞	134	15%	T2	T2
Hungary	4 054	6 637	7 169	3.0%	3 115	77%	532	8%	T2	T2
Ireland	270	1 387	1 387	0.6%	1 117	414%	0	0%	T2	T2
Italy	26 444	38 994	38 640	16.1%	12 195	46%	-354	-1%	T2	T2
Latvia	221	258	255	0.1%	34	16%	-3	-1%	T2	T2
Lithuania	509	374	404	0.2%	-105	-21%	30	8%	T2	T2
Luxembourg	170	576	605	0.3%	436	257%	29	5%	T2	T2
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	19 894	15 598	14 857	6.2%	-5 037	-25%	-741	-5%	T2	T2
Poland	6 750	8 430	8 909	3.7%	2 159	32%	479	6%	T2	T2
Portugal	NO	674	696	0.3%	696	∞	22	3%	T2	T2
Romania	5 228	5 815	6 327	2.6%	1 099	21%	512	8.8%	T2	T2
Slovakia	1 559	2 563	2 633	1.1%	1 074	69%	70	3%	T2	T2
Slovenia	25	250	248	0.1%	223	882%	-1	0%	T2	T2
Spain	912	7 032	8 114	3.4%	7 202	790%	1 082	15%	T2	T2
Sweden	86	53	48	0.02%	-38	-44%	-5	-9%	-	-
United Kingdom	54 475	53 867	54 483	22.7%	8	0%	616	1%	T2	T2
EU-27+UK	**184 731**	**239 767**	**239 733**	**100%**	**55 002**	**30%**	**-34**	**0%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	54 475	53 922	54 538	22.7%	63	0%	616	1%	T2	T2
EU-KP	**184 731**	**239 822**	**239 788**	**100%**	**55 057**	**30%**	**-34**	**0%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.152 shows CO_2 emissions for EU-KP and the Member States as well as the share of the Member States and UK with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to the United Kingdom, Germany, Italy, France and the Netherlands; together they cause 77% of the CO_2 emissions from gaseous fuels in 1.A.4.b. Fuel consumption in the EU-KP increased by 29% between 1990 and 2020. The CO_2 implied emission factor for gaseous fuels was 56.28 t/TJ in 2020.

Figure 3.152 1.A.4.b Residential, gaseous fuels: Emission trend and share for CO_2

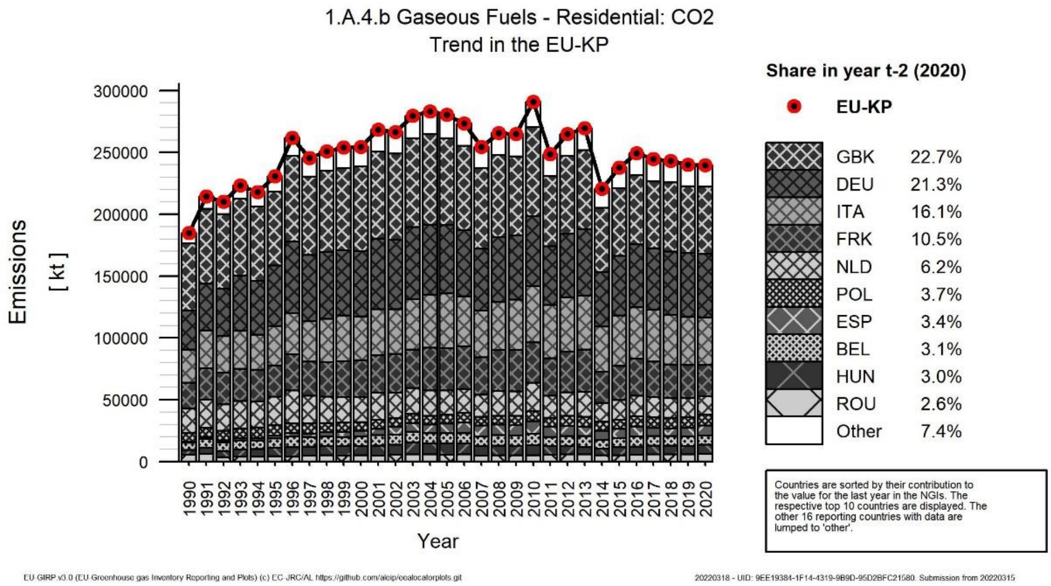
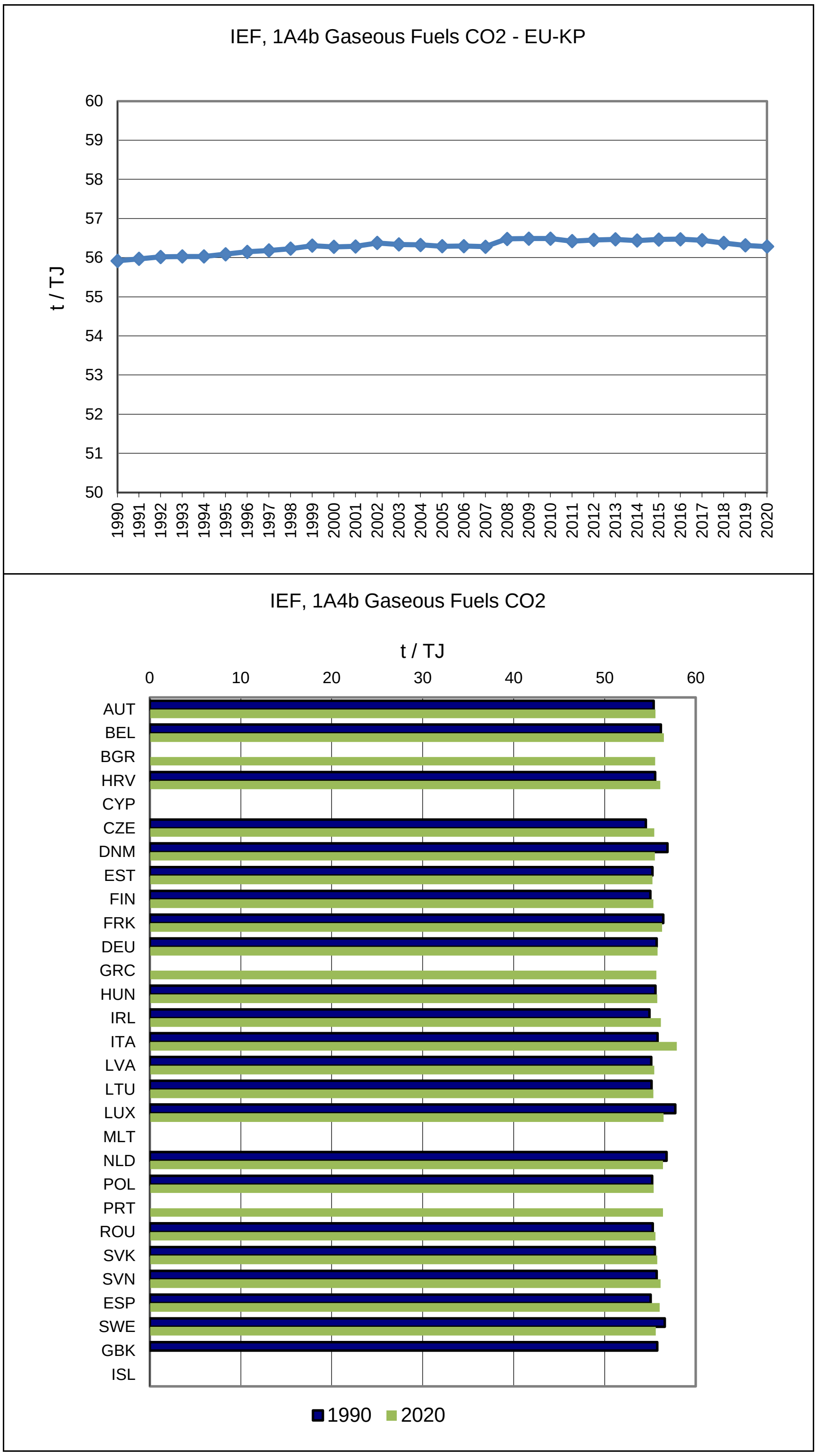


Figure 3.153 1.A.4.b Residential, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



CH_4 emissions from 1.A.4.b Residential

CH_4 emissions mainly occur from incomplete biomass and coal combustion. CH_4 emissions from 1.A.4.b Residential accounted for 56% of total CH_4 emissions and 0.5% of total GHG emissions in 1.A in 2020. Between 1990 and 2020, CH_4 emissions from households decreased by 37% in the EU-KP (Table 3.96).

France and Germany reported the highest decrease in emissions while Italy and Romania reported the highest increase in emissions. Between 2019 and 2020 CH_4 emissions decreased by 1%.

Table 3.96 1.A.4.b Residential: Member States' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	465	207	207	1.6%	-259	-56%	0	0%	T1,T2,T3	CS,D
Belgium	234	251	231	1.8%	-3	-1%	-20	-8%	CS,T1,T3	CR,D
Bulgaria	262	256	298	2.4%	36	14%	42	17%	T1	D
Croatia	354	320	325	2.6%	-29	-8%	4	1%	T1	D
Cyprus	2	8	7	0.1%	5	283%	-1	-9%	T1	D
Czechia	1 515	887	890	7.1%	-626	-41%	3	0%	T1	D
Denmark	120	69	62	0.5%	-57	-48%	-6	-9%	M,T1,T2,T3	CS,D,OTH
Estonia	90	120	125	1.0%	36	40%	5	4%	T1,T2,T3	CS,D
Finland	148	192	160	1.3%	11	8%	-32	-17%	T1,T2,T3	CR,CS,D
France	4 550	1 005	924	7.3%	-3 626	-80%	-81	-8%	T1,T2	CS,D
Germany	2 485	822	786	6.2%	-1 699	-68%	-37	-4%	T2,T3	CS,M
Greece	229	202	191	1.5%	-38	-17%	-12	-6%	T1	D
Hungary	828	435	433	3.4%	-395	-48%	-2	-1%	T1	D
Ireland	443	139	146	1.2%	-296	-67%	7	5%	T1	D
Italy	1 095	2 141	2 063	16.3%	968	88%	-78	-4%	T2	CR
Latvia	197	128	112	0.9%	-85	-43%	-15	-12%	T1,T2	CS,D
Lithuania	175	141	138	1.1%	-38	-22%	-4	-3%	T1,T2	CS,D
Luxembourg	9	8	8	0.1%	-1	-14%	0	5%	T1,T3	D,M
Malta	0	1	1	0.0%	0	98%	0	-14%	T1	D
Netherlands	450	342	328	2.6%	-122	-27%	-14	-4%	T1,T2	CS,D
Poland	2 475	2 356	2 445	19.4%	-30	-1%	90	4%	T1	D
Portugal	428	210	213	1.7%	-215	-50%	3	2%	T1,T2	D,OTH
Romania	408	982	990	7.8%	582	143%	8	1%	T1	D
Slovakia	378	204	209	1.7%	-169	-45%	5	2%	T1	D
Slovenia	142	111	102	0.8%	-40	-28%	-9	-8%	T1,T2	CS,D
Spain	794	631	628	5.0%	-166	-21%	-2	0%	T2	D
Sweden	103	53	52	0.4%	-51	-50%	-1	-3%	M,T1	CS
United Kingdom	1 536	540	542	4.3%	-994	-65%	2	0%	T1,T2,T3	CS,D
EU-27+UK	**19 915**	**12 762**	**12 616**	**100%**	**-7 299**	**-37%**	**-145**	**-1%**	**-**	**-**
Iceland	0	0	0	0.000%	0	-86%	0	36%	T1	D
United Kingdom (KP)	1 540	541	543	4.3%	-997	-65%	2	0%	T1,T2,T3	CS,D
EU-KP	**19 919**	**12 763**	**12 617**	**100%**	**-7 301**	**-37%**	**-145**	**-1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.b Residential – Biomass (CH_4)

In 2020 CH_4 from biomass had a share of 75% within source category on the total CH_4 emissions from 1.A.4.b (compared to 47% in 1990). Between 1990 and 2020 CH_4 emissions increased by less than 0.5% (Table 3.97). France reported the highest absolute decrease, while CH_4 emissions of Italy increased significantly. Between 2019 and 2020, CH_4 emissions decreased by 2%. According to the methodology as described in chapter 3.2.4 about 50% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.97 1.A.4.b Residential, biomass: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	243	189	189	2.0%	-54	-22%	0	0%	T1,T2	T1,T2
Belgium	98	222	204	2.2%	106	109%	-18	-8%	T1	T1
Bulgaria	54	223	266	2.8%	212	392%	43	19%	T1	T1
Croatia	316	316	321	3.4%	4.4	1.4%	4	1%	T1	T1
Cyprus	1	7	6	0.1%	5	519%	-0.7	-10%	-	-
Czechia	324	636	649	6.9%	325	100%	13	2%	T1	T1
Denmark	110	66	60	0.6%	-50	-45%	-6	-9%	-	-
Estonia	38	119	125	1.3%	86	226%	6	5%	-	-
Finland	132	184	153	1.6%	21	16%	-31	-17%	T2	T2
France	4 239	886	810	8.6%	-3 429	-81%	-76	-9%	-	-
Germany	280	651	624	6.6%	344	123%	-27	-4%	T2	T2
Greece	220	200	188	2.0%	-32	-15%	-12	-6%	T1	T1
Hungary	186	397	398	4.2%	211	113%	1	0%	T1	T1
Ireland	14	8	9	0.1%	-5	-38%	0	5%	T1	T1
Italy	996	2 091	2 014	21.4%	1 018	102%	-77	-4%	T2	T2
Latvia	145	125	111	1.2%	-34	-24%	-14	-12%	T2	T2
Lithuania	58	126	125	1.3%	67	114%	0	0%	T2	T2
Luxembourg	5	5	5	0.05%	0.17	3.6%	0	3%	T1	T1
Malta	NO	0.5	0	0.00%	0	∞	-0.1	-16%	T1	T1
Netherlands	91	60	59	0.6%	-33	-36%	-2	-3%	T1	T1
Poland	292	770	784	8.3%	492	169%	14	2%	T1	T1
Portugal	425	208	211	2.2%	-214	-50%	3	1%	T2	T2
Romania	181	956	961	10.2%	780	432%	6	1%	T1	T1
Slovakia	36	179	185	2.0%	149	416%	6	3%	T1	T1
Slovenia	115	109	101	1.1%	-15	-13%	-9	-8%	T2	T2
Spain	651	572	572	6.1%	-79	-12%	1	0.2%	T2	T2
Sweden	96	50	49	0.5%	-47	-49%	-1.3	-2.6%	T1	T1
United Kingdom	88	238	242	2.6%	154	175%	4	2%	T1	T1
EU-27+UK	**9 434**	**9 593**	**9 420**	**100%**	**-15**	**0%**	**-173**	**-2%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	88	238	242	2.6%	154	175%	4	2%	T1	T1
EU-KP	**9 434**	**9 593**	**9 420**	**100%**	**-15**	**0%**	**-173**	**-2%**		

Abbreviations explained in the Chapter 'Units and abbreviation'.

Figure 3.154 and

Figure 3.155 show CH_4 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CH_4 emissions correspond to Italy followed by Romania, France and Poland; together they cause 48% of the CH_4 emissions from biomass fuels in 1.A.4.b. Biomass fuel consumption in the EU-KP increased by 49% between 1990 and 2020. The CH_4 implied emission factor for biomass fuels was 220.68 kg/TJ in 2020.

The trend in implied emission factor is strongly affected by France, whose IEF changed dramatically over the time series; from 497.41 kg/TJ in 1990 to 126.34 kg/TJ in 2020. The decreasing trend of IEF in France (and also other Member States) reflects replacement of old biomass boilers, stoves and open fireplaces by modern technologies (pellets, automatic boilers). These new technologies have lower CH_4 (as well as NMVOC) emissions from incomplete combustion. However, this change in improved technologies is not reflected by the Member States which are using the default emission factor value (300 kg/TJ) for the whole time series.

Figure 3.154 1.A.4.b Residential, biomass: Emission trend and share for CH_4

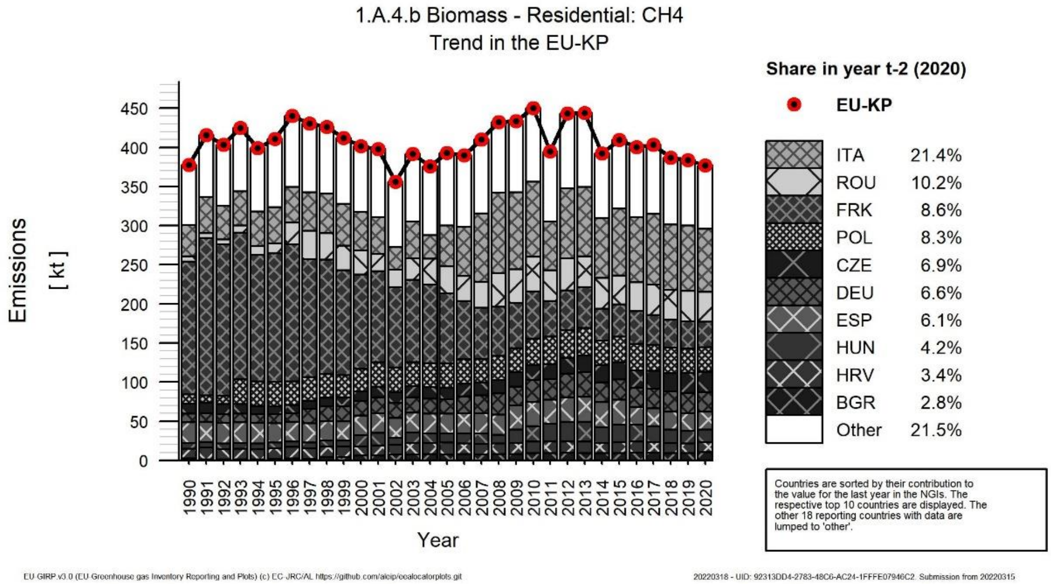
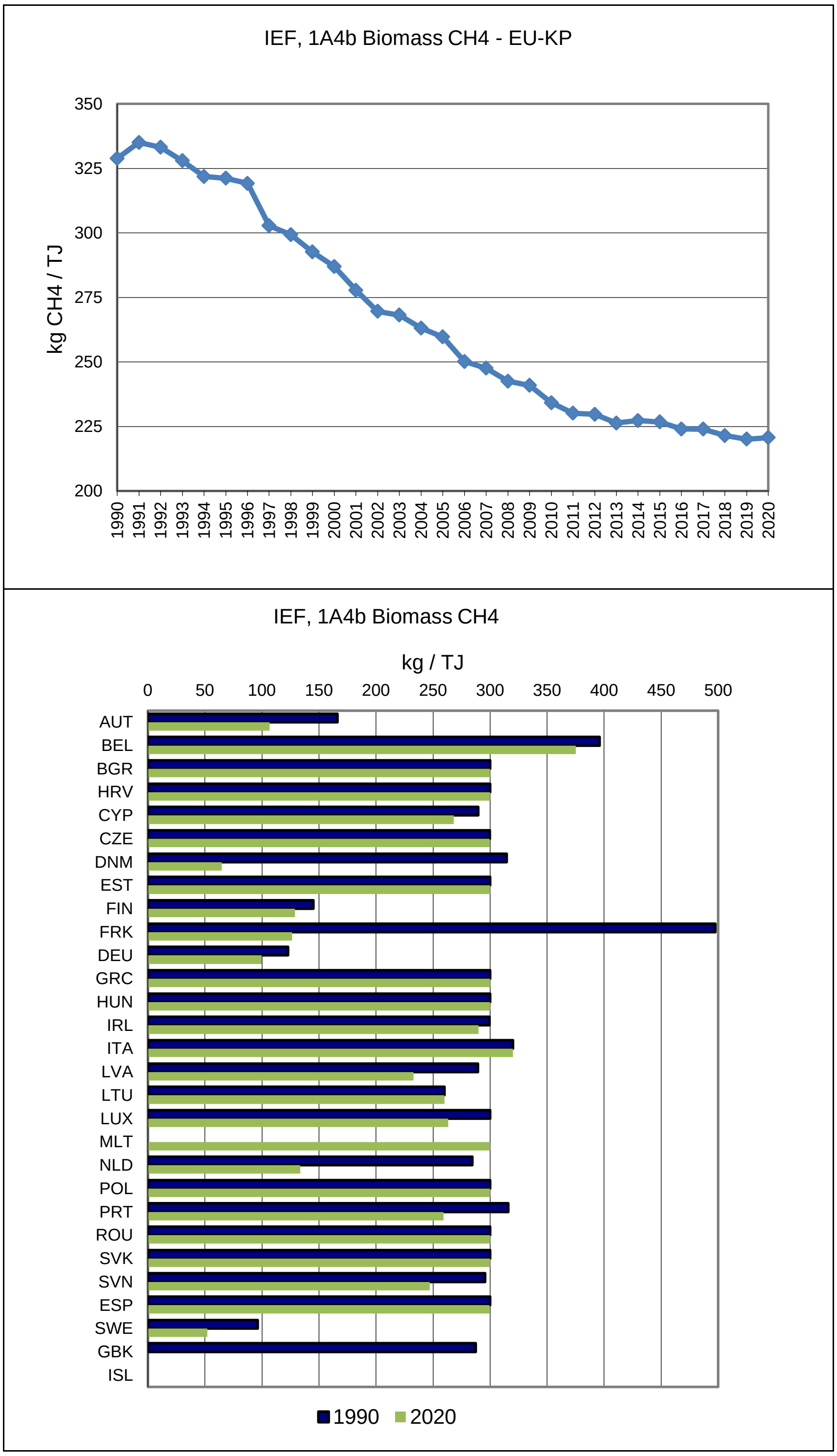


Figure 3.155 1.A.4.b Residential, biomass: Implied Emission Factors for CH_4 (in kg/TJ)



1.A.4.b Residential – Solid Fuels (CH_4)

In 2020, CH_4 from solid fuels had a share of 18% within source category on the total CH_4 emissions from 1.A.4.b (compared to 46% in 1990). Between 1990 and 2020 CH_4 emissions decreased by 75% (Table 3.97). All Member States reported decreasing emissions since 1990 with Germany and the United Kingdom showing the largest absolute decreases. Between 2019 and 2020 CH_4 emissions increased by 2%. According to the methodology as described in chapter 3.2.4, about 8% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.98: 1.A.4.b Residential, solid fuels: Member States' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	200	6	6	0.3%	-193	-97%	0.1	1%	T1	T1
Belgium	110	5	5	0.2%	-104	-95%	0	-7%	T1	T1
Bulgaria	207	32	31	1.4%	-176	-85%	-1	-3%	T1	T1
Croatia	33	1	1	0.03%	-33	-98%	-0.1	-14%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	-	-
Czechia	1 186	241	231	10.1%	-955	-81%	-11	-4%	T1	T1
Denmark	6	NO	NO	-	-6	-100%	-	-	-	-
Estonia	26	0	0	0.01%	-26	-99%	-0.07	-20%	-	-
Finland	3	0	0	0.001%	-3	-100%	-0.03	-73%	T1	T1
France	156	8	7	0.3%	-150	-96%	-1	-15%	-	-
Germany	2 168	93	85	3.7%	-2 084	-96%	-8	-9%	T2	T2
Greece	7	1	1	0.0%	-6	-86%	-0.2	-20%	T1	T1
Hungary	621	22	18	0.8%	-603	-97%	-4	-20%	T1	T1
Ireland	197	58	61	2.7%	-135	-69%	3	5%	T1	T1
Italy	10	NO	NO	-	-10	-100%	-	-	NA	NA
Latvia	48	1	0	0.0%	-48	-99%	-1	-72%	T1	T1
Lithuania	114	10	8	0.3%	-106	-93%	-2	-22%	T1	T1
Luxembourg	2.02	0.08	0.08	0.004%	-2	-96%	0.005	7%	T1	T1
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0.0078	0.0048	0.0013	0.0001%	-0.007	-84%	-0.004	-74%	T2	T2
Poland	2 168	1 563	1 638	71.5%	-530	-24%	75	5%	T1	T1
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	214	12	14	0.6%	-200	-94%	2	14%	T1	T1
Slovakia	339	19	18	0.8%	-320	-95%	-1	-5%	T1	T1
Slovenia	25	0	0	0.001%	-25	-100%	-0.001	-7%	T1	T1
Spain	116	24	17	0.7%	-99	-85%	-7	-29%	T2	T2
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	1 271	157	152	6.6%	-1 119	-88%	-6	-4%	T1,T2	T1,T2
EU-27+UK	**9 224**	**2 256**	**2 292**	**100%**	**-6 932**	**-75%**	**36**	**2%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 273	157	152	6.6%	-1 121	-88%	-6	-4%	T1,T2	T1,T2
EU-KP	**9 227**	**2 256**	**2 292**	**100%**	**-6 934**	**-75%**	**36**	**2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.154 and

Figure 3.155 show CH_4 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CH_4 emissions (above the average share calculated for EU-KP) correspond to Poland, Czechia and the United Kingdom with a share of 88% of total CH_4 emissions from solid fuels in 1.A.4.b. Solid fuel consumption in the EU-KP decreased by 78% between 1990 and 2020. The CH_4 implied emission factor for solid fuels was 297.91 kg/TJ in 2020.

Figure 3.156: 1.A.4.b Residential, solid fuels: Emission trend and share for CH_4

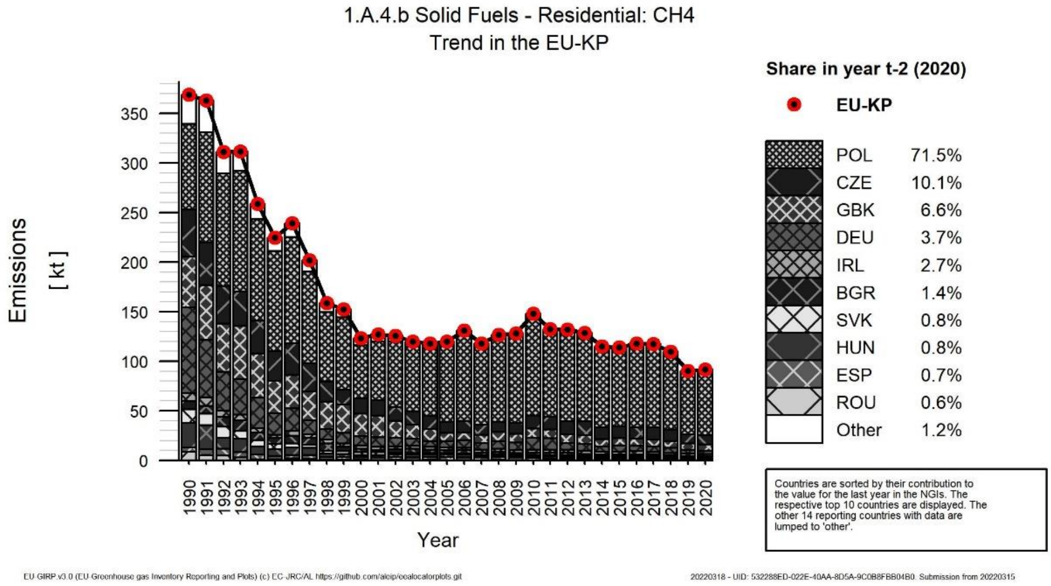
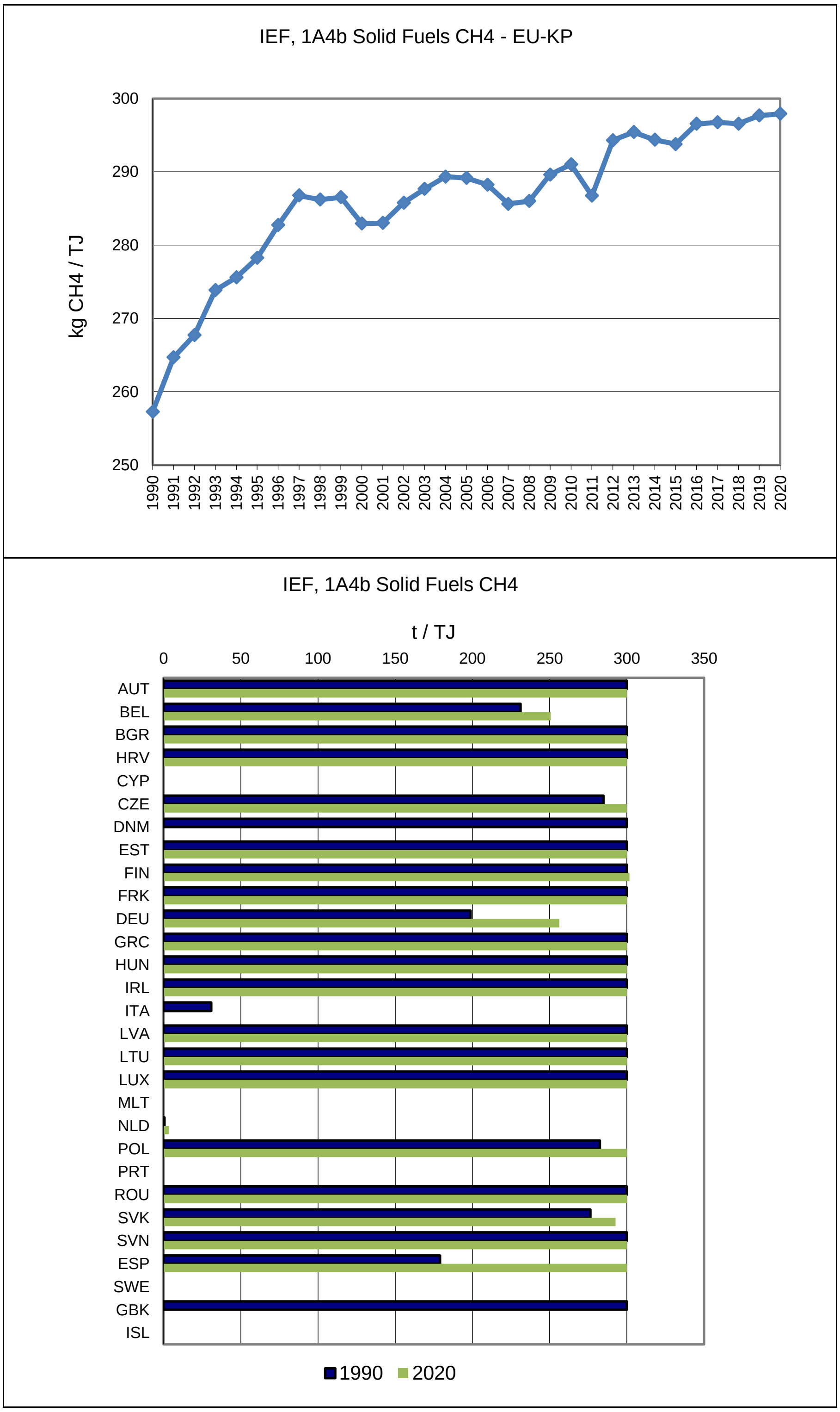


Table 3.99: 1.A.4.b Residential, solid fuels: Implied Emission Factors for CH_4 (in kg/TJ)

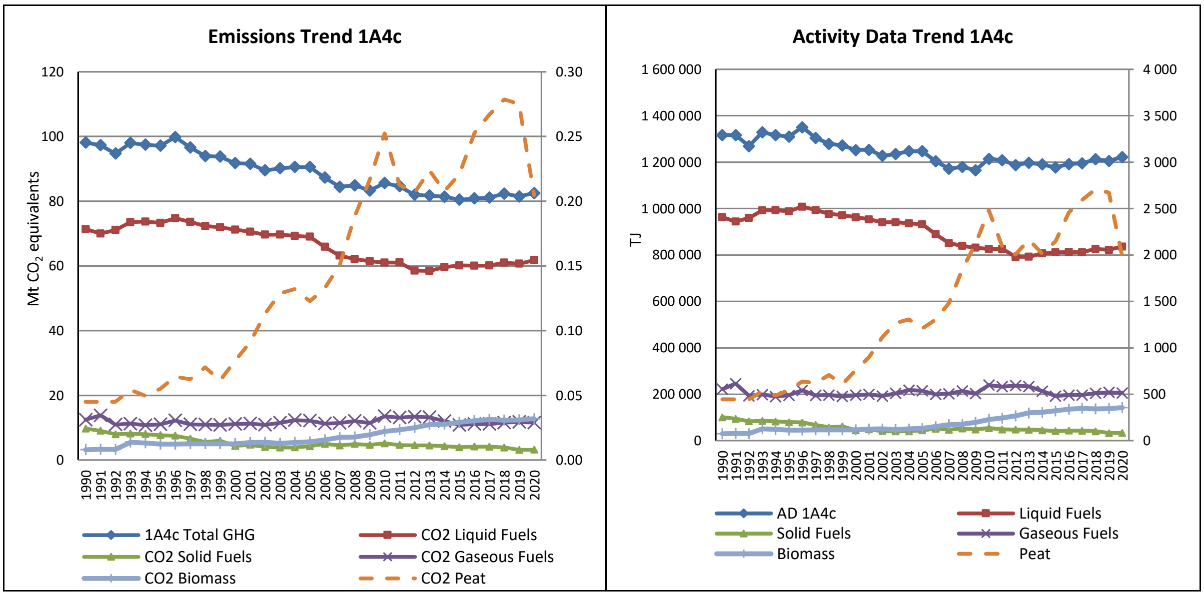


3.2.4.3 Agriculture/Forestry/Fisheries (1.A.4.c)

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1.A.4.c by fuels. CO_2 emissions from 1.A.4.c Agriculture/Forestry/Fisheries accounted for 2.8% of total EU-KP GHG emissions from 1.A Fuel Combustion in 2020. Between 1990 and 2020, CO_2 emissions from 1.A.4.c Agriculture/Forestry/Fisheries decreased by 18% in the EU-KP (Table 3.100).

Figure 3.157 shows the emission trend within source category 1.A.4.c, which is mainly dominated by CO_2 emissions from liquid fuels. Total GHG emissions decreased by 16% between 1990 and 2020, mainly due to decreases in CO_2 emissions from liquid fuels.

Figure 3.157 1.A.4.c Agriculture/Forestry/Fisheries: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Five Member States; Spain, Poland, France, the Netherlands and Italy together contributed 63% to the emissions from this source in 2020. Spain and Poland were the Member States with the highest increase in absolute terms between 1990 and 2020, while the highest decreases were achieved in Germany, Czechia and Greece.

Table 3.100 1.A.4.c Agriculture/Forestry/Fisheries: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 251	883	884	1.2%	-367	-29%	1	0%	IO,T1,T2,T3	CS,D,NO
Belgium	3 037	2 330	2 423	3.2%	-614	-20%	93	4%	CS,T1,T3	D
Bulgaria	1 649	446	422	0.5%	-1 228	-74%	-24	-5%	T1,T2	CS,D
Croatia	835	646	679	0.9%	-156	-19%	33	5%	T1	D
Cyprus	55	85	88	0.1%	33	59%	4	4%	T1	D
Czechia	3 672	1 250	1 224	1.6%	-2 448	-67%	-26	-2%	T1,T2	CS,D
Denmark	2 321	1 316	1 278	1.7%	-1 043	-45%	-38	-3%	M,T1,T2,T3	CS,D
Estonia	601	292	281	0.4%	-321	-53%	-12	-4%	T1,T2	CS,D
Finland	1 870	1 320	1 223	1.6%	-646	-35%	-97	-7%	T1,T2,T3	CS,D
France	11 217	9 851	10 379	13.5%	-838	-7%	527	5%	T1,T2	CS,D
Germany	10 178	5 824	6 027	7.8%	-4 151	-41%	203	3%	:S,T1,T2,T3	CS,D
Greece	2 893	450	703	0.9%	-2 189	-76%	253	56%	T1,T2	CS,D
Hungary	2 652	1 548	1 639	2.1%	-1 013	-38%	91	6%	T1,T2	CS,D
Ireland	747	611	595	0.8%	-153	-20%	-16	-3%	T1,T2	CS,D
Italy	8 352	7 029	7 065	9.2%	-1 287	-15%	36	1%	T2	CS
Latvia	1 585	466	482	0.6%	-1 103	-70%	15	3%	T1,T2	CS,D
Lithuania	1 483	215	219	0.3%	-1 264	-85%	5	2%	T2	CS
Luxembourg	34	23	22	0.0%	-12	-34%	0	-1%	T1,T2	CS,D
Malta	4	22	22	0.0%	18	452%	0	-1%	T1	D
Netherlands	9 836	9 083	8 900	11.6%	-936	-10%	-184	-2%	T1,T2	CS,D
Poland	8 504	10 617	10 694	13.9%	2 191	26%	77	1%	T1,T2	CS,D
Portugal	1 119	1 188	1 286	1.7%	167	15%	98	8%	NO,T1,T2	CS,D,NO
Romania	1 995	1 448	1 489	1.9%	-506	-25%	41	3%	T1,T2	CS,D
Slovakia	146	300	335	0.4%	189	129%	35	12%	T1,T2	CS
Slovenia	166	216	211	0.3%	45	27%	-5	-2%	T1	D
Spain	8 695	11 663	11 651	15.2%	2 956	34%	-12	0%	:R,T1,T2,T3	,CS,D,OTH
Sweden	1 797	1 155	1 122	1.5%	-675	-38%	-33	-3%	T1,T2	CS
United Kingdom	5 978	4 908	4 807	6.3%	-1 171	-20%	-100	-2%	T1,T2,T3	CS,D
EU-27+UK	**92 672**	**75 185**	**76 149**	**99%**	**-16 523**	**-18%**	**964**	**1%**	**-**	**-**
Iceland	753	531	529	0.688%	-224	-30%	-2	0%	T1,T2	CS,D
United Kingdom (KP)	6 164	5 112	4 968	6.5%	-1 196	-19%	-144	-3%	T1,T2,T3	CS,D
EU-KP	**93 611**	**75 920**	**76 838**	**100%**	**-16 773**	**-18%**	**919**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.c Agriculture/Forestry/Fisheries – Liquid Fuels (CO_2)

In 2020, CO_2 from liquid fuels had a share of 80% within source category 1.A.4.c (compared to 76% in 1990). Between 1990 and 2020 CO_2 decreased by 13% (Table 3.101. Eight Member States reported increasing emissions with the highest increases in absolute terms in Poland and Spain. Between 2019 and 2020 EU-KP emissions increased by 2%. According to the methodology as described in chapter 3.2.4 about 77% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.101 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	1 180	818	828	1.3%	-352	-30%	10	1%	T2	T2
Belgium	2 757	1 097	1 110	1.8%	-1 647	-60%	13	1%	T1	T1
Bulgaria	1 498	383	359	0.6%	-1 139	-76%	-24	-6%	T1	T1
Croatia	788	594	620	1.0%	-168	-21%	26	4.4%	T1	T1
Cyprus	55	85	88	0.1%	33	59%	4	4%	T1	T1
Czechia	1 536	1 074	1 066	1.7%	-470	-31%	-8	-1%	T1	T1
Denmark	1 957	1 205	1 184	1.9%	-773	-40%	-21	-2%	-	-
Estonia	574	282	272	0.4%	-302	-53%	-10	-3%	T1,T2	T1,T2
Finland	1 784	1 102	1 082	1.8%	-702	-39%	-20	-2%	T1	T1
France	10 895	9 376	9 900	16.0%	-995	-9%	524	5.6%	T1,T2	T1,T2
Germany	6 834	5 249	5 429	8.8%	-1 406	-21%	179	3%	CS	CS
Greece	2 882	448	697	1.1%	-2 184	-76%	250	56%	T2	T2
Hungary	2 085	1 239	1 283	2.1%	-801	-38%	44	4%	T1	T1
Ireland	747	611	595	1.0%	-153	-20%	-16	-3%	T1,T2	T1,T2
Italy	8 300	6 686	6 735	10.9%	-1 565	-19%	49	1%	T2	T2
Latvia	701	440	459	0.7%	-242	-35%	18	4%	T2	T2
Lithuania	1 173	157	167	0.3%	-1 006	-86%	10	6%	T2	T2
Luxembourg	34	23	22	0.04%	-12	-34%	-0.3	-1.3%	NA	NA
Malta	4	22	22	0.04%	18	452%	0	-1%	T1	T1
Netherlands	2 507	1 680	1 723	2.8%	-784	-31%	42	3%	T1,T2	T1,T2
Poland	4 724	7 618	7 605	12.3%	2 882	61%	-13	0%	T1,T2	T1,T2
Portugal	1 119	1 157	1 251	2.0%	132	12%	94	8%	T1	T1
Romania	9	1 076	1 108	1.8%	1 099	11725%	32	3%	T1,T2	T1,T2
Slovakia	104	241	247	0.4%	143	137%	7	3%	T2	T2
Slovenia	166	216	211	0.3%	45	27%	-5	-2%	NA	NA
Spain	8 652	11 201	11 302	18.3%	2 650	31%	100	0.9%	T2,T3	T2,T3
Sweden	1 607	1 138	1 107	1.8%	-500	-31%	-31	-3%	T1	T1
United Kingdom	5 747	4 707	4 614	7.5%	-1 133	-20%	-93	-2%	T2	T2
EU-27+UK	**70 420**	**59 926**	**61 087**	**99%**	**-9 333**	**-13%**	**1 161**	**2%**		
Iceland	753	531	529	0.9%	-224	-30%	-2	0%	T1	T1
United Kingdom (KP)	5 933	4 911	4 774	7.7%	-1 158	-20%	-136	-3%	T2	T2
EU-KP	**71 359**	**60 660**	**61 776**	**100%**	**-9 583**	**-13%**	**1 116**	**2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.158 and

Figure 3.159 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to Spain, France, Poland, Italy, Germany and the United Kingdom; together they cause 74% of the CO_2 emissions from liquid fuels in 1.A.4.c. Fuel consumption in the EU-KP decreased by 13% between 1990 and 2020. The CO_2 implied emission factor for liquid fuels was 73.84 t/TJ in 2020.

Figure 3.158 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Emission trend and share for CO_2

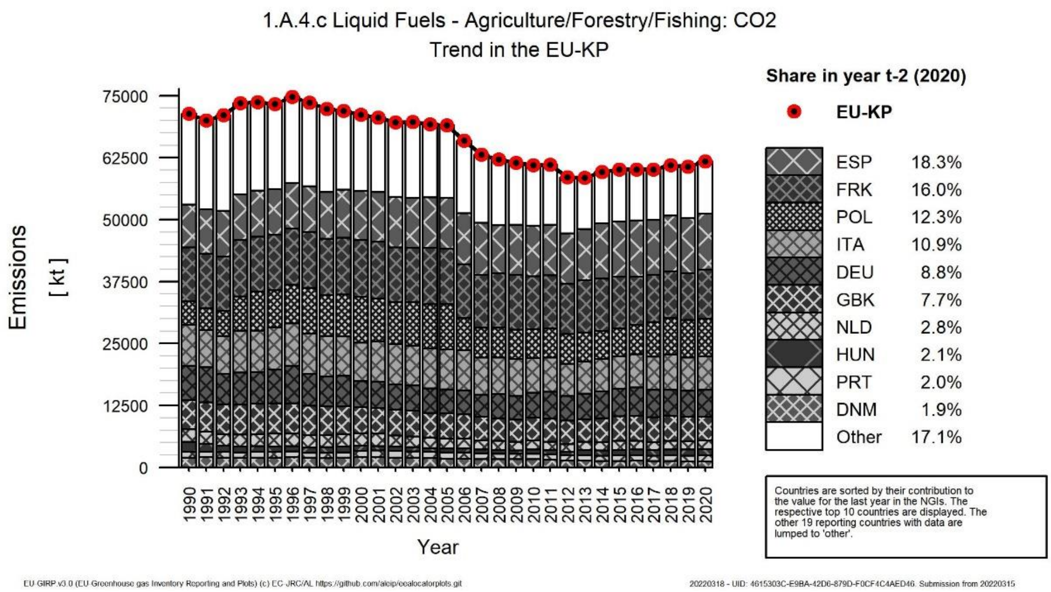
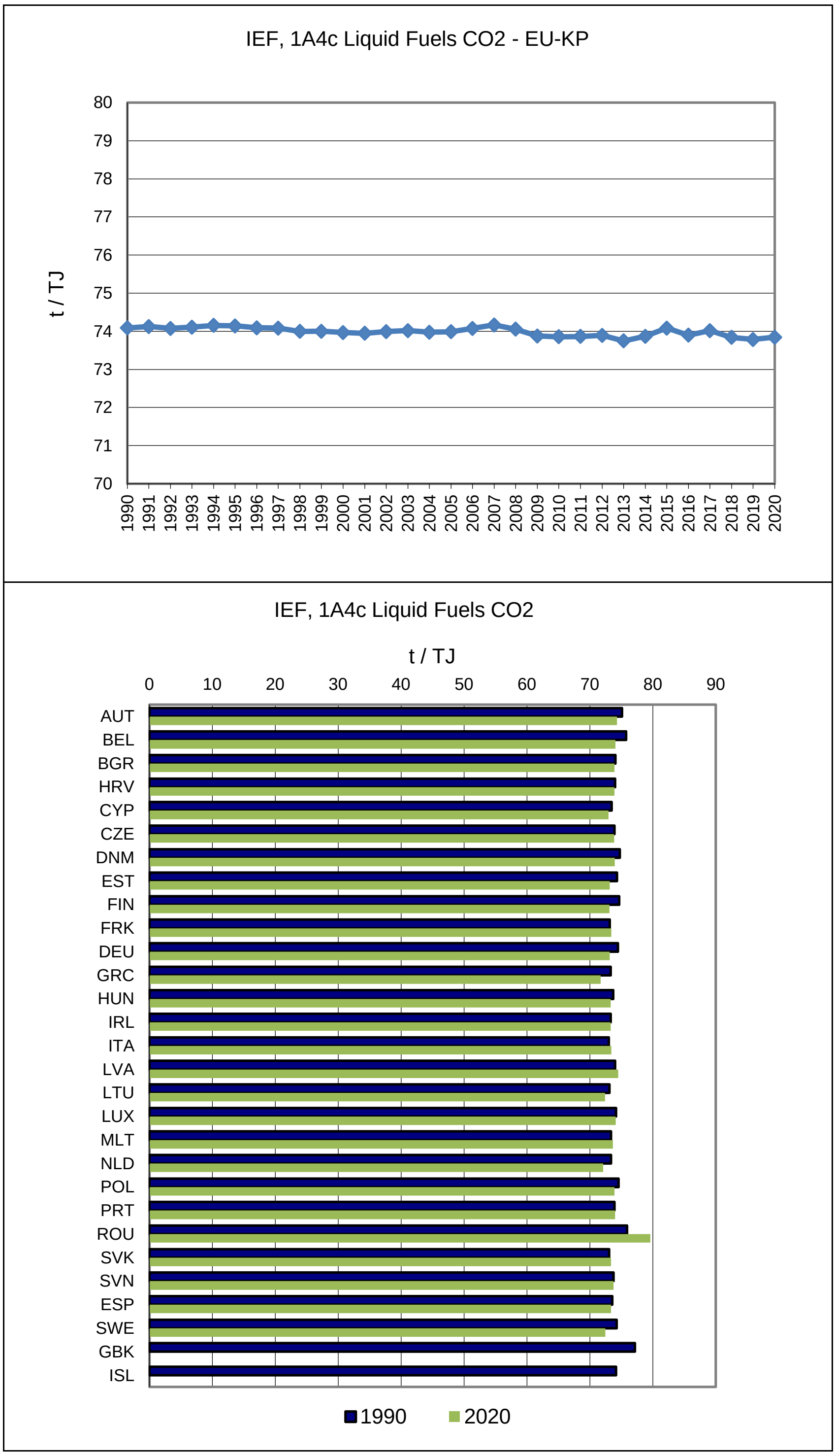


Figure 3.159 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.c Agriculture/Forestry/Fisheries – Solid Fuels (CO_2)

In 2020 CO_2 from solid fuels had a share of 4% within source category 1.A.4.c (compared to 10% in 1990). Between 1990 and 2020, CO_2 decreased by 67% (Table 3.102). Fourteen Member States, Iceland and the United Kingdom reported CO_2 emissions from this source category as 'Not occurring' in 2020. All Member States except Slovakia and Romania reported decreasing emissions between 1990 and

2020. Between 2019 and 2020, EU-KP emissions increased by 2%. The decrease in 1990 to 1992 emissions is due to the strong decrease reported by Germany (which had 29% share on 1990 emissions). According to the methodology as described in chapter 3.2.4 97% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.102 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	51	2	2	0.06%	-49	-96%	0	21%	T2	T2
Belgium	212	52	52	1.6%	-160	-76%	0	0%	T1	T1
Bulgaria	151	39	37	1.2%	-114	-75%	-2	-5%	T1,T2	T1,T2
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 730	24	20	0.6%	-1 710	-99%	-3	-14%	T2	T2
Denmark	237	21	12	0.4%	-225	-95%	-9	-42%	-	-
Estonia	22	1	1	0.02%	-21	-97%	-1	-52%	T1,T2	T1,T2
Finland	13	8	7	0.2%	-6	-47%	-1	-10%	T3	T3
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	2 861	1	NO	-	-2 861	-100%	-1	-100%	NA	NA
Greece	11	3	6	0.2%	-5	-46%	3.0	101%	T2	T2
Hungary	134	6	6	0.2%	-128	-96%	0	1%	T1,T2	T1,T2
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	99	NO	NO	-	-99	-100%	-	-	NA	NA
Lithuania	148	7	5	0.1%	-143	-97%	-2	-35%	T2	T2
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	3 755	2 913	2 989	93.1%	-766	-20%	76	3%	T1,T2	T1,T2
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	65	65	73	2.3%	7	11%	7	11%	T1,T2	T1,T2
Slovakia	1	2	1	0.0%	0	2%	-0.5	-27%	T2	T2
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	37	NO	NO	-	-37	-100%	-	-	NA	NA
Sweden	157	NO	NO	-	-157	-100%	-	-	NA	NA
United Kingdom	50	NO	NO	-	-50	-100%	-	-	NA	NA
EU-27+UK	**9 735**	**3 143**	**3 211**	**100%**	**-6 524**	**-67%**	**67**	**2%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	50	NO	NO	-	-50	-100%	-	-	NA	NA
EU-KP	**9 735**	**3 143**	**3 211**	**100%**	**-6 524**	**-67%**	**67**	**2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.160 and Figure **3.161** show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. Poland contributes to 93% of EU-KP emissions in 2020. Fuel consumption in the EU-KP decreased by 67% between 1990 and 2020. The CO_2 implied emission factor for solid fuels was 94.67 t/TJ in 2020.

Figure 3.160 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Emission trend and share for CO_2

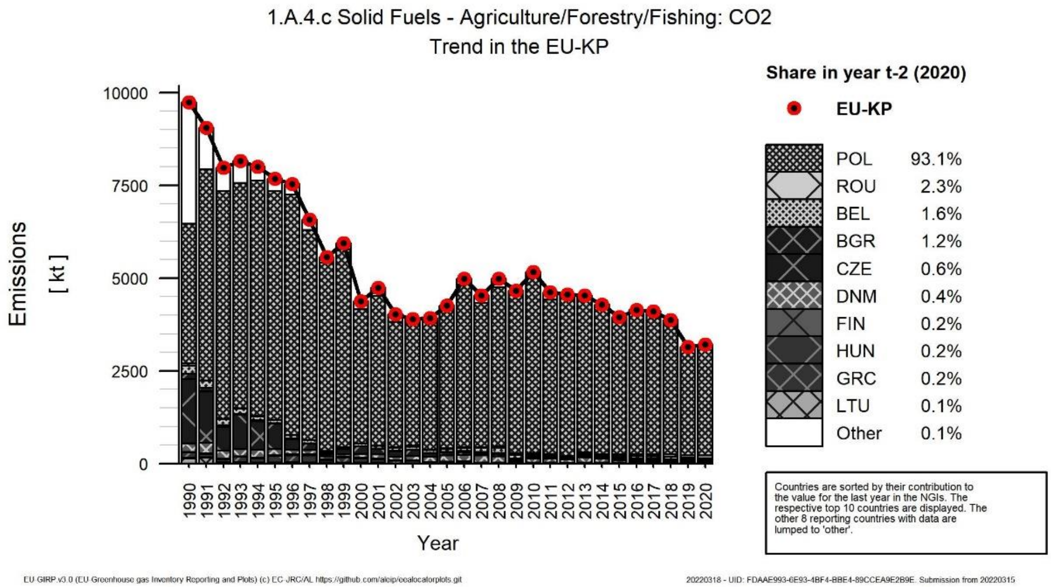
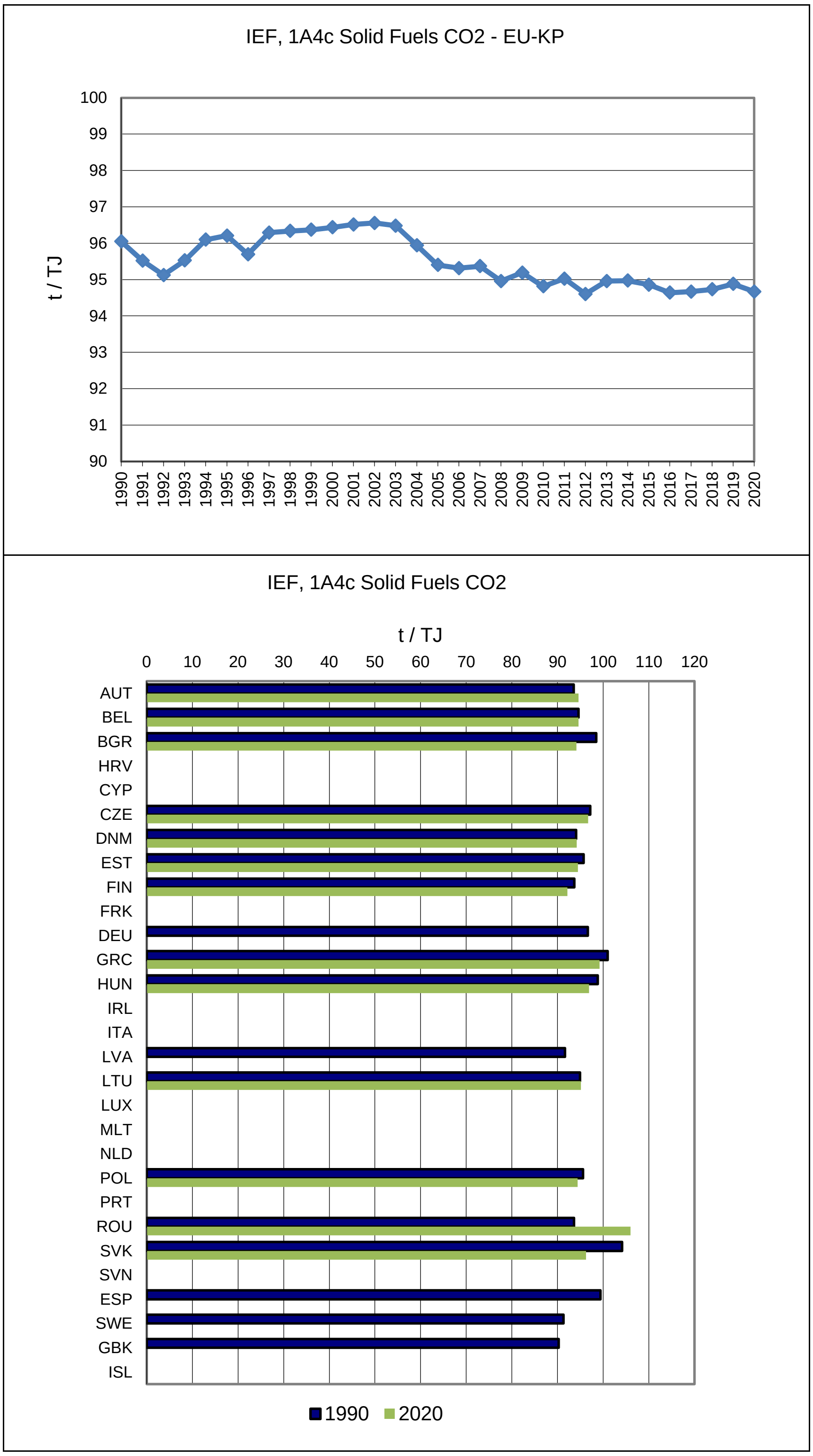


Figure 3.161 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.c Agriculture/Forestry/Fisheries –Gaseous Fuels (CO_2)

In 2020, CO_2 from gaseous fuels had a share of 15% within source category 1.A.4.c (compared to 13% in 1990). Between 1990 and 2020 CO_2 emissions decreased by 7% (Table 3.103). The highest absolute increase occurred in Belgium. Between 2019 and 2020, EU-KP emissions decreased by 2%. This source of emissions is dominated by the Netherlands where natural gas is used for greenhouse horticulture.

According to the methodology as described in chapter 3.2.4 about 88% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.103 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	20	61	51	0.4%	31	153%	-9	-16%	T2	T2
Belgium	67	1 181	1 261	10.9%	1 194	1769%	80	7%	T1	T1
Bulgaria	0	23	26	0.2%	25	12760%	2	11%	T2	T2
Croatia	48	52	59	0.5%	11	24%	7	14%	T1	T1
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	405	152	138	1.2%	-268	-66%	-14	-9%	T2	T2
Denmark	126	91	82	0.7%	-44	-35%	-9	-10%	-	-
Estonia	4	9	8	0.1%	5	125%	-1	-12%	T2	T2
Finland	32	2	2	0.0%	-30	-93%	0	0%	T2	T2
France	321	445	443	3.8%	122	38%	-1	0%	T1,T2	T1,T2
Germany	483	562	580	5.0%	98	20%	19	3%	CS	CS
Greece	IE,NO	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Hungary	433	303	350	3.0%	-83	-19%	46	15%	T2	T2
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	52	343	330	2.8%	278	534%	-13	-4%	T2	T2
Latvia	782	25	23	0.2%	-760	-97%	-3	-11%	T2	T2
Lithuania	162	48	47	0.4%	-115	-71%	-1	-2%	T2	T2
Luxembourg	NO	0	0	0.0%	0	∞	0	4%	T2	T2
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	7 329	7 399	7 174	61.9%	-155	-2%	-226	-3%	T1,T2	T1,T2
Poland	25	86	100	0.9%	75	304%	14	16%	T2	T2
Portugal	NO	30	34	0.3%	34	∞	4	13%	T2	T2
Romania	1 920	241	236	2.0%	-1 685	-88%	-6	-2%	T2	T2
Slovakia	41	58	86	0.7%	46	112%	29	50%	T2	T2
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	6	462	349	3.0%	343	5563%	-113	-24%	T2	T2
Sweden	33	12	11	0.1%	-22	-67%	-1	-10%	T1	T1
United Kingdom	182	201	193	1.7%	12	7%	-8	-4%	T2	T2
EU-27+UK	**12 472**	**11 787**	**11 582**	**100%**	**-890**	**-7%**	**-204**	**-2%**		
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	182	201	193	1.7%	12	7%	-8	-4%	T2	T2
EU-KP	**12 472**	**11 787**	**11 582**	**100%**	**-890**	**-7%**	**-204**	**-2%**		

Abbreviations explained in the Chapter 'Units and abbreviations'.
Greece reports emissions from stationary combustion and off road machinery as 'NO' and emissions from fishing as 'IE.'

Figure 3.162 and

Figure 3.163 show CO_2 emissions and implied emission factors for EU-KP as well as the share of the Member States with the highest contributions. It can be seen that the highest shares on total CO_2 emissions (above the average share calculated for EU-KP) correspond to the Netherlands, Belgium and Germany accounting for 78% of the CO_2 emissions from gaseous fuels in 1.A.4.c. Fuel consumption in the EU-KP decreased by 7% between 1990 and 2020. The CO_2 implied emission factor for gaseous fuels was 56.32 t/TJ in 2020. The strong decrease of IEF in 1998 is caused by a decrease of Belgium's IEF.

Figure 3.162 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Emission trend and share for CO_2

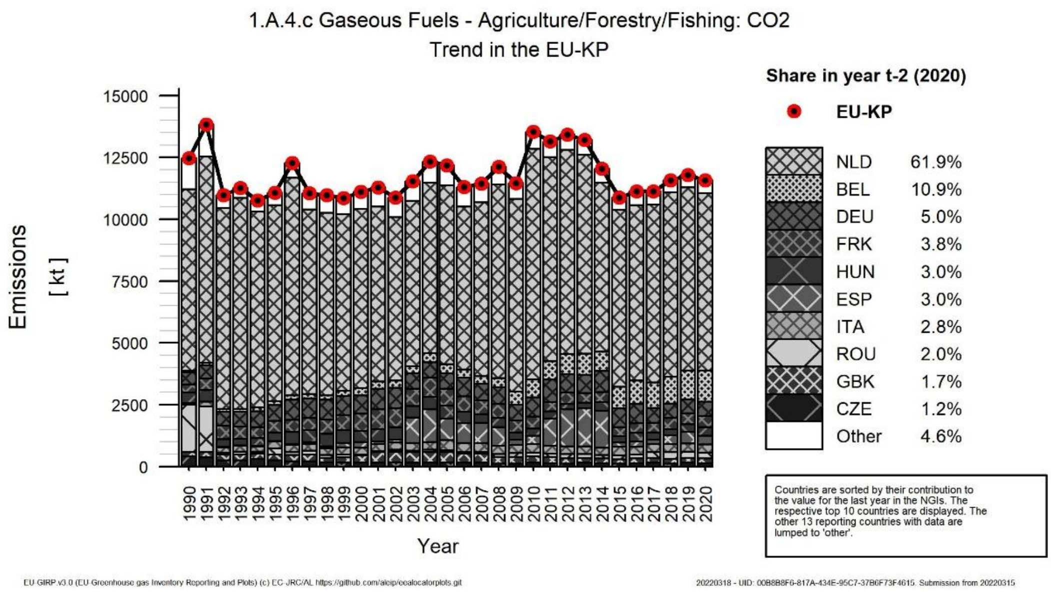
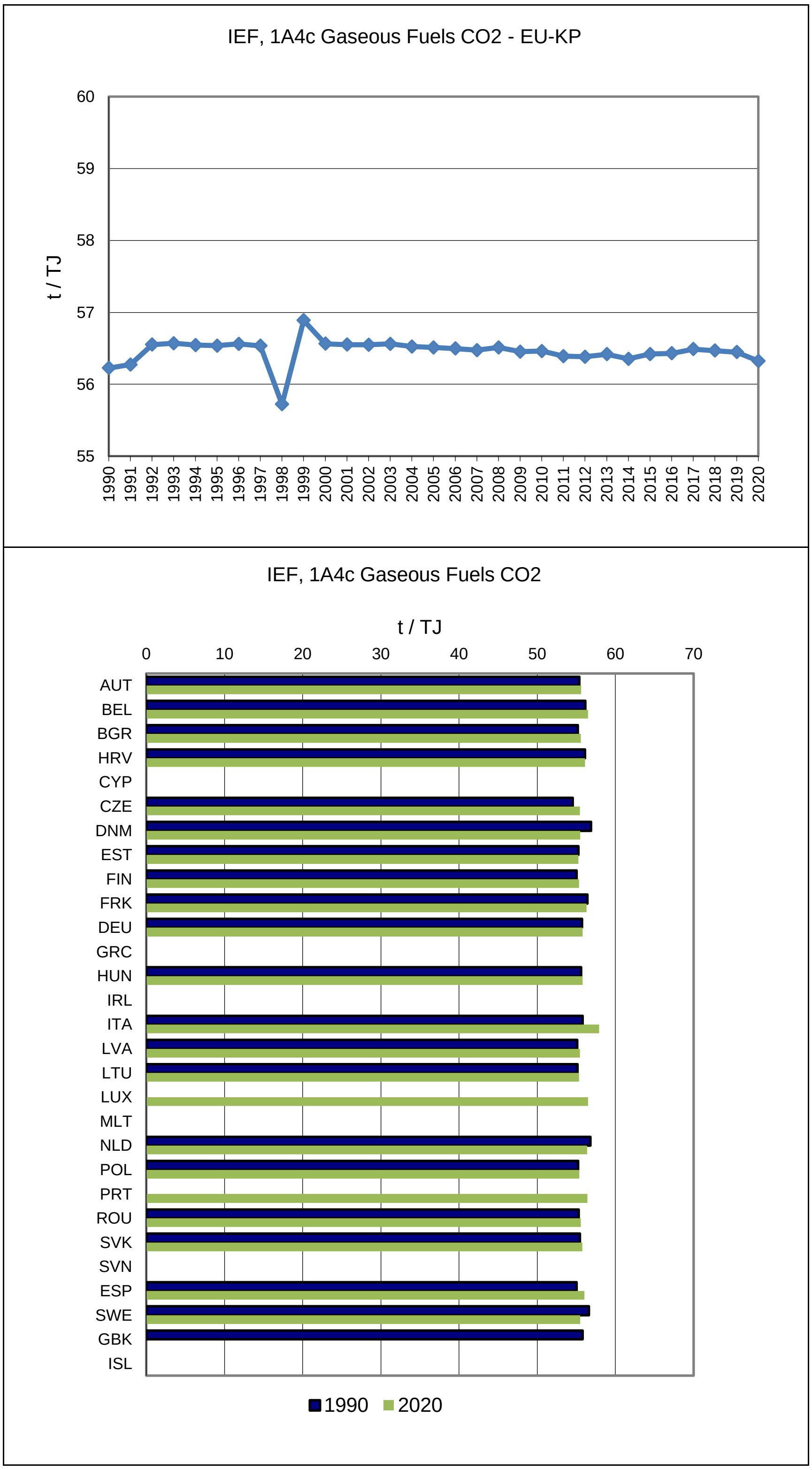


Figure 3.163 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



3.2.5 Other (CRF Source Category 1.A.5.)

Source category 1.A.5. Other includes emissions from stationary and mobile military fuel use including aircraft. In 2020, category 1.A.5 contributed to 7 800 kt CO_2 equivalents of which 98.9% is CO_2, 0.2% CH_4 and 0.9% N_2O.

Table 3.104: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 1.A.5. (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
1.A.5.a Other Other Sectors: Solid Fuels (CO_2)	5941	5	T	0	0	100%
1.A.5.b Other Other Sectors: Liquid Fuels (CO_2)	13368	4160	T	L	0	83%

Table 3.105 provides an overview of Member States' source allocation to Source Category 1.A.5 Other as reported in CRF Table1.A(a)s4.

Table 3.105 1.A.5. Other: Member States' allocation of sources

Member State	Source allocation to 1.A.5 Other
Austria	Stationary: Emissions are 'Not occurring' Mobile: Military use
Belgium	Stationary: Emissions are 'Not occurring' Mobile: Military use
Bulgaria	Stationary: Emissions are 'Not occurring' Mobile: Military aviation
Croatia	Stationary: Emissions are 'Not occurring' Mobile: Emissions are 'Not occurring' or 'Included elsewhere' (emissions from military aviation component and military water-borne component are reported under 1.A.3.b)
Cyprus	Stationary: Emissions reported from Liquid Fuels Mobile: aviation component
Czechia	Stationary: Emissions are 'Not occurring' Mobile: Other mobile sources not included elsewhere, Agriculture and Forestry and Fishing (emissions from aviation besides the public air transport, it is consumption of aviation fuels in the army in the state institutions (aerial vehicles from Integrated rescue system), or private air transport)
Denmark	Stationary: Emissions are 'Not occurring' Mobile: Military use, Recreational crafts
Estonia	Emissions are 'Not occurring'
Finland	Stationary: Includes emissions from non-specified consumption of fuels, military use and statistical corrections of fuel consumption Mobile: Emissions are 'Not occurring' or 'Included elsewhere' (emissions and fuel consumptions of all fuels from category 1A5b is reported in 1A5a due to confidentiality)
France	Stationary: Other non specified Mobile: Emissions are 'Not occurring' or 'Included elsewhere' (under 1.A.5.a)
Germany	Stationary: Military use Mobile: Military use
Greece	Stationary: Emissions are 'Not occurring' Mobile: Other (not specified elsewhere)
Hungary	Stationary: Military use – Emissions from Gaseous Fuels Mobile: Military use – Emissions from Liquid Fuels
Ireland	Stationary: Emissions are 'Included elsewhere' (under 1.A.4.a) Mobile: Emissions are 'Included elsewhere' (under 1.A.3)
Iceland	Stationary: Other (not specified elsewhere) Mobile: Emissions are 'Not occurring'
Italy	Stationary: Emissions are 'Not occurring' Mobile: Military use
Latvia	Stationary: Emissions are 'Not occurring' Mobile: Aviation gasoline, diesel oil and jet kerosene, used in aircrafts and ships
Lithuania	Stationary: Emissions are 'Not occurring' Mobile: Military use
Luxembourg	Stationary: Building and Plant Site Fuel Powered Machinery. Emissions are reported for 1990-2003 and 'Not occurring' from 2004 on. Mobile: Military Vehicles
Malta	Stationary: Emissions are 'Not occurring' Mobile: Military use
Netherlands	Stationary: Emissions are 'Not occurring' Mobile: military use
Poland	Stationary: Emissions are 'Included elsewhere' (without specification of allocation) Mobile: Emissions are 'Not occurring'
Portugal	Stationary: Emissions are 'Not occurring' Mobile: Military aviation
Romania	Stationary: Other sectors - Not elsewhere specified Mobile: Emissions are 'Included elsewhere' (under 1.A.5.a)
Slovakia	Stationary: Other, emissions from fuel combustion in stationary sources that are not specified elsewhere Mobile: Military use Jet Kerosene, Gasoline, Diesel Oil

Member State	Source allocation to 1.A.5 Other
Slovenia	Stationary: Emissions are ‘Not occurring’ Mobile: Military use
Spain	Stationary: Emissions are ‘Not occurring’ or ‘Included elsewhere’ (Included in 1.A.4.a.i - Military reference activity data are not separated from civil data, and their emissions are estimated together with the same methodology) Mobile: Military use
Sweden	Stationary: Emissions are ‘Not occurring’ Mobile: Emissions are ‘Included elsewhere’
United Kingdom	Stationary: Emissions are ‘Included elsewhere’ (Stationary combustion for military purposes is not reported separately in UK energy statistics and is allocated under 1.A.4.a.) Mobile: Military aviation and naval shipping

Figure 3.164 shows the total trend within source category 1.A.5 and the dominating emission sources: CO_2 emissions from 1.A.5.b Mobile and from 1.A.5.a Stationary. Total GHG emissions of source category 1.A.5 decreased by 71% between 1990 and 2020. Germany has the biggest influence on the overall trend; it reports minus 94% of CO_2 emissions since 1990 and contributes to 44% in 1990. The German NIR states that only military sources (incl. aircraft) are included in its inventory. From 1996 to 2014 the United Kingdom has had a main share. Since 2014, the two main contributors are the United Kingdom along with France; contributing together 37% of CO_2 emissions in 2020. The United Kingdom reports military aircraft and naval shipping within this category. France includes in this category other non-specified sources from its national energy balance.

Figure 3.164 1.A.5 Other: Total and CO_2 emission and activity trends

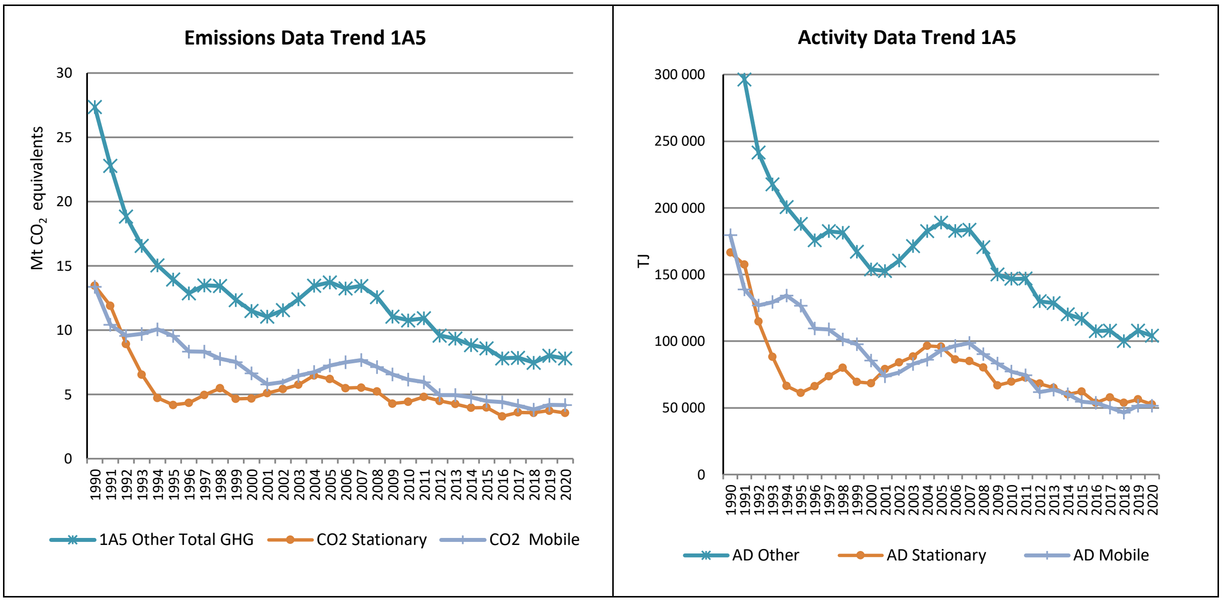


Table 3.106 shows total GHG and CO_2 emissions by Member State from 1.A.5. CO_2 emissions from 1.A.5 Other accounted for 0.2% of total EU-KP GHG emissions in 1.A in 2020. Between 1990 and 2020, CO_2 emissions from this source decreased by 71% in the EU-KP. Between 1990 and 2020, the largest reduction in absolute terms was reported by Germany, which was partly due to reduced military operations after German reunification.

Table 3.106 1.A.5. Other: Member States' contributions to CO_2 emissions

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt	
	1990	2020	1990	2020
Austria	36	34	35	33
Belgium	174	105	172	104
Bulgaria	86	13	86	13
Croatia	IE,NO	IE,NO	NO,IE	NO,IE
Cyprus	11	27	11	26
Czechia	194	323	192	312
Denmark	171	246	167	243
Estonia	NO	NO	NO	NO
Finland	1 139	949	1 126	940
France	4 502	1 487	4 464	1 476
Germany	12 093	748	11 753	743
Greece	IE,NO	298	NO,IE	296
Hungary	15	69	15	68
Ireland	IE	IE	IE	IE
Italy	1 143	642	1 071	625
Latvia	NE,NO	15	NO,NE	15
Lithuania	0	28	0	28
Luxembourg	3	0	3	0
Malta	1	4	1	4
Netherlands	320	164	314	161
Poland	IE,NO	IE,NO	NO,IE	NO,IE
Portugal	97	67	96	66
Romania	1 217	650	1 208	648
Slovakia	479	69	476	68
Slovenia	32	3	32	3
Spain	301	439	298	435
Sweden	IE,NO	IE,NO	NO,IE	NO,IE
United Kingdom	5 353	1 420	5 293	1 404
EU-27+UK	**27 367**	**7 800**	**26 814**	**7 713**
Iceland	0	0	0	0
United Kingdom (KP)	5 353	1 420	5 293	1 404
EU-KP	**27 367**	**7 800**	**26 814**	**7 714**

Croatia reports that 'military aviation component and military water-borne component' are included in 1.A.3.b.
Ireland reports that emissions of military use stationary combustion are included in 1.A.4.a and that emissions from 1.A.5.b military are included in 1.A.3
Poland reports emissions from stationary combustion as 'IE' without specification of the allocation.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 3.107 provides information on the contribution of Member States to EU27+UK recalculations in CO_2 from 1.A.5 Other for 1990 and 2019 and main explanations for the largest recalculations in absolute terms.

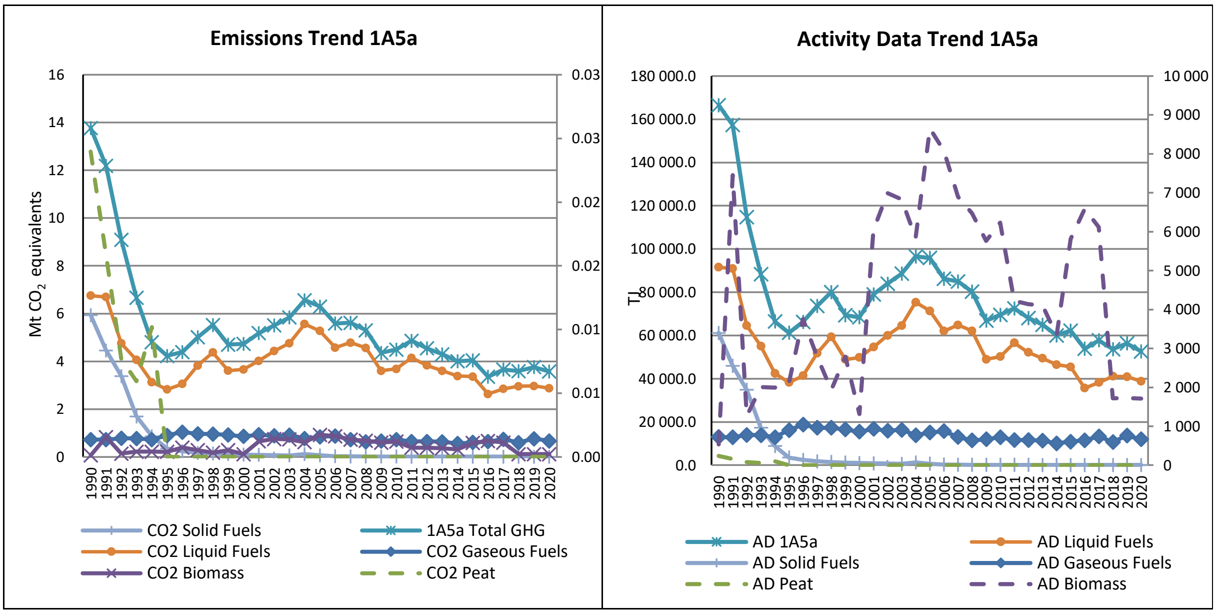
Table 3.1071.A.5 Other: Contribution of MS to EU-KP recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	-17	-34		Data on kerosene consumption was re-evaluated.
Belgium	0.0	0.0	-7.8	-7.5		in Flemish region: no difference in emissions/in Walloon region: -7.5 kt due to the update of the energy balance
Bulgaria	-	-	-	-		
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	-0.0	-0.0		
Denmark	0.0	0.0	0.1	0.1	Updated emission factors derived from the road transport model in the case of military equipment for all years have caused small emission changes from 1985-2019.	
Estonia	-	-	-	-		
Finland	-4.3	-0.4	-161	-14	Updated time series of LPG (-7 kt in 1990).	1.A.5/Liquid: part of LPG use allocated to agricultural buildings, total use of heavy fuel oil and LPG updated in 2019.
France	-	-	-0.2	-0.0		Marginal correction of the proportion of biomethane injected into the network with minor modifications.
Germany	-45	-0.4	-29	-3.2	Correction of the calorific value of petrol fuels, (1.A.5.b)	
Greece	-	-	-	-		
Hungary	-	-	-	-		
Ireland	-	-	-	-		
Italy	-	-	-	-		
Latvia	-	-	-	-		
Lithuania	-	-	-	-		
Luxembourg	0.0	0.0	-0.0	-0.0		AD changes due to small revisions of energy balance, change of country-specific CO_2 emission factors for liquid fuels,
Malta	-1.4	-55	2.0	129	updates in methodology and activity data	
Netherlands	-	-	-	-		
Poland	-	-	-	-		
Portugal	-	-	-	-		
Romania	-3.6	-0.3	-	-	Updated the CO_2 emission factors.	
Slovakia	-	-	-	-		
Slovenia	-	-	-	-		
Spain	0.1	0.0	-0.2	-0.1	The emission series of military road traffic activity have been updated as a consequence of the update of activity 1A3b	
Sweden	-845	-100	-181	-100.0	Reallocation	
United Kingdom	-	-	3.2	0.2		Minor (<0.1%) recalculations to emission factors.
EU27+UK	-899	-3.2	-391	-4.7		
Iceland	-	-	-	-		
United Kingdom (KP)	-	-	3.2	0.2		See above.
EU-KP	-899	-3.2	-391	-4.7		

3.2.5.1 Stationary (1.A.5.a)

In this chapter information about emission trends, Member States' contribution, activity data, and emission factors is provided for category 1.A.5.a by fuels. CO_2 emissions from 1.A.5.a Stationary accounted for 0.1% of total GHG emissions in 1.A in 2020. Figure 3.165 shows the emission trend within the categories 1.A.5.a, which is mainly dominated by CO_2 emissions from solid and liquid fuels for 1990 to 1993 and dominated by liquid fuels from 1994 on. The reduction in the early 1990s was driven by CO_2 from solid fuels. Total emissions decreased by 74%, mainly due to decreases in emissions from solid fuels (-99.9%) and liquid fuels (-57%).

Figure 3.165 1.A.5.a Stationary: Total and CO_2 emission and activity trends



Data displayed as dashed line refers to the secondary axis.

Only seven Member States and Iceland reported emissions from this key source in 2020 (Table 3.108). Luxembourg reported emissions for 1990 - 2003. Hungary reports emissions since 2015. Between 1990 and 2020, Germany reported the highest absolute decrease which also affected overall decreasing trend. Between 2019 and 2020 CO_2 emissions decreased by 5%.

Table 3.108 1.A.5.a Stationary: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	11	22	22	0.6%	11	98%	0	0%	T1	D
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 126	955	940	26.4%	-187	-17%	-16	-2%	T2	CS
France	4 464	1 608	1 476	41.6%	-2 988	-67%	-132	-8%	NA	NA
Germany	6 227	409	373	10.5%	-5 854	-94%	-37	-9%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	IE	39	37	1.0%	37	∞	-3	-6%	T2	CS
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	3	NO	NO	-	-3	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	IE	IE	IE	-	-	-	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	1 208	628	648	18.2%	-560	-46%	20	3%	T1,T2	CS,D
Slovakia	406	72	57	1.6%	-348	-86%	-14	-20%	T2	CS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	IE	IE	IE	-	-	-	-	-	NA	NA
EU-27+UK	**13 446**	**3 734**	**3 553**	**100%**	**-9 893**	**-74%**	**-181**	**-5%**	**-**	**-**
Iceland	0	2	0	0.010%	0	196%	-1	-79%	T1	D
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-	NA	NA
EU-KP	**13 446**	**3 736**	**3 553**	**100%**	**-9 893**	**-74%**	**-183**	**-5%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Spain reports, that military reference activity data are not separated from civil data and that those emissions are estimated together in 1.A.4.a.i by applying the same methodology.
The United Kingdom reports, that stationary combustion for military purposes is not reported separately in UK energy statistics and that it is allocated under 1.A.4.a.
Ireland reports that emissions of military use stationary combustion are included in 1.A.4.a.
Poland reports the emissions under category 1.A.4.c.

1.A.5.a Stationary – Solid Fuels (CO_2)

In 2020 CO_2 from solid fuels had a share of 0.1% within source category 1.A.5.a (compared to 44% in 1990). Between 1990 and 2020, CO_2 emissions decreased by nearly 100% (Table 3.109). In 2020, only Germany and Slovakia reported emissions for this key category. The main reason for the strong decline of emissions in the early 1990s was the closure of military barracks after the German reunification and the phase out of coal use for combustion in buildings.

Ireland reports that emissions of military use stationary combustion are included in 1.A.4.a. Spain reports, that military reference activity data are not separated from civil data and that those emissions are estimated together in 1.A.4.a.i by applying the same methodology. The United Kingdom reports, that stationary combustion for military purposes is not reported separately in UK energy statistics and that it is allocated under 1.A.4.a.

According to the methodology as described in chapter 3.2.1 100% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.109 1.A.5.a Stationary, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	NO	NO	NO	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	1	NO	NO	-	-1	-100%	-	-
France	NO	NO	NO	-	-	-	-	-
Germany	4 553	4	4	70.5%	-4 550	-100%	0	-11%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	-	-	-	-	-	-	-	-
Ireland	IE	IE	IE	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	IE	IE	IE	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	1 171	NO	NO	-	-1 171	-100%	-	-
Slovakia	216	2	1	29.5%	-215	-99%	0	-12%
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	IE	IE	IE	-	-	-	-	-
Sweden	NO	NO	NO	-	-	-	-	-
United Kingdom	IE	IE	IE	-	-	-	-	-
EU-27+UK	**5 941**	**6**	**5**	**100%**	**-5 936**	**-100%**	**-1**	**-12%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	IE	IE	IE	-	-	-	-	-
EU-KP	**5 941**	**6**	**5**	**100%**	**-5 936**	**-100%**	**-1**	**-12%**

Abbreviations explained in the Chapter 'Units and abbreviations'.
Note: The information on methodologies and emission factors is not available from the CRF/XML on fuels level.

Figure 3.166 shows CO_2 emissions for EU27+UK. Germany accounts for 70% of EU-KP CO_2 emissions from this source category. Fuel combustion in the EU-KP decreased by 99.9% between 1990 and 2020. The CO_2 implied emission factor for solid fuels was 99.0 t/TJ in 2020.

Figure 3.166 1.A.5.a Stationary, solid fuels: Emission trend and share for CO_2

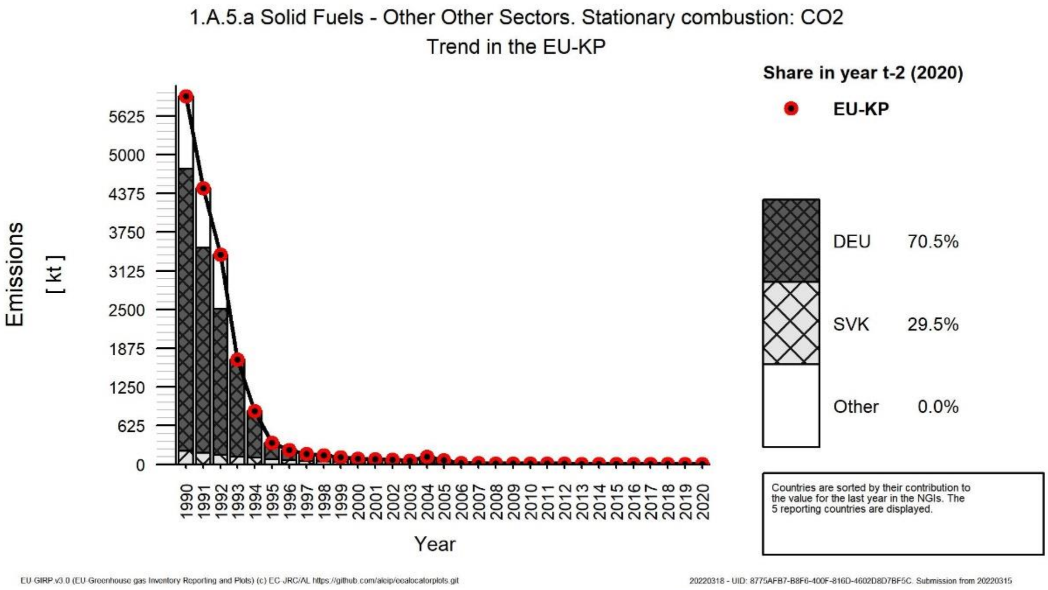
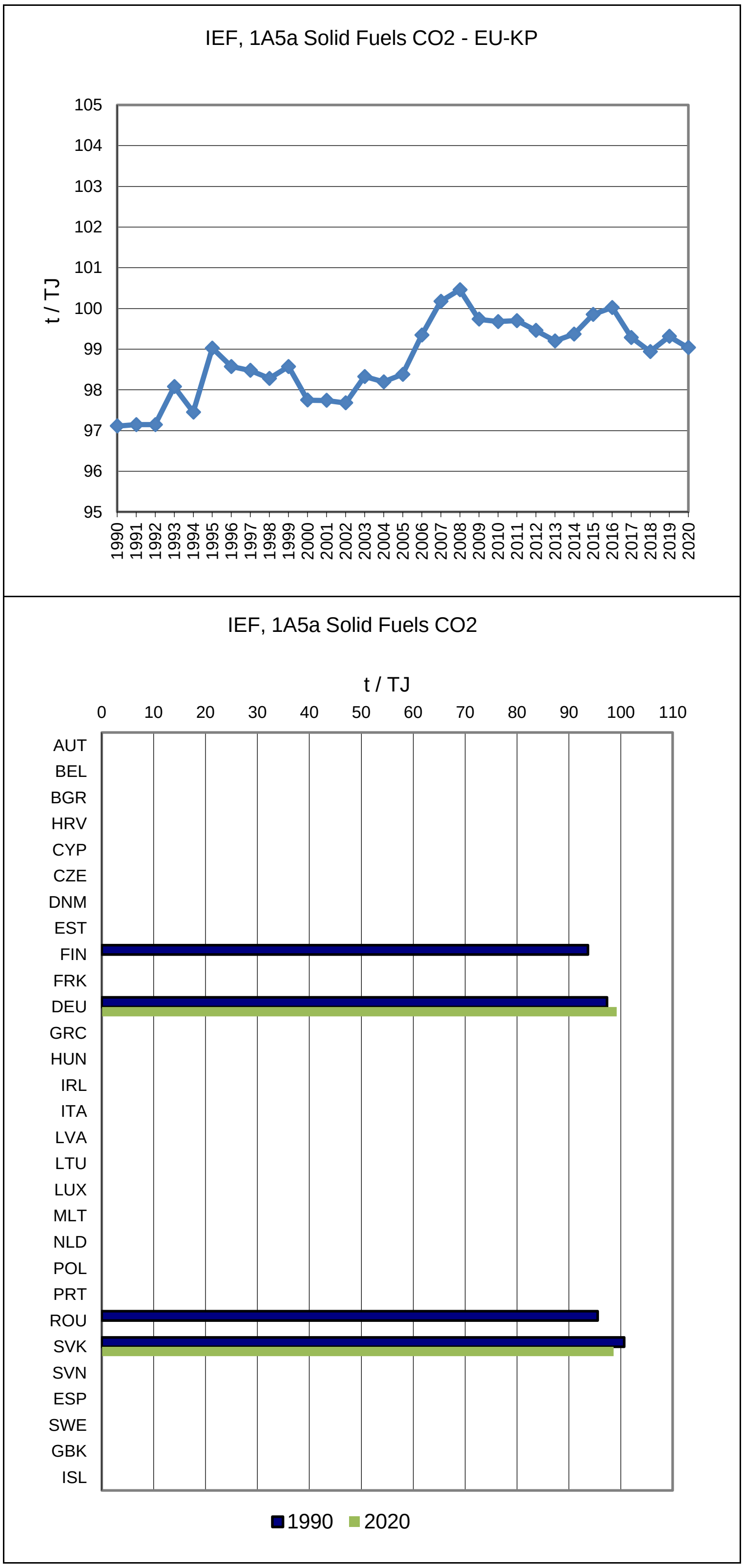


Figure 3.167 1.A.5.a Stationary, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)

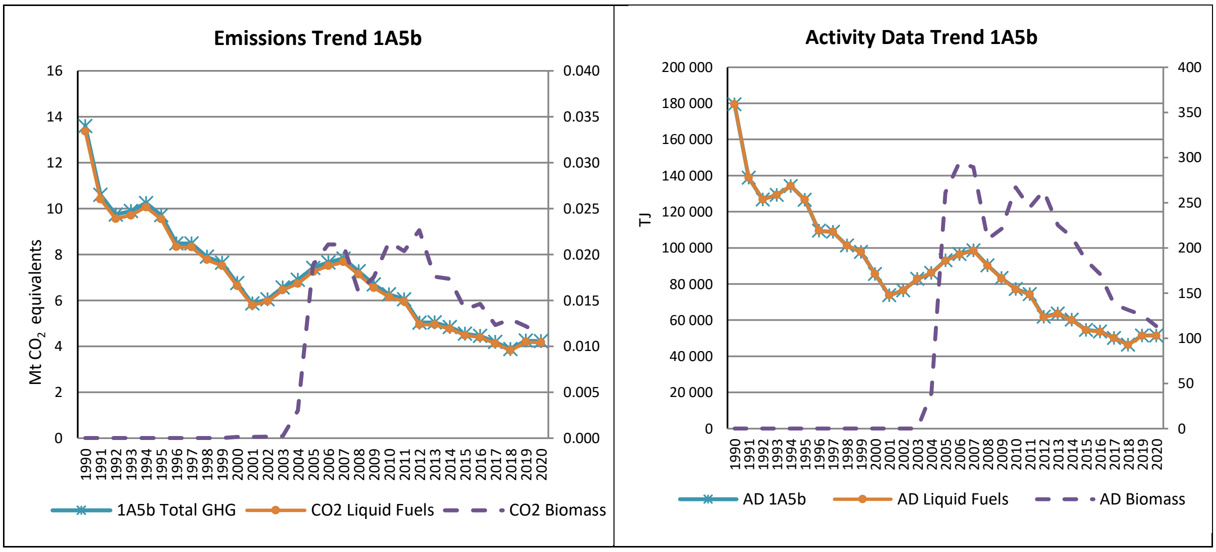


3.2.5.2 Mobile (1.A.5.b)

In this chapter information about emission trends, Member States' contribution and activity data is provided for category 1.A.5.b by fuels. CO_2 emissions from 1.A.5.b Mobile accounted for 0.1% of total

EU-KP GHG emissions in 1.A in 2020. Figure 3.168 shows the emission trend within the category 1.A.5.b, which is dominated by CO_2 emissions from liquid fuels. Total CO_2 emissions decreased by 69%.

Figure 3.168 1.A.5.b Mobile: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Eight Member States and Iceland reported emissions as ‘Not occurring’ or ’Included elsewhere‘. The United Kingdom had the highest share on emissions in 2020 and – together with Germany - decreased the most in absolute terms between 1990 and 2020. The EU-KP emissions decreased by less than 1% between 2019 and 2020.

“Included elsewhere” often indicates, that the country reports these emissions under 1.A.3 Transport or 1.A.5.a.

Table 3.110 1.A.5.b Mobile: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	35	34	33	0.8%	-2	-6%	-1	-3%	T1,T2	CS,D
Belgium	172	95	104	2.5%	-68	-39%	9	9%	CS,T1,T3	D
Bulgaria	86	14	13	0.3%	-72	-84%	0	-1%	T1	D
Croatia	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Cyprus	NO	4	5	0.1%	5	∞	1	18%	T1	D
Czechia	192	294	312	7.5%	120	62%	18	6%	T1	D
Denmark	167	198	243	5.8%	76	46%	45	23%	CR,M,T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
France	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Germany	5 526	479	371	8.9%	-5 155	-93%	-108	-23%	CS,D,M	CS,D
Greece	NO,IE	134	296	7.1%	296	∞	162	121%	T1	D
Hungary	15	25	31	0.8%	17	117%	6	25%	T2	CS
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 071	453	625	15.0%	-446	-42%	172	38%	T2	CS
Latvia	NO,NE	24	15	0.4%	15	∞	-9	-38%	T1	D
Lithuania	0	29	28	0.7%	27	7559%	-2	-5%	T2	CS
Luxembourg	0	0	0	0.0%	0	-12%	0	-2%	T1,T2	CS,D
Malta	1	4	4	0.1%	3	284%	1	21%	T1	D
Netherlands	314	159	161	3.9%	-153	-49%	2	1%	T2	CS
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	96	61	66	1.6%	-30	-31%	6	9%	T1	D
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	70	11	11	0.3%	-59	-85%	0	-1%	T1,T2	CS,D
Slovenia	32	4	3	0.1%	-29	-90%	-1	-21%	T1	D
Spain	298	448	435	10.5%	138	46%	-13	-3%	CR,T1,T2	CS,D
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
United Kingdom	5 293	1 719	1 404	33.7%	-3 890	-73%	-315	-18%	T1	CS
EU-27+UK	**13 368**	**4 188**	**4 161**	**100%**	**-9 207**	**-69%**	**-27**	**-1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	5 293	1 719	1 404	33.7%	-3 890	-73%	-315	-18%	T1	CS
EU-KP	**13 368**	**4 188**	**4 161**	**100%**	**-9 207**	**-69%**	**-27**	**-1%**	**-**	**-**

Croatia reports emissions from military aviation and navy in category 1.A.3.b.
Finland reports emissions from military activities as 'IE' for reasons of confidentiality.
France and Romania report emissions in category 1.A.5.a
Ireland reports emission from military activities in category 1.A.3.
Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.5.b Mobile – Liquid Fuels (CO_2)

In 2020, CO_2 from liquid fuels had a share of 99.9% within source category 1.A.5.b (compared to 100% in 1990). Between 1990 and 2020 CO_2 decreased by 69% (Table 3.111 **1.A.5.b Mobile, liquid** fuels: Member States' contributions to CO2 emissions). Eight Member States and Iceland reported emissions as 'Not occurring' or 'Included Elsewhere' in 2020. The highest decrease in absolute terms was achieved in Germany and the United Kingdom while Spain, Greece and Czechia had the largest increases.

According to the methodology as described in chapter 3.2.1 about 83% of EU-KP emissions are calculated by using higher tier methods in 2020.

Table 3.111 1.A.5.b Mobile, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	35	34	33	0.8%	-2	-6%	-1	-3%
Belgium	172	95	104	2.5%	-68	-39%	9	9%
Bulgaria	86	14	13	0.3%	-72	-84%	0	-1%
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NO	4	5	0.1%	5	∞	1	18%
Czechia	192	294	312	7.5%	120	62%	18	6%
Denmark	167	198	243	5.8%	76	46%	45	23%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	IE	IE	IE	-	-	-	-	-
France	IE	IE	IE	-	-	-	-	-
Germany	5 526	478	370	8.9%	-5 156	-93%	-108	-23%
Greece	IE	134	296	7.1%	296	∞	162	121%
Hungary	15	25	31	0.8%	17	117%	6	25%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	1 071	453	625	15.0%	-446	-42%	172	38%
Latvia	NE	24	15	0.4%	15	∞	-9	-38%
Lithuania	0	29	28	0.7%	27	7559%	-2	-5%
Luxembourg	0	0	0	0.0%	0	-13%	0	-2%
Malta	1	4	4	0.1%	3	284%	1	21%
Netherlands	314	159	161	3.9%	-153	-49%	2	1%
Poland	NO	NO	NO	-	-	-	-	-
Portugal	96	61	66	1.6%	-30	-31%	6	9%
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	70	11	11	0.3%	-59	-85%	0	-1%
Slovenia	32	4	3	0.1%	-29	-90%	-1	-21%
Spain	298	448	435	10.5%	137	46%	-13	-3%
Sweden	IE	IE	IE	-	-	-	-	-
United Kingdom	5 293	1 719	1 404	33.7%	-3 890	-73%	-315	-18%
EU-27+UK	**13 368**	**4 187**	**4 160**	**100%**	**-9 208**	**-69%**	**-27**	**-1%**
Iceland	NO	NO	NO	-	-	-	-	-
United Kingdom (KP)	5 293	1 719	1 404	33.7%	-3 890	-73%	-315	-18%
EU-KP	**13 368**	**4 187**	**4 160**	**100%**	**-9 208**	**-69%**	**-27**	**-1%**

*Information on methods and emission factors are identical with those described in Table **3.110** as emissions from this source only occur in liquid fuels*
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.169 shows CO_2 emissions for EU-KP and the Member States. It can be seen that the highest share on total CO_2 emissions (above the average share calculated for EU-KP) correspond to the United Kingdom, Italy, Spain, Germany, Czechia, Greece and Denmark; together they cause 89% of the CO_2 emissions from liquid fuels in 1.A.5.b. Fuel consumption in the EU-KP decreased by 69% between 1990 and 2020. The CO_2 implied emission factor for liquid fuels was 81.1 t/TJ in 2020. The IEF is comparably high because Spain reports activity data as confidential. This also explains the increasing trend of the EU IEF because the share of Spain in EU emissions increased from 2 % in 1990 to 10 % in 2020.

Figure 3.169   1.A.5.b Mobile, liquid fuels: Emission trend and share for CO_2

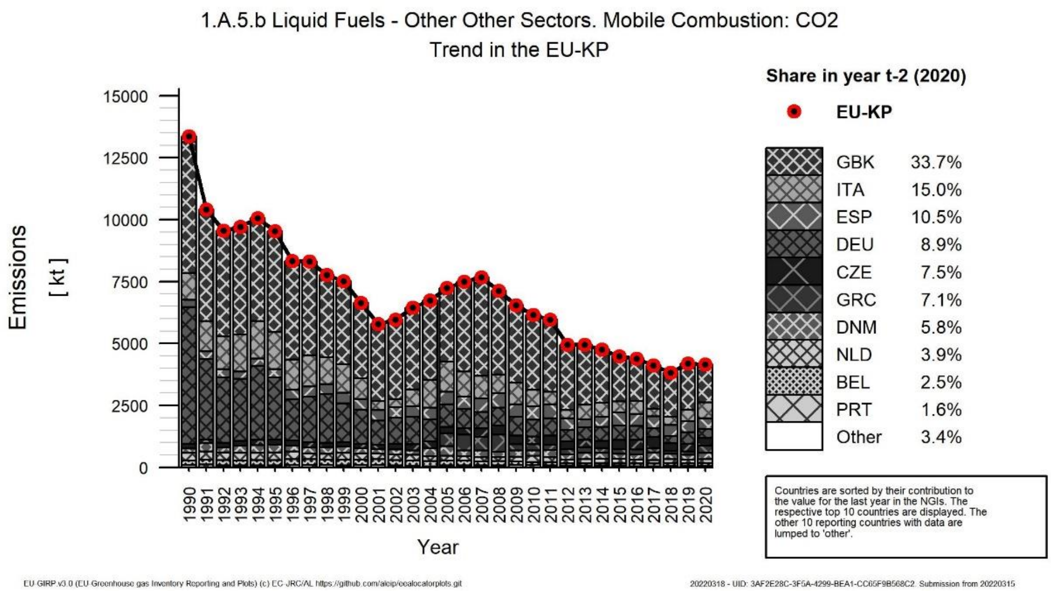
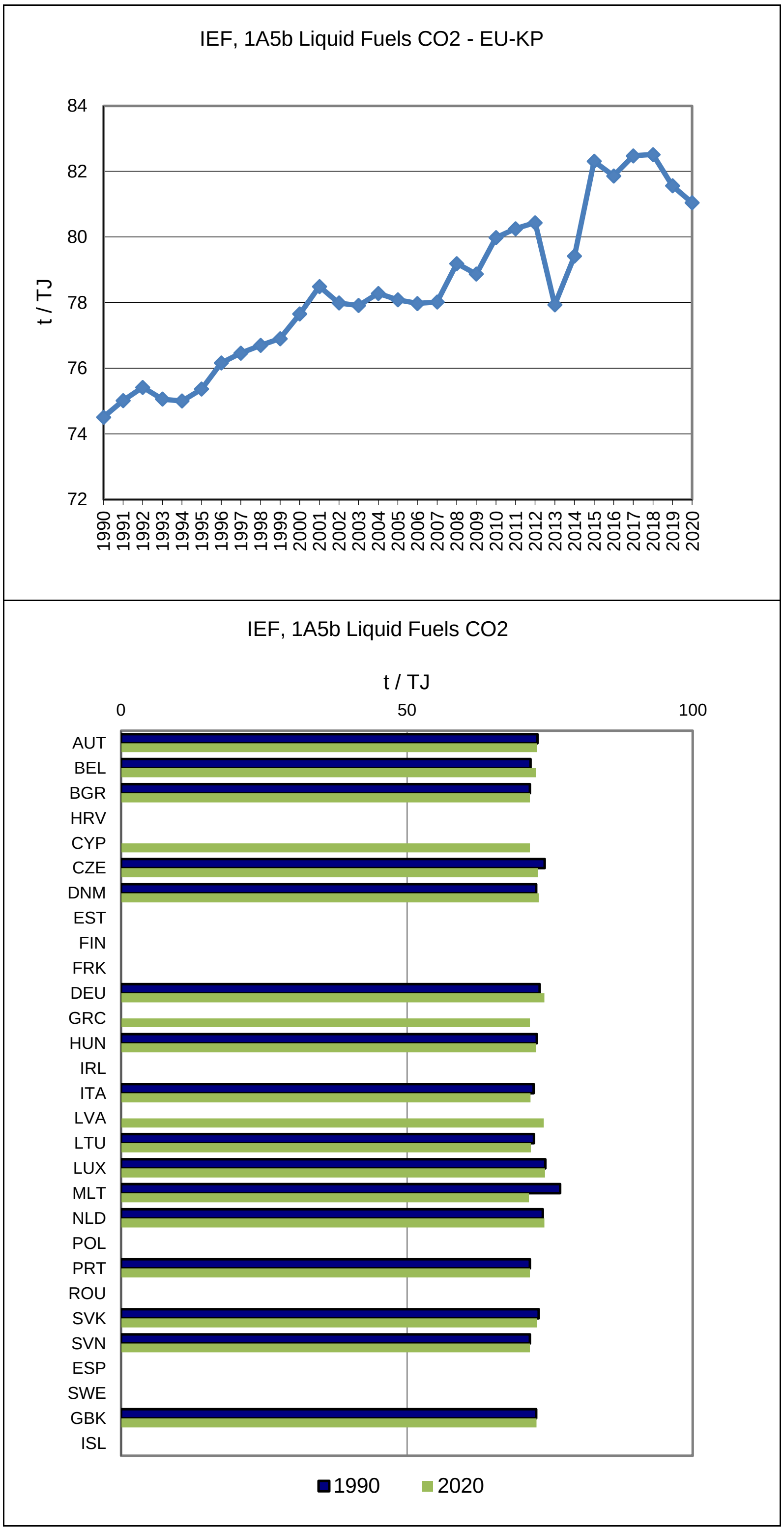


Figure 3.170 1.A.5.b Mobile, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)

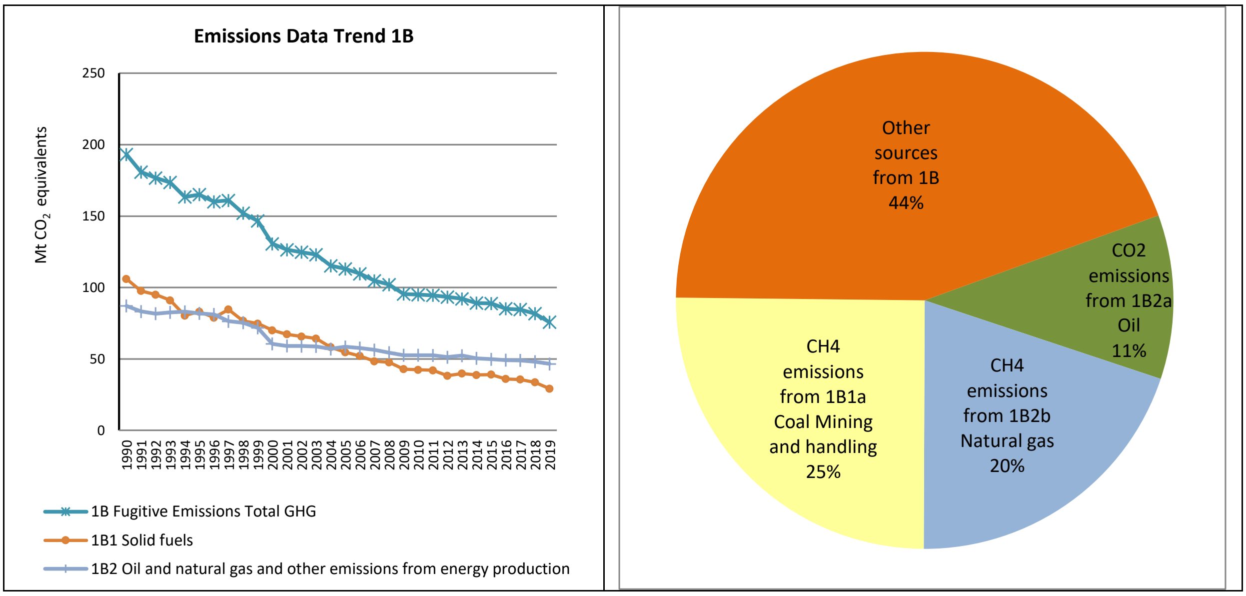


3.2.6 Fugitive emissions from fuels (CRF Source Category 1.B)

This chapter describes gaseous or volatile emissions, which occur during extraction, handling and consumption of fossil fuels. In the 2006 IPCC Guidelines fugitive emissions are defined as intentional or unintentional releases of gases from anthropogenic activities that in particular may arise from the production, processing, transmission, storage and use of fuels. Emissions from combustion are only included where it does not support a productive activity (e.g., flaring of natural gases at oil and gas production facilities). Evaporative emissions from vehicles are included under Road Transport as Subsection 1A3b v (2006 IPCC Guidelines).

In 2020, in terms of CO_2 equivalents, about 67% of emissions from source category 1.B were fugitive CH_4 emissions while 32% were fugitive CO_2 emissions. Together, they represent 2 % of total GHG emissions in the EU-KP. Fugitive GHG emissions have been steadily declining (Figure 3.171). Between 1990 and 2020, the total fugitive GHG emissions decreased by 64 %. This was mainly due to the decrease in underground mining activities: CH_4 emissions from underground mining activities have decreased by 77 % since 1990 (Figure 3.174) and decreases in CH_4 emissions from category 1B1a1i underground mines are responsible for 49 % of the total decrease of fugitive emissions. Between 1990 and 2020, GHG emissions from 1.B.1 Solid Fuels decreased by 74 % Figure 3.172), while emissions from 1.B.2 Oil and Natural Gas decreased only by 51 % (Figure 3.172). While emissions from 1.B.1 Solid Fuels and 1.B.2 Oil and Natural Gas each were responsible for roughly 55 % (1.B.1) and 45 % (1.B.2) of total fugitive emissions in 1990, fugitive emissions from 1.B.1 Solid Fuels represented only 39 % of total fugitive emissions in 2020 (Figure 3.171).

Figure 3.171 1.B Fugitive Emission from Fuel: GHG Emissions trend and proportion of fugitive emissions within source category in 2020



Fugitive emissions include five key sources:

Table 3.112: Key source categories for level and trend analyses and share of countries emissions using higher tier methods in sector 1.B (table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
1.B.1.a Coal Mining and Handling: Operation (CH_4)	97099	23569	T	L	L	74%
1.B.2.a Oil: Operation (CH_4)	6663	816	T	0	0	50%
1.B.2.a Oil: Operation (CO_2)	9010	10011	T	L	L	89%
1.B.2.b Natural Gas: Operation (CH_4)	51544	18552	T	L	L	83%
1.B.2.c Venting and Flaring: Operation (CO_2)	9128	5611	0	L	L	77%

The two largest key sources (CH_4 emissions from 1.B.1.a Coal Mining and Handling and 1.B.2.b Natural Gas) account together for 60 % of total fugitive GHG emissions (Figure 3.171).

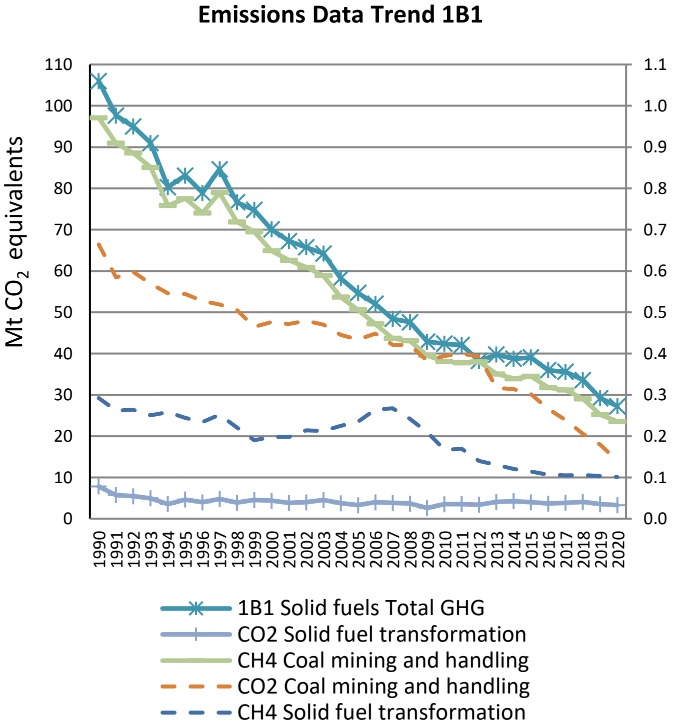
3.2.6.1 Fugitive emissions from Solid Fuels (1.B.1)

In the 2006 IPCC Guidelines fugitive emissions from solid fuels are defined as the intentional or unintentional release of greenhouse gases that may occur during the extraction, processing and delivery of fossil fuels to the point of final use. Combustion emissions from colliery methane recovered and used are excluded here and reported under Fuel Combustion Emissions. Coal mining data reported to the IEA include also peat extraction, which is not included in the CRF. Five countries (Denmark, Estonia, Finland, Latvia and Lithuania) have peat extraction but no coal mining.

In 2020 fugitive emissions from solid fuels accounted for 0.8 % of the total GHG emissions in the EU-KP and 39 % of total fugitive emissions:

- 86 % of fugitive emissions from solid fuels were CH_4 emissions from coal mining. The emissions arise due to the natural production of methane when coal is formed. Methane is partly stored within the coal seam and escapes when mined. Most CH_4 emissions resulted from underground mines; surface mines were a smaller source,
- 12 % of fugitive emissions from solid fuels were emissions due to solid fuel transformation,
- Since 1990 fugitive CH_4 emissions from 1.B.1 Solid fuels have been steadily decreasing, caused by the reduction of coal mining activities.

Figure 3.172   1.B.1 Fugitive Emissions from Solid Fuels: Trend



Note: Data displayed as dashed line refers to the secondary axis.

In 2020 three countries, Poland, Czechia and Romania represented 88 % of total fugitive GHG emissions from solid fuels (Table 3.113).

Table 3.113 1.B.1 Fugitive Emissions from Solid Fuels: Countries Contribution

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020
Austria	333	NA,IE,NO	NO,IE,NA	NO,IE,NA	333	NO,IE,NA
Belgium	433	40	0	NO,NA	432	40
Bulgaria	2 011	690	64	18	1 946	672
Croatia	60	NA,NO	NO	NO	60	NO
Cyprus	NO	NO	NO	NO	NO	NO
Czechia	10 779	1 701	456	49	10 323	1 652
Denmark	NO	NO	NO	NO	NO	NO
Estonia	NO	NO	NO	NO	NO	NO
Finland	NO	NO	NO	NO	NO	NO
France	4 810	26	NO,NA	NO,NA	4 810	26
Germany	27 386	766	1 833	630	25 553	137
Greece	1 130	306	NO	NO	1 130	306
Hungary	1 061	60	7	29	1 055	32
Ireland	56	18	NO	NO	56	18
Italy	132	26	0	NO,NA	132	26
Latvia	NA,NO	NA,NO	NO	NO	NO	NO
Lithuania	NO	NO	NO	NO	NO	NO
Luxembourg	NO	NO	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO
Netherlands	121	77	110	72	11	5
Poland	25 356	16 818	4 188	2 341	21 167	14 478
Portugal	143	15	3	NO	140	15
Romania	5 867	5 462	NA,NO	NO,NA	5 867	5 462
Slovakia	699	191	19	12	680	179
Slovenia	461	341	101	125	361	216
Spain	1 638	39	18	23	1 620	15
Sweden	5	7	5	7	0	0
United Kingdom	23 525	672	1 699	197	21 827	475
EU-27+UK	**106 007**	**27 254**	**8 503**	**3 502**	**97 504**	**23 752**
Iceland	NO	NO	NO	NO	NO	NO
United Kingdom (KP)	23 526	672	1 699	197	21 827	475
EU-KP	**106 008**	**27 254**	**8 503**	**3 502**	**97 504**	**23 752**

Abbreviations explained in the Chapter 'Units and abbreviations'
Austria includes emissions from 1.B.1.b – production of coke oven coke – in 1.A.2.a Iron and Steel
Hungary reports fugitive methane emissions released during coal mining and handling under sector 1.A.2. Fugitive emissions from solid fuel transformation are included in sector 1.A.1.c.

Nearly all fugitive CH_4 emissions from solid fuels originate from coal mining and handling (1B1a). Between 1990 and 2020 these emissions decreased by 76% (Table 3.114). Large reductions (in absolute terms) were observed in Czechia, Poland, Germany and the United Kingdom (Table 3.113).

CH_4 recovery from coal mining

The UK, which has a share of 98% of all reported CH_4 recovery in 2020 in category 1.B.1.a.1iii (Abandoned underground mines) in the EU GHG inventory, reports emissions from the utilisation of colliery methane under sectors 1A1ciii and 1A2gvii, of which almost all in 1A1ciii [UK NIR, 2022].

Romania has a share of 2% of all reported CH_4 recovery in category 1.B.1.a.1i (Mining activities) in the EU in 2020. The recovered CH_4 from Lupeni and Vulcan mines are used for energy purposes for the housework of the workers colonies and these information are included in '1.B.1.a Coal Mining and Handling, 1.B. 1.a.1 Underground Mines, 1.B.1.a.1.i Mining Activities, Recovery / Flaring CH_4' category.[ROU NIR, 2022]

Slovakia has reported CH_4 recovery in category 1.B.1.a.1 only for the reporting years 2007-2014. Emissions from cogeneration of mine gas is reported as other biogas from one facility in the category 1.A.1.c – Manufactured of Solid Fuels and Other Energy Industries. [SVK NIR 2022]

CH_4 from Coal Mining (1.B.1.a)

Fugitive emissions from coal mining correspond to the total emissions from:

- underground mining (emissions from underground mines, brought to the surface by ventilation systems),
- surface mining (emissions primarily from the exposed coal surfaces and coal rubble, but also emissions associated with the release of pressure on the coal),
- post-mining (emissions from coal after extraction from the ground, which occur during preparation, transportation, storage, or final crushing prior to combustion),
- abandoned underground mines.

CH_4 emissions from 1.B.1.a coal-mining accounted for 0.7 % of total GHG emissions in 2020 and for 34 % of all fugitive emissions in the EU-KP. CH_4 emissions from this source decreased by 76 % in the EU-KP between 1990 and 2020 and also a decrease by -6 % between 2019 and 2020 due to decreases in Czechia, Greece, Poland and Romania (Table 3.114). In 2020 Bulgaria, Czechia, Poland, Romania, the UK and Greece accounted together for 97 % of CH_4 emissions from 1.B.1.a. They had substantially reduced their emissions between 1990 and 2020 due to the decline of coal mining (Figure 3.90).

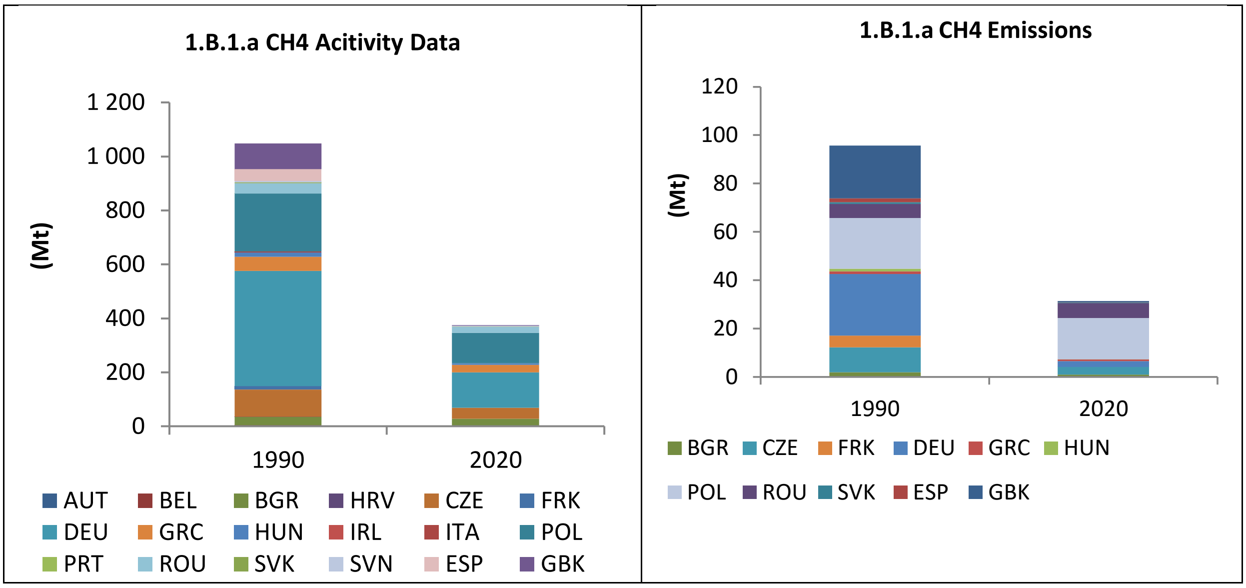
Table **3.114** shows that 74 % of EU-KP emissions are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (BRG, CZE, HUN, POL, ROU) only emissions from subcategories of sector 1.B.1.a were taken into account, where the countries actually apply a higher tier method, according to the IPCC 2006 Guidelines.

Table 3.114 1.B.1.a Coal Mining: Countries contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	333	NO,NA	NO,NA	-	-333	-100%	-	-	NA	NA
Belgium	396	40	40	0.2%	-356	-90%	0	-1%	D	D
Bulgaria	1 931	813	671	2.8%	-1 260	-65%	-142	-17%	T1,T2	CS,D
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	10 322	2 233	1 648	7.0%	-8 675	-84%	-586	-26%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	4 780	10	10	0.0%	-4 770	-100%	0	0%	T2,T3	CS,PS
Germany	25 494	101	92	0.4%	-25 402	-100%	-8	-8%	T2,T3	CS
Greece	1 130	596	306	1.3%	-824	-73%	-290	-49%	T1	D
Hungary	1 055	31	29	0.1%	-1 026	-97%	-2	-7%	NA	NA
Ireland	56	18	18	0.1%	-38	-68%	0	-1%	T1	D
Italy	53	9	8	0.0%	-45	-85%	-1	-11%	T2	D
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	21 054	14 503	14 395	61.1%	-6 659	-32%	-108	-1%	T1,T2	D
Portugal	140	16	15	0.1%	-124	-89%	0	-1%	NO	NO
Romania	5 825	5 880	5 462	23.2%	-363	-6%	-418	-7%	T1,T2	D
Slovakia	680	243	176	0.7%	-504	-74%	-67	-28%	T2	CS
Slovenia	361	215	216	0.9%	-144	-40%	2	1%	T2,T3	CS,D,PS
Spain	1 620	16	15	0.1%	-1 605	-99%	-1	-3%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 809	482	468	2.0%	-21 341	-98%	-14	-3%	T2,T3	CS
EU-27+UK	**97 099**	**25 204**	**23 569**	**100%**	**-73 530**	**-76%**	**-1 635**	**-6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 809	482	468	2.0%	-21 341	-98%	-14	-3%	T2,T3	CS
EU-KP	**97 099**	**25 204**	**23 569**	**100%**	**-73 530**	**-76%**	**-1 635**	**-6%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.173 1.B.1.a Coal Mining and Handling: Contribution of countries to CH_4 emission and activity data



CH_4 from Underground mines (1.B.1.a.1)

In 2020, 75% of fugitive emissions from coal mines were due to underground mines. Within the EU-KP coal mining in underground mines decreased substantially between 1990 and 2020 (-77 %) (Table **3.115** and Figure 3.174). Largest decreases of CH_4 emissions in absolute terms were observed in Germany (-99.8 %) and the United Kingdom (-98 %). In Germany, emissions from this source have been decreasing due to decreases in utilizable extracted quantities and increases in pit-gas utilization since 2001 (DEU NIR 2022). The decreasing trend in the United Kingdom is caused by the closure of deep-mining collieries, which led to a reduction from 188 small deep-mining collieries in the year 1990 to 5 in 2017 (GBE NIR 2022).

Poland contributing to 66% of methane emissions from this source applies a Tier 2 method based on direct measurements and calculations (POL NIR 2022). Romania has a share of 25% of CH_4 emissions from this source. 99% of CH_4 emissions from this category arise from subcategory 1B1aiii (abandoned coalmines), which is calculated with a Tier 2 methodology of the 2006 IPCC Guidelines (ROU NIR 2022). A Tier 2 method including country specific emission factors is applied by the Czechia, which is contributing 3% of methane emissions to this source (CZE NIR 2022) (Table **3.115**). For detailed information on countries methodologies please see Annex III.

Table 3.115 1.B.1.a.1 Coal Mining – underground mining: Countries contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	299	NO,NA	NO,NA	-	-299	-100%	-	-	NA	NA
Belgium	396	40	40	0.2%	-356	-90%	0	-1%	D	D
Bulgaria	1 325	203	185	0.9%	-1 140	-86%	-18	-9%	T2	CS
Croatia	60	NO	NO	-	-60	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	7 544	923	614	3.0%	-6 930	-92%	-309	-33%	T1,T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	4 734	10	10	0.0%	-4 724	-100%	0	0%	T2,T3	CS,PS
Germany	25 396	65	63	0.3%	-25 334	-100%	-2	-3%	T3	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	1 055	28	28	0.1%	-1 027	-97%	0	-1%	NA	NA
Ireland	56	18	18	0.1%	-38	-68%	0	-1%	T1	D
Italy	20	9	8	0.0%	-12	-62%	-1	-11%	T2	D
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	19 583	13 407	13 394	65.7%	-6 189	-32%	-13	0%	T1,T2	D
Portugal	140	16	15	0.1%	-124	-89%	0	-1%	NO	NO
Romania	5 282	5 418	5 144	25.2%	-138	-3%	-274	-5%	T1,T2	D
Slovakia	680	243	176	0.9%	-504	-74%	-67	-28%	T2	CS
Slovenia	361	215	216	1.1%	-144	-40%	2	1%	T2,T3	CS,D,PS
Spain	1 620	16	15	0.1%	-1 604	-99%	-1	-3%	CS,T2	CS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	21 616	456	451	2.2%	-21 165	-98%	-4	-1%	T2,T3	CS
EU-27+UK	**90 164**	**21 065**	**20 378**	**100%**	**-69 786**	**-77%**	**-687**	**-3%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	21 616	456	451	2.2%	-21 165	-98%	-4	-1%	T2,T3	CS
EU-KP	**90 164**	**21 065**	**20 378**	**100%**	**-69 786**	**-77%**	**-687**	**-3%**	**-**	**-**

Figure 3.174 1.B.1.a.1.i Mining activities - Underground Mines: Emission trend and share for EU-28 and the emitting countries of CH_4

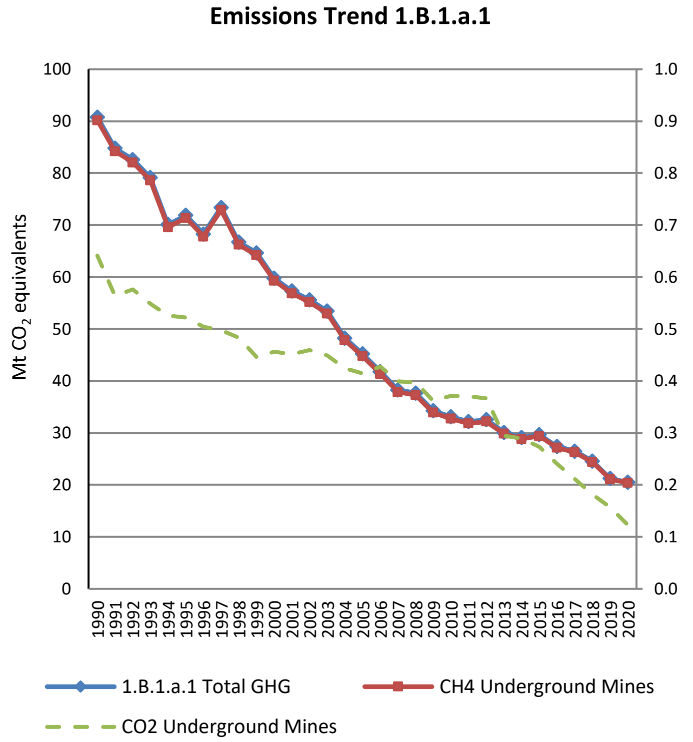


Figure 3.175 shows the implied emission factor of EU-KP and also the implied emission factor for each Member State for CH_4 emissions in 1B1a1i – underground mines, mining activities, which are responsible for 56 % of total GHG emissions from 1.B.1.a.1. The decrease of the implied emission factor is caused by the closure of underground mining in Germany. Between 1990 and 2018, Germany is calculating emissions from this source applying a Tier 3 methodology, which results in a higher emission factor, compared to the IEF of other countries; from 2019 onwards, Germany reports CH_4 emissions from this source as not occurring, which results in a decrease of the EU implied emission factor (see DEU NIR 2022).

Figure 3.175: 1.B.1.a.1.i Mining activities – Underground mines - Implied Emission Factors for CH_4 (in kg/t)

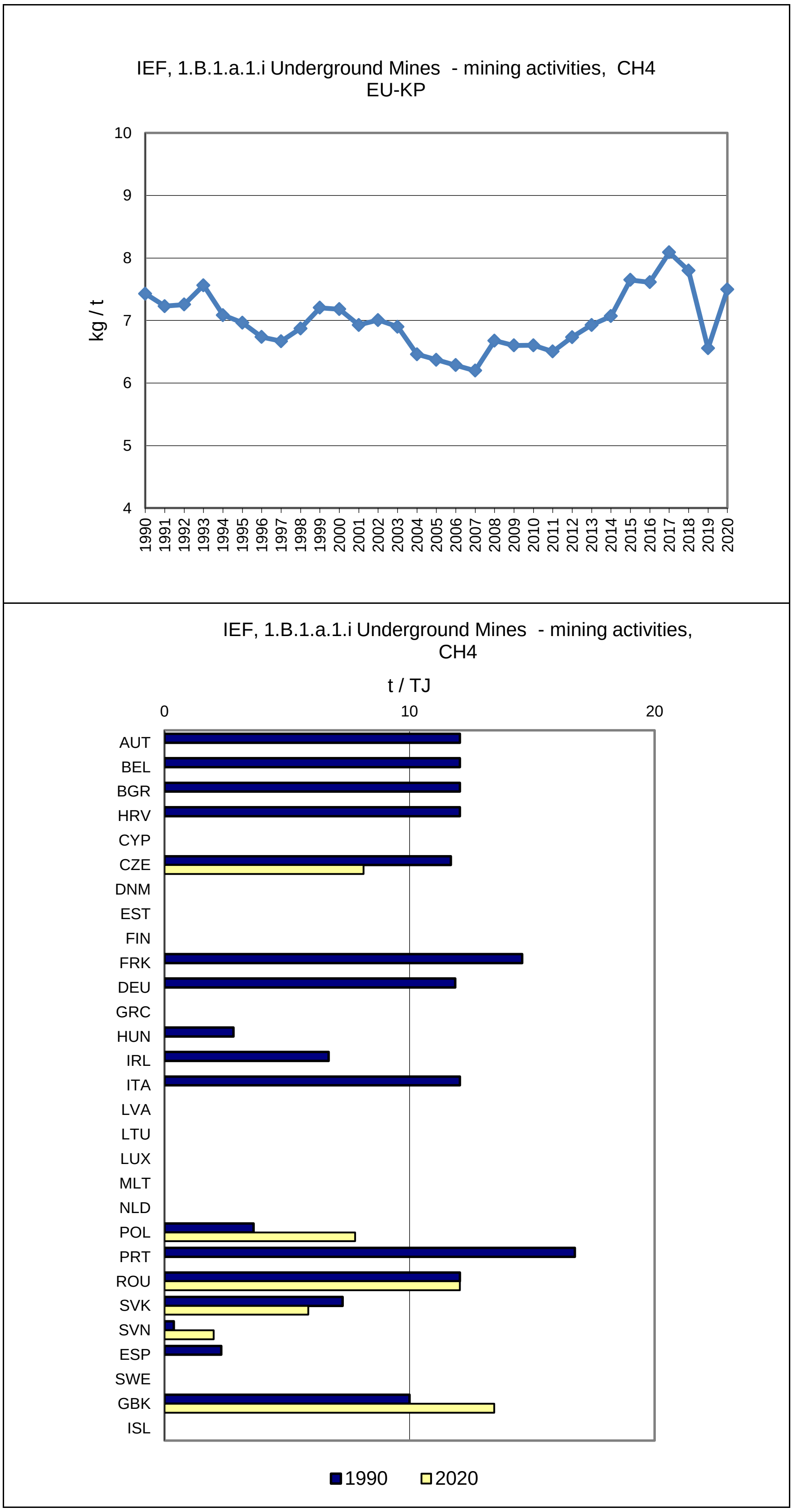
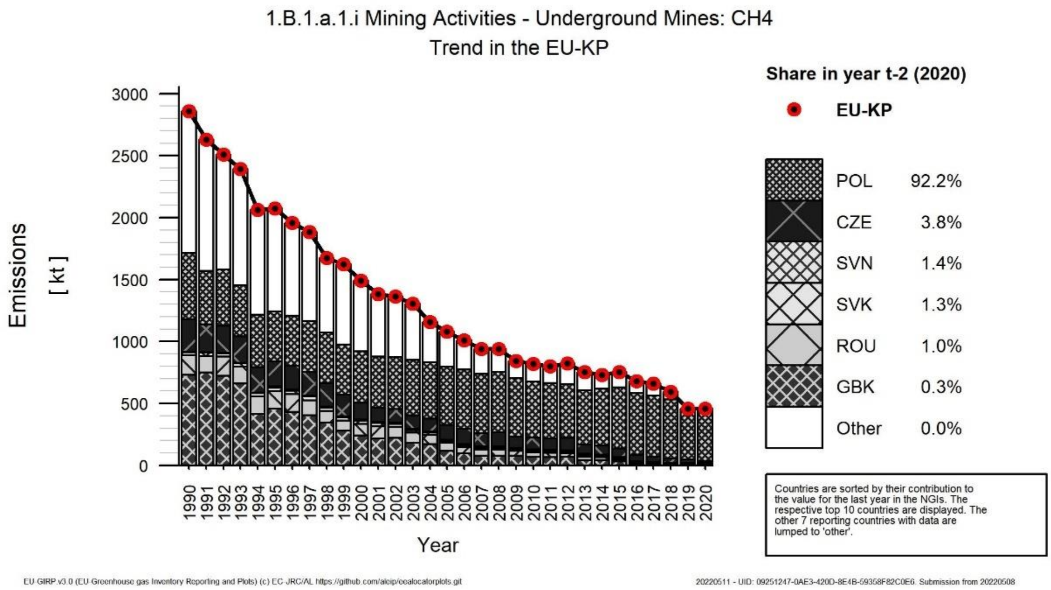


Figure 3.176 1.B.1.a.1.i Mining activities - Surface Mines: Emission trend and share for the emitting countries of CH_4



CH_4 from Surface mines (1.B.1.a.2)

In 2020, only 12% of emissions from coal mining originate from surface mining. Overall, the coal production from surface mines decreased by 40 % between 1990 and 2020 (Table **3.116** and Figure 3.177).

Czechia shows the largest decrease of methane emissions in absolute terms between 1990 and 2020 (- 1 745 kt CO_2 equ.), which is caused by the closure of mines (CZE NIR 2022).

Together, Czechia and Poland account for 64% of emissions from this source. Both apply a Tier 1 methodology with a default emission factor as methane emissions from surface mining represents only a minor source of methane emissions from coal mining – in Poland, 7 % of total emissions from coal mining arise from category 1.B.1.a.2, the share in Czechia is 63%. For detailed information on countries methodologies please see Annex III. (Table **3.116**).

Table 3.116 1.B.1.a.2 Coal Mining – surface mining: Countries contribution to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	34	NO	NO	-	-34	-100%	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	606	610	486	15.2%	-120	-20%	-124	-20%	T1,T2	D
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	2 778	1 310	1 033	32.4%	-1 745	-63%	-277	-21%	T1	D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	47	NO	NO	-	-47	-100%	-	-	NA	NA
Germany	98	36	30	0.9%	-69	-70%	-7	-18%	T2	CS
Greece	1 130	596	306	9.6%	-824	-73%	-290	-49%	T1	D
Hungary	NO	2	1	0.0%	1	∞	-2	-75%	-	-
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	33	NO	NO	-	-33	-100%	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	1 472	1 096	1 001	31.4%	-470	-32%	-95	-9%	T1	D
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	544	462	318	10.0%	-226	-42%	-145	-31%	T1	D
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1	NO	NO	-	-1	-100%	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	193	26	17	0.5%	-176	-91%	-10	-37%	T2	CS
EU-27+UK	**6 935**	**4 139**	**3 191**	**100%**	**-3 744**	**-54%**	**-949**	**-23%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	193	26	17	0.5%	-176	-91%	-10	-37%	T2	CS
EU-KP	**6 935**	**4 139**	**3 191**	**100%**	**-3 744**	**-54%**	**-949**	**-23%**	**-**	**-**

Figure 3.177 1.B.1.a.2.i Mining activities - Surface Mines: Emission trend and share for the emitting countries of CH_4

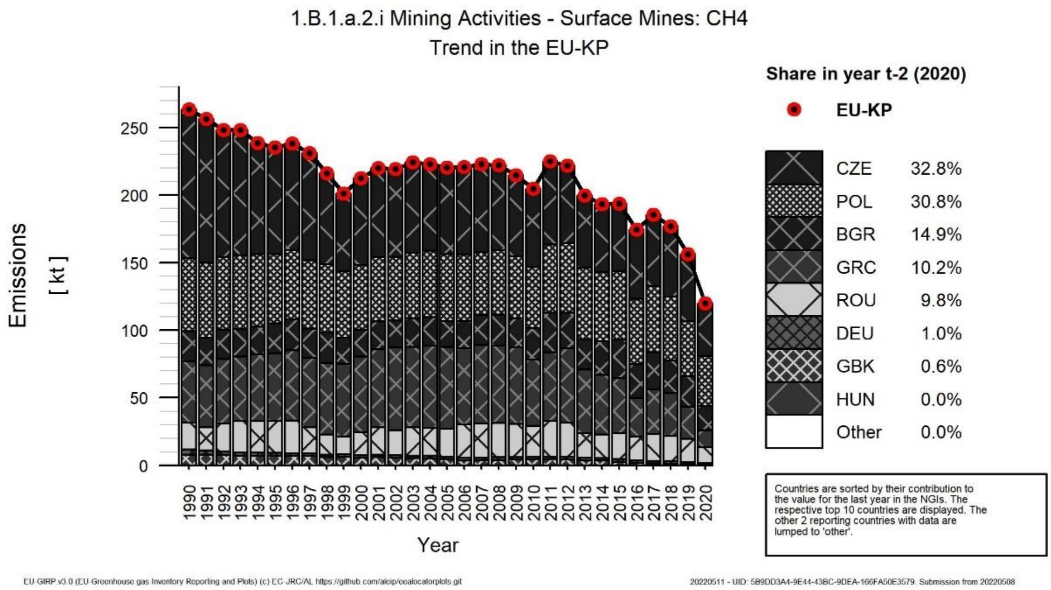
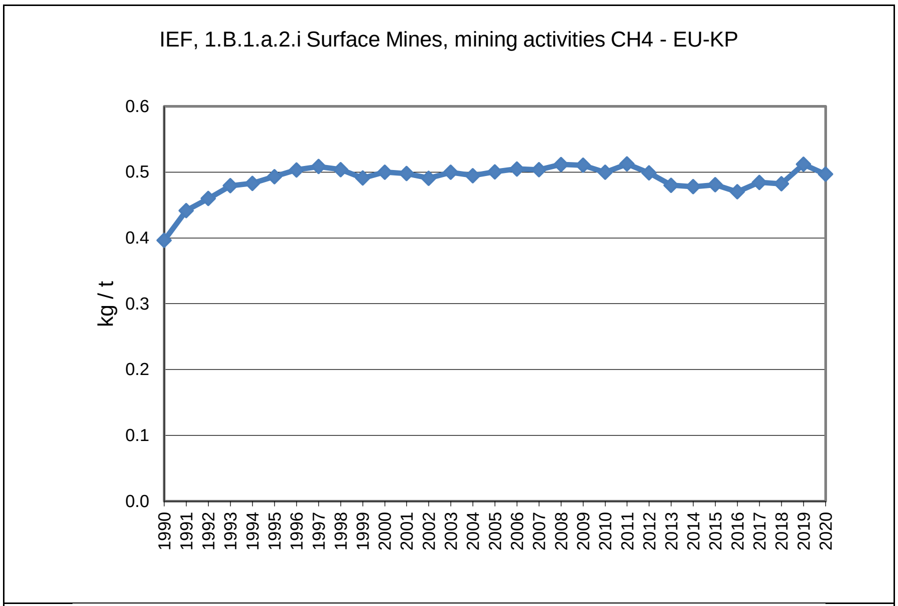
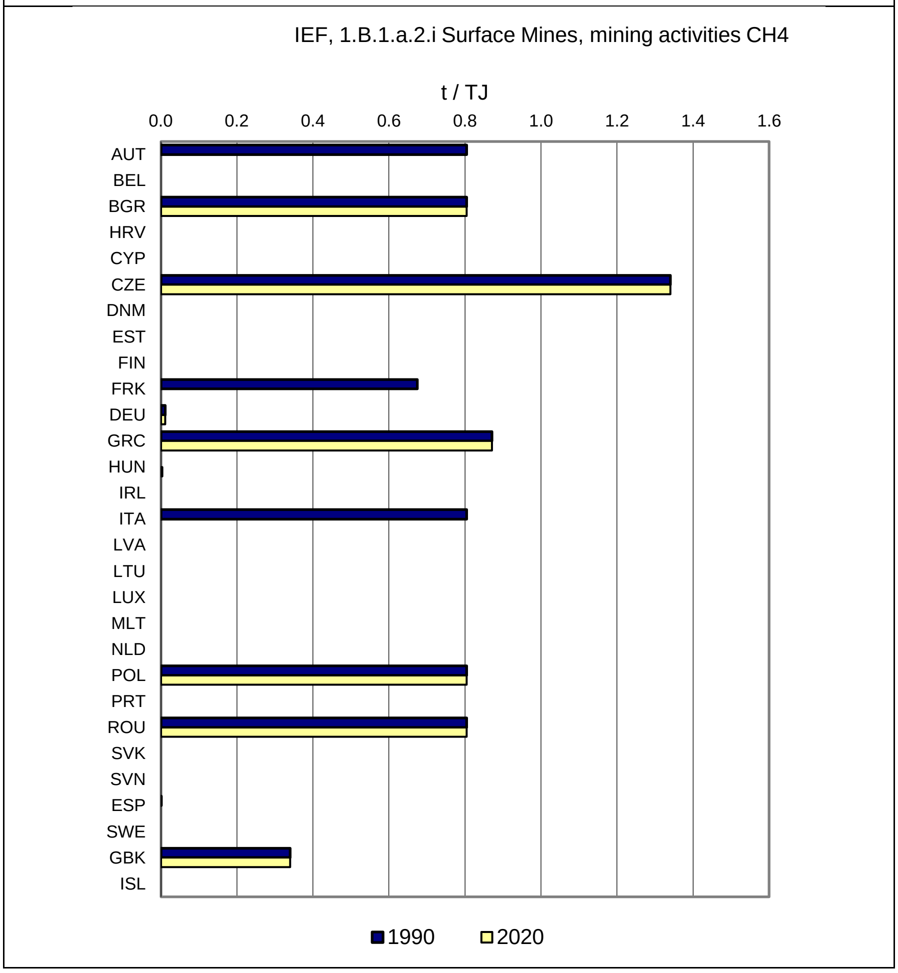


Figure **3.171** shows the Implied Emission factor of EU-KP and also the implied Emission factor for each Member State for CH_4 emissions in 1.B.1.a.2.i – mining activities from surface mines, which are responsible for 94 % of total GHG emissions from 1.B.1.a.2.

Czechia applies the upper default emission factor from the IPCC 2006 Guidelines, which explains the outlier in Figure 3.178 (lower figure). Germany's low emission factor is caused by the application of a Tier 2 method with a country specific emission factor for CH_4 from this source (0.015m^3 CH_4/t). According to the German NIR, emission factors from the IPCC 2006 Guidelines cannot be applied to German lignite, as it does not exceed a temperature of 50°C during the coalification process, while significant methane releases occur only at temperatures higher than 80°C (for detailed information see Annex III of the EU GHG inventory and German NIR, 2022).

Figure 3.178: 1.B.1.a.2.i Mining activities – Surface mines - Overview of outliers of Implied Emission Factors for CH_4 (in kg/t)





Emissions from Other (1.B.1.c)

Poland and Sweden both report CH_4 and CO_2 emissions in this sector. Sweden additionally reports N_2O emissions. Slovenia reports CO_2 emissions in this subcategory. The description of the subcategories is presented in Table 3.117.

Table 3.117 Description of subcategories in sector 1.B.1c for CO_2- and CH_4-emissions for reporting countries

Member state	Emission	Subcategory
Poland	CO_2, CH_4	Emissions from Coke Oven Gas Subsystem
Slovenia	CO_2	SO_2 scrubbing
Sweden	CO_2, CH_4, N_2O	Flaring of gas

Table 3.118 provides information on the contribution of countries to EU-KP recalculations in CH_4 from 1.B.1 Solid fuels for 1990 and 2019.

Table 3.1181.B.1 Fugitive Emissions from Solid Fuels: Contribution of countries to EU-KP recalculations in CH_4 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	-	-		
Belgium	-	-	-	-		
Bulgaria	-	-	-	-		
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	-7.6	-0.3		Due to the review for submission year 2019 we had to add amount of underground mined amout of Lignite. However, innaccurate activity data for the last submission (year 2019) were taken over.
Denmark	-	-	-	-		
Estonia	-	-	-	-		
Finland	-	-	-	-		
France	-	-	0.002	0.01		For the production of coke in iron and steel coking plants, a correction has been made to the steelmaking gas consumption in 2019. Improved accuracy and completeness.
Germany	-	-	1.3	0.8		Recalculations are caused by a change in hard coal coke production by +10%
Greece	-	-	-	-		
Hungary	-	-	-	-		
Ireland	-	-	-0.5	-2.6		For fugitive emissions from abandoned coal mines (1.B.1.a) an update was made based on the update to Table 4.1.6 (abandoned underground mines Emission Factors) in the 2019 Refinement to the 2006 IPCC Guidelines. Methane emissions for 2017, 2018 and 2019 were recalculated and were approximately 0.5 kt CO_2 eq less each year after the recalculation
Italy	-	-	-	-		
Latvia	-	-	-	-		
Lithuania	-	-	-	-		

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Luxembourg	-	-	-	-		
Malta	-	-	-	-		
Netherlands	-	-	0.1	1.6		Emissions of CH_4 from coke production were not correctly calculated from AD and IPCC-EF for the years 2018 and 2019. They are recalculated for this year's submission resulting in a small plus emission of 2547 kg for 2018 and 3004 kg for 2019.
Poland	-	-	-0.00003	-0.0000002		Recalculations for the 2004, 2005, 2018 and 2019 were implemented as the result of revision and updating of historical activities.
Portugal	-	-	-	-		
Romania	-	-	366	6.6		Recalculations have been made for the 2015 - 2016 period, and for the year 2019 for CH_4, due to an error of transcription from the spreadsheet in the CRF tables, in subcategory 1.B.1.a.iii – Abandoned underground mines.
Slovakia	-	-	2.3	0.9		Slovakia revised the activity data for charcoal production in the category 1.B.1.b which are provided by the FAO STAT and the ŠÚ SR and compared with data provided by companies allocated in this category. Charcoal production in Slovakia for the year 2019 was revised according to data provided by FAO STAT and corrected value is 4 kt. Emissions were recalculated for year 2019.
Slovenia	-	-	-	-		
Spain	-	-	-	-		
Sweden	-	-	-	-		
United Kingdom	-	-	4.5	0.9		There has been a minor recalculation to data for 1B1a1i due to DUKES revisions.
EU27+UK	-	**-**	**366**	**1.5**		
Iceland	-	-	-	-		
United Kingdom (KP)	-	-	4.5	0.9		There has been a minor recalculation to data for 1B1a1i due to DUKES revisions.
EU-KP	-	**-**	**366**	**1.5**		

3.2.6.2 Fugitive emissions from oil and natural gas (1.B.2)

Fugitive emissions from oil and natural gas correspond to the total fugitive emissions from oil and natural gas activities. Fugitive emissions may arise from equipment leaks, evaporation losses, venting, flaring and accidental releases (2006 IPCC Guidelines).

Fugitive emissions from 1.B.2 Oil and natural gas include all emissions from exploration, production, processing, transport, and handling of oil and natural gas. They account for 1.2 % of the total GHG emissions in 2020 and for 61 % (Figure 3.179) of all fugitive emissions in the EU-KP.

Of all fugitive emissions from oil and natural gas, in 2020:

- 44 % were CH_4 emissions from natural gas (exploration, production, processing, transport and distribution)
- 23 % were CO_2 emissions from oil (exploration, production, transport, refining and storage and distribution)
- 13% were CO_2 emissions from venting and flaring
- 8% were CH_4 emissions from venting and flaring
- 5 % were CO_2 emissions due to Other emissions

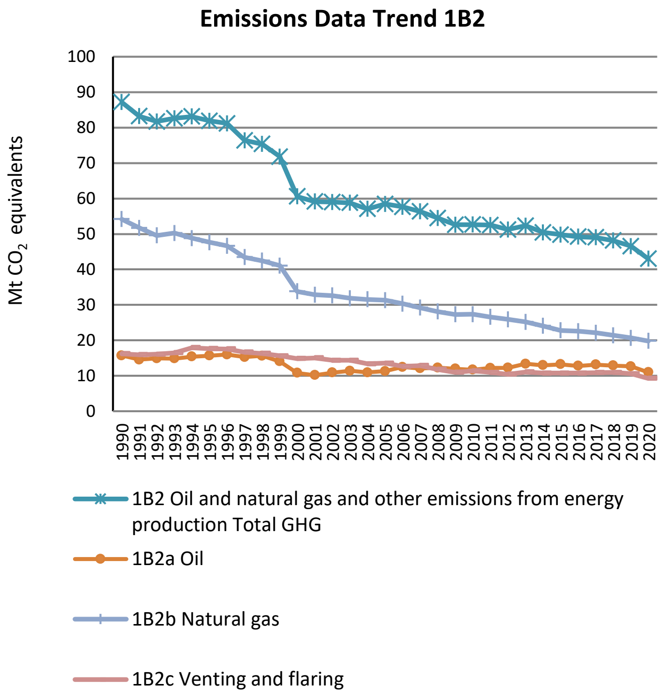
This source category includes four key categories:

Table 3.119: Key source categories for level and trend analyses and share of countries emissions using higher tier methods in sector 1.B.2 (table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
1.B.2.a Oil: Operation (CH_4)	6663	816	T	0	0	50%
1.B.2.a Oil: Operation (CO_2)	9010	10011	T	L	L	89%
1.B.2.b Natural Gas: Operation (CH_4)	51544	18552	T	L	L	83%
1.B.2.c Venting and Flaring: Operation (CO_2)	9128	5611	0	L	L	77%

Fugitive emissions from oil and natural gas occur in all countries but Malta (Table 3.120). Total greenhouse gas emissions from 1.B.2 decreased by 51 % between 1990 and 2020 (Figure **3.179**). This trend was mainly due to the reduction of fugitive CH_4 emissions from natural gas activities, which decreased by 6^4 % over that period.

Figure 3.179 1.B.2-Fugitive Emissions Oil and Natural Gas: Trend



In 2020, 56% of all fugitive GHG emissions from oil and natural gas were emitted by four countries: Germany, Italy, Poland and the United Kingdom. The largest reductions (in absolute terms) were observed in Romania and the United Kingdom (both mainly CH_4 emissions), while emissions increased most in Poland (mainly CH_4 emissions) (Table 3.120).

Table 3.120 1.B.2 Fugitive emissions from oil and natural gas: Countries' contributions

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020
Austria	369	329	102	109	267	220
Belgium	805	574	85	101	721	472
Bulgaria	219	933	60	666	158	267
Croatia	943	442	583	288	359	154
Cyprus	0	NE,NO	NO,NE	NO,NE	0	NO,NE
Czechia	1 082	611	2	4	1 080	607
Denmark	526	201	341	126	133	53
Estonia	64	19	0	0	64	19
Finland	124	99	111	76	11	22
France	6 189	3 180	4 362	2 203	1 801	826
Germany	10 251	5 969	2 008	1 185	8 241	4 783
Greece	79	136	43	5	36	130
Hungary	2 916	1 762	478	133	2 437	1 628
Ireland	50	74	0	0	50	73
Italy	12 985	5 966	4 047	2 113	8 926	3 845
Latvia	248	101	0	0	248	101
Lithuania	289	433	24	182	265	251
Luxembourg	20	28	0	0	20	28
Malta	NO	NO	NO	NO	NO	NO
Netherlands	2 707	1 278	775	860	1 932	419
Poland	1 136	4 553	47	1 884	1 089	2 668
Portugal	58	1 069	54	1 013	2	53
Romania	24 498	3 123	1 168	794	23 326	2 328
Slovakia	1 714	234	5	1	1 708	233
Slovenia	50	39	0	0	50	39
Spain	1 915	3 710	1 751	3 535	163	175
Sweden	412	483	331	438	80	44
United Kingdom	17 475	7 485	5 089	3 245	12 342	4 209
EU-27+UK	**87 125**	**42 828**	**21 466**	**18 963**	**65 510**	**23 647**
Iceland	62	179	61	175	1	4
United Kingdom (KP)	17 475	7 485	5 089	3 245	12 342	4 209
EU-KP	**87 187**	**43 008**	**21 527**	**19 138**	**65 511**	**23 651**

Abbreviations explained in the Chapter 'Units and abbreviations'.
AUT: N_2O emissions from venting and flaring are included in 1.A.1.b (petroleum refining)
BEL: N_2O emissions are reported in 1.A.1.b (petroleum refining)
NLD: N_2O emissions from gas transmission are included in 1.A.3.e.i (pipeline transport gaseous fuels)

CH_4 recovery from Oil and Gas

Germany is the only country that reports the recovery of CH_4 emissions in subcategory 1.B.2. These emissions occur in category 1.B.2.c (Venting and Flaring). Gas recovery systems liquefy most recovered CH_4 emissions and return them to refining processes or to refinery combustion systems. These emissions are reported under category 1.A.1.b. (DEU NIR 2022)

CO_2 from Oil (1.B.2.a)

Fugitive emissions from oil correspond to fugitive emissions from all sources associated with the exploration, production, transmission, upgrading and refining of crude oil and the distribution of crude oil products (2006 IPCC Guidelines).

CO_2 emissions from 1.B.2.a 'Fugitive emissions from oil' account for 0.3 % of total EU-KP GHG emissions in 2020 and for 14 % of all fugitive emissions. Between 1990 and 2020, CO_2 emissions from this source increased by 11 % in the EU-KP (Table 3.121). By contrast, during the same period 1990-2020, CH_4 emissions of this source category were reduced by 88 %.

Together France, Italy and Spain accounted for 64 % of the EU-KP total CO_2 emissions of 1.B.2.a 'Fugitive CO_2 emissions from oil' (Table 3.121, Figure 3.180). Main contributor to these emissions in all countries is subcategory 1.B.2.a.4 (Oil – Refining/Storage). Spain is applying a Tier 2 methodology with a plant specific emission factor in this subcategory. Italy also applies a Tier 2 methodology for CO_2 emissions from oil refining and storage, while the emission factor is country specific. France uses specific emission factors provided by the plant operator, for other processes, emissions are derived directly from annual emission reports (FRK NIR 2022). For detailed information on countries methodologies please see Annex III. Table **3.121** shows that 89 % of EU-KP CO_2 emissions from this source are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (FRK, ITA, LTU, NLD ROU, ESP, UK) only emissions from subcategories of sector 1.B.2.a were taken into account for the calculation, where the countries actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (HUN, POL, SVK) were calculated as a higher method, according to the IPCC 2006 Guidelines.

During the period 1990-2020, the largest decreases in CO_2 emissions (in absolute terms) were observed in Italy, France and the United Kingdom. (Table 3.121). Decreasing CO_2 emissions in Italy are mainly driven by the reduction in crude oil losses in refineries (ITA NIR 2022). In the UK, CO_2 emissions from this source decline mainly due to a decrease of 98% of CO_2 emissions in oil exploration (1.B.2.a.1).

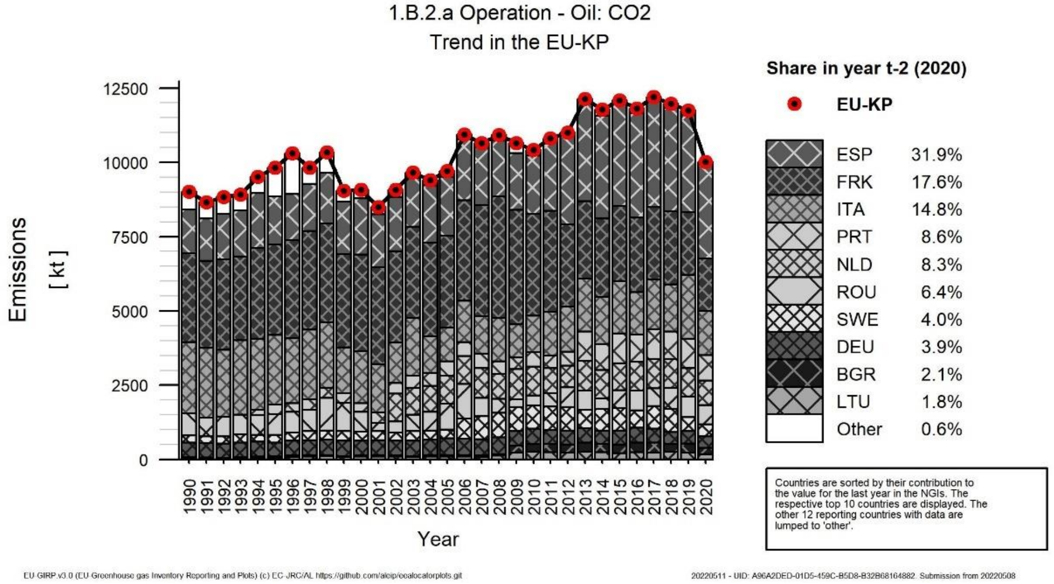
Largest increases between 1990-2020 are reported in the Netherlands, Portugal and Spain (Table 3.121). In all three countries, increases are mainly driven by increases in CO_2 emissions from subcategory 1.B.2.a.4 (Oil – Refining/Storage).

Table 3.121 1.B.2.a Fugitive CO_2 emissions from oil: Countries' contributions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	0.005	0.01	0.01	0.0%	0.0004	9%	-0.001	-13%	T1	D
Belgium	0.01	0.02	0.02	0.0%	0.001	9%	-0.004	-21%	T1	D
Bulgaria	60	306	210	2.1%	151	252%	-96	-31%	T1	D
Croatia	158	41	37	0.4%	-121	-77%	-4	-10%	T1	D
Cyprus	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Czechia	0.02	0.03	0.03	0.0%	0.01	67%	0.003	8%	T1	D
Denmark	5	0.05	0.1	0.0%	-5	-97%	0.1	207%	T3	D,PS
Estonia	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	2 983	2 098	1 765	17.6%	-1 219	-41%	-333	-16%	T1,T2,T3	CS,D,PS
Germany	478	411	393	3.9%	-84	-18%	-18	-4%	T2	CS
Greece	0.00004	0.00001	0.000005	0.0%	-0.00003	-88%	-0.000004	-46%	T1	D
Hungary	5	1	1	0.0%	-5	-90%	-0.04	-6%	T1	CS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	2 402	2 143	1 486	14.8%	-916	-38%	-657	-31%	T1,T2	CS,D
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Lithuania	23	232	180	1.8%	157	673%	-52	-22%	T1,T3	D,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0	953	826	8.3%	826	4592180%	-127	-13%	CS,T1	D,PS
Poland	2	11	10	0.1%	8	480%	-0.4	-4%	T1	CS,D
Portugal	0.4	999	859	8.6%	858	201768%	-140	-14%	D	D
Romania	738	697	636	6.4%	-102	-14%	-62	-9%	T1,T3	D,PS
Slovakia	0.03	0.01	0.01	0.0%	0	-79%	0	-2%	T1	CS,PS
Slovenia	0.03	0.1	0.1	0.0%	0	142%	0	-13%	T1	D
Spain	1 477	3 283	3 190	31.9%	1 713	116%	-93	-3%	T1,T2	D,PS
Sweden	255	470	402	4.0%	147	58%	-68	-14%	T3	PS
United Kingdom	425	106	17	0.2%	-409	-96%	-90	-84%	T1,T2,T3	CS,D,PS
EU-27+UK	**9 010**	**11 752**	**10 011**	**100%**	**1 001**	**11%**	**-1 740**	**-15%**	**-**	**-**
Iceland	0.003	0.005	0.004	0.0%	0.001	32%	-0.001	-22%	T1	D
United Kingdom (KP)	425	106	17	0.2%	-409	-96%	-90	-84%	T1,T2,T3	CS,D,PS
EU-KP	**9 010**	**11 752**	**10 011**	**100%**	**1 001**	**11%**	**-1 740**	**-15%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.180 1.B.2.a Oil: Emission trend and share for the emitting countries of CO_2



CH_4 from Oil (1.B.2.a)

CH_4 emissions from 1.B.2.a 'Fugitive emissions from oil' account for 0.02 % of total EU-KP GHG emissions in 2020 and for 1.2 % of all fugitive emissions. Between 1990 and 2020, CH_4 emissions from this source decreased by 88 % in the EU-KP (Table 3.121).

Together Romania, Italy, Poland and the UK accounted for 67 % of the EU-KP total CH_4 emissions of 1.B.2.a 'Fugitive CH_4 emissions from oil' (Table 3.122). In Romania main contributions to CH_4 emissions come from subcategory 1.B.2.a.2 (Oil – Production). From 1990 to 2000 CH_4 emissions are estimated using a Tier 1 methodology with a default emission factor for developing countries of the 2006 IPCC Guidelines. From 2000 on the country applies a Tier 1 methodology with a default emission factor for developed countries, due to change of technology (ROU NIR 2022). This also explains the outlier in ***Figure 3.181***. For detailed information on countries methodologies please see Annex III.

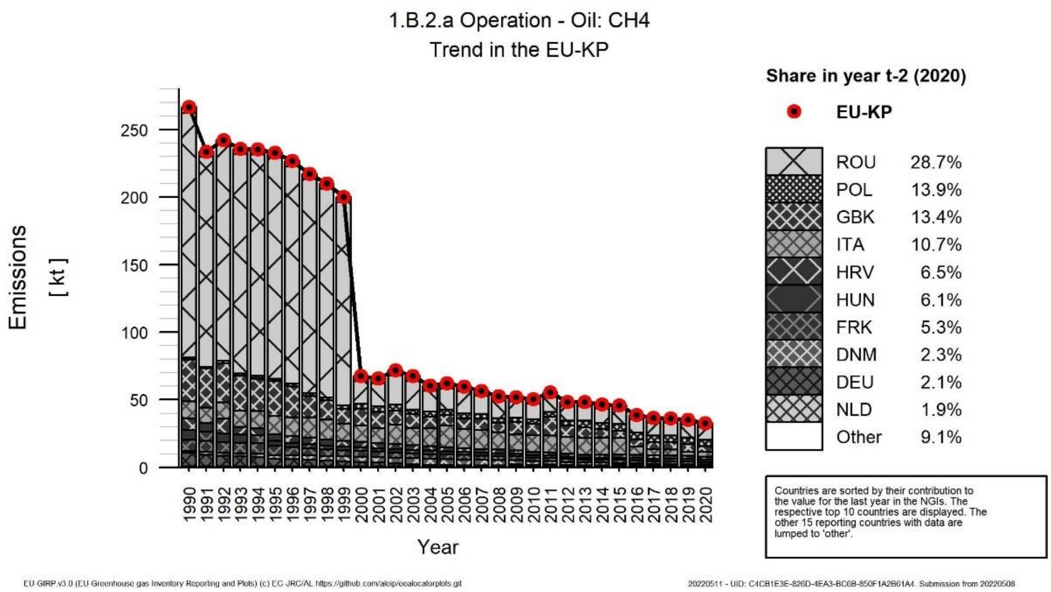
During the period 1990-2020, the largest decreases in CH_4 emissions (in absolute terms) were observed in the United Kingdom and Romania, caused by significant decreases in oil production (-95% in Romania, -89% in the UK). In the same period of time, emissions increased most in Poland due to an increase of 339% in oil production (Table 3.122).

Table 3.122 1.B.2.a Fugitive CH_4 emissions from oil: Countries' contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	8	9	8	1.0%	0	3%	-1	-12%	T1	D
Belgium	11	9	7	0.9%	-4	-34%	-1	-17%	CS,D	CS,D
Bulgaria	12	8	6	0.8%	-6	-50%	-2	-23%	T1	D
Croatia	220	59	53	6.5%	-168	-76%	-6	-10%	T1	D
Cyprus	0	NO,NE	NO,NE	-	0	-100%	-	-	NA	NA
Czechia	23	6	5	0.6%	-18	-77%	-1	-20%	T1,T2	CS,D
Denmark	43	21	19	2.3%	-24	-57%	-2	-10%	T2,T3	CS,D,OTH,PS
Estonia	NO,NE	NO,NE	NO,NE	-	-	-	-	-	NA	NA
Finland	6	9	8	1.0%	2	34%	-1	-8%	T1	D
France	206	50	43	5.3%	-162	-79%	-6	-12%	T1,T2,T3	CS,D,PS
Germany	242	16	17	2.1%	-225	-93%	1	7%	T2	CS
Greece	10	15	14	1.7%	5	47%	-1	-4%	T1	D
Hungary	179	54	50	6.1%	-129	-72%	-5	-9%	T1	CS
Ireland	0	0	0	0.0%	0	57%	0	12%	T1	D
Italy	310	67	87	10.7%	-223	-72%	20	29%	T1,T2	CS,D
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Lithuania	4	3	2	0.3%	-2	-47%	-1	-22%	T1	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	20	16	16	1.9%	-4	-22%	0	-2%	T1,T1b	D
Poland	35	123	113	13.9%	78	224%	-9	-7%	T1	CS,D
Portugal	2	2	2	0.2%	0	3%	0	-3%	CR,OTH	CR,OTH
Romania	4 530	243	234	28.7%	-4 296	-95%	-9	-4%	T1	D
Slovakia	15	7	8	1.0%	-7	-45%	1	19%	T1,T3	CS,PS
Slovenia	0	0	NO,NA	-	0	-100%	0	-100%	NA	NA
Spain	4	3	3	0.3%	-1	-27%	0	-13%	T1	D
Sweden	12	10	9	1.1%	-3	-25%	-1	-11%	T1,T2	CS,D,PS
United Kingdom	770	148	110	13.4%	-660	-86%	-38	-26%	T1,T2,T3	CS,D,PS
EU-27+UK	**6 662**	**878**	**815**	**100%**	**-5 847**	**-88%**	**-62**	**-7%**	**-**	**-**
Iceland	0	1	0	0.1%	0	-9%	0	-31%	T1	D
United Kingdom (KP)	770	148	110	13.4%	-660	-86%	-38	-26%	T1,T2,T3	CS,D,PS
EU-KP	**6 663**	**878**	**816**	**100%**	**-5 847**	**-88%**	**-63**	**-7%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.181: 1.B.2.a Oil: Emission trend and share for the emitting countries of CH_4



CH_4 from Natural gas (1.B.2.b)

Fugitive emissions from natural gas correspond to emissions from all fugitive sources associated with the exploration, production, processing, transmission, storage and distribution of natural gas (associated and non-associated gas) (2006 IPCC Guidelines).

CH_4 emissions from 1.B.2.b 'Fugitive emissions from natural gas' account for 0.5 % of total EU-KP GHG emissions in 2020 and for 26 % of all fugitive emissions in the EU-KP. Between 1990 and 2020, CH_4 emissions from this source decreased by 64 % (Table 3.123).

In 2020, 73% of the EU-KP CH_4 emissions from 1.B.2.b were emitted by four countries: Germany, Italy, Romania, Hungary and the United Kingdom (Table 3.123, Figure 3.182). In Germany, Italy and the United Kingdom, methane emissions are mainly due to natural gas distribution (1.B.2.b.5). Germany and the United Kingdom apply a Tier 3 methodology with country specific emission factors, while Italy and Hungary use a Tier 2 methodology and country specific emission factors to estimate emissions. Emissions from natural gas production (1.B.2.b.2) and other operations on natural gas (1.B.2.b.6) are the main sources of CH_4 emissions in Romania in this category. From 1990 to 2000, CH_4 emissions are estimated using a Tier 1 methodology with a default emission factor for developing countries of the 2006 IPCC Guidelines. From 2000 on the country applies a Tier 1 methodology with a default emission factor for developed countries, due to change of technology (ROU NIR 2022). This also explains the outlier in Figure **3.182**. For detailed information on countries methodologies, please see Annex III. Table **3.123** shows that 83 % of EU-KP emissions are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (AUT, FIN, ESP, UK) only emissions from subcategories of sector 1.B.2.b were taken into account for the calculation, where the countries actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (CZE, HUN, SVK) were counted as a higher Tier method, according to the IPCC 2006 Guidelines.

The emission decreases between 1990 and 2020 observed in Romania (-93 %), the United Kingdom (-69 %), Germany (-40 %) and in Italy (-63 %) contributed most significantly to the overall reduction in the EU-KP between 1990 and 2020. The decrease was mainly caused by improvement of technology (United Kingdom), the improvement of pipeline network (Germany), the reduction of losses in gas distribution (Italy) and the decrease in production and the change of methodology (Romania).

Table 3.123 1.B.2.b Fugitive CH_4 emissions from natural gas: Countries' contributions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	259	220	212	1.1%	-47	-18%	-8	-4%	T1,T2	CS,D
Belgium	709	489	465	2.5%	-245	-35%	-24	-5%	CS	CS
Bulgaria	146	230	260	1.4%	114	78%	30	13%	T1	D
Croatia	138	108	101	0.5%	-38	-27%	-7	-6%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 045	567	579	3.1%	-466	-45%	12	2%	T1,T2	CS
Denmark	60	37	22	0.1%	-38	-64%	-15	-41%	T2,T3	CS,D
Estonia	56	18	16	0.1%	-40	-71%	-2	-11%	T1	D
Finland	4	17	13	0.1%	9	212%	-4	-22%	T1,T2	CS,D,PS
France	1 520	923	763	4.1%	-757	-50%	-160	-17%	T2,T3	CS,PS
Germany	7 997	4 894	4 765	25.7%	-3 232	-40%	-129	-3%	T2,T3	CS
Greece	9	82	88	0.5%	78	851%	6	7%	T1	D
Hungary	1 577	1 329	1 322	7.1%	-255	-16%	-7	0%	T1,T2	CS
Ireland	22	61	68	0.4%	46	209%	7	12%	T3	CS,PS
Italy	8 236	3 200	3 073	16.6%	-5 163	-63%	-127	-4%	T2	CS
Latvia	177	84	83	0.4%	-94	-53%	-1	-1%	T3	CS
Lithuania	261	289	249	1.3%	-12	-5%	-41	-14%	T2	CS
Luxembourg	19	31	28	0.1%	8	44%	-3	-10%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	421	243	236	1.3%	-185	-44%	-8	-3%	T3	CS
Poland	753	1 216	1 270	6.8%	517	69%	54	4%	T1	D
Portugal	NO	52	50	0.3%	50	∞	-2	-5%	CR,NO,OTH	CR,NO,OTH
Romania	16 184	1 272	1 172	6.3%	-15 012	-93%	-100	-8%	T1	D
Slovakia	1 103	167	175	0.9%	-928	-84%	8	5%	T1,T3	CS,PS
Slovenia	42	33	33	0.2%	-9	-21%	0	0%	T1	D
Spain	136	175	138	0.7%	3	2%	-37	-21%	CS,T1	CS,D
Sweden	67	30	35	0.2%	-33	-49%	4	13%	T2,T3	CS,PS
United Kingdom	10 601	3 479	3 337	18.0%	-7 263	-69%	-142	-4%	T1,T2,T3	CS,D,PS
EU-27+UK	**51 544**	**19 246**	**18 552**	**100%**	**-32 992**	**-64%**	**-694**	**-4%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	10 601	3 479	3 337	18.0%	-7 263	-69%	-142	-4%	T1,T2,T3	CS,D,PS
EU-KP	**51 544**	**19 246**	**18 552**	**100%**	**-32 992**	**-64%**	**-694**	**-4%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.182   1.B.2.b Natural Gas: Emission trend and share for the emitting countries of CH_4

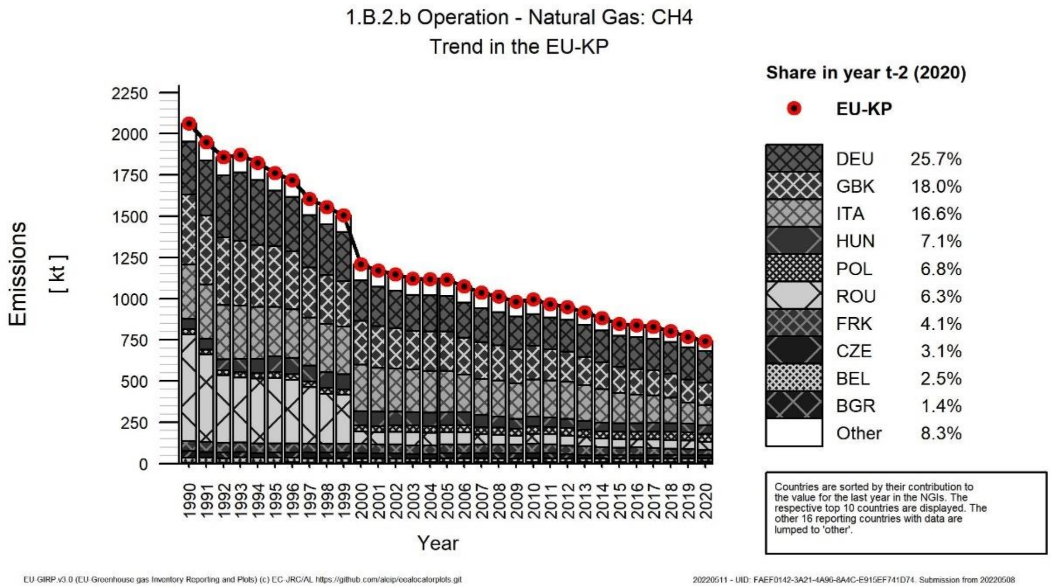


Table 3.124 and

Table 3.125 provide an overview on activity data description and emission factors for all countries for sector 1.B.2.a and 1.B.2.b. CRF Tables do not include activity data for sector 1.B.2 because countries use different types of activity data which cannot be aggregated.

Table 3.124: 1.B.2.a Fugitive CO_2- and CH_4 emissions from natural gas: Information on activity data, emission factors by Member State

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		**1990**							**2020**						
	GHG source category	**Activity data**			**CO_2 Implied emission factor (kg/unit)**	**CH_4 Implied emission factor (kg/unit)**	**CO_2 emissions (kt)**	**CH_4 emissions (kt)**	**Activity data**			**CO_2 Implied emission factor (kg/unit)**	**CH_4 Implied emission factor (kg/unit)**	**CO_2 emissions (kt)**	**CH_4 emissions (kt)**
		Description	**Unit**	**Value**					**Description**	**Unit**	**Value**				
Austria	**Oil**						**0**	**0.30**						**0**	**0.31**
	1. Exploration	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	Mt crude oil	Mt	0.56	NO,IE	IE	IE	IE
	2. Production	Mt crude oil	Mt	1	NO,IE	IE	IE	IE	Mt crude oil	Mt	0.56	NO,IE	IE	IE	IE
	3. Transport	1000 m3 crude oil	Mt	9 404	0.5	5	0.005	0.05	1000 m3 crude oil	Mt	10 235	0.49	5	0	0.06
	4. Refining and storage	Mt crude oil Input	Mt	8	NA,NO	31 663	NA	0.25	Mt crude oil Input	Mt	8	NO,NA	31663	NA	0.26
	5. Distribution of oil products	Mt gasoline	Mt	3	NA,NO	NA	NA	NA	Mt gasoline	Mt	1	NO,NA	NA	NA	NA
	6. Other		Mt	NO	NO	NO	NO	NO		Mt	NO	NO	NO	NO	NO
Belgium	**Oil**						**0**	**0.46**						**0.02**	**0.30**
	1. Exploration	Not occuring	PJ	NO	NO	NO	NO	NO	Not occuring	PJ	NO	NO	NO	NO	NO
	2. Production	Not occuring	PJ	NO	NO	NO	NO	NO	Not occuring	PJ	NO	NO	NO	NO	NO
	3. Transport	Oil transported	PJ	1 051	14	150	0.01	0.16	Oil transported	PJ	1 144	14	150	0.02	0.17
	4. Refining and storage	Oil refined	PJ	1 251	NA,NO	238	NA	0.30	Oil refined	PJ	1 178	NO,NA	109	NA	0.13
	5. Distribution of oil products	Not occuring	PJ	NO	NO	NO	NO	NO	Not occuring	PJ	NO	NO	NO	NO	NO
	6. Other	Not occuring	PJ	NO	NO	NO	NO	NO	Not occuring	PJ	NO	NO	NO	NO	NO
Bulgaria	**Oil**						**60**	**0.50**						**210**	**0.25**
	1. Exploration	Indigenous production	10^3m^3	C	4 400	20	0	0.00	Indigenous production	10^3m^3	C	4400	20	0	0.00
	2. Production	Indigenous production	10^3m^3	C	44 990	2 910	3.15	0.20	Indigenous production	10^3m^3	C	44990	2910	1	0.07
	3. Transport	Indigenous production	10^3m^3	C	2	25	0.0002	0.002	Indigenous production	10^3m^3	C	2	25	0	0.00
	4. Refining and storage	Refinery intake	10^3m^3	9 667	5 850	30	57	0.29	Refinery intake	10^3m^3	5 670	36918	31	209	0.18

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		1990							2020						
	GHG source category	Activity data: Description	Unit	Value	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data: Description	Unit	Value	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
	5. Distribution of oil products		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
	6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
Cyprus	**Oil**						**NO,NE**	**0.02**						**NO,NE**	**NO,NE**
Cyprus	1. Exploration		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
Cyprus	2. Production		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
Cyprus	3. Transport			NE	NO,NE	NE	NE	NE			NO	NO	NO	NO	NO
Cyprus	4. Refining and storage	Crude Oil refined (10^3 m3)	NO	743	NO,NE	22	NE	0.02	Crude Oil refined (10^3 m3)	NO	NO	NO	NO	NO	NO
Cyprus	5. Distribution of oil products		NE	NE	NO,NE	NE	NE	NE		NE	NE	NO,NE	NE	NE	NE
Cyprus	6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
Czechia	**Oil**						**0.02**	**0.91**						**0.03**	**0.21**
Czechia	1. Exploration	(e.g. number of wells drilled)	PJ	NE	NE	NE	NE	NE	(e.g. number of wells drilled)	PJ	NE	NE	NE	NE	NE
Czechia	2. Production	(e.g. PJ of oil produced)	PJ	2	7 576	5 978	0.02	0.01	(e.g. PJ of oil produced)	PJ	4	7576	4735	0.03	0.02
Czechia	3. Transport	(e.g. PJ oil loaded in tankers)	PJ	304	13	146	0.004	0.04	(e.g. PJ oil loaded in tankers)	PJ	258	13	146	0.003	0.04
Czechia	4. Refining and storage	(e.g. PJ oil refined)	PJ	304	NE,NO	2 800	NE	0.85	(e.g. PJ oil refined)	PJ	258	NO,NE	585	NE	0.15
Czechia	5. Distribution of oil products	(e.g. PJ oil refined)	PJ	304	NE,NO	NE	NE	NE	(e.g. PJ oil refined)	PJ	258	NO,NE	NE	NE	NE
Czechia	6. Other	(NO)	PJ	NO	NO	NO	NO	NO	(NO)	PJ	NO	NO	NO	NO	NO
Germany	**Oil**						**478**	**9.67**						**393**	**0.68**
Germany	1. Exploration	Number of wells drilled	number	12	0.5	64	0.00001	0.00	Number of wells drilled	number	12	0.48	64	0.00001	0.00
Germany	2. Production	oil produced	t	3 605 667	0.1	0.3	0.5	1.08	oil produced	t	1 906 681	0.10	0.04	0.19	0.08

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		1990							2020						
	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Description	Unit	Value				
	3. Transport	oil transported	t	84 042 887	NO,NA	0.01	NA	0.59	oil transported	t	83 048 930	NO,NA	0.01	NA	0.56
	4. Refining and storage	oil refined	t	214 116 000	2	0.0	477	8.00	oil refined	t	83 989 899	5	0.00	393	0.04
	5. Distribution of oil products	oil products distributed	t	89 461 000	NO,NA	NA	NA	NA	oil products distributed	t	71 664 317	NO,NA	NA	NA	NA
	6. Other	no activity data	t	NO	NO	NO	NO	NO	no activity data	t	NO	NO	NO	NO	NO
Denmark	**Oil**						**5**	**1.72**						**0.145**	**0.75**
Denmark	1. Exploration	Oil explored	m3	1 930	2 433	0	5	0.00	Oil explored	m3	NO	NO	NO	NO	NO
Denmark	2. Production	Oil produced	10^3m^3	6 999	0	1	0	0.00	Oil produced	10^3m^3	4 143	0.04	1	0.0002	0.00
Denmark	3. Transport	Oil loaded	Mg	3 370 410	NO,NA	0	NA	0.49	Oil loaded	Mg	1 359 614	NO,NA	0	NA	0.03
Denmark	4. Refining and storage	Oil refined	Mg	7 263 000	0	0	0	1.23	Oil refined	Mg	7 070 884	0.0205	0.10	0.145	0.71
Denmark	5. Distribution of oil products	Gasoline distribution	Mg	1 734 295	NA	NA	NA	NA	Gasoline distribution	Mg	1 179 208	NA	NA	NA	NA
Denmark	6. Other	Other	m3	NO	NO	NO	NO	NO	Other	m3	NO	NO	NO	NO	NO
Spain	**Oil**						**1477**	**0.16**						**3190**	**0.11**
Spain	1. Exploration	Crude oil produced	Tg	NA	NO,NA	NA	NA	NA	Crude oil produced	Tg	NA	NO,NA	NA	NA	NA
Spain	2. Production	Crude oil produced	Tg	1	64	783	0.00005	0.00	Crude oil produced	Tg	0	59.11	722	0.00000	0.00
Spain	3. Transport	Transport of crude oil	Tg	51	75	827	0.004	0.04	Transport of crude oil	Tg	55	51.08	563	0.003	0.03
Spain	4. Refining and storage	Oil refined	Tg	54	27 571 240	2 107	1477	0.11	Oil refined	Tg	59	54395870	1397	3190	0.08
Spain	5. Distribution of oil products	Oil products	Tg	NA	NO,NA	NA	NA	NA	Oil products	Tg	NA	NO,NA	NA	NA	NA
Spain	6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Est	**Oil**						**NO,NE**	**NO,NE**						**NO,NE**	**NO,NE**

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		1990							2020						
	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Description	Unit	Value				
	1. Exploration	Exploration	NA	NO	NO	NO	NO	NO	Exploration	NA	NO	NO	NO	NO	NO
	2. Production	Production	NA	NO	NO	NO	NO	NO	Production	NA	NO	NO	NO	NO	NO
	3. Transport	Transport	NA	NO	NO	NO	NO	NO	Transport	NA	NO	NO	NO	NO	NO
	4. Refining and storage	Refining/Storage	NA	NO	NO	NO	NO	NO	Refining/Storage	NA	NO	NO	NO	NO	NO
	5. Distribution of oil products	Distribution of oil products	kt	NE	NE	NE	NE	NE	Distribution of oil products	kt	NE	NE	NE	NE	NE
	6. Other	Other	NA	NO	NO	NO	NO	NO	Other	NA	NO	NO	NO	NO	NO
Finland	**Oil**						**NO**	**0.25**						**NO**	**0.34**
	1. Exploration		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
	2. Production		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
	3. Transport		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
	4. Refining and storage	kt oil refined	kt	9 884	NO	25	NO	0.25	kt oil refined	kt	13 207	NO	25	NO	0.34
	5. Distribution of oil products		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
	6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
France	**Oil**						**2983**	**8.23**						**1765**	**1.74**
	1. Exploration	Oil produced	PJ	127	252 097	5 373	32	0.68	Oil produced	PJ	27	252097	5373	7	0.15
	2. Production	Oil produced	PJ	127	7 201	54 578	1	6.93	Oil produced	PJ	27	7201	54578	0.20	1.49
	3. Transport	Oil loaded	PJ	5 189	7	73	0.03	0.38	Oil loaded	PJ	1 722	5	55	0.01	0.09
	4. Refining and storage	Oil refined	PJ	3 194	923 744	75	2950	0.24	Oil refined	PJ	1 456	1207087	6	1757	0.01
	5. Distribution of oil products	Oil refined	PJ	3 785	NA	NA	NA	NA	Oil refined	PJ	3 270	NA	NA	NA	NA
	6. Other	NO	PJ	NO	NO	NO	NO	NO	NO	PJ	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		**1990**							**2020**						
	GHG source category	**Activity data**			**CO_2 Implied emission factor (kg/unit)**	**CH_4 Implied emission factor (kg/unit)**	**CO_2 emissions (kt)**	**CH_4 emissions (kt)**	**Activity data**			**CO_2 Implied emission factor (kg/unit)**	**CH_4 Implied emission factor (kg/unit)**	**CO_2 emissions (kt)**	**CH_4 emissions (kt)**
		Description	**Unit**	**Value**					**Description**	**Unit**	**Value**				
United Kingdom	**Oil**						**425**	**30.80**						**17**	**4.38**
	1. Exploration	Exploration drilling: fuel use	t	101 345	3 204	35	325	3.57	Exploration drilling: fuel use	t	2 063	3036	34	6	0.07
	2. Production	Oil produced	PJ	3 981	25 202	6 287	100	25.03	Oil produced	PJ	2 161	4758	1277	10	2.76
	3. Transport	Oil loading	t	82 418 243	0	0.03	0	2.18	Oil loading	t	75 902 819	0	0	0	1.52
	4. Refining and storage	Refinery throughput	PJ	3 862	NO	1	NO	0.00	Refinery throughput	PJ	2 100	NO	5	NO	0.01
	5. Distribution of oil products		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
	6. Other	Abandoned wells	Number of wells	6 328	NO	3	NO	0.02	Abandoned wells	Number of wells	13 553	NO	2	NO	0.03
Greece	**Oil**						**0.00004**	**0.39**						**0.00000**	**0.57**
	1. Exploration			NE	NO,NE	NE	NE	NE			NE	NO,NE	NE	NE	NE
	2. Production		kt	773	0.1	1	0.00004	0.00		kt	92	0.05	1	0.00000	0.00
	3. Transport		kt	773	NO,NE	27	NE	0.02		kt	92	NO,NE	27	NE	0.00
	4. Refining and storage		kt	14 411	IE,NO	26	IE	0.37		kt	22 241	NO,IE	26	IE	0.57
	5. Distribution of oil products		kt	2 450	NA,NO	NA	NA	NA		kt	1 803	NO,NA	NA	NA	NA
	6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
Croatia	**Oil**						**158**	**8.82**						**37**	**2.11**
	1. Exploration	total oil production	1000 m3	3 135	9 102	194	29	0.61	total oil production	1000 m3	735	9102	194	7	0.14
	2. Production	total oil production	1000 m3	3 135	41 225	2 546	129	7.98	total oil production	1000 m3	735	41225	2546	30	1.87
	3. Transport	total oil transported by pipelines	1000 m3	9 949	0.49	5	0.00	0.05	total oil transported by pipelines	1000 m3	7 942	0.49	5	0.004	0.04

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		1990							2020						
	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Description	Unit	Value				
	4. Refining and storage	oil refined	1000 m3	7 978	NO,NA	22	NA	0.17	oil refined	1000 m3	2 312	NO,NA	22	NA	0.05
	5. Distribution of oil products	product transported	NA	NA	NO,NA	NA	NA	NA	product transported	NA	NA	NO,NA	NA	NA	NA
	6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
Hungary	**Oil**						**5**	**7.14**						**1**	**1.98**
	1. Exploration		NA	IE	IE,NO	IE	IE	IE		NA	IE	NO,IE	IE	IE	IE
	2. Production	conventional oil production (thousand m3)	1000 m3	2 269	2 150	3 000	5	6.81	conventional oil production (thousand m3)	1000 m3	967	130	1801	0.1	1.74
	3. Transport	Oil transported by pipeline (thousand m3)	1000 m3	10 432	25	13	0.3	0.13	Oil transported by pipeline (thousand m3)	1000 m3	7 692	52	10	0.4	0.07
	4. Refining and storage	Oil refined (thousand m3)	1000 m3	9 357	NA,NO	22	NA	0.20	Oil refined (thousand m3)	1000 m3	7 717	NO,NA	22	NA	0.17
	5. Distribution of oil products		NA	NA	NA,NO	NA	NA	NA		NA	NA	NO,NA	NA	NA	NA
	6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
Ireland	**Oil**						**NO**	**0.01**						**NO**	**0.01**
	1. Exploration		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
	2. Production		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
	3. Transport		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
	4. Refining and storage		PJ	77	NO	110	NO	0.01		PJ	121	NO	110	NO	0.01
	5. Distribution of oil products		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
	6. Other		PJ	NO	NO	NO	NO	NO		PJ	NO	NO	NO	NO	NO
Iceland	**Oil**						**0.003**	**0.02**						**0**	**0.02**
	1. Exploration			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		1990								2020							
	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Description	Unit	Value				
	2. Production			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
	3. Transport			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
	4. Refining and storage			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
	5. Distribution of oil products	oil distributed	TJ	27 920	0.1	1	0.003	0.02	oil distributed	TJ	25 269	0.15	1	0.004	0.02
	6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO
Italy	**Oil**						**2402**	**12.39**						**1486**	**3.48**
Italy	1. Exploration	Wells drilled	Number	6	1 900	112	0.01	0.00	Wells drilled	Number	NO	NO	NO	NO	NO
Italy	2. Production	Oil produced	Gg	4 668	320	2 049	1	9.56	Oil produced	Gg	5 424	321	365	2	1.98
Italy	3. Transport	Oil transported	Gg	94 600	1	6	0.1	0.58	Oil transported	Gg	99 295	0.56	6	0.06	0.61
Italy	4. Refining and storage	Oil refined	Gg	93 711	25 615	24	2400	2.24	Oil refined	Gg	65 500	22659	13	1484	0.88
Italy	5. Distribution of oil products	Oil distributed	NA	NA	NA	NA	NA	NA	Oil distributed	NA	NA	NA	NA	NA	NA
Italy	6. Other	Other	NA	NO	NO	NO	NO	NO	Other	NA	NO	NO	NO	NO	NO
Lithuania	**Oil**						**23.3**	**0.17**						**180**	**0.09**
Lithuania	1. Exploration	Oil produced	thous.m3	14	9 102	194	0.1	0.00	Oil produced	thous.m3	36	9101.90	194	0	0.01
Lithuania	2. Production	Oil produced, thous.m3	thous.m3	14	0.1	2	0.0000 02	0.00	Oil produced, thous.m3	thous.m3	36	0.11	2	0.0000 0	0.00
Lithuania	3. Transport	Oil transported, thous.m3	thous.m3	25 577	0.5	5	0.01	0.14	Oil transported, thous.m3	thous.m3	10 988	0.49	5	0.01	0.06
Lithuania	4. Refining and storage	Oil refined	thous.m3	11 181	NO	3	NO	0.03	Oil refined	thous.m3	9 200	NO	3	NO	0.02
Lithuania	5. Distribution of oil products		NA	NA	NO,NA	NA	NA	NA		NA	NA	NO,NA	NA	NA	NA
Lithuania	6. Other	Refinery gas	kt	8	2 870 000	NO	23	NO	Refinery gas	kt	64	2798050.00	NO	180	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		**1990**							**2020**						
	GHG source category	**Activity data**			**CO_2 Implied emission factor (kg/unit)**	**CH_4 Implied emission factor (kg/unit)**	**CO_2 emissions (kt)**	**CH_4 emissions (kt)**	**Activity data**			**CO_2 Implied emission factor (kg/unit)**	**CH_4 Implied emission factor (kg/unit)**	**CO_2 emissions (kt)**	**CH_4 emissions (kt)**
		Description	**Unit**	**Value**					**Description**	**Unit**	**Value**				
Luxembourg	**Oil**						**NO**	**NO**						**NO**	**NO**
	1. Exploration	number of wells drilled	NA	NO	NO	NO	NO	NO	number of wells drilled	NA	NO	NO	NO	NO	NO
	2. Production	oil produced	NA	NO	NO	NO	NO	NO	oil produced	NA	NO	NO	NO	NO	NO
	3. Transport	oil loaded in tankers	NA	NO	NO	NO	NO	NO	oil loaded in tankers	NA	NO	NO	NO	NO	NO
	4. Refining and storage	oil refined	NA	NO	NO	NO	NO	NO	oil refined	NA	NO	NO	NO	NO	NO
	5. Distribution of oil products	oil refined	TJ	66 031	NO	NO	NO	NO	oil refined	TJ	100 585	NO	NO	NO	NO
	6. Other	other n.i.e.	NA	NO	NO	NO	NO	NO	other n.i.e.	NA	NO	NO	NO	NO	NO
Latvia	**Oil**						**NO,NA**	**NO,NA**						**NO,NA**	**NO,NA**
	1. Exploration	Exploration	kt	NO	NO	NO	NO	NO	Exploration	kt	NO	NO	NO	NO	NO
	2. Production	Production	kt	NO	NO	NO	NO	NO	Production	kt	NO	NO	NO	NO	NO
	3. Transport	Transport	kt	NO	NO	NO	NO	NO	Transport	kt	NO	NO	NO	NO	NO
	4. Refining and storage	Refining/Storage	kt	NO	NO	NO	NO	NO	Refining/Storage	kt	NO	NO	NO	NO	NO
	5. Distribution of oil products	Distribution of Oil Products	kt	609	NO,NA	NA	NA	NA	Distribution of Oil Products	kt	166	NO,NA	NA	NA	NA
	6. Other	Other	kt	NO	NO	NO	NO	NO	Other	kt	NO	NO	NO	NO	NO
Malta	**Oil**						**NO**	**NO**						**NO**	**NO**
	1. Exploration	number of wells drilled	NO	NO	NO	NO	NO	NO	number of wells drilled	NO	NO	NO	NO	NO	NO
	2. Production	oil produced	NO	NO	NO	NO	NO	NO	oil produced	NO	NO	NO	NO	NO	NO
	3. Transport	oil loaded in tankers	NO	NO	NO	NO	NO	NO	oil loaded in tankers	NO	NO	NO	NO	NO	NO
	4. Refining and storage	oil refined	NO	NO	NO	NO	NO	NO	oil refined	NO	NO	NO	NO	NO	NO
	5. Distribution of oil products	Gasoline	NO	NO	NO	NO	NO	NO	Gasoline	NO	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		1990							2020						
	GHG source category	Activity data: Description	Activity data: Unit	Activity data: Value	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data: Description	Activity data: Unit	Activity data: Value	CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
	6. Other	Other Petroleum Product	NO	NO	NO	NO	NO	NO	Other Petroleum Product	NO	NO	NO	NO	NO	NO
Netherlands	**Oil**						**0.02**	**0.81**						**826**	**0.63**
Netherlands	1. Exploration		NA	IE	NO,IE	IE	IE	IE		NA	IE	NO,IE	IE	IE	IE
Netherlands	2. Production		NA	IE	NO,IE	IE	IE	IE		NA	IE	NO,IE	IE	IE	IE
Netherlands	3. Transport	Amount of oil transported	Gg	33 912	1	6	0.02	0.20	Amount of oil transported	Gg	39 388	0.53	6	0.02	0.23
Netherlands	4. Refining and storage	Total amount of oil products	PJ	2 077	NO,IE	296	IE	0.61	Total amount of oil products	PJ	2 259	365897	179	826	0.40
Netherlands	5. Distribution of oil products		NA	NE	NA	NA	NA	NA		NA	NE	NO,NA	NA	NA	NA
Netherlands	6. Other		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
Poland	**Oil**						**2**	**1.40**						**10.14**	**4.54**
Poland	1. Exploration	NA	Gg	160	10 571	225	2	0.04	NA	Gg	937	10571.31	225	10	0.21
Poland	2. Production	Production	PJ	7	7 305	101 149	0	0.67	Production	PJ	39	5464	75651	0.21	2.94
Poland	3. Transport	oil ltransported by pipeline	Gg	13 286	1	6	0	0.08	oil ltransported by pipeline	Gg	25 843	0.57	6	0.01	0.16
Poland	4. Refining and storage	oil refined	Gg	12 846	NA	48	NA	0.61	oil refined	Gg	25 757	NA	48	NA	1.23
Poland	5. Distribution of oil products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Poland	6. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Portugal	**Oil**						**0.4**	**0.07**						**859**	**0.07**
Portugal	1. Exploration		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
Portugal	2. Production		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
Portugal	3. Transport		Mt	0.00	578 512	6 375 442 739	0.00001	0.07		Mt	0	578512	6375442740	0.00001	0.07
Portugal	4. Refining and storage		Mt	0.04	9 571 940	6	0.4	0.00		Mt	0	17146242394	6	859	0.00

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		1990							2020						
	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Description	Unit	Value				
	5. Distribution of oil products		Mt	0.001	NO	NO	NO	NO		Mt	0	NO	NO	NO	NO
	6. Other		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
Romania	**Oil**						**738**	**181.19**						**636**	**9.36**
	1. Exploration	oil produced	PJ	322	2 220 323	12 582	716	4.05	oil produced	PJ	141	259006	950	36	0.13
	2. Production	oil produced	PJ	322	69 542	547 400	22	176.40	oil produced	PJ	142	7509	62826	1	8.90
	3. Transport	oil refined	PJ	975	14	151	0.01	0.15	oil refined	PJ	439	14	149	0.01	0.07
	4. Refining and storage	oil refined	PJ	962	IE,NO	609	IE	0.59	oil refined	PJ	435	NO,IE	613	IE	0.27
	5. Distribution of oil products	oil refined	PJ	NO	NO	NO	NO	NO	oil refined	PJ	NO	NO	NO	NO	NO
	6. Other	oil refined	kt	NO	NO	IE	NO	IE	oil refined	kt	169	3537202	IE	598	IE
Slovakia	**Oil**						**0.03**	**0.59**						**0.01**	**0.33**
	1. Exploration		NO	NO	NO	NO	NO	NO		NO	NO	NO	NO	NO	NO
	2. Production	Production	kt	73	260	3 600	0.02	0.26	Production	kt	2	260	3600	0.001	0.01
	3. Transport	Transfer	kt	13 581	0.5	5	0.01	0.07	Transfer	kt	9 975	0.49	5	0.005	0.05
	4. Refining and storage	Refining/Storage	kt	6 221	NE	41	NE	0.26	Refining/Storage	kt	6 438	NE	41	NE	0.26
	5. Distribution of oil products		NA	NE	NO,NE	NE	NE	NE		NA	NE	NO,NE	NE	NE	NE
	6. Other		NA	NO	NO	NO	NO	NO		NA	NO	NO	NO	NO	NO
Slovenia	**Oil**						**0.03**	**0.01**						**0**	**NO,NA**
	1. Exploration	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3	NO	NO	NO	NO	NO
	2. Production	Conventional oil produced	1000 m3	3	0.04	1	0.0000001	0.00	Conventional oil produced	1000 m3	NO	NO	NO	NO	NO

1.B.2.a Fugitive CO_2 and CH_4 Emissions from Oil		1990							2020						
	GHG source category	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)	Activity data			CO_2 Implied emission factor (kg/unit)	CH_4 Implied emission factor (kg/unit)	CO_2 emissions (kt)	CH_4 emissions (kt)
		Description	Unit	Value					Description	Unit	Value				
	3. Transport	Consumption of LPG	1000 m3	58	430	NA	0.03	NA	Consumption of LPG	1000 m3	141	430	NA	0.06	NA
	4. Refining and storage	Oil refined	1000 m3	626	NO,NA	22	NA	0.01	Oil refined	1000 m3	NO	NO,NA	NO	NA	NO
	5. Distribution of oil products	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3	NO	NO	NO	NO	NO
	6. Other	NA	1000 m3	NO	NO	NO	NO	NO	NA	1000 m3	NO	NO	NO	NO	NO
Sweden	**Oil**						**255**	**0.48**						**402**	**0.37**
	1. Exploration	Consumption of feedstock	TJ	375	101 897	3	38	0.00	Consumption of feedstock	TJ	4 523	C,NA	C	C	C
	2. Production	Oil production		NO	NO	NO	NO	NO	Oil production		NO	NO	NO	NO	NO
	3. Transport	Transported amount of oil	m3	20 000 046	NE	0	NE	0.04	Transported amount of oil	m3	19 337 823	NE	0	NE	0.04
	4. Refining and storage	Consumption of crude oil	Mt	17	12 497 656	25 612	217	0.44	Consumption of crude oil	Mt	17	C,NA	C	C	C
	5. Distribution of oil products	Distribution of oil products		NE	NA	NA	NA	NA	Distribution of oil products		NE	NA	NA	NA	NA
	6. Other			NO	NO	NO	NO	NO			NO	NO	NO	NO	NO

Table 3.125 1.B.2.b Fugitive CH_4 emissions from natural gas: Information on activity data, emission factors by Member State

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
Austria	**Natural Gas**					**10.36**					**8.48**
	1. Exploration	Mm3 natural gas	Mm3	1288.00	IE	IE	Mm3 natural gas	Mm3	743.00	IE	IE
	2. Production	Mm3 natural gas	Mm3	1288.00	4478.94	5.77	Mm3 natural gas	Mm3	743.00	4256.55	3.16
	3. Processing	Mm3 natural gas	Mm3	248.09	NA	NA	Mm3 natural gas	Mm3	219.61	NA	NA
	4. Transmission and storage	km pipeline length	km	3628.00	718.43	2.61	km pipeline length	km	7230.07	531.96	3.85
	5. Distribution	km distribution network length	km	11672.00	170.22	1.99	km distribution network length	km	30568.83	48.01	1.47
	6. Other	Mm3 natural gas stored	Mm3	NO	NO	NO	Mm3 natural gas stored	Mm3	NO	NO	NO
Belgium	**Natural Gas**					**28.38**					**18.59**
	1. Exploration	Not occuring	PJ	NO	NO	NO	Not occuring	PJ	NO	NO	NO
	2. Production	Not occuring	PJ	NO	NO	NO	Not occuring	PJ	NO	NO	NO
	3. Processing	Not occuring	PJ	NO	NO	NO	Not occuring	PJ	NO	NO	NO
	4. Transmission and storage	Gas consumed	PJ	341.98	16693.69	5.71	Gas consumed	PJ	618.66	6837.58	4.23
	5. Distribution	Gas consumed	PJ	341.98	66287.85	22.67	Gas consumed	PJ	618.66	23204.65	14.36
	6. Other	Not occuring	PJ	NO	NO	NO	Not occuring	PJ	NO	NO	NO
Bulgaria	**Natural Gas**					**5.84**					**10.40**
	2. Exploration	Indigenous production	10^6m^3	14.00	60.00	0.00	Indigenous production	10^6m^3	57.48	60.00	0.00
	3. Production	Indigenous production	10^6m^3	14.00	2540.00	0.04	Indigenous production	10^6m^3	57.48	2540.00	0.15
	4. Processing	Indigenous production	10^6m^3	14.00	570.00	0.01	Indigenous production	10^6m^3	57.48	570.00	0.03

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
	5. Transmission and storage	Pipeline length	km	1469.00	2123.34	3.12	Pipeline length	km	3275.00	2116.57	6.93
	6. Distribution	Pipeline length	km	50.00	230.00	0.01	Pipeline length	km	5292.00	230.00	1.22
	7. Other	Natural gas consumption at energy and industrial plants	10^6m^3	6610.22	403.27	2.67	Natural gas consumption at energy and industrial plants	10^6m^3	2511.12	825.54	2.07
Cyprus	**Natural Gas**					**NO**					**NO**
	2. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
	3. Production		NO	NO	NO	NO		NO	NO	NO	NO
	4. Processing		NO	NO	NO	NO		NO	NO	NO	NO
	5. Transmission and storage		NO	NO	NO	NO		NO	NO	NO	NO
	6. Distribution		NO	NO	NO	NO		NO	NO	NO	NO
	7. Other		NO	NO	NO	NO		NO	NO	NO	NO
Czechia	**Natural Gas**					**41.80**					**23.16**
	2. Exploration		PJ	NE	NE	NE		PJ	NE	NE	NE
	3. Production	(e.g. PJ gas produced)	PJ	7.84	39365.45	0.31	(e.g. PJ gas produced)	PJ	6.68	38649.05	0.26
	4. Processing		PJ	NO	NA	NA		PJ	NO	NA	NA
	5. Transmission and storage	(e.g. PJ gas consumed)	PJ	1357.98	9296.21	12.62	(e.g. PJ gas consumed)	PJ	1500.11	4404.98	6.61
	6. Distribution	(e.g. PJ gas consumed)	PJ	55.77	517563.35	28.86	(e.g. PJ gas consumed)	PJ	125.99	129301.37	16.29
	7. Other	(e.g. PJ gas consumed)	PJ	29.68	IE	IE	(e.g. PJ gas consumed)	PJ	172.40	IE	IE
Germany	**Natural Gas**					**319.90**					**190.60**
	3. Exploration	number of wells drilled	number	IE	IE	IE	number of wells drilled	number	IE	IE	IE

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
	4. Production	gas produced	1000 m³	15262000.00	0.38	5.80	gas produced	1000 m³	5155390.67	0.05	0.26
	5. Processing	gas produced	1000 m³	15262000.00	0.35	5.34	gas produced	1000 m³	5155390.67	0.02	0.10
	6. Transmission and storage	lenght of transmission pipelines	km	22696.00	1998.74	45.36	lenght of transmission pipelines	km	33809.00	2140.49	72.37
	7. Distribution	lenght of distribution pipelines	km	282612.00	828.87	234.25	lenght of distribution pipelines	km	503543.00	175.89	88.57
	8. Other	gas consumed	TJ	893519.00	32.62	29.15	gas consumed	TJ	1266816.97	23.13	29.30
Denmark	**Natural Gas**					**2.38**					**190.60**
	3. Exploration	Gas explored	m3	2892052.00	0.01	0.03	Gas explored	m3	NO	NO	NO
	4. Production	Gas produced	10^6 m3	5137.00	380.00	1.95	Gas produced	10^6 m3	1396.00	380.00	0.53
	5. Processing	Gas produced	10^6 m3	5137.00	NA	NA	Gas produced	10^6 m3	1396.00	NA	NA
	6. Transmission and storage	Gas transmission	10^6 m3	2739.00	52.22	0.14	Gas transmission	10^6 m3	3051.00	64.27	0.20
	7. Distribution	Gas distributed	10^6 m3	1749.06	145.93	0.26	Gas distributed	10^6 m3	2082.45	67.95	0.14
	8. Other	Incl. In transmission	m3	NO	NO	NO	Incl. In transmission	m3	NO	NO	NO
Spain	**Natural Gas**					**5.42**					**5.54**
	3. Exploration	Mm3 gas produced	Mm3	NO	NO	NO	Mm3 gas produced	Mm3	NO	NO	NO
	4. Production	Mm3 gas produced	Mm3	1254.88	464.56	0.58	Mm3 gas produced	Mm3	51.34	2115.02	0.11
	5. Processing	Mm3 gas produced	Mm3	1254.88	150.00	0.19	Mm3 gas produced	Mm3	51.34	150.00	0.01
	6. Transmission and storage	PJ gas (NCV)	PJ	198.34	5889.64	1.17	PJ gas (NCV)	PJ	1166.77	1512.00	1.76

1.B.2.b Fugitive CH_4 Emissions from Natural gas		**1990**					**2020**				
GHG source category		**Activity data**			**Implied emission factor (kg/unit)**	**CH_4 emissions (kt)**	**Activity data**			**Implied emission factor (kg/unit)**	**CH_4 emissions (kt)**
		Description	**Unit**	**Value**			**Description**	**Unit**	**Value**		
	7. Distribution	PJ of gaseous fuels (natural gas, LPG, gas work gas or propanized air) distributed by networks	PJ	205.75	16936.99	3.48	PJ of gaseous fuels (natural gas, LPG, gas work gas or propanized air) distributed by networks	PJ	1179.26	3101.71	3.66
	8. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Estonia	**Natural Gas**					**2.24**					**0.65**
	4. Exploration	Exploration	NA	NO	NO	NO	Exploration	NA	NO	NO	NO
	5. Production	Production	NA	NO	NO	NO	Production	NA	NO	NO	NO
	6. Processing	Processing	NA	NO	NO	NO	Processing	NA	NO	NO	NO
	7. Transmission and storage	Amount of the transmission of Natural Gas	PJ	51.23	5734.64	0.29	Amount of the transmission of Natural Gas	PJ	14.93	5734.64	0.09
	8. Distribution	Amount of natural gas distributed	PJ	51.23	38000.60	1.95	Amount of natural gas distributed	PJ	14.93	38000.60	0.57
	9. Other	Other	NA	NO	NO	NO	Other	NA	NO	NO	NO
Finland	**Natural Gas**					**0.17**					**0.53**
	4. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
	5. Production		NO	NO	NO	NO		NO	NO	NO	NO
	6. Processing		NA	NO	NO	NO		NA	NA	NO	NO
	7. Transmission and storage	PJ gas consumed	PJ	90.76	1873.15	0.17	PJ gas consumed	PJ	72.25	2625.74	0.19
	8. Distribution	PJ gas distributed	NO	NO	NO	NO	PJ gas distributed	NO	20.52	16569.20	0.34
	9. Other		NO	NO	NO	NO		NO	NO	NO	NO
France	**Natural Gas**					**60.81**					**30.52**
	4. Exploration	NO	PJ	NO	NO	NO	NO	PJ	NO	NO	NO
	5. Production	NO	PJ	IE	IE	IE	NO	PJ	IE	IE	IE
	6. Processing	Gas processed	PJ	309.00	2376.20	0.73	Gas processed	PJ	6.12	303.96	0.00

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
	7. Transmission and storage	Gas consumed	PJ	1091.00	24425.57	26.65	Gas consumed	PJ	1469.61	7395.27	10.87
	8. Distribution	Gas consumed	PJ	1091.00	30640.07	33.43	Gas consumed	PJ	1469.61	13367.65	19.65
	9. Other	NO	PJ	NO	NO	NO	NO	PJ	NO	NO	NO
United Kingdom	**Natural Gas**					**424.03**					**133.49**
	5. Exploration	Exploration drilling: fuel use	t	97495.66	35.00	3.41	Exploration drilling: fuel use	t	2063.90	28.97	0.06
	6. Production	Gas produced	PJ	1709.37	183.38	0.31	Gas produced	PJ	1420.19	1181.64	1.68
	7. Processing	Gas produced	PJ	1709.37	22731.16	38.86	Gas produced	PJ	1420.19	1203.31	1.71
	8. Transmission and storage	Natural gas supply	GWh	387730.56	23.71	9.19	Natural gas supply	GWh	488233.80	6.02	2.94
	9. Distribution	Natural gas supply	GWh	387730.56	960.08	372.25	Natural gas supply	GWh	488233.80	260.34	127.11
	10. Other		NA	NO	NO	NO		NA	NO	NO	NO
Greece	**Natural Gas**					**0.37**					**3.51**
	5. Exploration			NE	NE	NE			NE	NE	NE
	6. Production		mil_m3	123.00	1930.00	0.24		mil_m3	6.48	1930.00	0.01
	7. Processing		mil_m3	123.00	IE	IE		mil_m3	6.48	IE	IE
	8. Transmission and storage		mil m3	123.00	298.00	0.04		mil m3	5830.89	298.00	1.74
	9. Distribution		mil m3	86.24	1100.00	0.09		mil m3	1597.71	1100.00	1.76
	10. Other			IE	IE	IE			IE	IE	IE
Cro	**Natural Gas**					**5.54**					**4.04**

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
	5. Exploration	Natural gas production	1000000 m3	1982.30	IE	IE	Natural gas production	1000000 m3	849.00	IE	IE
	6. Production	gas produced	1000000 m3	1982.30	1340.76	2.66	gas produced	1000000 m3	849.00	1340.76	1.14
	7. Processing	gas produced	1000000 m3	1982.30	592.00	1.17	gas produced	1000000 m3	849.00	592.00	0.50
	8. Transmission and storage	marketable gas	1000000 m3	2686.60	480.00	1.29	marketable gas	1000000 m3	3040.70	480.00	1.46
	9. Distribution	utility sales	1000000 m3	379.30	1100.00	0.42	utility sales	1000000 m3	851.00	1100.00	0.94
	10. Other		NO	NO	NO	NO		NO	NO	NO	NO
Hungary	**Natural Gas**					**63.07**					**52.89**
	6. Exploration		NA	IE	IE	IE		NA	IE	IE	IE
	7. Production	Gas production (million m3)	million m3	4874.00	1340.00	6.53	Gas production (million m3)	million m3	1708.00	1340.00	2.29
	8. Processing	Sweet gas plants-raw gas feed (million m3)	million m3	1593.00	940.86	1.50	Sweet gas plants-raw gas feed (million m3)	million m3	597.80	935.14	0.56
	9. Transmission and storage	Marketable gas (million m3)	million m3	11278.00	2540.35	28.65	Marketable gas (million m3)	million m3	13901.00	921.42	12.81
	10. Distribution	length of pipelines	km	22559.00	1170.00	26.39	length of pipelines	km	84906.00	438.48	37.23
	11. Other		NO	NO	NO	NO		NO	NO	NO	NO
Ireland	**Natural Gas**					**0.88**					**2.71**
	6. Exploration	Natural gas exploration	PJ	NO	NO	NO	Natural gas exploration	PJ	NO	NO	NO
	7. Production		PJ	78.58	0.32	0.00		PJ	69.27	15.88	0.00
	8. Processing		PJ	IE	IE	IE		PJ	IE	IE	IE
	9. Transmission and storage		PJ	78.93	1608.49	0.13		PJ	211.27	1692.83	0.36
	10. Distribution		PJ	37.35	20067.10	0.75		PJ	99.98	23502.31	2.35

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
	11. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
Iceland	**Natural Gas**					**NO**					**NO**
Iceland	6. Exploration	Natural gas exploration	PJ	NO	NO	NO	Natural gas exploration	PJ	NO	NO	NO
Iceland	7. Production		PJ	NO	NO	NO		PJ	NO	NO	NO
Iceland	8. Processing		PJ	NO	NO	NO		PJ	NO	NO	NO
Iceland	9. Transmission and storage		PJ	NO	NO	NO		PJ	NO	NO	NO
Iceland	10. Distribution		PJ	NO	NO	NO		PJ	NO	NO	NO
Iceland	11. Other		PJ	NO	NO	NO		PJ	NO	NO	NO
Italy	**Natural Gas**					**329.45**					**122.93**
Italy	6. Exploration	Wells explored	Number	36.00	158.15	0.01	Wells explored	Number	NO	NO	NO
Italy	7. Production	Gas produced	Mm3	17296.39	1726.36	29.86	Gas produced	Mm3	4417.14	114.25	0.50
Italy	8. Processing	Gas produced	Mm3	17296.39	773.26	13.37	Gas produced	Mm3	4417.14	51.16	0.23
Italy	9. Transmission and storage	Gas transported	Mm3	45683.58	822.12	37.56	Gas transported	Mm3	69970.00	314.46	22.00
Italy	10. Distribution	Gas distributed	Mm3	20632.00	12051.86	248.65	Gas distributed	Mm3	31630.10	3167.71	100.19
Italy	11. Other	other	NA	NO	NO	NO	other	NA	NO	NO	NO
Lithuania	**Natural Gas**					**10.42**					**9.94**
Lithuania	7. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
Lithuania	8. Production		NO	NO	NO	NO		NO	NO	NO	NO
Lithuania	9. Processing		NO	NO	NO	NO		NO	NO	NO	NO
Lithuania	10. Transmission and storage	Natural gas leakages	kt	2.01	977699.00	1.97	Natural gas leakages	kt	2.34	951692.00	2.23

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
	11. Distribution	Natural gas leakages	kt	8.65	977699.00	8.46	Natural gas leakages	kt	8.04	951692.00	7.65
	12. Other	Natural gas leakages	NO	NO	NO	NO	Natural gas leakages	NO	0.07	951692.00	0.07
Luxembourg	**Natural Gas**					**1.11**					**1.11**
	7. Exploration	gas exploration	NA	NO	NO	NO	gas exploration	NA	NO	NO	NO
	8. Production	gas produced	NA	NO	NO	NO	gas produced	NA	NO	NO	NO
	9. Processing	NO	NA	NO	NO	NO	NO	NA	NO	NO	NO
	10. Transmission and storage	gas consumed	TJ	26013.71	12.98	0.34	gas consumed	TJ	26013.71	12.98	0.34
	11. Distribution	gas consumed	TJ	26013.71	29.75	0.77	gas consumed	TJ	26013.71	29.75	0.77
	12. Other	NO	NA	NO	NO	NO	NO	NA	NO	NO	NO
Latvia	**Natural Gas**					**7.09**					**3.32**
	7. Exploration	Exploration	m3	NO	NO	NO	Exploration	m3	NO	NO	NO
	8. Production	Production	m3	NO	NO	NO	Production	m3	NO	NO	NO
	9. Processing	Processing	m3	NO	NO	NO	Processing	m3	NO	NO	NO
	10. Transmission and storage	Transmission and storage	m3	125172.00	0.69	0.09	Transmission and storage	m3	12252.00	0.68	0.01
	11. Distribution	Distribution	m3	694188.00	0.69	0.48	Distribution	m3	758435.00	0.65	0.49
	12. Other	Other	m3	12435406.00	0.52	6.53	Other	m3	4320486.00	0.65	2.82
Malta	**Natural Gas**					**NO**					**NO**
	8. Exploration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	9. Production	gas produced	NO	NO	NO	NO	gas produced	NO	NO	NO	NO
	10. Processing	gas processed	no	NO	NO	NO	gas processed	no	NO	NO	NO

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
	11. Transmission and storage	gas consumed	NO	NO	NO	NO	gas consumed	NO	NO	NO	NO
	12. Distribution	gas consumed	NO	NO	NO	NO	gas consumed	NO	NO	NO	NO
	13. Other	gas consumed	NO	NO	NO	NO	gas consumed	NO	NO	NO	NO
Netherlands	**Natural Gas**					**16.84**					**9.43**
Netherlands	8. Exploration		NA	NA	IE	IE		NA	NA	IE	IE
Netherlands	9. Production	Gas produced	mln m3	72131.00	IE	IE	Gas produced	mln m3	22831.00	IE	IE
Netherlands	10. Processing		NA	IE	IE	IE		NA	IE	IE	IE
Netherlands	11. Transmission and storage	Gas transmitted	PJ	2648.08	4121.34	10.91	Gas transmitted	PJ	3006.00	1330.67	4.00
Netherlands	12. Distribution	Length distribution network	10^3 km	99.98	59294.88	5.93	Length distribution network	10^3 km	125.28	43378.35	5.43
Netherlands	13. Other		NA	NA	NO	NO		NA	NA	NO	NO
Poland	**Natural Gas**					**30.13**					**50.80**
Poland	8. Exploration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Poland	9. Production	Production	10^6m3	3218.20	2300.00	7.40	Production	10^6m3	4393.66	2289.59	10.06
Poland	10. Processing		10^6m3	3218.20	1030.00	3.31		10^6m3	4393.66	1030.00	4.53
Poland	11. Transmission and storage	gas consumed	10^6m3	12096.03	505.00	6.11	gas consumed	10^6m3	22560.92	505.00	11.39
Poland	12. Distribution	gas consumed	10^6m3	12096.03	1100.00	13.31	gas consumed	10^6m3	22560.92	1100.00	24.82
Poland	13. Other	NA	NA	NO	NO	NO	NA	NA	NO	NO	NO
Portugal	**Natural Gas**					**NO**					**2.00**
Portugal	9. Exploration		NO	NO	NO	NO		NO	NO	NO	NO
Portugal	10. Production		NO	NO	NO	NO		NO	NO	NO	NO

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
	11. Processing		NO	NO	NO	NO		NO	NO	NO	NO
	12. Transmission and storage		toe NG Transmitted	NO	NO	NO		toe NG Transmitted	5077.71	10.92	0.06
	13. Distribution		toe NG Distributed	NO	NO	NO		toe NG Distributed	1714.29	1135.92	1.95
	14. Other		NO	NO	NO	NO		NO	NO	NO	NO
Romania	**Natural Gas**					**647.35**					**46.87**
	9. Exploration	gas produced	PJ	IE	IE	IE	gas produced	PJ	IE	IE	IE
	10. Production	gas produced	106m3	28336.00	12190.00	345.42	gas produced	106m3	8914.19	1340.00	11.95
	11. Processing	gas produced and processed	106m3	28336.00	250.00	7.08	gas produced and processed	106m3	8914.19	590.00	5.26
	12. Transmission and storage	gas produced	106m3	35667.00	633.00	22.58	gas produced	106m3	12995.42	232.31	3.02
	13. Distribution	gas supplied	106m3	35667.00	1800.00	64.20	gas supplied	106m3	11058.54	1100.00	12.16
	14. Other	gas consumed	PJ	809.19	257135.36	208.07	gas consumed	PJ	240.93	60105.44	14.48
Slovakia	**Natural Gas**					**44.14**					**7.00**
	9. Exploration		NA	NO	NO	NO		NA	NO	NO	NO
	10. Production	Production/Processing	mil m3	444.00	2300.00	1.02	Production/Processing	mil m3	65.26	2300.00	0.15
	11. Processing		mil m3	444.00	1030.00	0.46		mil m3	65.26	1030.00	0.07
	12. Transmission and storage	Transfer	mil m3	73600.00	480.00	35.33	Transfer	mil m3	56980.00	18.60	1.06
	13. Distribution	Distribution	mil m3	6666.00	1100.00	7.33	Distribution	mil m3	5003.88	1100.00	5.50

1.B.2.b Fugitive CH_4 Emissions from Natural gas		1990					2020				
GHG source category		Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)	Activity data			Implied emission factor (kg/unit)	CH_4 emissions (kt)
		Description	Unit	Value			Description	Unit	Value		
	14. Other	Storage	mil m3	1.00	25.00	0.00	Storage	mil m3	2783.82	79.25	0.22
Slovenia	**Natural Gas**					**1.70**					**1.34**
	10. Exploration	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
	11. Production	Gas production	1000 m3	23631.00	12.19	0.29	Gas production	1000 m3	5350.00	1.34	0.01
	12. Processing	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
	13. Transmission and storage	Marketable gas	1000 m3	892000.60	0.48	0.43	Marketable gas	1000 m3	903450.00	0.37	0.34
	14. Distribution	Utility sale	1000 m3	892000.60	1.10	0.98	Utility sale	1000 m3	903450.00	1.10	0.99
	15. Other	NA	1000 m3	NO	NO	NO	NA	1000 m3	NO	NO	NO
Sweden	**Natural Gas**					**2.69**					**1.38**
	10. Exploration	Gas produced		NO	NO	NO	Gas produced		NO	NO	NO
	11. Production	Gas produced		NO	NO	NO	Gas produced		NO	NO	NO
	12. Processing	Gas produced		NO	NO	NO	Gas produced		NO	NO	NO
	13. Transmission and storage	Length of transmission pipelines	km	NA	NA	0.05	Length of transmission pipelines	km	NA	NA	0.08
	14. Distribution	Length of distribution pipelines	km	NA	NA	2.65	Length of distribution pipelines	km	NA	NA	1.30
	15. Other			NO	NO	NO			NO	NO	NO

3.2.6.3 CO_2 Emissions from Venting and Flaring (1.B.2.c)

Fugitive emissions from this source correspond to Emissions from venting and flaring of associated gas and waste gas/vapour streams at oil and gas facilities.

CO_2 emissions from 1.B.2.c – Venting and Flaring – account for 0.2% of total EU-KP GHG emissions in 2020 and for 8 % of all fugitive emissions in the EU-KP. Between 1990 and 2020 CO_2 emissions from this source decreased by 39%.

All but three countries (Austria, Cyprus, Malta) - are reporting CO_2 emissions in this category.

In 2020, 50% of the EU-KP CO_2 emissions from 1.B.2.c were emitted by the UK (Table 3.126, Figure 3.183). Main source for CO_2 emissions from this category in the UK is the flaring of oil, which is estimated by applying a Tier 3 methodology with country specific and plant specific emission factors. Table 3.126 shows that 77 % of EU-KP emissions are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (FRK, HUN, ESP) only emissions from subcategories of sector 1.B.2.b were taken into account for the calculation, where the countries actually apply a higher tier method. Countries that report a Tier 1 method but a country specific or plant specific emission factor (SVK) were calculated as a higher Tier method, according to the IPCC 2006 Guidelines.

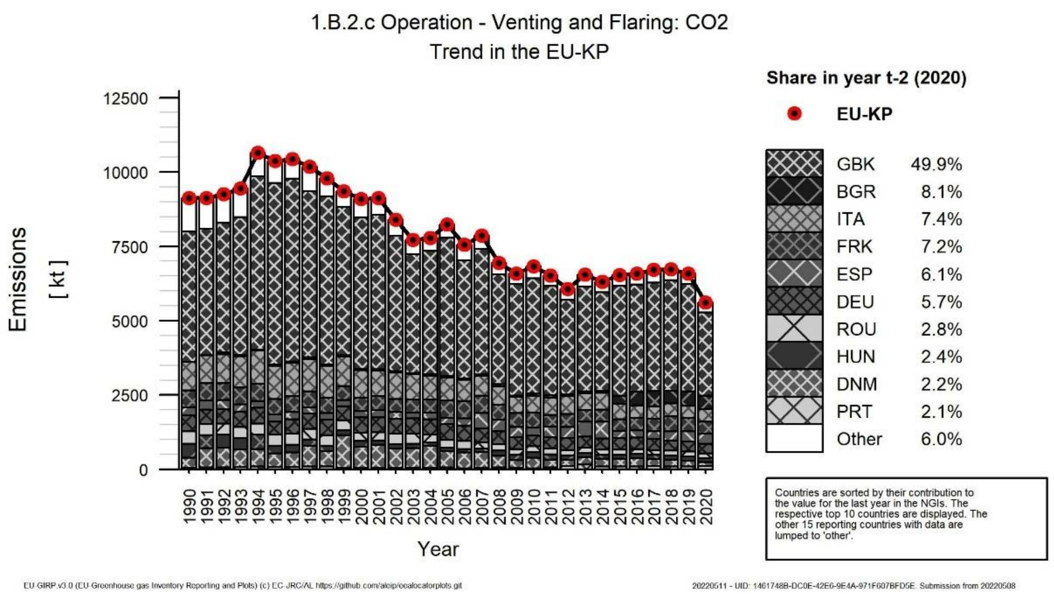
The emission decreases between 1990 and 2020 observed in the Netherlands (-96%), Italy (-56%), Germany (-41%), Hungary (-72%) and Romania (-63 %) contributed most significantly to the overall reduction in the EU-KP between 1990 and 2020.

Table 3.126: 1.B.2.c Fugitive CO_2 emissions from Other emissions: Countries' contributions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	84	116	101	1.8%	17	20%	-15	-13%	T3	PS
Bulgaria	NO,IE	497	454	8.1%	454	∞	-43	-9%	T1	D
Croatia	0	0	0	0.0%	0	-92%	0	11%	T1	D
Cyprus	NO,NE	NO	NO	-	-	-	-	-	NA	NA
Czechia	2	3	4	0.1%	2	88%	0	14%	T1	D
Denmark	328	195	126	2.2%	-202	-62%	-69	-35%	T3	PS
Estonia	0	0	0	0.0%	0	-71%	0	-11%	T1	D
Finland	111	65	76	1.4%	-34	-31%	11	17%	CS	CS
France	560	456	405	7.2%	-155	-28%	-50	-11%	T1,T2,T3	CS,D,PS
Germany	544	345	321	5.7%	-222	-41%	-24	-7%	T2	CS
Greece	43	9	5	0.1%	-38	-89%	-4	-45%	T1	D
Hungary	471	139	132	2.4%	-339	-72%	-7	-5%	T1,T3	CS,D
Ireland	NO	0	0	0.0%	0	∞	0	15%	CS,T3	CS,PS
Italy	956	396	418	7.4%	-538	-56%	22	6%	T1	D
Latvia	0	0	0	0.0%	0	2%	0	52%	T3	CS
Lithuania	1	2	1	0.0%	1	159%	0	-22%	T1	D
Luxembourg	0	0	0	0.0%	0	28%	0	31%	CS	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	774	36	33	0.6%	-741	-96%	-3	-7%	T2	PS
Poland	44	76	81	1.5%	38	87%	5	7%	T1	D
Portugal	52	97	116	2.1%	63	120%	19	20%	NO	NO
Romania	424	161	155	2.8%	-268	-63%	-6	-4%	T1	D
Slovakia	5	1	1	0.0%	-4	-88%	0	-33%	T1	CS
Slovenia	0	0	0	0.0%	0	-95%	0	-65%	T1	D
Spain	275	342	345	6.1%	70	26%	3	1%	CS,T1,T2	CS,D,PS
Sweden	73	59	37	0.7%	-37	-50%	-22	-38%	T2,T3	CS,PS
United Kingdom	4 383	3 600	2 799	49.9%	-1 583	-36%	-801	-22%	T3	CS,PS
EU-27+UK	**9 128**	**6 593**	**5 611**	**100%**	**-3 516**	**-39%**	**-982**	**-15%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 383	3 600	2 799	49.9%	-1 583	-36%	-801	-22%	T3	CS,PS
EU-KP	**9 128**	**6 593**	**5 611**	**100%**	**-3 516**	**-39%**	**-982**	**-15%**	**-**	**-**

Note: Austria includes CO_2 emissions from venting and flaring in 1.A.1b Petroleum refining

Figure 3.183: 1.B.2.c Venting and Flaring: Emission trend and share for the emitting countries of CO_2



3.2.6.4 Emissions from Other (1.B.2.d)

Fugitive emissions from other correspond to emissions from geothermal energy production and all other energy production that are not included in categories 1.B.1 and 1.B.2.

Seven countries report CO_2 emissions in this sector, four are reporting CH_4 emissions and three countries report N_2O emissions. The description of the subcategories is presented in Table 3.127.

Table 3.127 Description of subcategories in sector 1.B.2.d for CO_2-, N_2O- and CH_4-emissions for reporting countries

Member state	Emission	Subcategory
Finland	CO_2, CH_4	Distribution of town gas
Greece	CO_2, N_2O	LPG transport
Hungary	CH_4, CO_2	Groundwater extraction and CO_2 mining
Iceland	CH_4, CO_2	Geothermal Energy
Italy	CH_4, CO_2, N_2O	Flaring in refineries
Poland	CO_2	Underground storage of gas
Portugal	CO_2	Geothermal
United Kingdom	N_2O	Natural gas exploration: N_2O emissions

Table 3.128 and Table 3.129 provide information on the contribution of countries to EU-KP recalculations in CO_2 and CH_4 from 1.B.2 'Oil and natural gas' for 1990 and 2019 and main explanations for the largest recalculations in absolute terms.

Table 3.128 1.B.2 Fugitive CO_2 emissions from Oil and natural gas: Contribution of countries to EU-KP recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	0.001	0.001	0.001	0.001	Activity data in 1.B.2.a.3 Transport of oil had to be converted from unit tonnes to unit cubic metres, resulting in revised CH_4 and CO_2 emissions over the whole time series (e.g. 2019: +0.24 kt CO_2e). Moreover, small recalculations were reported for category 1.B.2.b (e.g. 2019: -0.01 kt CO_2e) as some transcription and rounding errors were identified and corrected.	
Belgium	-	-	-	-		
Bulgaria	-	-	0.1	0.01		As petroleum coke is combusted in order to restore the catalyst's activity and not for energy purposes, all GHG emissions from petroleum coke, which were previously reported under CRF subcategory 1.A.1.b were reallocated under CRF subcategory 1.B.2.a.4.
Croatia	-	-	83	40.9		For the category 1B2 Fugitive Emissions from Natural Gas CO_2 emission from Ivanić Grad fraction facility has been added. In addition to Molve, gas has been processed since 2013 at the Ivanić Grad faction facility as well. CO_2 emission data were obtained directly from the operator via a questionnaire. Recalculation is performed for the period 2013 -2019.
Cyprus	-	-	-	-		
Czechia	-0.004	-0.2	-0.03	-0.8	No explanation provided	

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Denmark	-0.2	-0.1	0.05	0.03	CO_2 emissions from catalytic regeneration at refineries have been added as a new source: The CO_2 emission factors have been updated for flaring in gas storage for the entire time series, and for flaring in gas transmission and distribution for 2011- 2019. The CO_2 emission factor for offshore flaring in oil and gas production has been corrected (change of rounding) for 2017-2019.	
Estonia	-0.0	-0.002	0.001	1.8	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance and venting category was added.	
Finland	-	-	-0.04	-0.1		Point source data in 1.B.2c was corrected for 2006 (-0.04 kt CO_2), 2012 (-0.05 kt CO_2) and 2019 (-0.04 kt CO_2).
France	-	-	-	-		
Germany	-	-	0.1	0.004		Update of statistical data. In addition, in the reporting 2022 for the first time emissions from the refueling of motor-driven boats using canisters are taken into account. Furthermore, the category "Storage of petroleum products" was divided into storage of fuels (1.B.2) and storage of chemical products (2.B.10) according to the IPCC Guidelines
Greece	-	-	-	-		
Hungary	-	-	15	12.1	Emissions from flaring in the refinery was omitted by mistake in the previous inventory. In addition, activity data have been revised for groundwater extraction, and the same country-specific emission factor: 4.5 t CH_4/million m3 groundwater, has been applied for the whole time series.	
Ireland	0.0004	6.9	0.01	3.4	Ireland has reallocated the emissions from natural gas transmission (category 1.B.2.b.4) and distribution (category 1.B.2.b.5), reporting emissions separately by applying the Gas Networks Ireland splits consistently and as accurately as possible across the whole time series	
Italy	-	-	-0.4	-0.0		1.B.2.a; 1.B.2.c Venting, oil; 1.B.2.c Flaring, oil – Updated data have been provided by oil&gas company concerning upstream emissions since 2016; 1.B.2.d Geotherm - The recalculation affects the years 2019 for the update of a provisional emission factor used in the previous submission.
Latvia	-	-	-	-		
Lithuania	-	-	0.00002	0.00001		correction of activity data in 1.B.2.b.4 for natural gas leakages (transmission network) in 2015, 2017 and 2019 based on updated information provided by Amber Grid AB
Luxembourg	-	-	-0.0001	-0.2		CH_4 and CO_2 content of natural gas, for 2019, was revised to reflect the measured value as reported by the operator. Emissions were increased by 0.0003 Gg CO_2 eq. in 2019.
Malta	-	-	-	-		
Netherlands	-	-	-	-		
Poland	1.7	3.6	-2.1	-0.1	Recalculations for the years 1988-2019 was made. Emission changes for subcategory 1.B.2 are presented in table below. Recalculations for this years was made as the result of: – revision and updating of historical activities according to EUROSTAT, – correction of two emission factors, – new emission estimation from oil exploration	

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Portugal	-	-	-	-		
Romania	-8	-0.7	270	45.6	Recalculations have been made for the year 1989, because of a transcription error at the value of the emission factors from IPCC 2006 GL on 1B2a1 category - Oil, Exploration.	Recalculation have been performed for the 2007-2019 period, as a result of the revised estimate on 1B2a6 category – Oil, Other, included in the 2022 NGHGI submission, and the actualisation of the activity data, based on revised Energy Balance 1990 - 2019
Slovakia	-	-	-0.02	-1.7		Natural gas production in the category 1.B.2.b.2 for the years 2010 – 2019 was revised by the new data provided directly by the Nafta, a. s. company. Natural gas storage in the category 1.B.2.b.6 for the years 2010 – 2019 revised by the new data provided directly by the Nafta, a. s. company Crude oil production in the category 1.B.2.a.2 for the years 2010 – 2019 was provided directly by the Nafta, a. s. company.
Slovenia	-	-	0.003	1.9		1.B.2.Venting and Flaring, CO_2, CH_4, N_2O For the year 2019 updated data for natural gas production and use has been obtain and fugitive GHG emissions for 2019 have been recalculated accordingly.
Spain	-	-	0.02	0.001		New gas transportation companies have been added.
Sweden	-0.0001	-0.00003	0.005	0.001	Hydrogen production at refineries. Amounts of feedstocks have been estimated for all facilities and included in the reporting; Gas transmission. Correction of earlier assumed share of biogas in the network resulted in the annual increase of CO_2 by 0.00007-0.0004 kt (4-31% within the category) compared to submission 2021. Gas venting in transmission/distribution networks. Small correction in activity data for 2019 has resulted in the decrease of GHG emissions (CH_4, CO_2) by 0.002 kt CO_2-ekv. (0.8% in the emission category) Gas flaring in gas transmission/distribution networks. Correction of earlier assumed share of biogas in the network resulted in the annual increase of CO_2 by 0.0001-0.003 kt (4-31% within the category) compared to submission 2021. Gas distrubution. Correction of earlier assumed share of biogas in the network resulted in the annual increase of CO_2 by 0.0004-0.001 kt (1-5% within the category) compared to submission 2021	
United Kingdom	-689	-11.9	-80	-1.9	Mainly due to alligning pre-1998 data with overall production throughput	Due to now using EEMS well testing data directly for recent years
EU27+UK	**-696**	**-3.1**	**286**	**1.3**		
Iceland	0.0	0.0	-0.0	-0.0	No explanation provided	
United Kingdom (KP)	-689	-11.9	-80	-1.9	see above	see above
EU-KP	**-696**	**-3.1**	**286**	**1.3**		

Table 3.1291.B.2 Fugitive CH_4 emissions from Oil and natural gas: Contribution of countries to EU-KP recalculations in CH_4 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	0.2	0.1	0.2	0.1	Activity data in 1.B.2.a.3 Transport of oil had to be converted from unit tonnes to unit cubic metres, resulting in revised CH_4 and CO_2 emissions over	

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
					the whole time series (e.g. 2019: +0.24 kt CO_2e). Moreover, small recalculations were reported for category 1.B.2.b (e.g. 2019: -0.01 kt CO_2e) as some transcription and rounding errors were identified and corrected.	
Belgium	-	-	-	-		
Bulgaria	-	-	-0.02	-0.01		As a result of ERT recommendation during the 2013 review cycle, the emission inventory was improved by adding emission estimates for category 1.B.2.a.iii. Oil transport. As petroleum coke is combusted in order to restore the catalyst's activity and not for energy purposes, all GHG emissions from petroleum coke, which were previously reported under CRF subcategory 1.A.1.b were reallocated under CRF subcategory 1.B.2.a.4. Similarly, the GHG emissions from hydrogen production, which were previously reported under CRF subcategory 1.A.1.b were reallocated under CRF subcategory 1.B.2.c.2.i For category 1.B.2.b.4 Fugitive emissions from gas transmission, the previous emission factor of 1340 kgCH_4/km was changed to 2500 kgCH_4/km (IPCC GPG 2000, Table 2.16, p.2.86), following a recommendation of the ERT during the Centralized review in 2012. For the latest submission the calculation approach was changed to rely on transited gas quantities following the adoption of the 2006 IPCC Guidelines.
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	-0.2	-0.0		Recalculation for 1.B.2.a.iii.2 Mining oil, CH_4 emissions was done for the time serie from 1997 till 2009 and then from 2011-2012. This recalculation was necessary due to the wrong calorific value used for this category.
Denmark	-0.3	-0.2	1.7	2.2	Activity data for transmission loss has been updated for 2010-2019 according to new data from the gas transmission company Energinet.dk. Activity data for gas loss in gas distribution has been updated for 2019. CH_4 emission factors for flaring in gas storage plant have been corrected for 1994-2019.	
Estonia	-0.001	-0.002	0.4	1.8	Emissions were recalculated due to using Joint Questionnaire dataset made by Statistics Estonia, which is sent to Eurostat and IEA databases, instead of national energy balance and venting category was added.	
Finland	-	-	-0.0	-0.0		Point source data in 1.B.2c was corrected for 2006 (-0.04 kt CO_2), 2012 (-0.05 kt CO_2) and 2019 (-0.04 kt CO_2).
France	0.02	0.001	-	-	Update of CH_4 and N_2O emissions for certain compressor stations leading to a change in average emission factors and emissions of these compounds.	
Germany	-60	-0.7	-77	-1.5	Update of statistical data. In addition, in the reporting 2022 for the first time emissions from the refueling of motor-driven boats using canisters are taken into account. Furthermore, the category "Storage of petroleum products" was divided into	

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
					storage of fuels (1.B.2) and storage of chemical products (2.B.10) according to the IPCC Guidelines	
Greece	-	-	-	-		
Hungary	26	1.1	3.3	0.2	Emissions from flaring in the refinery was omitted by mistake in the previous inventory. In addition, activity data have been revised for groundwater extraction, and the same country-specific emission factor: 4.5 t CH_4/million m3 groundwater, has been applied for the whole time series.	
Ireland	1.4	2.9	14	24	Ireland has reallocated the emissions from natural gas transmission (category 1.B.2.b.4) and distribution (category 1.B.2.b.5), reporting emissions separately by applying the Gas Networks Ireland splits consistently and as accurately as possible across the whole time series	
Italy	-	-	-894	-19		revision of national average emission factors of losses from gas distribution on the basis of new information provided by the operators
Latvia	-	-	-	-		
Lithuania	-	-	0.9	0.3		correction of activity data in 1.B.2.b.4 for natural gas leakages (transmission network) in 2015, 2017 and 2019 based on updated information provided by Amber Grid AB
Luxembourg	-	-	0.0004	0.001		CH_4 and CO_2 content of natural gas, for 2019, was revised to reflect the measured value as reported by the operator. Emissions were increased by 0.0003 Gg CO_2 eq. in 2019.
Malta	-	-	-	-		
Netherlands	-	-	-	-		
Poland	4	0.4	-169	-6.0	Recalculations for the years 1988-2019 was made. Emission changes for subcategory 1.B.2 are presented in table below. Recalculations for this years was made as the result of: – revision and updating of historical activities according to EUROSTAT, – correction of two emission factors, – new emission estimation from oil exploration	
Portugal	-	-	-	-		
Romania	-282	-1.2	-54	-2.2	Update of activity data 1.B.2.a.1: the Default Emission Factor values for CO_2 and CH_4, for 1989-1999 period have been modified, according to the 2006 IPCC GL for "Flaring and Venting", volume 2, chapter 4.2.2.3, page 4.55, Table 4.2.5; also, for 2000 – 2020 period, the Default Emission Factor values for CO_2 and CH_4 have been modified according to the 2006 IPCC GL for "Flaring and Venting", volume 2, chapter 4.2.2.3, page 4.48, Table 4.2.4;	
Slovakia	-	-	2.2	1.1		Natural gas production in the category 1.B.2.b.2 for the years 2010 – 2019 was revised by the new data provided directly by the Nafta, a. s. company. Natural gas storage in the category 1.B.2.b.6 for the years 2010 – 2019 revised by the new data provided directly by the Nafta, a. s. company Crude oil production in the category 1.B.2.a.2 for the years 2010 – 2019 was provided directly by the Nafta, a. s. company.
Slovenia	-	-	0.1	0.2		1.B.2.Venting and Flaring, CO_2, CH_4, N_2O For the year 2019 updated data for natural gas production and use has been obtain and fugitive GHG emissions for 2019 have been recalculated accordingly.

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Spain	-	-	33	19.8		New gas transportation companies have been added.
Sweden	-12	-13.3	-15	-26.9	Hydrogen production at refineries. Amounts of feedstocks have been estimated for all facilities and included in the reporting; Gas venting in transmission/distribution networks. Small correction in activity data for 2019 has resulted in the decrease of GHG emissions (CH_4, CO_2) by 0.002 kt CO_2-ekv. (0.8% in the emission category) Oil transportation. The entire time series has been recalculated as a result of the default emission factor change from 745 kg CH_4/PJ to 0.002 t CH_4/1000 m3 Gas distrubution. Correction of earlier assumed share of biogas in the network resulted in the annual increase of CO_2 by 0.0004-0.001 kt (1-5% within the category) compared to submission 2021 Oil transportation. The entire time series has been recalculated as a result of the default emission factor change from 745 kg CH_4/PJ to 0.002 t CH_4/1000 m3	
United Kingdom	-50	-0.4	61	1.3	Mainly due to alligning pre-1998 data with overall production throughput	Due to now using EEMS well testing data directly for recent years
EU27+UK	**-372**	**-0.6**	**-1 093**	**-4.3**		
Iceland	0.0	0.0	0.0	0.0	Recalculations were performed for CH_4 emissions from geothermal power plants in 2017. This is due to a minor error in the amount of numbers after decimal for CH_4.	
United Kingdom (KP)	-50	-0.4	61	1.3	See above	See above
EU-KP	**-372**	**-0.6**	**-1 093**	**-4.3**		

3.2.7 CO_2 capture and storage (1.C)

CO_2 capture and storage is not an EU key category (see Annex 1.1). Finland is the only Member State reporting captured CO_2 emissions in this category for the years 1993 to 2020.

The amount of CO_2 captured reflects the CO_2 captured in pulp and paper mills in Finland, where precipitated calcium carbonate (PCC) is formed and then used in the paper and paperboard industry. The final use of the CO_2 captured is considered as long-term storage except if the products are combusted. The resulting fossil CO_2 emissions from combustion of products containing PCC are taken into account in the corresponding categories in the greenhouse gas inventory of Finland. A detailed description of the methodology is provided in Finland's NIR.

Captured CO_2 emissions reported in 1C ' CO_2 capture and storage' correspond to 0.003 % of total EU-KP GHG emissions in 2020. The emissions captured increased between 1993 and 2020 by 11 833%.

3.2.8 Energy – non-key categories

Table 3.130 provides an overview on the role of non-key categories in the Energy sector.

Table 3.130 Aggregated GHG emission from non-key categories in the energy sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.1.a Public Electricity and Heat Production: Biomass (CH_4)	49.9	1 918.1	1 968.6	0.07%	1 918.8	3848%	50.5	3%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.1.a Public Electricity and Heat Production: Biomass (N_2O)	236.1	1 600.6	1 649.0	0.06%	1 412.8	598%	48.4	3%
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CH_4)	160.9	1 087.8	1 066.2	0.04%	905.2	562%	-21.6	-2%
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (N_2O)	150.7	870.3	844.2	0.03%	693.5	460%	-26.1	-3%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CH_4)	163.8	25.4	22.5	0.00%	-141.3	-86%	-2.9	-11%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (N_2O)	425.3	76.1	69.1	0.00%	-356.2	-84%	-7.0	-9%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CH_4)	35.9	161.1	171.1	0.01%	135.2	376%	9.9	6%
1.A.1.a Public Electricity and Heat Production: Other Fuels (N_2O)	137.6	465.4	467.4	0.02%	329.8	240%	2.0	0%
1.A.1.a Public Electricity and Heat Production: Peat (CH_4)	8.2	8.3	6.1	0.00%	-2.2	-26%	-2.3	-27%
1.A.1.a Public Electricity and Heat Production: Peat (N_2O)	124.1	107.0	69.9	0.00%	-54.2	-44%	-37.1	-35%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CH_4)	267.4	104.7	83.5	0.00%	-183.9	-69%	-21.3	-20%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (N_2O)	5 985.6	2 611.8	2 053.1	0.07%	-3 932.5	-66%	-558.7	-21%
1.A.1.b Petroleum Refining: Biomass (CH_4)	1.9	0.1	0.1	0.00%	-1.8	-95%	0.0	24%
1.A.1.b Petroleum Refining: Biomass (N_2O)	3.5	1.1	1.3	0.00%	-2.2	-62%	0.2	18%
1.A.1.b Petroleum Refining: Gaseous Fuels (CH_4)	5.7	25.8	22.4	0.00%	16.7	294%	-3.4	-13%
1.A.1.b Petroleum Refining: Gaseous Fuels (N_2O)	135.3	70.5	52.6	0.00%	-82.7	-61%	-17.9	-25%
1.A.1.b Petroleum Refining: Liquid Fuels (CH_4)	74.1	49.8	45.3	0.00%	-28.8	-39%	-4.5	-9%
1.A.1.b Petroleum Refining: Liquid Fuels (N_2O)	305.7	290.0	250.8	0.01%	-54.9	-18%	-39.3	-14%
1.A.1.b Petroleum Refining: Other Fuels (CH_4)	5.8	0.1	0.1	0.00%	-5.7	-98%	0.0	-11%
1.A.1.b Petroleum Refining: Other Fuels (CO_2)	920.7	317.5	276.1	0.01%	-644.6	-70%	-41.5	-13%
1.A.1.b Petroleum Refining: Other Fuels (N_2O)	9.7	0.5	0.4	0.00%	-9.2	-95%	-0.1	-13%
1.A.1.b Petroleum Refining: Peat (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.1.b Petroleum Refining: Peat (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.1.b Petroleum Refining: Peat (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.1.b Petroleum Refining: Solid Fuels (CH_4)	0.5	0.0	0.0	0.00%	-0.5	-96%	0.0	-17%
1.A.1.b Petroleum Refining: Solid Fuels (CO_2)	3 633.0	97.5	78.6	0.00%	-3 554.4	-98%	-18.9	-19%
1.A.1.b Petroleum Refining: Solid Fuels (N_2O)	29.9	0.4	0.4	0.00%	-29.6	-99%	-0.1	-17%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Biomass (CH_4)	82.2	129.1	129.9	0.00%	47.7	58%	0.8	1%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Biomass (N_2O)	3.8	48.2	48.2	0.00%	44.4	1160%	0.0	0%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CH_4)	196.9	308.6	181.0	0.01%	-15.9	-8%	-127.6	-41%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (N_2O)	279.1	307.6	281.7	0.01%	2.6	1%	-26.0	-8%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (CH_4)	5.2	2.5	2.5	0.00%	-2.7	-51%	0.0	2%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (CO_2)	4 950.5	2 902.4	2 830.7	0.10%	-2 119.8	-43%	-71.7	-2%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (N_2O)	48.0	39.3	44.0	0.00%	-4.0	-8%	4.7	12%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (CH_4)	4.9	0.0	0.0	0.00%	-4.9	-100%	0.0	3%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (CO_2)	456.1	0.1	0.1	0.00%	-455.9	-100%	0.0	3%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (N_2O)	9.1	0.0	0.0	0.00%	-9.1	-100%	0.0	3%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (CH_4)	0.1	0.0	0.0	0.00%	0.0	-48%	0.0	7%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (CO_2)	175.5	66.2	71.0	0.00%	-104.5	-60%	4.7	7%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (N_2O)	0.7	0.3	0.3	0.00%	-0.4	-59%	0.0	5%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CH_4)	156.5	19.4	15.7	0.00%	-140.7	-90%	-3.7	-19%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (N_2O)	692.2	140.3	133.8	0.00%	-558.4	-81%	-6.5	-5%
1.A.2.a Iron and Steel: Biomass (CH_4)	0.3	0.2	0.5	0.00%	0.3	102%	0.3	131%
1.A.2.a Iron and Steel: Biomass (N_2O)	0.4	0.5	1.0	0.00%	0.6	139%	0.5	88%
1.A.2.a Iron and Steel: Gaseous Fuels (CH_4)	19.5	11.6	9.8	0.00%	-9.7	-50%	-1.8	-16%
1.A.2.a Iron and Steel: Gaseous Fuels (N_2O)	126.2	43.7	42.8	0.00%	-83.4	-66%	-1.0	-2%
1.A.2.a Iron and Steel: Liquid Fuels (CH_4)	12.8	0.4	0.4	0.00%	-12.4	-97%	-0.1	-17%
1.A.2.a Iron and Steel: Liquid Fuels (N_2O)	29.4	3.2	3.0	0.00%	-26.4	-90%	-0.2	-6%
1.A.2.a Iron and Steel: Other Fuels (CH_4)	3.7	0.1	0.0	0.00%	-3.7	-99%	-0.1	-66%
1.A.2.a Iron and Steel: Other Fuels (CO_2)	652.9	19.1	22.3	0.00%	-630.7	-97%	3.1	16%
1.A.2.a Iron and Steel: Other Fuels (N_2O)	5.9	0.2	0.1	0.00%	-5.8	-99%	-0.1	-57%
1.A.2.a Iron and Steel: Peat (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.2.a Iron and Steel: Peat (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.2.a Iron and Steel: Peat (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.2.a Iron and Steel: Solid Fuels (CH_4)	216.5	117.5	99.4	0.00%	-117.0	-54%	-18.0	-15%
1.A.2.a Iron and Steel: Solid Fuels (N_2O)	338.1	159.0	137.5	0.00%	-200.6	-59%	-21.6	-14%
1.A.2.b Non-Ferrous Metals: Biomass (CH_4)	0.0	1.0	1.1	0.00%	1.1	33973%	0.0	2%
1.A.2.b Non-Ferrous Metals: Biomass (N_2O)	0.0	1.7	1.7	0.00%	1.7	35345%	0.1	4%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CH_4)	2.4	23.7	13.1	0.00%	10.7	454%	-10.6	-45%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (N_2O)	5.1	9.6	8.7	0.00%	3.6	70%	-0.9	-9%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CH_4)	4.0	0.8	0.9	0.00%	-3.2	-79%	0.0	3%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CO_2)	4 484.1	1 067.5	1 104.6	0.04%	-3 379.5	-75%	37.1	3%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (N_2O)	12.6	3.9	3.9	0.00%	-8.7	-69%	0.0	0%
1.A.2.b Non-Ferrous Metals: Other Fuels (CH_4)	0.3	0.0	0.0	0.00%	-0.3	-99%	0.0	-22%
1.A.2.b Non-Ferrous Metals: Other Fuels (CO_2)	64.9	1.2	0.9	0.00%	-63.9	-99%	-0.2	-21%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.b Non-Ferrous Metals: Other Fuels (N_2O)	0.5	0.0	0.0	0.00%	-0.5	-97%	0.0	-18%
1.A.2.b Non-Ferrous Metals: Peat (CH_4)	0.0	0.0	0.0	0.00%	0.0	-100%	0.0	0%
1.A.2.b Non-Ferrous Metals: Peat (CO_2)	6.5	0.0	0.0	0.00%	-6.5	-100%	0.0	0%
1.A.2.b Non-Ferrous Metals: Peat (N_2O)	0.0	0.0	0.0	0.00%	0.0	-100%	0.0	0%
1.A.2.b Non-Ferrous Metals: Solid Fuels (CH_4)	10.1	3.0	2.4	0.00%	-7.7	-77%	-0.7	-22%
1.A.2.b Non-Ferrous Metals: Solid Fuels (N_2O)	48.1	6.6	5.2	0.00%	-42.9	-89%	-1.5	-22%
1.A.2.c Chemicals: Biomass (CH_4)	1.6	10.6	12.4	0.00%	10.8	671%	1.7	16%
1.A.2.c Chemicals: Biomass (N_2O)	8.5	23.6	25.1	0.00%	16.6	194%	1.5	7%
1.A.2.c Chemicals: Gaseous Fuels (CH_4)	52.0	371.8	349.9	0.01%	297.9	573%	-21.9	-6%
1.A.2.c Chemicals: Gaseous Fuels (N_2O)	48.2	55.1	53.8	0.00%	5.6	12%	-1.3	-2%
1.A.2.c Chemicals: Liquid Fuels (CH_4)	45.1	18.6	19.1	0.00%	-26.0	-58%	0.4	2%
1.A.2.c Chemicals: Liquid Fuels (N_2O)	160.0	52.1	48.1	0.00%	-111.9	-70%	-4.0	-8%
1.A.2.c Chemicals: Other Fuels (CH_4)	15.3	7.4	7.2	0.00%	-8.1	-53%	-0.2	-3%
1.A.2.c Chemicals: Other Fuels (CO_2)	3 029.8	1 531.9	1 355.5	0.05%	-1 674.3	-55%	-176.5	-12%
1.A.2.c Chemicals: Other Fuels (N_2O)	27.1	17.6	17.7	0.00%	-9.4	-35%	0.1	0%
1.A.2.c Chemicals: Peat (CH_4)	0.1	0.0	0.0	0.00%	-0.1	-100%	0.0	0%
1.A.2.c Chemicals: Peat (CO_2)	191.1	0.0	0.0	0.00%	-191.1	-100%	0.0	0%
1.A.2.c Chemicals: Peat (N_2O)	3.8	0.0	0.0	0.00%	-3.8	-100%	0.0	0%
1.A.2.c Chemicals: Solid Fuels (CH_4)	32.6	21.6	18.7	0.00%	-14.0	-43%	-2.9	-13%
1.A.2.c Chemicals: Solid Fuels (N_2O)	84.5	38.8	33.4	0.00%	-51.2	-61%	-5.5	-14%
1.A.2.d Pulp, Paper and Print: Biomass (CH_4)	46.6	125.7	119.4	0.00%	72.8	156%	-6.3	-5%
1.A.2.d Pulp, Paper and Print: Biomass (N_2O)	198.4	391.4	372.1	0.01%	173.7	88%	-19.3	-5%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CH_4)	32.9	129.4	96.8	0.00%	64.0	194%	-32.6	-25%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (N_2O)	29.9	47.8	46.0	0.00%	16.1	54%	-1.8	-4%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CH_4)	13.1	6.8	6.7	0.00%	-6.5	-49%	-0.2	-2%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (N_2O)	38.3	13.2	5.8	0.00%	-32.5	-85%	-7.4	-56%
1.A.2.d Pulp, Paper and Print: Other Fuels (CH_4)	0.1	2.7	3.0	0.00%	2.9	2360%	0.3	11%
1.A.2.d Pulp, Paper and Print: Other Fuels (CO_2)	90.9	401.5	421.2	0.02%	330.4	364%	19.7	5%
1.A.2.d Pulp, Paper and Print: Other Fuels (N_2O)	0.5	4.7	5.8	0.00%	5.3	1012%	1.1	23%
1.A.2.d Pulp, Paper and Print: Peat (CH_4)	0.6	0.6	0.4	0.00%	-0.2	-27%	-0.2	-27%
1.A.2.d Pulp, Paper and Print: Peat (CO_2)	1 117.6	888.7	666.8	0.02%	-450.9	-40%	-221.9	-25%
1.A.2.d Pulp, Paper and Print: Peat (N_2O)	9.8	7.0	5.1	0.00%	-4.7	-48%	-1.9	-27%
1.A.2.d Pulp, Paper and Print: Solid Fuels (CH_4)	18.7	5.3	4.7	0.00%	-14.0	-75%	-0.6	-11%
1.A.2.d Pulp, Paper and Print: Solid Fuels (N_2O)	48.0	26.4	24.0	0.00%	-24.0	-50%	-2.4	-9%
1.A.2.e Food Processing, Beverages and Tobacco: Biomass (CH_4)	6.9	252.2	253.9	0.01%	246.9	3560%	1.7	1%
1.A.2.e Food Processing, Beverages and Tobacco: Biomass (N_2O)	17.8	112.7	113.1	0.00%	95.3	536%	0.4	0%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CH_4)	20.3	202.7	198.9	0.01%	178.5	878%	-3.8	-2%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (N_2O)	18.8	36.6	35.9	0.00%	17.1	91%	-0.7	-2%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CH_4)	19.1	3.1	2.7	0.00%	-16.4	-86%	-0.4	-12%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (N_2O)	80.2	12.1	11.8	0.00%	-68.4	-85%	-0.3	-3%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (CH_4)	0.0	0.2	0.2	0.00%	0.2	2402%	0.0	-8%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (CO_2)	8.3	37.0	25.9	0.00%	17.6	212%	-11.1	-30%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (N_2O)	0.0	0.4	0.4	0.00%	0.3	902%	0.0	-6%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (CH_4)	0.3	0.0	0.0	0.00%	-0.3	-100%	0.0	-100%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (CO_2)	139.1	0.6	0.0	0.00%	-139.1	-100%	-0.6	-100%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (N_2O)	1.5	0.0	0.0	0.00%	-1.5	-100%	0.0	-100%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CH_4)	32.3	10.4	8.7	0.00%	-23.5	-73%	-1.7	-16%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (N_2O)	68.7	21.2	17.7	0.00%	-51.0	-74%	-3.5	-16%
1.A.2.f Non-metallic minerals: Biomass (CH_4)	21.8	51.0	51.3	0.00%	29.4	135%	0.2	0%
1.A.2.f Non-metallic minerals: Biomass (N_2O)	59.4	120.5	107.6	0.00%	48.1	81%	-12.9	-11%
1.A.2.f Non-metallic minerals: Gaseous Fuels (CH_4)	23.5	46.5	39.3	0.00%	15.8	67%	-7.2	-16%
1.A.2.f Non-metallic minerals: Gaseous Fuels (N_2O)	137.2	143.4	135.1	0.00%	-2.1	-2%	-8.3	-6%
1.A.2.f Non-metallic minerals: Liquid Fuels (CH_4)	53.3	25.0	23.5	0.00%	-29.8	-56%	-1.4	-6%
1.A.2.f Non-metallic minerals: Liquid Fuels (N_2O)	715.2	313.4	310.7	0.01%	-404.4	-57%	-2.7	-1%
1.A.2.f Non-metallic minerals: Other Fuels (CH_4)	4.3	105.7	88.3	0.00%	84.0	1948%	-17.3	-16%
1.A.2.f Non-metallic minerals: Other Fuels (N_2O)	14.0	251.0	219.2	0.01%	205.2	1464%	-31.8	-13%
1.A.2.f Non-metallic minerals: Peat (CH_4)	0.0	0.0	0.0	0.00%	0.0	-100%	0.0	-96%
1.A.2.f Non-metallic minerals: Peat (CO_2)	27.0	2.4	0.1	0.00%	-26.9	-100%	-2.3	-96%
1.A.2.f Non-metallic minerals: Peat (N_2O)	0.1	0.0	0.0	0.00%	-0.1	-100%	0.0	-96%
1.A.2.f Non-metallic minerals: Solid Fuels (CH_4)	139.2	32.7	29.5	0.00%	-109.7	-79%	-3.2	-10%
1.A.2.f Non-metallic minerals: Solid Fuels (N_2O)	514.2	166.0	150.3	0.01%	-363.9	-71%	-15.7	-9%
1.A.2.g Other Manufacturing Industries and Constructions: Biomass (CH_4)	103.9	238.8	255.6	0.01%	151.7	146%	16.8	7%
1.A.2.g Other Manufacturing Industries and Constructions: Biomass (N_2O)	216.5	446.8	488.3	0.02%	271.7	125%	41.4	9%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (CH_4)	81.0	388.2	353.5	0.01%	272.5	337%	-34.7	-9%
1.A.2.g Other Manufacturing Industries and Constructions: Gaseous Fuels (N_2O)	165.5	280.1	266.8	0.01%	101.3	61%	-13.3	-5%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (CH_4)	133.4	60.5	57.8	0.00%	-75.6	-57%	-2.7	-4%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.g Other Manufacturing Industries and Constructions: Liquid Fuels (N_2O)	1 202.1	843.1	787.2	0.03%	-414.9	-35%	-55.9	-7%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (CH_4)	12.0	7.1	5.2	0.00%	-6.9	-57%	-1.9	-27%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (CO_2)	2 520.7	4 390.3	4 356.8	0.16%	1 836.1	73%	-33.5	-1%
1.A.2.g Other Manufacturing Industries and Constructions: Other Fuels (N_2O)	29.2	55.5	53.1	0.00%	24.0	82%	-2.4	-4%
1.A.2.g Other Manufacturing Industries and Constructions: Peat (CH_4)	0.1	0.0	0.0	0.00%	0.0	-58%	0.0	-35%
1.A.2.g Other Manufacturing Industries and Constructions: Peat (CO_2)	21.5	20.8	12.8	0.00%	-8.7	-41%	-8.1	-39%
1.A.2.g Other Manufacturing Industries and Constructions: Peat (N_2O)	0.2	0.1	0.1	0.00%	-0.2	-65%	-0.1	-40%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (CH_4)	113.5	10.4	9.4	0.00%	-104.1	-92%	-0.9	-9%
1.A.2.g Other Manufacturing Industries and Constructions: Solid Fuels (N_2O)	733.1	134.7	124.0	0.00%	-609.1	-83%	-10.7	-8%
1.A.3.a Domestic Aviation: Aviation Gasoline (CH_4)	2.9	1.0	0.5	0.00%	-2.5	-84%	-0.5	-51%
1.A.3.a Domestic Aviation: Aviation Gasoline (CO_2)	508.4	188.8	135.9	0.00%	-372.5	-73%	-52.9	-28%
1.A.3.a Domestic Aviation: Aviation Gasoline (N_2O)	8.0	3.4	2.6	0.00%	-5.4	-68%	-0.9	-25%
1.A.3.a Domestic Aviation: Biomass (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.3.a Domestic Aviation: Biomass (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.3.a Domestic Aviation: Jet Kerosene (CH_4)	11.9	7.0	3.7	0.00%	-8.1	-69%	-3.3	-47%
1.A.3.a Domestic Aviation: Jet Kerosene (N_2O)	124.2	144.9	74.1	0.00%	-50.2	-40%	-70.8	-49%
1.A.3.b Road Transportation: Biomass (CH_4)	0.0	47.9	50.3	0.00%	50.3	5895050 %	2.3	5%
1.A.3.b Road Transportation: Biomass (N_2O)	0.1	441.1	472.4	0.02%	472.3	333616%	31.3	7%
1.A.3.b Road Transportation: Diesel Oil (CH_4)	570.8	204.9	175.0	0.01%	-395.8	-69%	-29.9	-15%
1.A.3.b Road Transportation: Gaseous Fuels (CH_4)	11.2	71.6	71.7	0.00%	60.5	540%	0.1	0%
1.A.3.b Road Transportation: Gaseous Fuels (N_2O)	1.5	21.4	19.1	0.00%	17.6	1200%	-2.3	-11%
1.A.3.b Road Transportation: Gasoline (N_2O)	4 922.5	786.6	634.8	0.02%	-4 287.7	-87%	-151.7	-19%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CH_4)	42.6	58.3	48.9	0.00%	6.2	15%	-9.5	-16%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (N_2O)	18.0	103.8	87.2	0.00%	69.2	384%	-16.5	-16%
1.A.3.b Road Transportation: Other Fuels (CH_4)	0.0	4.5	5.1	0.00%	5.1	100%	0.6	13%
1.A.3.b Road Transportation: Other Fuels (N_2O)	0.0	15.0	14.9	0.00%	14.9	100%	-0.1	-1%
1.A.3.b Road Transportation: Other Liquid Fuels (CH_4)	0.9	0.1	0.1	0.00%	-0.9	-93%	0.0	-10%
1.A.3.b Road Transportation: Other Liquid Fuels (CO_2)	433.5	57.2	54.5	0.00%	-379.0	-87%	-2.6	-5%
1.A.3.b Road Transportation: Other Liquid Fuels (N_2O)	0.4	0.1	0.1	0.00%	-0.3	-74%	0.0	0%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.3.c Railways: Biomass (CH_4)	0.0	0.2	0.1	0.00%	0.1	1433586 %	0.0	-11%
1.A.3.c Railways: Biomass (N_2O)	0.0	2.1	1.9	0.00%	1.9	100%	-0.3	-12%
1.A.3.c Railways: Gaseous Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.3.c Railways: Gaseous Fuels (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.3.c Railways: Gaseous Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.3.c Railways: Liquid Fuels (CH_4)	19.5	5.9	4.8	0.00%	-14.7	-76%	-1.1	-19%
1.A.3.c Railways: Liquid Fuels (N_2O)	760.6	239.4	208.2	0.01%	-552.4	-73%	-31.2	-13%
1.A.3.c Railways: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-8%
1.A.3.c Railways: Other Fuels (CO_2)	0.0	4.4	5.1	0.00%	5.1	100%	0.7	15%
1.A.3.c Railways: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-8%
1.A.3.c Railways: Solid Fuels (CH_4)	15.2	1.0	0.8	0.00%	-14.4	-94%	-0.1	-12%
1.A.3.c Railways: Solid Fuels (CO_2)	661.6	77.2	66.2	0.00%	-595.4	-90%	-11.0	-14%
1.A.3.c Railways: Solid Fuels (N_2O)	3.2	0.3	0.2	0.00%	-2.9	-93%	0.0	-15%
1.A.3.d Domestic Navigation: Biomass (CH_4)	0.0	2.4	2.6	0.00%	2.6	100%	0.2	9%
1.A.3.d Domestic Navigation: Biomass (N_2O)	0.0	1.6	1.5	0.00%	1.5	100%	-0.1	-6%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CH_4)	24.2	17.3	15.9	0.00%	-8.4	-35%	-1.4	-8%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (N_2O)	284.0	246.0	199.4	0.01%	-84.6	-30%	-46.7	-19%
1.A.3.d Domestic Navigation: Gaseous Fuels (CH_4)	0.0	12.4	22.5	0.00%	22.5	100%	10.0	81%
1.A.3.d Domestic Navigation: Gaseous Fuels (CO_2)	0.0	51.3	90.8	0.00%	90.8	100%	39.5	77%
1.A.3.d Domestic Navigation: Gaseous Fuels (N_2O)	0.0	0.1	0.2	0.00%	0.2	100%	0.1	63%
1.A.3.d Domestic Navigation: Gasoline (CH_4)	44.9	36.4	35.5	0.00%	-9.4	-21%	-0.9	-2%
1.A.3.d Domestic Navigation: Gasoline (CO_2)	1 647.2	1 791.9	1 738.5	0.06%	91.3	6%	-53.4	-3%
1.A.3.d Domestic Navigation: Gasoline (N_2O)	7.5	11.0	10.6	0.00%	3.2	42%	-0.3	-3%
1.A.3.d Domestic Navigation: Other Fuels (CH_4)	0.0	0.6	0.6	0.00%	0.6	100%	0.0	4%
1.A.3.d Domestic Navigation: Other Fuels (CO_2)	0.0	29.7	30.8	0.00%	30.8	100%	1.1	4%
1.A.3.d Domestic Navigation: Other Fuels (N_2O)	0.0	0.2	0.2	0.00%	0.2	100%	0.0	4%
1.A.3.d Domestic Navigation: Other Liquid Fuels (CH_4)	0.1	0.3	0.3	0.00%	0.1	110%	0.0	1%
1.A.3.d Domestic Navigation: Other Liquid Fuels (CO_2)	5.7	34.8	37.8	0.00%	32.1	561%	2.9	8%
1.A.3.d Domestic Navigation: Other Liquid Fuels (N_2O)	0.0	0.2	0.2	0.00%	0.2	496%	0.0	9%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CH_4)	15.6	12.5	10.6	0.00%	-5.0	-32%	-1.9	-15%
1.A.3.d Domestic Navigation: Residual Fuel Oil (N_2O)	93.1	53.4	45.1	0.00%	-47.9	-51%	-8.3	-16%
1.A.3.e Other Transportation: Biomass (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-53%
1.A.3.e Other Transportation: Biomass (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-53%
1.A.3.e Other Transportation: Gaseous Fuels (CH_4)	9.9	9.4	6.5	0.00%	-3.4	-34%	-2.9	-31%
1.A.3.e Other Transportation: Gaseous Fuels (CO_2)	4 592.5	5 019.8	3 934.3	0.14%	-658.2	-14%	-1 085.5	-22%
1.A.3.e Other Transportation: Gaseous Fuels (N_2O)	23.6	24.7	19.5	0.00%	-4.1	-17%	-5.1	-21%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.3.e Other Transportation: Liquid Fuels (CH_4)	2.4	0.6	0.5	0.00%	-1.8	-78%	-0.1	-17%
1.A.3.e Other Transportation: Liquid Fuels (CO_2)	1 684.4	1 334.2	1 251.9	0.04%	-432.5	-26%	-82.3	-6%
1.A.3.e Other Transportation: Liquid Fuels (N_2O)	51.1	23.6	20.7	0.00%	-30.4	-59%	-2.8	-12%
1.A.3.e Other Transportation: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.3.e Other Transportation: Other Fuels (CO_2)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-54%
1.A.3.e Other Transportation: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.3.e Other Transportation: Solid Fuels (CH_4)	0.4	0.0	0.0	0.00%	-0.4	-100%	0.0	0%
1.A.3.e Other Transportation: Solid Fuels (CO_2)	54.7	0.0	0.0	0.00%	-54.7	-100%	0.0	0%
1.A.3.e Other Transportation: Solid Fuels (N_2O)	0.7	0.0	0.0	0.00%	-0.7	-100%	0.0	0%
1.A.4.a Commercial/Institutional: Biomass (CH_4)	143.3	412.5	392.1	0.01%	248.8	174%	-20.4	-5%
1.A.4.a Commercial/Institutional: Biomass (N_2O)	42.1	183.2	176.9	0.01%	134.8	320%	-6.3	-3%
1.A.4.a Commercial/Institutional: Gaseous Fuels (CH_4)	125.7	259.5	247.5	0.01%	121.9	97%	-11.9	-5%
1.A.4.a Commercial/Institutional: Gaseous Fuels (N_2O)	106.3	178.5	166.4	0.01%	60.1	57%	-12.1	-7%
1.A.4.a Commercial/Institutional: Liquid Fuels (CH_4)	151.3	73.5	69.4	0.00%	-81.9	-54%	-4.1	-6%
1.A.4.a Commercial/Institutional: Liquid Fuels (N_2O)	326.6	103.7	103.2	0.00%	-223.4	-68%	-0.4	0%
1.A.4.a Commercial/Institutional: Other Fuels (CH_4)	8.5	24.4	34.0	0.00%	25.5	302%	9.6	39%
1.A.4.a Commercial/Institutional: Other Fuels (N_2O)	18.0	160.8	163.5	0.01%	145.5	810%	2.7	2%
1.A.4.a Commercial/Institutional: Peat (CH_4)	0.7	0.2	0.2	0.00%	-0.5	-76%	0.0	-18%
1.A.4.a Commercial/Institutional: Peat (CO_2)	232.8	39.1	28.6	0.00%	-204.2	-88%	-10.5	-27%
1.A.4.a Commercial/Institutional: Peat (N_2O)	1.1	0.2	0.2	0.00%	-0.9	-84%	0.0	-14%
1.A.4.a Commercial/Institutional: Solid Fuels (CH_4)	1 474.1	7.5	8.0	0.00%	-1 466.2	-99%	0.5	6%
1.A.4.a Commercial/Institutional: Solid Fuels (N_2O)	172.4	14.9	14.4	0.00%	-158.0	-92%	-0.5	-3%
1.A.4.b Residential: Biomass (N_2O)	1 734.3	2 662.2	2 601.0	0.09%	866.6	50%	-61.2	-2%
1.A.4.b Residential: Gaseous Fuels (CH_4)	633.1	677.0	667.4	0.02%	34.3	5%	-9.6	-1%
1.A.4.b Residential: Gaseous Fuels (N_2O)	281.2	383.4	379.0	0.01%	97.8	35%	-4.4	-1%
1.A.4.b Residential: Liquid Fuels (CH_4)	340.6	173.9	174.2	0.01%	-166.4	-49%	0.4	0%
1.A.4.b Residential: Liquid Fuels (N_2O)	651.5	253.4	254.7	0.01%	-396.8	-61%	1.3	1%
1.A.4.b Residential: Other Fuels (CH_4)	0.0	0.4	0.4	0.00%	0.4	100%	0.0	5%
1.A.4.b Residential: Other Fuels (CO_2)	0.0	11.8	12.5	0.00%	12.5	100%	0.7	6%
1.A.4.b Residential: Other Fuels (N_2O)	0.0	0.1	0.1	0.00%	0.1	100%	0.0	5%
1.A.4.b Residential: Peat (CH_4)	283.6	62.7	63.2	0.00%	-220.4	-78%	0.5	1%
1.A.4.b Residential: Peat (CO_2)	3 957.6	870.1	875.1	0.03%	-3 082.5	-78%	4.9	1%
1.A.4.b Residential: Peat (N_2O)	16.9	3.7	3.7	0.00%	-13.2	-78%	0.0	0%
1.A.4.b Residential: Solid Fuels (N_2O)	1 101.3	172.1	171.8	0.01%	-929.5	-84%	-0.3	0%

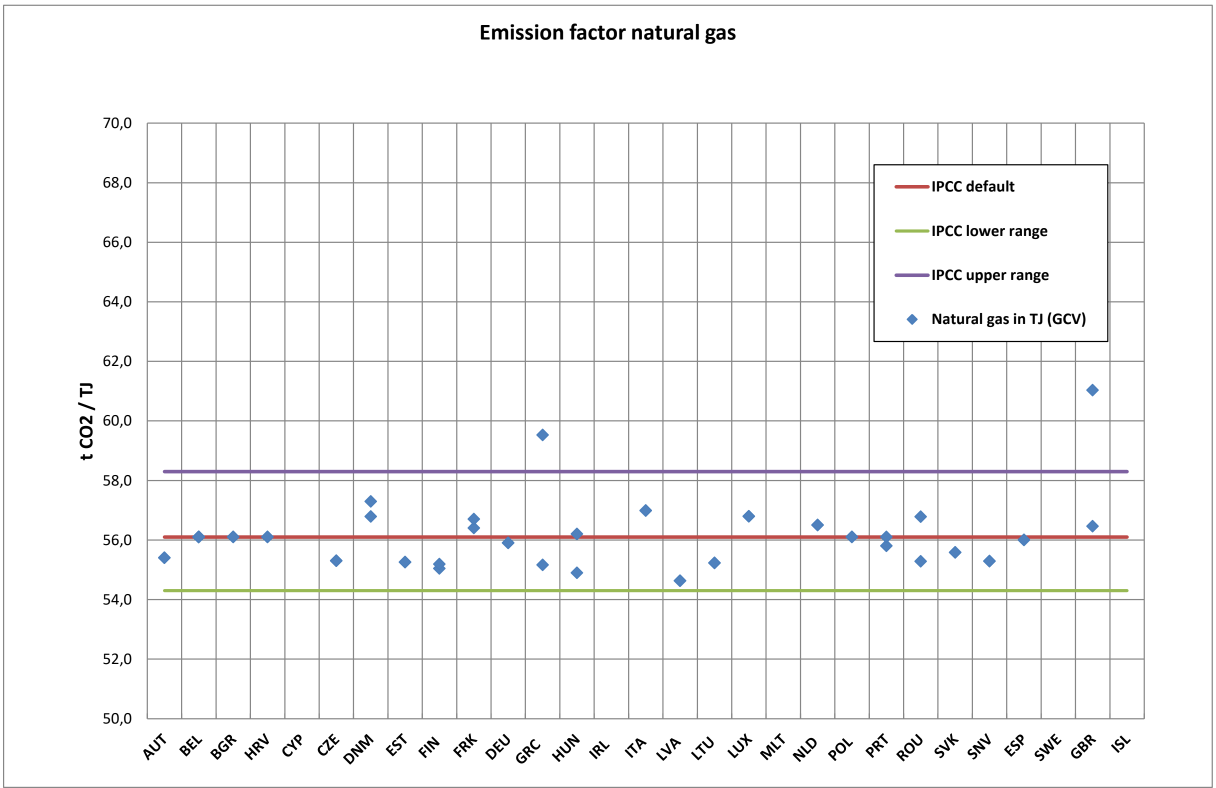
EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.4.c Agriculture/Forestry/Fishing: Biomass (CH_4)	100.9	561.2	572.7	0.02%	471.8	467%	11.5	2%
1.A.4.c Agriculture/Forestry/Fishing: Biomass (N_2O)	24.3	175.1	181.2	0.01%	156.9	645%	6.1	3%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CH_4)	77.5	1 194.3	1 184.2	0.04%	1 106.6	1427%	-10.1	-1%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (N_2O)	8.5	8.5	8.1	0.00%	-0.4	-5%	-0.4	-5%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CH_4)	204.6	91.7	93.5	0.00%	-111.1	-54%	1.8	2%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (N_2O)	3 386.4	3 247.6	3 336.8	0.12%	-49.5	-1%	89.2	3%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (CH_4)	0.0	0.2	0.3	0.00%	0.3	100%	0.0	6%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (CO_2)	0.0	54.2	64.7	0.00%	64.7	100%	10.5	19%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (N_2O)	0.0	3.0	3.6	0.00%	3.6	100%	0.5	17%
1.A.4.c Agriculture/Forestry/Fishing: Peat (CH_4)	0.9	7.3	6.8	0.00%	5.9	697%	-0.5	-7%
1.A.4.c Agriculture/Forestry/Fishing: Peat (CO_2)	45.0	275.3	204.8	0.01%	159.8	355%	-70.5	-26%
1.A.4.c Agriculture/Forestry/Fishing: Peat (N_2O)	0.5	2.7	2.4	0.00%	1.9	384%	-0.3	-11%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CH_4)	663.7	242.0	248.5	0.01%	-415.2	-63%	6.5	3%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (N_2O)	38.2	14.7	15.0	0.00%	-23.2	-61%	0.3	2%
1.A.5.a Other Other Sectors: Biomass (CH_4)	0.3	2.1	2.2	0.00%	1.8	518%	0.1	4%
1.A.5.a Other Other Sectors: Biomass (N_2O)	0.3	0.4	0.5	0.00%	0.2	82%	0.0	5%
1.A.5.a Other Other Sectors: Gaseous Fuels (CH_4)	0.4	0.9	0.8	0.00%	0.3	78%	-0.1	-10%
1.A.5.a Other Other Sectors: Gaseous Fuels (CO_2)	728.8	763.1	671.2	0.02%	-57.6	-8%	-91.9	-12%
1.A.5.a Other Other Sectors: Gaseous Fuels (N_2O)	1.2	1.4	1.1	0.00%	-0.1	-9%	-0.3	-20%
1.A.5.a Other Other Sectors: Liquid Fuels (CH_4)	6.1	4.1	4.0	0.00%	-2.1	-34%	-0.1	-3%
1.A.5.a Other Other Sectors: Liquid Fuels (CO_2)	6 751.9	2 966.6	2 876.5	0.10%	-3 875.4	-57%	-90.1	-3%
1.A.5.a Other Other Sectors: Liquid Fuels (N_2O)	45.8	16.4	15.6	0.00%	-30.2	-66%	-0.8	-5%
1.A.5.a Other Other Sectors: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-5%
1.A.5.a Other Other Sectors: Other Fuels (CO_2)	0.0	0.3	0.3	0.00%	0.3	100%	0.0	-5%
1.A.5.a Other Other Sectors: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-5%
1.A.5.a Other Other Sectors: Peat (CH_4)	0.3	0.0	0.0	0.00%	-0.3	-100%	0.0	0%
1.A.5.a Other Other Sectors: Peat (CO_2)	24.0	0.0	0.0	0.00%	-24.0	-100%	0.0	0%
1.A.5.a Other Other Sectors: Peat (N_2O)	0.1	0.0	0.0	0.00%	-0.1	-100%	0.0	0%
1.A.5.a Other Other Sectors: Solid Fuels (CH_4)	253.4	0.2	0.2	0.00%	-253.2	-100%	0.0	-12%
1.A.5.a Other Other Sectors: Solid Fuels (N_2O)	20.9	0.0	0.0	0.00%	-20.9	-100%	0.0	-13%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.5.b Other Other Sectors: Biomass (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-3%
1.A.5.b Other Other Sectors: Biomass (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-1%
1.A.5.b Other Other Sectors: Gaseous Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Other Other Sectors: Gaseous Fuels (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Other Other Sectors: Gaseous Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Other Other Sectors: Liquid Fuels (CH_4)	40.8	4.9	5.5	0.00%	-35.4	-87%	0.6	12%
1.A.5.b Other Other Sectors: Liquid Fuels (N_2O)	183.6	55.6	56.5	0.00%	-127.1	-69%	0.9	2%
1.A.5.b Other Other Sectors: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-7%
1.A.5.b Other Other Sectors: Other Fuels (CO_2)	0.0	0.7	0.6	0.00%	0.6	100%	-0.1	-13%
1.A.5.b Other Other Sectors: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-5%
1.A.5.b Other Other Sectors: Solid Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Other Other Sectors: Solid Fuels (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Other Other Sectors: Solid Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.B.1.a Coal Mining and Handling: Operation (CO_2)	664.2	179.6	140.8	0.01%	-523.4	-79%	-38.8	-22%
1.B.1.a Coal Mining and Handling: Operation (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.B.1.b Solid Fuel Transformation: Operation (CH_4)	292.0	103.7	101.2	0.00%	-190.9	-65%	-2.5	-2%
1.B.1.b Solid Fuel Transformation: Operation (CO_2)	7 832.4	3 538.6	3 290.0	0.12%	-4 542.3	-58%	-248.6	-7%
1.B.1.b Solid Fuel Transformation: Operation (N_2O)	0.1	0.0	0.0	0.00%	-0.1	-82%	0.0	5%
1.B.1.c Other Solid fuel operation: Operation (CH_4)	113.0	95.6	82.4	0.00%	-30.6	-27%	-13.2	-14%
1.B.1.c Other Solid fuel operation: Operation (CO_2)	6.9	72.4	71.2	0.00%	64.2	928%	-1.2	-2%
1.B.1.c Other Solid fuel operation: Operation (N_2O)	0.0	0.0	0.0	0.00%	0.0	21%	0.0	-14%
1.B.2.a Oil: Operation (N_2O)	28.7	10.9	147.9	0.01%	119.2	416%	137.0	1256%
1.B.2.b Natural Gas: Operation (CO_2)	2 645.5	1 426.7	1 284.4	0.05%	-1 361.1	-51%	-142.4	-10%
1.B.2.c Venting and Flaring: Operation (CH_4)	6 571.7	3 752.0	3 453.2	0.12%	-3 118.5	-47%	-298.8	-8%
1.B.2.c Venting and Flaring: Operation (N_2O)	107.1	81.6	63.2	0.00%	-43.9	-41%	-18.4	-23%
1.B.2.d Other emissions from energy production: Operation (CH_4)	297.5	574.4	667.5	0.02%	370.0	124%	93.0	16%
1.B.2.d Other emissions from energy production: Operation (CO_2)	743.7	2 063.9	2 231.1	0.08%	1 487.4	200%	167.2	8%
1.B.2.d Other emissions from energy production: Operation (N_2O)	13.2	8.5	7.1	0.00%	-6.0	-46%	-1.3	-16%
1.C CO_2 Transport and Storage: Fuels (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%

3.3 Methodological issues and uncertainties (EU-KP)

The previous section presented for each EU-KP key category in CRF Sector 1 an overview of the Member States' contributions to the key categories in terms of level and trend, and - for each key category - summary information on methodologies and emission factors using the notations T1, T2, D, etc. No detailed explanations of Member States methods used is included for 1A because for most categories the method used is simply multiplying activity data by (country-specific) emissions factors. The most relevant parameter for estimating the GHG emissions from 1A is the emission factor. Therefore, the following figures include overviews of emission factors used by the Member States for the most relevant fuels and also provide the uncertainty range of default emission factors. Where relevant, information from Member States is added that are using emission factors which are significantly outside the range of the default emission factors. The figures show that the large majority of country-specific emission factors used by the EU Member States are within the uncertainty range of the IPCC default emission factors. Note that Annex III of the EU NIR includes an extraction of the emission factors used by MS for each fuel; the following figures summarize this Annex. In addition the Member States' national inventory reports include more detailed information on national methods and circumstances.

*Figure **3**.184 Emission factors used by Member States for natural gas*



__GRC:__ The higher value is used in 1A1c and is due to the following factors: 1. The consumption of natural gas in 1A1c sector corresponds almost 100% to natural gas produced within the country. 2. The EF is based on ETS reporting, therefore it is a plant specific EF which has been verified according to EU ETS rules. 3. As it was reported in the 2016 NIR, domestic natural gas is produced from two reservoirs, which have high carbon contents (e.g. the "Prinos" reservoir in 2014 had a carbon content of 16.22tC/TJ). 4. The inter-annual changes of the IEFs are caused by the inter-annual changes of the share of each reservoir in the total natural gas production.

__GBR:__ The higher value is used in the 1A1c and it is due to the following fact: In the United Kingdom emissions of gaseous fuels within this sector include colliery methane combustion and natural gas combustion, including offshore own gas use. The carbon emission factor for offshore own gas use is higher than the emission factor for other natural gas combustion, particularly at the start of the time series. This higher emission factor is to be expected, as the unrefined gaseous fuels used in the upstream oil and gas sector will contain heavier hydrocarbons (which are removed in gas treatment prior to injection into natural gas supply infrastructure at onshore terminals).

*Figure **3**.185 Emission factors used by Member States for gas/diesel oil*

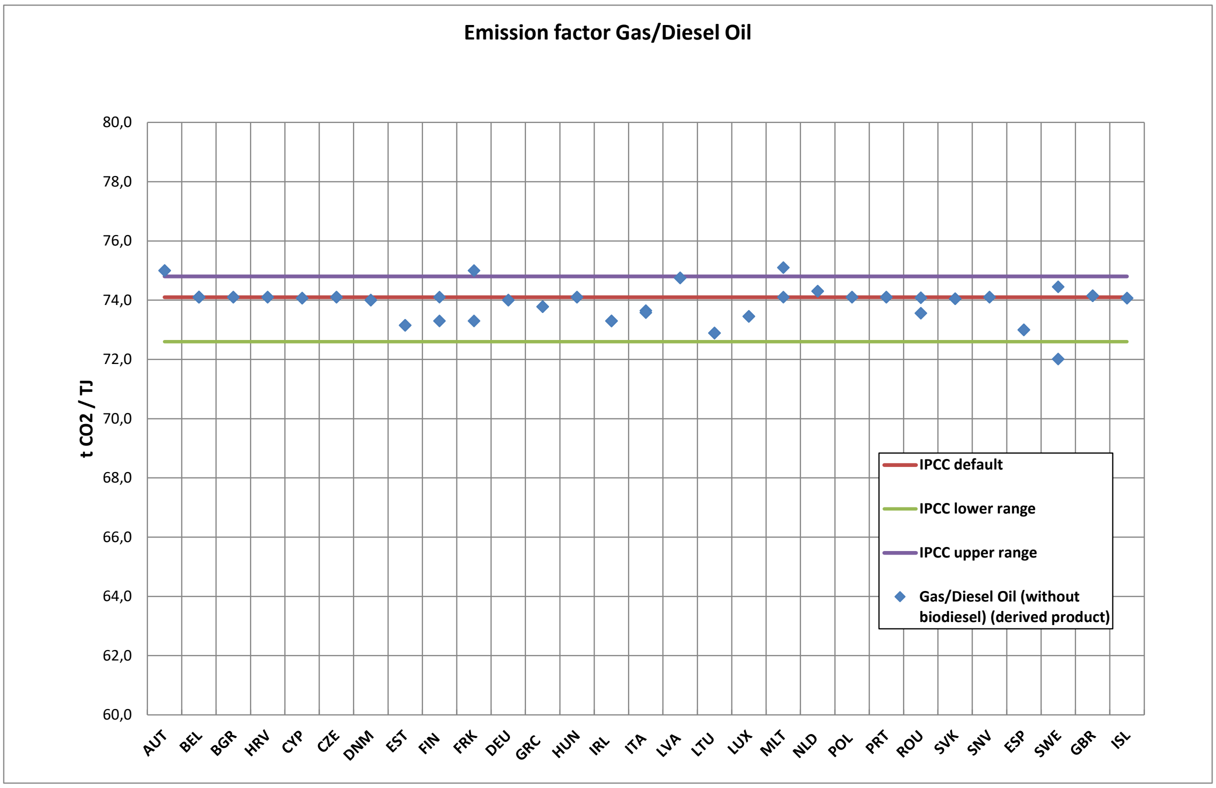


*Figure **3**.186 Emission factors used by Member States for LPG*

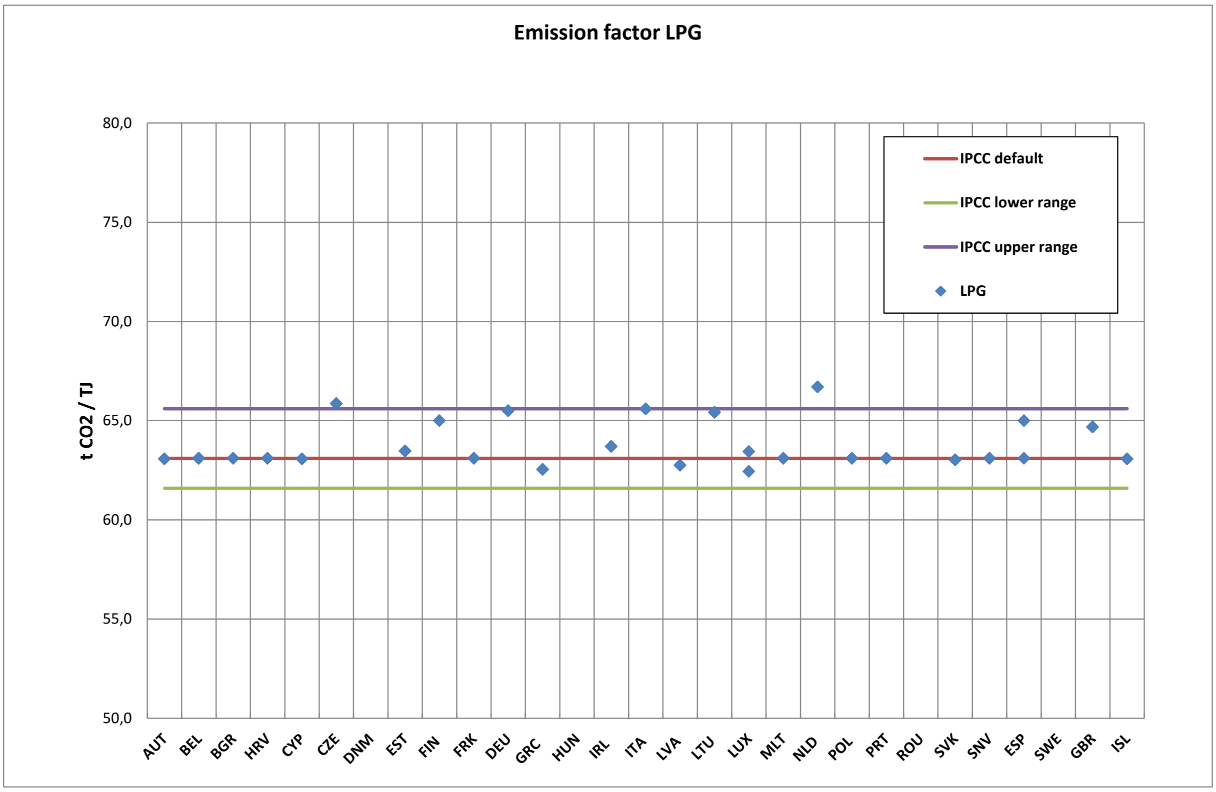
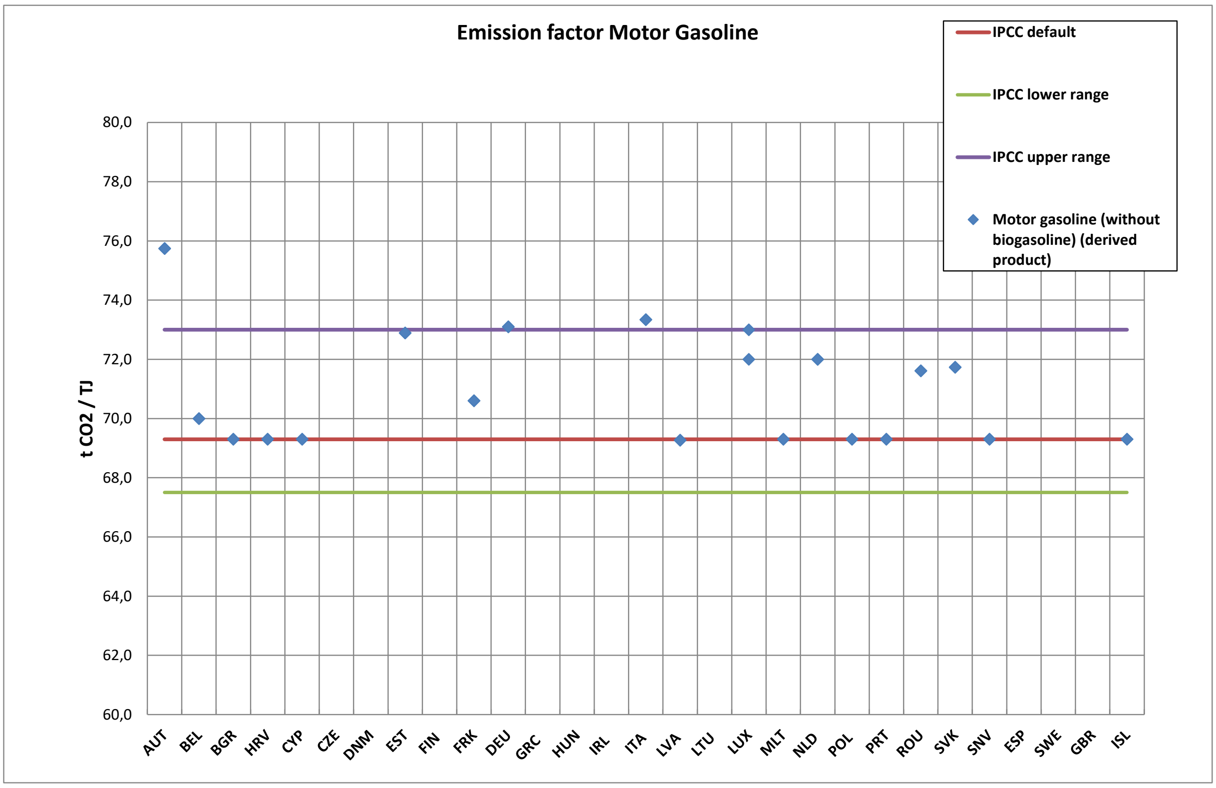


*Figure **3**.187 Emission factors used by Member States for motor gasoline*



AUT: The Austrian IEF is above the upper IPCC default values due to the application of the comparatively low NCV from the national energy balance, which is 41.8 TJ/kt Gasoline for the year 2020. The application of the IPCC default NCV (44.3 TJ/kt) would increase activity data and thus reduce the CO_2-IEF to about 70 t/TJ. Austria therefore does not assume that emissions from Gasoline are overestimated.

*Figure **3**.188 Emission factors used by Member States for jet kerosene*

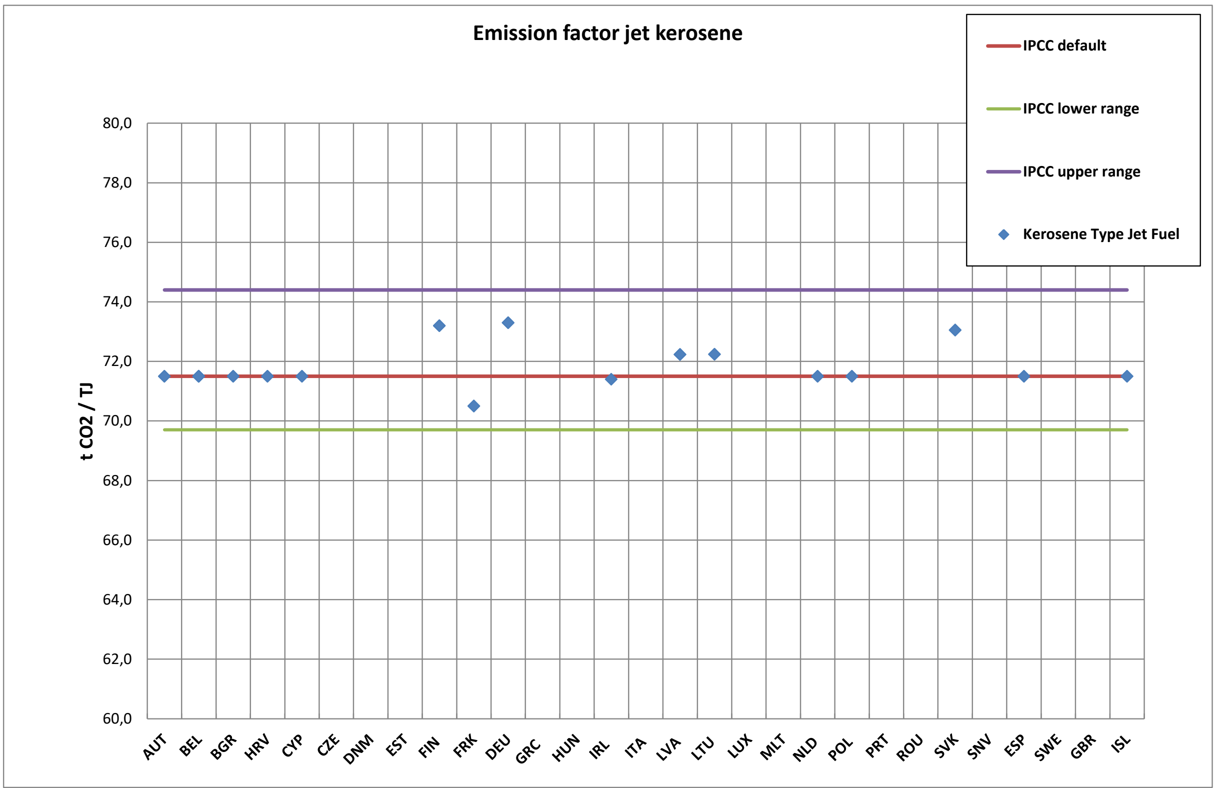
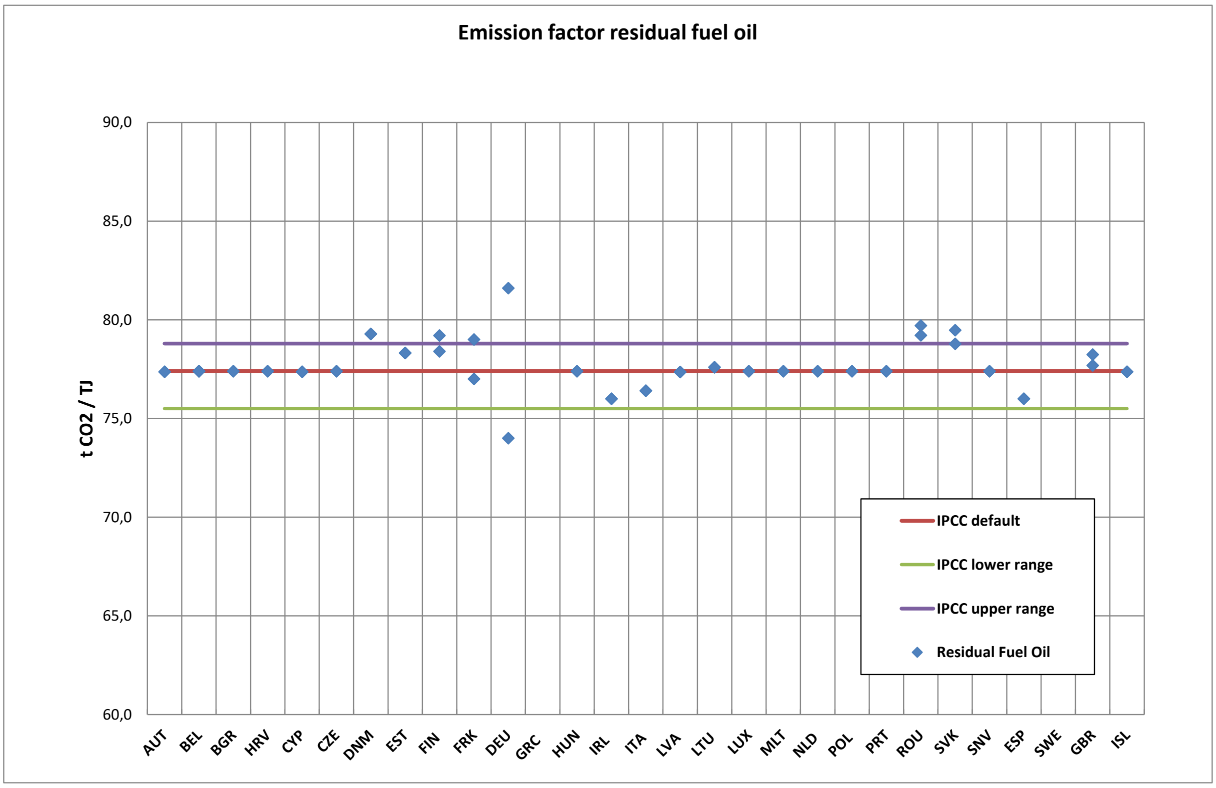


Figure 3.189 Emission factors used by Member States for residual fuel oil



DEU: The higher value is for heavy residual fuel oil, the value is for light fuel oil.

ROU: Romania has developed a specific methodology for the elaboration of national values of specific CO_2 emission factors and the energy sector. Primary data are collected from EU-ETS operators, the data are further processed and national values are developed, based on the previous mentioned methodology. Primarily, a number of 36 EU-ETS operators were considered.

Figure 3.190 Emission factors used by Member States for petroleum coke

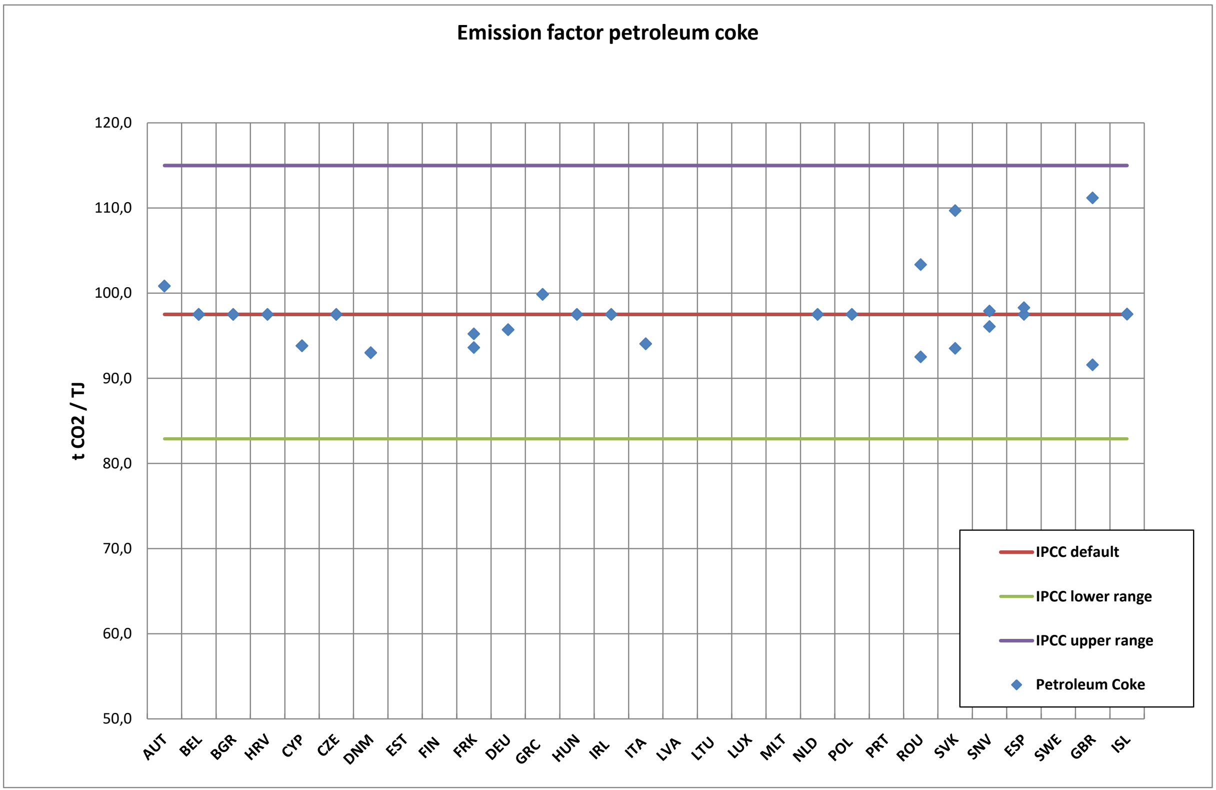


*Figure **3**.191 Emission factors used by Member States for refinery gas*

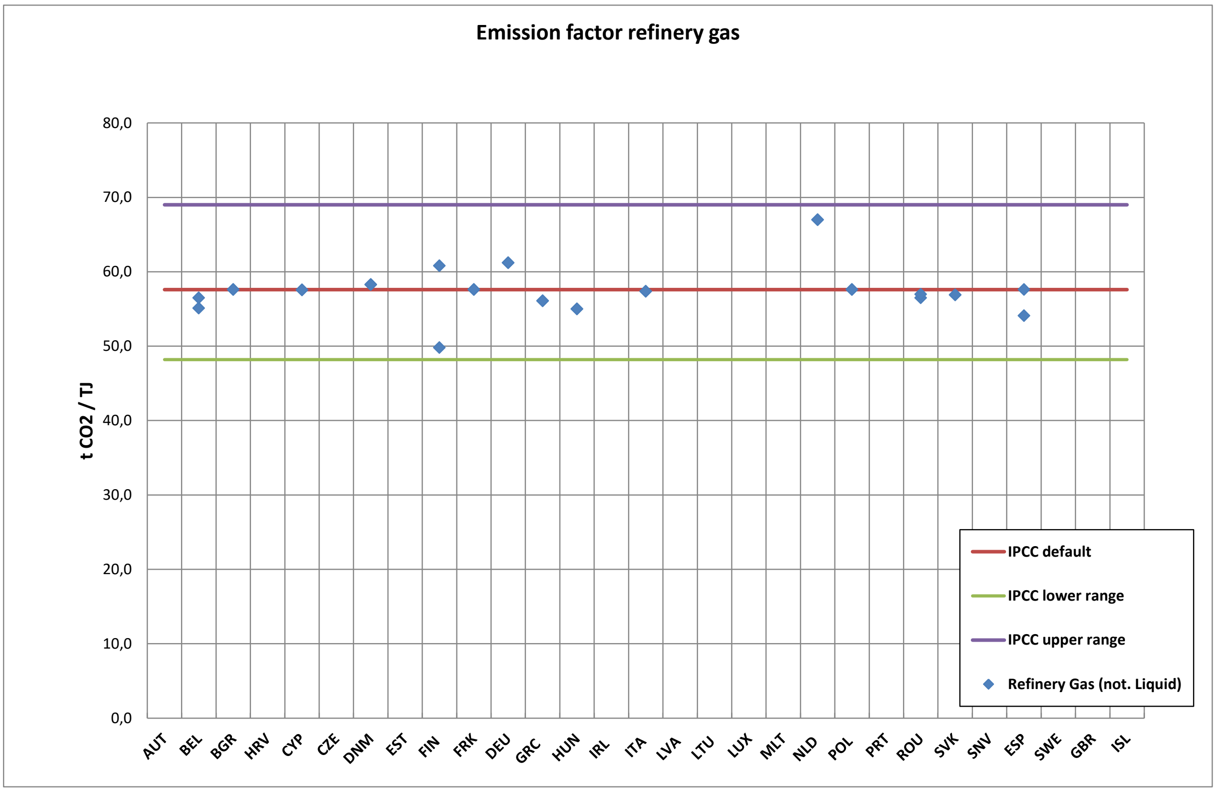


*Figure **3**.192 Emission factors used by Member States for bituminous coal*

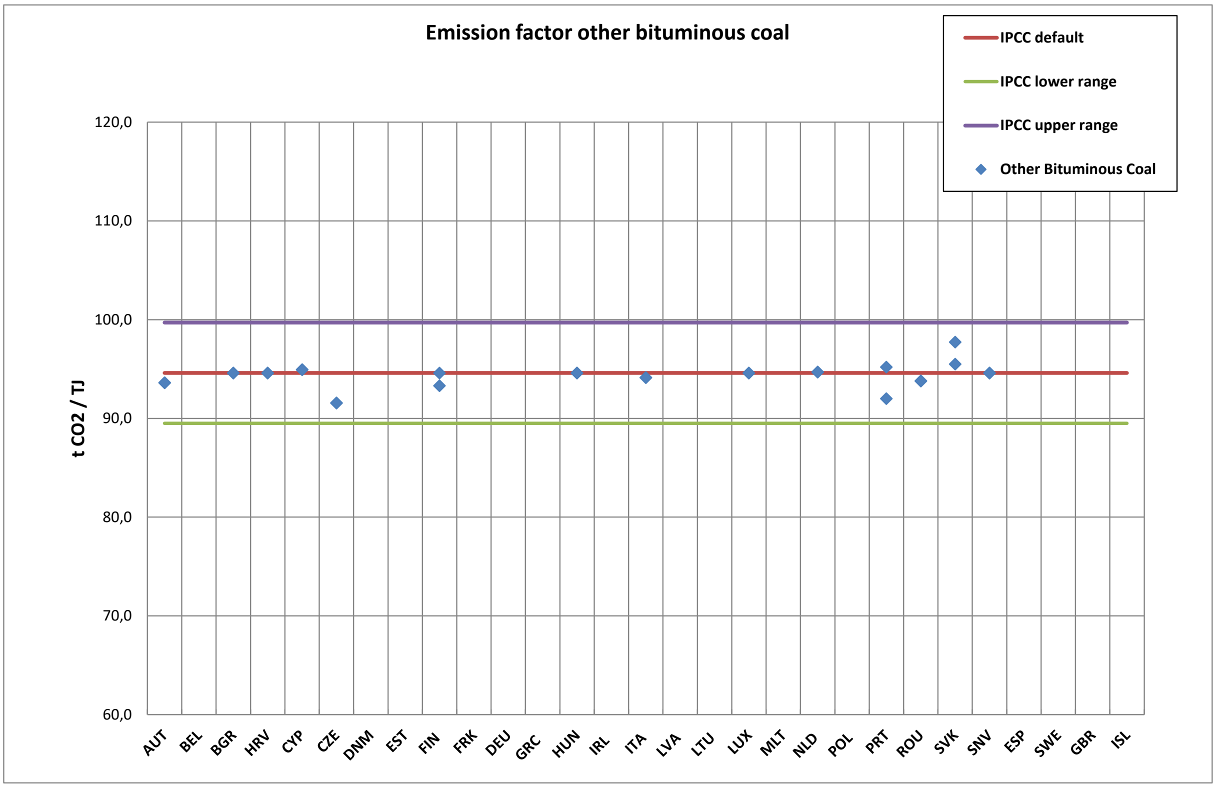
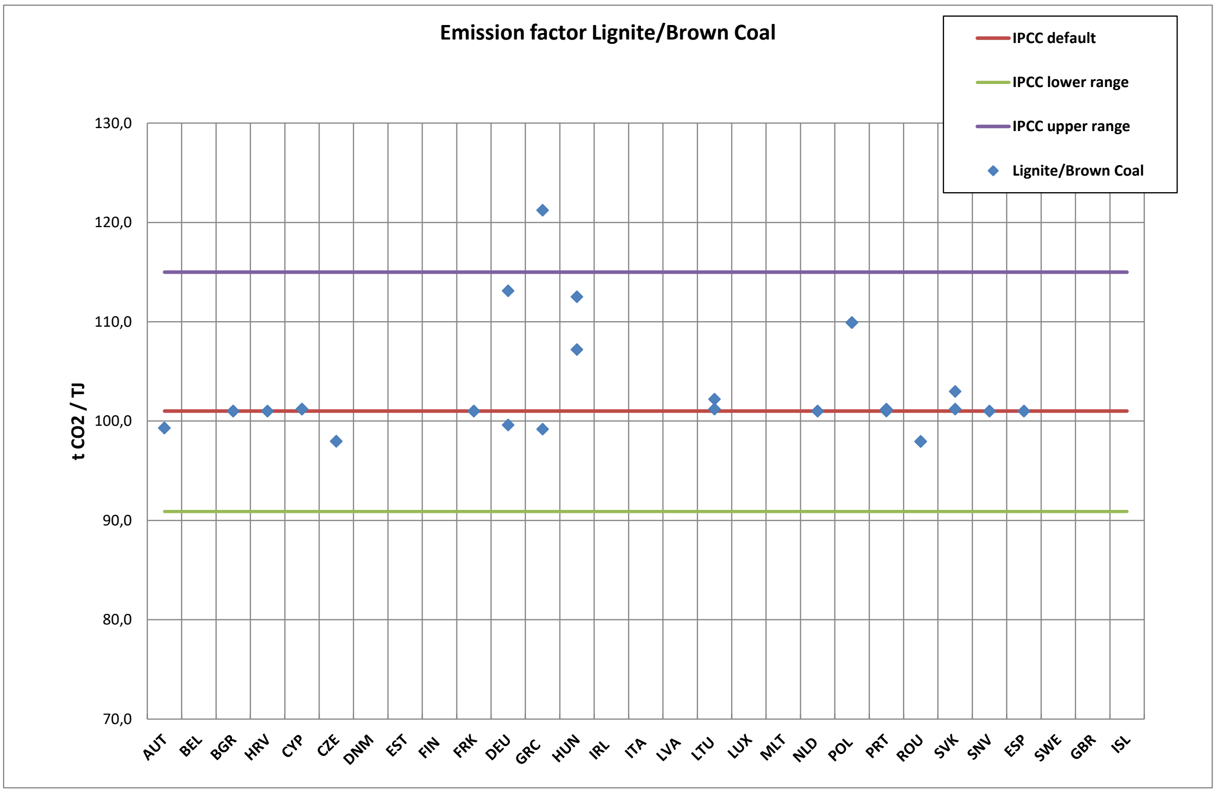


*Figure **3**.193 Emission factors used by Member States for lignite*



__GRC:__ A country specific carbon content of lignite used for electricity production was used in emission calculations for the period 1990-2005 (33.95 tC/TJ), which is based on studies of the Public Power Corporation (PPC 1993). For the period 2006-2019 plant specific values for CC were used, based on verified EU-ETS reports, ranging from 33.74 to 35.37 tC/TJ. These values lies out of the range suggested by the 2006 IPCC Guidelines. However, given that the net calorific value of the Greek lignite is one of lowest (see Papanicolaou et al., 2004 for an overview of the properties of the Greek lignites) a high value for the carbon content is expected. Moreover, according to international literature (Fott, 1999) the suggested value by IPCC corresponds to a net calorific value of 13 TJ / kt, which is not representative of national circumstances (see Table 3.14 and Figure 3.5). -The oxidation factor 98% is used for the combustion of lignite for electricity production. This is based on a study of the Public Power Corporation (PPC 1993) and verified EU-ETS reports.

Figure 3.194 Emission factors used by Member States for coking coal

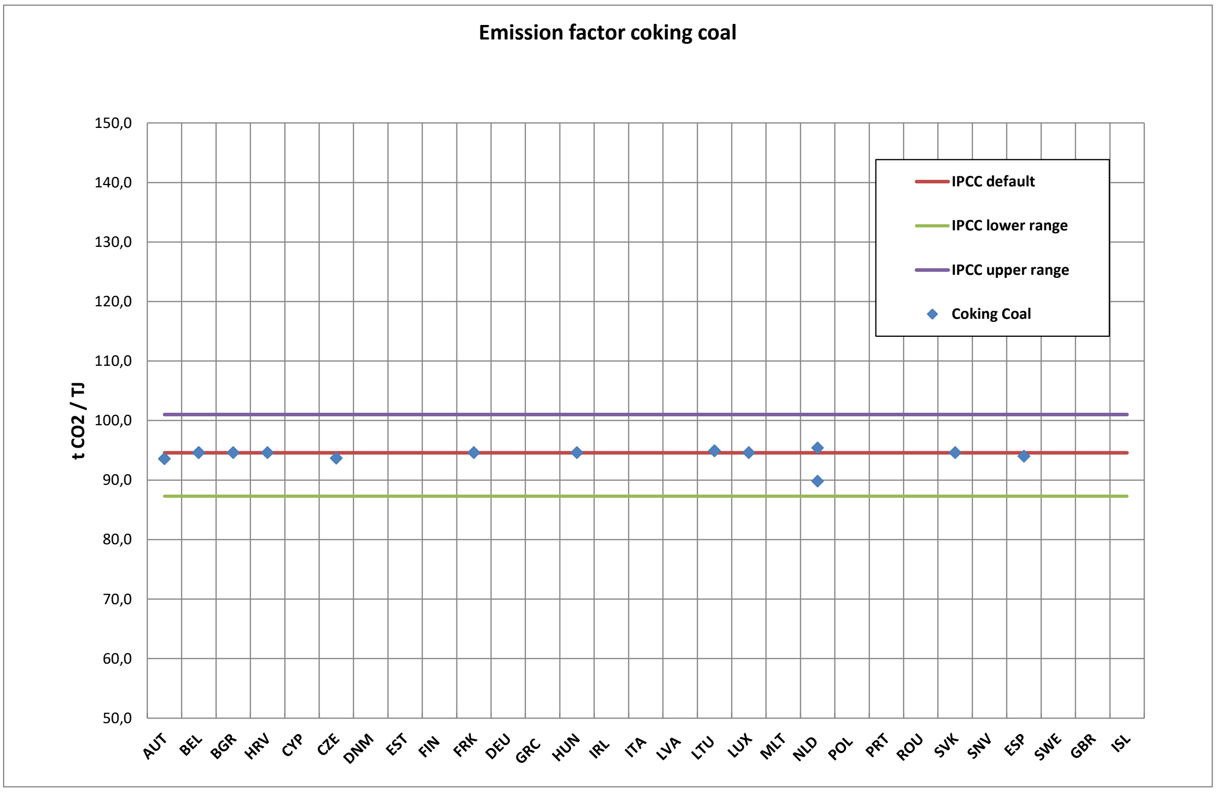


Figure 3.195 Emission factors used by Member States for coke oven coke

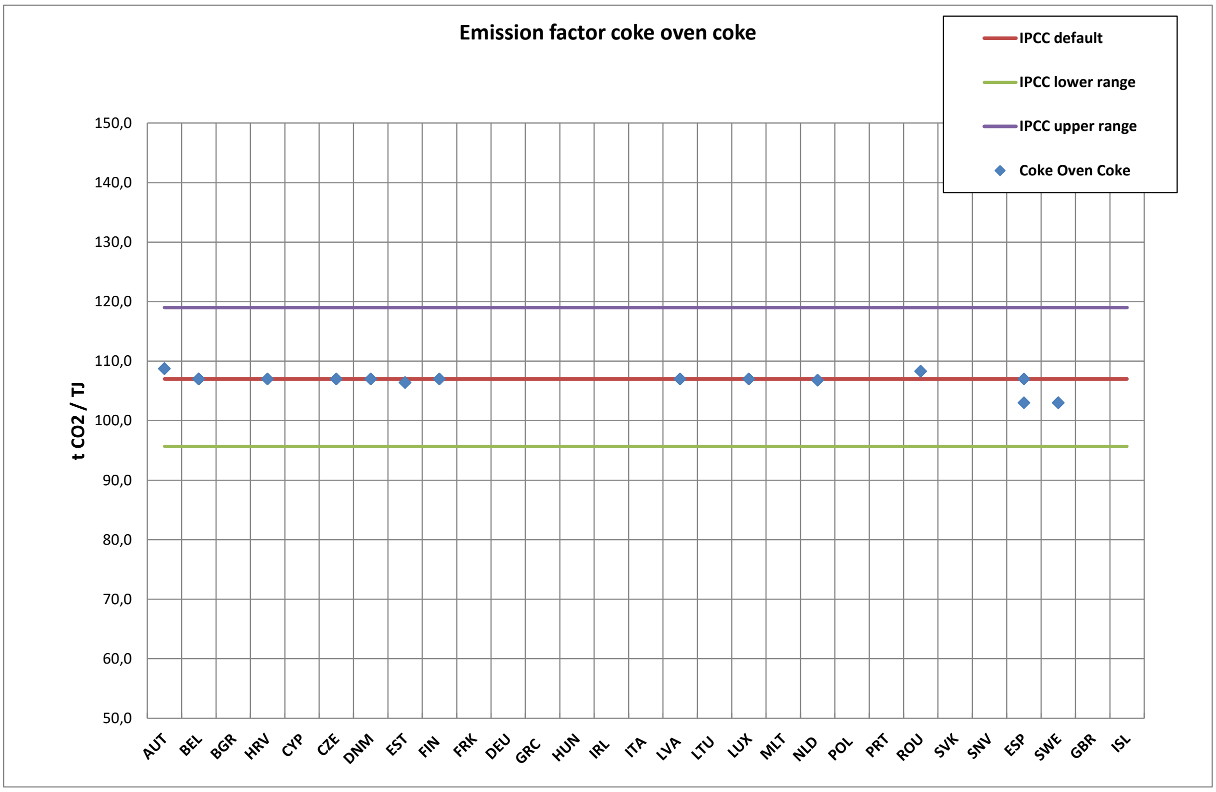
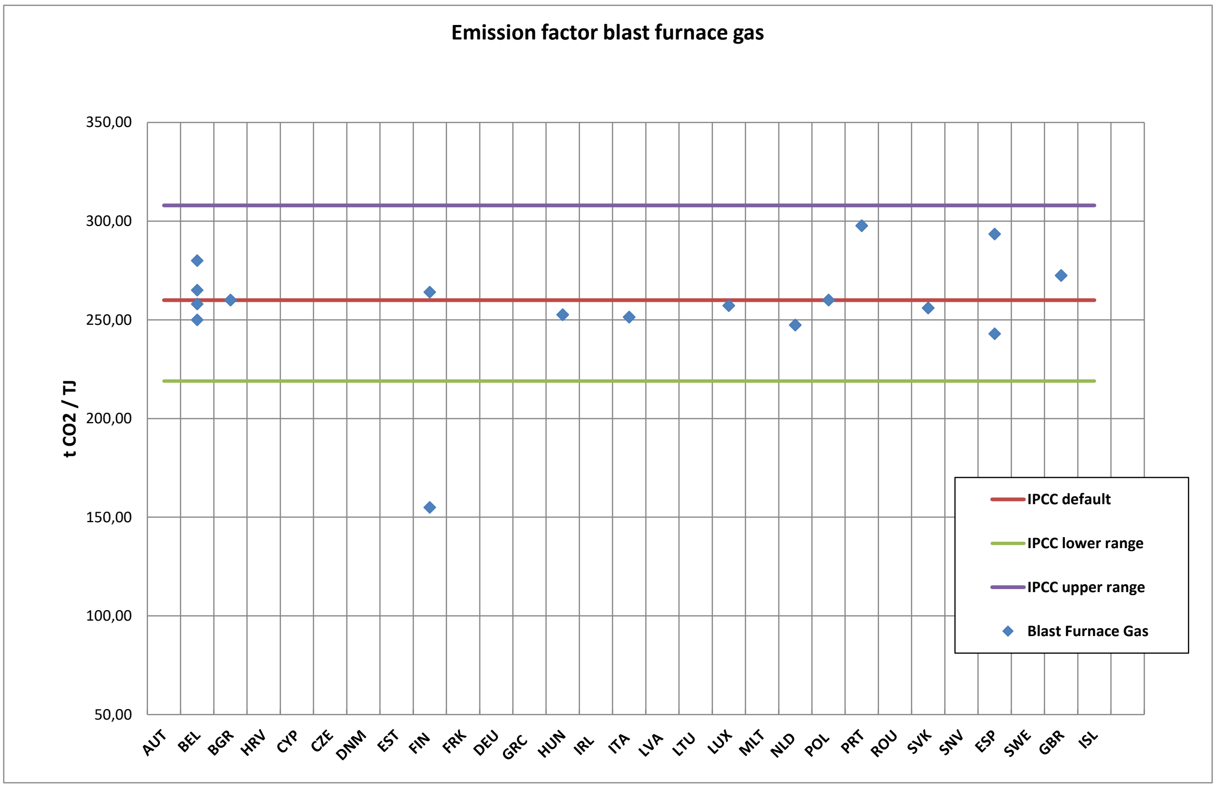


*Figure **3**.196 Emission factors used by Member States for blast furnace gas*



BEL: Highest value max. Wallonia, lowest value min. Flanders

FIN: Because the number of plants is very small, we have to aggregate certain fuel types to more general categories. In this case, blast furnace gas includes actually two types of gas. One is more like carbon monoxide (EF 155), and the other actual blast furnace gas (EF around 265). Both EF values (or range for actual blast furnace gas) are based on plant-level data. In the calculations we use different fuel codes for each fuel type (each plant), but in reporting we aggregate them in the same group, which is named as blast furnace gas (it should probably be 'Blast furnace gas and other derived gases from metal industries').

*Figure **3**.197 Emission factors used by Member States for anthracite*

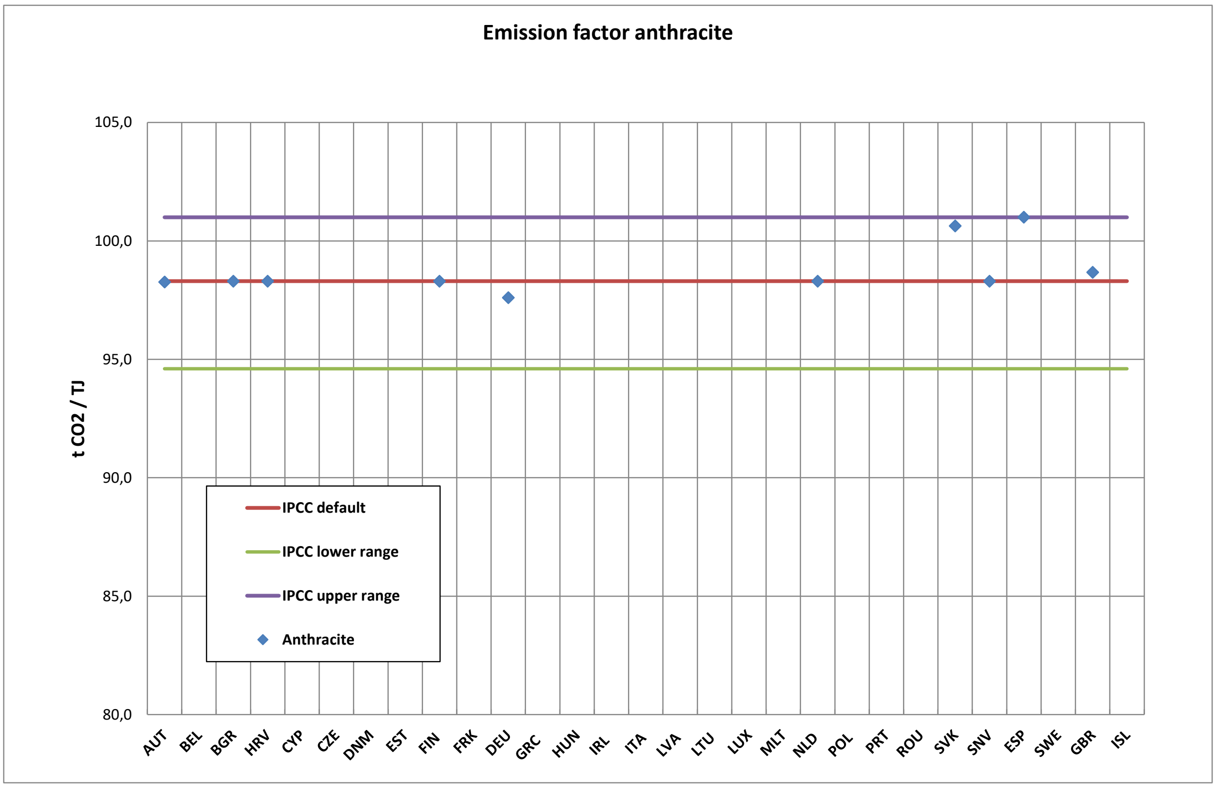
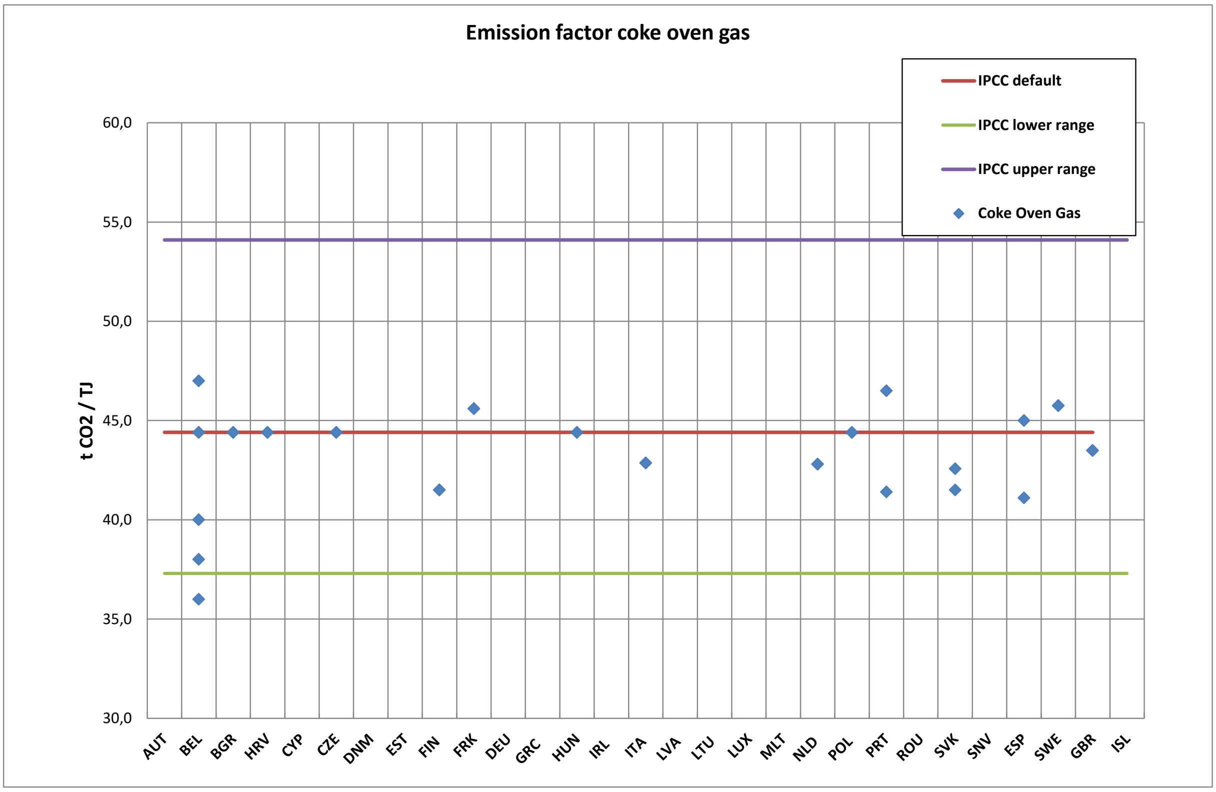


*Figure **3**.198 Emission factors used by Member States for coke oven gas*



* BEL: Highest value max. Wallonia, lowest value min. Wallonia

Table 3.131 shows the total EU-KP uncertainty estimates for the sector 'Energy' (excluding 1A3 'Transport' and 1B 'Fugitive') for the relevant gases for each source category. For those emissions for which no split by source category was available, uncertainty estimates were made for stationary combustion as a whole. The highest level uncertainty was estimated for CH_4 from 1A1c and the lowest for CO_2 from 1A2e. With regard to trend CH_4 from 1A1a shows the highest uncertainty estimates, CO_2 from 1A1a the lowest. The results of this year's uncertainty analysis are very similar to the results in 2021. For a description of the Tier 1 uncertainty analysis carried out for the EU-KP see Chapter 1.6.

Table 3.131 Sector 1 Energy (excl. 1A3b and 1B): Uncertainty estimates for EU-KP

Source category	Gas	Emissions Base Year	Emissions 2020	Emission trends Base Year-2020	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.1.a Public electricity and heat production	CO_2	579.148	291.785	-49,6%	2,3%	1,1%
1.A.1.a Public electricity and heat production	CH_4	245	2.330	849,9%	53,9%	471,9%
1.A.1.a Public electricity and heat production	N_2O	2.791	1.986	-28,9%	16,8%	5,9%
1.A.1.b Petroleum refining	CO_2	53.523	47.527	-11,2%	4,7%	1,7%
1.A.1.b Petroleum refining	CH_4	19	16	-17,0%	17,3%	4,4%
1.A.1.b Petroleum refining	N_2O	230	115	-49,8%	23,8%	19,4%
1.A.1.c Manufacture of solid fuels and other energy industries	CO_2	72.793	16.588	-77,2%	7,0%	4,1%
1.A.1.c Manufacture of solid fuels and other energy industries	CH_4	101	136	35,0%	111,3%	43,6%
1.A.1.c Manufacture of solid fuels and other energy industries	N_2O	664	158	-76,2%	21,9%	17,2%
1.A.2.a Iron and Steel	CO_2	52.268	35.918	-31,3%	5,8%	0,6%
1.A.2.a Iron and Steel	CH_4	76	57	-25,8%	24,9%	5,7%
1.A.2.a Iron and Steel	N_2O	231	100	-56,7%	33,2%	47,3%
1.A.2.b Non-ferrous Metals	CO_2	2.232	997	-55,3%	2,9%	6,2%
1.A.2.b Non-ferrous Metals	CH_4	2	1	-62,6%	36,7%	32,0%
1.A.2.b Non-ferrous Metals	N_2O	17	3	-84,7%	58,2%	50,4%
1.A.2.c Chemicals	CO_2	24.322	7.488	-69,2%	2,9%	1,9%
1.A.2.c Chemicals	CH_4	16	22	33,5%	50,1%	54,4%
1.A.2.c Chemicals	N_2O	29	29	-1,0%	103,9%	54,9%
1.A.2.d Pulp, Paper and Print	CO_2	3.155	1.444	-54,2%	3,1%	3,5%
1.A.2.d Pulp, Paper and Print	CH_4	15	19	28,1%	28,3%	7,6%
1.A.2.d Pulp, Paper and Print	N_2O	77	94	22,1%	34,9%	8,9%
1.A.2.e Food Processing, Beverages and Tobacco	CO_2	7.843	4.102	-47,7%	2,0%	1,7%
1.A.2.e Food Processing, Beverages and Tobacco	CH_4	11	14	28,7%	55,8%	53,7%
1.A.2.e Food Processing, Beverages and Tobacco	N_2O	39	12	-68,3%	55,1%	32,4%
1.A.2.f Non-metallic minerals	CO_2	28.209	21.205	-24,8%	3,4%	1,3%
1.A.2.f Non-metallic minerals	CH_4	67	42	-36,8%	23,8%	15,2%
1.A.2.f Non-metallic minerals	N_2O	236	189	-19,9%	32,2%	12,6%
1.A.2.g Other	CO_2	162.564	80.584	-50,4%	3,3%	1,3%

Source category	Gas	Emissions Base Year	Emissions 2020	Emission trends Base Year-2020	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.2.g Other	CH_4	181	236	30,7%	26,6%	12,1%
1.A.2.g Other	N_2O	1.142	678	-40,6%	28,9%	12,7%
1.A.4.a Commercial/Institutional	CO_2	84.239	43.368	-48,5%	7,0%	3,7%
1.A.4.a Commercial/Institutional	CH_4	1.581	227	-85,6%	44,5%	88,3%
1.A.4.a Commercial/Institutional	N_2O	281	144	-48,9%	81,7%	19,2%
1.A.4.b Residential	CO_2	192.638	129.387	-32,8%	6,9%	1,9%
1.A.4.b Residential	CH_4	4.088	2.695	-34,1%	53,2%	56,3%
1.A.4.b Residential	N_2O	1.037	646	-37,7%	67,8%	40,3%
1.A.4.c Agriculture/forestry/fishing	CO_2	32.162	22.639	-29,6%	7,1%	1,7%
1.A.4.c Agriculture/forestry/fishing	CH_4	409	1.464	257,7%	42,8%	123,8%
1.A.4.c Agriculture/forestry/fishing	N_2O	200	322	60,5%	77,2%	28,6%
1.A.5 Other	CO_2	21.219	5.551	-73,8%	3,9%	3,0%
1.A.5 Other	CH_4	297	11	-96,2%	36,3%	41,5%
1.A.5 Other	N_2O	193	55	-71,6%	88,4%	33,2%
1.A (where no subsector data were submitted)	*all*	383.740	*165.736*	*-56,8%*	*1,7%*	*1,8%*
1.A.1 (where no subsector data were submitted)	*all*	*714.848*	*411.285*	*-42,5%*	*13,8%*	*11,5%*
1.A.2 (where no subsector data were submitted)	*all*	*428.642*	*240.869*	*-43,8%*	*7,6%*	*3,3%*
1.A.3 (where no subsector data were submitted)	*all*	*245.477*	*258.719*	*5,4%*	*3,3%*	*1,0%*
1.A.4 (where no subsector data were submitted)	*all*	*492.154*	*389.581*	*-20,8%*	*9,0%*	*2,1%*
1.A.5 (where no subsector data were submitted)	*all*	*0*	*0*	*0,0%*	*0,0%*	*0,0%*
Total - 1.A (where no subsector data were submitted)	**all**	**383.740**	**165.736**	**-56,8%**	**1,7%**	**1,8%**
Total - 1.A.1	**all**	**1.424.362**	**771.928**	**-45,8%**	**7,4%**	**5,8%**
Total - 1.A.2	**all**	**711.375**	**394.103**	**-44,6%**	**4,7%**	**2,0%**
Total - 1.A.3	**all**	**780.317**	**803.299**	**2,9%**	**2,0%**	**0,5%**
Total - 1.A.4	**all**	**808.790**	**590.473**	**-27,0%**	**6,2%**	**1,5%**
Total - 1.A.5	**all**	**21.710**	**5.617**	**-74,1%**	**4,0%**	**3,0%**
Total - 1.A	**all**	**4.130.294**	**2.731.155**	**-33,9%**	**2,8%**	**2,1%**

Note: Emissions are in kt CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories.

Table 3.132 shows the total EU-KP uncertainty estimates for the sector 1.B 'Fugitive emissions' and the uncertainty estimates for the relevant gases for each source category. The highest level uncertainties were estimated for N_2O from 1B2 and the lowest for CO_2 from 1B1; the highest trend uncertainties were estimated for N_2O from 1B2, the lowest for CO_2 from 1B1. Uncertainties analysis show very similar results as in 2021.

Table 3.132 1B Fugitive Emissions: Uncertainty estimates for EU-KP

Source category	**Gas**	**Emissions Base Year**	**Emissions 2020**	**Emission trends Base Year-2020**	**Level uncertainty estimates based on MS uncertainty estimates**	**Trend uncertainty estimates based on MS uncertainty estimates**
1.B.1 Solid Fuels	CO_2	8.421	3.461	-58,9%	13,5%	6,4%
1.B.1 Solid Fuels	CH_4	96.242	23.420	-75,7%	71,8%	10,0%
1.B.1 Solid Fuels	N_2O	0,1	0,0	-81,9%	118,0%	96,6%
1.B.2. Oil and Natural Gas and other emissions from energy production	CO_2	17.475	17.025	-2,6%	16,6%	11,4%
1.B.2. Oil and Natural Gas and other emissions from energy production	CH_4	56.421	19.631	-65,2%	27,1%	14,9%
1.B.2. Oil and Natural Gas and other emissions from energy production	N_2O	137	210	53,5%	159,0%	240,8%
1.B (werhe no subsector data were submitted)	*all*	*14.498*	*6.514*	*-55,1%*	*34,5%*	*32,8%*
Total - 1.B	**all**	**193.194**	**70.262**	**-63,6%**	**29,0%**	**7,1%**

Note: Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories.

Table 3.133 shows the total EU-KP uncertainty estimates for the sector 1A3 'Transport' and the uncertainty estimates for the relevant gases for each source category. The highest uncertainty was estimated for N_2O from 1A3d and the lowest for CO_2 from 1A3b. With regard to trend N_2O from 1A3e show the highest uncertainty estimates, CO_2 from 1A3b the lowest. The results of this year's uncertainty analysis are very similar to the results in 2021.

Table 3.133 1A3 Transport: Uncertainty estimates for EU-KP

Source category	**Gas**	**Emissions Base Year**	**Emissions 2020**	**Emission trends Base Year-2020**	**Level uncertainty estimates based on MS uncertainty estimates**	**Trend uncertainty estimates based on MS uncertainty estimates**
1.A.3.a Domestic aviation	CO_2	7.670	4.071	-46,9%	10,2%	3,4%
1.A.3.a Domestic aviation	CH_4	11	2	-78,5%	76,9%	36,7%
1.A.3.a Domestic aviation	N_2O	72	29	-59,7%	149,0%	45,0%
1.A.3.b Road transport	CO_2	481.661	515.676	7,1%	2,6%	0,3%
1.A.3.b Road transport	CH_4	4.324	613	-85,8%	33,2%	20,4%
1.A.3.b Road transport	N_2O	4.373	4.907	12,2%	47,4%	8,1%
1.A.3.c Railways	CO_2	9.732	4.002	-58,9%	8,1%	2,5%
1.A.3.c Railways	CH_4	27	4	-86,5%	70,6%	20,9%
1.A.3.c Railways	N_2O	524	160	-69,4%	82,0%	35,4%
1.A.3.d Domestic navigation	CO_2	20.592	12.080	-41,3%	20,7%	11,5%
1.A.3.d Domestic navigation	CH_4	23	42	82,1%	58,2%	42,3%
1.A.3.d Domestic navigation	N_2O	291	189	-35,1%	185,1%	46,3%
1.A.3.e Other transportation	CO_2	5.465	2.778	-49,2%	2,8%	1,8%
1.A.3.e Other transportation	CH_4	9	5	-48,3%	63,5%	21,3%
1.A.3.e Other transportation	N_2O	65	21	-67,4%	95,1%	61,6%
Total - 1.A.3	**all**	**780.317**	**803.299**	**2,9%**	**2,0%**	**0,5%**

Note: Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories.

3.4 Sector-specific quality assurance and quality control

There are several activities for improving the quality of GHG emissions from energy: Before and during the compilation of the EU GHG inventory, several checks are made of the Member States data in particular for time series consistency of emissions and implied emission factors, comparisons of implied emission factors across Member States and checks of internal consistency. Table 3.134 summarizes the main checks carried out on Member States' submissions.

Table 3.134 Quality checks carried out on Member States' submissions

Issue	Check
Completeness	Check categories where Member States report the notation key NE for potential underestimations Check categories where Member States report a notation key and 20 or more Member States report emissions and assess if there are potential over- or underestimates Focus on the year 2020 (ESD) Focus on EU key categories
Time series of emissions	Check time series consistency of Member States' emission estimates for potential over- and underestimates: Focus on the year 2020 (ESD) Focus on EU key categories
Time series of IEFs	Check time series consistency of Member States' IEFs for potential over- and underestimates: Focus on the years 2020 (ESD) Focus on EU key categories
Outlier checks of IEFs	Compare IEFs across Member States and assess if there are potential over- and underestimations of emissions Compare Member States' IEFs with (range of) default EF from 2006 IPCC GL Focus on the years 2020 (ESD) Focus on EU key categories
Recalculations	Check categories where Member States provide recalculations and focus on those of more than 0.05% of national total emissions for each main gas and assess if there are potential over- or underestimates. Also explanations for recalculations were checked either from MS Annexes - MMR IR Art. 8 or NIR. Focus on the year 2019 Focus on EU key categories
Follow-up from 2021	Check if issues that were classified as "Unresolved" or "Partly resolved" in 2021 have been resolved by Member States in 2022.
Implementation of UNFCCC and ESD review recommendations	Check if recommendations from the latest UNFCCC review reports have been implemented by Member States. Check if recommendations from ESD review 2021 have been implemented by Member States.
Reporting of non-energy use of fossil fuels	Check plausibility of reporting in CRF table 1A(d) as compares reporting in CRF table 1A(b), 1A(c) and the IPPU sector.

In the second half of the year, the EU internal review is carried out for selected source categories. In 2005, the EU internal review was carried out for the first time. Since 2012 the EU internal reviews are carried out in the context of the ESD reviews.

- In 2012 a comprehensive review was carried out for all sectors and all EU Member States in order to fix the base year for the 2020 targets under the EU Effort Sharing Decision (ESD review 2012). This review also covered the energy sector of the MS GHG inventories (peer review).
- In 2015, a few Member States volunteered to be reviewed under step 2 of the ESD trial review for the sector energy.
- In 2016, again a comprehensive review was carried out for all sectors and all EU Member States with a focus on the years 2005, 2008-2010, 2013 and 2014 in order to track progress of the EU Member States under the EU Effort Sharing Decision (ESD review 2016).
- In 2017-2019, annual reviews were carried out for all significant issues identified during the initial checks phase with a focus on the years 2015-2017 in order to track progress of the EU Member States under the EU Effort Sharing Decision.
- In 2020, again a comprehensive review was carried out for all sectors and all EU Member States with a focus on the years 2005, 2016-2018 in order to track progress of the EU Member States under the EU Effort Sharing Decision and in order to fix the base year for the 2030 targets under the EU Effort Sharing Regulation (ESD review 2020).
- In 2021 an annual review was carried out for all significant issues identified during the initial checks phase with a focus on the year 2019 in order to track progress of the EU Member States under the EU Effort Sharing Decision.
- In 2022 an annual review is carried out for all significant issues identified during the initial checks phase with a focus on the year 2020 in order to track progress of the EU Member States under the EU Effort Sharing Decision.

In addition, every year after the ESD review capacity building activities are organized. In 2021 the energy-related webinar had 55 participants from 22 countries. Main issues discussed at the webinar were:

- Main findings from ESD review 2021
- Biogas injected into the gas network
- Consistency with EU ETS
- Development of country-specific emission factors based on EU ETS data

EU ETS data

Since the inventory 2005 plant-specific data is available from the EU Emission Trading Scheme (EU ETS). This information has been used by EU Member States for quality checks and as input for calculating total CO_2 emissions for the sectors Energy and Industrial Processes in this report (see Section 1.4.2). During the ESD reviews and during the initial checks consistency checks have been carried out between EU ETS data and the inventory estimates.

Eurostat energy data

During the initial checks carried out before the compilation of the EU GHG inventory and during the ESD reviews Eurostat energy data is used for cross checking the sectoral and reference approach of the MS submissions. This cross check between the European energy reporting system and the EU GHG inventory system is an important QA/QC element of the EU GHG inventory compilation.

The quality of the EU GHG inventory is directly affected by the quality of Member States and EU energy statistics systems. EU energy statistics are collected by Eurostat on the basis of the EU energy statistics regulation[18]. The energy statistics regulation was adopted as part of the energy package and

[18] REGULATION (EC) No 1099/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 October 2008 on energy statistics as amended by Commission Regulation (EU) No 147/2013 of 13 February 2013.

establishes a common framework for the production, transmission, evaluation and dissemination of comparable energy statistics in the EU.

This regulation aims at collecting detailed statistical data on energy flows by energy commodity at annual and monthly level. It ensures harmonised and coherent reporting of national energy data, which is indispensable for the assessment of EU energy policies and targets. The content and structure of this regulation reflects the essence of the existing European statistical system, a system that is part of the international energy statistical system, and is in direct link with the national statistical structures (classifications) and methodologies. It also has concrete links to other statistical domains, such as economic, environment, trade and business statistics. These links provide an additional dimension in safeguarding data quality assurance.

The European energy statistics system and the quality of the EU inventory are directly affected by this regulation that:

- ensures a stable and institutional basis for energy statistics in the EU
- guarantees long-term availability of energy data for EU policies
- reinforces available resources for the production of the basic energy statistics at national level

The energy statistics regulation helps improving the QA/QC of the EU inventory as it:

- makes available more detailed energy statistics by fuel
- allows the estimation of CO_2 emissions from energy with the reference and sectoral approach
- assures the quality of the underlying energy statistics
- improves timeliness of energy statistics
- provides a formal legal framework assuring consistency between national and Eurostat data

Moreover, Article 6, paragraph 2 stipulates that:

'Every reasonable effort shall be undertaken to ensure coherence between energy data declared in the energy statistics regulation, and data declared in accordance with Commission Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol'.

In addition, Article 7(1)(m)(iii) of the MMR in conjunction with Article 12 of the implementing regulation requires Member States to report to the European Commission textual information on the comparison between the reference approach calculated on the basis of the data included in the greenhouse gas inventory and the reference approach calculated on the basis of the data reported pursuant to the Energy Statistics Regulation. Member States with differences of more than +/- 2% in the total national apparent fossil fuel consumption have to provide quantitative information and explanations for the year X-2 in accordance with the tabular format set out in Annex VI of the implementing regulation.

Eurocontrol data

Since 2010 there are framework contracts in place between the European Commission and EUROCONTROL, the European organization for the safety of air navigation, pertaining to the improvement of GHG and air pollutant emissions inventories submitted by the 27 Member States and the European Union to the UNFCCC and to the UNECE. EU Member States shall be assisted to improve the reporting of annual greenhouse gas (and other air pollutant) emission inventories by e.g., estimating the fuel split domestic/international using real flight data from EUROCONTROL. For this, the European

Environment Agency and its ETC/ACM is preparing comparisons between EUROCONTROL results and MS inventory data and is promoting discussions between EUROCONTROL and EEA Member States related to these results. For more information on the process refer to Chapter 1.4.2.

In August 2021 EUROCONTROL provided results on fuel consumption, emissions of CO_2, CH_4 and N_2O and other air pollutants for domestic and international aviation for the years 2005 to 2020 by EU Member States and other EEA member countries (United Kingdom, Iceland, Switzerland, Norway and Turkey). Recalculations took place to reflect i.e., corrections of aircraft types and their relation to engine Types and the calculation of taxi-in and taxi-out times.

The calculation of EUROCONTROL is a bottom-up modelling, applying the Advanced Emissions Model (AEM). This is a Tier 3b approach basing on EUROCONTROL information on flight plan data and flight trajectories (detailed documentation available upon request). Flight plan data is only available for flights under Instrumental Flight Rules. Flights which take place under Visual Flight Rules (VFR) are not included in the dataset of EUROCONTROL.

The comparison of EUROCONTROL results and MS inventory data for the time series 2005 to 2020 has been prepared by the European Environment Agency and its ETC/ACM in February 2022. Results have been shared with Member States during the 'initial checks' for aviation gasoline and kerosene consumption, domestic splits for kerosene and implied emission factors for CO_2, N_2O and CH_4. In addition, Member States have been contacted in case of considerable differences between inventory and EUROCONTROL results.

Due to the exclusion of flights under VFR in EUROCONTROL's calculations, the results for the consumption of aviation gasoline (which mainly takes place in smaller aircrafts under VFR) are considerably lower for most Member States in EUROCONTROL calculations than in inventories. In addition, most Member States allocate the total consumption of aviation gasoline to domestic aviation, following the recommendation of the IPCC 2006 guidelines, whereas EUROCONTROL displays some small amounts of aviation gasoline consumption for international aviation, too. EU-27 kerosene consumption in 2020 resulting from EUROCONTROL calculations is 4 % lower for domestic and 3% higher for international aviation compared to the aggregation of Member State results from inventories. The domestic split (as the share of kerosene consumption for domestic aviation on total kerosene consumption) for EU-27 is identical between EU inventory and EUROCONTROL results.

Obviously both the reporting of Member States but also the calculation of EUROCONTROL improved considerably during the years. The development of kerosene consumption along the time series 2005 to 2020 for EU-27 shows the same trends for both domestic and international aviation following EUROCONTROL results and EU inventory numbers. Differences are slightly higher in the years 2005 to 2007 due to different underlying datasets in EUROCONTROL calculations. With the new methodology applied for the calculation of N_2O and CH_4 emissions by EUROCONTROL, implied emission factors for these gases are now much more comparable with Member State results.

Absolute differences in kerosene consumption are partly higher for single Member States. The reasons for these differences are mainly due to the fact, that respective Member States are basing their estimates on fuel sales statistics and on different estimates of domestic splits. In addition, there are several general sources of possible differences: First there is the fact, that the consideration of flight trajectories for the calculation of cruise emissions is a method exclusively applied by EUROCONTROL. Furthermore, the use of different sources for flight statistics for bottom-up modelling, the allocation of aircraft types and engines to flights in statistics and the use of different emission factors for cruise and LTO lead to different results.

During the last years, it can be seen that EUROCONTROL information has increasingly been used by Member States, for checking purposes but also by using the numbers directly in inventory calculations.

During the ‘initial checks’ 2016, 2017, 2018, 2019 and 2020 an intensive discussion with Member States took place to understand the reasons for differences on MS level. On the one hand, some of the outcomes could lead to eventual further improvement of inventories in next submissions or on the other hand for additional use of national information in EUROCONTOL calculations. In most cases the differences occur due to the need to align inventory numbers with the energy balance which might always lead to differences compared to a bottom-up calculation.

In Table 3.135 an overview is given on how EUROCONTROL data has been used by Member States, as it has been mentioned in their NIR 2022 version.

Table 3.135 Use of Eurocontrol data by Member States in their national inventory reports

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For possible planned improvements	Indirect use	Direct use	How has time series consistency been ensured?
Austria	-	-	-	-	-
Belgium			Data per airport, to make distribution of emissions in the regions possible	In Flemish region for international flights. In Wallonia, for N_2O and CH_4	
Bulgaria			LTO per aircraft type for the period 1996-2020		
Cyprus				For domestic and international flights	Trend of domestic share from Eurocontrol data has been applied to years 2005-2020
Czechia				Emissions were calculated with EUROCONTROL implied emission factors.	
Germany	yes				
Denmark			List of aircraft types provided by Eurocontrol used		
Spain				For domestic and international flights	An adaptation model has been applied to link results based on national statistic with Eurocontrol results (2005-2020).
Estonia	-	-	-	-	-
Finland				For domestic flights from 2005 onwards	For the years before 2005, the own model (ILMI) has been used. ILMI was implemented by Finavia and calculated emissions partly until the year 2008, since 2010 the model was not updated. No specific adaptation.
France	not mentioned, but numbers match very closely				
United Kingdom			EMEP/EEA Eurocontrol cruise factors for generic aircraft are used		
Greece				For domestic and international flights	To keep timeseries consistency, emissions from 1990-2005 have been recalculated taking into account only international aviation fuel consumption and by applying Tier 1 methodology.
Croatia	-	-	-	-	-

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For possible planned improvements	Indirect use	Direct use	How has time series consistency been ensured?
Hungary				For domestic flights	Fuel use (and consequently the emissions) of the years before 2005 have been adapted with built-in extrapolation procedures: The same share of kerosene use from Eurocontrol result 2005-2015 for domestic flights has been applied for the years 1985-2004.
Iceland	yes				
Ireland				The fuel consumption based on origin and destination data for domestic air travel provided by EUROCONTROL using an Advanced Emission Model (AEM) (from 2005 to 2020).	
Italy	yes			domestic	Emissions from aviation have been recalculated from 1990 on the basis of information on activity data and emission factors provided by Eurocontrol. A linear interpolation took place between 1999 (the year of a Tier 3 calculation) and 2005 for fuel consumption factors and emission factors.
Lithuania					
Luxembourg	-	-	-	-	-
Latvia	Yes (2008-2019)				
Malta				For domestic aviation (from 2005 until 2020)	Recalculations would have been implemented for the whole timeseries, from 1990 until 2020, if possible but the EUROCONTROL model data started from 2005.
Netherlands	-	-	-	-	-
Poland				For the share of domestic flights	Due to the lack of Eurocontrol data for the years before 2005, the share of domestic use for years 1988-2004 was assumed as a 5-years average from Eurocontrol data for years 2005-2009.
Portugal					
Romania	-	-	-	-	-
Slovakia				For the time series 2005 – 2020, EUROCONTROL data on the number of flights, fuels consumption and share of domestic and international flights was used.	For the years 1990-2004 summary information from the Eurocontrol database was used (emission factors and domestic share).
Slovenia				For domestic flights. Since 2017: Data on fuel consumption based on Eurocontrol from 2005	Only a small amount of domestic flights has been recorded by Eurocontrol. No adaptation took place for the years 1990-2004
Sweden	-	-	-	-	-

Four Member States report a comparison or a verification of their results with EUROCONTROL data. Three Member States mention the indirect use of this data, using emissions factors or LTO information. Thirteen Member States report direct use of EUROCONTROL data and most of them informed about related adaptation process to ensure time-series consistency.

3.5 Sector-specific improvements

The improvements implemented in 2022 were partly due to recommendations derived from an EU internal review and partly motivated by recommendations made by the UNFCCC review team. The major improvements are included in included in Table 10.7 in chapter 10.

3.6 Sector-specific recalculations

Table 3.136 shows that in the energy sector the largest recalculations in absolute terms in 1990 and in 2019 were made for CO_2. In relative terms, the recalculations made for N_2O (- 1.4 %) and for CH_4 (- 2.6 %) for the year 2019 were the largest.

Table 3.136 Sector 1 Energy: Recalculations of total GHG emissions and recalculations of GHG emissions for the years 1990 and 2019 by gas in kt (CO_2-eq.) and percentage

	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6		Unspecified mix of HFCs and PFCs		NF3	
1990	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%
Total emissions and removals	-19.935	-0,5%	-1.905	-0,3%	-7.051	-1,7%	1,3	0,0%	-2,7	0,0%	-115	-1,0%	0,0	0,0%	-0,3	-1,3%
Energy	-33.719	-0,8%	-298	-0,2%	-75	-0,2%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2019																
Total emissions and removals	3.998	0,1%	-3.657	-0,8%	-9.520	-3,7%	5.924	6,3%	-138	-4,6%	-105	-1,5%	0,5	0,0%	-0,3	-0,5%
Energy	-16.602	-0,5%	-1.945	-2,6%	-389	-1,4%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

NO: not occurring

Table 3.137 provides an overview of Member States' contributions to EU-KP recalculations. In absolute terms, the UK had the most influence on CO_2 recalculations in the EU-KP for 2019. Explanations for recalculations by Member State are provided in Chapters 3.2 and 10.1.

Table 3.137 Sector 1 Energy: Contribution of Member States to EU-KP recalculations for 1990 and 2019 by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2019							
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3
Austria	0,0	0,5	0,0	NO	NO	NO	NO	NO	-67	-2,4	-1,3	NO	NO	NO	NO	NO
Belgium	-16	-0,8	-1,7	NO	NO	NO	NO	NO	-313	2,2	-8,0	NO	NO	NO	NO	NO
Bulgaria	0,5	0,0	-18,2	NO	NO	NO	NO	NO	28	1,8	-42	NO	NO	NO	NO	NO
Croatia	0,0	0,8	-0,8	NO	NO	NO	NO	NO	83	-0,1	-4,7	NO	NO	NO	NO	NO
Cyprus	1,5	0,2	-6,8	NO	NO	NO	NO	NO	3,3	0,0	-0,6	NO	NO	NO	NO	NO
Czechia	-131	3,7	-5,6	NO	NO	NO	NO	NO	211	2	17	NO	NO	NO	NO	NO
Denmark	17	-0,8	1,0	NO	NO	NO	NO	NO	57	-0,1	0,1	NO	NO	NO	NO	NO
Estonia	-728	-21	-53	NO	NO	NO	NO	NO	-1,0	-17	-49	NO	NO	NO	NO	NO
Finland	-54	-5,4	0,2	NO	NO	NO	NO	NO	-166	-2,0	-5,8	NO	NO	NO	NO	NO
France	711	0,9	38,2	NO	NO	NO	NO	NO	170	53	93	NO	NO	NO	NO	NO
Germany	-497	-45	-13,1	NO	NO	NO	NO	NO	-2.963	-535	-27	NO	NO	NO	NO	NO
Greece	12	0,0	0,1	NO	NO	NO	NO	NO	25	0,3	-0,7	NO	NO	NO	NO	NO
Hungary	0,0	25,8	-3,2	NO	NO	NO	NO	NO	150	3,6	-4,0	NO	NO	NO	NO	NO
Ireland	-0,2	0,8	-2,7	NO	NO	NO	NO	NO	46	16	-7,2	NO	NO	NO	NO	NO
Italy	0,1	0,0	-24,0	NO	NO	NO	NO	NO	-561	-895	-105	NO	NO	NO	NO	NO
Latvia	0,0	-0,2	-0,7	NO	NO	NO	NO	NO	-0,3	0,1	0,1	NO	NO	NO	NO	NO
Lithuania	0,0	0,0	0,0	NO	NO	NO	NO	NO	0,7	0,9	0,0	NO	NO	NO	NO	NO
Luxembourg	0,0	0,0	0,0	NO	NO	NO	NO	NO	-0,5	-0,1	0,0	NO	NO	NO	NO	NO
Malta	-14	0,0	0,1	NO	NO	NO	NO	NO	-20	-3,2	1,2	NO	NO	NO	NO	NO
Netherlands	0,0	1,9	4,3	NO	NO	NO	NO	NO	-271	14	-48	NO	NO	NO	NO	NO
Poland	3,5	4,5	-0,4	NO	NO	NO	NO	NO	-1.043	-284	21	NO	NO	NO	NO	NO
Portugal	1,2	0,1	0,0	NO	NO	NO	NO	NO	22	0,3	0,9	NO	NO	NO	NO	NO
Romania	-16.352	-294	-18,3	NO	NO	NO	NO	NO	74	308	-4	NO	NO	NO	NO	NO
Slovakia	0,0	0,0	0,0	NO	NO	NO	NO	NO	10	-1,7	-1,2	NO	NO	NO	NO	NO
Slovenia	11,9	-0,1	1,5	NO	NO	NO	NO	NO	44	0,1	-3,5	NO	NO	NO	NO	NO
Spain	13	28	-3,5	NO	NO	NO	NO	NO	239	-199	-10	NO	NO	NO	NO	NO
Sweden	202	-7,8	3,6	NO	NO	NO	NO	NO	92	-17	-7,4	NO	NO	NO	NO	NO
United Kingdom	-16.968	9,6	29,5	NO	NO	NO	NO	NO	-12.270	-389	-189	NO	NO	NO	NO	NO
EU27+UK	-33.786	-298	-74	NO	NO	NO	NO	NO	-16.419	-1.944	-385	NO	NO	NO	NO	NO
Iceland	-13	0,0	-0,6	NO	NO	NO	NO	NO	-4,0	0,0	-2,4	NO	NO	NO	NO	NO
United Kingdom (KP)	-16.888	9,7	30	NO	NO	NO	NO	NO	-12.449	-389	-190	NO	NO	NO	NO	NO
EU-KP	-33.719	-298	-75	NO	NO	NO	NO	NO	-16.602	-1.945	-389	NO	NO	NO	NO	NO

Abbreviations explained in the Chapter 'Units and abbreviations'.

3.7 Comparison between the sectoral approach and the reference approach (EU-KP)

The IPCC reference approach for CO_2 from fossil fuels for the EU-KP is based on Eurostat energy data (Eurostat database, February 2022) for apparent consumption included in CRF table 1A(b) and data from MS CRF submissions for CRF table 1A(d). The reason for using Eurostat data in CRF table 1A(b) is that Eurostat provides a coherent data set for all Member States for apparent consumption in TJ whereas in the CRF submissions some MS use TJ and other MS use kt. Up to 2017 also for CRF table 1A(d) we used apparent consumption from Eurostat. The reason for having used Eurostat data in CRF table 1A(d) for many years was that also for non-energy use of fuels Eurostat provided a coherent data set for all 28 EU Member States. The drawback of Eurostat data was that the definition of non-energy use of fuels in energy statistics is narrower than the definition in the IPCC guidelines because fuels used as reductants are not classified as non-energy use of fuels in energy statistics. In addition, Member States may use other data than the energy balance for compiling the non-energy use data (e.g. EU ETS data, environmental reporting of companies, etc.). Therefore, the EU decided to change the reporting in CRF table 1A(d) and calculate all data as the sum of respective MS data. The drawback of this approach is that Member States may use different allocation of energy use and non-energy use of fuels (e.g. in iron and steel) depending on the allocation in the sectoral approach.

Energy statistics are submitted to Eurostat by Member States on an annual basis with the five joint Eurostat/IEA/UNECE questionnaires on solid fuels, oil, natural gas, electricity and heat, and renewables and wastes. On the basis of this information Eurostat provides the annual energy balances which can be used for the estimation of CO_2 emissions from fossil fuels by Member State and for the EU-KP as a whole.

The Eurostat data for the EU-KP IPCC reference approach includes activity data and net calorific values as available in the Eurostat database. For the calculation of CO_2 emissions, the IPCC default carbon emission factors are used.

The IPCC reference approach method at EU-KP level is a three-step process.

- The Energy Statistics Regulation (Regulation EC/1099/2008) is the basis for MS reporting of energy data to Eurostat as well as the basis for the EU's IPCC Reference Approach. For each of the EU Member States, annual data on energy production, imports, exports, international bunkers and stock changes by fuel are available from Eurostat's database http://ec.europa.eu/eurostat/data/database The energy data used for the Reference Approach in the EU-KP 2022 inventory submission, and reported in table 1.A(b), corresponds to the sum of the EU Member States + UK and Iceland.
- The energy data in Eurostat's database can be exported in mass or volume units or in Terajoules. The latter is based on the calorific values reported by MS in the energy questionnaires, on a net basis. Table 1.A(b) was reported in Terajoules. The data was downloaded in February 2022.
- The carbon emission factors are those from the IPCC 2006 Guidelines http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
- The carbon excluded from table 1.A(b) is fully consistent with the data included in table 1.A(d).
- Eurostat data is not used for table 1.A(d). Instead we use the sum of the Member States CRF data because the definition of Eurostat non-energy use of fuels is narrower than in the IPCC guidelines and because the reporting in column I is closely linked to the inventories in IPPU sectors.
- The fractions of carbon oxidised reported in table 1.A(b) are the default 2006 IPCC factors of 1, thus assuming complete oxidation of emissions.

CRF table 1A(c) compares EU-KP CO_2 emissions calculated with the IPCC reference approach and the sectoral approach (Table 3.138). The percentage differences for both energy consumption and CO_2 emissions are very similar to previous submissions.

Table 3.138 Comparison of reference approach and sectoral approach for EU-KP

[1. Energy][1.AC Comparison of CO2 Emissions from Fuel Combustion]	Unit	1990	2000	2010	2015	2016	2017	2018	2019	2020
Fuel consumption										
Sectoral approach	PJ	51.765	50.942	49.697	43.630	43.812	43.991	43.118	41.765	37.911
Apparent energy consumption (excluding non-energy use, reductants and feedstocks)	PJ	51.264	50.131	48.955	42.551	42.979	43.506	42.834	41.380	37.532
Energy consumption difference	%	-1,0	-1,6	-1,5	-2,5	-1,9	-1,1	-0,7	-0,9	-1,0
CO2 emissions										
Reference approach	kt	3.991.971	3.714.045	3.565.450	3.143.036	3.139.242	3.160.436	3.105.831	2.950.643	2.644.255
Sectoral approach	kt	4.067.708	3.809.366	3.644.404	3.223.520	3.211.273	3.213.989	3.136.294	2.986.132	2.682.539
Difference	%	-1,9	-2,5	-2,2	-2,5	-2,2	-1,7	-1,0	-1,2	-1,4

Table 3.139 provides an overview for EU Member States on differences between the Eurostat and national reference approach for apparent consumption in TJ for 2020. For EU-27 the differences are very small. However, for some Member States the two data sets show larger differences. The main reasons for diverging energy data are:

- the use of different calorific values (CV)

- differences in the basic energy balance data reported by Member States to Eurostat (in the joint questionnaires) and to the Commission and the UNFCCC (in the CRF tables)

Table 3.139 Comparison between Eurostat and national reference approach for apparent consumption for EU-27 for 2020 (CRF 1.A) [19]

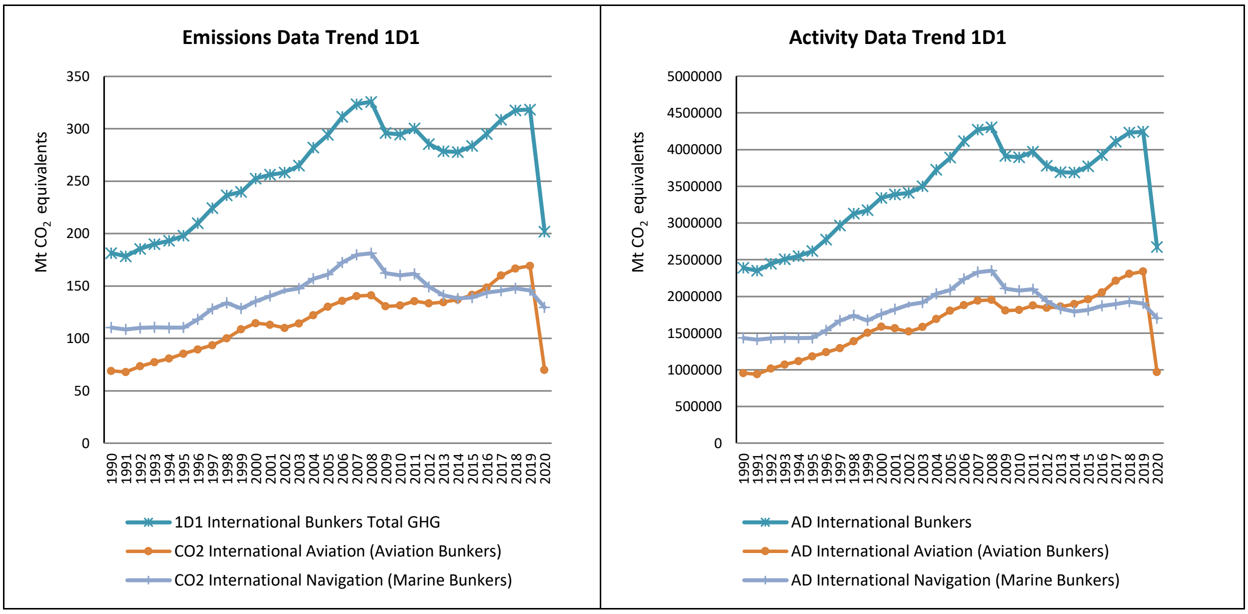
	Total gaseous			Total liquid			Total solid		
	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %
AT	304.907	304.907	0,0%	452.039	450.294	-0,4%	103.477	104.296	0,8%
BE	635.507	635.507	0,0%	771.808	771.808	0,0%	97.454	98.456	1,0%
BG	105.304	105.304	0,0%	174.004	175.582	0,9%	172.628	172.517	-0,1%
CY	- -	- -	0,0%	77.766	77.898	0,2%	586	586	0,0%
CZ	304.636	305.334	0,2%	355.175	353.396	-0,5%	508.797	507.698	-0,2%
DE	3.123.351	3.147.467	0,8%	3.962.241	3.857.772	-2,6%	1.867.132	1.855.154	-0,6%
DK	88.435	88.439	0,0%	229.029	233.264	1,8%	29.820	29.723	-0,3%
EE	14.570	14.649	0,5%	43.970	43.970	2,0%	103.662	98.203	-5,3%
ES	1.168.762	1.171.465	0,2%	1.846.955	1.799.735	-2,6%	129.784	118.306	-8,8%
FI	88.412	88.909	0,6%	314.143	303.598	-3,4%	77.055	76.650	-0,5%
FR	1.460.981	1.461.898	0,1%	2.606.211	2.596.809	-0,4%	221.854	222.126	0,1%
GR	206.346	206.346	0,0%	404.144	412.290	2,0%	76.657	77.408	1,0%
HR	105.725	105.725	0,0%	114.428	113.031	-1,2%	15.122	15.124	0,0%
HU	366.947	366.947	0,0%	308.611	308.578	0,0%	70.464	70.477	0,0%
IE	190.695	190.997	0,2%	243.732	247.579	1,6%	18.663	18.737	0,4%
IT	2.440.311	2.440.601	0,0%	1.817.766	1.894.953	4,2%	240.571	240.571	0,0%
LT	82.553	82.555	0,0%	118.138	114.713	-2,9%	5.635	5.633	0,0%
LU	26.011	26.011	0,0%	77.315	78.125	1,0%	1.610	1.528	-5,0%
LV	38.111	38.207	0,3%	56.208	57.237	1,8%	962	966	0,5%
MT	13.324	13.324	0,0%	12.178	11.932	-2,0%	- -	- -	0,0%
NL	1.316.248	1.320.900	0,4%	1.053.308	1.028.571	-2,3%	172.081	172.300	0,1%
PL	730.192	715.468	-2,0%	1.210.725	1.222.595	1,0%	1.704.845	1.700.886	-0,2%
PT	217.318	218.038	0,3%	352.754	355.670	0,8%	23.686	23.687	0,0%
RO	405.363	401.310	-1,0%	401.308	399.949	-0,3%	145.781	145.829	0,0%
SE	52.459	51.826	-1,2%	335.639	360.952	7,5%	60.855	63.492	4,3%
SI	30.798	30.796	0,0%	83.707	84.401	0,8%	42.625	42.612	0,0%
SK	171.167	171.103	0,0%	149.447	149.772	0,2%	96.505	96.868	0,4%
EU-27	13.688.433	13.704.032	0,1%	17.572.748	17.504.475	-0,4%	5.988.313	5.959.834	-0,5%

[19] Minus means that Member State-based estimates are lower than the Eurostat-based estimates. The table does not include the UK because the Eurostat database does not include data for the UK.

3.8 International bunker fuels (EU-KP)

International bunker emissions include emissions from Aviation bunkers and Marine bunkers. The emissions of the EU inventory are the sum of the international bunker emissions of the countries[20]. Between 1990 and 2020, greenhouse gas emissions from international bunker fuels increased by 11 % in the EU-KP. CO_2 emissions from "Marine bunkers" account for 67 % of total greenhouse gas emissions from international bunkers in 2020, CO_2 from "Aviation bunkers" accounts for 33 % (Figure 3-199).

Figure 3-199 1D1 International bunker fuels: GHG emission trend and activity data



3.8.1 Aviation bunkers (EU-KP)

This source category includes emissions from flights that depart in one country and arrive in a different country (include take-offs and landings for these flight stages).

CO_2 emissions from Aviation Bunkers equal 1.9 % of total GHG emissions in 2020 but are not included in the national total of GHG emissions.

The countries France, Germany, Spain and the United Kingdom contributed 60.7% to the EU-KP emissions from this source (Table **3.140**).

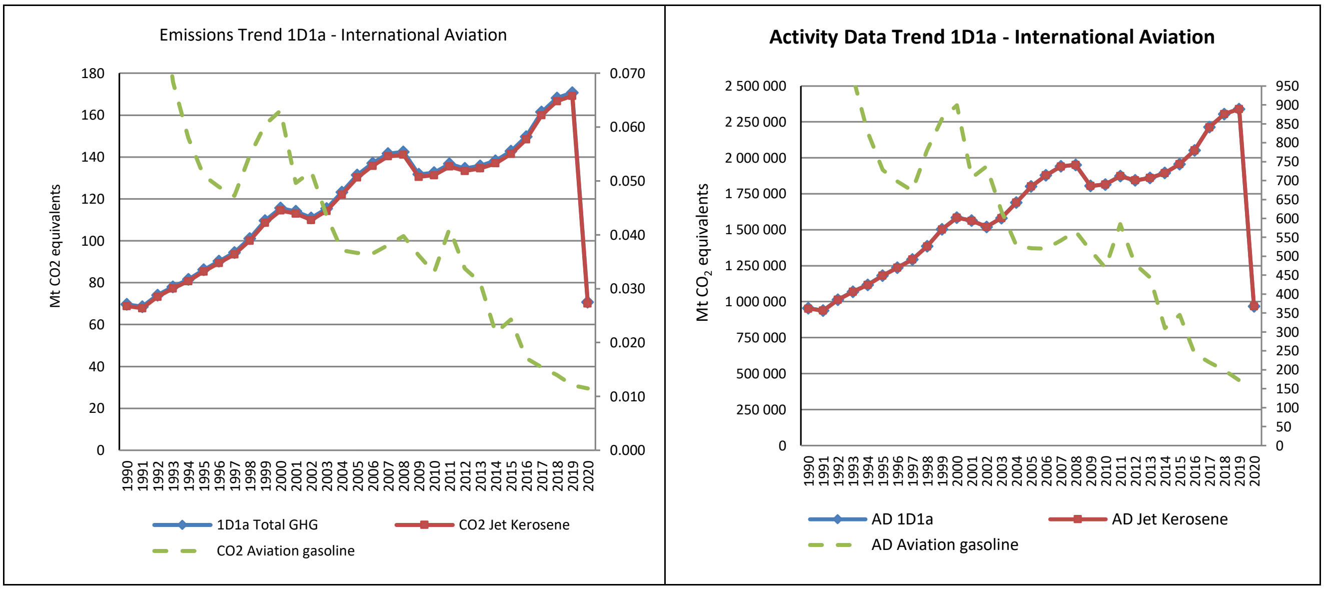
[20] The definitions in Tables 2.8 and 2.9 of the IPCC good practice guidance are based on activities within 'one country". This means domestic aviation is defined for individual countries. The decision tree in Figure 2.8 of the IPCC good practice guidance considers 'national fuel statistics' for domestic aviation. As the EU is neither a country nor a nation, the EU's interpretation of the good practice guidance is that the emission estimate at EU level has to be the sum of countries estimates for domestic air or marine transport as they are the countries or nations addressed in the definition and decision trees of the IPCC good practice guidance.

*Table **3**.140 1D1a Aviation bunkers: Countries' contributions to CO_2*

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	880	2 907	1 044	1.5%	164	19%	-1 863	-64%
Belgium	3 125	5 175	3 606	5.2%	481	15%	-1 569	-30%
Bulgaria	713	728	417	0.6%	-296	-42%	-311	-43%
Croatia	497	606	164	0.2%	-333	-67%	-442	-73%
Cyprus	718	1 027	327	0.5%	-391	-55%	-700	-68%
Czechia	661	1 282	349	0.5%	-312	-47%	-934	-73%
Denmark	1 753	3 100	976	1.4%	-776	-44%	-2 123	-69%
Estonia	107	210	72	0.1%	-35	-32%	-138	-66%
Finland	1 008	2 574	869	1.2%	-139	-14%	-1 705	-66%
France	8 805	19 046	8 046	11.5%	-759	-9%	-11 000	-58%
Germany	11 922	29 622	13 623	19.5%	1 701	14%	-15 999	-54%
Greece	2 475	3 989	1 324	1.9%	-1 151	-47%	-2 665	-67%
Hungary	505	851	309	0.4%	-196	-39%	-542	-64%
Ireland	1 073	3 320	1 178	1.7%	105	10%	-2 142	-65%
Italy	4 285	12 403	3 788	5.4%	-497	-12%	-8 615	-69%
Latvia	221	481	178	0.3%	-43	-19%	-303	-63%
Lithuania	399	370	163	0.2%	-236	-59%	-207	-56%
Luxembourg	394	1 798	1 636	2.3%	1 242	315%	-162	-9%
Malta	197	514	198	0.3%	1	1%	-316	-61%
Netherlands	4 604	11 890	6 631	9.5%	2 027	44%	-5 258	-44%
Poland	640	3 195	1 349	1.93%	710	111%	-1 845	-58%
Portugal	1 533	4 367	1 569	2.2%	36	2%	-2 798	-64%
Romania	790	457	142	0.2%	-649	-82%	-315	-69%
Slovakia	67	186	55	0.1%	-12	-18%	-131	-71%
Slovenia	49	77	26	0.0%	-23	-47%	-51	-66%
Spain	4 741	18 984	6 424	9.2%	1 683	35%	-12 561	-66%
Sweden	1 335	2 645	928	1.3%	-407	-30%	-1 716	-65%
United Kingdom	15 346	36 414	14 324	20.5%	-1 022	-7%	-22 090	-61%
EU-27+UK	**68 842**	**168 217**	**69 714**	**100%**	**871**	**1%**	**-98 504**	**-58.6%**
Iceland	219	956	261	0.4%	42	19%	-695	-73%
United Kingdom (KP)	15 277	36 437	14 345	20.5%	-932	-6%	-22 092	-61%
EU-KP	**68 993**	**169 197**	**69 996**	**100%**	**1 004**	**1%**	**-99 201**	**-58.6%**

CO_2 emissions from jet kerosene account for 99 % of total emissions from "Aviation bunkers" in 2020 (Figure 3-200). Countries with the highest increase between 1990 and 2019 in percent were Luxembourg and Poland.

Figure 3-200 1D1a Aviation bunkers: Trend of CO_2 Emissions and Activity Data



Data displayed as dashed line refers to the secondary axis.

3.8.1.1 Aviation Bunkers – Jet Kerosene (CO_2)

Figure 3-201 provides an overview of emissions for EU-KP and the contribution of each country to EU-KP emissions. The United Kingdom, Germany, France and Spain are the countries that contributed most to the EU-KP emissions. Fuel combustion of EU-KP increased by 1% between 1990 and 2020.

In Figure 3-202 the IEF is depicted, showing a mean value of around 72 t/TJ for 2020.

Figure 3-201 Aviation bunkers, Jet kerosene: Emission trend and share for CO_2

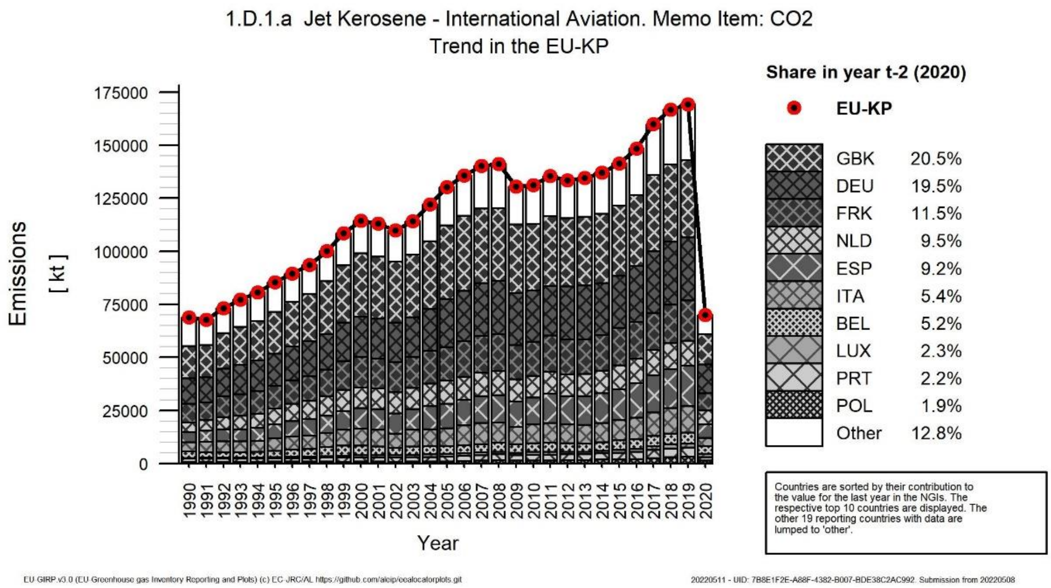
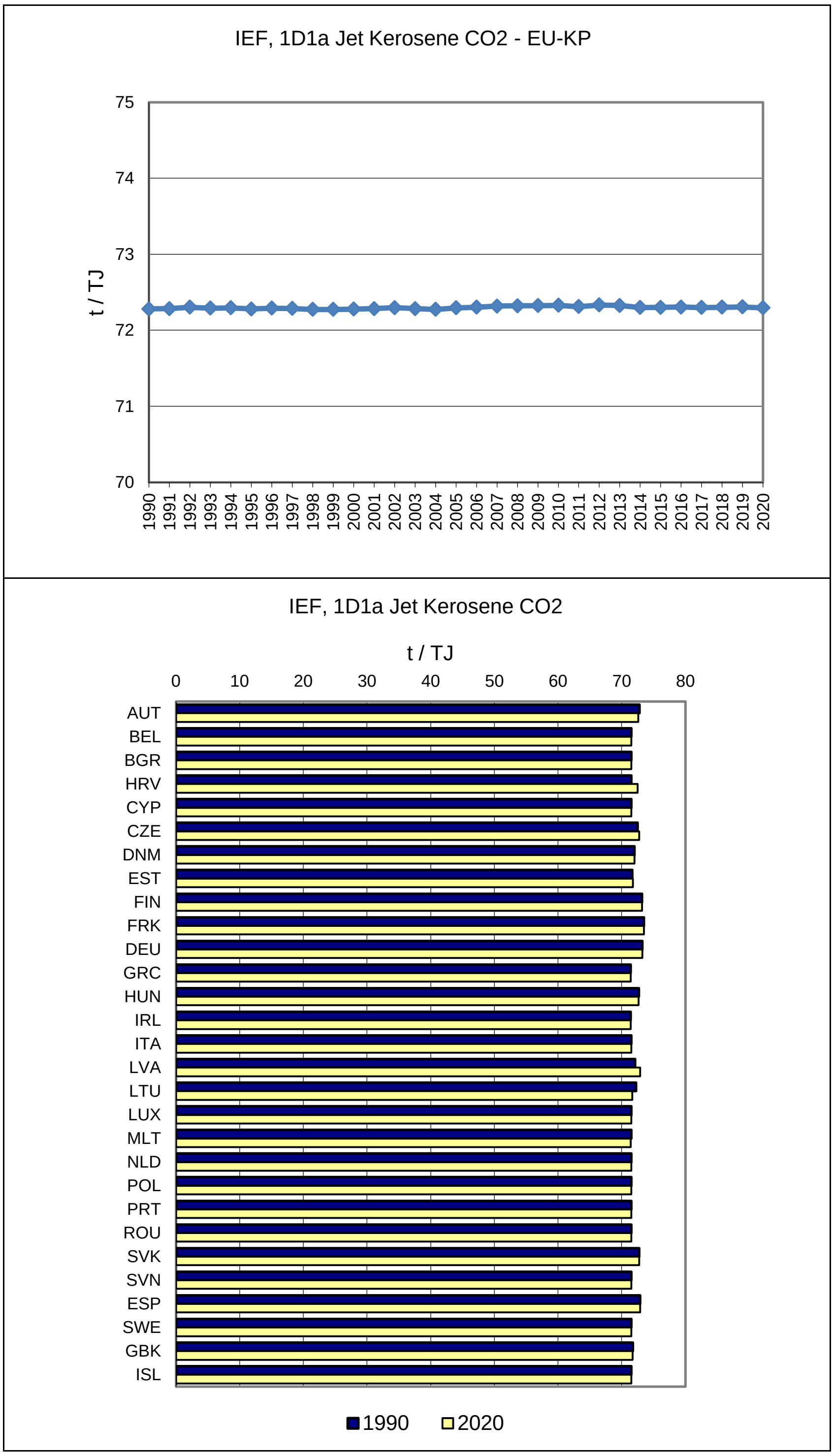


Figure 3-202 1D1a Aviation bunkers – Jet kerosene: Implied Emission Factors for CO_2 (in t/TJ)



3.8.2 Marine bunkers (EU-KP)

This source category includes emissions from fuels used by vessels of all flags that are engaged in international water-borne navigation. The international navigation may take place at sea, on inland lakes and waterways and in coastal waters. Marine bunkers include emissions from journeys that depart in one country and arrive in a different country. Marine bunkers exclude consumption by fishing vessels (see Other Sector - Fishing).

CO_2 emissions from "Marine bunkers" equal 3.5 % of total GHG emissions in 2020 and are also not included in the national total of GHG emissions. Between 1990 and 2020, CO_2 emissions from Marine bunkers increased by 17 % in the EU-KP (Table **3.141**).

The Netherlands, Spain and Belgium contributed most to the emissions from this source (60.2%) in 2020. Between 1990 and 2020, most countries (13 in total) increased emissions from Marine bunkers. The countries with the highest increase in absolute terms were Belgium, Spain and Malta. Hungary stated that consumption in international navigation was not considered, because separate data on the uses for international navigation are not included in the national statistics.

*Table **3**.141 1D1b Marine bunkers: Countries' contributions to CO_2 emissions*

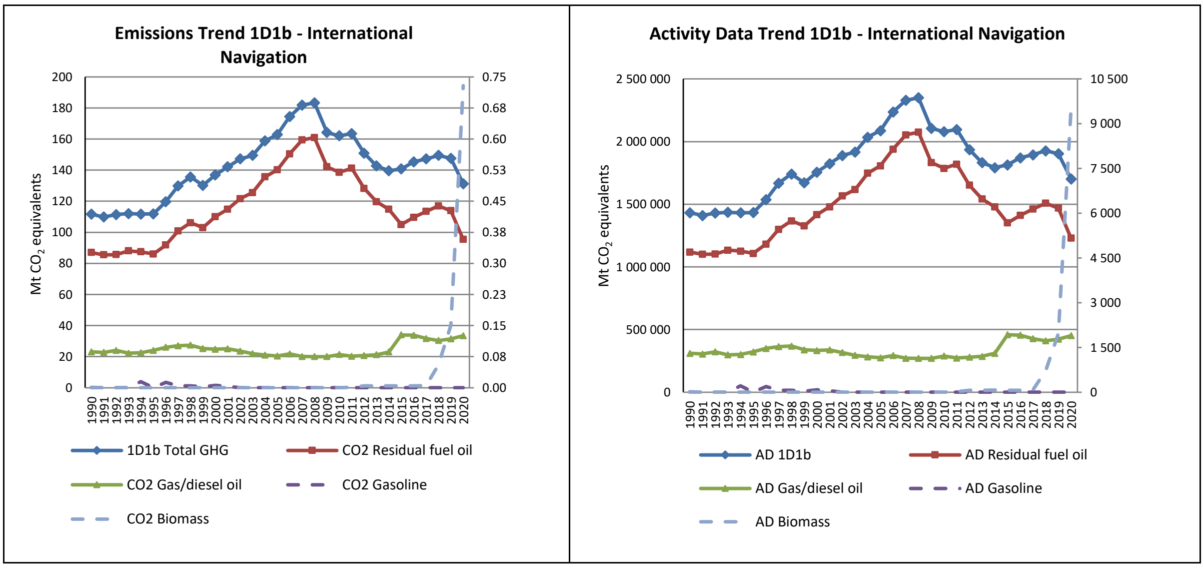
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	46	45	43	0.0%	-3	-7%	-3	-6%
Belgium	13 313	26 745	20 470	15.8%	7 158	54%	-6 274	-23%
Bulgaria	183	234	261	0.2%	79	43%	27	12%
Croatia	147	78	64	0.0%	-84	-57%	-14	-18%
Cyprus	183	883	874	0.7%	692	378%	-8	-1%
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	3 013	2 224	1 629	1.3%	-1 385	-46%	-595	-27%
Estonia	572	560	901	0.7%	329	58%	341	61%
Finland	1 832	1 045	980	0.8%	-852	-47%	-65	-6%
France	7 961	5 534	3 127	2.4%	-4 834	-61%	-2 406	-43%
Germany	7 111	3 607	3 598	2.8%	-3 513	-49%	-9	0%
Greece	8 106	8 250	5 421	4.2%	-2 685	-33%	-2 829	-34%
Hungary	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Ireland	57	437	477	0.4%	420	740%	39	9%
Italy	4 454	6 579	5 563	4.3%	1 109	25%	-1 016	-15%
Latvia	1 515	920	648	0.5%	-867	-57%	-272	-30%
Lithuania	302	616	581	0.4%	279	92%	-35	-6%
Luxembourg	0	0	0	0.0%	0	-84%	0	-88%
Malta	956	7 278	7 027	5.4%	6 071	635%	-251	-3%
Netherlands	34 947	36 413	37 283	28.8%	2 335	7%	870	2%
Poland	1 265	867	947	0.73%	-318	-25%	80	9%
Portugal	1 400	3 069	2 192	1.7%	792	57%	-876	-29%
Romania	NO	104	138	0.1%	138	∞	35	33%
Slovakia	65	16	15	0.0%	-50	-77%	-1	-6%
Slovenia	NO,NA	613	350	0.3%	350	∞	-263	-43%
Spain	11 659	22 923	20 245	15.6%	8 586	74%	-2 678	-12%
Sweden	2 333	6 837	8 177	6.3%	5 843	250%	1 340	20%
United Kingdom	8 911	9 775	8 491	6.6%	-420	-5%	-1 284	-13%
EU-27+UK	**110 331**	**145 652**	**129 503**	**100%**	**19 173**	**17%**	**-16 148**	**-11.1%**
Iceland	28	204	77	0.1%	49	178%	-126	-62%
United Kingdom (KP)	8 883	9 749	8 477	6.5%	-406	-5%	-1 272	-13%
EU-KP	**110 330**	**145 829**	**129 566**	**100%**	**19 236**	**17%**	**-16 263**	**-11.2%**

Austria, Croatia, Denmark, Finland, France, Germany, Greece, Latvia, Luxembourg, Poland, Slovakia and United Kingdom decreased their emissions. Czechia and Hungary reported in 1990 and/or 2020 notation keys. All other countries reported increased emissions from marine bunkers between 1990 and 2020. Countries with the highest increase in percent were Cyprus, Ireland, Malta and Sweden.

CO_2 emissions from residual fuel oil account for 73 % of total emissions from "Marine bunkers" in 2020 (Figure 3-203). Between 1990 and 2020, CO_2 emissions from residual fuel oil increased by 11 % in the EU-KP.

CO_2 emissions from gas/diesel oil account for 27 % of total emissions from "Marine bunkers" in 2020. Between 1990 and 2020, CO_2 emissions from gas/diesel oil increased by 75 % in the EU-KP.

Figure 3-203 1D1b Marine bunkers: Trend of CO_2 Emissions and Activity Data



Data displayed as dashed line refers to the secondary axis.

Figure 3-204 and Figure 3-205 provide an overview of emissions for residual oil and gas/diesel oil for EU-KP and those countries contributing most to EU-KP emissions.

Figure 3-204 Marine bunkers, residual fuel oil: Emission trend and share for CO_2

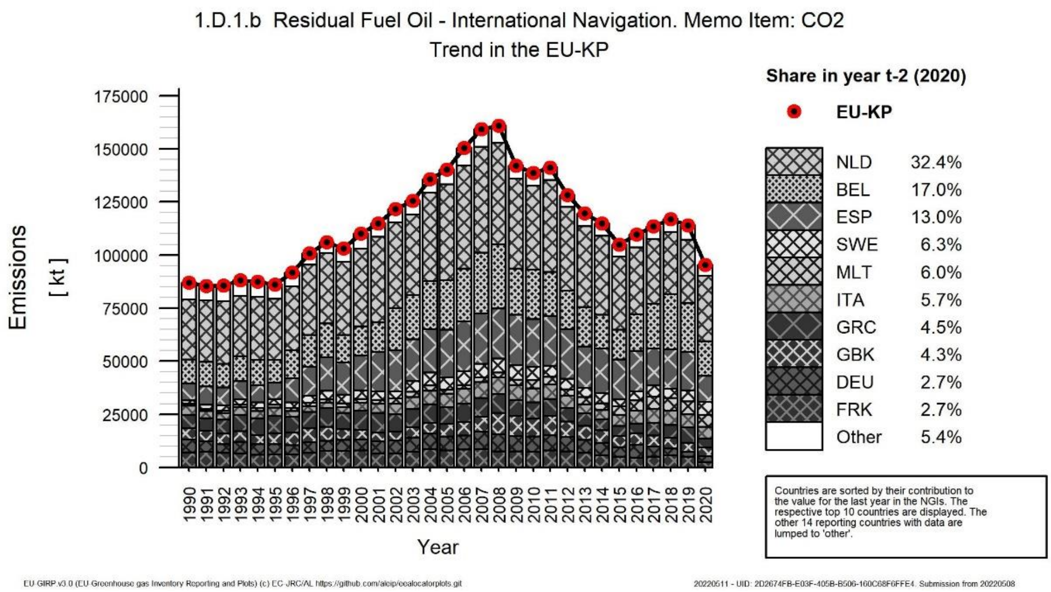
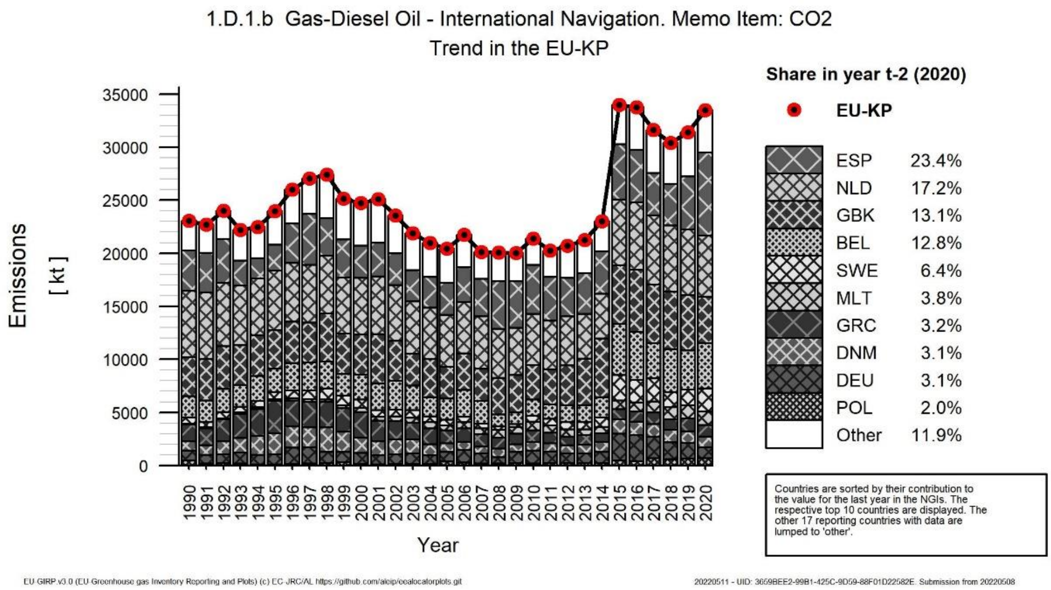


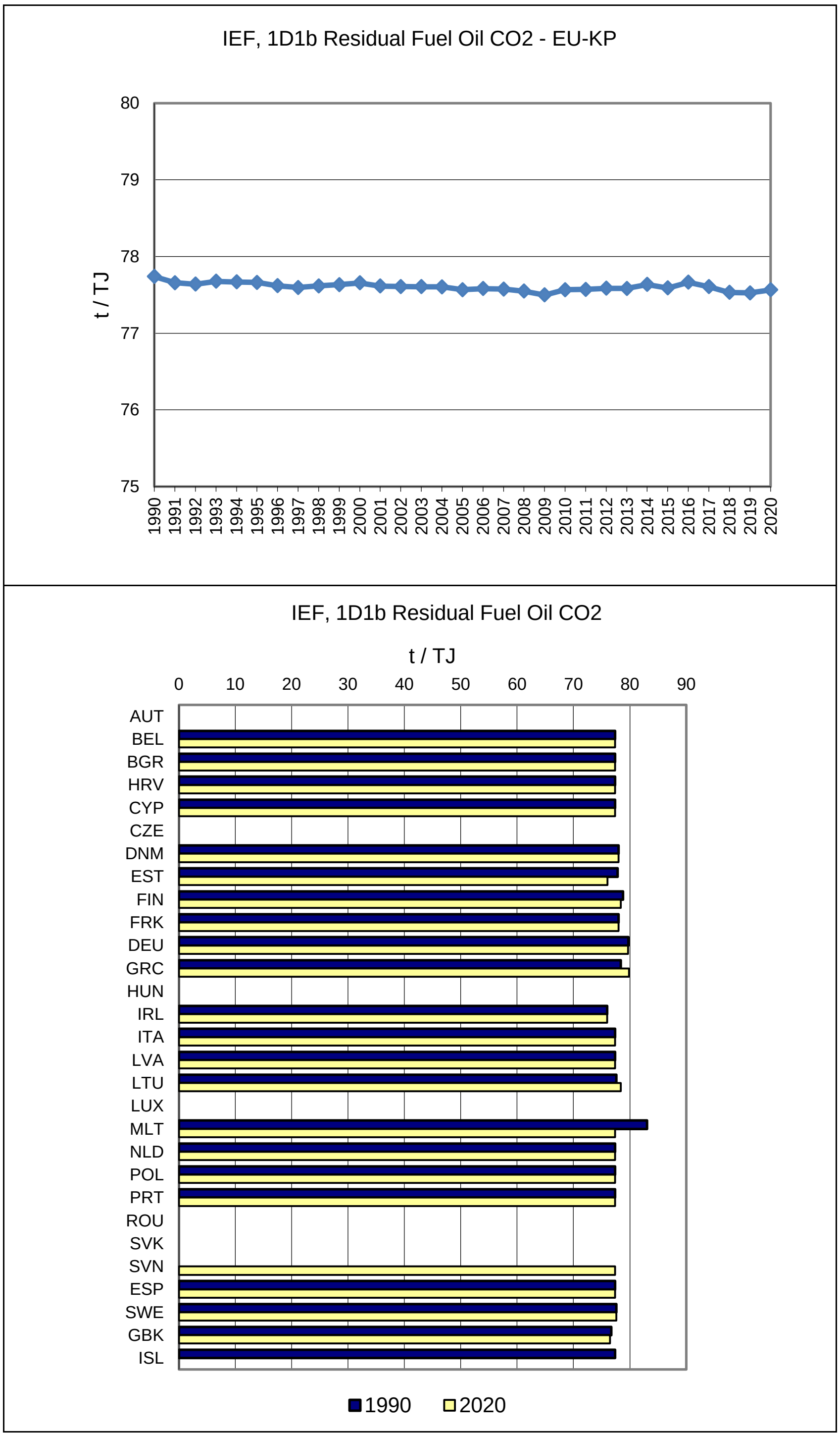
Figure 3-205 Marine bunkers, gas/diesel oil: Emission trend and share for CO_2



3.8.2.1 Marine Bunkers – Residual Oil (CO_2)

Combustion of residual oil in the EU-KP increased by 14% between 1990 and 2020. In Figure 3-206 the IEF is depicted, with a mean value of 77.5 t/TJ.

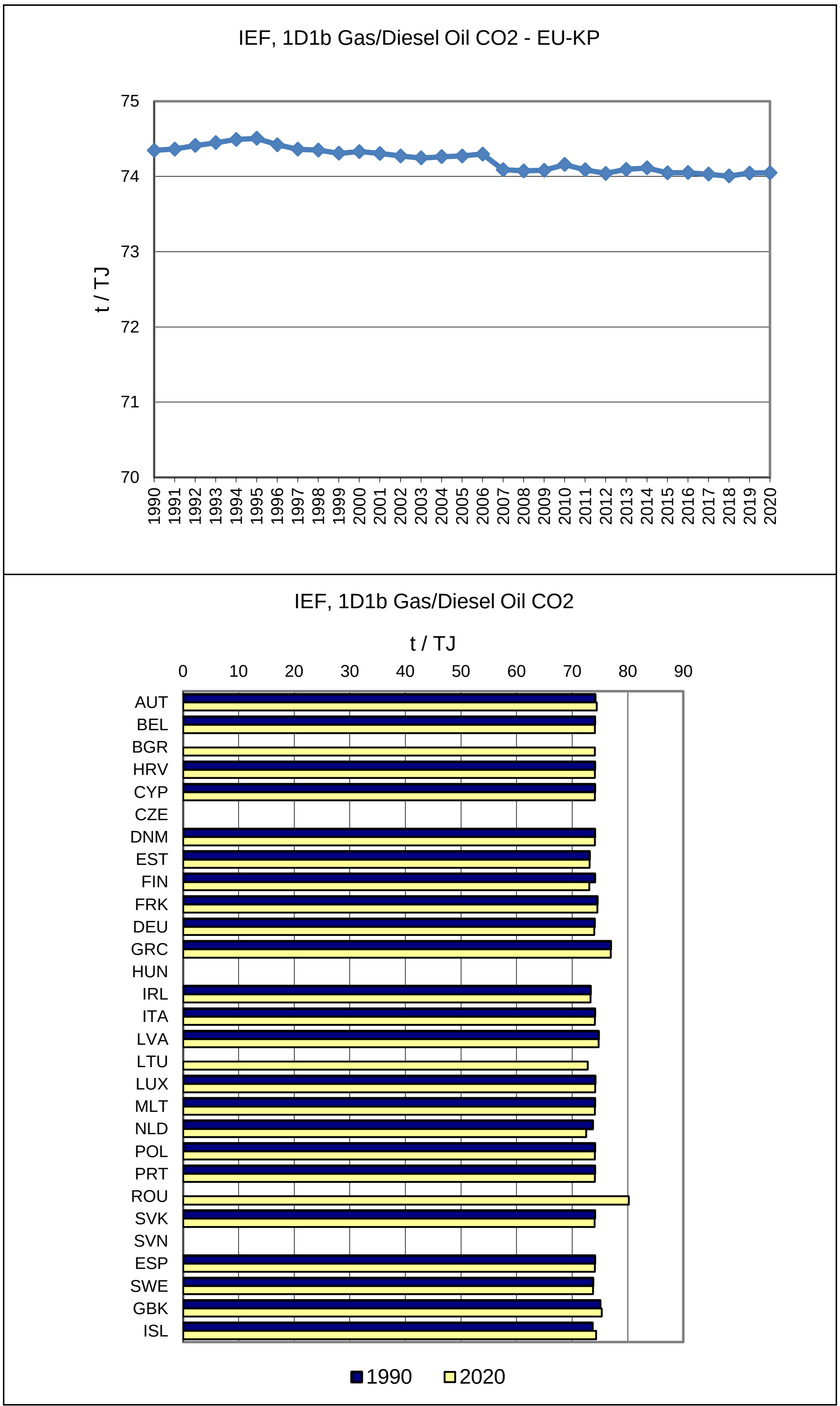
Figure 3-206 1D1b Marine bunkers – Residual Oil: Implied Emission Factors for CO_2 (in t/TJ)



3.8.2.2 Marine Bunkers – Gas/Diesel Oil (CO_2)

Combustion of gas/diesel oil in the EU-KP increased by 35 % between 1990 and 2020. In Figure 3-207 the IEF is depicted, with a mean value of 74.2 t/TJ.

Figure 3-207 1D1b Marine bunkers – Gas/Diesel Oil: Implied Emission Factors for CO_2 (in t/TJ)



3.8.3 QA/QC activities

For more information on QA/QC activities refer to chapter 3.4

3.9 Feedstocks and non-energy use of fuels

According to the 2006 IPCC guidelines non non-energy fuels is divided into three categories:

(1) Raw materials for the chemical industry (Feedstocks). These fossil fuels are used in particular in the production of organic compounds and to a lesser extent in the production of inorganic chemicals (e.g. ammonia) and their derivatives. For organic substances, normally part of the carbon contained in the feedstock remains largely stored in these products. Typical examples of raw materials are feedstocks for the petrochemical industry (naphtha), natural gas, or different types of oils (e.g. the production of hydrogen for the subsequent production of ammonia by partial oxidation).
(2) Reductants. Carbon is used as a reductant in metallurgy and inorganic technologies. Unlike the previous case, here when using fossil fuel as reductant only a very small amount of carbon remains fixed in the products for a longer time and the larger part of the carbon is oxidized during the reduction process. Metallurgical coke is a typical reductant.
(3) Non-energy products. Non-energy products are materials derived from fuels in refineries or coke plants which, unlike the previous two cases, are used directly for their conventional physical properties, specifically as lubricants (lubricating oils and petrolatum), diluents and solvents, bitumen (for covering roads and roofs) and paraffin. Emissions of CO_2 and other GHG occur only to a limited extent in the IPPU category (e.g. during the oxidation of lubricants and paraffin). Substantial emissions occur during their recovery and during disposal by incineration (in the sector Energy and in Waste).

The non-energy use of fuels is reported in CRF table 1.A(d). The purpose of CRF table 1A(d) is twofold:

(1) The table should make transparent the amount of carbon from non-energy use of fuels that is subtracted from the carbon included in all fuels (both energy and non-energy use) in order to make a meaningful comparison between sectoral and reference approach.
(2) The table should make transparent in which categories other than Energy CO_2 emissions from non-energy use of fuels are included in the inventory (mostly IPPU). Therefore, the table serves as a basis for consistency checks with the IPPU sector reporting.

Table **3.142** shows the fuels that were used for the purpose of non-energy use in the EU-KP in 2020. All data in CRF table 1A(d) is calculated as the sum of respective MS data. It shows that 71 % of non-energy use of fuels are liquid fuels with naphta, bitumen and LPG showing the largest contribution to NEU of liquid fuels. Naphta and LPG are mainly used as feedstock in the petrochemical industry. Bitumen is mainly used in the construction industry. Natural gas accounts for 15 % of non-energy use of fuels and is mainly used for feedstock in ammonia production. Coke oven / gas coke accounts for 9 % of NEU of fuels and is mainly used as reductant in the metal industry.

Table 3.142 Fuel quantity for non-energy use in TJ and % for the EU-KP

Fuel			TJ	%
Liquid fossil	Primary fuels	Crude oil	562	0,01%
		Natural gas liquids	68.100	1,3%
		Gasoline	148.551	2,854%
		Jet kerosene	0,5	0,00001%
		Other kerosene	1.932	0,04%
		Gas/diesel oil	133.984	2,6%
		Residual fuel oil	59.585	1,1%
		Liquefied petroleum gases (LPG)	533.753	10,3%
		Ethane	51.464	1,0%
		Naphtha	1.560.164	30,0%
		Bitumen	618.451	11,9%
		Lubricants	179.200	3,4%
		Petroleum coke	48.692	0,9%
		Refinery feedstocks	14.337	0,3%
		Other oil	255.427	4,9%
Other liquid fossil			7.254	0,1%
Liquid fossil totals			**3.681.455**	**70,7%**
Solid fossil	Primary fuels	Anthracite	69.080	1,3%
		Coking coal	115.681	2,2%
		Other bituminous coal	67.770	1,3%
		Sub-bituminous coal	7.448	0,1%
		Lignite	318	0,01%
		Oil shale and tar sand	9.460	0,2%
		Coke oven/gas coke	463.979	8,9%
		Coal tar	25.289	0,5%
Solid fossil totals			**759.025**	**14,6%**
Gaseous fossil		Natural gas (dry)	764.789	14,7%
Gaseous fossil totals			**764.789**	**14,7%**
Waste (non-biomass fraction)			637	0,01%
Total			**5.205.268**	**100,0%**

Table **3.143** shows the associated CO_2 emissions from the NEU reported in the inventory for the year 2020. It shows that 47 % of the CO_2 emissions stem from solid fuels, 21 % from liquid fuels and 32 % from natural gas. It has to be noted that the reporting in CRF table 1A(d) is still not fully coherent and work is ongoing between the EU and its Member States in order to improve the reporting in this table.

Table 3.143 CO_2 emissions from the NEU reported in the inventory kt CO_2 and % for the EU-KP

Fuel			kt	%
Liquid fossil	Primary fuels	Crude oil	7	0,01%
		Other kerosene	0,3	0,0002%
		Gas/diesel oil	2	0,00%
		Residual fuel oil	134	0,1%
		Liquefied petroleum gases (LPG)	2.886	2,7%
		Ethane	324	0,3%
		Naphtha	11.513	10,8%
		Bitumen	327	0,3%
		Lubricants	2.315	2,2%
		Petroleum coke	2.890	2,7%
		Other oil	1.477	1,4%
Other liquid fossil			222	0,2%
Liquid fossil totals			22.312	**21,0%**
Solid fossil	Primary fuels	Anthracite	11.151	10,5%
		Coking coal	10.782	10,1%
		Other bituminous coal	6.192	5,8%
		Sub-bituminous Coal	699	0,7%
		Coke oven/gas coke	21.114	19,8%
		Coal tar	169	0,2%
Solid fossil totals			**50.106**	**47,1%**
Gaseous fossil		Natural gas (dry)	34.017	32,0%
Gaseous fossil totals			**34.017**	**32,0%**
Waste (non-biomass fraction)			111	0,1%
Total			**106.435**	**100,0%**

Table **3.144** shows the recalculations of non-energy use of fuels for the year 2019. A major recalculation can be seen for non-energy use of gasoline which is due the inclusion of gasoline by Germany Across all fuels recalculations were at 4%. Most recalculations at fuel level were due to revisions in the energy balance.

Table 3.144 Recalculations of fuel quantity for non-energy use of fuels for the inventory year 2017

FUEL TYPE			ACTIVITY DATA AND RELATED INFORMATION			
			Fuel quantity for NEU (TJ)		Difference in TJ	Difference in %
			2021	2022		
Liquid fossil fossil	Primary fuels	Crude oil	440	440	0	0%
		Orimulsion	IE,NO	IE,NO	0	-
		Natural gas liquids	61.000	61.500	500	1%
	Secondary fuels	Gasoline	100	145.465	145.365	145365%
		Jet kerosene	NO	NO	0	-
		Other kerosene	2.238	2.238	0	0%
		Shale oil	NO	NO	0	-
		Gas/diesel oil	100.349	100.601	252	0%
		Residual fuel oil	75.888	75.888	0	0%
		Liquefied petroleum gases (LPG)	631.216	632.134	918	0%
		Ethane	51.801	78.099	26.298	51%
		Naphtha	1.427.554	1.443.614	16.061	1%
		Bitumen	623.994	620.973	-3.021	0%
		Lubricants	174.961	189.701	14.740	8%
		Petroleum coke	52.616	50.988	-1.628	-3%
		Refinery feedstocks	10.980	13.583	2.603	24%
		Other oil	325.944	307.850	-18.093	-6%
Other liquid fossil			9.118	9.107	-12	0%
Liquid fossil totals			**3.548.199**	**3.732.181**	**183.982**	**5%**
Solid fossil	Primary fuels	Anthracite	90.674	90.858	183	0%
		Coking coal	122.548	125.591	3.043	2%
		Other bituminous coal	82.846	82.971	125	0%
		Sub-bituminous Coal	9.282	9.282	0	-
		Lignite	358	358	0	0%
		Oil shale and tar sand	7.301	7.301	0	0%
	Secondary fuels	BKB and patent fuel	NA,NO	NA,NO	0	-
		Coke oven/gas coke	541.861	533.505	-8.355	-2%
		Coal tar(7)	26.633	29.333	2.700	10%
Other solid fossil					0	-
		Other			0	-
Solid fossil totals			**881.504**	**879.199**	**-2.305**	**0%**
Gaseous fossil		Natural gas (dry)	762.146	768.527	6.381	1%
Other gaseous fossil			NA,NO	NA,NO	0	-
Gaseous fossil totals			**762.146**	**768.527**	**6.381**	**1%**
Waste (non-biomass fraction)			394	394	0	0%
Other fossil fuels			NA,NO	NA,NO	0	-
Other fossil fuels totals			NA,NO	NA,NO	0	-
Total fossil fuels			**5.191.848**	**5.379.907**	**188.059**	**4%**

Table **3.145** provides information on feedstocks and non-energy use of fuels from Member States' NIRs.

Table 3.145 Information related to feedstocks and non-energy use from Member States' NIRs

MS	Information on feedstocks and non-energy use of fuels	Source
Austria	Non-energy use of fuels is considered in the national energy balance. Below explanations for the reported non-energy use is provided together with information on where CO_2 emissions due to the manufacture, use and disposal of carbon containing products are considered. **Lubricants** manufacture: emissions are assumed to be included in total emissions from category *1.A.1.b* petroleum refinery. use: VOC emissions from lubricants used in rolling mills are considered in category *2.C.1*. It is assumed that other uses of lubricants do not result in VOC or CO_2 emissions due to the low vapour pressure of lubricants. CO_2 from lubricants which are used in engines are considered in category *2.D.1* disposal: emissions from incineration of lubricants (waste oil) are either included in categories *1.A.1.a* and *1.A.2* if waste oil is used as fuel or to a minor degree reported under category *5.C* if energy is not recovered. **Bitumen** manufacture: emissions from the production of bitumen are assumed to be included in total emissions of category *1.A.1.b* petroleum refinery. use: indirect CO_2 emissions from the use of bitumen for road paving and roofing that should be reported in categories *2.A.5* and *2.A.6* are included in sector *3 solvent and other product use*. disposal: CO_2 emissions from the disposal from bitumen are assumed to be negligible. Recycling is not considered. **Naphtha** manufacture: Naphta is produced in the oil refinery and transferred to a petrochemical plant. Residues from the petrochemical plants are transferred back to the oil refinery steam cracker. use: Naphta is used for plastics production (e.g. ethylene). **Petroleum coke** In IEA JQ (2016) non energy use is reported for the manufacture of electrodes. manufacture: No information about emissions from manufacture of electrodes is currently available. Therefore it is not clear if emissions are not estimated or not applicable. use: Emissions from the use of electrodes are considered in category *2.B.4* carbide production and *2.C* metal production. **Residual fuel oil** use: Considerable amounts of residual fuel are used in blast furnaces. Emissions are considered in *2.C.1*. **Coking coal, Bituminous coal, Coke oven coke, Coal Tar** manufacture: emissions from the production of coke are considered in category *1.A.2.a*. use: CO_2 emissions from coal, coke and coal tar used in iron and steel industry are reported under *2.C*. **Natural Gas** use: emissions from the use of natural gas as a feedstock in ammonia production are accounted for in the industrial processes sector (category *2.B.1*). **Plastics waste** manufacture: Emissions from manufacture of plastics are considered in category *2.B.* use: plastics waste is used as a reductant in blast furnaces. Emissions are considered in *2.C.1*. Disposal: Any emissions from waste disposal are considered in category 5.A. Waste incineration with energy use is considered in *1.A – other fuels* and - to a minor degree - waste incineration without energy recovery is considered in category *5.C*. **Solvents** manufacture: emissions from the production of solvents are considered in sector *2.D.3* use: CO_2 emissions from solvent use are considered in sector *2.D.3*. disposal: emissions from the disposal of solvents are considered in 5.A. **Paraffin wax** use: CO_2 emissions from paraffin wax use are considered in sector *2.D.2*.	National Inventory Report, Chapter 3.2.3
Belgium	The emissions of non-energy use of fuels and related emissions (emissions from recovered fuels from processes) are reported under categories 2B1, 2B8 and 2B10. During the 2015 submission a re-allocation of the offgas-emissions/recovered fuels from cracking units (biggest part) plus some other processes (non-energy use) emissions (reported in the category 1A2c / other fuels before), were moved to the category 2B8b Industrial Processes and Product Use / Chemical Industry / Petrochemical and Carbon Black Production / Ethylene during this submission as prescribed in the new IPCC 2006 guidelines. In Flanders, a recalculation of the non-energy use and related CO_2 emissions was performed during the 2005 submission, based on the results of a study conducted in 2003. Belgium participated in a European network on the CO_2-emissions from non-energy use (see website http://www.chem.uu.nl/nws/www/nenergy/) and one of the conclusions of this network is that the new IPCC guidelines need to give more information on this subject. The result of the study made a recalculation possible for all years. The effect of the recalculation was greater in the more recent years because the petrochemical industry has expanded its activities in the beginning of the nineties (that's one of the reasons why this sector 2B8b is a key source for the trend assessment). Since the petrochemical industry is important in Flanders and Belgium and the emissions from the feedstocks are a key source in the Belgian inventory, the study mentioned above was conducted to get more detailed, country-specific information. A distinction is made between: 1. The use of recovered fuels from cracking units or other processes where a fuel is used as raw material and where part of this fuel (or transformed product) is recovered for energy purposes. These emissions are reported under category 2B8. This is the largest source of CO_2 emissions. This includes the recovered fuels in the steam cracking units in the petrochemical industry (approx. 2/3) and other recovered fuels from the chemical industry (approx. 1/3). These	National Inventory Report, Chapter 3.2.3

MS	Information on feedstocks and non-energy use of fuels	Source
	recovered fuels are reported directly in the yearly surveys carried out by the chemical federation in cooperation with the VITO [1] and from emission estimates from 2013 on, these emissions are taken over from the reported emissions via the ETS-Directive. 2. CO_2 emissions occurring during chemical processes, for example, the production of ammonia based on natural gas or the production ethylene oxide (and production of acrylic acid from propene, production of cyclohexanone from cyclohexane, production of paraxylene/metaxylene, etc) where CO_2 is formed in a side reaction (reported respectively under 2B1 and 2B10). These CO_2 emissions result from the same surveys in the chemical sector in Flanders as those reported under 2B8 and are taken over from the reported emissions via the ETS-Directive from emission estimates from 2013 on. Emissions of flaring activities in the chemical industry are allocated to the category 5C1.2.b (Waste Incineration / Non-biogenic / Other / Flaring in the chemical industry) since last submission. 3. Waste treatment of final products was not included in the study. This is practically impossible due to import/export of plastic products, etc. (it is also not clear if the waste phase is included in the default IPCC carbon stored % or not). The emissions of waste incineration are therefore calculated separately and are reported under the sector of waste (category 5C) or under the sector of energy (category 1A1a), depending whether or not energy recuperation takes place during the process.	
Bulgaria	Non-energy use of fuels is reported for the following fuels: • Anthracite • Coke Oven Coke • Other bituminous coal • Lubricants • Bitumen • Naphtha • Paraffin waxes • White spirit • Residual Fuel Oil • Other Oil Products • Petroleum Coke • Natural Gas as Feedstock There are some fluctuations of the reported consumption for some of the fuels during the time series due to changes in the industrial production – differences in production volume, decommissioning of installations or shift from one fuel type to another. Some discrepancies with the quantities of fuels reported as non-energy use exist in the Energy balance – for some fuels only for the latest years is reported non-energy use, in addition some industrial plants do not properly report their non-energy use of fuels. In order to improve the consistency, additional data was collected from several chemical plants regarding the annual production of ammonia, soda ash and calcium carbide. The amounts of energy and non-energy use of natural gas, anthracite, other bituminous coal and coke oven coke we reallocated according to the quantities of fuels considered as emission sources in the Industrial Processes sector. The non-energy use of fuels is on average 8.1% of the total apparent energy consumption during the period 1988-2016 and 6.3% for 2016. The apparent consumption is calculated according to Equation 6.2 in Vol. 2, Ch. 6 of the 2006 IPCC Guidelines. The most significant fuels used as feedstock are bitumen, anthracite and natural gas. The use of naphtha has been discontinued since 2010. In general, most of the non-energy use of fuels is attributed to the industrial sector (lubricants, paraffin wax), chemical and petrochemical industry (anthracite, natural gas, naphtha, white spirit and other petroleum products) and construction (bitumen). All sources of emissions due to non-energy use of fuels (natural gas) are reported under category 2B Chemical Industry. The quantities of waste oils, which are used with energy recovery in the non-metallic minerals and other industrial plants, are reported as other fuels under category 1.A.2.g Other industries.	National Inventory Report, Chapter 3.3.3
Cyprus	In Cyprus fuels that are used for non-energy uses are Lubricants and Bitumen. Bitumen/asphalt is used for road paving and roof covering where the carbon it contains remains stored for long periods of time. Consequently, there are no fuel combustion emissions arising from the deliveries of bitumen within the year of the inventory. Lubricating oil statistics usually cover not only use of lubricants in engines but also oils and greases for industrial purposes and heat transfer and cutting oils. All deliveries of lubricating oil should be excluded from the Reference Approach. Non-energy use of fuels in Cyprus refers to the consumption of lubricants in transport and bitumen in construction. Data on the non-energy consumption of fuels was obtained from the national energy balance (Gross inland deliveries (Calculated)).	National Inventory Report, Chapter 3.2.10
Croatia	Non-energy fuel consumptions (fuels used as feedstock) and appropriate emissions, where onepart or even the whole carbon is stored in product for a longer time and the other part oxidizes and goes to atmosphere, are described here. The feedstock use of energy carriers occurs in chemical industry (natural gas consumption for ammonia production, production of naphtha, ethane, paraffin and wax), construction industry (bitumen production), and other products such as motor oil, industrial oil, grease etc. As a result of non-energy use of bitumen in construction industry there is no CO_2 emission because all carbon is bound to the product.	National Inventory Report, Chapter 3.2.3

MS	Information on feedstocks and non-energy use of fuels	Source
Denmark	The consumption for non-energy purposes is subtracted in the reference approach, because non-energy use of fuels is included in other sectors (Industrial processes and Solvent use) in the Danish national approach. Three fuels are used for non-energy purposes: lubricants, bitumen and white spirit. The total consumption for non-energy purposes is relatively low – 10.5 PJ in 2016. The CO_2 emission from oxidation of lube oil during use was 31.7 Gg in 2016 and this emission is reported in the sector industrial processes and product use (sector 2.D). The reported emission corresponds to 20 % of the CO_2 emission from lube oil consumption assuming full oxidation. This is in agreement with the methodology for lube oil emissions in the 2006 IPCC Guide-lines (IPCC, 2006). Methodology and emission data for lube oil are shown in NIR Chapter 4.5.2. For white spirit the CO_2 emission is indirect as the emissions occur as NMVOC emissions from the use of white spirit as a solvent. The indirect CO_2 emission from solvent use was 57.8 Gg in 2016. The methodology and emission data for white spirit are included in NIR Chapter 4.5.4. The CO_2 emission from bitumen is included in sector 2.D.3, Road paving with asphalt and Asphalt roofing. The total CO_2 emissions for these sectors are 0.84 Gg in 2016. Methodology and emission data for non-energy use of bitumen are shown in NIR Chapter 4.5.6.	National Inventory Report, Chapter 3.4.1
Estonia	The following fuels are reported under CRF category 1.AD Feedstocks and non–energy use of fuels: Lubricants; Bitumen; Natural gas; Other/Oil shale. Activity data on lubricants and bitumen consumption is received from Statistics Estonia (Joint Questionnaire that Statistics Estonia sends to IEA annually). Data on natural gas that is used for the category non-energy use, is taken from the national energy balance sheet. Activity data on oil shale reported in the CRF 1.AD is calculated on the basis of plant-specific data. This reported amount consists of oil shale semi coke – the by-product of shale oil production which contains a small amount of organic matter (carbon). Oil shale semi-coke is stored in the oil shale waste dumps (carbon stored). Natural gas for non-energy purposes was used for ammonia production and is reported in the CRF category 2.B.1. Natural gas was only used in the company Nitrofert AS. In 2010 and 2011 the factory was temporarily closed down due to low ammonia price in the World market. In 2012 the ammonia production factory was reopened and during 2013 it was closed again and has remained closed ever since.Lubricants are used in the Energy sector for lubricating (mainly in transport and manufacturing sub-sectors). Some used lubricants (waste oils) are incinerated and corresponding emissions are taken into account in the CRF 1.A.2.f/Other fuels.	National Inventory Report, Chapter 3.2.3
Finland	The emissions from the non-specified burning of feedstocks are calculated by a separate module in ILMARI. The ILMARI system includes point source (bottom-up) data on feedstock combustion in the petrochemical industry and these emissions are reported in corresponding subcategories of 1.A.2. These specified energy uses of feedstock are subtracted from the corresponding total amounts of feedstock. For the rest of the feedstock, 100% of carbon is estimated to be stored in products (mainly plastics). Residual fuel oil and coke are used as feedstocks in the metal industry and corresponding amounts are subtracted from the reference approach. All (100%) of this carbon is estimated to be released as CO_2 during the process and emissions are reported in category 2.C.1 (see section 4.4.2). Natural gas, heavy fuel oil, LPG, naphtha and other oil products are used as feedstock in the chemical industry. Carbon included in these feedstocks is subtracted from the reference approach. Most of carbon is stored in the products, but certain process emissions are reported in sector 2.B.10 (see section 4.3.5). From other feedstocks, only carbon from paraffin waxes is estimated to oxidise and these emissions are reported in sector 2.D.2 (section 4.5.3). The ILMARI system includes point source (bottom-up) data also on waste oil combustion in different branches of industry, and these emissions are reported in corresponding subcategories of 1.A.2. For the rest of lubricants we use top-down calculation methodology, presuming that 33% of carbon is stored in products (recycled lubricants) and 67% of carbon is released as CO_2 either in burning of lubricants in motors (two-stroke oil and part of motor oil in four-stroke engines) or illegal combustion of waste oil in small boilers. These non-specified emissions from burning of lubricants (excluding above mentioned emissions reported in 1.A.2) are included in category 2.D.1 (Section 4.5.2). According to IPCC 2006 Revised Guidelines emissions from 2-stroke oil should be reported in the Energy Sector. We do not have data on sales of 2-stroke oil separately, thus we have not separated these emissions from the use of 4-stroke oil and other lubricants. However, we have made a rough estimate for 2013, showing that CO_2 emissions from 2-stroke oil might be around (less than) 7 kt. To be able to reallocate these emissions to Energy Sector, we would have to split the figure to four subsectors (road transport, residential non-road machinery, commercial non-road machinery and leisure boats). As we do not have full time series of activity data to allocate these emissions to Energy subsectors, we are not able to do the split and have included them in 2.D.1, correspondingly to the top-down calculation methodology described above. This misallocation should not result in over- or underestimation of emissions.	National Inventory Report, Chapter 3.2.3

MS	Information on feedstocks and non-energy use of fuels	Source
France	The fossil fuels are consumed for different purposes, for energy use and non-energy use (raw material, intermediate material as well as reducing agent). Emissions can occur in the sector of fuel combustion and industrial process. However, it is not always possible, partly for practical reasons, to separately report these two types of emissions. In the IPCC Guidelines, 2006, the following rule is formulated: Combustion emissions from fuels obtained directly or indirectly from the feedstock for an IPPU process will normally be allocated to the part of the source category in which the process occurs. These source categories are normally 2B and 2C. However, if the derived fuels are transferred for combustion in another source category, the emissions should be reported in the appropriate part of Energy Sector source categories (normally 1A1 or 1A2). In the French inventory, in order to preserve the coherence of the inventory of greenhouse gas emissions (under the UNFCCC) and the inventory of atmospheric pollutants (under the UNECE) on the one hand, and between the sectoral approach and the reference approach, on the other hand, it was decided to maintain the distinction between energy uses (reported in CRF 1A) and non-energy (in CRF 2). Finally, to ensure the completeness of the inventory, a feedback on total final consumption (energy + non-energy) energy balance is assured. With regard to the consumption of solid fuels (coal and coke coal) the energy balance accounts all types of use of these fuels as energy consumption and they are well distinguished after energy use and non-energy use in the inventory as well. The solid fuels which are used as reducing agents as well as intermediate material are considered in the CRF category 2C in steel and ferro-alloys production and 2B7 soda ash production. The petroleum products for non-energy use are principally consumed on site of petrochemical installations. This usage is well investigated by an exhaustive survey conducted by the national statistics authority. According to the survey approximately 14% of the consumption of petroleum products is used for non-energy use, mainly as primary material. This survey defines the quantities of different oil products that are consumed in steam crackers reported under CRF 2B (in particular naphta). Emissions from non-energy use of petroleum coke are reported in under 2C3 (aluminium production) and 2B6 (titanium dioxide production). Emissions which are related to the combustion of motor oil for 2-stroke engines are considered in CRF category 1A3 whereas emissions from 4-stroke engines are covered under 2D1. The emissions of recovered oil which is combusted during cement production are reported under category CRF 1A2. Those which are burned in waste incinerators are reported under CRF 6. The non-energy use of natural gas is mainly occurring in the ammonia and hydrogen production and is reported under CRF 2B. The emissions from energy use of natural gas in these industries is included in 1A2.	National Inventory Report, Chapter 3.2.3
Germany	The great majority of the coal, oil and gas that Germany uses is used for energy-related purposes. The remainder of the coal, oil and gas is used as feedstock for production processes. This consumption enters into the balance as "non-energy use" (NEU). In the German Energy Balance, this consumption is listed separately, in line 43. The chemical industry is the leading user of fossil fuels for non-energy-related purposes. It uses fossil fuels in steam crackers, in reforming, in synthetic-gas production and in the produciton of graphite electrodes. In crackers and reforming, the most important products resulting from such processes are ethylene, propylene, 1,3-butadiene, benzene, toluene and xylene; in production of synthetic gases, the most important such products are ammonia and methanol. Bitumen, lubricants and paraffin waxes are produced in refineries. Bitumen is used in a range of applications, including road surfaces and bitumen sheeting for roofs. Lubricants are used in road vehicles and machines (inter alia). Without suitable adjustments, the consumption figures listed in Energy Balance line 43 cannot be compared with the CO_2 and NMVOC emissions from use of fossil fuels, in non-energy-related uses, that are reported in the inventory under industrial processes. The reason is that for the industrial processes, only emissions from production or use of products are taken into account, while line 43 takes account of entire feedstocks, thereby including both product-specific emissions and the carbon quantities stored in products. The latter account for far and away the largest share of the feedstocks. Yet a more important difference is that import and export quantities are taken into account in calculation of emissions from use of products. In the interest of obtaining a complete balance, Table 477 (see below) also takes account of the fossil-fuel carbon quantities stored in products. The correlation between material-related applications and products and the various relevant fuels is oriented to Table 1.3 from Volume 3 of the 2006 IPCC GL, and is based on information provided by relevant associations, producers and experts. In some cases, we had to make our own estimates of the applicable correlation with individual fuels. The produced quantities of the products listed in the table have been obtained from data reported by the Federal Statistical Office and by the Federal Office of Economics and Export Control (BAFA) and have been converted into CO_2 equivalents. For methanol, ethylene, propylene, 1,3-butadiene, benzene, toluene and xylene, the conversions were carried out via the molar masses of the relevant products and the molar mass of CO_2. The pertinent CO_2 equivalent emissions were split among the three feedstocks used in Germany (naphta, LP gas and other petroleum products), in keeping with (internal) data provided by associations. In the case of carbon black, the product is assumed to consist of pure carbon. That carbon was also converted into CO_2 equivalents. The production quantities for bitumen, lubricants and paraffin waxes were obtained from the Official Mineral Oil Statistics, and they are based on gross refinery production. The production quantities have been converted into CO_2 equivalents with the help of the following IPCC standard values (Table 1.2 and Table 1.4 from Vol. 2 of the 2006 IPCC GL). For the year 2014, the sum of the carbon from the pertinent emissions and of the carbon stored in products amounts to 106 % of the non-energy-related consumption given in line 43 of the Energy Balance. Consequently, the relevant material-related use can clearly be shown to include the quantities listed in the Energy Balance as non-energy-related consumption. No gaps in determination of non-energy-related CO_2 emissions are apparent in the inventory.	National Inventory Report, Chapter 18.8

MS	Information on feedstocks and non-energy use of fuels	Source
Greece	Non-energy fuel use concerns the consumption of fuels as raw materials (e.g. in chemical industry, metal production) for the production of other products, or the use of fuels for non-energy purposes (e.g. bitumen). Part of the carbon content of fuels is stored in final products and is not oxidized into carbon dioxide for a certain time period. The fraction of the carbon contained in final products and the time period for which carbon is stored in them, depend on the type of fuel used and of the products produced. The oxidation of the carbon stored in final products occurs either during the use of the product (e.g. solvents) or during their decomposition (e.g. through combustion). It should be noted that emissions during production processes (e.g. ammonia and hydrogen production) should be reported under the sector of IPPU, while emissions from burning of products should be reported under the waste sector or energy sector (as long as energy exploitation takes place).Non-energy use of fuels in Greece refers to the consumption of: • naphtha, natural gas, and lignite (for the period 1990 – 1991) in chemical industry, • petroleum coke in the production of non-ferrous metals, • lubricants in transport (including off-road transportation), • bitumen in construction and • other petroleum products in the industrial and residential sectors The calculation of carbon dioxide emissions from non-energy use of fuels is based on the relevant consumption by fuel type (Table 3.9) and the fraction of the carbon stored by fuel type (Table 3.10). Data on the non-energy consumption of fuels derive from the national energy balance. However, plant specific data derived from verified ETS reports and information provided by specific greek industries resulted to the improvement of reallocation of non-energy use fuels from the energy to the industrial processes sector: • The non-energy use of natural gas for ammonia production has been reallocated to industrial processes sector since the 2012 submission, by using data from ETS reports and plant specific information. Non-energy use of lignite is accounted in the industrial processes sector and refers only to ammonia production (in one installation for 1990 and 1991) and as a result the fraction of carbon stored is equal to 0. The operation of this installation ended at 1998 while itdid not produce ammonia for the period 1992 – 1998. • The non-energy use of natural gas for hydrogen production is included in the industrial processes sector, by using data from ETS reports and information from Public Gas Corporation. The associated CO_2 emissions from hydrogen production from liquid fuels are reported under the subcategory 1.A.1.b, because while disaggregated data on the amount of liquid fuels used for hydrogen production are available from the EU ETS reports for the period 2005–2016, for the period 1990–2004 the amount of liquid fuel used for hydrogen production is reported together with the amount of fuel combusted in the refineries as provided in the national energy balance. It is therefore not possible to report these emissions separately for the period 1990–2004. • CO_2 emissions from the use of fuels as reduction agents in the iron and steel industry, are only reported under the industrial processes sector. • Solid fuels consumption in the ferroalloys production industry is included (in the national energy balance) in the solid fuels consumption of the non-ferrous metals sector. However, by using data from ETS reports and plant specific information, emissions from solid fuels for ferroalloys production are reallocated to the industrial processes sector, as from 2010 submission. • The non-energy use of petroleum coke (see Table 3.9) refers exclusively to the primary aluminium production. Given that the relevant emissions are reported under the industrial processes sector, petroleum coke consumption is not taken into account in the energy sector. Since this submission, following 2006 IPCC GLs, all fuels with non-energy use were reallocated to the IPPU sector (e.g. other petroleum products, lubricants, etc). On the basis of the abovementioned clarifications, the possibility to double-count or underestimate CO_2 emissions from the non-energy use of fuels is minor.	National Inventory Report, Chapter 3.2.3
Hungary	All the fuels regarded as NEU in IEA Energy Statistics are allocated into IPPU sectors and also some amount from the quantities regarded as energy use in order to follow the suggestion of IPCC 2006. This is the case by Natural Gas use in sector 2B1 – Ammonia, Naphtha use in 2.B.8 Petrochemical and the Coke used in 2C1 – Iron and steel. Therefore, the Fuel quantities for NEU reported in CRF Table 1.A.(d) and QA/QC check Table for NEU included in Annex of the NIR are higher than the actual quantity reported in IEA Energy Statistics. However, the differences are well-known and documented. Carbon content of all fuels which are allocated under the Industrial Processes sector is taken as stored carbon in the 1.AD sector (and in the reference approach), however the calculation of emission in the IPPU sector is not based on a default carbon-stored approach, but usually plant-specific (EU ETS) data, except for Lubricant and Paraffin wax use source categories.	National Inventory Report, Chapter 3.2.3
Ireland	This category includes fossil fuels used for non-energy purposes; without the combustion and oxidation process. There are a number of fuel types applicable in Ireland: • Lubricants – IPCC default oxidation value of 0.2 is used, see category 2.D.1; • Bitumen – IPCC default value of 1.0 is used for the proportion of carbon stored; • Paraffin wax – IPCC oxidation value of 0.9 is used for candles and 0.2 for all other paraffin wax, see category 2.D.2; • White spirit – IPCC default value of 1.0 is used for the proportion of carbon stored; • Natural Gas – a significant amount of natural gas feedstock was used in ammonia production from 1990-2003.	National Inventory Report, Chapter 3.2.3

MS	Information on feedstocks and non-energy use of fuels	Source
	Emissions from the non-energy use of fossil fuels have been included in the Industrial Processes and Product Use sector, CRF Category 2.D (Chapter 4 of this report).	
Italy	The quantities of fuels stored in products in the petrochemical plants are calculated on the basis of information contained in a detailed yearly report, the petrochemical bulletin, by Ministry of Economic development (MSE, several years [b]). The report elaborates results from a detailed questionnaire that all operators in Italy fill out monthly. The data are more detailed than those normally available by international statistics and refer to: • input to plants; • quantities of fuels returned to the market; • fuels used internally for combustion; • quantities stored in products. National petrochemical balance includes information on petrochemical input entering the process and used for the production of petrochemical products, and petrochemical plants output, returns to the market, losses and internal consumption. Due to chemical reactions in the petrochemical transformation process, the output quantity of some fuels could be greater than the input quantity; in particular it occurs for light products as LPG, gasoline and refinery gas, and for fuel oil. Therefore for these fuels it is possible to have negative values of the balance. For this matter, with the aim to allow the reporting on CRF tables, these fuels have been added to naphta. The amount of fuels recovered from the petrochemical processes and returning on the market are considered as an output, because consumed for transportation or in the industrial sectors, and no carbon is stored. In Table 3.36 and Table 3.37 the overall results and details by product are reported respectively. In Table 3.36 the breakdown of total petrochemical process is reported; the percentages referring to the "net" input are calculated on the basis of the total input subtracting the quantity of fuels as gasoil, LPG, fuel oil and gasoline which return on the market because produced from the petrochemical processes. In Table 3.37 the input to the petrochemical processes in petrochemical plants and the relevant losses, internal consumption and return to the market are reported, at fuel level, allowing the calculation of the quantity stored in products, subtracting the output (returns to the market, losses and internal consumption) from the input (petrochemical input). Carbon stored, for all the fuels, is therefore calculated from the amounts of fuels stored (in tonnes) multiplied by the relevant emission factors (tC/t) reported in Table 3.37. Non-energy products amount stored from refineries, and other manufacturers, are reported in the National Energy Balance (MSE, several years [a]) and the carbon stored is estimated with emission factors reported in Table 3.38. For lubricants the net carbon stored results from the difference between the amount of lubricants and the amount of recovered lubricant oils. The energy content has been calculated on the basis of the IPCC default values. Minor differences in the overall energy content of these products occur if the calculation is based on national parameters instead of IPCC default values. In the CRF tables the fuel input amount is reported so that the fractions of carbon stored could be derived. As these fractions are derived from actual measurements they do not correspond to any default values and may vary over time. At national level, this methodology seems the most precise according to the available data. The European Project "Non Energy use- CO_2 emissions" ENV4-CT98-0776 has analysed our methodology performing a mass balance between input fuels and output products in a sample year. The results of the project confirm the reliability of the reported data (Patel and Tosato, 1997).	National Inventory Report, Chapter 3.8
Latvia	Under this category consumption of different types of fuels used as feedstock is reported. Emissions from these fuels are reported as " CO_2 not emitted" because it is assumed that in CO_2 emissions is captured and not emitted to the air. Consumption of Bitumen, Lubricants, Coke, White spirits and Paraffin wax is reported in 1.D tables for all years in time series 1990–2016. Carbon emission factors used in 2006 IPCC Guidelines were taken for all fuel types – Bitumen (22 t/TJ), Lubricants (20 t/TJ), Coke (29.2 t/TJ), White spirits (20 t/TJ) and Paraffin waxes (20t/TJ). Activity data prepared by CSB and available on CSB on-line database were used (Table 3.14). Constant increase of bitumen use since 2004 until 2008 is explained with development of construction sector and availability of financial resources from European Union (Latvia is a member of European Union since 2004) for building and improvement of transportation infrastructure. However, during the economic crisis the funding reduced and the amounts of bitumen used decreased in 2008-2010. After 2010 increase of bitumen use can be seen, it can be explained with increased financial resource to road paving. Lubricants are mainly used in transport sector and IPPU. Coke is used as ingredient in metallurgy to produce higher quality steel. Evident decrease in coke use can be explained with changes in metallurgy. Financial crisis in 2010 and bankruptcy of "Liepājas metalurgs" is the reason of reduced metal production and use of coke. Therefore in last three years there has been no usage of coke. Paraffin waxes and white spirits mainly are used as feedstocks in chemical industry and wood processing..	National Inventory Report, Chapter 3.2.3

MS	Information on feedstocks and non-energy use of fuels	Source
Lithuania	Feedstocks and non-energy use of fuel are included in national Energy balances (see Annex III). Use of fuels for feedstocks and non-energy use is dominated by natural gas (Figure 3-14). In 2016, natural gas amounted about 80.4% in the structure of feedstocks and non-energy use of fuels. The natural gas is used for ammonia, calcium ammonium nitrate, organic products and nitric acid production in the JSC Achema. JSC Achema is a leading manufacturer of nitrogen fertilizers and chemical products in Lithuania and the Baltic states. The previous ERT recommended to cross-check the data reported as non-energy use in the energy sector and the data reported under the industrial processes as the calculated CO_2 non-emitted from the use of natural gas for non-energy purpose differs from CO_2 emissions from ammonia production. A cross-check between the natural gas data used in industrial processes and the data reported as non-energy use in the energy sector showed that difference occur due to the use of different calorific values for the natural gas. In the industrial processes sector a specific calorific value is based on average annual lower calorific value of natural gas which is calculated on the basis of reports from the natural gas supplier AB Lietuvos dujos, which measure the calorific value twice a month. In the energy sector calculations are based on the data provided by the Lithuanian Statistics where fuel consumption is calculated in terms of tonnes of oil equivalent and terajoules using the net calorific value. The data reported as non-energy use in the energy sector and the data reported under the industrial processes also differs because the data reported as non-energy use in the energy sector accounts not only feedstocks for ammonia production, but also feedstocks for calcium ammonium nitrate, organic products and nitric acid production. It is necessary to mentioned that JSC Achema revised data for non-energy use for 2005-2014 in 2016, therefore in this submission revised data are reported in CRF 1.AD Feedstocks, reductants and other non-energy use of fuels. The amounts of excluded carbon were calculated in accordance with the methodology provided in 2006 IPCC Guidelines Volume 2 (page 6.7). The amounts of excluded carbon are reported in CRF 1.AD Feedstocks, reductants and other non-energy use of fuels and linked to the CRF 1.AB Fuel Combustion - Reference Approach as excluded carbon.	National Inventory Report, Chapter 3.2.3
Luxembourg	Non-energy use of fuels is considered in the national energy balance. Below explanations for the reported non-energy use is provided together with information on where CO_2 emissions due to the manufacture, use and disposal of carbon containing products are considered. For the fraction of carbon stored, the IPCC default values are applied. Lubricants Manufacturing: manufacturing of lubricants does not occur in Luxembourg. Use: Lubricants are either used in road transportation (motor oil and greases) or in the manufacturing and construction industry (mainly greases). Emissions from lubricants use are reported under category 2D1 – Lubricant Use. Please refer to section 4.5.1 for more details on the estimation of emissions from lubricant use. Disposal: incineration of lubricants (waste oil) does not occur in Luxembourg. Waste oil is either recycled or exported. Bitumen Manufacturing: manufacturing of bitumen does not occur in Luxembourg. Use: by default the carbon contained in bitumen is considered to be entirely stored in the product, i.e. asphalt for road paving. Disposal: CO_2 emissions from the disposal of bitumen are assumed to be negligible. Recycling is not considered. Coke oven coke Manufacturing: not occurring. All coke used in the iron and steel industry is imported. Use: CO_2 emissions from coke used in iron and steel industry are reported under 2.C.1 – Iron and Steel Production. Disposal: not applicable. Other bituminous coal Manufacturing: Manufacturing of electrodes from anthracite used in the electric arc furnaces does not occur in Luxembourg. Use: Emissions from the use of electrodes in the iron and steel production are considered in category 2.C.1 – Iron and steel production. Disposal: not applicable. Other oil products Manufacturing: not occurring. All products such as white spirits, etc. are imported. Use: CO_2 emissions from solvent and other products use are considered in category 2.D.3. - Nonenergy products from fuels and solvent use – Other – Solvent use. Disposal: emissions from the disposal of plastics in landfills are considered in 6.A and emissions from incineration, with energy recovery, of waste plastics are considered in 1 A 1 a.	National Inventory Report, Chapter 3.2.3

MS	Information on feedstocks and non-energy use of fuels	Source
Malta	Activity data on feedstocks and non-energy use of fuels has been obtained from the National Statistics Office. The non-energy fuels used locally are bitumen and lubricant, which are used for asphalting and to minimise friction between moving surfaces, respectively. Emissions from Lube oil used in 2-stroke engines are estimated using the COPERT 5 model and are included under sub-category 1A3b Road Transportation.	National Inventory Report, Chapter 3.2.3
Netherlands	Table 3.2 shows that a large share of the gross national consumption of petroleum products was used in non-energy applications. These fuels were mainly used as feedstock in the petro-chemical industry (naphtha) and in products in many applications (bitumen, lubricants, etc.). Also, a fraction of the gross national consumption of natural gas (mainly in ammonia production) and coal (mainly in iron and steel production) was used in non-energy applications and hence not directly oxidized. In many cases, these products are finally oxidized in waste incinerators or during use (e.g. lubricants in two-stroke engines). In the RA, these product flows are excluded from the calculation of CO_2 emissions.	National Inventory Report, Chapter 3.2.3
Poland	As the use of energy products for non-energy purposes can lead to emissions, Poland has calculated emissions from lubricant and paraffin waxes use and report them under category 2D Non-energy products from fuels and solvent use.For more description see chapter 4.5.	National Inventory Report, Chapter 3.2.3
Portugal	Emissions of greenhouse gas emissions from feedstock use are only clearly accounted in the inventory in the following situations: - emission of CO_2 resulting from use of feedstock sub-products as energy sources. That is the case of emissions from consumption of fuel gas in refinery and petrochemical industry; - emission of CO_2 liberated as sub-product in production processes such as ammonia production; - emission of NMVOC from fossil fuel origin, and occurring from solvent use and evaporation. Although in this case it is not possible to establish which part results from feedstock consumption in Portugal in the energy balance; However, some potential emissions are not estimated or are only partly estimated. Those that are estimated in the reference approach but not in sectoral approach are: - emissions from mineral oil use as lubricants; - emissions from wear of bitumen in roads.	National Inventory Report, Chapter 3.6.5
Romania	Non-energy use of fuels is reported in the Energy balance for the following fuels on the entire time-series: Lubricants; Bitumen; Naphtha; LPG; Refinery gas; Motor Gasoline; Kerosene Type Jet Fuel; Other Kerosene; Gas-Diesel Oil; Petroleum Coke; Residual Fuel Oil; Natural Gas as Feedstock; Other Products; Paraffin waxes; White spirit; Lignite; Brown Coal; Coal Oil and Tars (from coking coal); Other Bituminous Coal. For the liquid fuels reported on the EU-ETS, the national parameter of the NCVs were determined and used to calculate the non-energy use of the fuels: annualy for the EU-ETS period (2007-2012 years) and average of the EU-ETS period for the rest of the back time series; it is the case of the following fuels: Transport Diesel, Refinery Gas, Petroleum Coke, Residual Fuel Oil, Heating and Other Gasoil. COuntry specific values NCVs and CO_2 EFs have determined and used for 2015 and 2016 years. The following type of fuels have been added to the Table1.A(d), "Feedstocks, reductants and other non-energy use of fuels - Other fuels" category: Refinery gas, Paraffin waxes, White spirit. According to the IPCC 2006GL provisions, Volume 3, Chapter 5: Non-Energy Products from Fuels and Solvent Use, the following methodology to report in the CRF Table 1.A(d), Feedstocks, reductants and other non-energy use of fuels, was used: • Bitumen: the carbon is reported as being full stored in the final product; • Lubricants, Naphta, Refinery gas, Other kerosene, Gas Diesel-Oil, Petroleum Coke, Residual Fuel Oil, Other products, White spirit: the carbon was presumed that is fully emitted and not stored, having the full oxidation during use; • Paraffin Waxes: the fraction of carbon stored is 0.8, the rest of 0.2 being emitted. The non-energy use of fuels is an average of 11% from the total apparent energy consumption during the period 1999-2008, and arround 15% for the rest of the years. This could be in tight relation with the developing of the industry after 2000 until the economic crisis to have effects on the industry branches. In 2015 the share of the non-energy use of the fuels in total consumption is about 6%. In 2016 the share of the non-energy use of the fuels in total consumption is about 7%. The most significant fuels used as feedstock are natural gas, bitumen, naphtha and lubricants. Also, the Coke_Oven_Coke used as reduction agent in Blast Furnace, the associated emissions being accounted in Industrial Processes sector, represents an important non-energy use quantity. For coal oil and tars the assumption suggested in the methodology (5.91 % from the coking coal consumption is assumed to be stored in products) was applied.	National Inventory Report, Chapter 3.2.3

MS	Information on feedstocks and non-energy use of fuels	Source
Slovakia	Using the IPCC 2006 Guidelines, the quantity of carbon excluded from reference approach (carbon used for ammonia production, petrochemicals production, carbide production, hydrogen production, iron and steel production, ferroalloys production, aluminium production as well as non-energy using of lubricants) was estimated. Total carbon excluded from reference approach was 1 974.5 Gg in 2016, which represents 7 239.9 Gg of CO_2. The emissions from the carbon excluded are reported in respective categories in the IPPU sector. The major share of carbon excluded represents the carbon from coking coal, both in fuel consumption and in amount of carbon (52.1% and 51.8%, respectively) The other significant source of carbon excluded is using of natural gas (21.8% in fuel consumption and 17.8% in quantity of carbon). Details on the share in fuel units and carbon units are presented on the Figures 3.33 and 3.34. The CO_2 emissions excluded from the RA are presented in Figure 3.35 for the whole time series 1990 – 2016. Liquid fuels (natural gas liquids, naphtha, and refinery feedstocks), solid fuels (coking coal, other bituminous coal) and gaseous fuels (natural gas) are used as feedstock in Slovakia. Lubricants and bitumen (liquid fuels) are used for non-energy purposes. The respective amounts of mentioned fuels are allocated in the IPPU sector and emissions are included there. The allocation of the fuels excluded from the reference approach and included in the IPPU sector is presented in the Table 3.66 and 3.67. The plant-specific (where available) and country-specific NCVs and EFs are used for estimation the volume of carbon excluded and respective CO_2 emissions excluded from the reference approach balance. The following fuels were balanced as feedstocks and non-energy use: natural gas, natural gas liquids, naphtha, lubricants, refinery feedstocks, coking coal, other bituminous coal. The quantities of the fuels and carbon used for non-energy purposes were provided directly by the plant operators or by the Statistical Office of the Slovak Republic.	National Inventory Report, Chapter 3.4
Slovenia	The biggest fraction of non-energy usage of fuels was the consumption of natural gas for the production of methanol, amounting to 89,475 Sm3 of natural gas in 2010, when this production stopped, and there has been no methanol production in Slovenia since 2011. Natural gas was entirely used as the row material for transformation into methanol. In every cycle only a fifth of it is transformed to the product, while the remaining natural gas is returned into the process. Stored CO_2 has been calculated on the basis of the formula from IPCC guidelines. We have assumed that all methane used for methanol production is stored in the product or in CO in emitted gas. This fact was confirmed also by expert from the company Nafta-Petrochem. The remaining amount of non-energy use of natural gas is used in the chemical industry also as a row material for production of organic and inorganic chemicals and plastics. According to the Statistical data all lubricants in Slovenia have been used for non-energy purpose only. Data about different types of use are not available. Likely, the largest applications for lubricants are in the form of motor oil. After the end of use, the lubricants which have been used in the engines are collected and mostly used as a fuel. In the line with the IPCC methodology emissions from lubricants used in the 2-stroke engines are reported in energy sector under road transport, while other emissions from lubricants are reported in the IPPU sector. The remaining amount of lubricants which is not combusted or oxidised during use is collected as waste oil. Slovenia has been adhering to the basic system of collection, recovery and disposal of waste oil since 1998. Recovery is the preferred choice, if technically feasible and if its cost is not unreasonably higher than the cost of disposal One of the forms of recovery is the utilisation of waste oils for energy – co-incineration in accordance with recovery procedure R1. Records by the SEA show that most waste oils have been used for this purpose. The only evidence of such a use is in the cement production. Emissions are already included in the inventory and are reported in the CRF tables in "1.A.2.g.viii Manufacturing industry and construction/Other industries under other fossil fuels". A small portion of collected waste oils has also been incinerated (procedure R9) or reformed and then reused (procedure D10). We reported these emissions in waste sector under waste incineration in submission 2010 for the first time. No other use of lubricants as a fuel has been recorded in Slovenia until now. The data on import and export as well as data from waste oil combusted in the industry have been obtained from SORS while the data on incineration of waste oils are from SEA. Stored CO_2 has been calculated on the basis of the formula 6.4 from 2006, IPCC guidelines, Vol. 2, Ch.6 Reference Approach. **Other fuels** Coke and petroleum coke, used in industry as reduction agent or feedstock, have been subtracted from energy sector and emissions from these fuels are presented in industrial processes sector. Before 1997, amount of coke, used for production of iron and steel, ferroalloys and carbide was reported as fuel consumption in relevant sectors. After 1997, this fuel started to be collected separately, but it took a while that all non-energy used fuel was reported correctly. Energy and non-energy use of fuel in industry have been presented separately in statistical data since 2000. To avoid double counting we have subtracted all coke used in iron and steel, ferroalloys and carbide production from energy sector except coke in iron production in the base year 1986. In that time, pig iron was still produced and disaggregated into the consumption of fuel as an additive. Thus the consumption of fuel as an energy product was impossible. For consumption of coke, the decision was taken to attribute all coke, which is consumed in the production of iron and steel in this year, to the energy sector as fuel consumption and no emissions from coke used in iron and steel production are presented in industrial processes. There are also other uses of fuel in chemical processes not emitting any GHGs, therefore no explanation is included in the CRF tables. In 2016, a small amount of fuel oil, LPG and white spirit was used, mostly for production of lacquers, paintings and other coatings. The same is valid also for bitumen which is used for road paving and for production of roofing material and during this use no GHG emissions occur.	National Inventory Report, Chapter 3.2.3

MS	Information on feedstocks and non-energy use of fuels	Source
Spain	The consumption of fuel for non-energy use is accounted for in the energy balance. The quantities of each fuel type are included in the reference approach. For each fuel type a split into two parts is given: a) the part that stays in the product and b) the part that is set free and causes the corresponding CO_2 emissions. Main sources are information directly from the plant or industry association about the use of fossil fuels, such as non-energy inputs following the sector/process to determine types of fuels, determined types of fuels from the quantity consumed for this purpose as retention carbon products, such as CO_2 emissions versus its complementing and replacing the figures reported in the above mentioned sources . Following sectors / processes - in most cases on individual plant level - are investigated: i) sodium carbonate; ii) calcium carbide and silicon ; iii) silicon ; iv) ferroalloys (ferrosilicon, ferromanganese and silicon manganese); v) ammonia ; vi) glass; vii) electrical steel mills ; viii) aluminum (anode manufacture); ix) hydrogen in the refining industry emplaced x) refinery plants. The exploitation of this information has led to a revision in the inventory figures for natural gas, petroleum coke, coal coke and coal (anthracite) and other fuels whose registered consumption for non-energy use is minor , such as coking coal , diesel , LPG, fuel oil, gas and refinery steel or wood.	National Inventory Report, Chapter 3.1.4 translation
Sweden	Activity data on feedstocks and non-energy use of fuels is collected from the environmental reports and the EU ETS statistics. Sweden uses the same data for CRF table 1.A.d, non-energy use (NEU) of fuels as for feedstocks and non-energy uses in the IPPPU sector (CRF 2) and Fugitive sector (CRF 1.B). Net calorific values and carbon emission factors are the same as in CRF 1.A.b. The parameter "fraction of carbon stored" has been set to 1.00 for all fuels, which is in line with the 2006 IPCC Guidelines. Emissions from use of fuels reported in CRF 1.B or CRF 2 is reported as " CO_2 emissions from the NEU reported in the inventory" in the CRF-tables.	National Inventory Report, Chapter 3.2.3
United Kingdom	The methodology for estimating emissions from fuels used for non-energy purposes is set out in the relevant sections of this NIR. A summary of the method, including all non-energy uses is included in **Annex 3**. The UK energy statistics (DUKES, 2016) contain an allocation for non-energy use for each fuel in the commodity balance tables. The UK inventory estimates emissions from fuels, including emissions arising from non-energy uses. In some cases, the inventory estimate for non-energy use does not agree with the DUKES allocation, and reallocations are made between energy and non-energy use for inventory reporting. In 2013, the Inventory Agency carried out research into non-energy uses of fuels; this was followed up by the DECC (now BEIS as of 2016) energy statistics team during 2014, and a series of revised allocations were introduced in the Digest of UK Energy Statistics 2014 (DECC, 2014), improving consistency between the inventory and the UK energy statistics. The activity data used for the national inventory and any deviations from the UK energy balance are presented and explained in **Annex 4**. The evidence that the Inventory Agency uses to make estimates for NEU includes: • annual reporting by plant operators (e.g. EU ETS returns include data on the use of process off-gases in the chemical and petrochemical production sector); • periodic surveys or research by trade associations / research organisations / environmental regulators, such as to assess the fate of coal tars and benzoles, petroleum coke or waste oils, or the impact of regulations on solvents, waste, product design and use; and, • information on the estimated split of stored: emitted carbon from feedstock chemicals in literature sources, including other country NIRs, where UK-specific information is not available. In many cases the energy statistics allocate fuels to non-energy use that are used in chemical and petrochemical production processes where either: • fossil carbon-containing off-gases are used for combustion in facility boilers; or • products containing the "stored" carbon are subsequently used / partly combusted / disposed and degraded with some proportion of the "stored carbon" in products ultimately emitted to atmosphere. In other instances, the allocation of fuels to "non-energy use" in the UK energy balance is contrary to other statistical evidence from industry or surveys that the Inventory Agency has access to in the compilation of the national inventory. For example, in the UK the allocation of petroleum coke to domestic and industrial combustion sources in the energy balance are missing for many years in the time series, whereas evidence from environmental reporting and research indicates that several industries use petroleum coke directly as a fuel or process input (e.g. cement kilns, chemical manufacturing processes, domestic fuel manufacturers), and that petroleum coke is supplied as a fuel for the residential market..	National Inventory Report, Chapter 3.2.3

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF SECTOR 2)

This chapter starts with an overview on emission trends in CRF Sector 2 Industrial processes and Product Use. This sector covers the following sub-sectors:

- Mineral Industry (CRF Source Category 2.A)
- Chemical Industry (CRF Source Category 2.B)
- Metal Industry (CRF Source Category 2.C)
- Non-Energy Products from Fuels and Solvent Use (CRF Source Category 2.D)
- Electronics Industry (CRF Source Category 2.E)
- Product Uses as Substitutes for Ozone Depleting Substances (CRF Source Category 2.F)
- Other Product Manufacture and Use (CRF Source Category 2.G)
- Other (CRF Source Category 2.H)

For each Union key category, overview tables are presented including the Member States' contributions to the key categories in terms of level and trend, and information on methodologies and emission factors.

4.1 Overview of sector

CRF Sector 2 Industrial Processes and Product Use is the third largest sector contributing 10 % to total EU-KP GHG (without LULUCF) emissions in 2020. The most important GHGs from this sector are CO_2 (7 % of total GHG emissions), HFCs (2.6 %) and N_2O (0.3 %).

The emissions from the sector Industrial Processes and Product Use decreased by 36 % from 548 Mt in 1990 to 351 Mt in 2020 (*Figure 4.1*). In 2020, the emissions decreased by 8 % compared to 2019, mainly due to decreased industrial production in the first year of the COVID-19 pandemic. The largest annual decrease in emissions was observed between 2008 and 2009, driven by reductions in cement production and a significant drop in the iron and steel production as a consequence of the economic crisis.

The key categories in this sector are:

- 2.A.1 Cement Production (CO_2)
- 2.A.2 Lime Production (CO_2)
- 2.A.4 Other Process Uses of Carbonates (CO_2)
- 2.B.1 Ammonia Production (CO_2)
- 2.B.2 Nitric Acid Production (N_2O)
- 2.B.3 Adipic Acid Production (N_2O)
- 2.B.8 Petrochemical and Carbon Black Production (CO_2)
- 2.B.9 Fluorochemical Production (HFCs)
- 2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)
- 2.B.10 Other chemical industry (CO_2)
- 2.C.1 Iron and Steel Production (CO_2)
- 2.C.3 Aluminium production (PFCs)
- 2.D.3 Other non energy products (CO_2)
- 2.F.1 Refrigeration and Air Conditioning Equipment (HFCs)

Figure 4.1: CRF Sector 2 Industrial Processes and Product Use: EU-KP GHG emissions for 1990–2020 in CO_2 equivalents (Mt)

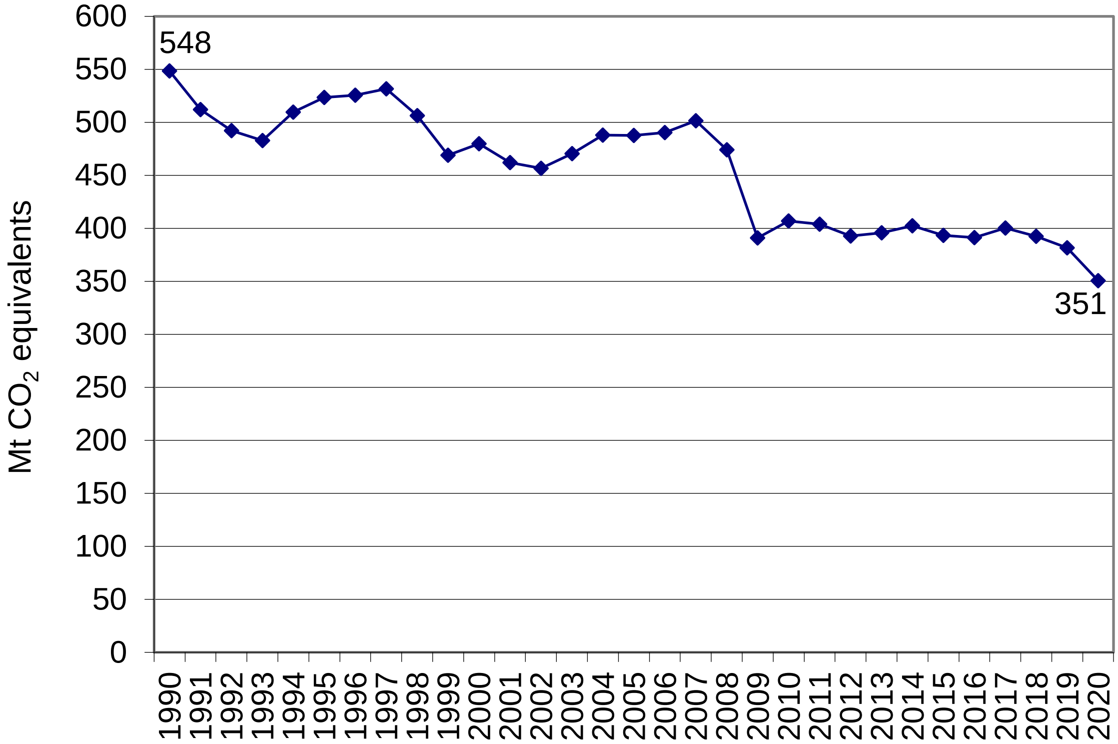
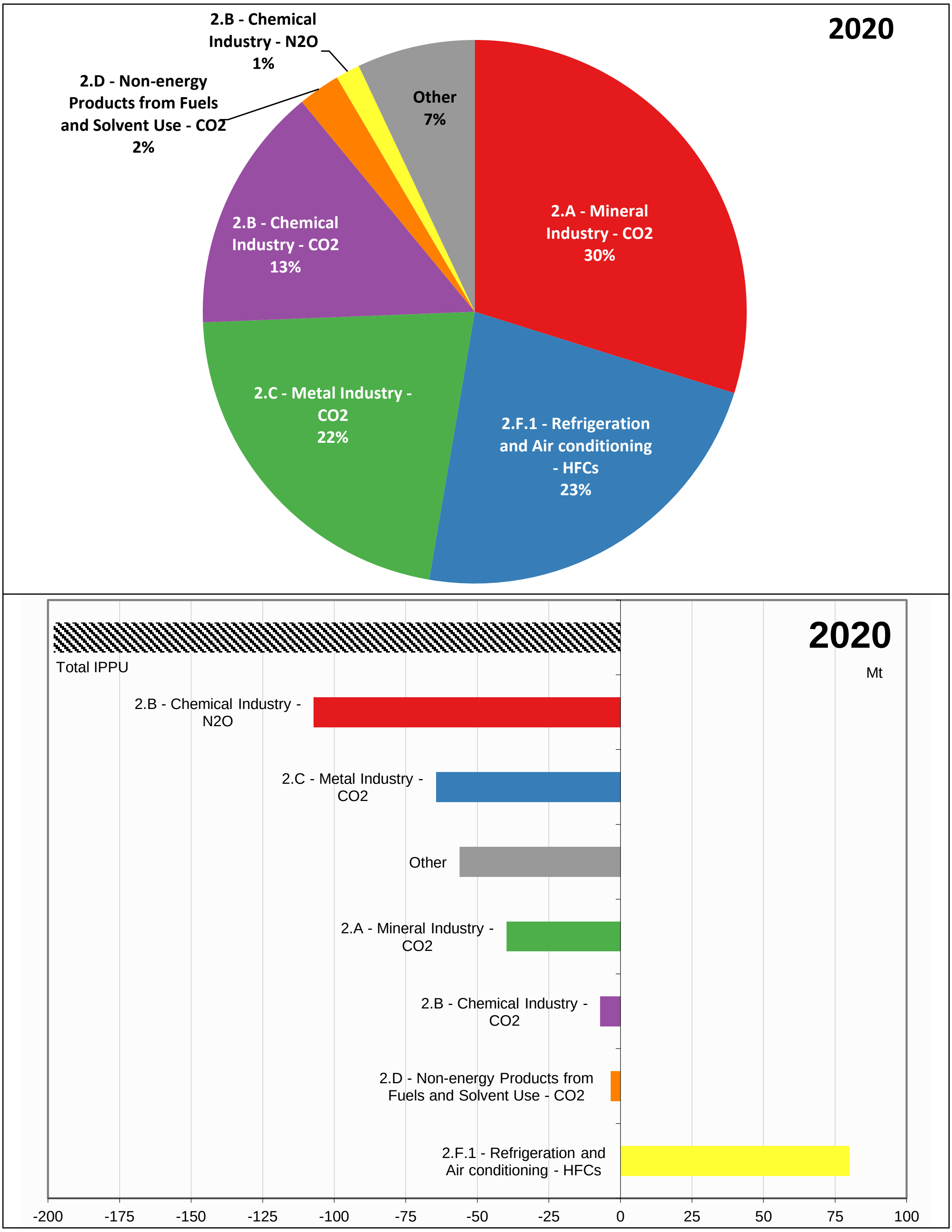


Figure 4.2: CRF Sector 2 Industrial processes and Product Use: Share of largest key categories in 2020 and absolute change of GHG emissions by large key categories 1990–2020 in CO_2 equivalents (Mt)



Note: Other is calculated by subtracting the presented categories from the sector total

4.2 Source categories and methodological issues

4.2.1 Mineral industry (CRF Source Category 2A)

The source category 2A Mineral industry includes three key categories:

Table 4.1: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2A (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
2.A.1 Cement Production (CO_2)	102698	74304	T	L	L	100%
2.A.2 Lime Production (CO_2)	25242	16903	0	L	L	99.98%
2.A.4 Other Process Uses of Carbonates (CO_2)	12192	9291	0	L	L	89.65%

This sector is dominated by cement production which contributes approx. 71% of mineral industry emissions. Cement production emissions occur during the production of clinker, an intermediate component in the cement manufacturing process. The source category 2A2 Lime production accounts for approx. 16% of the sector where CO_2 is emitted during the calcination of the calcium in limestone or dolomite for lime production. The source category 2A4 Other process uses of carbonates accounts for 9% of the sector and is composed of several sources with independent estimation methods. The remaining 4% of emissions is from 2A3 Glass production. All emissions from cement production are estimated using higher tier methods. The same is true for lime production, except for Cyprus, which uses a Tier 1 method for estimating its emissions from this category. Under category 2A4, several countries use Tier 1 methods for some sub-categories, but approx. 90% of emissions are estimated using higher tier methods.

Mineral industry emissions decreased during the 2009 economic crisis. They showed another, less pronounced decrease in 2020 as a consequence of reduced economic activities during the COVID-19 pandemic. Overall, these emissions have fallen by 28% since 1990 (Figure **4-3**). Seven countries (Croatia, Cyprus, Denmark, Ireland, Latvia, Poland and Sweden) have higher Mineral industry CO_2 emissions in 2020 compared to 1990 (Table 4.2).

Figure 4-3 2A Mineral industry CO_2 emissions

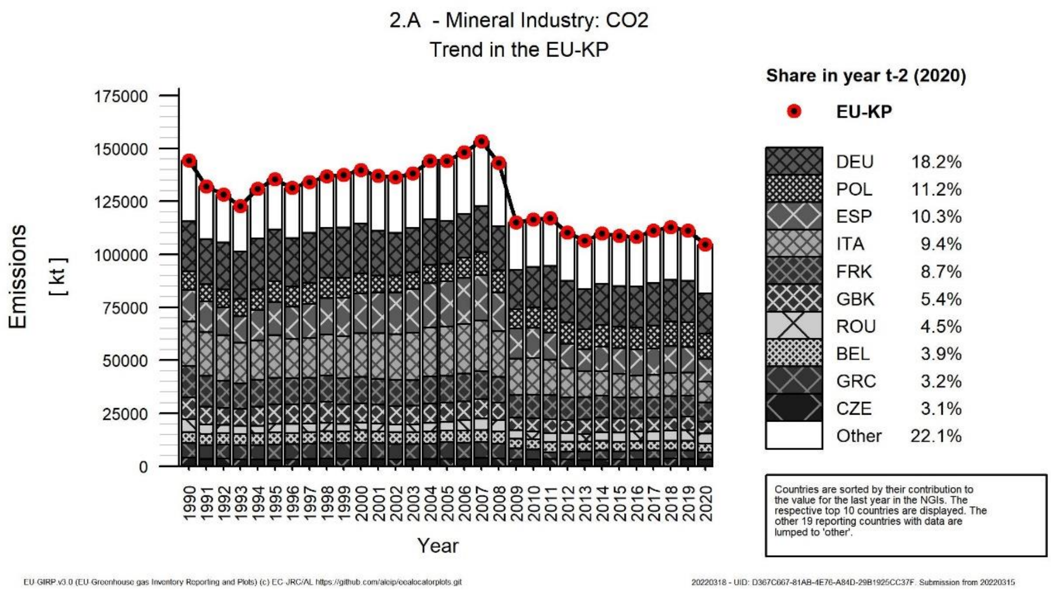


*Table **4**.2 2A Mineral industry: Member States total GHG and CO_2 emissions*

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt	
	1990	2020	1990	2020
Austria	3 092	2 821	3 092	2 821
Belgium	5 320	4 128	5 320	4 128
Bulgaria	3 278	2 182	3 278	2 182
Croatia	1 303	1 359	1 303	1 359
Cyprus	717	902	717	902
Czechia	4 082	3 211	4 082	3 211
Denmark	1 081	1 353	1 081	1 353
Estonia	614	70	614	70
Finland	1 218	947	1 218	947
France	14 977	9 083	14 977	9 083
Germany	23 522	19 043	23 522	19 043
Greece	6 775	3 362	6 775	3 362
Hungary	2 890	1 311	2 890	1 311
Ireland	1 117	1 907	1 117	1 907
Italy	20 720	9 780	20 720	9 780
Latvia	537	561	537	561
Lithuania	2 130	579	2 130	579
Luxembourg	593	433	593	433
Malta	1	0	1	0
Netherlands	1 411	1 070	1 411	1 070
Poland	8 855	11 740	8 855	11 740
Portugal	3 686	3 127	3 686	3 127
Romania	6 083	4 718	6 083	4 718
Slovakia	2 714	2 219	2 714	2 219
Slovenia	694	561	694	561
Spain	15 120	10 784	15 120	10 784
Sweden	1 673	1 681	1 673	1 681
United Kingdom	10 133	5 659	10 133	5 659
EU-27+UK	**144 338**	**104 593**	**144 338**	**104 593**
Iceland	52	1	52	1
United Kingdom (KP)	10 133	5 659	10 133	5 659
EU-KP	**144 390**	**104 594**	**144 390**	**104 594**

Abbreviations explained in the Chapter 'Units and abbreviations'.
For consistency with other sub-sectors this table shows both CO_2e and CO_2, however as there are no N_2O or CH_4 emissions for this category, the two sets of columns in this table show the same numbers.

Table 4.3 provides information on the countries' contribution to EU-KP recalculations in CO_2 from 2A Mineral industry for 1990 and 2020 as well as the explanations for recalculations provided by the countries.

Table 4.3 *2A Mineral industry: Contribution of MS to EU-KP recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)*

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	-	-		
Belgium	0.6	0.0	-	-	Correction of emissions reported by one company under 2A4d for 1990-2012	
Bulgaria	-	-	-	-		
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	356	12		Updated activity data and methodological change in 2.A.4.d
Denmark	-0.5	-0.0	-0.1	-0.0	New activity data for stone wool production for 1990-2004	Updated activity data for clay production
Estonia	-	-	-	-		
Finland	-	-	0.1	0.0		Emissions from one additional plan were included in 2A4d for the years 2016 to 2019
France	0.1	0.0	-36	-0.4	Update of activity data under 2A4b for the whole time series	Update of production data of one plant under 2A1, update of emissions of several plants under 2A2, 2A3 and 2A4a; updated of activity data under 2A4b for the whole time series
Germany	-	-	-	-		
Greece	-	-	-	-		
Hungary	-	-	-	-		
Ireland	-	-	-	-		
Italy	-	-	-21	-0.2		Update emissions data under 2A2; update of activity data under 2A3 and 2A4
Latvia	-	-	-	-		
Lithuania	-	-	-	-		
Luxembourg	-	-	-	-		
Malta	-	-	-	-		
Netherlands	-	-	-	-		
Poland	-	-	0.4	0.0		Update of emission data under 2A3 and 2A4a
Portugal	-10	-0.3	-0.1	-0.0	In 2A2, CO_2 recovery from lime in paper pulp was removed; CO_2 emissions from lime production in sugar mills were estimated for the first time; in 2Ab, activity data were updated.	In 2A2, CO_2 recovery from lime in paper pulp was removed; CO_2 emissions from lime production in sugar mills were estimated for the first time; in 2Ab, activity data were updated.
Romania	-	-	-	-		
Slovakia	-	-	-	-		
Slovenia	-	-	-	-		
Spain	-	-	5.4	0.0		Update of activity data under 2A4a.
Sweden	-	-	0.7	0.0		Update of activity data under 2A3.

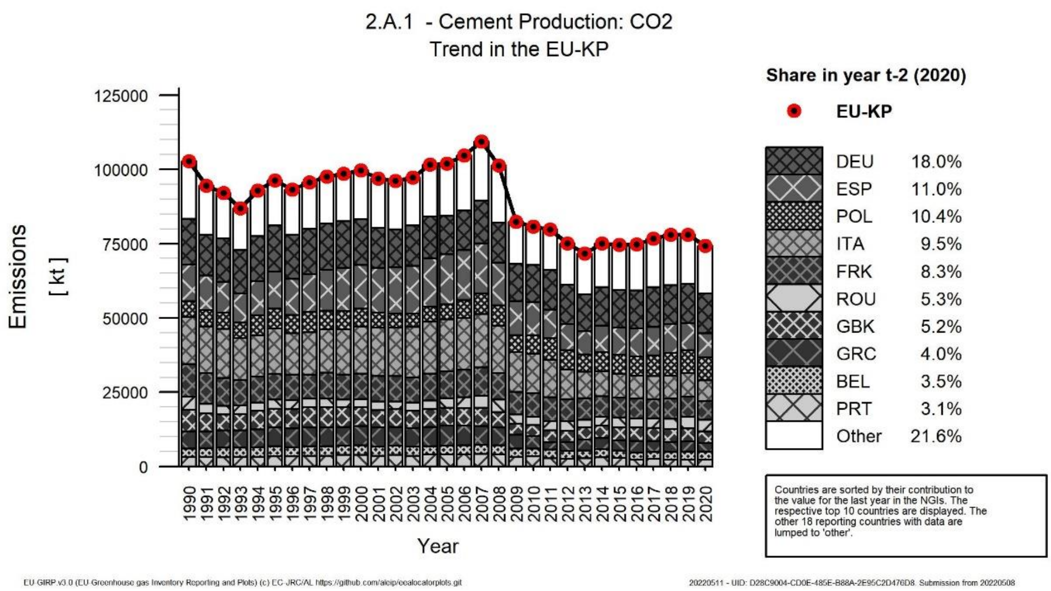
	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
United Kingdom	355	3.6	10	0.2	Under 2A4a Other ceramics, Clays & shales are reported in the 2022 submission.	Under 2A4a Other ceramics, Clays & shales are reported in the 2022 submission.
EU27+UK	**345**	**0.2**	**314**	**0.3**		
Iceland	-	-	-	-		
United Kingdom (KP)	355	3.6	10	0.2	See above	See above
EU-KP	**345**	**0.2**	**314**	**0.3**		

(*) contribution of the recalculation as percentage of the total emissions of category 2A for the respective year and MS

4.2.1.1 2A1 Cement production

CO_2 emissions from Cement production contributed 2.0% of total EU-KP (without LULUCF) emissions in 2020. In that year, emissions were approx. 5% below 2019 and approx. 28% below 1990 levels. This source is a key category of CO_2 emissions in terms of emissions level and trend.

Figure 4-4 2A1 Cement production: EU-KP CO_2 emissions



In 2020, Germany, Spain and Poland were the largest emitters accounting for respectively 18.0%, 11.0% and 10.4% of cement related emissions. (Figure 4-4 and Table **4.4**). Between 2019 and 2020, these emissions decreased in 18 countries, while they increased in 9 countries. The three countries with the largest absolute reductions were Spain, Italy and France.

Table 4.4 2A1 Cement production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	2 033	1 771	1 821	2.5%	-212	-10%	51	3%	T3	PS
Belgium	2 824	2 819	2 634	3.5%	-190	-7%	-185	-7%	T3	PS
Bulgaria	2 142	1 127	1 066	1.4%	-1 077	-50%	-61	-5%	T2	PS
Croatia	1 093	1 184	1 213	1.6%	119	11%	29	2%	T2,T3	PS
Cyprus	668	789	882	1.2%	215	32%	93	12%	CS	CS
Czechia	2 489	1 977	1 891	2.5%	-598	-24%	-86	-4%	T3	PS
Denmark	882	1 129	1 227	1.7%	345	39%	98	9%	T3	PS
Estonia	483	295	20	0.0%	-463	-96%	-275	-93%	T2	PS
Finland	729	583	570	0.8%	-160	-22%	-14	-2%	T3	PS
France	10 937	6 807	6 197	8.3%	-4 740	-43%	-609	-9%	T2,T3	CS,PS
Germany	15 297	13 287	13 357	18.0%	-1 940	-13%	71	1%	T2	CS
Greece	5 762	3 360	2 978	4.0%	-2 784	-48%	-382	-11%	CS	PS
Hungary	1 751	1 023	929	1.2%	-822	-47%	-94	-9%	T3	PS
Ireland	884	1 893	1 770	2.4%	886	100%	-123	-6%	T3	PS
Italy	15 846	7 912	7 059	9.5%	-8 787	-55%	-852	-11%	T2	CS,PS
Latvia	346	561	551	0.7%	205	59%	-11	-2%	T2	PS
Lithuania	1 668	578	557	0.7%	-1 111	-67%	-21	-4%	T2	PS
Luxembourg	539	395	399	0.5%	-140	-26%	4	1%	T2	CS,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	416	6	NO	-	-416	-100%	-6	-100%	NA	NA
Poland	5 453	7 692	7 691	10.4%	2 237	41%	-2	0%	T2	CS
Portugal	3 176	2 225	2 310	3.1%	-867	-27%	85	4%	T3	OTH
Romania	4 445	3 828	3 901	5.3%	-544	-12%	73	2%	CS,T2	PS
Slovakia	1 464	1 404	1 443	1.9%	-21	-1%	39	3%	T2	PS
Slovenia	470	478	475	0.6%	4	1%	-3	-1%	T2	CS
Spain	12 279	9 064	8 192	11.0%	-4 087	-33%	-872	-10%	T2	CS
Sweden	1 272	1 349	1 272	1.7%	0	0%	-77	-6%	T3	PS
United Kingdom	7 295	4 448	3 900	5.2%	-3 396	-47%	-549	-12%	T3	CS
EU-27+UK	**102 647**	**77 986**	**74 304**	**100%**	**-28 343**	**-28%**	**-3 682**	**-5%**	**-**	**-**
Iceland	52	NO	NO	-	-52	-100%	-	-	NA	NA
United Kingdom (KP)	7 295	4 448	3 900	5.2%	-3 396	-47%	-549	-12%	T3	CS
EU-KP	**102 698**	**77 986**	**74 304**	**100%**	**-28 394**	**-28%**	**-3 682**	**-5%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Cyprus and Greece use a country-specific method and report 'CS' accordingly. The methods used by these countries correspond to methodological Tier 3 (T3). The table lists methods and emission factors used in the latest reporting year. As the Netherlands and Iceland did not report emissions in that year, 'NA' is reported. The Netherlands and Iceland reported emissions from cement production in 1990. The methodological tier used for that year is Tier 3 (T3) for the Netherlands and Tier 2 (T2) for Iceland.

Table 4.5 shows information on methods, activity data, and emission factors for CO_2 emissions from 2A1 Cement production for 1990 and 2020. All cement production emissions are estimated with higher Tier methods and most countries use plant-specific emission factors.

The implied emission factors per tonne of clinker produced in 2020 range from 0.49 t CO_2/t of clinker produced for Slovakia to 0.58 t CO_2/t of clinker produced for Estonia. Countries use country-specific and plant-specific emission factors (typically based on raw meal carbon content characterization), they also provide data on clinker production which allows for the calculation of comparative IEFs. In 2020 the EU-KP IEF amounted to 0.53 t CO_2/t of clinker.

*Table **4**.5 2A1 Cement production: Information on methods applied and emission factors for CO_2 emissions*

Member State	1990				2020				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Clinker production	3 694	0.55	2 033	Clinker production	3 522	0.52	1 821	T3	PS
Belgium	Clinker production	5 292	0.53	2 824	Clinker production	4 817	0.55	2 634	T3	PS
Bulgaria	Clinker production	3 987	0.54	2 142	Clinker production	2 000	0.53	1 066	T2	PS
Croatia	Clinker production	2 062	0.53	1 093	Clinker production	2 351	0.52	1 213	T2,T3	PS
Cyprus	Clinker production	1 249	0.53	668	Clinker production	1 694	0.52	882	CS	CS
Czechia	Clinker production	4 726	0.53	2 489	Clinker production	3 556	0.53	1 891	T3	PS
Denmark	Clinker production	1 406	0.63	882	Clinker production	2 240	0.55	1 227	T3	PS
Estonia	Clinker production	790	0.61	483	Clinker production	35	0.58	20	T2	PS
Finland	Clinker production	1 470	0.50	729	Clinker production	1 141	0.50	570	T3	PS
France	Clinker production	20 854	0.52	10 937	Clinker production	11 771	0.53	6 197	T2,T3	CS,PS
Germany	Clinker production	28 863	0.53	15 297	Clinker production	25 203	0.53	13 357	T2	CS
Greece	Clinker production	10 645	0.54	5 762	Clinker production	5 745	0.52	2 978	CS	PS
Hungary	Clinker production	3 210	0.55	1 751	Clinker production	C	-	929	T3	PS
Ireland	Clinker production	1 610	0.55	884	Clinker production	3 273	0.54	1 770	T3	PS
Italy	Clinker production	29 786	0.53	15 846	Clinker production	13 389	0.53	7 059	T2	CS,PS
Latvia	Clinker production	669	0.52	346	Clinker production	1 084	0.51	551	T2	PS
Lithuania	Clinker production	3 058	0.55	1 668	Clinker production	1 039	0.54	557	T2	PS
Luxembourg	Clinker production	1 048	0.51	539	Clinker production	784	0.51	399	T2	CS,PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	Clinker production	770	0.54	416	Clinker production	NO	NO	NO	NA	NA
Poland	Clinker production	10 309	0.53	5 453	Clinker production	14 361	0.54	7 691	T2	CS
Portugal	Clinker production	6 128	0.52	3 176	Clinker production	4 569	0.51	2 310	T3	OTH
Romania	Clinker production	8 379	0.53	4 445	Clinker production	7 474	0.52	3 901	CS,T2	PS
Slovakia	Clinker production	2 836	0.52	1 464	Clinker production	2 945	0.49	1 443	T2	PS
Slovenia	Clinker production	891	0.53	470	Clinker production	924	0.51	475	T2	CS
Spain	Clinker production	23 212	0.53	12 279	Clinker production	15 653	0.52	8 192	T2	CS
Sweden	Clinker production	2 348	0.54	1 272	Clinker production	2 438	0.52	1 272	T3	PS
United Kingdom	Clinker production	13 199	0.55	7 295	Clinker production	6 941	0.56	3 900	T3	CS
EU-27+UK	-	**192 489**	**0.53**	**102 647**	-	**140 705**	**0.53**	**74 304**	-	-
Iceland	Clinker production	97	0.53	52	Clinker production	NO	NO	NO	NA	NA
United Kingdom (KP)	Clinker production	13 199	0.55	7 295	Clinker production	6 941	0.56	3 900	T3	CS
EU-KP	-	**192 586**	**0.53**	**102 698**	-	**140 705**	**0.53**	**74 304**	-	-

Abbreviations are explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
The methods used by Cyprus and Greece correspond to methodological Tier 3 (T3). The table lists methods and emission factors used in the latest reporting year. The Netherlands and Iceland did not report emissions from cement production in that year but reported emissions in 1990. The methodological tier used for 1990 is Tier 3 (T3) for the Netherlands and Tier 2 (T2) for Iceland.

4.2.1.2 2A2 Lime production

CO_2 emissions from 2A2 Lime production account for 0.5% of total EU-KP (without LULUCF) emissions in 2020. Between 1990 and 2020, CO_2 emissions from this source decreased by 33%, and between 2019 and 2020, these emissions decreased by 10%, due to decreased economic activity as a consequence of the COVID-19 pandemic. The largest decreases between 2019 and 2020 were -369 kt in Germany and -266 kt in France. Increases occurred in six countries only (Table 4.6). Emissions from lime production typically show annual fluctuations of several percent; the largest decrease was observed between 2008 and 2009. Germany, France and Italy are the largest emitters contributing approx. 24.7%, 11.8% and 9.5% of the total respectively (Figure 4-5).

Figure 4-5 2A2 Lime production: EU-KP CO_2 emissions

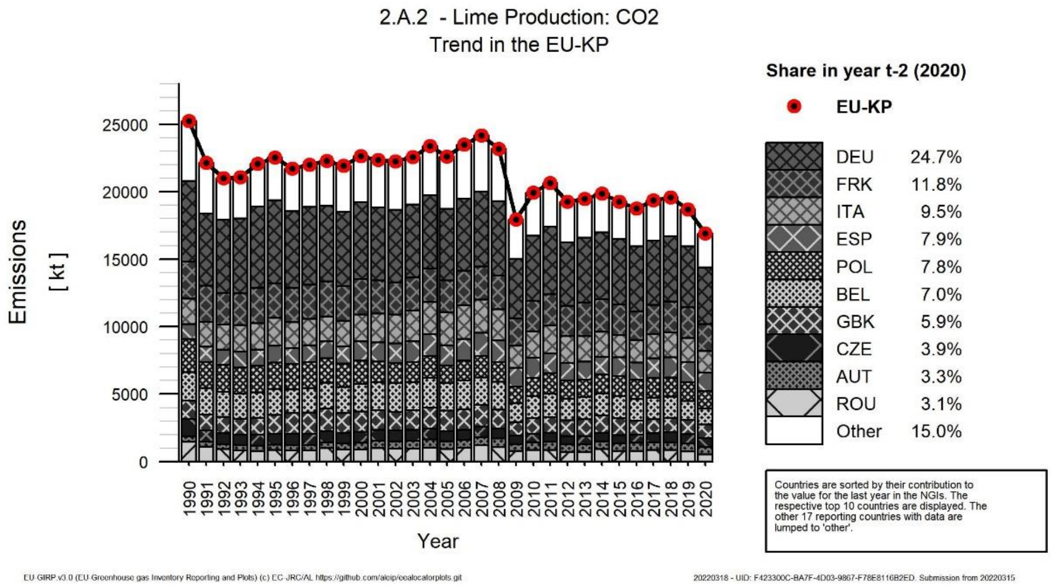


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*Table **4**.6 2A2 Lime production: Member States' contributions to CO_2 emissions*

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	396	584	559	3.3%	163	41%	-25	-4.3%	T3	PS
Belgium	2 097	1 397	1 188	7.0%	-909	-43%	-209	-15%	T3	PS
Bulgaria	390	249	201	1.2%	-189	-48%	-47	-19%	T2	D
Croatia	157	93	104	0.6%	-53	-34%	11	12%	T3	PS
Cyprus	5.3	3.9	3.1	0.0%	-2.2	-42%	-0.8	-21%	T1	D
Czechia	1 337	681	651	3.9%	-686	-51%	-30	-4.4%	T3	PS
Denmark	105	34	43	0.3%	-62	-59%	10	28%	T2	CS,PS
Estonia	130	53	41	0.2%	-89	-69%	-12	-23%	T2	PS
Finland	401	262	265	1.6%	-135	-34%	3.5	1.3%	T3	CS
France	2 750	2 263	1 997	12%	-753	-27%	-266	-12%	T2,T3	CS,PS
Germany	5 987	4 549	4 181	25%	-1 806	-30%	-369	-8.1%	T2	D
Greece	404	199	159	0.9%	-245	-61%	-40	-20%	CS	PS
Hungary	614	145	144	0.8%	-470	-77%	-1.1	-0.8%	T3	PS
Ireland	214	164	136	0.8%	-79	-37%	-28	-17%	T3	PS
Italy	1 877	1 776	1 611	9.5%	-266	-14%	-165	-9.3%	T2	CS,PS
Latvia	122	NO	NO	-	-122	-100%	-	-	NA	NA
Lithuania	210	1.4	1.9	0.0%	-208	-99%	0.5	38%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1.3	NO	NO	-	-1.3	-100%	-	-	NA	NA
Netherlands	163	181	181	1.1%	18	11%	0.0	0%	CS	D
Poland	2 461	1 407	1 326	7.8%	-1 135	-46%	-82	-5.8%	T2	CS
Portugal	206	410	383	2.3%	177	86%	-26	-6.4%	T3	OTH
Romania	1 450	761	519	3.1%	-931	-64%	-242	-32%	T2	CS,D
Slovakia	795	489	431	2.5%	-364	-46%	-59	-12%	T2	PS
Slovenia	200	57	57	0.3%	-144	-72%	-0.2	-0.3%	T3	CS
Spain	1 109	1 494	1 334	7.9%	225	20%	-160	-11%	T3	PS
Sweden	332	373	388	2.3%	57	17%	16	4.2%	T3	D
United Kingdom	1 329	1 053	1 000	5.9%	-328	-25%	-53	-5.0%	T3	CS
EU-27+UK	**25 242**	**18 678**	**16 903**	**100%**	**-8 339**	**-33%**	**-1 775**	**-10%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 329	1 053	1 000	5.9%	-328	-25%	-53	-5.0%	T3	CS
EU-KP	**25 242**	**18 678**	**16 903**	**100%**	**-8 339**	**-33%**	**-1 775**	**-10%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations are explained in the Chapter 'Units and abbreviations'.

The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Greece and the Netherlands use country-specific methods and report 'CS' accordingly. The level of complexity of the methods applied by Greece and the Netherlands is Tier 3 (T3).
The table lists methods and emission factors used in the latest inventory year. As Latvia, Luxembourg, Malta and Iceland did not report emissions in that year, 'NA' is reported. Latvia and Malta reported emissions from lime production in 1990. The methodological tier used in that year is Tier 2 (T2) for Latvia and Tier 1 (T1) for Malta.

Table 4.7 shows information on the methods and emission factors for CO_2 emissions from 2A2 Lime production for 1990 and 2020. While production data is not necessarily explicitly used for emissions calculations (plant-specific emission factors are typically derived from raw meal carbon content characterization), countries that report emissions from lime production also report production activity data for calculating comparative IEFs. Lime production data is the combined figure for the three types of lime: quicklime (high-calcium lime), dolomitic lime and hydraulic lime production. The weighted average IEF in 2020 is 0.73 t CO_2/t of lime produced. The lime production activity data for each country reflect a mix of lime types, and so the implied emission factors per tonne of lime produced in 2020 range from 0.66 for France to 0.80 for Croatia and Finland. Three countries report activity data other than lime production: The Netherlands report limestone used, and Portugal and the United Kingdom report carbonate used. Of the twenty-five countries which report lime production emissions, all but one use higher tier methodologies (Tier 2 or Tier 3) which accounts for more than 99.9% of emissions from this category.

Table 4.7 2A2 Lime production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	1990				2020				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Lime Production	513	0.77	396	Lime Production	747	0.75	559	T3	PS
Belgium	Lime Production	2 660	0.79	2 097	Lime Production	1 529	0.78	1 188	T3	PS
Bulgaria	Lime Production	490	0.80	390	Lime Production	258	0.78	201	T2	D
Croatia	Lime Production	219	0.72	157	Lime Production	129	0.80	104	T3	PS
Cyprus	Lime Production	7	0.73	5	Lime Production	4	0.73	3	T1	D
Czechia	Lime Production	1 823	0.73	1 337	Lime Production	856	0.76	651	T3	PS
Denmark	Lime Production	134	0.79	105	Lime Production	55	0.78	43	T2	CS,PS
Estonia	Lime Production	185	0.70	130	Lime Production	55	0.74	41	T2	PS
Finland	Lime Production	488	0.82	401	Lime Production	332	0.80	265	T3	CS
France	Lime Production	3 589	0.77	2 750	Lime Production	3 032	0.66	1 997	T2,T3	CS,PS
Germany	Lime Production	7 927	0.76	5 987	Lime Production	5 571	0.75	4 181	T2	D
Greece	Lime Production	491	0.82	404	Lime Production	218	0.73	159	CS	PS
Hungary	Lime Production	831	0.74	614	Lime Production	194	0.74	144	T3	PS
Ireland	Lime Production	255	0.84	214	Lime Production	179	0.76	136	T3	PS
Italy	Lime Production	2 583	0.73	1 877	Lime Production	2 178	0.74	1 611	T2	CS,PS
Latvia	Lime Production	225	0.54	122	Lime Production	NO	NO,NA	NO	NA	NA
Lithuania	Lime Production	288	0.73	210	Lime Production	2	0.78	2	T2	D
Luxembourg	Lime Production	NO	NO	NO	Lime Production	NO	NO	NO	NA	NA
Malta	Lime Production	2	0.75	1	Lime Production	NO	NO	NO	NA	NA
Netherlands	Limestone used	372	0.44	163	Limestone used	414	0.44	181	CS	D
Poland	Lime Production	3 464	0.71	2 461	Lime Production	1 802	0.74	1 326	T2	CS
Portugal	Carbonate used	291	0.71	206	Carbonate used	558	0.69	383	T3	OTH
Romania	Lime Production	2 025	0.72	1 450	Lime Production	695	0.75	519	T2	CS,D
Slovakia	Lime Production	1 076	0.74	795	Lime Production	554	0.78	431	T2	PS
Slovenia	Lime Production	275	0.73	200	Lime Production	76	0.75	57	T3	CS
Spain	Lime Production	1 619	0.69	1 109	Lime Production	1 907	0.70	1 334	T3	PS
Sweden	Lime Production	439	0.75	332	Lime Production	521	0.75	388	T3	D
United Kingdom	Carbonate used	2 982	0.45	1 329	Carbonate used	2 245	0.45	1 000	T3	CS
EU-27+UK	**-**	**NE**	**NE**	**25 242**	**-**	**23 024**	**0.73**	**16 903**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Carbonate used	2 982	0.45	1 329	Carbonate used	2 245	0.45	1 000	T3	CS
EU-KP	**-**	**NE**	**NE**	**25 242**	**-**	**23 024**	**0.73**	**16 903**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Not all countries show lime production as the activity data for this emissions category. Gap-filled values are shown against Lime production for EU activity and the EU IEF for 2020.
The level of complexity of the methods applied by Greece and the Netherlands is Tier 3 (T3). The methodological tier used in 1990 is Tier 2 (T2) for Latvia and Tier 1 (T1) for Malta.

4.2.1.3 2A4 Other process uses of carbonates

CO_2 emissions from 2A4 Other process uses of carbonates contributed 0.3% of total EU-KP (without LULUCF) emissions in 2020. Emissions from this sector in 2020 were 24% lower than 1990 levels and 10% lower compared to 2019. It is not necessarily useful to compare specific shares of emissions due to the fact that each country's estimates are mostly composed of several sources with independent estimation methods, using partly higher tiers, partly default methods.

Table 4.8 2A4 Other process uses of carbonates: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	624	413	401	4.3%	-223	-36%	-12	-2.8%	T1,T3	D,PS
Belgium	136	198	198	2.1%	62	45%	-0.3	-0.1%	T3	CS,PS
Bulgaria	607	873	830	8.9%	223	37%	-43	-5.0%	T1,T2	D,PS
Croatia	9.1	19	17	0.2%	8.0	87%	-1.6	-8.5%	T3	PS
Cyprus	44	21	17	0.2%	-27	-62%	-4.5	-21%	CS,T1	CS,D
Czechia	114	641	530	5.7%	416	365%	-111	-17%	T1,T3	D,PS
Denmark	77	77	73	0.8%	-3.4	-4.5%	-3.8	-4.9%	CS,T3	CS,D
Estonia	NO,IE,NA	0.5	0.5	0.0%	0.5	∞	0.0	-3.5%	T1,T2	D,PS
Finland	67	124	110	1.2%	42	63%	-14	-12%	T1,T3	CS,D
France	488	451	420	4.5%	-69	-14%	-32	-7.1%	T1,T2,T3	CS,D,PS
Germany	1 458	710	648	7.0%	-810	-56%	-63	-8.8%	T1,T2	CS,D
Greece	590	355	209	2.2%	-381	-65%	-146	-41%	CS,T1	CS,D
Hungary	449	249	195	2.1%	-254	-57%	-54	-22%	T2,T3	CS,D,PS
Ireland	5.3	1.4	2.0	0.0%	-3.3	-62%	0.6	42%	T3	PS
Italy	2 544	627	541	5.8%	-2 003	-79%	-86	-14%	T2	CS,PS
Latvia	69	8.8	9.0	0.1%	-60	-87%	0.3	2.9%	T1,T2	D,PS
Lithuania	240	15	13	0.1%	-226	-94%	-1.4	-10%	T1,T2	CS,D,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	0.2	0.2	0.2	0.0%	0.0	4.9%	0.0	4.4%	T1	D
Netherlands	690	896	825	8.9%	135	20%	-71	-7.9%	CS,T1	D
Poland	771	2 191	2 126	23%	1 355	176%	-65	-2.9%	T1,T2	CS,D
Portugal	234	321	278	3.0%	43	19%	-43	-13%	T1,T3	OTH
Romania	38	325	243	2.6%	205	535%	-81	-25%	OTH,T2,T3	D,PS
Slovakia	447	373	327	3.5%	-120	-27%	-47	-13%	T3	PS
Slovenia	20	18	18	0.2%	-2.4	-12%	0.1	0.7%	T2	D
Spain	1 358	920	818	8.8%	-539	-40%	-101	-11%	T1,T2,T3	CS,D,PS
Sweden	15	10	5.6	0.1%	-10	-64%	-4.8	-46%	T3	D
United Kingdom	1 097	458	436	4.7%	-661	-60%	-23	-4.9%	CS,T1,T3	CS,OTH
EU-27+UK	**12 192**	**10 297**	**9 290**	**100%**	**-2 902**	**-24%**	**-1 007**	**-10%**	**-**	**-**
Iceland	0.7	1.0	0.9	0.0%	0.2	29%	-0.1	-6.5%	T3	PS
United Kingdom (KP)	1 097	458	436	4.7%	-661	-60%	-23	-4.9%	CS,T1,T3	CS,OTH
EU-KP	**12 192**	**10 298**	**9 291**	**100%**	**-2 901**	**-24%**	**-1 007**	**-10%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.1.4 Non-key sources

Glass production is the only non-key source in the mineral industry. CO_2 emissions from 2A3 Glass production contributed to only 0.1% of total EU-KP (without LULUCF) emissions in 2020. Emissions in that year were 4% below 1990 levels and 6% lower than in 2019.

Table 4.10 shows information on the methods applied, activity data, and the emission factors for CO_2 emissions from 2A3 Glass production for 1990 and 2020.

Table 4.9 2A3 Glass production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	39	41	39	1.0%	0.7	1.9%	-1.9	-4.7%	T3	PS
Belgium	263	135	108	2.6%	-154	-59%	-27	-20%	T3	CS,PS
Bulgaria	138	76	85	2.1%	-53	-39%	8.8	12%	T1	CS
Croatia	43	29	26	0.6%	-18	-41%	-3.8	-13%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	143	144	139	3.4%	-3.9	-2.8%	-4.8	-3.3%	T3	PS
Denmark	16	10	10	0.2%	-6.7	-41%	0.0	-0.1%	T3	PS
Estonia	1.2	10	9.0	0.2%	7.8	635%	-1.4	-13%	T3	PS
Finland	21	2.0	1.6	0.0%	-19	-92%	-0.4	-21%	T3	CS
France	802	540	469	11%	-333	-42%	-71	-13%	T2,T3	CS,PS
Germany	780	866	857	21%	77	10%	-8.9	-1.0%	T2	CS
Greece	20	17	17	0.4%	-3.6	-18%	-0.2	-1.3%	CS	CS
Hungary	77	49	43	1.1%	-34	-44%	-6.1	-12%	T3	CS,PS
Ireland	13	NO	NO	-	-13	-100%	-	-	NA	NA
Italy	453	597	569	14%	115	25%	-28	-4.7%	T2	CS,PS
Latvia	0.4	0.6	0.7	0.0%	0.3	92%	0.1	19%	T3	D,PS
Lithuania	12	8.0	7.5	0.2%	-4.2	-36%	-0.5	-6.3%	T2	D
Luxembourg	54	64	34	0.8%	-19	-36%	-30	-46%	CS	PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	142	69	64	1.6%	-79	-55%	-5.4	-7.7%	T3	PS
Poland	169	559	598	15%	429	253%	39	7.1%	T2	D
Portugal	69	160	156	3.8%	87	126%	-3.7	-2.3%	T3	OTH
Romania	150	42	55	1.3%	-95	-63%	13	30%	T2	CS,D
Slovakia	7.9	18	18	0.4%	11	133%	0.2	1.3%	T3	PS
Slovenia	3.3	13	11	0.3%	8.0	246%	-2.2	-16%	T3	D
Spain	374	502	440	11%	66	18%	-62	-12%	T3	CS,D,PS
Sweden	54	16	16	0.4%	-38	-71%	-0.9	-5.5%	T3	CS,D
United Kingdom	412	369	323	7.9%	-89	-22%	-46	-12%	T3	CS
EU-27+UK	**4 258**	**4 339**	**4 096**	**100%**	**-162**	**-3.8%**	**-242**	**-5.6%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	412	369	323	7.9%	-89	-22%	-46	-12%	T3	CS
EU-KP	**4 258**	**4 339**	**4 096**	**100%**	**-162**	**-3.8%**	**-242**	**-5.6%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Greece and Luxembourg use country-specific methods and report 'CS' accordingly. The level of complexity of the methods is Tier 3 (T3) for Greece and Tier 2 (T2) for Luxembourg.

The table below shows that while most countries report glass production as activity data under this category, some report inputs (carbonate use). Based on gap-filling, the implied emission factor for EU-KP is 0.12 t CO_2 per t of glass produced.

Table 4.10 2A3 Glass production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	1990				2020				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Glass Production	399	0.10	39	Glass Production	503	0.08	39	T3	PS
Belgium	Glass Production	1 993	0.13	263	Glass Production	1 162	0.09	108	T3	CS,PS
Bulgaria	-	818	0.17	138	-	635	0.13	85	T1	CS
Croatia	Glass Production	99	0.44	43	Glass Production	59	0.43	26	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Glass Production	1 237	0.12	143	Glass Production	1 152	0.12	139	T3	PS
Denmark	Glass Production	200	0.08	16	Glass Production	183	0.05	10	T3	PS
Estonia	Glass Production	12	0.10	1	Glass Production	77	0.12	9	T3	PS
Finland	Used Carbonates	45	0.47	21	Used Carbonates	4	0.40	2	T3	CS
France	Glass Production	4 333	0.19	802	Glass Production	2 988	0.16	469	T2,T3	CS,PS
Germany	Glass Production	6 562	0.12	780	Glass Production	7 356	0.12	857	T2	CS
Greece	Glass Production	135	0.15	20	Glass Production	101	0.16	17	CS	CS
Hungary	Glass Production	418	0.18	77	Glass Production	333	0.13	43	T3	CS,PS
Ireland	Carbonate Use	64	0.21	13	Carbonate Use	NO	NO	NO	NA	NA
Italy	Glass Production	3 779	0.12	453	Glass Production	5 876	0.10	569	T2	CS,PS
Latvia	Glass Production	44	0.01	0	Glass Production	C	C	1	T3	D,PS
Lithuania	Glass Production	66	0.18	12	Glass Production	48	0.16	7	T2	D
Luxembourg	Glass Production	377	0.14	54	Glass Production	287	0.12	34	CS	PS
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	1 095	0.13	142	-	1 582	0.04	64	T3	PS
Poland	Glass Production	1 058	0.16	169	Glass Production	3 737	0.16	598	T2	D
Portugal	-	626	0.11	69	-	1 654	0.09	156	T3	OTH
Romania	Glass Production	926	0.16	150	Glass Production	423	0.13	55	T2	CS,D
Slovakia	Used Carbonates	18	0.44	8	Used Carbonates	43	0.42	18	T3	PS
Slovenia	Glass Production	25	0.13	3	Glass Production	87	0.13	11	T3	D
Spain	Glass Production	2 866	0.13	374	Glass Production	4 547	0.10	440	T3	CS,D,PS
Sweden	-	NE	NE	54	-	NE	NE	16	T3	CS,D
United Kingdom	Glass Production	1 942	0.21	412	Glass Production	1 846	0.18	323	T3	CS
EU-27+UK	**-**	**29 134**	**0.15**	**4 258**	**-**	**34 683**	**0.12**	**4 096**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Glass Production	1 942	0.21	412	Glass Production	1 846	0.18	323	T3	CS
EU-KP	**-**	**29 134**	**0.15**	**4 258**	**-**	**34 683**	**0.12**	**4096**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
Not all countries show production as the activity data for this emissions category. The EU activity and EU IEF is based on gap-filling and expressed as glass production.
The level of complexity of the methods is Tier 3 (T3) for Greece and Tier 2 (T2) for Luxembourg.

4.2.2 Chemical industry (CRF Source Category 2B)

The chemical industry includes seven key categories, which are presented in ***Table** 4.11*.

Table 4.11: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2B (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
2.B.1 Ammonia Production (CO_2)	32487	22646	0	L	L	98.3%
2.B.2 Nitric Acid Production (N_2O)	49649	2813	T	L	0	86.3%
2.B.3 Adipic Acid Production (N_2O)	57555	279	T	L	0	100.0%
2.B.8 Petrochemical and Carbon Black Production (CO_2)	14807	14501	T	L	L	84,2%
2.B.9 Fluorochemical Production (HFCs)	29033	1010	T	L	0	100.0%
2.B.9 Fluorochemical Production (Unspecified mix of HFCs and PFCs)	5567	45	T	0	0	100.0%
2.B.10 Other chemical industry (CO_2)	6931	12043	T	0	L	81.1%

The key category 2B1 Ammonia production accounts for 38.0% of total GHG emissions in the chemical industry, followed by 2B8 Petrochemical and Carbon Black Production (24.4%), which includes the CO_2 emissions associated with the production of a wide range of petrochemicals including methanol, ethylene and carbon black. The category 2B10 Other chemical industry (20.2%) is the third most important category. Higher tier methods are used by most countries. However, as categories 2B8 and 2B10 comprise a variety of emission sources, including minor ones, several countries use Tier 1 methods to estimate emissions from some of these sources.

Figure **4-6** shows chemical industry CO_2 emissions while *Table 4.12* presents a summary of emissions of CO_2, N_2O, CH_4 and total emissions as CO_2 equivalents.

Figure 4-6 2B Chemical industry CO_2 emissions

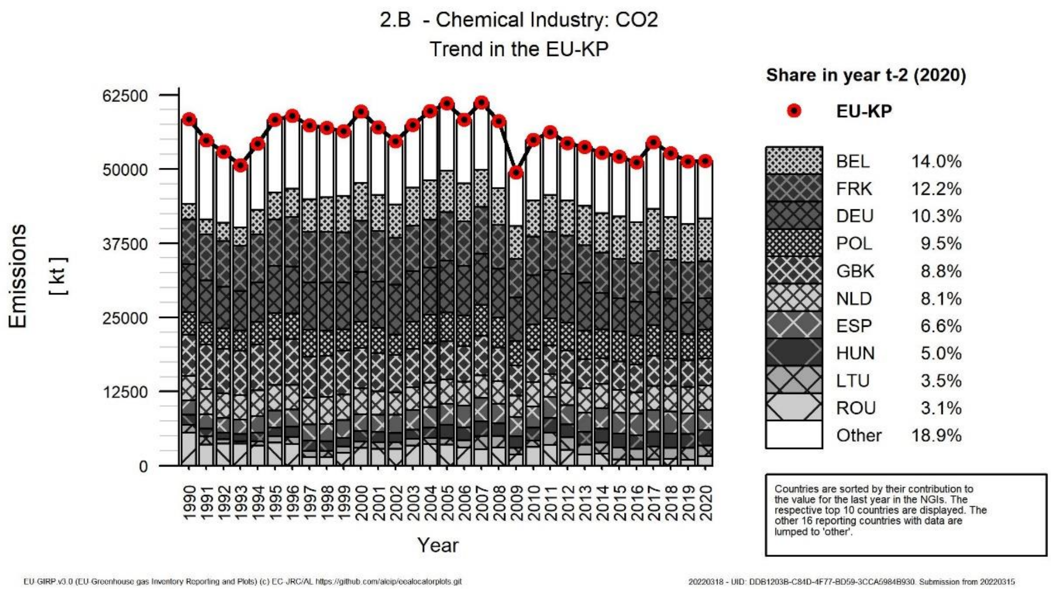


Table 4.12 shows chemical industry CO_2, CH_4, N_2O and total GHG emissions (which includes F-gases) as CO_2e. Between 1990 and 2020 overall GHG emissions from the chemical industry sector have decreased markedly, largely due to the significant reduction in N_2O emissions which have decreased by approx. 95%. The greatest absolute decreases in N_2O emissions over the period were observed in France, Germany and the United Kingdom.

Table 4.12 2B Chemical industry: EU-KP CO_2, N_2O, CH_4 and total emissions as CO_2 equivalents

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt		N2O emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020	1990	2020
Austria	1 555	785	644	683	877	53	35	49
Belgium	10 093	8 895	2 590	7 207	3 807	703	18	16
Bulgaria	4 943	1 126	3 283	1 044	1 647	82	13	NO,NA
Croatia	1 511	600	751	535	754	65	5	NO,NE,IE
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	2 942	1 628	1 783	1 442	1 122	145	36	40
Denmark	1 003	1	1	1	1 003	NO,NA	NO,NA	NO,NA
Estonia	308	NO	308	NO	NO	NO	NO	NO
Finland	1 866	1 277	270	1 050	1 592	227	5	1
France	37 021	7 015	7 540	6 283	23 708	606	78	31
Germany	35 518	6 467	8 109	5 291	21 334	567	393	563
Greece	2 931	865	681	846	1 066	19	1	NO,NA
Hungary	4 812	2 656	1 704	2 579	3 090	33	18	44
Ireland	1 986	NO	990	NO	995	NO	NO	NO
Italy	10 493	1 900	2 524	1 358	6 418	119	61	4
Latvia	NA,NO	NA,NO	NO	NO	NO	NO	NO	NO
Lithuania	2 176	1 938	1 278	1 783	893	155	5	NO
Luxembourg	NO	NO	NO	NO	NO	NO	NO	NO
Malta	0	0	0	0	NO,NA	NO,NA	NO,NA	NO,NA
Netherlands	17 077	5 860	4 132	4 180	7 069	1 224	269	328
Poland	7 378	5 330	3 802	4 867	3 536	415	40	48
Portugal	1 978	721	1 435	660	518	34	26	26
Romania	9 745	1 689	5 560	1 591	4 135	92	50	6
Slovakia	2 020	1 514	878	1 437	1 142	77	0	1
Slovenia	88	62	83	62	NO	NO	4	NO,NA
Spain	8 409	3 892	2 430	3 392	2 855	397	84	102
Sweden	1 470	598	666	591	803	6	1	1
United Kingdom	45 399	4 708	6 976	4 513	23 797	51	222	67
EU-27+UK	**212 721**	**59 526**	**58 418**	**51 397**	**112 160**	**5 069**	**1 365**	**1 328**
Iceland	47	NA,NO	0	NO,NA	46	NO	NO,NA	NO,NA
United Kingdom (KP)	45 399	4 708	6 976	4 513	23 797	51	222	67
EU-KP	**212 768**	**59 526**	**58 418**	**51 397**	**112 207**	**5 069**	**1 365**	**1 328**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'. Note that emissions from F-gases are included in the total.

Table 4.13 provides information on recalculations in 2B Chemical industry for 1990 and 2019, including explanations.

Table 4.13 2B Chemical Industry: Contribution of MS to EU recalculated CO_2 emissions for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	-8.7	-1.2		Update of CO_2 emissions under 2B1 due to revised urea amounts used in road transport. Update of activity data in fertilizer production.
Belgium	-	-	-	-		
Bulgaria	-	-	-	-		
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	-	-		
Denmark	-	-	0.0	0.0		Updata of activity data under 2B10.
Estonia	-	-	-	-		
Finland	-	-	-7.1	-0.6		Update of activity data under 2B10,
France	52	0.7	58	0.9	Update of the CO_2 emission factor for natural gas under 2B1 for the whole time series; inclusion of emissions from an additional plant under 2B3.	Update of the CO_2 emission factor for natural gas under 2B1 for the whole time series; inclusion of emissions from an additional plant under 2B3.
Germany	-	-	-0.0	-0.0		Re-allocation of emissions from mineral oil products which are not used as fuels from 1B2a to 2B10.
Greece	-	-	-	-		
Hungary	-	-	-	-		
Ireland	-	-	-	-		
Italy	-	-	-0.1	-0.0		Update of activity data under 2B5b
Latvia	-	-	-	-		
Lithuania	-	-	0.4	0.0		Update of CO_2 emissions under 2B1 due to revised urea application data.
Luxembourg	-	-	-	-		
Malta	-	-	-	-		
Netherlands	-	-	4.0	0.1		Update of activity data under 2B8d.
Poland	-	-	-	-		
Portugal	-	-	0.2	0.0		Update of activity data under 2B6 and 2B8c.
Romania	-3.1	-0.1	5.1	0.5	Update of activity data under 2B8a.	Update of activity data under 2B8a; update of CO_2 emission factor under 2B1.
Slovakia	-	-	-	-		
Slovenia	-	-	-	-		
Spain	-	-	-0.3	-0.0		Update of CO_2 emission data under 2B1.
Sweden	-	-	-	-		
United Kingdom	0.0	0.0	-133	-2.9	Update of CO_2 emissions under 2B8g.	Update of CO_2 emissions under 2B8g.
EU27+UK	**49**	**0.1**	**-81**	**-0.2**		
Iceland	-0.0	-0.0	-	-		
United Kingdom (KP)	0.0	0.0	-133	-2.9	See above	See above
EU-KP	**49**	**0.1**	**-81**	**-0.2**		

(*) contribution of the recalculation as percentage of the total emissions of category 2B for the respective year and MS

Table 4.14 2B Chemical Industry: Contribution of MS to EU recalculated N_2O emissions for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	-	-		
Belgium	-	-	-	-		
Bulgaria	-	-	-694	-89		Methodological update, use of country-specific emission factor under 2B2.
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	-	-		
Denmark	-	-	-	-		
Estonia	-	-	-	-		
Finland	-	-	-	-		
France	-0.0	-0.0	15	1.9	Update of emissions at one plant under 2B2.	Update of emissions at one plant under 2B2.
Germany	-0.9	-0.0	-3.4	-0.6	Update of emissions under 2B2.	Update of emissions under 2B2.
Greece	-	-	-	-		
Hungary	-	-	-	-		
Ireland	-	-	-	-		
Italy	-	-	-	-		
Latvia	-	-	-	-		
Lithuania	-	-	-	-		
Luxembourg	-	-	-	-		
Malta	-	-	-	-		
Netherlands	-	-	-	-		
Poland	-	-	-191	-28		Update of the emission factor for N_2O under 2B4.
Portugal	20	4.0	-	-	Update of the N_2O emission factor for one plant under 2B2.	
Romania	-	-	-	-		
Slovakia	-	-	-	-		
Slovenia	-	-	-	-		
Spain	-	-	-	-		
Sweden	-	-	-	-		
United Kingdom	0.0	0.0	-0	-0.2	Update of N_2O emissions under 2B1.	Update of N_2O emissions under 2B1.
EU27+UK	**19**	**0.0**	**-873**	**-13**		
Iceland	-	-	-	-		
United Kingdom (KP)	0.0	0.0	-0	-0.2	See above.	See above.
EU-KP	**19**	**0.0**	**-873**	**-13**		

4.2.2.1 2B1 Ammonia production

In most facilities, anhydrous ammonia is produced by catalytic steam reforming of natural gas (CH_4) or fuel oil. At plants using this process, CO_2 is primarily released during regeneration of the CO_2 scrubbing solution, with additional but relatively minor emissions resulting from condensate stripping.

CO_2 emissions from ammonia production contributed 0.6% of total EU-KP (without LULUCF) emissions in 2020. Emissions have decreased by approx. 30% since 1990. Unlike many other source categories, ammonia production saw an increase in CO_2 emissions between 2019 and 2020. The largest increase between 2019 and 2020 was observed in Romania, due to the re-opening of an ammonia plant which had been closed in recent years.

Figure 4-7 2B1 Ammonia production: CO_2 emissions

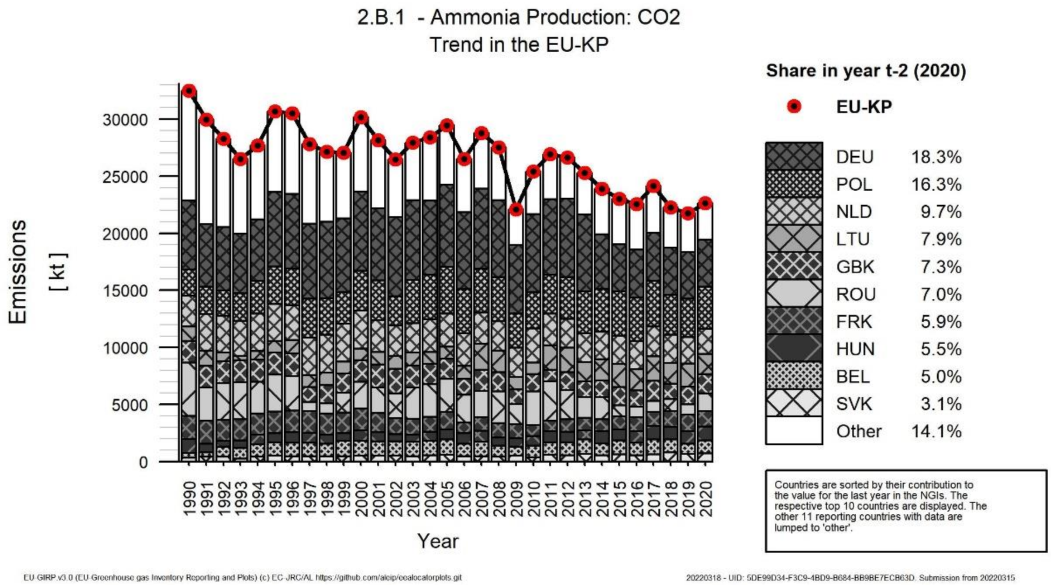


Figure 4-7 and Table 4.15 show that in 2019 Germany was responsible for 18.3% of this category's emissions. The next largest contributors are Poland and the Netherlands which contribute 16.3% and 9.7% respectively.

Bulgaria, Germany, Italy, Ireland and Romania have all had large reductions in absolute terms since 1990. The reasons for these reductions include shifting to low emitting technology and production decreases and the cessation of production in Ireland. The largest growth in absolute terms in emissions between 1990 and 2020 occurred in Belgium, Lithuania, Poland and Slovakia.

Table 4.15 2B1 Ammonia production: Member States' contributions to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	467	521	491	2.2%	24	5.1%	-30	-5.7%	T2	PS
Belgium	423	877	1 137	5.0%	714	169%	260	30%	T3	D,PS
Bulgaria	2 508	601	593	2.6%	-1 915	-76%	-7.9	-1.3%	T2	PS
Croatia	559	595	535	2.4%	-23	-4.2%	-59	-10%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	991	583	382	1.7%	-609	-61%	-201	-35%	T1	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	308	NO	NO	-	-308	-100%	-	-	NA	NA
Finland	93	NO	NO	-	-93	-100%	-	-	NA	NA
France	2 019	1 463	1 325	5.9%	-694	-34%	-138	-9%	T1,T2,T3	CS,D,PS
Germany	6 025	4 077	4 133	18%	-1 892	-31%	56	1.4%	T3	PS
Greece	652	224	196	0.9%	-456	-70%	-27	-12%	T1a	CS
Hungary	1 200	1 081	1 239	5.5%	39	3.2%	158	15%	T3	PS
Ireland	990	NO	NO	-	-990	-100%	-	-	NA	NA
Italy	1 892	531	658	2.9%	-1 233	-65%	127	24%	T2	PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 254	1 989	1 783	7.9%	529	42%	-206	-10%	T3	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2 695	2 349	2 200	10%	-495	-18%	-150	-6.4%	T3	CS
Poland	2 344	3 349	3 700	16%	1 356	58%	351	10%	T2	CS
Portugal	763	NO	NO	-	-763	-100%	-	-	NA	NA
Romania	4 678	916	1 587	7.0%	-3 091	-66%	671	73%	T3	PS
Slovakia	332	688	703	3.1%	371	112%	15	2.1%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	400	340	339	1.5%	-60	-15%	-0.2	0.0%	T3	PS
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	1 895	1 548	1 645	7.3%	-250	-13%	96	6.2%	T3	CS
EU-27+UK	**32 487**	**21 732**	**22 646**	**100%**	**-9 841**	**-30%**	**915**	**4.2%**	**-**	**-**
Iceland	NA	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	1 895	1 548	1 645	7.3%	-250	-13%	96	6.2%	T3	CS
EU-KP	**32 487**	**21 732**	**22 646**	**100%**	**-9 841**	**-30%**	**915**	**4.2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.
The table lists methods and emission factors used in the latest inventory year. Estonia, Finland, Ireland and Portugal did not report emissions in that year, but they reported emissions in 1990. The methodological tier used in 1990 is Tier 3 (T3) for Estonia and Tier 1 (T1) for Finland, Ireland and Portugal.

In line with the IPCC guidelines all emissions (energy and non-energy use of feedstocks/fuels) from ammonia production should be reported in category 2B1. In a review of the inventory submission of the European Union, the ERT recommended that the European Union include in the NIR a table that includes the potentially combustion-related EU ETS emission values rather than only the process-related emissions reported for ammonia production. Table 4.16 aligns 2B1 Ammonia production against EU ETS reported emissions for Production of ammonia (EU ETS activity sector code 41). Of the seventeen countries which report emissions under 2B1 Ammonia production thirteen report against EU ETS activity Production of Ammonia and of these eleven report higher levels to the EU ETS than is reported in the inventory. The column labelled 'Potentially combustion related' shows differences between IPPU 2B1 and ETS reported emissions from production of ammonia where the ETS figure is greater.

Table 4.16 2B1 Ammonia production: inventory and relevant EU ETS reported CO_2 emissions for 2020 (kt CO_2 emissions)

Member State	IPPU 2B1. Ammonia production	EU ETS: Production of ammonia	Potentially combustion related [1]	EU ETS: Production of hydrogen and synthesis gas
Austria	491	913	421	-
Belgium	1 137	-	-	976
Bulgaria	593	690	98	-
Croatia	535	1 264	729	-
Cyprus	NO	-	-	-
Czech Republic	382	-	-	-
Denmark	NO	-	-	-
Estonia	NO	-	-	-
Finland	NO	-	-	-
France	1 325	1 510	185	512
Germany	4 133	4 488	355	3 029
Greece	196	215	19	-
Hungary	1 239	981	-	130
Ireland	NO	-	-	-
Italy	658	-	-	621
Latvia	NO	-	-	-
Lithuania	1 783	2 523	740	-
Luxembourg	-	-	-	-
Malta	NO	-	-	-
Netherlands	2 200	3 298	1 098	2 035
Poland	3 700	1 758	-	-
Portugal	NO	-	-	61
Romania	1 587	-	-	55
Slovakia	703	1 031	328	-
Slovenia	NO	-	-	-
Spain	339	641	302	772
Sweden	NO	-	-	-
United Kingdom	1 645	1 702	58	572
EU-27+UK	**22 646**	**21 015**	**4 332**	**8 765**
Iceland	-	-	-	-
United Kingdom (KP)	1 645	1.702	58	572
EU-KP	**22 646**	**21 015**	**4 332**	**8 765**

[1] Potentially combustion related: difference between IPPU 2B1 and EU ETS reported emissions from production of ammonia where the ETS figure is greater.
EU ETS data from: www.eea.europa.eu/data-and-maps/dashboards/emissions-trading-viewer-1

The different scopes, reporting thresholds and reporting obligations mean that it is not possible to make a detailed analysis of the differences visible in Table 4.16. To analyse the consistency between EU ETS and inventory data would require a detailed analysis of the data reported by each ETS installation to the national competent authorities and the allocation to the specific CRF categories, including the methods, activity data and calculation parameters used. Please refer to chapter 1.4.1 on ‘the use of data from EU ETS for the purposes of the national GHG inventories’. See also the mapping table (Table 1.10 in section 1.4.1) between ETS activities and CRF categories (including on ammonia production).

It is worth observing that the EU ETS activity sector: Production of hydrogen and synthesis gas (code 43) does not have a direct counterpart in the inventory and is included here to illustrate the difficulty of comparing UNFCCC and EU ETS reported emissions. Note also that ammonia can be produced using hydrogen supplied by another company and that not all hydrogen producers are obliged to report within the framework of EU ETS.

Table 4.17 shows information on methods applied, activity data and emission factors for CO_2 emissions from 2B1 Ammonia production for 1990 and 2020. Not all countries show ammonia production as activity data for this emissions category but the EU IEF was determined using gap-filling. For 2020, 98.3% of emissions from ammonia production were estimated using higher Tier methods (Tier 2 or Tier 3).

Table 4.17 2B1 Ammonia production: Information on methods applied, activity data, emission factors for CO_2 emissions

Member State	1990				2020				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	CO2 Emission (kt)	Activity Data		Implied Emission Factor (t/t)	CO2 Emission (kt)		
	Description	(kt)			Description	(kt)				
Austria	Ammonia Production	461	1.22	467	Ammonia Production	516	1.26	491	T2	PS
Belgium	Ammonia Production	360	1.17	423	Ammonia Production	1 069	1.18	1 137	T3	D,PS
Bulgaria	-	C	C	2 508	-	C	C	593	T2	PS
Croatia	Ammonia Production	345	2.24	559	Ammonia Production	454	1.98	535	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Ammonia Production	336	3.27	991	Ammonia Production	117	3.27	382	T1	CS
Denmark	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Estonia	Ammonia Production	294	1.44	308	Ammonia Production	NO	NO	NO	NA	NA
Finland	Ammonia Production	28	3.27	93	Ammonia Production	NO	NO	NO	NA	NA
France	Ammonia Production	1 928	1.14	2 019	Ammonia Production	1 000	1.47	1 325	T1,T2,T3	CS,D,PS
Germany	Ammonia Production	2 705	2.41	6 025	Ammonia Production	2 994	1.78	4 133	T3	PS
Greece	Ammonia Production	313	2.08	652	Ammonia Production	116	1.70	196	T1a	CS
Hungary	Natural Gas Consumption	25 334	0.06	1 200	Natural Gas Consumption	23 119	0.06	1 239	T3	PS
Ireland	Natural Gas Feedstocks	430	2.30	990	Natural Gas Feedstocks	NO	NO	NO	NA	NA
Italy	Ammonia Production	1 455	1.94	1 892	Ammonia Production	598	1.83	658	T2	PS
Latvia	Ammonia Production	NO	NO	NO	Ammonia Production	NO	NO	NO	NA	NA
Lithuania	Ammonia Production	568	2.27	1 254	Ammonia Production	995	2.07	1 783	T3	CS
Luxembourg	Ammonia Production	NO	NO	NO	Ammonia Production	NO	NO	NO	NA	NA
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	C	C	2 695	-	C	C	2 200	T3	CS
Poland	Ammonia Production	1 532	1.90	2 344	Ammonia Production	2 647	1.73	3 700	T2	CS
Portugal	-	C	C	763	-	NO	NO	NO	NA	NA
Romania	Natural Gas Consumption	2 101	2.28	4 678	Natural Gas Consumption	860	2.30	1 587	T3	PS
Slovakia	Ammonia Production	360	1.71	332	Ammonia Production	545	1.62	703	T3	PS
Slovenia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Spain	Ammonia Production	C	C	400	Ammonia Production	C	C	339	T3	PS
Sweden	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom	Ammonia Production	1 328	1.43	1 895	Ammonia Production	1 038	1.58	1 645	T3	CS
EU-27+UK	**-**	**NE**	**NE**	**32 487**	**-**	**16 077**	**1.41**	**22 646**	**-**	**-**
Iceland	-	IE	NA,NO	NA	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Ammonia Production	1 328	1.43	1 895	Ammonia Production	1 038	1.58	1 645	T3	CS
EU-KP	**-**	**NE**	**NE**	**32 487**	**-**	**16 077**	**1.41**	**22 646**	**-**	**-**

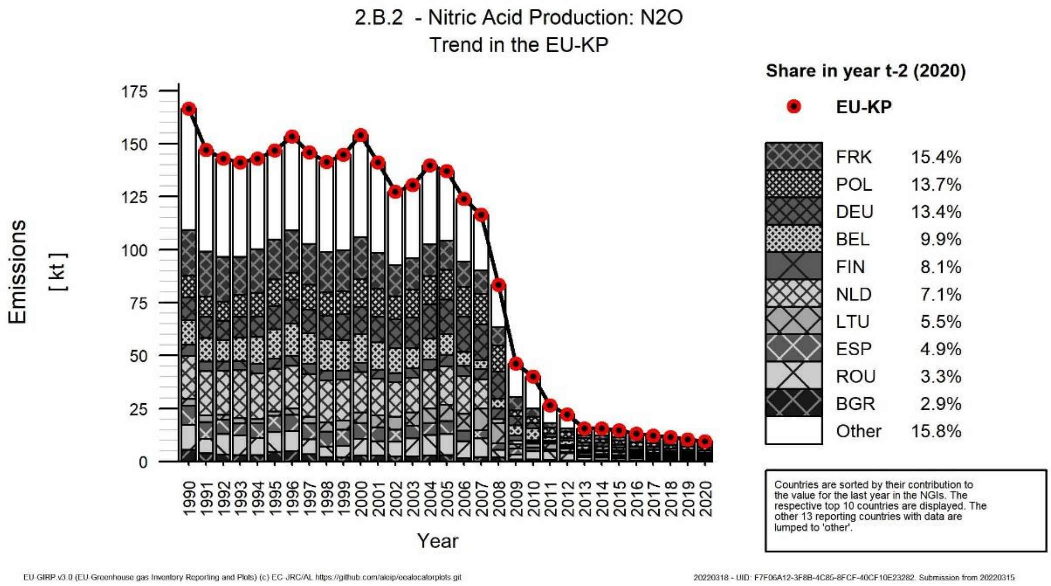
Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'. Not all countries show production as the activity data for this emissions category. Some countries report activity data and IEF as confidential for this category. Values for the EU-27+UK and EU-KP have therefore been gap filled for 2020.
The table lists methods and emission factors used in the latest inventory year. Estonia, Finland, Ireland and Portugal did not report emissions in that year, but they reported emissions in 1990. The methodological tier used in 1990 is Tier 3 (T3) for Estonia and Tier 1 (T1) for Finland, Ireland and Portugal.

4.2.2.2 2B2 Nitric acid production

N_2O can be emitted in the production of nitric acid as a by-product of the high temperature catalytic oxidation of ammonia (NH_3). Emissions have decreased by 94% since 1990. All countries have had marked reductions from this source notably post 2007 when pollution control measures were introduced and post 2013 under EU ETS reporting obligations. Between 2019 and 2020, emissions decreased by 10%.

N_2O emissions from nitric acid production contributed less than 0.1% of total EU-KP (without LULUCF) emissions in 2020 (Figure **4-8** and Table 4.18). France and the Netherlands have had the greatest reductions in absolute terms, due to the implementation of technical measures at all Dutch nitric acid plants and due to the improvement of the process and catalyst efficiency in France. Production stopped in Denmark in 2004 and in Ireland in 2002.

Figure 4-8 2B2 Nitric acid production N_2O emissions



The substantial decrease in N_2O emissions seen since 2007 is largely due to technical measures that have been implemented at all nitric acid plants. Special catalysts and improvement of the process efficiency led to a continuation of the declining trend in emissions. This trend has slowed in recent years. Twenty countries reported these emissions in 2020, six of which reported emissions increases compared to the previous year.

*Table **4**.18 2B2 Nitric acid production: Member States' contributions to N_2O emissions*

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	877	81	53	1.9%	-824	-94%	-29	-35%	T3	PS
Belgium	3 422	228	278	10%	-3 143	-92%	50	22%	T3	PS
Bulgaria	1 647	86	82	2.9%	-1 566	-95%	-4.3	-5.0%	T3	PS
Croatia	754	50	65	2.3%	-689	-91%	15	30%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 049	92	72	2.6%	-977	-93%	-20	-22%	T3	PS
Denmark	1 003	NO	NO	-	-1 003	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 592	205	227	8.1%	-1 365	-86%	21	10%	T3	PS
France	6 368	532	433	15%	-5 936	-93%	-100	-19%	T2,T3	CS,D,PS
Germany	3 258	362	378	13%	-2 880	-88%	15	4.2%	T3	PS
Greece	1 066	21	19	0.7%	-1 047	-98%	-2.3	-11%	CS	CS
Hungary	3 090	32	33	1.2%	-3 057	-99%	0.9	2.7%	T3	PS
Ireland	995	NO	NO	-	-995	-100%	-	-	NA	NA
Italy	2 005	43	39	1.4%	-1 966	-98%	-3.7	-8.7%	T3	D,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	893	179	155	5.5%	-738	-83%	-24	-14%	T3	PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	6 085	297	200	7.1%	-5 885	-97%	-97	-32.55%	T2	PS
Poland	3 041	457	387	14%	-2 654	-87%	-70	-15%	T1	CS
Portugal	518	36	34	1.2%	-484	-93%	-2.3	-6.3%	T3	PS
Romania	3 473	119	92	3.3%	-3 381	-97%	-27	-23%	T3	PS
Slovakia	1 142	91	76	2.7%	-1 066	-93%	-15	-16%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	2 730	149	137	4.9%	-2 593	-95%	-12	-8.2%	T3	PS
Sweden	782	28	5.5	0.2%	-777	-99%	-22	-80%	T2	PS
United Kingdom	3 860	38	49	1.8%	-3 811	-99%	11	29%	T3	CS
EU-27+UK	**49 649**	**3 127**	**2 813**	**100%**	**-46 836**	**-94%**	**-314**	**-10%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	3 860	38	49	1.8%	-3 811	-99%	11	29%	T3	CS
EU-KP	**49 649**	**3 127**	**2 813**	**100%**	**-46 836**	**-94%**	**-314**	**-10%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. Greece uses a country-specific method and reports 'CS' accordingly. The level of complexity of the method applied by Greece is Tier 3 (T3).
The table lists methods and emission factors used in the latest inventory year. As Cyprus, Denmark, Estonia, Ireland, Latvia, Luxembourg, Malta, Slovenia and Iceland did not report emissions in that year, 'NA' is reported. Denmark and Ireland reported emissions from nitric acid production in 1990. The methodological tier used in that year is Tier 2 (T2) for Denmark and Tier 3 (T3) for Ireland.

Table 4.19 shows information on methods applied, activity data and emission factors for N_2O emissions from 2B2 Nitric acid production for 1990 and 2020. The table shows that while most countries report nitric acid production as activity data, for some countries this information is confidential. The IEFs are shown as kg N_2O per tonne of production. The EU IEF was determined using gap-filling. The low IEFs are mainly due to the implementation of improved abatement technologies in the various Member States and the closure of some older plants. The majority of emissions (86.3%) are estimated with higher tier methods (Tier 2 or Tier 3).

Table 4.19 2B2 Nitric acid production: Information on methods applied, activity data, emission factors for N_2O emissions

Member State	1990				2020				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	N2O 'Emissions' (kt CO2 equiv.)	Activity Data		Implied Emission Factor (t/t)	N2O 'Emissions' (kt CO2 equiv.)		
	Description	(kt)			Description	(kt)				
Austria	Nitric Acid Production	530	0.01	877	Nitric Acid Production	557	0.00	53	T3	PS
Belgium	Nitric Acid Production	1 436	0.01	3 422	Nitric Acid Production	2 209	0.00	278	T3	PS
Bulgaria	-	C	C	1 647	-	C	C	82	T3	PS
Croatia	Nitric Acid Production	332	0.01	754	Nitric Acid Production	294	0.00	65	T3	PS
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Nitric Acid Production	530	0.01	1 049	Nitric Acid Production	492	0.00	72	T3	PS
Denmark	-	450	0.01	1 003	-	NO	NO	NO	NA	NA
Estonia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Finland	Nitric Acid Production	549	0.01	1 592	Nitric Acid Production	659	0.00	227	T3	PS
France	Nitric Acid Production	3 200	0.01	6 368	Nitric Acid Production	1 731	0.00	433	T2,T3	CS,D,PS
Germany	Nitric Acid Production	1 698	0.01	3 258	Nitric Acid Production	2 535	0.00	378	T3	PS
Greece	Nitric Acid Production	511	0.01	1 066	Nitric Acid Production	189	0.00	19	CS	CS
Hungary	Nitric Acid Production	732	0.01	3 090	Nitric Acid Production	900	0.00	33	T3	PS
Ireland	Nitric Acid Production	339	0.01	995	Nitric Acid Production	NO	NO	NO	NA	NA
Italy	Nitric Acid Production	1 037	0.01	2 005	Nitric Acid Production	447	0.00	39	T3	D,PS
Latvia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Lithuania	Nitric Acid Production	355	0.01	893	Nitric Acid Production	1 113	0.00	155	T3	PS
Luxembourg	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	C	C	6 085	-	C	C	200	T2	PS
Poland	Nitric Acid Production	1 577	0.01	3 041	Nitric Acid Production	2 413	0.00	387	T1	CS
Portugal	-	C	C	518	-	C	C	34	T3	PS
Romania	Nitric Acid Production	1 261	0.01	3 473	Nitric Acid Production	C	C	92	T3	PS
Slovakia	Nitric Acid Production	401	0.01	1 142	Nitric Acid Production	580	0.00	76	T3	PS
Slovenia	Nitric Acid Production	NO	NO	NO	Nitric Acid Production	NO	NO	NO	NA	NA
Spain	Nitric Acid Production	1 329	0.01	2 730	Nitric Acid Production	692	0.00	137	T3	PS
Sweden	Nitric Acid Production	374	0.01	782	Nitric Acid Production	280	0.00	5	T2	PS
United Kingdom	Nitric Acid Production	2 408	0.01	3 860	Nitric Acid Production	1 141	0.00	49	T3	CS
EU-27+UK	**-**	**19 049**	**2.61**	**49 649**	**-**	**16 232**	**0.17**	**2 813**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Nitric Acid Production	2 408	0.01	3 860	Nitric Acid Production	1 141	0.00	49	T3	CS
EU-KP	**-**	**19 049**	**2.61**	**49 649**	**-**	**16 232**	**0.17**	**2813**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The level of complexity of the method applied by Greece is Tier 3 (T3). The table lists methods and emission factors used in the latest inventory year. The methodological tier used in 1990 is Tier 2 (T2) for Denmark and Tier 3 (T3) for Ireland.

4.2.2.3 2B3 Adipic acid production

Adipic acid production emits N_2O as a by-product when a cyclohexanone/cyclohexanol mixture is oxidized by nitric acid. N_2O emissions from adipic acid production now account for less than 0.01% of total EU-KP (without LULUCF) emissions. Between 1990 and 2020, N_2O emissions from this source decreased by 99% (Figure 4-9 and Table **4.20**), and Emission in 2020 were 25% lower than in 2018. Only Germany, Italy and France continue to produce adipic acid.

Figure 4-9 2B3 Adipic acid production N_2O emissions

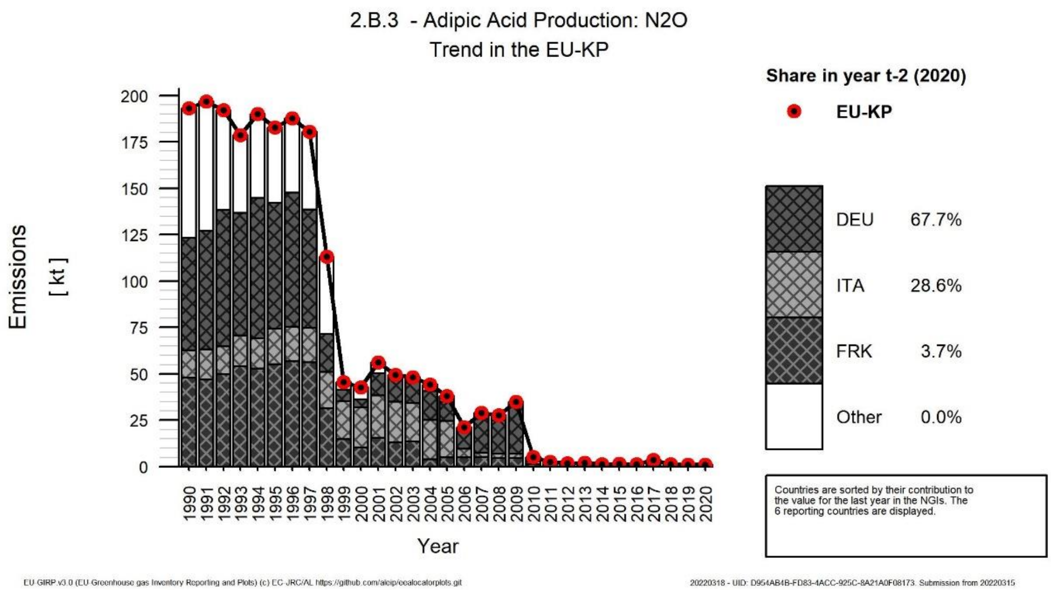


*Table **4**.20 2B3 Adipic acid production: Member States' contributions to N_2O emissions*

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
France	14 232	16	10	3.7%	-14 222	-100%	-6	-36%	T2,T3	CS,D,PS
Germany	18 077	200	189	67.7%	-17 888	-99%	-11	-6%	T3	PS
Italy	4 402	78	80	28.6%	-4 322	-98%	2	3%	T3	D,PS
Poland	358	NO	NO	-	-358	-100%	-	-	NA	NA
Romania	552	NO	NO	-	-552	-100%	-	-	NA	NA
United Kingdom	19 935	NO	NO	-	-19 935	-100%	-	-	NA	NA
EU-27+UK	**57 555**	**294**	**279**	**100%**	**-57 275**	**-100%**	**-14**	**-5%**	**-**	**-**
United Kingdom (KP)	19 935	NO	NO	-	-19 935	-100%	-	-	NA	NA
EU-KP	**57 555**	**294**	**279**	**100%**	**-57 275**	**-100%**	**-14**	**-5%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The table lists methods and emission factors used in the latest inventory year. Poland, Romania and the United Kingdom did not report emissions from this category in 2020, but in 1990. The methodological tier used in that year is Tier 1 (T1) for Poland and Romania and Tier 3 (T3) for the United Kingdom.

Table 4.21 shows information on methods applied, activity data and emission factors for N_2O emissions from 2B3 Adipic acid production for 1990 to 2020. Adipic acid production is used as activity data but the information is confidential in France and Germany. The implied emission factors per tonne of adipic acid produced is only provided by Italy with 0.3 t/t for 1990 and 0.004 t/t for 2020. In 2020 all emissions are estimated with higher Tier methods.

Table 4.21 2B3 Adipic acid production: methods, activity data, emission factors for N_2O emissions

Member State	1990				2020				Method	Emission Factor Informa-tion
	Activity Data		Implied Emission Factorn (t/t)	N2O 'Emissions' (kt CO2 equiv.)	Activity Data		Implied Emission Factor (t/t)	N2O 'Emissions' (kt CO2 equiv.)		
	Description	(kt)			Description	(kt)				
Austria	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Belgium	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Bulgaria	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Croatia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Cyprus	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Czechia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Denmark	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Estonia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Finland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
France	Adipic Acid Production	C	C	14 232	Adipic Acid Production	C	C	10	T2,T3	CS,D,PS
Germany	Adipic Acid Production	C	C	18 077	Adipic Acid Production	C	C	189	T3	PS
Greece	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Hungary	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Ireland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Italy	Adipic Acid Production	49	0.30	4 402	Adipic Acid Production	73	0.00	80	T3	D,PS
Latvia	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Lithuania	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Luxembourg	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Malta	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Netherlands	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Poland	Adipic Acid Production	4	0.30	358	Adipic Acid Production	NO	NO,NA	NO	NA	NA
Portugal	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Romania	Adipic Acid Production	6	0.30	552	Adipic Acid Production	NO	NO	NO	NA	NA
Slovakia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Slovenia	-	NO	NO	NO	-	NO	NO	NO	NA	NA
Spain	Adipic Acid Production	NO	NO	NO	Adipic Acid Production	NO	NO	NO	NA	NA
Sweden	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom	Adipic Acid Production	C	C	19 935	Adipic Acid Production	NO	NO	NO	NA	NA
EU-27+UK	**-**	**59**	**968.82**	**57 555**	**-**	**73**	**3.83**	**279**	**-**	**-**
Iceland	-	NO	NO	NO	-	NO	NO	NO	NA	NA
United Kingdom (KP)	Adipic Acid Production	C	C	19 935	Adipic Acid Production	NO	NO	NO	NA	NA
EU-KP	**-**	**59**	**968.82**	**57 555**	**-**	**73**	**3.83**	**279**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The methodological tier used in 1990 is Tier 1 (T1) for Poland and Romania and Tier 3 (T3) for the United Kingdom.

4.2.2.4 2B8 Petrochemical and carbon black production

Europe has a significant petrochemical industry, with production of all of the chemicals that are in the 2006 IPCC Guidelines. Eighteen countries report CO_2 emissions from this category for at least part of the period 1990-2020 with this source being a key category of CO_2 emissions in terms of emissions level and trend for EU-KP.

CO_2 emissions from 2B8 Petrochemical and carbon black production increased by 1.7% between 2019 and 2020 and are now just 2.1% below 1990 levels. They contributed 0.4% of total EU-KP (without LULUCF) emissions in 2020. Belgium, the United Kingdom and Spain contribute the largest share of emissions, respectively 24.9%, 17.9% and 13.9%. Trends vary widely between countries, due to increases and decreases in production of the various chemicals over the 30-year period.

Figure 4-10 2B8 Petrochemical and carbon black production: EU-28+ISL CO_2 emissions

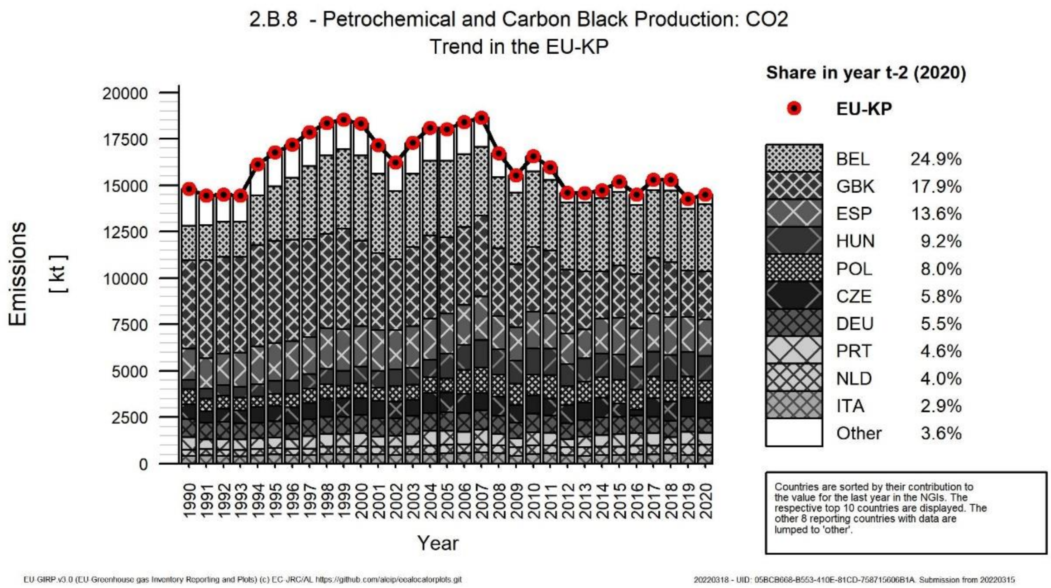


Table 4.22: 2B8 Petrochemical and carbon black production: Member States' contribution to CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
Belgium	1 882	3 308	3 615	25%	1 733	92%	307	9.3%	T3	PS
Bulgaria	346	NO,NA	NO,NA	-	-346	-100%	-	-	NA	NA
Croatia	192	NO,IE	NO,IE	-	-192	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	792	998	839	5.8%	46	5.9%	-159	-16%	T1	D,PS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO,IE	NO,IE	NO,IE	-	-	-	-	-	NA	NA
France	376	182	142	1.0%	-234	-62%	-40	-22%	T1,T2,T3	CS,D,PS
Germany	974	830	793	5.5%	-181	-19%	-37	-4.5%	T1,T2	CS,D
Greece	29	NO,NA	NO,NA	-	-29	-100%	-	-	NA	NA
Hungary	504	1 307	1 340	9.2%	836	166%	33	2.5%	T3	PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	422	477	426	2.9%	4.3	1.0%	-50	-11%	T2	CR,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	24	NO	NO	-	-24	-100%	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	336	554	574	4.0%	238	71%	20	3.5%	CS	CS
Poland	806	1 147	1 167	8.0%	361	45%	20	1.7%	T1	D
Portugal	672	681	660	4.6%	-11	-1.7%	-20	-3.0%	NO	NO
Romania	571	8.6	NO	-	-571	-100%	-8.6	-100%	NA	NA
Slovakia	429	344	382	2.6%	-47	-11%	38	11%	T2	CS,PS
Slovenia	16	NO	NO	-	-16	-100%	-	-	NA	NA
Spain	1 684	1 893	1 972	14%	288	17%	78	4.1%	T1,T3	D,PS
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-	NA	NA
United Kingdom	4 752	2 533	2 592	18%	-2 159	-45%	59	2.3%	CS,T1	CS,D
EU-27+UK	**14 807**	**14 262**	**14 501**	**100%**	**-306**	**-2.1%**	**240**	**1.7%**	**-**	**-**
Iceland	NO	NO,NA	NO,NA	-	-	-	-	-	NA	NA
United Kingdom (KP)	4 752	2 533	2 592	18%	-2 159	-45%	59	2.3%	CS,T1	CS,D
EU-KP	**14 807**	**14 262**	**14 501**	**100%**	**-306**	**-2.1%**	**240**	**1.7%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

The methods provided in this table are consistent with the information submitted by Member States in their national inventory submissions. The Netherlands use a country-specific method and report 'CS' accordingly. The level of complexity of the method applied by the Netherlands is Tier 1 (T1).
The table lists methods and emission factors used in the latest inventory year. Bulgaria, Croatia, Greece, Lithuania, Romania and Slovenia reported emissions from petrochemical and carbon black production in 1990. The methodological tier used in that year is Tier 1 (T1) for Bulgaria, Greece, Lithuania and Slovenia and Tier 2 (T2) for Croatia. Romania reported a default ('D') method for 1990, which corresponds to Tier 1 (T1).

4.2.2.5 Chemical industry – Fluorochemical production (CRF Source Category 2.B.9)

Table 4.23 Key categories for sector 2B9 (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
2.B.9 Fluorochemical Production: no classification (HFCs)	29033	1010	T	L	0	100%
2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)	5567	45	T	0	0	100%

In this subcategory, by-product emissions and fugitive emissions are to be reported.

As regards by-product emissions, the generation of HFC-23 as a by-product during the manufacture of HCFC-22, HFC-32 and other fluorocarbons is particularly relevant due to its high global warming potential of 14,800. HFC-23 is primarily generated during the fluorination of chloroform (trichloromethane, CHCl3 or R20). Since chloroform is a feedstock for chlorodifluoromethane (HCFC-22 or R22), HFC-23 is a by-product during the manufacture of this chemical which is nowadays mainly used as feedstock. The HFC-23 yield amounts to 2-3% of the amount of R22 produced. In addition, where R22 is used as an intermediate product or feedstock this may also lead to HFC-23 by-production. This is the case e.g. for some production pathways of difluoromethane (HFC-32 or R32). HFC-32 is widely used as a single substance refrigerant but has also been included in a number of frequently used refrigerant blends such as the R407 series (10-30% R32) and R410A (50% R32) for many years. Production of these blends may therefore also involve HFC-23 by-production. (EU Commission, 2015)

It is estimated that in 1990 the HFC-23 released from HCFC-22 plants was at most 4 percent of the global production of HCFC-22 (U.S. EPA, 2002[1]), in the absence of abatement measures. Before the mid-1990s, ten HCFC-22 plants were operated in Europe. At that time, HFC-23 by-product emissions were partly captured and processed but emissions were also high. In the late 1990s, HFC-23 emissions accounted for about half of the EU's F-gas emissions. Due to the closure of several HCFC production plants and the installation of abatement systems in the remaining facilities, HFC-23 emissions were significantly reduced.

In fluorochemical manufacture also other fluorinated greenhouse gases can occur as by-products including e.g. CF4, C2F6, C3F8, C4F10, C5F12, C6F14 as well as SF_6. The type and amount of these by-product emissions depends on the applied production pathway and installed abatement technology.

The ERT (2015, 2016, 2018) recommended the EU to provide an explanation in the NIR on how CF4 emissions from the production of HCFC-22 occur and work with Italy to allocate these emissions under the subcategory fluorochemical production – by-product emissions (other) (2.B.9.a.2) instead of the

[21] U.S. EPA (2001). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1999. United States Environmental Protection Agency, Report No. EPA 236-R-01-001, Washington, U.S.A., 2001.

subcategory fluorochemical production – by-product emissions (production of HCFC-22) (2.B.9.a.1). The plant where the production of HCFC-22 and other fluorocarbons occurs in Italy, is an integrated plant and all emissions from the different production lines are collected and treated in a centralized abatement unit: The specific design (refractory walls of combustion chamber, particular residence time) leads to specific thermodynamic conditions so that CF4 is formed and escapes. Thus, it is not possible to separate the share of CF4 emissions formed directly during HCFC-22 production and the quota of CF4 to be attributed to fluoropolymers or others. CF4 emissions are allocated under the sub-category 2.B.9.a.1 "By-product emissions – Production of HCFC-22", also because without the production of HCFC-22, no other production could occur.

In contrast, HFC-125 is not formed as a by-product but was formerly allocated to subcategory 2.B.9.a as share of emissions from the handling of F-gas containers. These amounts have been reallocated to 2.B.9.b.

Fugitive emissions are also released during the production process of F-gases. Hence certain amounts of emissions of all types of F-gases that are manufactured in the EU are reported in this subcategory. In the last decades, the production processes have been optimized in all facilities so that this type of emissions has been significantly reduced as well.

Several Member States report "unspecified mix of HFCs and PFCs" from 2.B.9 since the waste gases still contain F-gas emissions after the abatement process.

Table 4.24: 2B9 Fluorochemical production – HFCs: Countries' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2020	Change 1990-2020		Change 1995-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	1995	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	-	-	-	-	-	-	-	-	-	-	-	-	-
Belgium	NO	NO	1 288	795.72	78.8%	796	∞	796	∞	-493	-38%	NA	NA
Bulgaria	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
France	4 374	666	128	94	9.4%	-4 279	-98%	-571	-86%	-33	-26%	T3	PS
Germany	IE,NA	IE,NA	IE,NA	IE,NA	-	-	-	-	-	-	-	NA	NA
Greece	1 183	4 115	NO	NO	-	-1 183	-100%	-4 115	-100%	-	-	NA	NA
Hungary	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Italy	444	549	1	1	0.1%	-443	-100%	-548	-100%	0	-21%	CS	PS
Latvia	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Netherlands	5 606	7 298	381	119	11.8%	-5 488	-98%	-7 179	-98%	-262	-69%	T2	CS
Poland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Portugal	NO,NA	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Spain	3 040	5 867	NO	NO	-	-3 040	-100%	-5 867	-100%	-	-	NA	NA
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-
United Kingdom	14 387	17 671	NO	NO	-	-14 387	-100%	-17 671	-100%	-	-	NA	NA
EU-27+UK	**29 033**	**36 165**	**1 798**	**1 010**	**100%**	**-28 024**	**-97%**	**-35 155**	**-97%**	**-788**	**-44%**	**-**	**-**
Iceland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	14 387	17 671	NO	NO	-	-14 387	-100%	-17 671	-100%	-	-	NA	NA
EU-KP	**29 033**	**36 165**	**1 798**	**1 010**	**100%**	**-28 024**	**-97%**	**-35 155**	**-97%**	**-788**	**-44%**	**-**	**-**

Table 4.25: 2B9 Fluorochemical production: Countries' contributions to Unspecified mix of HFC and PFC emissions and information on method applied, activity data and emission factor

Member State	Unspecified mix of HFCs and PFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2020	Change 1990-2020		Change 1995-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	1995	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	-	-	-	-	-	-	-	-	-	-	-	-	-
Belgium	-	-	-	-	-	-	-	-	-	-	-	NA	NA
Bulgaria	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
France	NO,NA	NO,NA	NO,NA	NO,NA	-	-	-	-	-	-	-	NA	NA
Germany	5 567	5 335	47	45	100.0%	-5 522	-99%	-5 290	-99%	-3	-5%	T3	PS
Greece	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Italy	-	-	-	-	-	-	-	-	-	-	-	-	-
Latvia	NA	NA	NA	NA	-	-	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Malta	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	NO	-	-	-	-	-	-	-	NO	NO
Portugal	NO,NA	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Slovakia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-
United Kingdom	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
EU-27+UK	**5 567**	**5 335**	**47**	**45**	**100%**	**-5 522**	**-99%**	**-5 290**	**-99%**	**-3**	**-5%**	**-**	**-**
Iceland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
EU-KP	**5 567**	**5 335**	**47**	**45**	**100%**	**-5 522**	**-99%**	**-5 290**	**-99%**	**-3**	**-5%**	**-**	**-**

Table 4.26: 2B Chemical production: Contribution of MS to EU recalculations in HFCs for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	-	-		
Belgium	-	-	-	-		
Bulgaria	-	-	-	-		
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	-	-		
Denmark	-	-	-	-		
Estonia	-	-	-	-		
Finland	-	-	-	-		
France	-	-	-8.4	-6.1		From 2018, the detection thresholds for F-gas emission measurements from a production site of trifluoroacid were no longer reached, therefore the emissions were corrected. Correction of an error on a F-gas production site in 2019 which took into account the emissions from refrigeration units.
Germany	-	-	-	-		
Greece	-	-	-	-		
Hungary	-	-	-	-		
Ireland	-	-	-	-		

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Italy	-	-	-	-		
Latvia	-	-	-	-		
Lithuania	-	-	-	-		
Luxembourg	-	-	-	-		
Malta	-	-	-	-		
Netherlands	-	-	-	-		
Poland	-	-	-	-		
Portugal	-	-	-	-		
Romania	-	-	-	-		
Slovakia	-	-	-	-		
Slovenia	-	-	-	-		
Spain	-	-	-	-		
Sweden						
United Kingdom	-	-	-	-		
EU27+UK	-	-	-8.4	-0.5		
Iceland	-	-	-	-		
United Kingdom (KP)	-	-	-	-		
EU-KP	-	-	-8.4	-0.5		

4.2.2.1 2B10 Other chemical industry

Fifteen countries reported CO_2, CH_4 or N_2O emissions in this category in 2020 which contributed 12.8 Mt of CO_2e or 0.3% of total EU-KP (without LULUCF) emissions.

Between 1990 and 2020, CO_2 emissions from this source increased by 74% (Table 4.28) while CH_4 and N_2O emissions decreased by about 51% and 38% respectively. This category contains a wide range of emissions and sources as shown in the tables below.

Table 4.27 2B10 Other: CO_2, CH_4 and N_2O emissions for 1990 and 2020

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
		1990	1990	1990	1990	2020	2020	2020	2020
AUT	10. Other (please specify)	138.56	7.30	NA	145.86	146.28	9.98	NA	156.25
	CO_2 from Nitric Acid Production	0.41	NA	NA	0.41	0.40	NA	NA	0.40
	Other chemical bulk production	138.15	7.30	NA	145.44	145.88	9.98	NA	155.85
BEL	10. Other (please specify)	285.15	17.68	27.42	330.24	2394.73	16.46	60.45	2471.63
	Other non-specified	285.15	17.68	27.42	330.24	2394.73	16.46	60.45	2471.63
BGR	10. Other (please specify)	NA	NA	NA		NA	NA	NA	
CYP	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
CZE	10. Other (please specify)	IE	NO	NO		221.52	NO	NO	221.52
	Other non energy use in chemical industry	IE	NO	NO		205.56	NO	NO	205.56
	Non selective catalytic reduction	IE	NO	NO		15.96	NO	NO	15.96
DEU	10. Other (please specify)	NA	59.508225	IE	59.508225	NA	59.48	IE	59.48
	Other	NA	59.508225	IE	59.508225	NA	59.48	IE	59.48
DNM	10. Other (please specify)	0.57	NA	NA	0.57	1.43	NA	NA	1.43
	Production of catalysts	0.57	NA	NA	0.57	1.43	NA	NA	1.43
ESP	10. Other (please specify)	NO,NA	NA	NA		772.48	NA	NA	772.48
	Other No-Specify	NO	NA	NA		772.48	NA	NA	772.48
EST	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
FIN	10. Other (please specify)	177.28	NO	NO	177.28	1049.67	NO	NO	1049.67
	Phosphoric Acid Production	24.54	NO	NO	24.54	40.39	NO	NO	40.39
	Hydrogen Production	116.22	NO	NO	116.22	927.57	NO	NO	927.57

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
	Limestone and Dolomite Use	36.52	NO	NO	36.52	81.70	NO	NO	81.70
	Chemicals Production	NO	NO	NO		NO	NO	NO	
FRK	10. Other (please specify)	4558.50	76.95	534.25	5169.69	4530.13	31.05	59.49	4620.68
GBE	10. Other (please specify)	NO	191.21	2.21	193.41	NO	55.75	1.41	57.16
	Chemical industry - other	NO	191.21	2.21	193.41	NO	55.75	1.41	57.16
GRC	10. Other (please specify)	NA,NO	NA	NA		649.23	NA	NA	649.23
	Sulfuric acid	NA	NA	NA		NA	NA	NA	
	Hydrogen production	NO	NA	NA		649.23	NA	NA	649.23
HRV	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
HUN	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
IRL	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
ITA	10. Other (please specify)	NA	NA	NA		NA	NA	NA	
	other (indirect emissions)	NA	NA	NA		NA	NA	NA	
	Soda Ash (CO emissions only)	NA	NA	NA		NA	NA	NA	
LTU	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
	Sulfuric acid production	NO	NO	NO		NO	NO	NO	
LUX	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
LVA	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
MLT	10. Other (please specify)	0.17	NA	NA	0.17	0.00	NA	NA	0.00
	Carbide use	0.17	NA	NA	0.17	0.00	NA	NA	0.00
NLD	10. Other (please specify)	1037.63	NO	244.19	1281.83	1406.87	NO	422.78	1829.65
	Other process emissions	1037.63	NO	244.19	1281.83	1406.87	NO	422.78	1829.65
POL	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
PRT	10. Other (please specify)	NO,NA	NO,NA	NO,NA		NO,NA	NO,NA	NO,NA	
	2.B.10.a Sulphuric Acid	NO	NO	NO		NO	NO	NO	

Member State	2.B.10 Other	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]	CO_2 emissions [kt]	CH_4 emissions [kt CO_2 equ]	N_2O emissions [kt CO_2 equ]	Total emissions [kt CO_2 equ]
	2.B.10.c Explosives	NO	NO	NO		NO	NO	NO	
	2.B.10.d Solvent use in plastic products manufacturing	NA	NA	NA		NA	NA	NA	
ROU	10. Other (please specify)	NO	NO	NO		NO	NO	NO	
	Other - non-specified	NO	NO	NO		NO	NO	NO	
SVK	10. Other (please specify)	116.99	0.05	0.06	117.10	306.64	0.14	0.16	306.94
	Hydrogen Production	116.99	0.05	0.06	117.10	306.64	0.14	0.16	306.94
SVN	10. Other (please specify)	17.43	NO	NO	17.43	12.29	NO	NO	12.29
SWE	10. Other (please specify)	598.46	0.71	20.72	619.89	551.52	0.80	0.75	553.07
	Pharmaceutical industry	NA	NE	14.90	14.90	NA	NE	NE	
	Other non-specified	NE	NE	NE		NE	NE	NE	
	Other organic chemical products	520.07	0.63	0.01	520.70	450.93	C	C	450.93
	Base chemicals for plastic industry	37.52	0.00	3.55	41.08	41.84	C	C	41.84
	Other inorganic chemical products	40.87	0.07	2.27	43.21	58.75	0.08	0.72	59.55
	Sulphuric acid production	NE	NA	NA		NE	NA	NA	
EU-27+UK		**6931**	**353**	**829**	**8113**	**12043**	**174**	**545**	**12761**
ISL	10. Other (please specify)	0.36	NA	46.49	46.85	NO	NO	NO	
	Silicium production	0.36	NA	NA	0.36	NO	NO	NO	
	Fertilizer production	NA	NA	46.49	46.49	NO	NO	NO	
GBK	10. Other (please specify)	NO	191.21	2.21	193.41	NO	55.75	1.41	57.16
	Chemical industry - other	NO	191.21	2.21	193.41	NO	55.75	1.41	57.16
EU-KP		**6931**	**353**	**875**	**8160**	**12043**	**174**	**545**	**12761**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table **4.28** provides an overview of changes in CO_2 emissions between 1990 and 2020 at an aggregated level. The diverging trends can be explained by various increases and decreases in the production of chemicals between 1990 and 2020. The same holds true for N_2O (Table **4.29**) and CH_4 (***Table** 4.30*).

Table 4.28 2B10 Other: CO_2 emissions

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	139	148	146	1.2%	8	6%	-2	-1%	T3	PS
Belgium	285	2 234	2 395	19.9%	2 110	740%	160	7%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	IE	226	222	1.8%	222	∞	-5	-2%	T1	CS
Denmark	1	1	1	0.0%	1	151%	0	-4%	T2	PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	177	1 138	1 050	8.7%	872	492%	-88	-8%	CS,T2,T3	CS,PS
France	4 558	4 746	4 530	37.6%	-28	-1%	-216	-5%	T1,T2,T3	CS,D,PS
Germany	NA	NA	NA	-	-	-	-	-	NA	NA
Greece	NA,NO	654	649	5.4%	649	∞	-5	-1%	T1	CS
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NA	NA	NA	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	0	0	0	0.0%	0	-100%	0	-100%	T1	D
Netherlands	1 038	1 548	1 407	11.7%	369	36%	-141	-9%	T1	D
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	117	312	307	2.5%	190	162%	-6	-2%	T3	CS
Slovenia	17	13	12	0.1%	-5	-29%	-1	-6%	T2	CS
Spain	NO,NA	884	772	6.4%	772	∞	-112	-13%	T3	PS
Sweden	598	855	552	4.6%	-47	-8%	-304	-36%	T3	PS
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**6 931**	**12 762**	**12 043**	**100%**	**5 112**	**74%**	**-719**	**-6%**	**-**	**-**
Iceland	0	NO	NO	-	0	-100%	-	-	NA	NA
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**6 931**	**12 762**	**12 043**	**100%**	**5 112**	**74%**	**-719**	**-6%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
Iceland did not report emissions from this category in 2020, but in 1990. The methodological tier used in that year by Iceland is Tier 3 (T3).

Table 4.29 2B10 Other: N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NA	NA	NA	-	-	-	-	-	NA	NA
Belgium	27	43	60	11.1%	33	120%	17	40%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NA	NA	NA	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	534	65	59	10.9%	-475	-89%	-5	-8%	T2,T3	CS,D,PS
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NA	NA	NA	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NA	NA	NA	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NA	NA	NA	-	-	-	-	-	NA	NA
Netherlands	244	382	423	77.6%	179	73%	41	11%	T1	CS
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	0	0	0	0.0%	0	168%	0	-2%	T3	D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NA	NA	NA	-	-	-	-	-	NA	NA
Sweden	21	1	1	0.1%	-20	-96%	0	-28%	T2,T3	CS,PS
United Kingdom	2	1	1	0.3%	-1	-36%	0	4%	T3	CS
EU-27+UK	**829**	**492**	**545**	**100%**	**-284**	**-34%**	**53**	**11%**	**-**	**-**
Iceland	46	NO	NO	-	-46	-100%	-	-	NA	NA
United Kingdom (KP)	2	1	1	0.3%	-1	-36%	0	4%	T3	CS
EU-KP	**875**	**492**	**545**	**100%**	**-330**	**-38%**	**53**	**11%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
Iceland did not report emissions from this category in 2020, but in 1990. The methodological tier used in that year by Iceland is Tier 3 (T3).

Table 4.30: 2B10 Other: CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	7.3	7.4	10	5.7%	2.7	37%	2.6	35%	T3	PS
Belgium	18	17	16	9.5%	-1.2	-6.9%	-0.2	-1.2%	T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NA	NA	NA	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	77	34	31	17.9%	-46	-60%	-2.7	-0.1	T2,T3	CS,D,PS
Germany	60	60	59	34.3%	0	0%	-0.4	0.0	T2	CS
Greece	NA	NA	NA	-	-	-	-	-	NA	NA
Hungary	NO	NO	NO	-	-	-	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NA	NA	NA	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NA	NA	NA	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NO,NA	NO,NA	NO,NA	-	-	-	-	-	NA	NA
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	0.1	0.1	0.1	0.1%	0.1	168%	0.0	-1.9%	T3	D
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NA	NA	NA	-	-	-	-	-	NA	NA
Sweden	0.7	0.8	0.8	0.5%	0.1	14%	0.0	2.8%	T1,T2,T3	CS,D,PS
United Kingdom	191	59	56	32.1%	-135	-71%	-2.9	-5.0%	CS	CS
EU-27+UK	**353**	**177**	**174**	**100%**	**-180**	**-51%**	**-3.6**	**0.0**	**-**	**-**
Iceland	NA	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	191	59	56	32.1%	-135	-71%	-2.9	0.0	CS	CS
EU-KP	**353**	**177**	**174**	**100%**	**-180**	**-51%**	**-3.6**	**0.0**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
The methods provided in this table are consistent with the information submitted by Members States in their national inventory submissions. The United Kingdom uses a country-specific method and reports 'CS' accordingly. The methods applied by the United Kingdom are comparable to T2 or T3 methodologies.

Table 4.31 provides an overview of all sources reported under 2B10 Other Chemical Industry for all gases for the year 2020. The largest contributors to total emissions in that year are France, Belgium and the Netherlands.

Table 4.31 2B10 Other: Overview of sources reported under this source category for 2020

Member State	2.B.10 Other Chemical Industry	CO2 emissions [kt]	CH4 emissions [kt]	N2O emissions [kt]	Total emissions [kt CO2 equivalents	Share in EU-28 Total
		2020	2020	2020	2020	2020
Austria	10. Other (please specify), CO2 from Nitric Acid Production, Other chemical bulk production	146	0.40	NA	156	1%
Belgium	10. Other (please specify), Other non-specified	2395	0.66	0.20	2472	19%
Bulgaria	10. Other (please specify)	NA	NA	NA	-	-
Croatia	10. Other (please specify)	NO	NO	NO	-	-
Cyprus	10. Other (please specify)	NO	NO	NO	-	-
Czech Republic	10. Other (please specify), Other non energy use in chemical industry, Non selective catalytic reduction	222	NO	NO	222	2%
Denmark	10. Other (please specify), Production of catalysts	1	NA	NA	1	0.01%
Estonia	10. Other (please specify)	NO	NO	NO	-	-
Finland	10. Other (please specify), Phosphoric Acid Production, Hydrogen Production, Limestone and Dolomite Use, Chemicals Production	1050	NO	NO	1050	8%
France	10. Other (please specify)	4530	1	0.20	4621	36%
Germany	10. Other (please specify), Other	NA	2	IE	-	-
Greece	10. Other (please specify), Sulfuric acid, Hydrogen production	649	NA	NA	649	5%
Hungary	10. Other (please specify)	NO	NO	NO	-	-
Ireland	10. Other (please specify)	NO	NO	NO	-	-
Italy	10. Other (please specify), other (indirect emissions), Soda Ash (CO emissions only)	NA	NA	NA	-	-
Latvia	10. Other (please specify)	NO	NO	NO	-	-
Lithuania	10. Other (please specify), Sulfuric acid production	NO	NO	NO	-	-
Luxembourg	10. Other (please specify)	NO	NO	NO	-	-
Malta	10. Other (please specify)	0.00	NA	NA	0.00	0.0000%
Netherlands	10. Other (please specify), Other process emission	1407	NO	1	1830	14%
Poland	10. Other (please specify)	NO	NO	NO	-	-
Portugal	10. Other (please specify), 2.B.10.a Sulphuric Acid, 2.B.10.c Explosives, 2.B.10.d Solvent use in plastic products manufacturing,	NO,NA	NO,NA	NO,NA	-	-
Romania	10. Other (please specify), Other - non-specified	NO	NO	NO	-	-
Slovakia	10. Other (please specify), Hydrogen Production	307	0	0	307	2%
Slovenia	10. Other (please specify)	12	NO	NO	12	0.1%
Spain	10. Other (please specify), Other No-Specify	772	NA	NA	772	6%
Sweden	10. Other (please specify), Pharmaceutical industry, Other non-specified, Other organic chemical products, Base chemicals for plastic industry, Other inorganic chemical products, Sulphuric acid production	552	0	0	553	4%
United Kingdom	10. Other (please specify), Chemical industry - othe	NO	2.23	0.00	57	0.4%
EU-27+UK		**12043**	**7**	**2**	**12761**	**100%**
Island	10. Other (please specify), Silicium production, Fertilizer production	NO	NO	NO	-	-
United Kingdom (K	10. Other (please specify), Chemical industry - othe	NO	2.23	0.00	57	0.4%
EU-KP		**12043**	**7**	**2**	**12761**	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.6 Non-key sources

Non key sources in the chemical industry sector include: 2B4 Caprolactam, glyoxal and glyoxylic acid production; 2B5 Carbide production; 2B6 Titanium dioxide production and 2B7 Soda ash production. They also include emissions of CH_4 and N_2O from 2B1 Ammonia Production, CO_2 emissions from 2B3 Adipic Acid Production, CH_4 from 2B8 Petrochemical and carbon black production, and PFC and SF_6 emissions from 2B9 Fluorochemical production. In 2020 emissions from these categories contributed 6.2 Mt of CO_2 equivalent or 0.2% of total EU-KP (without LULUCF) emissions.

Table 4.32 2B: Emissions from non-key categories in the chemical industry

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
2.B.1 Ammonia Production: no classification (CH_4)	2.1	2.3	2.4	0.00%	0.3	16%	0.1	5%
2.B.1 Ammonia Production: no classification (N_2O)	0.6	0.7	0.8	0.00%	0.2	26%	0.1	7%
2.B.10 Other chemical industry: no classification (CH_4)	353.4	177.3	173.7	0.05%	-179.7	-51%	-3.6	-2%
2.B.10 Other chemical industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other chemical industry: no classification (N_2O)	875.3	492.3	545.0	0.16%	-330.3	-38%	52.8	11%
2.B.10 Other chemical industry: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other chemical industry: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other chemical industry: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other chemical industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.3 Adipic Acid Production: no classification (CO_2)	26.5	22.0	14.2	0.00%	-12.3	-46%	-7.8	-36%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (N_2O)	4 127.2	1 703.9	1 431.0	0.41%	-2 696.2	-65%	-272.9	-16%
2.B.5 Carbide Production: no classification (CH_4)	5.6	8.5	8.5	0.00%	2.9	53%	0.0	0%
2.B.5 Carbide Production: no classification (CO_2)	1 798.6	265.1	216.5	0.06%	-1 582.1	-88%	-48.6	-18%
2.B.6 Titanium Dioxide Production: no classification (CO_2)	126.2	272.5	251.5	0.07%	125.3	99%	-21.0	-8%
2.B.7 Soda Ash Production: no classification (CO_2)	2 242.1	2 007.7	1 724.8	0.49%	-517.3	-23%	-282.9	-14%
2.B.8 Petrochemical and Carbon Black Production: no classification (CH_4)	1 003.7	1 087.5	1 143.4	0.33%	139.7	14%	55.9	5%
2.B.9 Fluorochemical Production: no classification (NF_3)	0.0	0.0	7.6	0.00%	7.6	100%	7.6	100%
2.B.9 Fluorochemical Production: no classification (PFCs)	4 331.8	1 155.2	665.7	0.19%	-3 666.1	-85%	-489.6	-42%
2.B.9 Fluorochemical Production: no classification (SF_6)	1 845.5	1.1	3.6	0.00%	-1 842.0	-100%	2.5	237%

4.2.3 Metal Industry (CRF Source Category 2C)

This source category includes two key sources for level and trend, namely CO_2 emissions from 2C1 Iron and Steel Production and PFC emissions from 2C3 Aluminium Production (*Table 4.33*).

Table 4.33: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for sector 2C (Table excerpt).

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
2.C.1 Iron and Steel Production: no classification (CO_2)	126872	67779	T	L	L	98,6%
2.C.3 Aluminium Production: no classification (PFCs)	21277	491	T	L	0	100%

Table **4.34** summarises information by countries on total GHG emissions, CO_2, SF_6 and PFC emissions from Metal Production. Between 1990 and 2020, CO_2 emissions from 2C Metal Production decreased by 46% of total EU-KP (without LULUCF). The absolute decrease of GHG emissions was largest in United Kingdom, Germany Romania, France, and Belgium (in decending order).

*Table **4**.34 2C Metal Industry: Countries' contributions to total GHG, CO_2, HFC, PFC and SF_6 emissions*

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt		N2O emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents		HFC emissions in kt CO2 equivalents		PFC emissions in kt CO2 equivalents		NF3 emissions in kt CO2 equivalents		SF6 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020	1990	2020	1990	2020	1990	2020	1990	2020	1990	2020
Austria	8 180	9 460	6 786	9 454	NO	NO	3	2	-	-	1 149	NO	-	-	242	5
Belgium	10 106	3 068	10 092	3 059	NO	NO	14	9	-	-	-	-	-	-	-	-
Bulgaria	1 629	149	1 603	149	NA	NA	27	NO,NA	NA	NA	NA	NA	NA	NA	NA	NA
Croatia	1 581	5	336	5	NO	NO	4	NO,NA	NO	NO	1 240	NO	NO	NO	NO	NO
Cyprus	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	9 810	5 946	9 795	5 934	NA	NA	15	12	NO	NO	NO	NO	NO	NO	NO	NO
Denmark	60	0	30	0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	30	NO
Estonia	1	3	1	3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Finland	1 976	1 757	1 976	1 757	NO	NO	0	0	NO	-	NO	-	NO	-	NO	NO
France	22 106	9 957	17 678	9 863	NO	NO	141	26	NO,IE	NO,IE	3 567	61	-	-	721	8
Germany	28 188	15 780	25 080	15 625	27	12	13	6	NA	8	2 889	77	-	-	180	52
Greece	1 203	814	1 012	695	NO	NO	0	0	NO	NO	190	119	NO	NO	NO	NO
Hungary	3 701	1 114	3 317	1 110	NO	NO	7	4	NO	NO	376	NO	NO	NO	NO	NO
Ireland	26	NO	26	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Italy	6 421	1 474	4 378	1 439	NA	NO	68	30	NO	5	1 975	NO	-	-	NO	NO
Latvia	70	NO	70	NO	NO	NO	0	NO	NO	NO	NO	NO	NO	NO	NO	NO
Lithuania	17	0	17	0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Luxembourg	985	97	985	97	NO	NO	NO	NO	-	-	-	-	-	-	-	-
Malta	NO	NO	NO	NO	-	-	NO	NO	-	-	-	-	-	-	NO	-
Netherlands	3 090	158	452	132	NO	NO	NO,IE	NO,IE,NA	NO	NO	2 638	26	-	-	NO	NO
Poland	5 817	1 834	5 652	1 824	NA	NA	23	10	NA	NA	142	NO,NA	NA	NA	NA,NO	NO,NA
Portugal	447	98	446	98	NO	NO	1	NO,NE	NA	NO	NO,NA	NO	-	-	NO,NA	NO
Romania	16 057	3 844	13 228	3 836	NO	NO	21	4	NO	NO	2 808	4	NO	NO	NA,NO	NO,NA
Slovakia	4 901	3 606	4 586	3 599	NO	NO	NO,NA,IE	1	NO	NO	315	6	NO	NO	NO	NO
Slovenia	551	144	343	134	NO	NO	0	NO,NA	NO	NO	208	10	NO	NO	NO	NO
Spain	4 730	2 230	3 537	2 192	NA	NA	29	13	NO,NA	NO,NA	1 164	25	NA	NA	NO,NA	NO,NA
Sweden	3 871	2 750	3 260	2 684	NA	NA	19	0	NO	1	569	65	-	-	23	NO
United Kingdom	27 429	10 724	25 429	10 673	21	7	39	11	NO	1	1 553	4	-	-	387	27
EU-27+UK	**162 952**	**75 010**	**140 116**	**74 359**	**47**	**19**	**425**	**129**	**NA,IE,NO**	**16**	**20 783**	**396**	**NA,NO**	**NA,NO**	**1 582**	**91**
Iceland	844	1 775	348	1 677	NO	NO	2	3	NO	NO	495	96	NO	NO	NO	NO
United Kingdom (KP)	27 429	10 724	25 429	10 673	21	7	39	11	NO	1	1 553	4	-	-	387	27
EU-KP	**163 796**	**76 786**	**140 464**	**76 036**	**47**	**19**	**426**	**133**	**NA,IE,NO**	**16**	**21 277**	**491**	**NA,NO**	**NA,NO**	**1 582**	**91**

Presented methods and emission factor information refer to the last inventory year.
Note: Total GHG emissions given in this table include CO_2, N_2O, CH_4, HFC, PFC and SF_6.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4-11 2C Metal Industry CO_2 – Trend in EU-KP

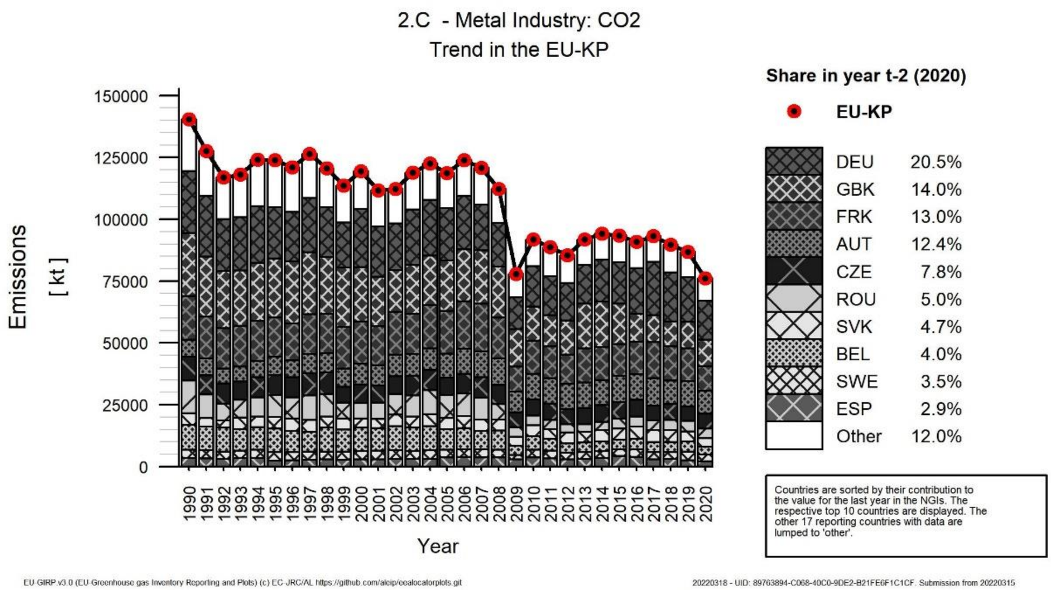


Table 4.35 provides information on the contribution of countries to EU recalculations of CO_2 emissions from 2C Metal Production for 1990 and 2020, including main explanations.

Table 4.35: 2C Metal Production: Contribution of countries to EU recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 and percent of sector total)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	42	0,4	/	Updated activity data from the energy balance led to a redistribution of emissions between this category and 1.A.2.a Iron and Steel. For 2.C.1.a Steel emissions were revised by +42.09 kt CO_2e in 2019.
Belgium	-	-	-	-		
Bulgaria	-	-	-0,1	-0,0	/	
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	139	1,4	-382	-6,2	For 2C1, activity data was revised for dolomite and limestone. Instead of interpolation, the Overlap Method (Guidelines: Chapter 5: Time Series Consistency, page 5.9) was applied.	For 2C1: corrected activity data: incorrect emission sources were included in the calculations for dolomite and limestone usage. They were corrected.
Denmark	-	-	-	-		
Estonia	0,5	148,6	0,8	34,1	Emissions were recalculated because more CO_2 emitting processes were taken into account fort he whole time-series: 1) use of ammonium bicarbonate for precipitation of rare earth metal carbonates from acidic solution; 2) rare earth metal carbonate calcination into oxides	
Finland	-	-	8,6	0,5	/	Emissions data were corrected due to changes in ETS data.
France	2,0	0,0	15	0,1	Slight revision of CO_2 emissions from large combustion plants on steelmaking plants, which are subtracted, among others, from the total emissions reported by the ETS, which are therefore impacted accordingly (transfer between 1A2a and 2C1).	For 2C1: Revision of 2019 coke production (slight decrease), therefore the associated emissions of coke ovens (1A1c) have been decreased accordingly, increasing in consequence the steel production emissions (2C1) which are based on ETS reported emissions to which the

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						1A1c and 1A2a emissions are substracted : transfer from 1A1c to 2C1a emissions.
Germany	-	-	-1.144	-6,0	/	Update of provisional 2019 energy balance data with actual ones
Greece	-	-	-39	-3,9	/	For 2C5: updated activity data (thanks to updated US Geological Survey)
Hungary	-	-	-	-		
Ireland	-	-	-	-		
Italy	-	-	-	-		
Latvia	-	-	-	-		
Lithuania	-	-	-	-		
Luxembourg	-	-	-	-		
Malta	-	-	-	-		
Netherlands	-	-	132	730,0		CO_2 emissions were taken from and AERs
Poland	-	-	-0,1	-0,0	/	Steel production in electric furnaces for 2019 was slighty corrected.
Portugal	-	-	-	-		
Romania	-	-	-	-		
Slovakia	-	-	-	-		
Slovenia	-	-	-	-		
Spain	-	-	-	-		
Sweden	-	-	-5,9	-0,2		For 2C1: - A correction of CO_2 emissions from one of the facilities has been done for 2019 – a more precise value, the same as in the EU ETS, instead of rounded value from the environmental report. - Correction of the method for allocation of CO_2 emissions between the energy sector and IPPU for 2019. - Correction of CO_2 from the use of bentonite in one facility in 2019
United Kingdom	18.059	245,0	8.320	370,3	- Due to a methodology update to further utilise the EU ETS data, a more complete timeseries of operator data has been developed. - Reallocation from 1A2a to 2C1	
EU27+UK	**18.201**	**14,9**	**6.947**	**8,9**		
Iceland	-	-	-1,0	-0,1		Microsilica usage added in 2C2 for 2019.
United Kingdom (KP)	18.059	245,0	8.320	370,3	see above	
EU-KP	**18.201**	**14,9**	**6.946**	**8,7**		

In the current submission no significant recalculations were performed in PFC emissions from 2C – Metal production.

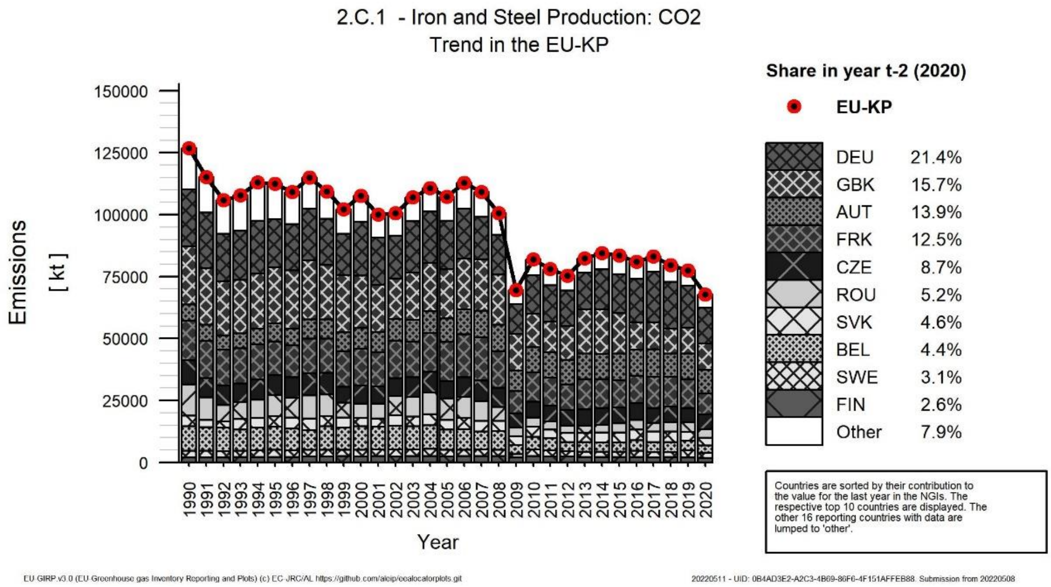
4.2.3.1 2C1 Iron and steel production

This source category includes emissions from the iron and steel industry. Crude iron is produced by the reduction of iron oxide ores mostly in blast furnaces, using coke or other forms of carbon as fuel and reducing agent. In most iron furnaces, the process is aided by the use of carbonate fluxes (limestone). Additional emissions occur as the limestone or dolomite flux releases CO_2 during reduction of pig iron in the blast furnace. Coke plays the dual role of fuel and reducing agent. Countries use different methods for the allocation of emissions that are described in Table 4.38.

CO_2 emissions from 2C1 Iron and Steel Production amounted to approximately 1.8 % of total GHG emissions (without LULUCF) in 2020. Germany accounts for 31.8% of these emissions in the EU KP, and France for 18.5% in 2020. United Kingdom had the largest decrease in absolute terms between 1990 and 2020, followed by Romania. Increases were encountered (in order of magnitude) in Austria, and Slovenia between 1990 and 2020.

The overall emission trend between 1990 and 2020 roughly follows the trend of emissions that fluctuates due to varying production figures. Between 1990 and 2020, overall CO_2 emissions from iron and steel production decreased by 47% (Table 4.36). Between 2019 and 2020, emissions decreased by 12%.

Figure 4-12 2C1 Iron and Steel Production: CO_2 emissions – Trend in EU-KP



CO_2 emissions from iron and steel industry are reported by all countries except Cyprus, Estonia and Malta. Denmark, Ireland and Latvia reported emissions from this sector in 1990, but no more in 2019 and 2020. All follow higher-tier methods and most use country or plant specific methods (see Table **4.36**).

*Table **4**.36 2C1 Iron and Steel Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor*

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	6 610	10 313	9 427	13.9%	2 816	43%	-886	-9%	T1,T3	CS,PS
Belgium	10 048	3 925	2 961	4.4%	-7 087	-71%	-964	-25%	CS,T3	PS
Bulgaria	1 283	32	22	0.0%	-1 261	-98%	-10	-30%	T2	CS
Croatia	44	5	5	0.0%	-39	-89%	0	0%	OTH,T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	9 782	5 813	5 923	8.7%	-3 859	-39%	110	2%	CS,T2	CS,D,PS
Denmark	30	NO	NO	-	-30	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 967	1 852	1 732	2.6%	-235	-12%	-120	-7%	CS,T3	CS
France	15 788	11 565	8 466	12.5%	-7 322	-46%	-3 099	-27%	T2	CS
Germany	22 810	16 948	14 538	21.4%	-8 272	-36%	-2 410	-14%	T2	CS
Greece	105	81	74	0.1%	-31	-29%	-7	-9%	CS	PS
Hungary	3 155	1 218	1 110	1.6%	-2 045	-65%	-109	-9%	T3	PS
Ireland	26	NO	NO	-	-26	-100%	-	-	NA	NA
Italy	3 124	1 357	1 215	1.8%	-1 909	-61%	-142	-10%	T2	CR,CS,PS
Latvia	70	NO	NO	-	-70	-100%	-	-	NA	NA
Lithuania	17	2	0	0.0%	-17	-100%	-1	-97%	T2	D
Luxembourg	985	104	96	0.1%	-889	-90%	-8	-7%	CS,T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	44	18	17	0.0%	-27	-61%	-1	-5%	T2	CS
Poland	4 959	1 897	1 368	2.02%	-3 590	-72%	-529	-28%	T2,T3	CS
Portugal	440	81	84	0.1%	-356	-81%	3	4%	T1,T3	D,PS
Romania	12 621	3 846	3 513	5.2%	-9 108	-72%	-333	-9%	T3	CS
Slovakia	4 168	3 554	3 146	4.6%	-1 022	-25%	-408	-11%	T2	PS
Slovenia	44	59	53	0.1%	10	22%	-6	-9%	T2	PS
Spain	2 501	1 398	1 322	1.9%	-1 179	-47%	-76	-5%	T2	CS,PS
Sweden	2 624	2 961	2 089	3.1%	-535	-20%	-872	-29%	T3	PS
United Kingdom	23 628	10 506	10 618	15.7%	-13 010	-55%	112	1%	T2	CS
EU-27+UK	**126 872**	**77 534**	**67 779**	**100%**	**-59 093**	**-47%**	**-9 755**	**-13%**	**-**	**-**
Iceland	NO	NO,NA	NO,NA	-	-	-	-	-	NA	NA
United Kingdom (KP)	23 628	10 506	10 618	15.7%	-13 010	-55%	112	1%	T2	CS
EU-KP	**126 872**	**77 534**	**67 779**	**100%**	**-59 093**	**-47%**	**-9 755**	**-13%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

For this category (2C1 – Iron and steel), it is not relevant to analyse an average IEF across countries because of their varying emission allocation (the split between process and combustion related emissions for pig iron production, which is an important sub-category). Activity data, implied emission factors and CO_2 emissions for the various countries and sub-categories are provided in Table 4.38.

Table 4.37 2C1 Iron and Steel Production: Implied emission factors

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Austria	**Iron and steel production**			6610	Austria	**Iron and steel production**	-	-	9427		
	Steel	3921	1.68	6591		Steel	6187	1.52	9393	T1,T3	CS,PS
	Pig Iron	3444	NO,IE	IE		Pig Iron	5286	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			20		Other	-	-	34		
	Electric Furnace Steel	370	0	20		Electric Furnace Steel	680	0.05	34	T3	PS
Belgium	**Iron and steel production**			10048	Belgium	**Iron and steel production**	-	-	2961		
	Steel	11570	0.73	8445		Steel	6008	0.48	2870	CS,T3	PS
	Pig Iron	9415	NA,IE	IE		Pig Iron	3647	IE,NA	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	13075	0.12	1589		Sinter	4262	0.02	85	CS,T3	PS
	Pellet	660	NO,IE	IE		Pellet	NO	NO	NO	NA	NA
	Other			14		Other	-	-	6		
	Use of electrodes	NA	NO,IE	IE		Use of electrodes	1679	0.00	6	CS,T3	PS
Bulgaria	**Iron and steel production**			1283	Bulgaria	**Iron and steel production**	-	-	22		
	Steel	2180	0.59	1283		Steel	579	0.04	22	T2	CS
	Pig Iron	1143	NO,IE	IE		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	C	NO,IE	IE		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NA		Other	-	-	NA		

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Croatia	**Iron and steel production**			44	Croatia	**Iron and steel production**	-	-	5		
	Steel	424	0.05	20		Steel	45	0.10	4	T3	PS
	Pig Iron	209	0.12	24		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	1		
Cyprus	**Iron and steel production**			NO	Cyprus	**Iron and steel production**	-	-	NO		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Czechia	**Iron and steel production**			9782	Czechia	**Iron and steel production**	-	-	5923		
	Steel	8190	IE,NA	IE		Steel	4455	IE,NA	IE	NA	NA
	Pig Iron	6106	IE,NA	IE		Pig Iron	3552	IE,NA	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	8469	IE,NA	IE		Sinter	5134	IE,NA	IE	NA	NA

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2020 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			9782		Other	-	-	5923		
	Use of limestone and dolomite	1380	0	602		Use of limestone and dolomite	2227	2.51	5585	CS	PS
	Metallurgical coke	7125	1	9180		Metallurgical coke	2227	2.51	5585	T2	CS,D
Denmark	**Iron and steel production**			30	Denmark	**Iron and steel production**	-	-	NO		
	Steel	614	0.05	30		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Estonia	**Iron and steel production**			NO	Estonia	**Iron and steel production**	-	-	NO		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Finland	**Iron and steel production**			1967	Finland	**Iron and steel production**	-	-	1732		
	Steel	2861	0.69	1967		Steel	3440	0.50	1732	CS,T3	CS
	Pig Iron	NO	NO,IE	IE		Pig Iron	NO	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NA	IE,NO	IE		Sinter	NA	NO,IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
	Other Iron and Steel Production.Other non-specified	487	NO	NO		Other Iron and Steel Production.Other non-specified	762	NO	NO	NA	NA
France	**Iron and steel production**			15788	France	**Iron and steel production**	-	-	8466		
	Steel	19073	0.83	15788		Steel	11590	0.73	8433	T2	CS
	Pig Iron	IE	IE	IE		Pig Iron	IE	IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	IE	IE	IE		Sinter	IE	IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	33		

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Germany	**Iron and steel production**			22810	Germany	**Iron and steel production**	-	-	14538		
	Steel	43939	0.52	22810		Steel	35680	0.41	14538	T2	CS
	Pig Iron	32263	IE	IE		Pig Iron	23003	IE	IE	NA	NA
	Direct reduced iron	IE	IE	IE		Direct reduced iron	IE	IE	IE	NA	NA
	Sinter	IE	IE	IE		Sinter	IE	IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Greece	**Iron and steel production**			105	Greece	**Iron and steel production**	-	-	74		
	Steel	999	0.10	105		Steel	1323	0.06	74	CS	PS
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Hungary	**Iron and steel production**			3155	Hungary	**Iron and steel production**	-	-	1110		
	Steel	2963	0.12	348		Steel	1518	0.09	143	T3	PS
	Pig Iron	1697	1.65	2427		Pig Iron	930	1.85	708	T3	PS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	72	5.28	380		Sinter	44	5.93	259	T3	PS
	Pellet	IE	IE	IE		Pellet	IE	IE	IE	NA	NA
	Other			NO		Other	-	-	NO		
Iceland	**Iron and steel production**			NO	Iceland	**Iron and steel production**	-	-	NO,NA		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NA		
Ireland	**Iron and steel production**			26	Ireland	**Iron and steel production**	-	-	NO		
	Steel	326	0.08	26		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Italy	**Iron and steel production**			3124	Italy	**Iron and steel production**	-	-	1215		
	Steel	25467	0.05	1346		Steel	20378	0.05	926	T2	CR,CS,PS
	Pig Iron	11852	0.15	1778		Pig Iron	3406	0.08	289	T2	CR,CS,PS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	13577	NO,NA	NA		Sinter	4235	NO,NA	NA	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
Latvia	**Iron and steel production**			70	Latvia	**Iron and steel production**	-	-	NO		
	Steel	550	0.13	70		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Lithuania	**Iron and steel production**			17	Lithuania	**Iron and steel production**	-	-	0		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2020 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			17		Other	-	-	0		
	Cast Iron	106	0	17		Cast Iron	2	0.02	0	T2	D
Luxem-bourg	**Iron and steel production**			985	**Luxem-bourg**	**Iron and steel production**	-	-	96		
	Steel	3506	0.12	404		Steel	1887	0.05	96	CS,T2	CS
	Pig Iron	2645	0.08	200		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	4804	0.08	380		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Malta	**Iron and steel production**			NO	**Malta**	**Iron and steel production**	-	-	NO		
	Steel	NO	NO	NO		Steel	NO	NO	NO	NA	NA
	Pig Iron	NO	NO	NO		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			-		Other	-	-	-		
Nether-lands	**Iron and steel production**			44	**Nether-lands**	**Iron and steel production**	-	-	17		
	Steel	5162	0.01	43		Steel	6212	0.00	17	T2	CS
	Pig Iron	NA	NO,IE	IE		Pig Iron	NA	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NA	NO,IE	IE		Sinter	NA	NO,IE	IE	NA	NA
	Pellet	NA	NO,IE	IE		Pellet	NA	NO,IE	IE	NA	NA
	Other			1		Other	-	-	NO		

Member State	1990 category	1990 Activity data (kt)	1990 Implied Emission Factor (t/t)	1990 CO_2 Emissions (kt)	Member State	2020 category	2020 Activity data (kt)	2020 Implied Emission Factor (t/t)	2020 CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Other Iron and Steel Production.Other non-specified	NA	NA	1		Other Iron and Steel Production.Other non-specified	NA	NO	NO	NA	NA

Member State	1990 category	1990 Activity data (kt)	1990 Implied Emission Factor (t/t)	1990 CO_2 Emissions (kt)	Member State	2020 category	2020 Activity data (kt)	2020 Implied Emission Factor (t/t)	2020 CO_2 Emissions (kt)	Method	Emission factor informa-tion
Poland	**Iron and steel production**			4959	**Poland**	**Iron and steel production**	-	-	1368		
	Steel	IE	IE	IE		Steel	IE	IE	IE	NA	NA
	Pig Iron	8657	0.12	1043		Pig Iron	3470	0.13	457	T3	CS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	11779	0.07	841		Sinter	4890	0.03	164	T2	CS
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			3075		Other	-	-	748		
	Basic Oxygen Furnace Steel	7207	0	929		Basic Oxygen Furnace Steel	4007	NO,NA	NO	T2	CS
	Electric Furnace Steel	2309	0	85		Electric Furnace Steel	4007	NO,NA	NO	T2	CS
	Open-hearth Steel	3945	1	2060		Open-hearth Steel	4007	NO,NA	NO	NA	NA
Portugal	**Iron and steel production**			440	**Portugal**	**Iron and steel production**	-	-	84		
	Steel	746	0.10	73		Steel	2203	0.04	84	T1,T3	D,PS
	Pig Iron	339	0.88	298		Pig Iron	NO	NO	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	344	0.20	69		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA

Member State	1990 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Member State	2020 category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)	Method	Emission factor informa-tion
	Other			NO		Other	-	-	NO		
Romania	**Iron and steel production**			12621	Romania	**Iron and steel production**	-	-	3513		
	Steel	9769	1.29	12621		Steel	2875	1.22	3513	T3	CS
	Pig Iron	5916	NO,IE	IE		Pig Iron	C	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	11357	NO,IE	IE		Sinter	2331	NO,IE	IE	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		
Slovakia	**Iron and steel production**			4168	Slovakia	**Iron and steel production**	-	-	3146		
	Steel	3562	1.17	4150		Steel	3119	1.01	3136	T2	PS
	Pig Iron	17	NO,IE	IE		Pig Iron	NO	NO,IE	IE	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	IE	NO,IE	IE		Sinter	IE	NO,IE	IE	NA	NA
	Pellet	IE	NO,IE	IE		Pellet	IE	NO,IE	IE	NA	NA
	Other			18		Other	-	-	10		
	EAF production of steel	311	0	18		EAF production of steel	280	0.03	10	T2	PS
Slovenia	**Iron and steel production**			44	Slovenia	**Iron and steel production**	-	-	53		
	Steel	632	0.07	44		Steel	609	0.09	53	T2	PS
	Pig Iron	NO	NO,NA	NO		Pig Iron	NO	NO,NA	NO	NA	NA
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	NO	NO	NO		Sinter	NO	NO	NO	NA	NA
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA
	Other			NO		Other	-	-	NO		

Member State	1990	Member State	2020	Method	Emission factor

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		informa-tion
Spain	**Iron and steel production**			2501	**Spain**	**Iron and steel production**	-	-	1322		
	Steel	13163	0.08	1045		Steel	11077	0.05	508	T2	CS,PS
	Pig Iron	C	C	246		Pig Iron	C	C	400	T2	CS
	Direct reduced iron	IE	IE,NA	IE		Direct reduced iron	IE	IE,NA	IE	NA	NA
	Sinter	C	C	538		Sinter	C	C	125	T2	CS
	Pellet	IE	IE,NA	IE		Pellet	IE	IE,NA	IE	NA	NA
	Other			672		Other	-	-	288		
	Flaring in iron and steel production	C	C	672		Flaring in iron and steel production	C	C	288	T2	PS
Sweden	**Iron and steel production**			2624	**Sweden**	**Iron and steel production**	-	-	2089		
	Steel	1755	0.09	156		Steel	1750	C,NA	C	T3	PS
	Pig Iron	2736	0.77	2094		Pig Iron	2846	0.60	1708	T3	PS
	Direct reduced iron	109	1.19	129		Direct reduced iron	88	C,NA	C	T3	PS
	Sinter	1058	0.20	212		Sinter	NO	NO	NO	NA	NA
	Pellet	13079	0.00	33		Pellet	24100	0.00	107	T3	PS
	Other			NO		Other	-	-	NO		
United Kingdom	**Iron and steel production**			23628	**United Kingdom**	**Iron and steel production**	-	-	10618		
	Steel	17904	0.02	389		Steel	7154	0.01	103	T2	CS
	Pig Iron	12463	1.58	19720		Pig Iron	5236	1.77	9272	T2	CS
	Direct reduced iron	NO	NO	NO		Direct reduced iron	NO	NO	NO	NA	NA
	Sinter	C	0.28	3519		Sinter	C	0.24	1243	T2	CS
	Pellet	NO	NO	NO		Pellet	NO	NO	NO	NA	NA

Member State	1990				Member State	2020				Method	Emission factor informa-tion
	category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		category	Activity data (kt)	Implied Emission Factor (t/t)	CO_2 Emissions (kt)		
	Other			NO		Other	-	-	NO		

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

As shown in the table, several countries use the notation IE for some categories. This can be explained by the fact that they make use of carbon balances and several processes occur within the same industrial plant, which makes differentiation into the various sub-categories difficult. For example, several countries include emissions from the production of pig iron (which occurs at integrated iron and steel production plants) under “steel production”.

According to the 2006 IPCC guidelines, all emissions from iron and steel production should be reported under category 2.C.1, irrespective of their role as reducing agent or fuel for energy use.

However, some countries report emissions from blast furnace gas and from basic oxygen furnace gas under 1A2a instead of 2C1 because this can be interpreted as emissions from energy supply.

Thus, for an overview of total emissions it seems to be more convenient to take into account all emissions covered by the combined category 1A2a + 2C1. Resulting emissions for this combined category are given in Table 4.38.

*Table **4**.38 CO_2 Emissions (2020) from iron and steel production: 1A2a, 2C1 and combined (sum of both categories). The column "Share 2C1" denotes the ratio of emissions under 2C1 and combined emissions.*

Member State	CO_2 emissions in kt			Share in EU-KP emissions in 2020	Share 2C1
	1A2a	2C1	Combined		
Austria	1 848	9 427	11 275	8%	84%
Belgium	1 239	2 961	4 200	3%	71%
Bulgaria	115	22	137	0%	16%
Croatia	34	5	39	0%	13%
Cyprus	0	NO	0	0%	-
Czech Republic	1 885	5 923	7 809	6%	76%
Denmark	94	NO	94	0%	-
Estonia	0	NO	0	0%	-
Finland	809	1 732	2 541	2%	68%
France	5 625	8 466	14 090	10%	60%
Germany	32 590	14 538	47 128	34%	31%
Greece	94	74	168	0%	44%
Hungary	173	1 110	1 282	1%	87%
Ireland	2	NO	2	0%	-
Italy	8 004	1 215	9 219	7%	13%
Latvia	0	NO	0	0%	-
Lithuania	NO	0	0	0%	100%
Luxembourg	264	96	360	0%	27%
Malta	NO	NO	-	-	-
Netherlands	4 150	17	4 167	3%	0%
Poland	3 710	1 368	5 078	4%	27%
Portugal	98	84	182	0%	46%
Romania	890	3 513	4 403	3%	80%
Slovakia	2 179	3 146	5 325	4%	59%
Slovenia	197	53	250	0%	21%
Spain	4 341	1 322	5 663	4%	23%
Sweden	1 197	2 089	3 287	2%	64%
United Kingdom	933	10 618	11 551	8%	92%
EU-27+UK	70 471	67 779	138 250	100%	49%
Iceland	1	0	1	0%	0%
United Kingdom (KP)	933	0	-2 652	-2%	0%
EU-KP	**70 473**	**57 161**	**124 048**	**90%**	**46%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

It can be seen that the ratio of emissions under 2C1 and combined emissions (see column "Share 2C1" in Table **4.38**) varies across countries. This indicates that the boundary between 1A2a and 2C1 is not uniformly interpreted by countries. The nine countries with largest CO_2 emissions from iron and steel production allocate their emissions in the following ways in 2020:

- Germany: Approximately 31% of emissions are reported under 2C1. This category comprises process-related CO_2 emissions (including emissions from carbonate use). However, emissions from energy-related use of top gas and converter gas are reported under the respective sub-categories of sector 1.
- France: From the 2019 inventory onwards, France changes its methodology of estimating and allocating CO_2 emissions in the iron and steel sector sub-categories (process and combustion), to be more compliant with the 2006 IPCC Guideines. While major share of emissions (84%) was

reported under 1A2a in the 2018 inventory, 60% are allocated in 2C1 in the 2020 inventory. Emissions from sinter production are reported under 1A2a.

- United Kingdom: Major share of emissions (92%) is reported under 2C1. Emissions from sintering (coke breeze and carbonates), from flared blast furnace gas and from electric and ladle arc furnances are reported under 2C1.
- Austria: 84% of emissions are reported under 2C1. Generally, all emissions from iron and steel production are reported under this category, irrespective of their role as reducing agent or fuel, but emissions related to the coke oven and to on-site power plants are reported under category 1A2a.
- Italy: Major share of emissions (87%) is reported under 1A2a. CO_2 emissions due to the consumption of coke, coal and other reducing agents used in the iron and steel industry have been accounted for as fuel consumption and reported in the energy sector. In sector 2C1, emissions are reported from carbonates used in sinter plants and in basic oxygen furnaces, emissions related to steel and pig iron scraps and emissions from graphite electrodes consumed in electric arc furnaces.
- Czech Republic: 76% of emissions are reported under category 2C1. It also includes emissions from limestone and dolomite use.
- Spain: Major share of emissions (77%) is reported under 1A2a, including emissions from coke production.
- Slovakia: 59% of emissions are reported in 2C1. Category iron and steel production includes following processes: steel production, pig iron production, sinter production and steel production in electric arc furnaces. Due to the difficult disaggregation between emissions originated from pig iron and from steel production, total CO_2 emissions from total production processes were allocated directly in steel production category.
- Poland: 27% of CO_2 emissions are reported in 2C1, including steel production (basic oxygen furnaces and electric arc furnaces), pig iron production, sinter production.

4.2.3.2 2C3 Aluminium production

This category includes PFC emissions from aluminium production. Two PFCs, tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6), are known to be emitted from the process of primary aluminium smelting. These PFCs are formed during the phenomenon known as the anode effect, when the aluminium oxide concentration in the reduction cell electrolyte is low.

Information on CO_2 emissions from Aluminium production can be found at the end of this section.

Table 4.39 summarises information by countries on emission trends for the key source PFCs from 2C3 Aluminium Production. PFC emissions from 2C3 Aluminium production account for 0.013 % of total EU-KP GHG emissions (without LULUCF) in 2020. Between 1990 and 2020, PFC emissions from this source decreased by 98 %. In 2020, Greece contributed the highest share among the EU-KPs, amounting to 24.1 % of overall emissions, followed by Iceland (19.5 %), Germany (15.6 %), Sweden (13.3 %) and France (12.5%). Of the twelve countries reporting PFC emissions under this category in 2020, nine use plant or country-specifc emission factors.

*Table **4**.39 2C3 Aluminium Production: Countries' contributions to PFC emissions and information on method applied and emission factor*

Member State	PFCs Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 149	NO	NO	-	-1 149	-100%	-	-	NA	NA
Belgium	-	-	-	-	-	-	-	-	NA	NA
Bulgaria	-	-	-	-	-	-	-	-	NA	NA
Croatia	1 240	NO	NO	-	-1 240	-100%	-	-	NA	NA
Cyprus	-	-	-	-	-	-	-	-	-	-
Czechia	-	-	-	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	-	-	-	-	-	-	-	NA	NA
Finland	NO	-	-	-	-	-	-	-	NA	NA
France	3 567	67	61	12.5%	-3 506	-98%	-6	-9%	T2,T3	CS,PS
Germany	2 889	91	77	15.6%	-2 812	-97%	-14	-15%	T3	CS
Greece	190	105	119	24.1%	-72	-38%	14	13%	T3	PS
Hungary	376	NO	NO	-	-376	-100%	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	1 975	NO	NO	-	-1 975	-100%	-	-	NA	NA
Latvia	-	-	-	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	-	-	-	-	-	-	-	-	NA	NA
Malta	-	-	-	-	-	-	-	-	-	-
Netherlands	2 638	27	26	5.3%	-2 611	-99%	-1	-4%	T2	CS
Poland	142	NO	NO	-	-142	-100%	-	-	NA	NA
Portugal	NO,NA	NO	NO	-	-	-	-	-	NA	NA
Romania	2 808	4	4	0.7%	-2 805	-100%	0	-8%	T2	D,PS
Slovakia	315	5	6	1.1%	-309	-98%	0	8%	T2	PS
Slovenia	208	12	10	2.0%	-198	-95%	-2	-18%	T3	D,PS
Spain	1 164	41	25	5.0%	-1 140	-98%	-16	-40%	T2	D
Sweden	569	49	65	13.3%	-504	-89%	16	32%	T2	D
United Kingdom	1 553	6	4	0.9%	-1 549	-100%	-2	-31%	T2	PS
EU-27+UK	**20 783**	**407**	**396**	**81%**	**-20 387**	**-98%**	**-11**	**-3%**	**-**	**-**
Iceland	495	97	96	19.5%	-399	-81%	-1	-1%	T2	D
United Kingdom (KP)	1 553	6	4	0.9%	-1 549	-100%	-2	-31%	T2	PS
EU-KP	**21 277**	**504**	**491**	**100%**	**-20 786**	**-98%**	**-13**	**-3%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

All countries reduced their emissions from this source between 1990 and 2020. France, Germany, the Netherlands, and Romania had the largest decreases in absolute terms. The decreasing trend of PFC emissions from this key source between 1990 and 2020 is due to production stop or decline and due to process improvements. The emission peak in 2002 (see Figure 13) can be explained by technological changes and sub-optimal conditions of operation (in France and in the Netherlands).

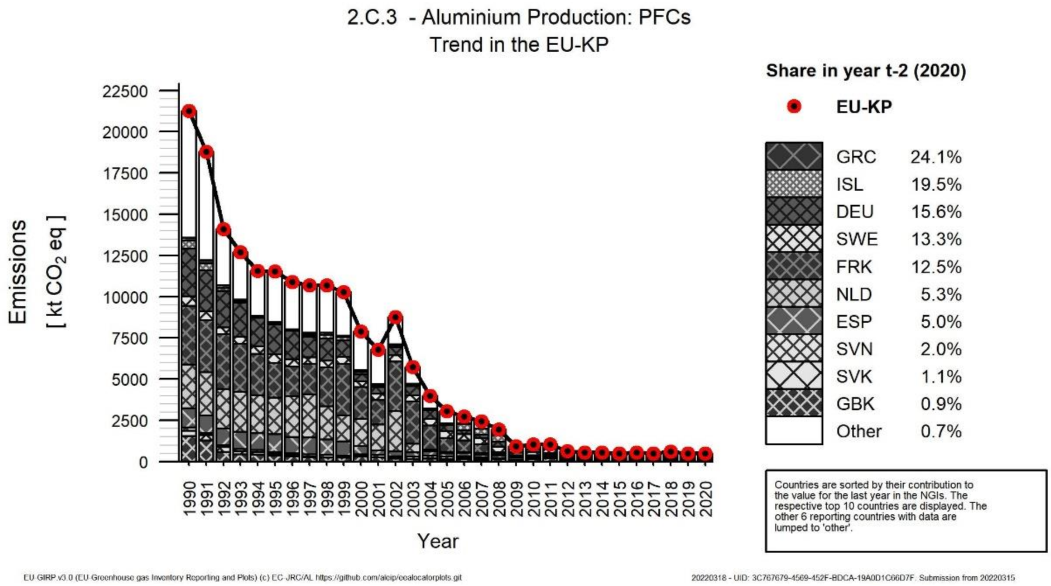
In the review of the 2014 inventory submission of the European Union, the ERT recommended that the European Union provide in the NIR adequate methodology overviews to enable the ERT to make a thorough review of the AD and EF used in the aluminium production emission estimations provided by Greece, the Netherlands and Sweden. This information is provided below. Additional information can be found in the individual NIRs (Greece: section 4.13, Netherlands: section 4.4, Sweden: section 4.4.3). An overview of methods can also be found in Annex III to this year's inventory submission.

Greece: The estimation of emissions from aluminium production is performed in close collaboration with the sole plant operating in Greece and since 2013 ETS verified reports are also provided to the inventory team. Carbon dioxide emissions from primary aluminium production are calculated using a highly detailed methodology, tracking the carbon content throughout the process. The methodology is based on the 2006 IPCC Tier 3 method, with small interventions that increase the certainty of the estimations. The equations are described in Greece's NIR. Data are provided by the plant for years 2005-2012. Since detailed data for the previous years are not available, emissions of years 1990-2004 have been recalculated using the Overlap method in line with the IPCC GPG. It should be noted that the production methodology applied is Centre Worked Prebake with Feed Point System (PFPB methodology). Data since 2013 are provided by the verified ETS reports. Aluminium production data are directly provided by the plant and are considered confidential. However, publicly available data from the US Geological Survey, the UN Commodity Statistics Database and the Greek Mining Enterprises Association are also used for QA/QC reasons. According to the recommendation made by the previous ERTs, Greece is reporting aluminium production based on these data, although the estimations are based on the more detailed and accurate production quantities provided directly by the plant. It should be mentioned that the reported values are the ones provided by the US Geological Survey, since they cover the whole of the time-series. PFC emissions estimates are based on anode effect performance by calculating the anode effect overvoltage statistic (Overvoltage method) and are provided directly to the inventory team by the sole plant operating in Greece. This methodology concerns measurements and recordings that are being performed concerning the parameters of the equation used for the CF4 emission's calculation, namely the overvoltage and the aluminium production process current efficiency. The EF is estimated based on EF=Over-Voltage Coefficient*AEO/CE. The Over-Voltage Coefficient value used by the plant is 1.16 (the updated default one of 2006 IPCC Guidelines), while the Anode Effect Overvoltage (AEO) and Current Efficiency (CE) are measured for each series of electrolytic cells (there are three series).

The Netherlands: Estimations of the PFC emissions from primary aluminium production reported by these two facilities are based on the IPCC Tier 2 method for the complete period 1990–2017. Emission factors are plant-specific and confidential and are based on measured data. Since emission year 2018 the emission data is taken from the ETS reports.

Sweden: The two different processes for aluminium production, prebaked (CWPB) and Söderberg (VSS), have substantially different emission factors for PFCs. Estimates of emissions are based on the number of ovens and the number and duration of anode effects. This activity data is considered to be of good quality. Activity data used for the PFC emission calculations, anode effects in min/oven day and production statistics, were provided by the company, and specified for the prebaked and Söderberg processes. The activity data and emissions can be found in Sweden's NIR 2022.

Figure 13 2C3 Aluminium Production: PFC emissions



Besides PFC emissions, aluminium production is a source of CO_2 emissions. Of the thirteen countries which reported CO_2 emissions from aluminium production for 2020, three use a Tier 1 method, two use a Tier 2 method, seven use a Tier 3 method and one uses a country-specific method. One country uses the default emission factor, four use country-specific emission factors and eight use plant-specific emission factors (Table **4.40**). Further details, e.g. on assumptions made by the various countries, can be found in the countries' NIRs.

Table 4.40 2C3 Aluminium Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	150	5	5	0.1%	-145	-97%	0	-1%	T3	PS
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	119	NO	NO	-	-119	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	534	667	670	15.7%	136	26%	3	0%	T3	PS
Germany	1 012	694	723	16.9%	-289	-29%	29	4%	T3	CS
Greece	225	291	294	6.9%	69	30%	3	1%	CS	CS
Hungary	128	NO	NO	-	-128	-100%	-	-	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	359	NO	NO	-	-359	-100%	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	408	132	115	2.7%	-294	-72%	-18	-13%	T1a	D
Poland	78	NO	NO	-	-78	-100%	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NA	NA
Romania	268	329	315	7.4%	47	17%	-14	-4%	T3	PS
Slovakia	121	275	239	5.6%	117	97%	-36	-13%	T3	PS
Slovenia	170	111	73	1.7%	-97	-57%	-38	-34%	T2	D,PS
Spain	610	393	354	8.3%	-256	-42%	-38	-10%	T2,T3	D,PS
Sweden	133	177	172	4.0%	39	30%	-5	-3%	T2	PS
United Kingdom	450	61	55	1.3%	-395	-88%	-6	-9%	T1	CS
EU-27+UK	**4 767**	**3 134**	**3 015**	**71%**	**-1 752**	**-37%**	**-120**	**-4%**	**-**	**-**
Iceland	139	1 276	1 261	29.5%	1 122	806%	-15	-1%	T3	PS
United Kingdom (KP)	450	61	55	1.3%	-395	-88%	-6	-9%	T1	CS
EU-KP	**4 906**	**4 410**	**4 276**	**100%**	**-630**	**-13%**	**-134**	**-3%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'

4.2.3.3 2C7 Other

Under this category, various emissions are reported which cannot be attributed to another category under 2C. Specifically, this includes the process emissions from the non-ferro sector (including lead and zinc) in Belgium, Silicium production in Spain, Copper and nickel smelting in Finland, emissions of CO_2 from one plant producing copper, lead and zinc, and one metal recycling plant mainly producing lead by melting used batteries and recovering the lead in Sweden and CO_2 emissions from anode burn-off during the baking process of anodes (used for aluminium production) in Slovenia.

Information on the emissions from this category is given in the overview table in chapter 4.2.8.

4.2.4 Non-energy products from fuels and solvent use (CRF Source Category 2D)

This source category includes greenhouse gas emissions from non-energy products from fuel and solvent use. In 2020, this source category is not a key-category. However, this sector used to be a key category therefore this section is kept in the EU NIR.

Table 4.41 summarises information by countries on total GHG emissions. Between 1990 and 2020, GHG emissions from 2D non-energy products from fuels and solvent use decreased by 27.7 %. The absolute decrease of GHG emissions was largest in France, Germany and Italy (in descending order).

Table 4.41: 2D Non-energy products from fuels and solvent use: countries' contributions to total GHG, CO_2, N_2O- and CH_4 emissions

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt		N2O emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020	1990	2020
Austria	349	154	349	154	NA	NA	NA	NA
Belgium	202	105	202	105	NO,NA	NO,NA	NO,NA	NO,NA
Bulgaria	169	84	169	84	NO,NA	NO,NA	NO,NA	NO,NA
Croatia	176	87	176	87	NA	NA	NA	NA
Cyprus	1	4	1	4	NE,NA	NE,NA	NE,NA	NE,NA
Czechia	126	133	126	133	NA,NO	NO,NA	NA,NO	NO,NA
Denmark	166	169	166	168	0	0	0	0
Estonia	36	32	36	32	NO	NO	NO	NO
Finland	220	131	218	130	2	1	0	0
France	2 051	1 070	2 048	1 068	1	2	1	0
Germany	2 983	1 928	2 982	1 927	1	1	NA	NA
Greece	130	62	130	62	NA,NO	NO,NA	NA,NO	NO,NA
Hungary	202	121	202	121	NA,NO	NO,NA	NA,NO	NO,NA
Ireland	95	101	95	101	NO	NO	NO	NO
Italy	1 712	1 091	1 712	1 091	NA,NO	NO,NA	NA,NO	NO,NA
Latvia	44	43	44	43	NO,NA	NO,NA	NO,NA	NO,NA
Lithuania	41	55	41	55	NO	NO	NO	NO
Luxembourg	21	29	21	29	NO	NO	NO	NO
Malta	4	4	4	4	NA	NA	NA	NA
Netherlands	188	335	188	335	NO,NA	NO,NA	0	0
Poland	378	715	378	715	NA,NO	NO,NA	NA,NO	NO,NA
Portugal	248	224	248	224	NO,NA	NO,NA	NO,NE,NA	NO,NE,NA
Romania	659	544	659	544	NO,NA	NO,NA	NO,NA	NO,NA
Slovakia	50	30	50	30	NO,NA,NE	NO,NE,NA	NO,NA,NE	NO,NE,NA
Slovenia	8	31	8	31	NA	NA	NA	NA
Spain	932	738	932	738	NO,NA	NA	NO,NA	NA
Sweden	393	370	393	370	NA	NA	NA	NA
United Kingdom	553	379	553	379	NO,NE,IE	NO,NE,IE	NO,IE	NO,IE
EU-27+UK	**12 137**	**8 770**	**12 131**	**8 764**	**4**	**4**	**2**	**1**
Iceland	7	6	7	6	NA	NO,NA	NA	NO,NA
United Kingdom (KP)	553	379	553	379	NO,NE,IE	NO,NE,IE	NO,IE	NO,IE
EU-KP	**12 144**	**8 776**	**12 138**	**8 771**	**4**	**4**	**2**	**1**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.42 provides information on the contribution of countries to EU recalculations of CO_2 emissions from 2D Non-energy products from fuels and solvent use for 1990 and 2019, including main explanations.

Table 4.42: 2D Non-energy products from fuels and solvent use: Contribution of countries to EU recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 and percent of sector total)

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	0.1	0.1	-	-
Belgium	-0.3	-0.1	-0.6	-0.5	-	-

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Bulgaria	-	-	-	-	-	-
Croatia	2.1	1.2	-3.4	-3.5	Activity data and emissions aligned with the IIR report	Activity data and emissions aligned with the IIR report
Cyprus	-	-	0.0	0.1	-	-
Czechia	-	-	10	6.5	-	Updated activity data in official CzSO balance
Denmark	0.1	0.0	1.7	1.0	The majority of recalculations in this category are made for Solvent use (1990-2019). Recalculations also occur for Paraffin wax use (2018-2019) and minor recalculations for Asphalt roofing (2018-2017) and Urea based catalysts (2001-2019). Changes made for Urea based catalysts are caused by the annual up-date of the traffic model. For solvents and NEU, updated activity data from Statistics Denmark.	
Estonia	-	-	0.0	0.1	-	Emissions were recalculated because EstEA made activity data corrections.
Finland	-	-	-	-	-	-
France	10	0.5	-3.3	-0.3	-	-
Germany	-0.6	-0.0	-81	-4.0	-	see NIR, chapters 4.5.1.4, 4.5.2.4, 4.5.3.5 and 4.5.6.5
Greece	-	-	35	98	-	Updated data.
Hungary	-	-	4.8	4.8	-	Revised AD based on the latest ESIG report (2D3a) and on the latest national statistics (2D3d)
Ireland	1.0	1.1	3.6	3.6	-	-
Italy	-	-	3.7	0.3	-	An error occurred and one category was not added to the total, and it will be corrected in the next submission. No recalculation occurred for this category.
Latvia	0.0	0.1	0.8	1.8	-	Recalculations in 2.D.1 Lubricant use are made due to precised Activity data. NMVOC emissions from Solvent use sector were recalculated taking into account that activity data for year 2019 was specified and therefore emissions were recalculated for this year. Since 2022 submission emissions from use of tobacco combustion is calculated for time period 1990 – 2020. Recalculations in 2.D.3. Urea use are made due to precised Activity data.
Lithuania	-	-	-0.5	-0.8	-	Recalculation of CO_2 emissions from lubricants use (year 2019) have been done due to updated statictical activity data on consumption of lubricant oil for non energy purposes.
Luxembourg	-	-	0.0	0.0	-	-
Malta	-	-	0.0	0.5	-	-
Netherlands	-	-	8.9	2.7	-	Final energy statistics
Poland	2.3	0.6	8.3	1.2		Update of NMVOC emission
Portugal	4.9	2.0	-34	-14.4		Methodolgoical chanes in minor 2D3 sub-sectors fort he whole time-series
Romania	-6.9	-1.0	6.1	1.1		Recalculations have been made for the 2019 year due to the recalculation of the values for NCV and EFox for petroleum coke (errors were identified in the calculation formulas for NCV and EFox for this year). (CRF Category 2.D.3)
Slovakia	-	-	-0.8	-2.2	-	-
Slovenia	0.0	0.1	-1.9	-5.4	-	Correction of emissions from urea and lubricants due to the new estimates from road transport

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						calculated with the new Copert 5 version.
Spain	11	1.2	-31	-3.8	Updating of the methodology for estimating emissions from road transport	
Sweden	-	-	-37	-9.1	-	Updated activity data
United Kingdom	-0.0	-0.0	-0.9	-0.2	-	No significant recalculation
EU27+UK	**24**	**0.2**	**-112**	**-1.2**		
Iceland	0.4	5.3	0.5	8.9	-	Updated AD for candle export (2D2), AD change (population, consistenty reasons) in 2D3f and tier update in 2D3a.
United Kingdom (KP)	-0.0	-0.0	-1.0	-0.2	-	No significant recalculation
EU-KP	**24**	**0.2**	**-111**	**-1.2**		

4.2.4.1 2D1 Lubricant Use

CO_2 emissions from this sector amounted to approximately 0.06% of total GHG emissions (without LULUCF) in 2020. CO_2 emissions from this sector decreased by 34.3% since 1990.

4.2.4.2 2D3 Other non-energy products from fuels and solvent use

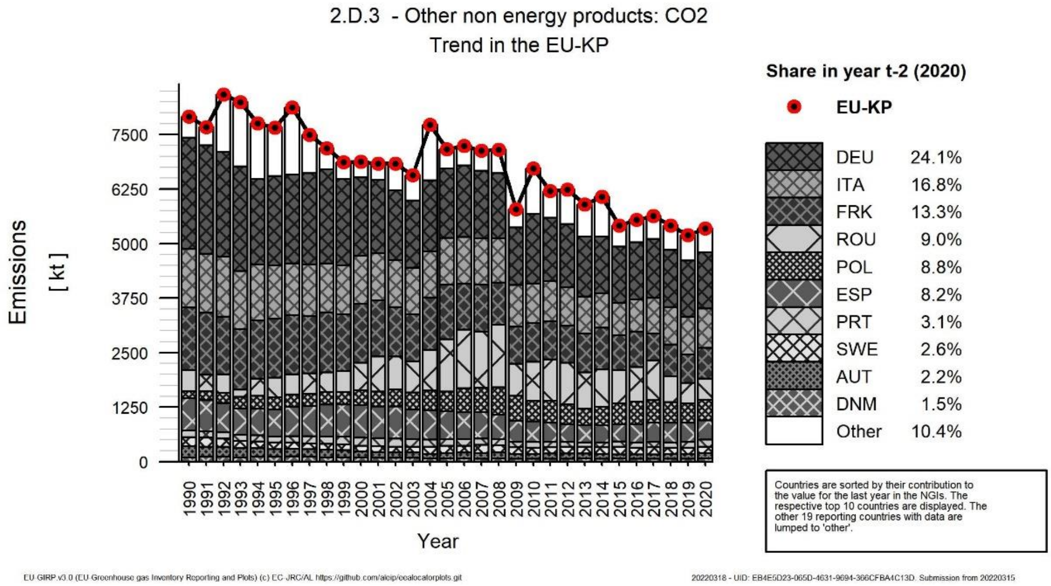
CO_2 emissions from this sector amounted to approximately 0.14% of total GHG emissions (without LULUCF) in 2020. France, Germany, Italy, Spain, Romania and Poland together account for 80% of all emissions in the EU-KP. CO_2 emissions from this sector decreased by 32% since 1990, the biggest reductions in absolute terms occurred in Germany and France (respectively -1259 and -723 kt). CO_2 emissions decreased in ten countries, are stable in two countries and increased in the remaining seventeen countries between 1990 and 2020. The peak in 2002 is due to an increase of CO_2 emissions in the United Kingdom. In addition, some countries do not report emissions in this category for 1990, but report emissions, mainly from urea use in the transport sector, for more recent years.

*Table **4**.43 2D3 Other non-energy products from fuels and solvent use: countries' contributions to CO_2 emissions*

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2	%	kt CO2	%		
Austria	252	111	120	2.2%	-132	-52%	10	9%	T1,T2	CS,D
Belgium	NO,NA	31	31	0.6%	31	∞	0	-1%	M,T3	CS,OTH
Bulgaria	87	72	72	1.3%	-16	-18%	0	-1%	T1,T2	CR,D
Croatia	135	72	67	1.3%	-67	-50%	-5	-7%	OTH,T1	D
Cyprus	NO,NE,IE	0	1	0.0%	1	∞	0	35%	D	D
Czechia	NO,NA	26	25	0.5%	25	∞	-1	-5%	T1	D
Denmark	94	68	79	1.5%	-15	-16%	12	17%	CS,T2,T3	CS,D,OTH
Estonia	18	22	26	0.5%	7	40%	4	18%	D,T2	D
Finland	NO	14	15	0.3%	15	∞	1	7%	T1	D
France	1 434	650	711	13.3%	-723	-50%	61	9%	T1,T2	CS,D,PS
Germany	2 551	1 292	1 292	24.1%	-1 259	-49%	0	0%	CS,D	D
Greece	NO,NA	8	7	0.1%	7	∞	0	-6%	D	D
Hungary	116	74	71	1.3%	-45	-39%	-4	-5%	T1,T2	D
Ireland	52	56	52	1.0%	0	-1%	-4	-8%	T1,T2	D
Italy	1 343	870	897	16.8%	-446	-33%	26	3%	R,CS,T2,T3	R,CS,M,PS
Latvia	21	27	26	0.5%	5	23%	-1	-5%	CS,D,T1,T2	D,PS
Lithuania	34	43	39	0.7%	4	13%	-4	-9%	T1,T3	CR,D
Luxembourg	14	27	22	0.4%	8	57%	-4	-16%	CS,M	CS,D
Malta	0	1	1	0.0%	1	2928%	0	10%	T1	CR,D
Netherlands	NO	30	30	0.6%	30	∞	0	1%	T3	CS
Poland	164	435	473	8.84%	309	188%	38	9%	T1,T3	D
Portugal	152	130	164	3.1%	12	8%	34	26%	CR,NO,T2	CS,NO,OTH
Romania	484	473	480	9.0%	-3	-1%	8	2%	CR,D	CR,CS,PS
Slovakia	NO	9	8	0.2%	8	∞	-1	-6%	CS	CS
Slovenia	NO,NA	6	6	0.1%	6	∞	-1	-9%	M	M
Spain	739	443	437	8.2%	-303	-41%	-6	-1%	T1,T2	D
Sweden	217	140	141	2.6%	-76	-35%	1	1%	T1,T3	CS,D
United Kingdom	NE,NO	58	53	1.0%	53	∞	-5	-8%	T3	CR,D
EU-27+UK	**7 909**	**5 187**	**5 345**	**100%**	**-2 564**	**-32%**	**158**	**3%**	**-**	**-**
Iceland	3	4	4	0.1%	1	31%	0	3%	D,T1	D
United Kingdom (KP)	NO,NE	58	53	1.0%	53	∞	-5	-8%	T3	CR,D
EU-KP	**7 911**	**5 191**	**5 349**	**100%**	**-2 563**	**-32%**	**158**	**3%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 14 2D3 Other non-energy products from fuels and solvent use: CO_2 emissions



For this category, it is not useful to give an average EF across the countries because of the different methods used, and because of the fact that this category is split into many subcategories with varying EFs. Table **4.43** provides an overview of countries' reporting of CO_2 emissions from 2D3 in 2020.

*Table **4**.44 2D3 Other non-energy products from fuels and solvent use: Reporting of CO_2 emissions by countries*

MS	Category	kt
AUT	3. Other (please specify)	120.22
	Solvent use	80.67
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used as a catalyst	39.55
BEL	3. Other (please specify)	30.82
	Solvent use	NA
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used as a catalyst	30.82
	Unspecified	NO
BGR	3. Other (please specify)	71,55
	Solvent use	67,60
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Other chemical products	3,95
CYP	Other (please specify)	0.53
	Dry cleaning	IE
	Coating applications	IE
	Chemical products	IE
	Asphalt roofing	IE
	Domestic solvent use including fungicides	IE
	Road paving with asphalt	IE
	Printing	IE
	Urea-based catalysts	0.53
	Other	IE
CZE	3. Other (please specify)	24.97

MS	Category	kt
EST	3. Other (please specify)	25.87
	Solvent use	24.70
	Road paving with asphalt	0.05
	Urea based catalysts for motor vehicles	1.13
FIN	3. Other (please specify)	14.69
	Solvent use	NO
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Use of urea-based catalysts	14.69
FRK	3. Other (please specify)	710.91
	Solvent use	288.99
	Road paving with asphalt	NA
	Asphalt roofing	NE
	Other incl. urea use in SCR	421.92
GBE	3. Other (please specify)	53.18
	Solvent use	NE
	Urea use (road transport)	53.18
	Petroleum coke use	NO
GRC	3. Other (please specify)	7.40
	Solvent use	NA
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Urea used as a catalyst	7.40
HRV	3. Other (please specify)	67.43
	Solvent use	61.07
	Road paving with asphalt	0.06
	Asphalt roofing	0.01

MS	Category	kt
LTU	3. Other (please specify)	38.83
	Solvent use	37.75
	Road paving with asphalt	0.00
	Asphalt roofing	0.02
	Urea-based catalyst	1.06
LUX	3. Other (please specify)	22.20
	Solvent use	11.43
	Urea-based catalysts	10,77
LVA	3. Other (please specify)	25.76
	Urea use	1.27
	Solvent Use	24.38
	Asphalt roofing	0.05
	Road paving with asphalt	0.06
MLT	3. Other (please specify)	0.70
	Solvent use	NA
	Road paving with asphalt	0.01
	Urea for denoxification	0.69
NLD	3. Other *(please specify)*	29.87
	Ureum use in SCR	29.87
POL	3. Other (please specify)	472,93
	Solvent use	401,93
	Urea used as catalyst	71.00
PRT	3. Other (please specify)	164.30
	Solvent use	143.98
	Road paving with asphalt	11.35
	Urea-based catalysts	8.97
ROU	3. Other (please specify)	480.46
	Solvent use	108.05

MS	Category	kt
	Solvent use	NO
	Road paving with asphalt	NA
	Urea used as catalyst	24.97
DEU	3. Other (please specify)	1291.75
	Solvent use	1020.92
	Road paving with asphalt	NE
	Asphalt roofing	NE
	AdBlue	270.83
DNM	3. Other (please specify)	79.15
	Solvent use	69.16
	Road paving with asphalt	0.88
	Asphalt roofing	0.02
	Urea used in catalysts	9.09
ESP	3. Other (please specify)	436.57
	Solvent use	380.70
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea-based catalytic converter	55.87

MS	Category	kt
	Urea based CC	6.29
HUN	3. Other (please specify)	70.91
	Other (please specify)	70.91
	Indirect CO_2 from solvents	62.66
	Urea based catalysts	8.25
IRL	3. Other (please specify)	52.07
	Solvent use	40.00
	Urea used as a catalyst	12.07
ITA	3. Other (please specify)	896.83
	Solvent use	825.42
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Urea used in power plants	10.61
	Urea used in engines	60.79

MS	Category	kt
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Petroleum coke use	377.70
	Urea use	1.77
SVK	3. Other (please specify)	8.26
	Solvent use	NO
	Road paving with asphalt	NO
	Asphalt roofing	NO
	Urea catalytic converters	8.26
SVN	3. Other (please specify)	5.67
	Asphalt roofing	NA
	Road paving	NA
	Solvent use	NA
	Urea based catalyst	5.67
SWE	3. Other (please specify)	141.05
	Road paving with asphalt	NA
	Asphalt roofing	NA
	Solvent use	106.65
	Urea used as catalyst	34.40
ISL	Other (please specify)	3.79
	Chemical products	0.02
	Decreasing	0.09
	Dry cleaning	0.00
	Printing	0.17
	Coating applications	0.97
	Organic preservative	0.08
	Creosotes	NO
	Domestic solvent use including fungicide	1.97
	Urea used as catalyst	0.46

4.2.5 Electronics Industry (CRF Source Category 2.E)

2.E Electronics Industry includes the following subcategories: 2.E.1 Integrated Circuit or Semiconductor, 2.E.2 TFT Flat Panel Display, 2.E.3 Photovoltaics, 2.E.4 Heat Transfer Fluid and 2.E.5 Other. Out of these, the most important emission source in Europe is the production of integrated circuits and semiconductors (2.E.1), which relates to highly specialized industrial processes.

Emissions from photovoltaics industry and heat transfer fluids are reported by very few Member States only. Manufacture of TFT Flat Panel Displays does currently not take place in the EU.

The gases emitted include in particular PFCs, SF_6 and NF_3 while HFC emissions occur to relatively small extent only. Attempts have been made in recent years to reduce emissions through process optimization and replacement of certain high-GWP gases, when feasible.

4.2.6 Product uses as substitutes for ODS (CRF Source Category 2.F)

This emission source category relates to the consumption of halocarbons (HFCs and PFCs) in different applications.

HFCs are predominantly serving as alternatives to ozone depleting substances (ODS) that are being phased out under the Montreal Protocol and have been introduced to the EU market first at the end of 1990. Due to their high global warming potentials, HFCs are addressed by the so-called MAC Directive, which bans the use of HFCs with a GWP >150 in new passenger cars since 2017, and the EU F-gas Regulation No. 517/2014, which establishes a phase down scheme for HFCs and other measures to limit use and emissions of F-gases. The EU F-gas Regulation is currently subject to review again and new measures are expected from ca. 2024 onwards.

The main applications of halocarbons include refrigeration and air conditioning, foam blowing, fire protection, aerosols, solvents as well as some other applications. PFCs are used to minor extent in this subcategory nowadays but mainly in semiconductor manufacture (2.E.1).

The source category 2.F Product uses as substitutes for ODS includes two key categories which occur in all countries: Refrigeration and air conditioning (2.F.1) and aerosols (2.F.4, KC only with LULUCF), especially MDIs. The use of HFCs as fire extinguishing agents (2.F.3) used to be common but decreased widely in recent years due to restrictions at EU level through the F-gas Regulation and national rules.

Table 4.45: Key categories for sector 2F (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
2.F.1 Refrigeration and Air conditioning: no classification (HFCs)	13	80077	T	0	L	99%
2.F.4 Aerosols: no classification (HFCs)	2	3159	T	0	0	92%

Table.**4.46** provides information on the contribution of countries to EU-KP recalculations in HFC from 2.F Product uses as substitutes for ODS for 1990 and 2019 and main explanations for the largest recalculations in absolute terms.

Table.4.46 2F Product uses as substitutes for ODS: Contribution of MS to EU recalculations in HFC for 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and percent)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	101	5.8		2.F.1.a, 2.F.1.c: An inquire on HFC use in supermarkets was conducted to update this part of the sub-category “Commercial refrigeration” in the refrigerant model. Consumption, lifetime, and leakage rates for supermarkets were updated for 2010 onwards. Improvements of refrigerant model. 2.F.1.d: The estimation of stock was revised by correcting a transcription error, which led to recalculations from 2013 onwards. 2.F.1.e: A minor correction of stocks for trains led to recalculations from 2005 onwards. 2.F.1.f: Updated statistical data for heat pumps placed on the market in 2019 became available, which led to a minor recalculation. 2.F.4: A minor correction of a transcription error.
Belgium	-	-	107	4.1		2.F.1.a: Change resulting from a reallocation of refrigerant between Commercial refrigeration and Stationary air conditioning. 2.F.1.f: Recalculation of time series based on updated information on split between different equipment types. Emissions calculated based on bank at the start of the year. 2.F.1.b: Calculation bank adjusted affecting emissions. 2.F.1.d: Small adjustment stocks of equipment in 2019. 2.F.1.e: Adjustment disposal emissions from buses.
Bulgaria	-	-	4 650	255.7		There was a TC from TERT in 2020. 2.F.1.f: A recalculation was made after the emission inventory review in 2020. The equipment lifetime factor was changed to 15 years.
Croatia	-	-	998	180.7		2.F.1, 2.F.2, 2.F.3: Study results which includes the preparation of data on activities to improve the calculation of greenhouse gas emissions from subsectors 2.F was used in NIR 2022.
Cyprus	-	-	16	4.5		2.F.1: Correction on the formula calculating Bank in Existing Equipment (Bt) for each gas and each year.
Czechia	-	-	361	9.6		2.F.1.e: Recalculation due to updated information in activity data in model COPERT for calculating of HFC-134a emissions from stock in whole time series and emissions from disposal for years 2018–2020. There is new information about amount of vehicles available which changes reported data.

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Denmark	-	-	-	-		
Estonia	-	-	2.0	0.9		2.F.1: The recalculations were because of 1) stock of reefer containers (2.F.1.d), 2) stock and decommissioned domestic refrigerators were changed because more accurate source data was obtained, 3) the amounts of R-134a filled into new industrial refrigeration equipment were changed because of new data was obtained. 2.F.2: New data on HFC-containing spray foams sold in Estonia were obtained from a survey. 2.F.3: Service companies reported additional stock that has not accounted before.
Finland	-	-	-124	-11.0		2.F.1: End-of-life emission factor update and activity data corrections.
France	-	-	-1 153	-8.2		2.F.1.a: A correction has been applied to the retrofit emissions calculation method in the fluorinated gases tool. 2.F.1.c: The calculation method for industrial refrigeration was completely reviewed this year and a large survey was carried out. A reduction in refrigerant charges over time has been taken into account, as well as a greater high penetration of ammonia over all the years, explaining the drop in HFC emissions. 2.F.1.f: Update of production of chillers and heat pumps in 2019. 2.F.4: Update of sales of pharmaceutical aerosols.
Germany	-	-	-288	-3.0		2.F.1: Correction of static data on charges, refrigerant fractions, percentages of automobiles with air conditioners, and input data, for the period as of 2006. 2.F.2: Correction of domestic consumption, and first-time data collection pursuant to the Environmental Statistics Act (Umweltstatistikgesetz), for the period as of 2005.
Greece	-	-	17	0.3		2.F.1, 2.F.4: Updated activity data.
Hungary	-	-	25	1.2		2.F.1.e: Correction of emission data. 2.F.2: Revision of activity data.
Ireland	-	-	0.7	0.1		2.F.1: Revised statistics on number of units of air conditioners and heat pumps. 2.F.4: Updated proxy activity data reflect the change in the UK inventory to take into account of the ban on HFC with a GWP > 150.
Italy	-	-	70	0.4		2.F.1: Update of activity data by gas as a consequence of the addition of R-448A, R-449A and R-452A gas consumptions previously considered as R-404A and R-507A.
Latvia	-	-	0.1	0.0		2.F.1: Recalculations were done due to precised activity data.

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Lithuania	-	-	-35	-6.1		2.F.1.b, 2.F.1.d, 2.F.1.e: Recalculations have been done based on the report of "Analysis and verification of the inventory of fluorinated greenhouse gases" (2021 study) results. 2.F.1.b: Operation EF (0.7% is used instead of 0.4%) and the initial charge remaining at system disposal (refrigerators and freezers) were updated (90% is used instead of 80%). 2.F.1.d: The assumptions on the distribution of refrigerants were updated: F-gases used for 1993-2014– HFC-134a and R404A, and since 2015 refrigerant R452A was included. Furthermore, the operation emission factor has been updated (EF-25% since 2020) and emissions from vehicles manufacturing were included (2018-2019). 2.F.1.e: Recalculations of HFCs emissions for 2012-2019 have been done and assumptions on the share of vehicles equipped with MAC systems by category and year of production since 2018 were updated. 2.F.4.a: Recalculations have been done based on the report of "Analysis and verification of the inventory of fluorinated greenhouse gases" (2021 study) results. Activity data on metered dose inhalers with HFC-227ea use were additionally included in the NIR (2014-2019).
Luxembourg	-	-	-2.6	-4.3		2.F.1, 2.F.2, 2.F.4: Activity data revision.
Malta	-	-	-23	-8.8		Revised estimate of recovered HFC, affecting 2.F.1.a and 2.F.1.f. Revised activity data (number of vehicles), affecting 2.F.1.d and 2.F.1.e. Revised activity data (bulk HFC imports), affecting 2.F.1.f. Emissions of HFO from 2.F.1.a, which were reported under "Unspecified mix of HFCs" were deleted. 2.F.3: Revised activity data (consumption of HFCs in fire fighting equipment).
Netherlands	-	-	-382	-26.6		The 2018 figure of 2F1 (HFC´s from stationary refrigeration) was replaced by the final value. The 2019 and 2020 figures are kept equal to last year for which figures are available (2018). As a result of the use of the new estimation method, the series 2F6 (HFC´s from other uses) was recalculated over the period 2015-2020.

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Poland	-	-	1 667	44.5		2.F.1.a, 2.F.1.f: Revision of parameters in reaction to recommendation of last ESD Review. F-gases reports were reanalyzed and revised structure of equipment was applied in estimates for commercial refrigeration and stationary AC. This revision resulted in significant increase of implied product life factor for both sub categories.
Portugal	-	-	2.5	0.1		2.F.1, 2.F.2, 2.F.4: Update of activity data.
Romania	-	-	-339	-15.0		2.F.1.e: Recalculations of HFC emissions have been made for the 1996-2019 period due to improvements in activity data for the rail transport. 2.F.1.f: Recalculations have been made for the period 2015-2019 due to the change in the disposal loss factor used to estimate the actual emissions from disposal (the default recovery assumption of 85% was adopted). 2.F.3: Recalculations have been made for the 2009-2019 period due to improvement in activity data regarding the quantity of banks in the fire protection equipment.
Slovakia	-	-	-	-		
Slovenia	-	-	1.0	0.3		2.F.1, 2.F.4: Improved activity data.
Spain	-	-	40	0.9		2.F.1: Methodological change applied in 2.F.1.b (consider that no recharging occurs in this equipment and estimate decreasing emissions since 2015 over the next 16 years). 2.F.1.e: Due to an error in the interpretation of the comments of the ESD 2020 review, a recalculation was applied in the 2021 edition, which has been revised and rejected in this edition. Reverted to the recovery emissions estimate from the 2020 edition.
Sweden	-	-	2.1	0.2		2.F.1: Corrected and updated activity data led to updated emissions for 2015-2019. 2.F.2: Updated activity data for 2019. 2.F.3: Minor correction of activity data for 2019.
United Kingdom	0.0	0.0	3.8	0.0	No significant recalculations.	No significant recalculations.
EU27+UK	**0.0**	**0.0**	**5 719**	**6.2**		
Iceland	-	-	-5	-2.2		2.F.1.d: Changed lifetime of equipment in fishing ships. 2.F.1.d: Updated AD (number of reefers). 2.F.1.a, 2.F.1.c, 2.F.1.d: Changed distribution of the remaining

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						unallocated blends over the categories.
United Kingdom (KP)	0.0	0.5	219	1.7	No significant recalculations.	Recalculations mainly in 2.F.1.f emissions from stocks and disposal
EU-KP	**0.0**	**0.3**	**5 929**	**6.4**		

For 2.F Product uses as substitutes for ODS, table 1 summarizes information by Member States on emission trends of total GHG emissions as well as on HFCs and PFCs. SF_6 and NF_3 are not used in this subcategory. It should be noted that the amounts reported as “unspecified mix of HFCs and PFCs” are not shown in the table but also need to be taken into account in the total greenhouse gas emission estimates.

Table.**4**.47 2F Product uses as substitutes for ODS in 1990 and 2020: Member States and EU GHG emissions from this category and their split into HFC and PFC emissions

Member State	GHG emissions in kt CO2 equivalents		HFC emissions in kt CO2 equivalents		PFC emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020
Austria	NO	1 754	NO	1 754	NO	NO,IE
Belgium	NO	2 514	NO	2 514	NO	0
Bulgaria	NO	1 704	NO	1 704	NO	0
Croatia	NO	1 680	NO	1 680	NO	NO
Cyprus	NE,NO	358	NO,NE	358	NO	NO
Czechia	NO	4 020	NO	4 019	NO	1
Denmark	NO	335	NO	335	NO	0
Estonia	NO	185	NO	185	NO	-
Finland	0	972	0	971	NO	1
France	IE,NO	11 634	NO,IE	11 634	-	-
Germany	NA,IE,NO	8 760	NO,IE,NA	8 756	IE,NA	4
Greece	NO	5 152	NO	5 123	NO	30
Hungary	0	2 192	0	2 189	NO	3
Ireland	NO	689	NO	689	NO	NO
Italy	NO	15 861	NO	15 861	NO	NO
Latvia	NO	249	NO	249	NO	NO
Lithuania	NO	508	NO	508	NO	NO
Luxembourg	0	54	0	54	-	-
Malta	NE,NO	272	NO,NE	272	NO	NO
Netherlands	NO	1 033	NO	1 033	NO	NO
Poland	NO	5 231	NO	5 221	NO	10
Portugal	NA	3 358	NA	3 334	NA	24
Romania	0	1 989	0	1 989	NO	0
Slovakia	NO	679	NO	679	NO	NO
Slovenia	NO	295	NO	295	NO	NO
Spain	NO	5 175	NO	3 727	NO	7
Sweden	6	938	6	938	NO	NO
United Kingdom	8	11 662	8	11 662	NO	NO
EU-27+UK	**15**	**89 252**	**15**	**87 731**	**NA,IE,NO**	**80**
Iceland	0	198	0	198	NO	0
United Kingdom (KP)	8	11 960	8	11 960	NO	NO
EU-KP	**15**	**89 747**	**15**	**88 227**	**NA,IE,NO**	**80**

Abbreviations explained in the Chapter ‘Units and abbreviations’. Spain also reports emissions of “unspecified mix of HFCs and PFCs” for 2.F.1.a Commercial refrigeration and 2.F.1.c Industrial refrigeration in 2011-2020 (in total 1441 kt CO_2 equivalents in 2020). In Spain, Law 16/2013 created a national Tax on Fluorinated Greenhouse Gases. The tax rate depends on the GWP of the employed gas or gas blend. This Tax scheme foresees codes *for many blends of refrigerants, but the new ones do not have an assigned code, and their data are registered as "unspecified mix of HFCs and PFCs". By knowing the total tax payments under "unspecified mix of HFCs and PFCs" and the total quantity of "unspecified mix", the yearly average GWP for the "unspecified mix of HFCs and PFCs" can be calculated. This average GWP allows to estimate the emissions in CO_2 equivalents, but these cannot be split into individual gases in the CRF tables, because they come from a mix of different blends, with different compositions. Spain is the only country reporting this and therefore no extra column for the mix of HFC and PFC emissions have been included in the table. Pease note that consequently HFC and PFC emissions for the year 2020 do not add up to the total GHG emissions for Spain and EU-27+UK or EU-KP.*

F-gas emissions from 2.F Product uses as substitutes for ODS account for 2.4% of total EU-KP GHG emissions (without LULUCF) in 2020. HFC emissions account for the lion's share of 2.F emissions (98%) and were in 2020 about 5700 times higher than in 1990. The main reason for this is the phase-out of ODS such as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and halons under the Montreal Protocol and the subsequent replacement of these substances by HFCs (mainly in refrigeration, air conditioning, foam production, fire protection and as aerosol propellants). Moreover, refrigeration and air conditioning sectors have also grown to some extent in Europe in the last decades.

Table**.4.47** shows the sub-categories of HFC-gas emissions from 2.F Product uses as substitutes for ODS by countries. It highlights that 2.F.1 Refrigeration and Air Conditioning is by far the largest sub-category accounting for 91% (EU-27+UK) of HFC emissions in this source category. While ODS were formerly widely used also as aerosols and foam blowing agents, the subcategories 2.F.4 Aerosols/Metered Dose Inhalers contribute today 3.6% and 2.F.2 Foam blowing agents approximately 2.4%. Emissions from fire protection relate to 3.0% of HFC emissions from 2.F in 2020.

The EU F-gas Regulation 517/2014 sets out several measures to reduce use and emissions of F-gases with a focus on HFCs. These measures include restrictions of the bulk supply of HFCs on the EU market (the so called HFC phase down) starting from 2015. The following schedule for supply reductions was established: 100% in 2015, 93% in 2016-2017, 63% in 2018-2020, 45% in 2021-2023, 31% in 2024-2026, 24% in 2027-2029, 21% in 2030. This mechanism led to significant price increases for HFCs on the EU market and promoted the uptake of alternatives to HFCs in many applications.

Other important measures of the F-gas Regulation relate to placing on the market bans for certain products (Annex III), for example stationary refrigeration equipment containing high-GWP gases, which were partly implemented by industry ahead of the prohibition dates and possibly due to the price increases under the HFC phase down scheme.

Table.4.48 2F Product uses as substitutes for ODS: Countries' sub-categories of HFC emissions (kt CO_2 equivalents)

Member State	**2.F Product uses as substitutes**	2.F.1 Refrigeration and air conditioning	2.F.2 Foam blowing agents	2.F.3 Fire protection	2.F.4 Aerosols	2.F.5 Solvents	2.F.6 Other applications
Austria	**1 754**	1 696	19	13	26	NO	-
Belgium	**2 514**	2 409	45	10	50	-	NO
Bulgaria	**1 704**	1 678	NO	12	14	-	-
Croatia	**1 680**	1 644	20	6	10	-	-
Cyprus	**358**	340	2	11	4	-	-
Czech Republic	**4 019**	3 980	3	33	2	1	-
Denmark	**335**	323	1	NO	11	NO	NO
Estonia	**185**	177	1	3	3		0
Finland	**971**	947	4	NO,IE,NA	20	0	0
France	**11 634**	10 785	204	46	563	36	NO,IE
Germany	**8 756**	7 985	324	105	342	IE	-
Greece	**5 123**	4 751	171	156	45	-	-
Hungary	**2 189**	1 997	149	7	35	NO	NO
Ireland	**689**	572	NO	33	84	NO	NO
Italy	**15 861**	13 479	555	1 600	227	-	-
Latvia	**249**	243	0	0	6	-	-
Lithuania	**508**	454	40	4	10	NO	NO
Luxembourg	**54**	51	1	-	1	-	-
Malta	**272**	265	6	1	1	NO	NO
Netherlands	**1 033**	906	NO	-	NO	-	127
Poland	**5 221**	4 933	71	102	114	0	-
Portugal	**3 334**	3 217	46	54	17	NO	NO
Romania	**1 989**	1 934	1	5	49	NO	NO
Slovakia	**679**	646	2	22	9	NO	NO
Slovenia	**295**	288	1	0	5	NO	-
Spain	**3 727**	3 281	45	98	303	NO	NO
Sweden	**938**	898	25	1	14	-	-
United Kingdom	**11 662**	9 714	400	308	1 185	16	40
EU-27+UK	**87 731**	**79 594**	**2 136**	**2 630**	**3 151**	**53**	**167**
United Kingdom (KP)	**11 960**	10 000	401	310	1 192	16	41
Iceland	**198**	197	-	-	1	-	-
EU-KP	**88 227**	**80 077**	**2 138**	**2 632**	**3 159**	**53**	**168**

Abbreviations explained in the Chapter 'Units and abbreviations'. Note: NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

Table **4.49** to Table.**4.52** shows the contribution of each country to EU-KP HFC emissions from 2.F.1 as well as information on the method applied, activity data and emission factor.

Table 4.49 2F1 Refrigeration and Air conditioning: Member States' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2020	Change 1990-2020		Change 1995-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	1995	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	35	1 787	1 696	2.1%	1 696	∞	1 661	4759%	-91	-5%	T2	D
Belgium	NO	94	2 606	2 409	3.0%	2 409	∞	2 315	2462%	-197	-8%	T2	CS,D,PS
Bulgaria	NO	3	6 436	1 678	2.1%	1 678	∞	1 675	50317%	-4 758	-74%	T2	D
Croatia	NO	22	1 513	1 644	2.1%	1 644	∞	1 622	7491%	131	9%	T2	CS,D
Cyprus	NO	31	340	340	0.4%	340	∞	310	1016%	0	0%	T2	D
Czechia	NO	96	4 075	3 980	5.0%	3 980	∞	3 884	4066%	-95	-2%	T2	CS
Denmark	NO	48	323	323	0.4%	323	∞	275	578%	0	0%	T2	D
Estonia	NO	10	217	177	0.2%	177	∞	167	1684%	-40	-18%	T2	CS
Finland	0	147	981	947	1.2%	947	8971079%	800	543%	-34	-3%	T2	CS,D
France	NO	356	11 874	10 785	13.5%	10 785	∞	10 429	2927%	-1 089	-9%	T2	CS
Germany	NA	589	8 425	7 985	10.0%	7 985	∞	7 396	1255%	-439	-5%	T2	CS,D
Greece	NO	42	5 070	4 751	5.9%	4 751	∞	4 709	11118%	-319	-6%	IE,T2	D,IE
Hungary	0	24	1 963	1 997	2.5%	1 997	84352347%	1 973	8096%	35	2%	T2	CS,D
Ireland	NO	5	694	572	0.7%	572	∞	567	11392%	-122	-18%	T2,T3	CS
Italy	NO	356	14 396	13 479	16.8%	13 479	∞	13 123	3684%	-917	-6%	T2	CS,D
Latvia	NO	17	250	243	0.3%	243	∞	226	1355%	-7	-3%	T2	CS,D,OTH
Lithuania	NO	6	479	454	0.6%	454	∞	449	8159%	-25	-5%	T2	CS,D,PS
Luxembourg	0	3	54	51	0.1%	51	71968900%	48	1468%	-3	-5%	T2	CS,M,PS
Malta	NO	0	229	265	0.3%	265	∞	265	14039969%	36	16%	T2	CS
Netherlands	NO	47	924	906	1.1%	906	∞	859	1832%	-18	-2%	T2	CS
Poland	NO	154	5 101	4 933	6.16%	4 933	∞	4 779	3094%	-168	-3%	T2	D
Portugal	NA	32	3 241	3 217	4.0%	3 217	∞	3 184	9803%	-24	-1%	NO,T2	D,NO
Romania	NO	2	1 864	1 934	2.4%	1 934	∞	1 932	99771%	70	4%	T2	CS,D
Slovakia	NO	11	687	646	0.8%	646	∞	634	5653%	-41	-6%	T2	CS
Slovenia	NO	3	290	288	0.4%	288	∞	285	9647%	-2	-1%	T1,T2	CS,D
Spain	NO	NO	4 053	3 281	4.1%	3 281	∞	3 281	∞	-772	-19%	T2	CS
Sweden	5	128	945	898	1.1%	893	17665%	770	602%	-47	-5%	T2	CS,D
United Kingdom	8	213	10 210	9 714	12.1%	9 706	120727%	9 500	4450%	-496	-5%	T2	CS
EU-27+UK	**13**	**2 475**	**89 026**	**79 594**	**99%**	**79 581**	**607031%**	**77 119**	**3116%**	**-9 431**	**-11%**	**-**	**-**
Iceland	NO	3	202	197	0.2%	197	∞	194	7163%	-5	-2%	T2	D
United Kingdom (KP)	8	215	10 496	10 000	12.5%	9 991	123747%	9 785	4559%	-496	-5%	T2	CS
EU-KP	**13**	**2 479**	**89 513**	**80 077**	**100%**	**80 064**	**609104%**	**77 598**	**3130%**	**-9 436**	**-11%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

In 2020, HFC emissions from 2.F.1 were more than 32 times higher than in 1995 (Table **4.49** and ***Figure 4.15*** to Figure 4.18) but decreased by 11% compared to 2019 (EU-27+UK).

France, Germany, Italy and the UK were responsible for 53% of total EU-KP emissions from this source in 2020.

Figure 4.15: 2F1 Refrigeration and Air conditioning: EU-KP HFC emissions

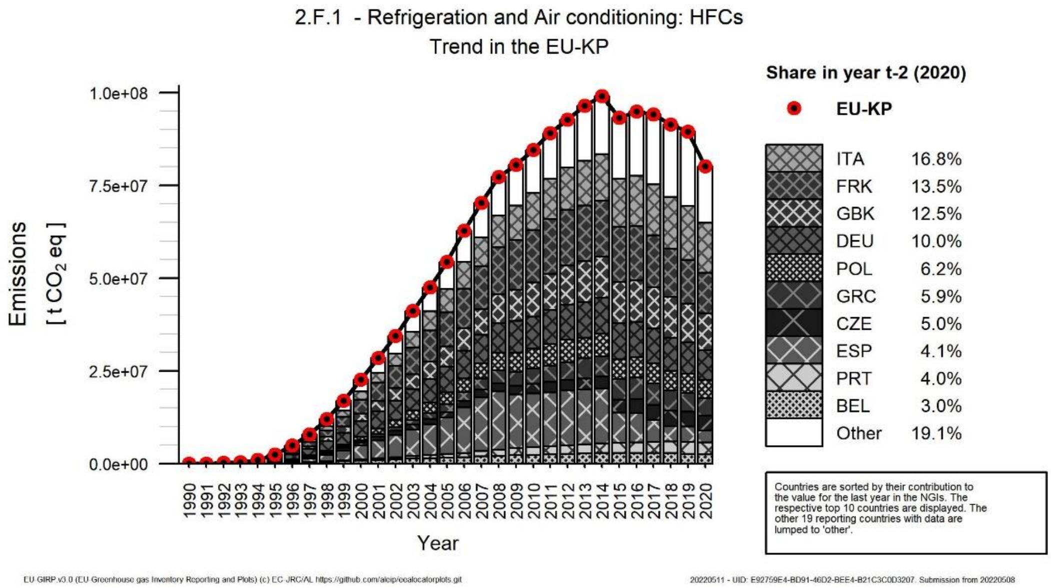


Figure 4.15 shows that emissions in sector 2.F.1 decreased again in 2020.

The main HFCs reported in this subcategory are HFC-32, HFC-125, HFC-134a and HFC-143a. They can be used as pure substances (such as HFC-32 and HFC-134a) and in mixtures (e.g. a refrigerant blend commonly used in stationary air conditioning is called "R410A" and is composed of 50% HFC-32 and 50% HFC-125).

Major developments in category 2.F.1 are driven by the subcategories 2.F.1.a Commercial refrigeration, 2.F.1.e Mobile air conditioning and 2.F.1.f Stationary air conditioning.

Emission plots for these three prominent subcategories are provided in the following graphs. Please note that 2.F.1.a often includes emissions from all types of stationary equipment in Member States (i.e. also industrial refrigeration and partly also stationary air conditioning). After a peak in 2014, emissions from 2.F.1.a decreased in 2015, 2017, 2018 and 2020. This is in line with the policies and measures of the EU F-gas Regulation No. 517/2014 and the EU MAC Directive.

Figure 4.16: 2F1a Commercial refrigeration: EU-KP HFC emissions

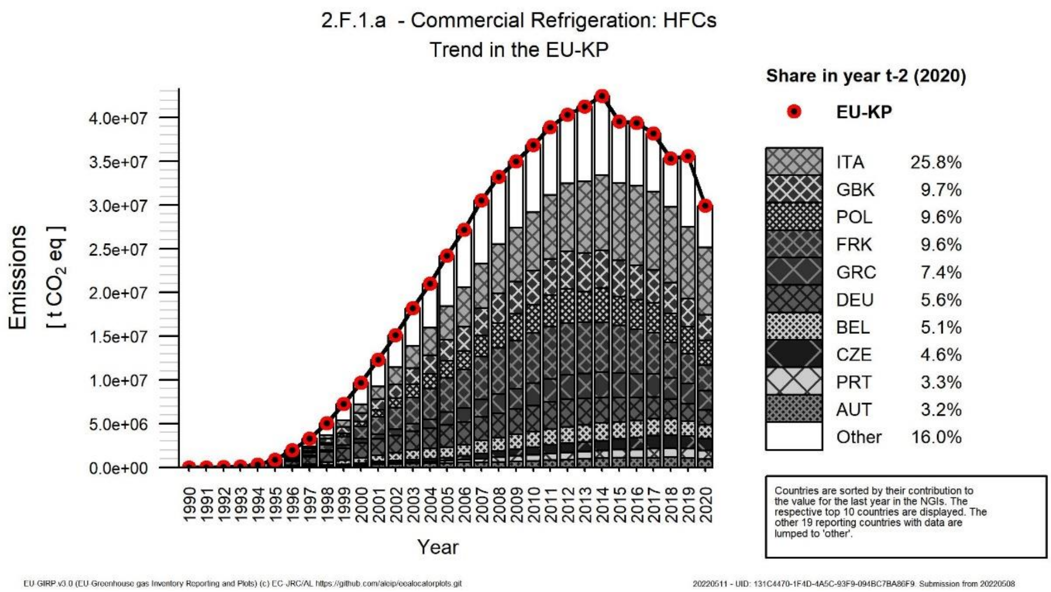


Figure 4.17: 2F1e Mobile air conditioning: EU-KP HFC emissions

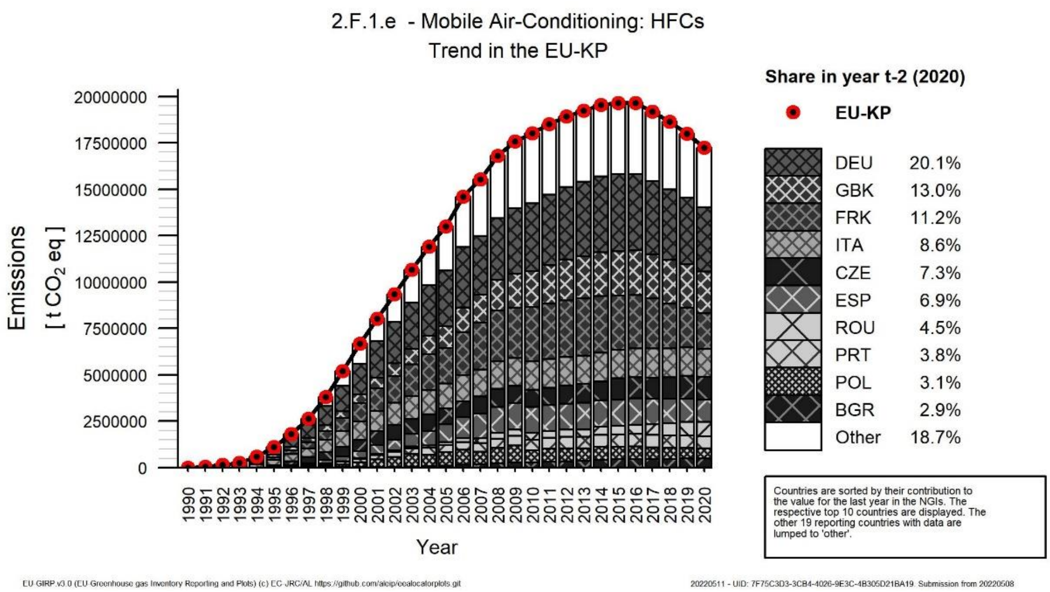


Figure 4.17 shows emission trends for mobile air-conditioning: The EU reported HFC-134a emissions from disposal in the subcategory mobile air conditioning (2.F.1.e) in CRF table 2(II)B-Hs2. The disposal loss factor related to HFC-134a emissions from disposal in mobile air conditioning (2.F.1.e) was 99.8% for the year 1995. HFC-134a was introduced in the early 1990s, and 1995 was the first year in which it was used on a large scale for mobile air conditioning in passenger cars. The very small amounts in 1995 relate to particularities of the inventories of France and Latvia, which run models of the vehicle stock that assume end of life of a certain share of vehicles each year, in line with a Gaussian normal distribution. Some cars reached their end of life in the first year of widespread use of HFC-134a in mobile air conditioning. The 2018 ERT considered the assumption that not every car reaches an average lifespan and that some are disposed of earlier (e.g. owing to damage in an accident) as

realistic; and considered acceptable the assumption that in the first year when disposal emissions occurred, there was no (or only minor) recovery of emissions. Emissions from 2.F.1.e decreased in 2017, 2018, 2019 and 2020. This relates to the introduction of the low-GWP refrigerant R1234yf in air-conditioning systems of new passenger cars. Germany accounts for 20.1% of emissions from 2.F.1.e followed by the UK (13.0%) and France (11.2%).

*Figure **4**.18: 2F1f Stationary air conditioning: EU-KP HFC emissions*

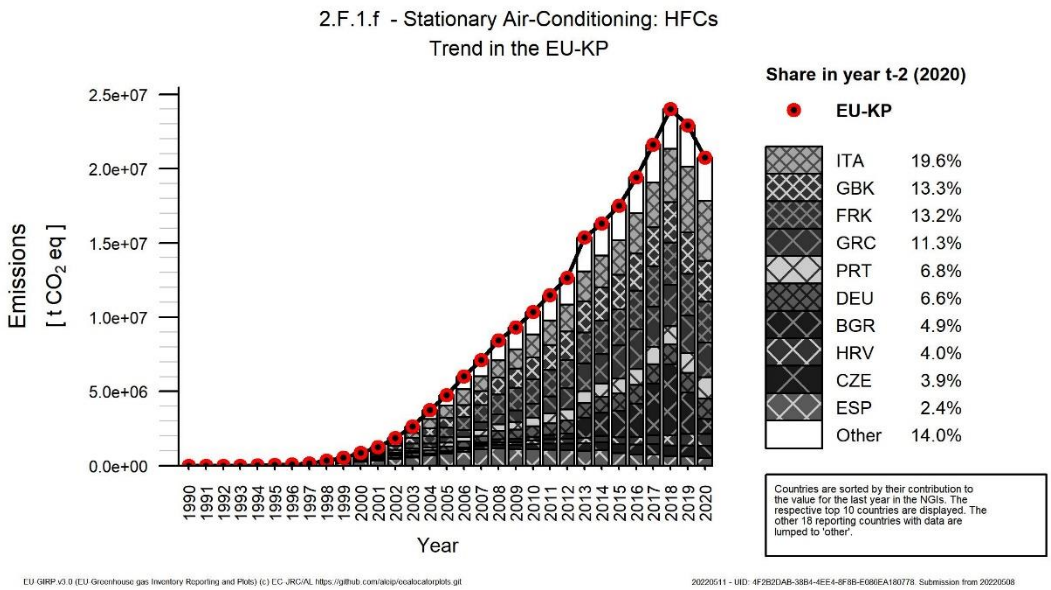


Figure 4.18 shows a consistent trend for sector 2.F.1.f with increasing emissions until 2018. This development reflects the growing use of air conditioning equipment, in particular in Southern Europe, and the delayed uptake of alternatives to HFCs in this sub-category. It should also be noted that some Member States allocate emissions from 2.F.1.f under the 2.F.1.a subcategory. In 2020, emissions decreased compared to 2019.

The EU also reported „unspecified mix of HFCs" for 2.F.1.f in the 2018 submission (for 1995-2016). Since 2019 submission, Cyprus has reported HFC emissions according to a tier 2a approach, with no unspecified mix of HFCs. Denmark also reported "unspecified mix of HFCs" in its 2019 submission for some years. In 2022 submission, all Member States reported HFC emissions from 2.F.1.f disaggregated by substances.

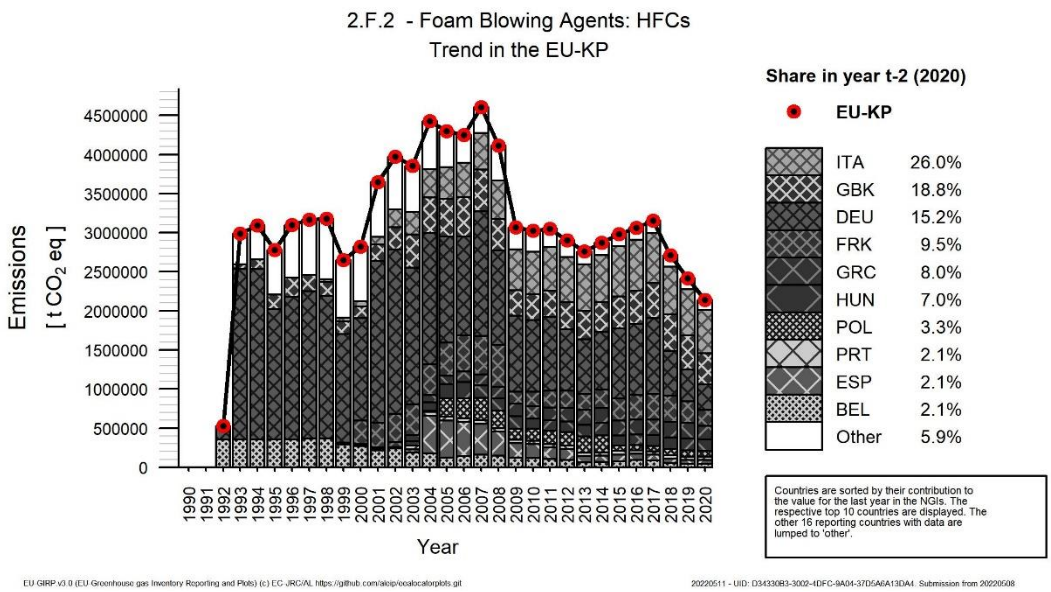
*Table **4**.50 2F2 Foam Blowing: Countries' contributions to HFC emissions and information on method applied, activity data and emission factor*

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2020	Change 1990-2020		Change 1995-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	1995	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	301	18	19	0.9%	19	∞	-282	-94%	1	6%	T2	D
Belgium	NO	357	42	45	2.1%	45	∞	-312	-87%	2	6%	T2	CS,D,PS
Bulgaria	NO	NO	10	NO	-	-	-	-	-	-10	-100%	NA	NA
Croatia	NO	NO	20	20	0.9%	20	∞	20	∞	-1	-4%	CS	D
Cyprus	NO,NE	NO,NE	1	2	0.1%	2	∞	2	∞	0	4%	CS	CS
Czechia	NO	0	4	3	0.2%	3	∞	3	24104%	-1	-14%	NO,T1	D
Denmark	NO	210	1	1	0.0%	1	∞	-210	-100%	0	-10%	T2	D
Estonia	NO	18	2	1	0.1%	1	∞	-17	-92%	-1	-30%	T2	CS
Finland	NO	1	5	4	0.2%	4	∞	4	738%	-1	-12%	T2	D
France	NO	NO	277	204	9.5%	204	∞	204	∞	-73	-26%	T2	CS,D
Germany	IE,NA	1 666	405	324	15.2%	324	∞	-1 342	-81%	-81	-20%	T2	CS
Greece	NO	NO	199	171	8.0%	171	∞	171	∞	-28	-14%	T2	D
Hungary	NO	NO	154	149	7.0%	149	∞	149	∞	-4	-3%	T2	CS
Ireland	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Italy	NO	NO	587	555	26.0%	555	∞	555	∞	-32	-5%	T2	D
Latvia	NO	0	1	0	0.0%	0	∞	0	-29%	0	-62%	T1a	D,OTH
Lithuania	NO	NO	41	40	1.9%	40	∞	40	∞	-1	-3%	T2	D
Luxembourg	NO	10	1	1	0.0%	1	∞	-9	-90%	0	-29%	T1	CS
Malta	NO	NO	5	6	0.3%	6	∞	6	∞	1	11%	T1	D
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	75	71	3.3%	71	∞	71	∞	-4	-5%	T2	D
Portugal	NA	1	47	46	2.1%	46	∞	45	5991%	-1	-3%	T2	D
Romania	NO	NO	2	1	0.0%	1	∞	1	∞	-2	-76%	T2	D
Slovakia	NO	NO	2	2	0.1%	2	∞	2	∞	0	0%	T2	D
Slovenia	NO	30	1	1	0.1%	1	∞	-29	-95%	0	-4%	T2	CS,D
Spain	NO	NO	48	45	2.1%	45	∞	45	∞	-3	-6%	T2	D
Sweden	NO	NO	26	25	1.2%	25	∞	25	∞	-1	-2%	T2	PS
United Kingdom	NO	184	439	400	18.7%	400	∞	216	118%	-39	-9%	T2	CS
EU-27+UK	**E,NA,IE,NO**	**2 777**	**2 414**	**2 136**	**100%**	**2 136**	**∞**	**-642**	**-23%**	**-278**	**-12%**	**-**	**-**
Iceland	-	-	-	-	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	184	441	401	18.8%	401	∞	217	118%	-39	-9%	T2	CS
EU-KP	**E,NA,IE,NO**	**2 778**	**2 416**	**2 138**	**100%**	**2 138**	**∞**	**-640**	**-23%**	**-278**	**-12%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

In 2020, HFC emissions from 2.F.2 (Table **4.50** and ***Figure 4.19***) decreased by 12% compared to the previous year. The HFC foam blowing agents reported in 2.F.2 are HFC-152a, HFC-134a, HFC-227ea, HFC-245fa and HFC-365mfc. The biggest contributors to emissions from this sector are Italy (26.0%), UK (18.8%), Germany (15.2%) and France (9.5%) and those four countries account for 69.5% of the share in EU-KP emissions in this sector.

Figure 4.19: 2F2 Foam Blowing Agents: EU-KP HFC emissions



This ***Figure 4.19*** displays that emissions from sector 2.F.2 varied noticeable until 2008 but are rather stable since then. Major foam manufacturers converted their production to non-HFC blowing agents (usually hydrocarbons) which resulted in a drop of emissions from this subcategory in the last ten years. The F-gas Regulation further limits the use of F-gases for this subcategory as the placing on the market of foams containing HFCs with GWP of 150 or more is banned from 2020 for extruded polystyrene (XPS) foams and for other foams from 2023, unless HFCs with higher GWPs are needed to meet national safety requirements (Annex III, point 16).

Table4.51 2F3 Fire protection: Countries' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2020	Change 1990-2020		Change 1995-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	1995	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	14	13	0.5%	13	∞	13	∞	-1	-9%	T2	D
Belgium	NO	1	12	10	0.4%	10	∞	10	1679%	-2	-14%	T2	CS
Bulgaria	NO	NO	9	12	0.5%	12	∞	12	∞	4	46%	T2	D
Croatia	NO	0	6	6	0.2%	6	∞	6	3109%	0	-2%	T1,T2	D,PS
Cyprus	NO,NE	0	11	11	0.4%	11	∞	11	21171%	0	-1%	CS	CS
Czechia	NO	NO	31	33	1.3%	33	∞	33	∞	2	6%	D	D
Denmark	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Estonia	NO	NO	3	3	0.1%	3	∞	3	∞	0	-6%	T2	CS
Finland	NO	NO	NO,IE,NA	NO,IE,NA	-	-	-	-	-	-	-	NA	NA
France	NO	5	54	46	1.8%	46	∞	42	906%	-8	-15%	T1	CS
Germany	NA	NA	105	105	4.0%	105	∞	105	∞	-1	-1%	CS	CS,D
Greece	NO	NO	151	156	5.9%	156	∞	156	∞	4	3%	CS	D
Hungary	NO	NO	7	7	0.3%	7	∞	7	∞	0	-4%	T1	D
Ireland	NO	NO	32	33	1.2%	33	∞	33	∞	0	0%	T2	CS
Italy	NO	16	1 609	1 600	60.8%	1 600	∞	1 585	10143%	-9	-1%	T2	CS
Latvia	NO	NO	0	0	0.0%	0	∞	0	∞	0	0%	T2	D
Lithuania	NO	NO	4	4	0.2%	4	∞	4	∞	0	5%	T1b	D
Luxembourg	-	-	-	-	-	-	-	-	-	-	-	-	-
Malta	NO	NO	0	1	0.1%	1	∞	1	∞	1	655%	CS	D
Netherlands	-	-	-	-	-	-	-	-	-	-	-	T2	CS
Poland	NO	NO	108	102	3.9%	102	∞	102	∞	-6	-6%	T2	D
Portugal	NA	NO	70	54	2.1%	54	∞	54	∞	-16	-23%	T2	D
Romania	NO	NO	5	5	0.2%	5	∞	5	∞	0	0%	T2	D
Slovakia	NO	2	23	22	0.8%	22	∞	20	957%	-1	-3%	T1a	CS
Slovenia	NO	NO	0	0	0.0%	0	∞	0	∞	0	14%	T2	CS,D
Spain	NO	1	107	98	3.7%	98	∞	97	10576%	-9	-9%	T1a	CS,D
Sweden	NO	NO	1	1	0.0%	1	∞	1	∞	-1	-54%	T1	CS
United Kingdom	NO	1	314	308	11.7%	308	∞	307	31726%	-7	-2%	T2	CS
EU-27+UK	**NE,NA,NO**	**25**	**2 679**	**2 630**	**100%**	**2 630**	**∞**	**2 605**	**10409%**	**-49**	**-2%**	**-**	**-**
Iceland	-	-	-	-	-	-	-	-	-	-	-	NA	NA
United Kingdom (KP)	NO	1	317	310	11.8%	310	∞	309	31852%	-7	-2%	T2	CS
EU-KP	**NE,NA,NO**	**25**	**2 682**	**2 632**	**100%**	**2 632**	**∞**	**2 607**	**10418%**	**-49**	**-2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

In 2020, HFC emissions from 2.F.3 (Table4.51) did hardly change compared to 2015-2019 – but increased dramatically since 1995. This development was caused by the phase-out of ozone depleting substances, especially halons, as fire extinguishing agents under the Montreal Protocol and the subsequent introduction of HFCs and other ODS alternatives as replacements. The HFCs reported in this subcategory are HFC-23 (banned in new equipment in the EU since 2015), HFC-227ea and HFC-236fa. In Denmark, Luxembourg and Iceland HFCs are not used as fire extinguishing agents. Instead, other chemicals or not-in-kind alternatives, e.g. water mist, fluorinated ketones etc., have been applied for many years. In the Netherlands, emissions from this subcategory are included in the 2.F.6 subcategory.

The biggest contributors to this sector are Italy (60.8%), UK (11.8%) and Greece (5.9%), those three countries account for 78.5% of the share in EU-KP emissions in this sector. Relevant increases of emissions from this subcategory compared to 2019 were reported by Malta (+655%), Bulgaria (+46%) and Slovenia (+14%), while certain decreases were reported by Sweden (-54%), Portugal (-23%), France (-15%) and Belgium (-14%).

Figure 4.20: 2F3 Fire Protection, EU-KP: HFC emissions

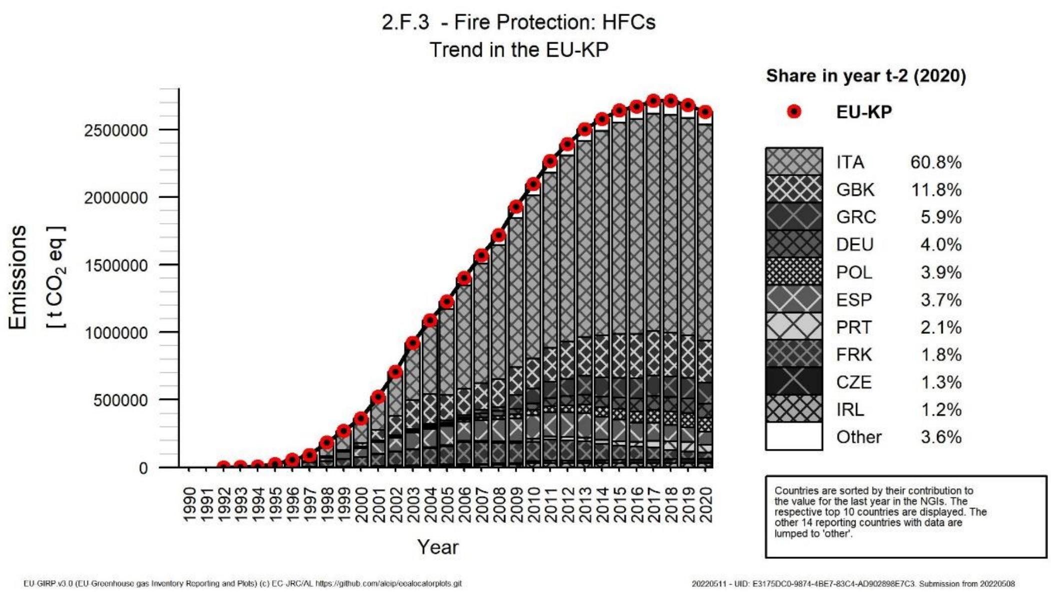


Figure 4.20 illustrates that emissions from fire protection were rather stable in recent years.

Table.4.52 2F4 Aerosols/ Metered Dose Inhalers: Countries' contributions to HFC emissions and information on method applied, activity data and emission factor

Member State	HFCs Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2020	Change 1990-2020		Change 1995-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	1995	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	4	28	26	0.8%	26	∞	21	475%	-2	-8%	T2	D
Belgium	NO	41	50	50	1.6%	50	∞	9	21%	0	1%	T2	CS,D,PS
Bulgaria	NO	NO	14	14	0.4%	14	∞	14	∞	0	-1%	T2	D
Croatia	NO	NO	11	10	0.3%	10	∞	10	∞	-1	-6%	T1a	NA
Cyprus	NO	0	4	4	0.1%	4	∞	4	682480%	0	2%	CS	CS
Czechia	NO	0	2	2	0.1%	2	∞	2	20346106%	0	2%	T1	D
Denmark	NO	NO	12	11	0.4%	11	∞	11	∞	-1	-10%	T2	D
Estonia	NO	0	5	3	0.1%	3	∞	3	6450%	-1	-28%	T2	CS
Finland	NO	2	22	20	0.6%	20	∞	18	889%	-2	-8%	T2	D
France	NO	623	619	563	17.8%	563	∞	-60	-10%	-56	-9%	T2	CS,PS
Germany	NO,IE,NA	342	353	342	10.8%	342	∞	0	0%	-11	-3%	CS,T2	CS
Greece	NO	0	45	45	1.4%	45	∞	45	140299%	0	0%	T2	D
Hungary	NO	12	35	35	1.1%	35	∞	23	199%	0	0%	T2	CS,D
Ireland	NO	38	87	84	2.7%	84	∞	46	122%	-3	-4%	T1,T2	CS
Italy	NO	NO	262	227	7.2%	227	∞	227	∞	-35	-13%	T2	CS
Latvia	NO	0	5	6	0.2%	6	∞	6	9829%	2	34%	T1a	D
Lithuania	NO	1	9	10	0.3%	10	∞	9	1020%	0	2%	T1a	D
Luxembourg	NO	2	1	1	0.0%	1	∞	-1	-35%	0	3%	T1,T2	CS
Malta	NO,NE	NO,NE	1	1	0.0%	1	∞	1	∞	0	-4%	T1	CS
Netherlands	NO	NO	NO	NO	-	-	-	-	-	-	-	NA	NA
Poland	NO	18	127	114	3.6%	114	∞	97	553%	-13	-10%	T1a,T1b,T2	D
Portugal	NA	27	18	17	0.5%	17	∞	-10	-36%	-1	-3%	T2	D
Romania	0	1	46	49	1.6%	49	27003%	48	6716%	3	7%	T2	D
Slovakia	NO	NO	9	9	0.3%	9	∞	9	∞	0	0%	T1a	D
Slovenia	NO	NO	5	5	0.2%	5	∞	5	∞	0	-1%	T1	D
Spain	NO	NO,NA	324	303	9.6%	303	∞	303	∞	-21	-6%	T2	CS
Sweden	1	7	18	14	0.4%	12	851%	6	87%	-4	-24%	T2	D
United Kingdom	NO	446	1 453	1 185	37.5%	1 185	∞	739	166%	-268	-18%	T2	CS
EU-27+UK	**2**	**1 563**	**3 565**	**3 151**	**100%**	**3 149**	**195464%**	**1 588**	**102%**	**-414**	**-12%**	**-**	**-**
Iceland	0	1	1	1	0.0%	1	155%	0	22%	0	-5%	T1a	D
United Kingdom (KP)	NO	448	1 460	1 192	37.7%	1 192	∞	744	166%	-268	-18%	T2	CS
EU-KP	**2**	**1 566**	**3 573**	**3 159**	**100%**	**3 157**	**161455%**	**1 593**	**102%**	**-414**	**-12%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. Note: NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

In 2020, HFC emissions from 2.F.4 grew by about 100% compared to 1995 (Table.**4.52** and ***Figure 4.20***). This partly relates to the phase-out of ODS in this subcategory but also to increased use of medical aerosols throughout Europe, especially for asthma treatment. The HFCs reported in 2.F.4 are HFC-134a (medical and technical aerosols), HFC-227ea (medical aerosols only) and HFC-152a (technical aerosols). Emissions from technical aerosols play a minor role from 2018 onwards as the EU F-gas Regulation bans the placing on the market of technical aerosols containing HFCs with GWP of 150 or more, except when required to meet national safety standards or when used for medical applications since 1 January 2018 (Annex III, point 17). This is reflected in a 12% decrease of EU-KP emissions in 2020 compared to 2019.

UK (37.7%), France (17.8%) and Germany (10.8%) accounted for 66.3% of total EU-KP emissions from this source. A significant relative decrease between 2019 and 2020 was reported by Estonia (-28%), Sweden (-24%) and UK (-18%); the biggest relative increase was reported by Latvia (+34%) and Romania (+7%).(Table.**4.52**). It should be noted that emissions from this subcategory have been decreasing slowly since 2006 despite the growing number of patients in need of MDI treatment in most EU Member States. This is mainly due to increased application of dry powder inhalers and other alternative treatment measures.

Figure 6 4 2F4 Aerosols/Metered Dose Inhalers: EU-KP HFC emissions

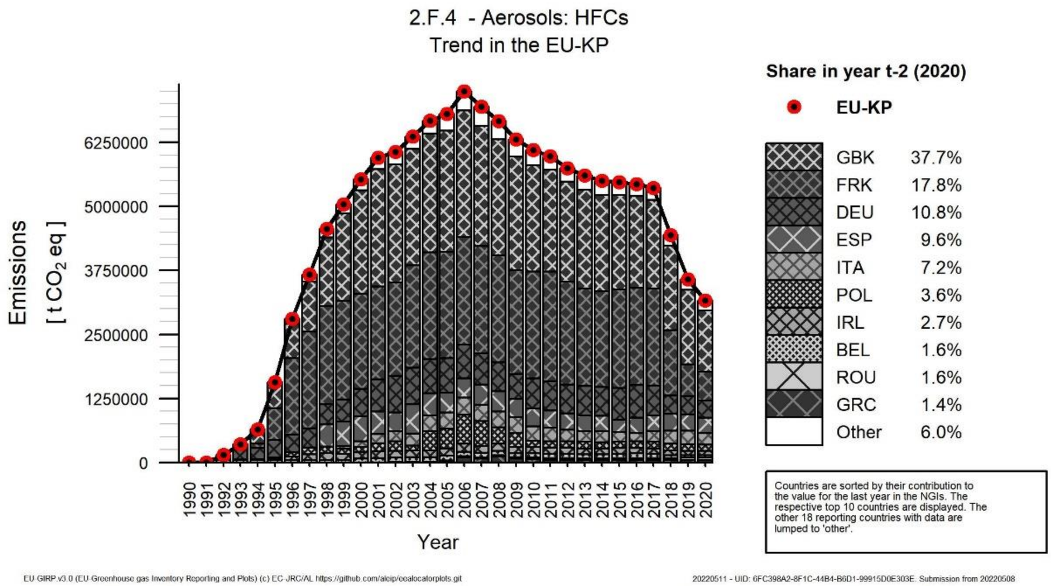


Figure 4.20 shows the emission reductions in 2020 compared to previous years.

For 2.F.4/Other, the EU also reported „unspecific mix of HFCs" for 2001-2006 in the 2018 submission. Since 2019 submission, unspecified mix of HFCs for this category is reported as "NO" for the whole time series except 2001-2002. The change relates to the 2019 submission from Finland which reporting of the unspecified mix only for 2001-2002, but disaggregated by gas for the later years in the time series.

The subcategories 2.F.5 Solvents and 2.F.6 Other applications are not described in detail in this submission. Emission estimates from these subcategories are confidential in several Member States because the relevant industrial processes are only performed by very few companies. Emissions are thus reported together with other subcategories.

4.2.7 Other product manufacture and use (CRF Source Category 2G)

PFCs and SF_6 have been used for certain applications within this category for many decades. SF_6 is a particularly potent greenhouse gas (GWP 22800) that is used predominantly in insulated switch gear for transportation and distribution of electric power (2.G.1). Emissions also occur from other product use (2.G.2), for example military applications (SF_6), particle accelerators (SF_6), applications of adiabatic properties - shoes and tyres (SF_6, PFCs), sound proof windows (SF_6), medical and cosmetic applications (SF_6, PFCs), other (SF_6, PFCs) etc.

Table 8 shows that all Member States report GHG emissions in 2.G Other product manufacture and use for the year 2020. SF_6 emissions from the subcategory electrical equipment (2.G.1) are reported by all Member States except the Netherlands where the share of non-F-gas alternatives is particularly high and SF_6 emission estimates are included elsewhere.

Table.4.53 2G Other: Overview of sources reported under this source category

Country	2.G Other product manufacture and use	HFC emissions [kt CO_2 equivalents]	PFC emissions [kt CO_2 equivalents]	SF_6 emissions [kt CO_2 equivalents]	NF_3 emissions [kt CO_2 equivalents]	Unspecified mix of HFCs and PFCs [kt CO_2 equivalents]	Total emissions [kt CO_2 equivalents]	Share in EU-KP Total
AUT	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (SF_6)	NO	NO	421			421	7.3%
BEL	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (C6F14)	NO	NO	83	NO	NO	83	1.4%
BGR	Electrical equipment (SF_6)		NO	20			20	0.3%
HRV	Electrical equipment (SF_6)	NO	NO	9	NO	NO	9	0.2%
CYP	Electrical equipment (SF_6)		NO	18			18.2	0.3%
CZE	Electrical equipment (SF_6); Accelerators (SF_6); Soundproof windows (SF_6); Other (SF_6)			63			63	1.1%
DNM	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (SF_6)	NO,NA	NO,NA	46	NO,NA	NO,NA	46	0.8%
EST	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	3	NO	NO	3	0.1%
FIN	Electrical equipment (SF_6)	0	NO,IE	14	0	0	14	0.2%
FRK	Electrical equipment (SF_6); Accelerators (SF_6); Other (SF_6, Unspecified mix of PFCs)	1	405	335			740	12.8%
DEU	Electrical equipment (SF_6); Military applications (SF_6 => Notation Key C); Accelerators (SF_6); Soundproof windows (SF_6); Adiabatic properties: shoes and tyres (SF_6, C3F8 => Notation Key C); Other (SF_6 => partly Notation Key C, C10F18 => Notation Key C); 4. Other (HFC-134a, HFC-245fa => Notation Key C, HFC-365mfc => Notation Key C)	14	IE,NA	2928	NA	NA	2943	50.7%
GRC	Electrical equipment (SF_6)		NO	5			5	0.1%
HUN	Electrical equipment (SF_6); Other (SF_6)	NO	NO	109	NO	NO	109	1.9%

Country	2.G Other product manufacture and use	HFC emissions [kt CO_2 equivalents]	PFC emissions [kt CO_2 equivalents]	SF_6 emissions [kt CO_2 equivalents]	NF_3 emissions [kt CO_2 equivalents]	Unspecified mix of HFCs and PFCs [kt CO_2 equivalents]	Total emissions [kt CO_2 equivalents]	Share in EU-KP Total
IRL	Electrical equipment (SF_6); Soundproof windows (SF_6); Adiabatic properties: shoes and tyres (SF_6); Other (SF_6)	NO	NO	6	NO	NO	6	0.1%
ITA	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	216	NO	NO	216	3.7%
LVA	Electrical equipment (SF_6)	NO	NO	12	NO	NO	12	0.2%
LTU	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	0	NO	NO	0	0.0%
LUX	Electrical equipment (SF_6); Soundproof windows (SF_6), Other (HFC-43-10mee)	2		10			12	0.2%
MLT	Electrical equipment (SF_6), Other (SF_6, C3F8)		0.00	0.40			0.40	0.007 %
NLD	Other (SF_6)	NO	NO	125			125	2.1%
POL	Electrical equipment (SF_6)	NA	NA	90	NA	NA	90	1.5%
PRT	Electrical equipment (SF_6)	NO	NO	23	NO	NO	23	0.4%
ROU	Electrical equipment (SF_6)	NO	NO	82	NO	NO	82	1.4%
SVK	Electrical equipment (SF_6)	NO	NO	17	NO	NO	17	0.3%
SVN	Electrical equipment (SF_6)	NO	NO	16	NO	NO	16	0.3%
ESP	Electrical equipment (SF_6); Accelerators (SF_6), Other (SF_6)	NO	NO	231	NO	NO	231	4.0%
SWE	Electrical equipment (SF_6); Soundproof windows (SF_6)		NO	39			39	0.7%
GBE	Electrical equipment (SF_6); Military applications (SF_6); Accelerators (SF_6); Other (CF4, C2F6, C3F8, c-C4F8, SF_6)		79	380			459	8%
EU-27+UK	**TOTAL**	17	484	5299	0	0	5801	

Country	2.G Other product manufacture and use	HFC emissions [kt CO_2 equivalents]	PFC emissions [kt CO_2 equivalents]	SF_6 emissions [kt CO_2 equivalents]	NF_3 emissions [kt CO_2 equivalents]	Unspecified mix of HFCs and PFCs [kt CO_2 equivalents]	Total emissions [kt CO_2 equivalents]	Share in EU-KP Total
GBK	Electrical equipment (SF_6); Military applications (SF_6); Accelerators (SF_6); Other (CF4, C2F6, C3F8, c-C4F8, SF_6)		79	380			459	7.9%
ISL	Electrical equipment (SF_6)		NO	3			3	0.05%
EU-KP	**TOTAL**	17	484	5302	0	0	5804	**100%**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 4.21 and Table 4.54 summarize information by Member State on SF_6 emissions for the key source 2.G. Emissions have been relatively stable since 2002 with a small but rather steady increase since 2014. However, in 2020 emissions decreased considerably compared to 2019. The development of emissions from this category is dominated by the emission trend in Germany (55.2% of SF_6 emissions from EU-KP in 2020), where the disposal of sound-proof windows containing SF_6 represents a particularly high emission source.

Table 4.54: 2G - Member States' contributions to SF_6 emissions

Member State	SF6 Emissions in kt CO2 equiv.				Share in EU-KP Emissions in 2020	Change 1990-2020		Change 1995-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	1995	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	132	268	400	421	7.9%	290	220%	153	57%	21	5%	T2	D
Belgium	135	135	82	83	1.6%	-52	-39%	-52	-39%	1	1%	T1,T2	D
Bulgaria	4	5	18	20	0.4%	16	437%	15	305%	2	9%	NO,T2	D,NO
Croatia	11	12	8	9	0.2%	-2	-18%	-3	-27%	1	12%	T2	CS
Cyprus	3	6	15	18	0.3%	16	586%	12	216%	3	21%	T1	D
Czechia	84	89	66	63	1.2%	-21	-25%	-26	-29%	-2	-4%	D,T1	D
Denmark	13	70	71	46	0.9%	33	257%	-24	-35%	-26	-36%	T2,T3	D
Estonia	NO	3	3	3	0.1%	3	∞	0	-5%	0	3%	T3	CS
Finland	45	27	14	14	0.3%	-31	-69%	-13	-47%	0	2%	T2	CS
France	1 249	1 479	351	335	6.3%	-914	-73%	-1 144	-77%	-17	-5%	T1,T2	CS,D
Germany	4 050	6 072	3 845	2 928	55.2%	-1 121	-28%	-3 144	-52%	-916	-24%	CS,D,T3	CS,D
Greece	3	3	5	5	0.1%	2	69%	2	44%	0	0%	NA	NA
Hungary	12	51	101	109	2.1%	97	783%	58	114%	8	8%	T1,T2	D
Ireland	33	38	10	6	0.1%	-27	-81%	-32	-83%	-4	-39%	T1,T2	CS
Italy	294	551	380	216	4.1%	-78	-27%	-335	-61%	-164	-43%	CS,T2	CS,PS
Latvia	NO	0	14	12	0.2%	12	∞	12	6786%	-2	-14%	T1	D
Lithuania	NO	0	1	0	0.0%	0	∞	0	355%	0	-63%	T3	CS
Luxembourg	1	1	10	10	0.2%	9	998%	8	592%	0	-3%	D,T1,T3	CS,D,M,PS
Malta	0	1	0	0	0.0%	0	3684%	-1	-72%	0	23%	-	-
Netherlands	207	256	117	125	2.3%	-82	-40%	-131	-51%	7	6%	NA	NA
Poland	NA,NO	13	91	90	1.7%	90	∞	77	614%	-1	-1%	T1	D
Portugal	NO,NA	14	24	23	0.4%	23	∞	9	64%	-1	-5%	T1	NO
Romania	0	1	77	82	1.5%	81	17107%	81	8272%	5	6%	T2	D
Slovakia	0	10	9	17	0.3%	17	29370%	7	69%	8	94%	T3	CS
Slovenia	10	12	16	16	0.3%	6	62%	4	31%	0	0%	T2	CS
Spain	64	100	228	231	4.3%	167	260%	131	131%	3	1%	T2,T3	CS,D
Sweden	79	108	34	39	0.7%	-40	-51%	-69	-64%	5	14%	T2,T3	CS,PS
United Kingdom	813	858	398	380	7.2%	-434	-53%	-479	-56%	-18	-5%	,OTH,T2,T3	CS,D
EU-27+UK	**7 241**	**10 182**	**6 387**	**5 299**	**100%**	**-1 942**	**-27%**	**-4 883**	**-48%**	**-1 088**	**-17%**	**-**	**-**
Iceland	1	1	2	3	0.1%	2	188%	2	154%	1	39%	T2	CS
United Kingdom (KP)	813	858	398	380	7.2%	-434	-53%	-479	-56%	-18	-5%	,OTH,T2,T3	CS,D
EU-KP	**7 242**	**10 183**	**6 389**	**5 302**	**100%**	**-1 940**	**-27%**	**-4 881**	**-48%**	**-1 087**	**-17%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.

Figure 4.21: 2G - Other Product Manufacture and Use: SF_6 Trend in the EU-KP

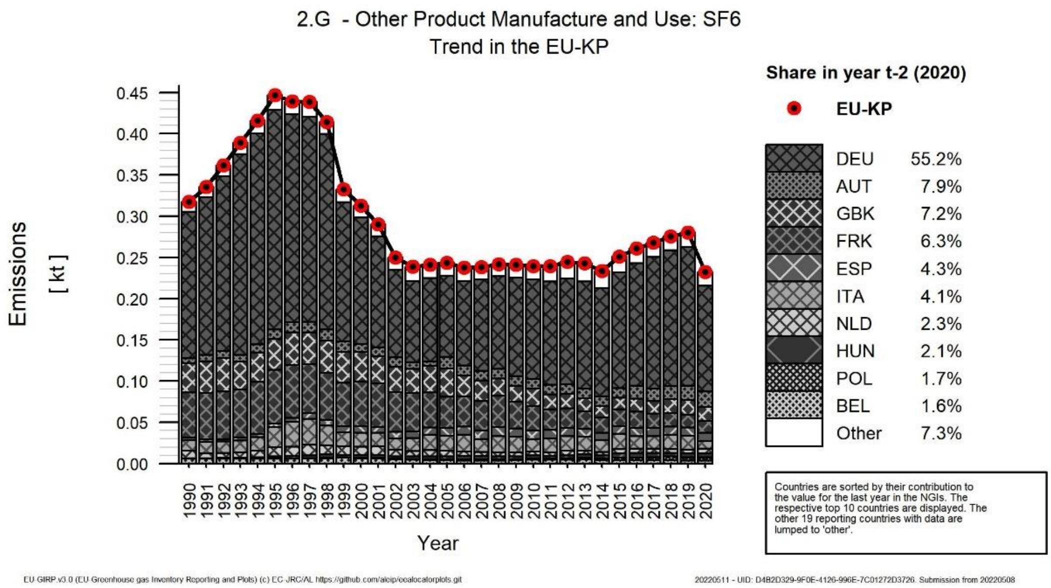


Figure 4.21 shows a stable trend for emissions from SF_6 in sector 2.G in the period 2002-2014, after a considerable decrease since 1995. Since 2014 smaller but steady increases took place until 2019, which after emissions fell significantly (- 17% in 2020 compared to 2019).

4.2.8 IPPU – non-key categories

Table 4.55 provides an overview on the role of non-key categories in the IPPU sector.

Table 4.55 Aggregated GHG emission from non-key categories in the IPPU sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
2.B.1 Ammonia Production: no classification (CH_4)	2.1	2.3	2.4	0.00%	0.3	16%	0.1	5%
2.B.1 Ammonia Production: no classification (N_2O)	0.6	0.7	0.8	0.00%	0.2	26%	0.1	7%
2.B.10 Other chemical industry: no classification (CH_4)	353.4	177.3	173.7	0.05%	-179.7	-51%	-3.6	-2%
2.B.10 Other chemical industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other chemical industry: no classification (N_2O)	875.3	492.3	545.0	0.16%	-330.3	-38%	52.8	11%
2.B.10 Other chemical industry: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other chemical industry: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other chemical industry: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other chemical industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
2.B.3 Adipic Acid Production: no classification (CO_2)	26.5	22.0	14.2	0.00%	-12.3	-46%	-7.8	-36%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (N_2O)	4 127.2	1 703.9	1 431.0	0.41%	-2 696.2	-65%	-272.9	-16%
2.B.5 Carbide Production: no classification (CH_4)	5.6	8.5	8.5	0.00%	2.9	53%	0.0	0%
2.B.5 Carbide Production: no classification (CO_2)	1 798.6	265.1	216.5	0.06%	-1 582.1	-88%	-48.6	-18%
2.B.6 Titanium Dioxide Production: no classification (CO_2)	126.2	272.5	251.5	0.07%	125.3	99%	-21.0	-8%
2.B.7 Soda Ash Production: no classification (CO_2)	2 242.1	2 007.7	1 724.8	0.49%	-517.3	-23%	-282.9	-14%
2.B.8 Petrochemical and Carbon Black Production: no classification (CH_4)	1 003.7	1 087.5	1 143.4	0.33%	139.7	14%	55.9	5%
2.B.9 Fluorochemical Production: no classification (NF_3)	0.0	0.0	7.6	0.00%	7.6	100%	7.6	100%
2.B.9 Fluorochemical Production: no classification (PFCs)	4 331.8	1 155.2	665.7	0.19%	-3 666.1	-85%	-489.6	-42%
2.B.9 Fluorochemical Production: no classification (SF_6)	1 845.5	1.1	3.6	0.00%	-1 842.0	-100%	2.5	237%
2.C.1 Iron and Steel Production: no classification (CH_4)	399.2	146.5	115.8	0.03%	-283.4	-71%	-30.7	-21%
2.C.2 Ferroalloys Production: no classification (CH_4)	27.2	22.0	16.7	0.00%	-10.4	-38%	-5.3	-24%
2.C.2 Ferroalloys Production: no classification (CO_2)	4 868.5	3 017.0	2 139.4	0.61%	-2 729.1	-56%	-877.7	-29%
2.C.3 Aluminium Production: no classification (CO_2)	4 906.1	4 410.4	4 276.0	1.22%	-630.1	-13%	-134.4	-3%
2.C.3 Aluminium Production: no classification (SF_6)	13.7	0.0	0.0	0.00%	-13.7	-100%	0.0	-100%
2.C.4 Magnesium Production: no classification (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.C.4 Magnesium Production: no classification (HFCs)	0.0	19.6	15.7	0.00%	15.7	100%	-3.9	-20%
2.C.4 Magnesium Production: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.C.4 Magnesium Production: no classification (SF_6)	847.7	130.1	83.6	0.02%	-764.2	-90%	-46.6	-36%
2.C.5 Lead Production: no classification (CO_2)	391.5	202.3	202.4	0.06%	-189.1	-48%	0.1	0%
2.C.6 Zinc Production: no classification (CO_2)	2 961.0	1 057.8	998.0	0.28%	-1 962.9	-66%	-59.8	-6%
2.C.7 Other Metal Industry: no classification (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.C.7 Other Metal Industry: no classification (CO_2)	464.8	220.7	219.2	0.06%	-245.6	-53%	-1.5	-1%
2.C.7 Other Metal Industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.C.7 Other Metal Industry: no classification (N_2O)	47.3	21.2	19.1	0.01%	-28.2	-60%	-2.1	-10%
2.C.7 Other Metal Industry: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.C.7 Other Metal Industry: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
2.C.7 Other Metal Industry: no classification (SF_6)	720.6	30.6	7.7	0.00%	-712.9	-99%	-22.9	-75%
2.C.7 Other Metal Industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.D.1 Lubricant Use: no classification (CH_4)	1.7	0.4	0.4	0.00%	-1.4	-79%	-0.1	-19%
2.D.1 Lubricant Use: no classification (CO_2)	3 561.6	2 660.4	2 339.1	0.67%	-1 222.6	-34%	-321.4	-12%
2.D.1 Lubricant Use: no classification (N_2O)	3.1	3.4	2.8	0.00%	-0.3	-11%	-0.7	-19%
2.D.2 Paraffin Wax Use: no classification (CH_4)	0.2	0.4	0.4	0.00%	0.2	115%	0.0	0%
2.D.2 Paraffin Wax Use: no classification (CO_2)	664.7	1 069.3	1 082.7	0.31%	418.0	63%	13.4	1%
2.D.2 Paraffin Wax Use: no classification (N_2O)	0.7	1.4	1.4	0.00%	0.7	92%	0.1	4%
2.D.3 Other non energy products: no classification (CH_4)	0.3	0.4	0.4	0.00%	0.1	51%	0.0	9%
2.D.3 Other non energy products: no classification (CO_2)	7 911.5	5 190.7	5 352.5	1.53%	-2 559.0	-32%	161.8	3%
2.D.3 Other non energy products: no classification (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.1 Integrated Circuit or Semiconductor: no classification (HFCs)	87.4	67.9	67.1	0.02%	-20.3	-23%	-0.8	-1%
2.E.1 Integrated Circuit or Semiconductor: no classification (NF_3)	23.5	57.5	52.6	0.01%	29.1	124%	-4.9	-9%
2.E.1 Integrated Circuit or Semiconductor: no classification (PFCs)	433.4	531.7	466.5	0.13%	33.0	8%	-65.2	-12%
2.E.1 Integrated Circuit or Semiconductor: no classification (SF_6)	237.7	156.5	121.2	0.03%	-116.6	-49%	-35.3	-23%
2.E.2 TFT Flat Panel Display: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.2 TFT Flat Panel Display: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.3 Photovoltaics: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.3 Photovoltaics: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.4 Heat Transfer Fluid: no classification (HFCs)	0.0	0.2	0.2	0.00%	0.2	100%	0.0	0%
2.E.4 Heat Transfer Fluid: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.5 Other electronics industry: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.5 Other electronics industry: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.5 Other electronics industry: no classification (PFCs)	0.0	1.1	0.0	0.00%	0.0	0%	-1.1	-100%
2.E.5 Other electronics industry: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.5 Other electronics industry: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.1 Refrigeration and Air conditioning: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.1 Refrigeration and Air conditioning: no classification (PFCs)	0.0	74.7	69.4	0.02%	69.4	100%	-5.3	-7%
2.F.1 Refrigeration and Air conditioning: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
2.F.1 Refrigeration and Air conditioning: no classification (Unspecified mix of HFCs and PFCs)	0.0	1 441.6	1 440.9	0.41%	1 440.9	100%	-0.7	0%
2.F.2 Foam Blowing Agents: no classification (HFCs)	0.0	2 415.6	2 137.7	0.61%	2 137.7	100%	-277.9	-12%
2.F.2 Foam Blowing Agents: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.2 Foam Blowing Agents: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.2 Foam Blowing Agents: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.2 Foam Blowing Agents: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.3 Fire Protection: no classification (HFCs)	0.0	2 691.8	2 641.9	0.75%	2 641.9	100%	-49.9	-2%
2.F.3 Fire Protection: no classification (PFCs)	0.0	10.8	10.3	0.00%	10.3	100%	-0.5	-5%
2.F.4 Aerosols: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.4 Aerosols: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.4 Aerosols: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.4 Aerosols: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.5 Solvents: no classification (HFCs)	0.0	51.1	53.2	0.02%	53.2	100%	2.1	4%
2.F.5 Solvents: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.6 Other Applications: no classification (HFCs)	0.4	183.6	167.7	0.05%	167.3	46425%	-15.9	-9%
2.F.6 Other Applications: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.6 Other Applications: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.6 Other Applications: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.F.6 Other Applications: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.G.1 Electrical Equipment: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.G.1 Electrical Equipment: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.G.1 Electrical Equipment: no classification (SF_6)	-	-	-	-	-	-	-	-
2.G.2 SF_6 and PFCs from Other Product Use: no classification (PFCs)	319.3	551.0	484.1	0.14%	164.9	52%	-66.8	-12%
2.G.2 SF_6 and PFCs from Other Product Use: no classification (SF_6)	4 172.4	4 368.8	3 403.6	0.97%	-768.8	-18%	-965.2	-22%
2.G.3 N_2O from Product Uses: no classification (N_2O)	5 578.8	3 403.7	3 504.1	1.00%	-2 074.7	-37%	100.4	3%
2.G.4 Other unspecifed product manufacture and use: no classification (CH_4)	58.3	81.4	71.2	0.02%	12.9	22%	-10.2	-13%
2.G.4 Other unspecifed product manufacture and use: no classification (CO_2)	789.8	563.6	570.2	0.16%	-219.6	-28%	6.6	1%
2.G.4 Other unspecifed product manufacture and use: no classification (HFCs)	0.0	14.2	17.2	0.00%	17.2	100%	3.0	21%
2.G.4 Other unspecifed product manufacture and use: no classification (N_2O)	46.0	216.9	103.8	0.03%	57.8	126%	-113.1	-52%
2.G.4 Other unspecifed product manufacture and use: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
2.G.4 Other unspecifed product manufacture and use: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.G.4 Other unspecifed product manufacture and use: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.G.4 Other unspecifed product manufacture and use: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.H Other Industrial Process and Product Use: no classification (CH_4)	37.2	13.8	11.4	0.00%	-25.8	-69%	-2.5	-18%
2.H Other Industrial Process and Product Use: no classification (CO_2)	112.9	116.1	106.5	0.03%	-6.5	-6%	-9.6	-8%
2.H Other Industrial Process and Product Use: no classification (HFCs)	0.0	3.8	4.5	0.00%	4.5	43685%	0.8	20%
2.H Other Industrial Process and Product Use: no classification (N_2O)	63.8	88.1	90.7	0.03%	27.0	42%	2.7	3%
2.H Other Industrial Process and Product Use: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.H Other Industrial Process and Product Use: no classification (PFCs)	0.2	1.1	0.9	0.00%	0.7	351%	-0.2	-17%
2.H Other Industrial Process and Product Use: no classification (SF_6)	7.5	4.5	5.2	0.00%	-2.3	-31%	0.7	15%
2.H Other Industrial Process and Product Use: no classification (Unspecified mix of HFCs and PFCs)	282.9	157.6	96.0	0.03%	-187.0	-66%	-61.6	-39%

4.3 Methodological issues and uncertainties

The previous section presented for each EU-KP key source in CRF Sector 2 an overview of the Member States' contributions to the key source in terms of level and trend, information on methodologies, emission factors, completeness and qualitative uncertainty estimates. Detailed information on national methods and circumstances is available in the Member States' national inventory reports.

4.3.1 Gap filling of Activity data

It is important to explain the reasons why the EU is not always able to provide EU-level AD or IEFs but has instead opted to transparently document what the MS have reported.

Because of the differences in methodological approaches used by countries the EU NIR provides overview tables for the activity data used by countries and the corresponding IEFs. Some of these tables do include a calculation of EU-level implied emission factors based on a number of countries. In those cases where (a) more than 75% of the emissions are calculated on basis of consistent activity data, and (b) the IEF has a reasonable degree of consistency (i.e. standard deviation divided by mean

< 50%) we gap-filled activity data in the CRF. In these cases we are confident that the IEF included in the CRF provides reliable information to reviewers and adds to the transparency of the EU inventory. In all other cases we believe that an IEF in the CRF would be misleading because it would be based on a limited number of countries or based on very different methodological approaches which cannot be meaningfully aggregated. Due to the significant amount of time required, the CRF only includes gap filled activity data for 2020 and only for the EU key categories where the criteria above apply. In 2022 the following categories have been gap-filled:

- Cement Production 2.A.1
- Lime production in 2.A.2
- Ammonia Production in 2.B.1

The method for gap filling includes four steps:

1. Emissions have been aggregated for those MS that are using the same activity data and that are reporting activity data and emissions (i.e. not using notation keys for either activity data or emissions. Usually the geographical coverage of these MS is smaller than EU-KP.
2. These emissions have been divided by the aggregated activity data of those MS in order to derive an IEF for those MS.
3. The total emissions of the EU-KP have been divided by this IEF in order to derive a gap-filled estimate for activity data for EU-KP.

Table **4.56** shows the details for the gap filling of activity data for the four categories in particular the geographical coverage of MS used as a basis for calculating the IEF.

Table 4.56 Documentation of gap filling of activity data

Category	Geographical coverage	2020			
		Activity data Description	(kt)	IEF (t/t)	Emissions (kt)
2.A.1	EUA	Clinker production	140 705	0.53	74 304
	EUC	Clinker production	140 705	0.53	74 304
2.A.2	EUA	Lime Production	23 024	0.73	16 903
	EUC	Lime Production	23 024	0.73	16 903
2.B.1	EUA	Ammonia Production	16 077	1.41	22 646
	EUC	Ammonia Production	16 077	1.41	22 646

4.3.2 Uncertainty estimates

Table 4.57 shows the total EU-KP uncertainty estimates for the sector ‘Industrial processes’ and the uncertainty estimates for the relevant gases of each source category. The highest level uncertainty was estimated for PFCs from 2.F (157.9%) and the lowest for CO_2 from 2.A (3 %). With regard to trend HFC from 2.F shows the highest uncertainty estimates, CO_2 from 2.A the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-KP see Chapter 1.6.

Table 4.57 Sector 2 Industrial processes: Uncertainty estimates for the EU-KP

Source category	Gas	Emissions Base Year	Emissions 2020	Emission trends Base Year-2020	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.A Mineral Industry	CO_2	144 390	104 594	-27.6%	3.0%	0.8%
2.A Mineral Industry	CH_4	0	0	0.0%	0.0%	0.0%
2.A Mineral Industry	N_2O	0	0	0.0%	0.0%	0.0%
2.B Chemical Industry	CO_2	58 418	51 397	-12.0%	9.0%	1.7%
2.B Chemical Industry	CH_4	1 220	1 222	0.2%	24.2%	6.5%
2.B Chemical Industry	N_2O	112 207	5 069	-95.5%	8.7%	3.5%
2.B Chemical Industry	HFC	29 033	1 010	-96.5%	18.7%	6.5%
2.B Chemical Industry	PFC	4 332	666	-84.6%	32.7%	10.3%
2.B Chemical Industry	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.B Chemical Industry	SF_6	1 846	4	-99.8%	19.5%	21.4%
2.B Chemical Industry	NF_3	0	8	Inf	26.0%	Inf
2.C Metal Industry	CO_2	140 464	76 036	-45.9%	4.8%	1.4%
2.C Metal Industry	CH_4	397	119	-70.0%	12.2%	5.7%
2.C Metal Industry	N_2O	47	19	-59.6%	63.2%	40.6%
2.C Metal Industry	HFC	0	16	Inf	20.4%	Inf
2.C Metal Industry	PFC	21 135	491	-97.7%	5.8%	9.8%
2.C Metal Industry	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.C Metal Industry	SF_6	1 402	40	-97.2%	8.0%	15.6%
2.C Metal Industry	NF_3	0	0	0.0%	0.0%	0.0%
2.D Non-energy products from fuels and solvent use	CO_2	11 206	8 032	-28.3%	40.3%	5.8%
2.D Non-energy products from fuels and solvent use	CH_4	2	1	-58.1%	48.1%	60.9%
2.D Non-energy products from fuels and solvent use	N_2O	4	4	8.9%	61.3%	23.5%
2.E Electronics industry	CO_2	0	0	0.0%	0.0%	0.0%
2.E Electronics industry	CH_4	0	0	0.0%	0.0%	0.0%
2.E Electronics industry	N_2O	0	0	0.0%	0.0%	0.0%
2.E Electronics industry	HFC	87	62	-29.0%	25.9%	28.8%
2.E Electronics industry	PFC	433	396	-8.7%	9.7%	11.0%
2.E Electronics industry	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.E Electronics industry	SF_6	237	107	-54.9%	16.2%	65.5%
2.E Electronics industry	NF_3	23	49	108.6%	15.0%	28.9%
2.F Product uses as substitutes for ODS	CO_2	0	0	0.0%	0.0%	0.0%

Source category	Gas	Emissions Base Year	Emissions 2020	Emission trends Base Year-2020	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.F Product uses as substitutes for ODS	CH_4	0	0	0.0%	0.0%	0.0%
2.F Product uses as substitutes for ODS	N_2O	0	0	0.0%	0.0%	0.0%
2.F Product uses as substitutes for ODS	HFC	15	73 555	475667.7%	31.4%	81799.2%
2.F Product uses as substitutes for ODS	PFC	0	34	Inf	157.9%	Inf
2.F Product uses as substitutes for ODS	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.F Product uses as substitutes for ODS	SF_6	0	0	0.0%	0.0%	0.0%
2.F Product uses as substitutes for ODS	NF_3	0	0	0.0%	0.0%	0.0%
2.G Other product manufacture and use	CO_2	790	570	-27.8%	8.7%	2.3%
2.G Other product manufacture and use	CH_4	58	71	22.1%	34.5%	10.2%
2.G Other product manufacture and use	N_2O	3 191	2 694	-15.6%	40.2%	7.3%
2.G Other product manufacture and use	HFC	0	15	Inf	19.0%	Inf
2.G Other product manufacture and use	PFC	319	484	51.6%	23.5%	11.5%
2.G Other product manufacture and use	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.G Other product manufacture and use	SF_6	3 128	2 027	-35.2%	37.4%	13.1%
2.G Other product manufacture and use	NF_3	0	0	0.0%	0.0%	0.0%
2.H Other	CO_2	92	48	-47.9%	8.7%	5.3%
2.H Other	CH_4	6	9	43.5%	21.1%	9.2%
2.H Other	N_2O	64	91	42.4%	21.0%	8.9%
2.H Other	HFC	0	5	43684.6%	59.4%	25699.8%
2.H Other	PFC	0	1	351.4%	59.7%	209.8%
2.H Other	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.H Other	SF_6	7	5	-30.9%	59.9%	18.5%
2.H Other	NF_3	0	0	0.0%	0.0%	0.0%
2 (where no subsector data were submitted)	*all*	13 881	21 578	55.5%	12.9%	14.4%
Total - 2	**all**	**548 435**	**350 527**	-36.1%	**8.1%**	**2.5%**

Note: Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions because uncertainty estimates are not available for all source categories

4.4 Sector-specific quality assurance and quality control

There are several arrangements for improving the quality of GHG emissions from industrial processes: (1) Before and during the compilation of the EU GHG inventory, a number of assessments are made of the Member States data in particular for time series consistency of emissions and implied emission factors, comparisons of implied emission factors across countries and checks of internal consistency. Table 3.127 (in the Energy chapter), summarizes the main checks carried out on Member States' submissions. Internal reviews are carried out for selected source categories. In 2006 the following source categories were reviewed by countries experts: 2A Mineral Products, 2B Chemical Industry, 2C Iron and Steel Production and Fluorinated Gases, 2E Production of Halocarbons and SF_6 and 2F Consumption of Halocarbons and SF_6. In 2008, completeness and allocation issues were reviewed by countries experts for all source categories in Industrial Processes. In 2012 a comprehensive review was carried out for all sectors and all EU countries in order to fix the base year emissions under the EU Effort Sharing Decision. (ESD review 2012). For the inventory 2005 plant-specific data was available from the EU ETS for the first time. This information was used by EU Member States for quality checks and as an input for calculating total CO_2 emissions for the sectors Energy and Industrial Processes in the 2005 report (see Section 1.4.2). During the ESD review 2012 consistency checks were carried out between EU ETS data and the inventory estimates.

In 2013 two workshops were organized in the context of the MS assistance project with the aim of supporting Member States in improving their inventories related to the use of EU ETS data and related to F-gases.

In 2014, the initial checks for F-gases were extended: (1) the time series of HFC emissions of the EU Member States was checked at 3-digit level (2.F.1, 2.F.2,…) and at 4-digit level for 2.F.1 (i.e. 2.F.1.1, 2.F.1.2,…); (2) time series and comparability across EU Member States was checked for per capita HFC emissions of category 2-F.1 and its subcategories (2.F.1.1, 2.F.1.2, …). As a result of the checks, 74 issues were clarified with EU Member States. Furthermore, in 2014 additional quality checks of the EU NIR chapter waste were carried out in order to improve the consistency between the CRF tables and the EU NIR and consistency of tables and figures with text in the EU NIR.

In recent years, comprehensive ESD reviews were performed in 2016 and 2020, and annual ESD reviews were conducted in 2017, 2018, 2019 and 2021.

Since 2016, additional focus is put on the introduction of alternatives to F-gases in the quality checks of Member States' submissions. This is relevant in the context of the HFC phase-down under the EU F-gas Regulation.

4.5 Sector Specific Recalculations

Table 4.58 shows that in the industrial processes sector the largest recalculations in absolute terms were made in 1990 and 2019 for CO_2, but also recalculations for HFCs in 2019 and for N_2O in 1990 are remarkable.

Table 4.58 Recalculations of total GHG emissions and recalculations from industrial processes and product use for 1990 and 2019 by gas (kt CO_2 equivalents) and percent of sector total)

1990	**CO_2**		**CH_4**		**N_2O**		**HFCs**		**PFCs**		**SF_6**		**Unspecified mix of HFCs and PFCs**		**NF3**	
	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%	kt	%
Total emissions and removals	-19 935	-0.5%	-1 905	-0.3%	-7 051	-1.7%	1	0.0%	-3	0.0%	-115	-1.0%	-0.0003	0.0%	-0.3	-1.3%
Industrial Processes and Product Use	18 618	5.5%	66	3.6%	26	0.0%	1	0.0%	-3	0.0%	-115	-1.0%	-0.0003	0.0%	-0.3	-1.3%
2019																
Total emissions and removals	3 998	0.1%	-3 657	-0.8%	-9 520	-3.7%	5 924	6.3%	-138	-4.6%	-105	-1.5%	1	0.03%	-0.3	-0.5%
Industrial Processes and Product Use	7 071	2.8%	62	4.2%	-1 096	-10.5%	5 924	6.3%	-138	-4.6%	-105	-1.5%	1	0.03%	-0.3	-0.5%

Table 4.59 provides an overview of Member States' contributions to EU-KP recalculations.

Table 4.59 Sector 2 Industrial processes: Contribution of Member States to EU-KP recalculations for 1990 and 2019 by gas (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990								2019							
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF3
Austria	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	34	1.9	0.0	101	0.0	0.0	0.0	0.0
Belgium	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.6	0.0	0.0	107	0.0	-0.1	0.0	0.0
Bulgaria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-694	4 650	0.0	0.0	0.0	0.0
Croatia	2.1	0.0	3.3	0.0	0.0	0.3	0.0	0.0	-3.4	0.0	-88	998	0.0	2.5	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16	0.0	0.0	0.0	0.0
Czechia	139	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-16	0.0	0.0	361	0.0	0.1	0.0	0.0
Denmark	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Estonia	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	2.0	0.0	0.1	0.0	0.0
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	-122	0.0	0.0	0.0	0.0
France	64	0.2	0.1	0.0	0.0	0.0	0.0	0.0	35	-2.7	15	-1 162	-4.4	5.0	0.0	0.0
Germany	-0.6	60	-0.9	0.0	0.0	0.0	0.0	0.0	-1 225	62	-117	-287	0.1	0.0	0.9	0.0
Greece	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-4.6	0.0	0.0	17	0.0	0.0	0.0	0.0
Hungary	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	25	0.0	0.0	0.0	0.0
Ireland	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-18	0.0	0.0	70	0.0	-4.1	0.0	0.0
Latvia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Lithuania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-35	0.0	-0.1	0.0	0.0
Luxembourg	0.0	0.0	0.2	0.0	0.0	-0.4	0.0	0.0	0.0	0.0	0.3	-2.6	0.0	-0.5	0.0	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-23	0.0	0.1	0.0	0.0
Netherlands	0.0	1.5	0.7	0.0	0.0	0.0	0.0	0.0	145	0.9	4.7	-382	0.4	5.9	0.0	0.0
Poland	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	0.0	-191	1 667	0.0	0.0	0.0	0.0
Portugal	-5.6	-0.9	20	0.0	0.0	0.0	0.0	0.0	-34	-0.9	0.0	2.5	0.0	0.2	0.0	0.0
Romania	-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11	0.0	0.0	-339	0.0	0.0	0.0	0.0
Slovakia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Slovenia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.9	0.0	-32	1.0	0.0	0.0	0.0	0.0
Spain	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-26	0.0	0.0	40	0.0	0.0	-0.4	0.0
Sweden	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-42	0.0	0.0	2.1	0.0	0.9	0.0	0.0
United Kingdom	18 414	2.3	2.7	1.2	-2.7	-115	0.0	-0.3	8 196	1.0	4.8	4.1	-134	-115	0.0	-0.3
EU27+UK	18 618	66	26	1.2	-2.7	-115	0.0	-0.3	7 072	62	-1 096	5 714	-138	-105	0.5	-0.3
Iceland	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	0.4	0.0	-4.6	0.0	0.3	0.0	0.0
United Kingdom (KP)	18 414	2.3	2.7	1.3	-2.7	-115	0.0	-0.3	8 196	1.0	4.9	219	-134	-115	0.0	-0.3
EU-KP	18 618	66	26	1.3	-2.7	-115	0.0	-0.3	7 071	62	-1 096	5 924	-138	-105	0.5	-0.3

5 AGRICULTURE (CRF SECTOR 3)

About half the European Union's land is farmed. This fact alone highlights the importance of farming for the EU's natural environment. Farming and nature exercise a profound influence over each other. Farming has contributed over the centuries to creating and maintaining a variety of valuable semi-natural habitats, shaping the majority of today's EU's landscapes and home to much of the EU's richest wildlife. Farming also supports a diverse rural community that is not only a fundamental asset of European culture, but also plays an essential role in maintaining the environment in a healthy state[22].

The links between the richness of the natural environment and farming practices are complex. While many valuable habitats in Europe are maintained by extensive farming, and a wide range of wild species rely on this for their survival, agricultural practices can also have an adverse impact on natural resources. Pollution of soil, water and air, fragmentation of habitats and loss of wildlife can be the result of inappropriate agricultural practices and land use.

Agriculture in Europe is strongly influenced by the Common Agricultural Policy (CAP) of the European Union. The CAP dates from 1957, and its foundations are entrenched in the Treaty of Rome. Initially, the emphasis of the CAP was to increase agricultural productivity, partly for food security reasons, but also to ensure that the EU had a viable agricultural sector and that consumers had a stable supply of affordable food (Gay et al., 2005). With the MacSharry reform of 1992 several steps were taken by the EU to shift CAP subsidies away from price and market support towards direct support for farmers. This was further pursued with the Agenda 2000 reform, as signified by the shift in focus towards the maintenance and enhancement of the rural environment and the growing recognition of agriculture as a multifunctional activity. In environmental terms, the focus is on less-favoured areas and areas with environmental restrictions, and on agricultural production methods designed to protect the environment and to maintain the countryside.

However, price support and income payments, together with milk quotas, remained the dominant support measures. The 2003 CAP reform made further progress in the direction initiated by the Agenda 2000 reform, by aiming to make European agriculture more market oriented and giving a stronger focus to environmental protection. With the CAP reform, cross-compliance became an obligatory element of the CAP. Cross compliance links direct payments to respecting a number of statutory management requirements and to maintain all agricultural land in good agricultural and environmental conditions (EC 2003)[23].

- "Statutory management requirements" (SMR, Annex III of Regulation (EC) No 1782/2003) which are set in 19 community legislative acts on environment, food safety, animal health and welfare.
- The obligation to maintaining land in good agricultural and environmental conditions (GAECs) and maintaining permanent pasture at level at 1.5.2004. Definitions of GAEC are specified at national or regional level and should warrant appropriate soil protection, ensure a minimum level of maintenance of soil organic matter and soil structure and avoid the deterioration of habitats.

In 2013, the Council of the EU Agriculture Ministers adopted four Basic Regulations for a reformed CAP following a CAP Health Check[24] in 2008 and a Commission Communication on the CAP towards 2020[25] in 2011. The four legislative texts that regulate the post-2013 CAP are (i) Rural Development: Regulation

[22] http://ec.europa.eu/agriculture/envir/index_en.htm

[23] http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32003R1782

[24] http://ec.europa.eu/agriculture/healthcheck/index_en.htm

[25] https://ec.europa.eu/agriculture/cap-post-2013_en

1305/2013[26]; (ii) "Horizontal" issues such as funding and controls: Regulation 1306/2013[27]; (iii) Direct payments for farmers: Regulation 1307/2013[28]; (iv) Market measures: Regulation 1308/2013[29].

With the adoption of the 2013 CAP reform, the environment concerns received an enhanced focus being materialised by explicitly linking the agricultural support to "agricultural practices beneficial to the climate and environment" (so called 'CAP greening'). Agro-environmental indicators have been identified as useful tools to perform this task, especially since they allow for the assessment of territorial impacts. The monitoring and evaluation of CAP performance is carried out through indicators (EC 2006[30], 2001[31], 2000[32]). Green direct payments account for 30% of EU countries' direct payment budgets. Farmers receiving an area-based payment have to make use of various straightforward, non-contractual practices that benefit the environment and the climate. These require action each year. They include:

- diversifying crops;
- maintaining permanent grassland; and
- dedicating 5% of arable land to ecologically beneficial elements ('ecological focus areas').

Currently, the next reform of the CAP is under discussion enabling agriculture in Europe by its modernisation and simplification to face new challenges, such related to economic prospects and care for the environment including action over climate change and maximise its contribution to the Commission's priorities and to the Sustainable Development Goals[33].

The **Nitrates Directive** (Council Directive 91/676/EEC) is the SMR with the largest impact on greenhouse gas emissions from agriculture. The directive aims at reducing and preventing water pollution caused by nitrates from agricultural sources with the goal that nitrate concentrations in groundwater will not exceed 50 mg NO_3^- l^{-1} and listing codes of good practice (Annex II A) to be implemented by the farmers on a voluntary basis. Nitrate vulnerable zones (NVZ) must be designated on the basis of monitoring results which indicate that the groundwater and surface waters in these zones are or could be affected by nitrate pollution from agriculture. The action program must contain mandatory measures relating to: (i) periods when application of animal manure and fertilisers are prohibited; (ii) capacity of and facilities for storage of animal manure; and (iii) limits to the amounts of animal manure and fertilisers applied to land.

The action programmes need to be implemented by farmers within NVZs on a compulsory basis. These programmes must include measures already included in Codes of Good Agricultural Practice, which become mandatory, and other measures, such as limitation of fertiliser application (mineral and organic), taking into account crop needs and all nitrogen inputs and soil nitrogen supply, with maximum amount of livestock manure to be applied. Every four years countries are required to report on nitrates concentrations in groundwaters and surface waters; eutrophication of surface waters; assessment of the impact of action programme(s) on water quality and agricultural practices; revision of NVZs and action programme(s); estimation of future trends in water quality.

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[26] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:en:PDF

[27] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0549:0607:en:PDF

[28] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0608:0670:en:PDF

[29] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0671:0854:en:PDF

[30] EC (2006). Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy. Communication from the Commission to the Council and the European Parliament. COM(2006) 508 final. Commission of the European Communities, Brussels.

[31] EC (2001). Statistical Information needed for Indicators to monitor the Integration of Environmental concerns into the Common Agricultural Policy. Communication from the Commission to the Council and the European Parliament. COM(2001) 144 final. Commission of the European Communities.

[32] EC (2000). Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy. Commission of the European Communities.

[33] https://ec.europa.eu/agriculture/consultations/cap-modernising/2017_en

This has affected emissions in most countries:

- In Belgium, Manure Action Plans (MAP, based on the Nitrate Directive) in Flanders affected NH_3 volatilization from manure application. The first action plan in 1991 regulated the reduced period in which manure can be spread and foresaw low-emission techniques for the application of manure on land. The MAP2bis in 2000 focused on the reduction of the manure surplus and manure processing in order to reduce the NH_3 emissions from manure application on land. Other MAP's followed, which have had a positive effect on the NH_3 and N_2O emissions.
- In Denmark, the environmental policy has introduced a series of measures to prevent loss of nitrogen from agricultural soils to the aquatic environment. The measures include improvements to the utilisation of nitrogen in manure, a ban on manure application during autumn and winter, increasing area with winter-green fields to catch nitrogen, a maximum number of animals per hectare and maximum nitrogen application rates for agricultural crops. All farmers are obliged to do N-mineral accounting at farm and field level with the N-excretion data from FAS (Faculty of Agricultural Sciences). The N figures also include the quantities of mineral fertilisers bought and sold. Suppliers of mineral fertilisers are required to report all N sales to commercial farmers to the Plant Directorate. An active environmental policy has brought about a decrease in the N-excretion and a decrease of emission per produced animal, because of more efficient feeding. As a result of increasing requirements to reduce the nitrogen loss to the environment, the consumption of nitrogen in synthetic fertiliser has more than halved since 1990.
- In the Netherlands, manure and fertiliser policy influences livestock numbers. Especially young cattle, pigs and poultry numbers decreased by the introduction of measures like buying up part of the so-called pig and poultry production rights (ceilings for total animal numbers) by the government and lowering the maximum nutrient application standards for manure and fertiliser. However, greater compliance to standards and requirements for animal welfare and the housing of animals may contribute to increasing emissions (so-called pollution swapping).

Beside the environmentally-targeted directives, also the first pillar of the CAP (dealing with market support in contrast to pillar two covering rural development measures) had a strong impact on the greenhouse gas emissions from agriculture in Europe, namely through the milk quota system, which lead to a strong reduction of animal numbers in the dairy sector to compensate for the increasing animal performance during the last decades. The milk quota system ended in 2015.

Other important policies affecting greenhouse gas emissions from agriculture, particularly by addressing the abatement of air pollution through the control of NO_x and NH_3 emissions include, amongst others:

- The 1999 Gothenburg Protocol under the Convention on Long Range Transboundary Air Pollution (CLRTAP[34]) to 'Abate Acidification, Eutrophication and Ground-level Ozone', revised in 2012 setting national emission reduction commitments to be achieved by 2020 and beyond;
- The National Emission Ceilings Directive (NEC - Directive 2016/2284/EC[35]) sets upper limits for each country for the total emissions in 2010 of the four pollutants responsible for acidification,

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34 http://www.unece.org/env/lrtap/multi_h1.html

35 https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1554903780611&uri=CELEX:32016L2284

eutrophication and ground-level ozone pollution. It has been updated in 2016[36] setting new objectives for EU air policy for 2020 and 2030;

- The Industrial Emission Directive (IED[37][38]), which was established in 1996, and aims at minimizing pollution from point sources, i. e., intensive animal production facilities (pig and poultry farms, with more than 2000 fattening pigs (over 30 kg); more than 750 sows or more than 40,000 head of poultry). These are required under the directive to apply control techniques for preventing NH_3 emissions according to Best Available Technology (BAT).

Legislation related with animal health may also affect emissions through changes in specific parameters. That is the case of Spain, where the methane conversion factor (Ym), and therefore the implied emission factor for CH_4 emissions from enteric fermentation from swine decreased in 2006, partly due to the ban of the use of growth-promoting antibiotics in animal feeding. This resulted in a radical change in feeding conditions: raw materials with lowest digestibility were removed and replaced by carbohydrates (mainly cereals). To increase higher digestibility and quality protein supply, the soybean flour 44 was systematically replaced by soybean 47 which has higher protein content. Also, affordable synthetic amino acids and digestive enzymes were systematically introduced. In addition, during the same year, the regulation on additives used in animal feeding was published, thus forcing the withdrawal of products that were being used to date, in order to make the digestion of other diet components easier.

Structural changes are caused also by the general development of countries. For example, in Finland, the membership in the EU resulted in changes in the economic structure followed by an increase in the average farm size and a decrease in the number of small farms (Pipatti, 2001), causing also a decrease in the livestock numbers for most animal types. Swedish agriculture has undergone radical structural changes and rationalizations over the past 50 years. One fifth of the Swedish arable land cultivated in the 1950s is no longer farmed. Closures have mainly affected small holdings and those remaining are growing larger. In 1999, some 31,000 agricultural holdings were livestock farms, 14,000 were purely crop husbandry farms, and only 5,000 were a combination of the two. Livestock farmers predominately engage in milk production and the main crops grown in Sweden are grain and fodder crops. The decrease of agricultural land area has continued since Sweden joined the European Union in 1995 and the acreages of land for hay and silage has increased. Organic farming increased from 3% of the arable land area in 1995 to 17% in 2007.

In the case of Croatia, we can observe livestock population drops in 1992 due to the beginning of the Croatian War of Independence in 1991/1992, which significantly influenced animal production for most animal categories. The countries which formed part of the communist block suffered structural changes when they changed regime, mainly due to privatizations. Lithuania shows an important decrease of non-dairy cattle population in 1993-1994, after the collapse of the Soviet Union and the restoration of independence in 1990, when changes in economy and significant reforms occurred. The reform included the re-establishment of private ownership and management in agriculture sector. Legislation defined dismemberment of collective farms, but they did not definitively ensure their replacement by at least equally productive private farms and corporations. The decrease in cattle population occurred also due to high costs in production, product differences in prices and lack of market for meat and milk. Similarly, Bulgaria shows a decline in cattle numbers in 1992-1995, after the communist period, due to the reforms in agricultural holdings, together with a decrease in the quantities of inorganic fertilisers. Poland, in turn, had a significant drop in cattle population since mid-1990s up to 2002 due to intentional limitations of cattle breeding related to weakening demand for beef meat. Further increase in population could be connected with the prospect of inclusion of Poland into the EU planned for 2004 and joining the common

36 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284&from=EN

37 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

38 http://ec.europa.eu/environment/industry/stationary/index.htm

agricultural policy, with expectations for stable agricultural production. An increase in population in 2012 was probably triggered by the improved economic situation for the agricultural markets. The economic situation seems to highly influence the use of fertilisers in the EU countries, especially for liming and urea fertilization. In Poland, limestone/dolomite fertiliser use dramatically decreased after 2004 as a result of a cut in their subsidies for farmers. In 2006, limestone use was lower by 40% than in previous year, despite remaining high need of soils. In Lithuania, a sharp increase of N input from application of other organic fertilisers took place in 2013, caused by changes in national circumstances when using financial resources of 2004-2006 EU ISPA/Cohesion funds Lithuania started to improve municipal solid waste management system. Also in Italy, fertiliser use was affected by the economic crisis (2009-2011), which led to a reduction in the application of all synthetic fertilisers, in particular urea. In 2012, a recovery from the sharp decline was recorded. In the same line, Slovenia reports a strong decrease in urea fertilisers in 1991 and 2008 due to the economic crisis and high prices of fertilisers.

Similarly, the area used for rice cultivation suffers large changes for both continuous flooded and intermittently flooded rice as consequences of economic and environmental pressures. For emissions at EU-level, the combination of emissions from rice from different countries and cultivation systems contributes additionally to fluctuations. Emissions from burning of agricultural residues also have fluctuating trends due to the heterogeneity of the emission source: it is a composite emission categories over countries and crops with different shares of residues burned and different shares of agricultural area and, consequently, large fluctuations are to be expected.

5.1 Overview of sector

In the year 2020, CH_4, N_2O and CO_2 emissions from CRF sector 3 Agriculture were 49.6%, 73.7%, and 0.33% of total CH_4, N_2O and CO_2 EU-KP emissions, respectively. Total emissions from agriculture were 424 Mt CO_2-eq with contributions from CH_4, N_2O, and CO_2 of 231 Mt CO_2-eq, 182 Mt CO_2-eq and 10.9 Mt CO_2-eq, respectively. Thus, CH_4, N_2O, and CO_2 contributed with 5.6%, 4.4% and 0.27% to total EU-KP GHG emissions. In perspective, total EU-KP CH_4 emissions were 434 Mt CO_2 equivalent, N_2O emissions were 242 Mt CO_{2eq}, and CO_2 emissions were 2962 Mt CO_{2eq}.

Units in the plots refer to gas emissions; when mass is expressed as CO_2 equivalent it is specifically indicated (GWP-100 recommended in IPCC AR4 is used for calculating CO_2eq mass).

Figure 5.1 shows the development of total GHG emissions from agriculture from 532 Mt CO_2-eq in 1990 to 424 Mt CO_2-eq in 2020. The reduction of emissions was most pronounced for CO_2 with a decrease of 29.2%, followed by CH_4 with a decrease of 20.5% and N_2O with a decrease of 19.7%. The cut was most pronounced in the first decade with a total reduction of 14.3% between 1990 and 2000, a further decrease by between 2000 and 2005, while remaining almost constant since 2005 (change -2.4%).

Figure 5.2 shows that largest reductions occurred in the largest key sources CH_4 from *3.A.1: Cattle* and N_2O from *3.D.1: Direct emissions from managed soils*. The main reasons for this are decreasing use of fertiliser and manure and declining cattle numbers in most countries. Figure 5.3 shows the distribution of agricultural GHG emissions among the different source categories for the year 2020.

Figure 5.1: EU-28 GHG emissions for 1990-2020 from CRF Sector 3: 'Agriculture' in CO_2 equivalents (Mt)

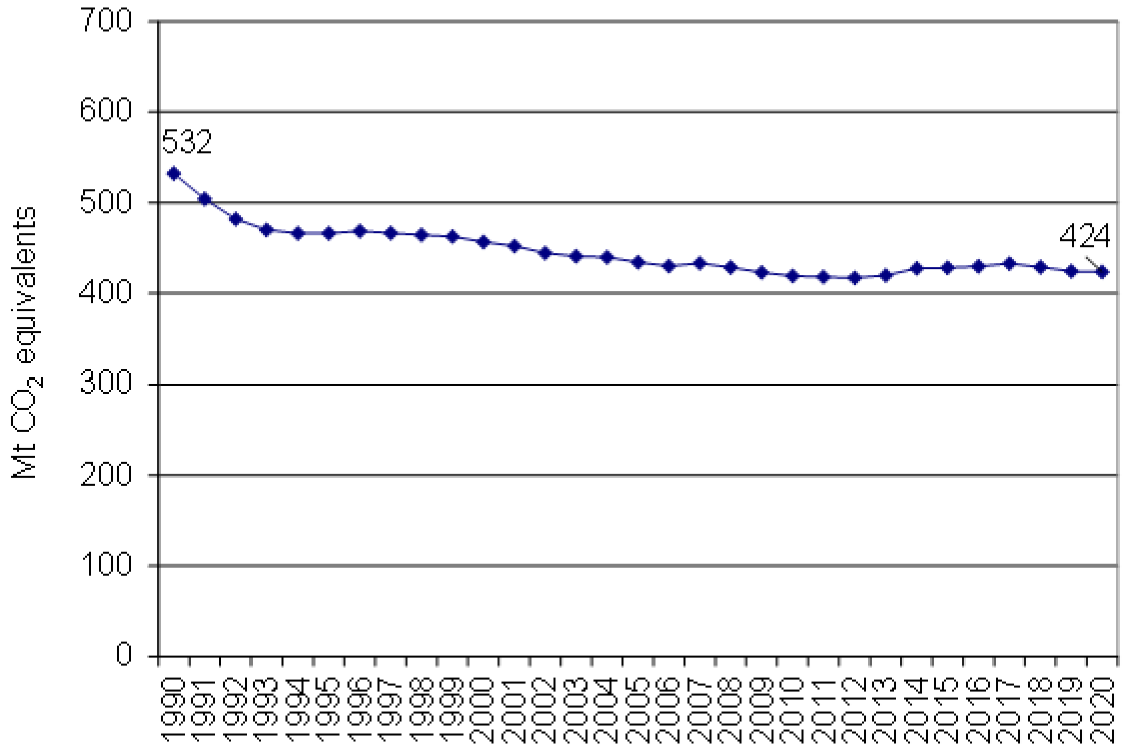


Figure 5.2: Absolute change of GHG emissions by large key source categories 1990-2020 in CO_2 equivalents (Mt) in CRF Sector 3: 'Agriculture'

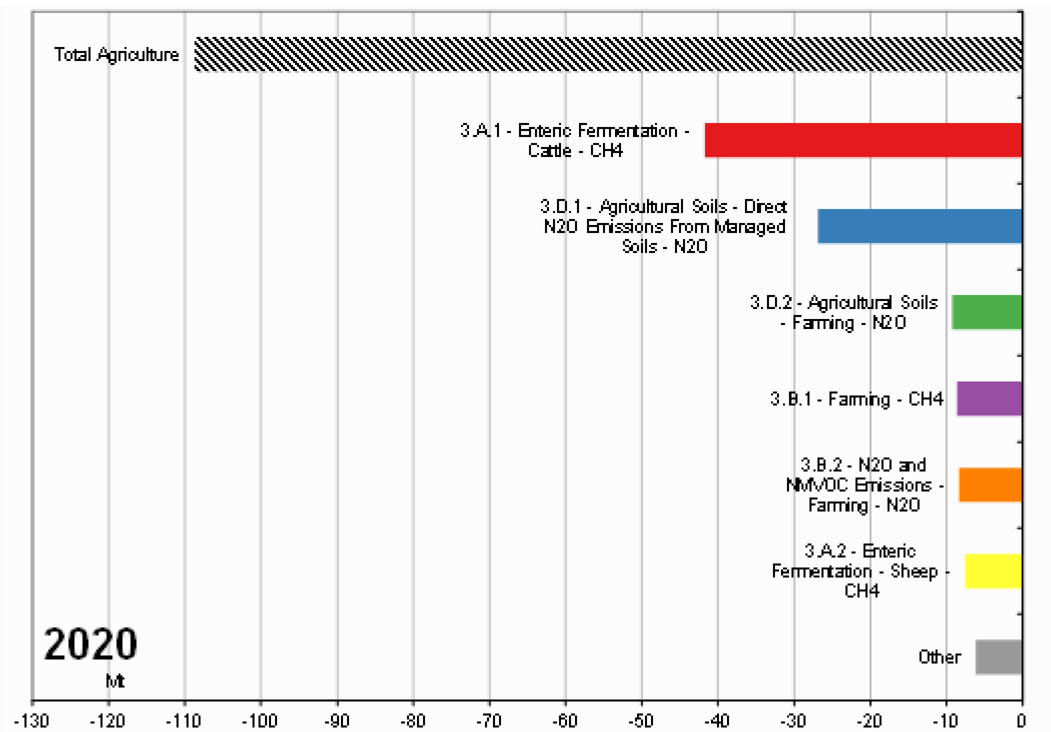
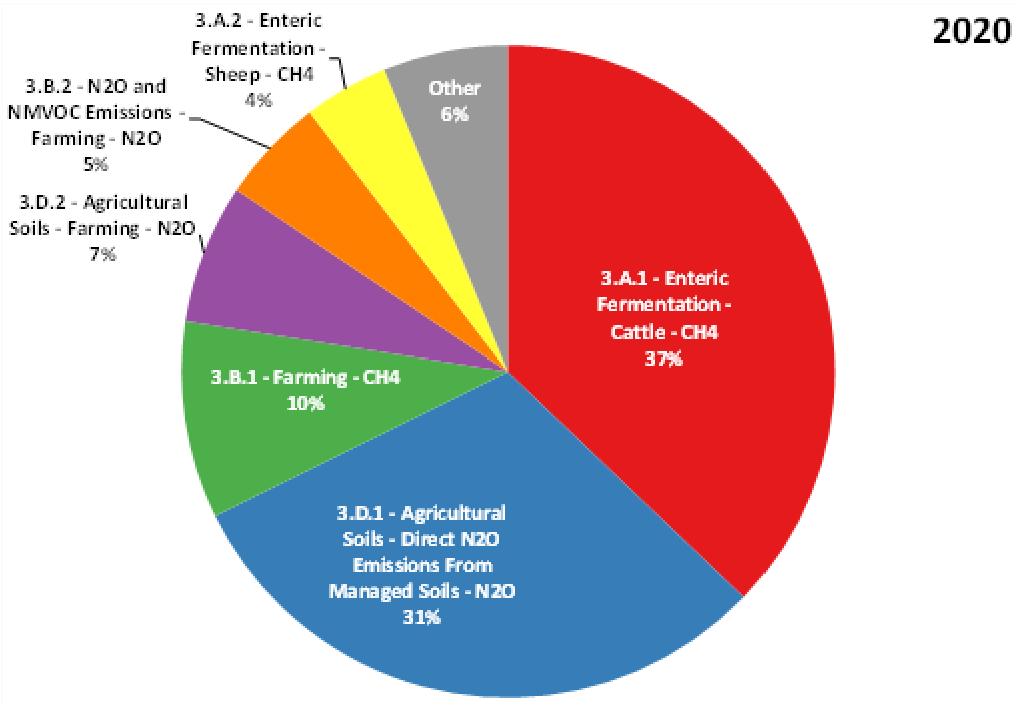


Figure 5.3: Distribution of agricultural GHG emissions among the different source categories for the year 2020



5.2 Emission trends

In this section we analyse the contribution of the different emission categories and the individual countries to the overall trend of emissions from the EU agricultural sector. Table 5.1 shows the different emission categories, their contribution to total emissions in the EU sector and their contribution to the trend 1990-2020 and 2019-2020. A negative share of the trend means that the emissions in that category are evolving in the opposite direction to those of the EU.

Total emissions from agriculture have decreased by 20.7% compared to 1990, and 46% of this reduction is due to sector 3.A. Another important sector in determining long-term emission trends is 3.D.1 which accounts for 24% of the total decrease in agricultural emissions, followed by 3.B.1 (8%), 3.B.2 (8%), and 3.D.2 (8%), while all the other categories contribute less. The decrease in emissions is due to the decrease in the cattle population (28.6% between 1990 and 2020) and the decrease in the quantities applied of fertilisers, both synthetic and organic (25.2% and 12.4% decrease, respectively). Only emissions from follow the opposite trend, contributing to compensate the emission decrease but with a very low impact (% of agriculture total trend).

Table 5.1 Contribution of the different emission categories to the total trend in emissions from the agricultural sector, compared to the share of emissions of those categories from the total of the sector

Emission category	Gas	Contribution to total agricultural emissions (2020)	Share of trend 1990-2020	Share of trend 2019-2020
3.A	CH_4	44%	46%	86%
3.B.1	CH_4	10%	8%	-46%
3.B.2	N_2O	5%	8%	0%
3.C	CH_4	1%	0%	4%
3.D.1	N_2O	31%	24%	47%
3.D.2	N_2O	7%	8%	40%
3.F	CH_4	0%	1%	-26%
3.F	N_2O	0%	0%	-10%

3.G	CO_2	1%	4%	5%
3.H	CO_2	1%	0%	7%
3.I	CO_2	0%	0%	-6%

The contribution of individual countries to the key categories will be addressed in the corresponding sections; as a summary, the 2019-2020 changes in category 3.A are mainly caused by France, Germany, and the UK, with Spain, Italy and Poland signing an increase of emissions in this sector. In 3.B.1, the Netherlands is among the main responsible for the increasing trend, accounting for 17.6% of the EU trend. If we look at the main countries driving the EU trend in the different emission categories, we find that France, Poland, Spain, Italy, Germany and UK

Table 5.2 shows the contribution of the different emission categories in the individual countries to the overall emission trend of EU agriculture (2019-2020). Looking at the data by country in Table 5.2, the impacts on trends (both positive or negative) are mostly proportional to the importance of the MS to the overall agricultural emissions. Different figures are observed for the short-term trends, where the contribution of the emission categories is not linked to their weight in total emissions, and some of them have different sign from changes in the overall emissions of the sector. For the whole agricultural sector, there was a very slight decrease of emissions between 2019 and 2020 (-0.2% of total emissions), with 6 categories increasing emissions (3.A,3.C,3.D.1,3.D.2,3.G,3.H) and 3 decreasing (3.B.1,3.F,and 3.I), resulting in an overall decrease of emissions for the whole sector. The main contributor to the total decrease in agricultural emissions from last year is category 3.A (86% of the total trend), followed by 3.D.1, 3.D.2, and 3.H (47%, 40%, and 7%, respectively). The contribution of the other categories is approximately -79% of total change.

Table 5.2 Contribution to EU emission trends (2019-2020) per country and emission category (%). A negative share of the trend means that the emissions in that category are evolving in the opposite direction to those of the EU.

Country	3.A	3.B.1	3.B.2	3.D.1	3.D.2	3.G	3.H	Share of total EU emissions from agriculture in 2020
France	67.55	-8.62	5.41	155.71	37.40	3.71	23.31	16.68
Germany	49.35	-3.26	3.81	19.97	22.78	10.06	5.47	12.92
United Kingdom	40.35	3.73	4.80	70.20	27.92	47.98	11.45	9.57
Spain	-10.16	-40.68	-2.79	-38.83	-8.65	0.24	-11.95	9.12
Poland	-28.77	-4.83	-18.45	-81.63	-23.17	-39.28	-2.65	8.13
Italy	-22.76	-1.20	-1.34	-110.89	-31.36	0.83	-10.05	7.75
Ireland	-18.79	-3.40	-0.79	-4.07	0.79	-7.40	-2.32	4.92
Rumania	13.55	1.42	2.55	74.13	16.93	-0.63	-0.30	4.34
Netherlands	-8.04	17.55	0.04	-1.10	-0.73	0.72	0.21	4.18
Denmark	2.09	-6.59	1.13	-0.99	2.30	-9.08	-0.03	2.67
Belgium	3.76	-1.89	0.85	4.35	1.18	-0.01	-0.18	2.21
Greece	1.55	0.45	-0.05	-8.03	-2.68	NA	-0.32	1.86
Czech Republic	0.41	-0.28	0.31	21.66	7.95	1.21	-0.91	1.86
Hungary	-3.05	-0.98	0.55	-16.21	-1.52	0.37	-2.72	1.73
Portugal	-3.06	-1.35	-1.21	-2.29	-1.73	-0.13	-0.28	1.66

Country	3.A	3.B.1	3.B.2	3.D.1	3.D.2	3.G	3.H	Share of total EU emissions from agriculture in 2020
Austria	4.07	0.47	0.34	-2.27	-0.14	0.06	0.30	1.65
Sweden	2.73	0.08	0.12	-17.00	-0.20	0.00	0.04	1.64
Finland	-1.08	1.01	1.15	5.13	1.85	-0.39	0.08	1.56
Bulgaria	-7.71	-1.17	0.65	11.95	2.24	NA	-0.06	1.47
Lithuania	5.02	-0.29	0.33	-25.80	-5.81	0.72	-0.02	1.05
Croatia	2.56	2.68	0.69	-2.24	-0.49	-0.64	-1.96	0.64
Slovakia	0.37	1.60	1.73	-0.65	-3.53	-0.50	-0.02	0.61
Latvia	-0.79	0.74	0.42	-3.94	-0.88	-2.30	0.15	0.53
Slovenia	-0.32	0.48	0.07	-0.35	-0.12	-0.20	-0.19	0.41
Estonia	0.43	-0.99	-0.28	0.01	-0.06	-0.04	0.00	0.36
Luxemburg	-1.15	-0.50	-0.01	0.77	0.17	-0.09	0.00	0.17
Iceland	0.72	0.14	0.07	-0.48	-0.09	-0.02	0.00	0.15
Cyprus	-3.15	-0.53	-0.41	-0.37	-0.08	NA	0.00	0.13
Malta	-0.09	-0.02	-0.06	-0.03	-0.02	NA	NA	0.02
Total	85.60	-46.20	-0.40	46.70	40.20	5.20	7.00	100.00

5.3 Source categories and methodological issues

In this section, we present the information relevant for EU-KP key source categories in the sector 3 Agriculture.

Key source categories identified are:

- CH_4 emissions from source category 3.A.1 - Cattle.
- CH_4 emissions from source category 3.A.2 - Sheep.
- CH_4 emissions from source category 3.A.4 - Other livestock.
- CH_4 emissions from source category 3.B.1 - Manure management.
- N_2O emissions from source category 3.B.2 - Manure management.
- N_2O emissions from source category 3.D.1 - Direct N_2O emissions from managed soils.
- N_2O emissions from source category 3.D.2 - Indirect emissions from managed soils

Table 5.3 shows emissions from key categories in the base year and in the last reported year, whether they are identified as key due to the level or to the trend in emissions and the share of emissions in the category which are calculated using a Tier 2 or Tier 3 method. CH_4 emissions from enteric fermentation from dairy and non-dairy cattle are calculated with sophisticated methods in 27 countries, with only Cyprus and Croatia using partially T1. For enteric fermentation of sheep, the situation is more divided with 13 countries use Tier 1 methods and 16 using higher tiers (including those with higher emissions). For sector 3.A.4, six countries (Denmark, Spain, France, Portugal, Italy, Finland) are using higher tiers, with all the others combining different methods. In 3.B.1 and 3.B.2 it is also more mixed, with Germany, Denmark, Finland, France, Croatia and Portugal using exclusively higher tiers in both categories. For the calculation of N_2O emissions from soils, the share of high tiers is very low; only Denmark and Sweden use solely higher tiers in 3.D.2, while there are no countries using only high tiers in 3.D.1, but only some combining high with low tier methods.

Table 5.3 Key categories for the EU (Agriculture - sector excerpt). Emissions in kt CO_2 eq.

	Source	Emissions 1990 [kt CO_{2eq}]	Emissions 2020 [kt CO_{2eq}]	Trend	Level 1990	Level 2020	Share higher tiers 1990	Share higher tiers 2020
3.A.1	3.A.1 Enteric Fermentation: Cattle (CH_4)	198,863	157,074	T	L	L	0.99	0.99
3.A.2	3.A.2 Enteric Fermentation: Other Sheep (CH_4)	25,211	17,656	0	L	L	0.90	0.91
3.A.4	3.A.4 Enteric Fermentation: Other livestock (CH_4)	5,964	5,731	0	0	L	0.45	0.51
3.B.1	3.B.1 CH_4 Emissions: Farming (CH_4)	49,796	41,154	T	L	L	0.96	0.97
3.B.2	3.B.2 N_2O and NMVOC Emissions: Farming (N_2O)	30,404	22,025	0	L	L	0.97	0.98
3.D.1	3.D.1 Agricultural Soils: Direct N_2O Emissions From Managed Soils (N_2O)	155,445	127,951	T	L	L	0.51	0.52
3.D.2	3.D.2 Agricultural Soils: Farming (N_2O)	38,012	28,662	T	L	L	0.33	0.36

Other source categories are not identified as key source in the analysis at EU-KP level and are therefore not further discussed here. Emissions from source category J - other agriculture emissions are reported only by Germany (digestion of energy crops) and the UK (emissions from liming in oversee territories and crown dependencies).

For each of the above-mentioned source categories, data on the countries contributing most to EU-KP emissions and to EU-KP emission trends are provided, as well as information on relevant activity data and IEFs and other parameters, if relevant.

Many countries recognize that in the agriculture sector the emissions from the different categories are inherently linked and are best estimated in a comprehensive model that covers not only greenhouse gases (CH_4 and N_2O) in a consistent manner, but also ammonia. Estimations of ammonia emissions are required for reporting under the Convention on Long-Range Transboundary Air Pollution and are needed to estimate indirect N_2O emissions. Hence, several countries have developed comprehensive models covering consistently different source categories and different gases.

5.3.1 Enteric fermentation (CRF Source Category 3.A)

In 2020 CH_4 emissions in source category 3.A - Enteric Fermentation in EU-KP were 185247.8 kt CO_2 equivalent. This corresponds to 4.5% of total EU-KP GHG emissions and 40% of total EU-KP CH_4 emissions. They make 43.7% of total agricultural emissions and 80% of total agricultural CH_4 emissions. It is thus the largest GHG source in agriculture and the largest source of CH_4 emissions. The main sub-categories are 3.A.1.2 (Non-Dairy Cattle), 3.A.1.1 (Dairy Cattle) and 3.A.2 (Sheep) as shown in Figure 5.4. Emissions are also reported for 3.A.4 (Other Livestock) and 3.A.3 (Swine). CH_4 emissions from Enteric Fermentation for 'Other Livestock' are reported for the categories Buffalo, Deer, Goats, Horses, Mules and Asses, Poultry, and in Other Livestock Fur-bearing animals, Ostrich, Rabbits, Reindeer and Other are included.

Regarding the origin of emissions in the different countries, Figure 5.5 shows the distribution of CH_4 emissions from enteric fermentation by livestock category in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting animal types.

Figure 5.4: Share of source category 3.A on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2020.

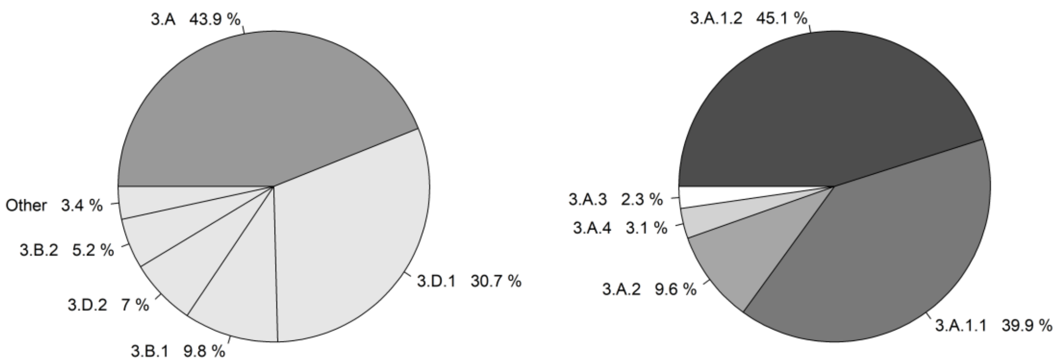
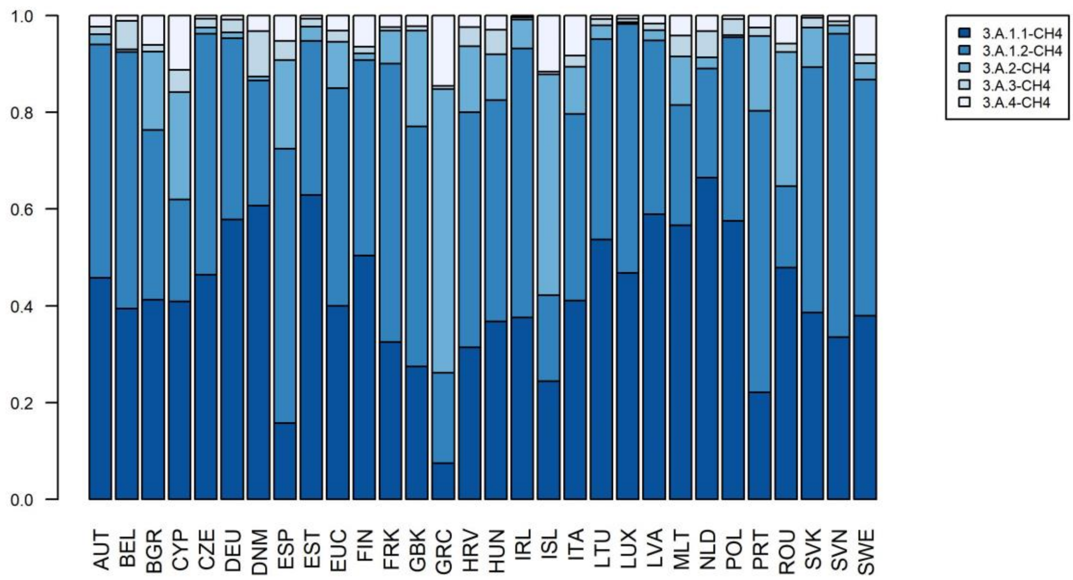


Figure 5.5: Decomposition of emissions in source category 3.A - Enteric Fermentation into its sub-categories by country in the year 2020.



Total GHG and CH_4 emissions by country from 3.A *Enteric Fermentation* are shown in Table 5.4 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. In this category GHG and CH_4 columns have the same values, as no other greenhouse gases are produced in the enteric fermentation process. Between 1990 and 2020, CH_4 emission in this source category decreased by 22% or 50.9 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (69%) and in Germany in absolute terms (9.3 Mt CO_2-eq). From 2019 to 2020 emissions in the current category decreased by 0.3%.

Table 5.4 3.A - Enteric Fermentation: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4 513	3 764	3 733	2.0%	-780	-17%	-31	-1%	T1,T2	CS,D
Belgium	4 756	4 064	4 036	2.2%	-720	-15%	-28	-1%	T1,T2	CS,D
Bulgaria	4 805	1 435	1 493	0.8%	-3 312	-69%	58	4%	T1,T2	CS,D
Croatia	2 121	995	975	0.5%	-1 146	-54%	-19	-2%	T1,T2	CS,D
Cyprus	197	271	294	0.2%	97	49%	24	9%	T1,T2	CS,D
Czechia	5 737	3 094	3 091	1.7%	-2 646	-46%	-3	0%	T1,T2	CS,D
Denmark	4 039	3 695	3 680	2.0%	-360	-9%	-16	0%	T1,T2	CS,D,OTH
Estonia	1 228	527	523	0.3%	-704	-57%	-3	-1%	D,T1,T2	CS,D,OTH
Finland	2 421	2 070	2 078	1.1%	-342	-14%	8	0%	CS,OTH,T1,T2	CS,D,OTH
France	38 631	33 644	33 137	17.9%	-5 494	-14%	-507	-2%	T2,T3	CS
Germany	33 162	24 238	23 867	12.9%	-9 294	-28%	-371	-2%	T1,T2,T3	CS,D
Greece	4 110	3 622	3 610	1.9%	-500	-12%	-12	0%	T1,T2	CS,D
Hungary	3 668	2 072	2 095	1.1%	-1 572	-43%	23	1%	T1,T2	CS,D
Ireland	10 466	12 148	12 289	6.6%	1 823	17%	141	1%	CS,T1,T2	CS,D
Italy	15 564	13 364	13 535	7.3%	-2 030	-13%	171	1%	T1,T2	CS,D
Latvia	2 222	850	856	0.5%	-1 366	-61%	6	1%	T1,T2	CS,D,OTH
Lithuania	4 291	1 483	1 445	0.8%	-2 846	-66%	-38	-3%	T1,T2	CS,D,OTH
Luxembourg	392	394	402	0.2%	10	3%	9	2%	T1,T2	CS,D
Malta	52	34	35	0.0%	-18	-34%	1	2%	T1,T2	CS,D
Netherlands	9 232	8 136	8 196	4.4%	-1 035	-11%	60	1%	T1,T2,T3	CS,D
Poland	19 650	12 700	12 916	7.0%	-6 733	-34%	216	2%	T1,T2	CS,D
Portugal	3 520	3 551	3 574	1.9%	54	2%	23	1%	T1,T2	CS,D
Romania	14 975	7 328	7 227	3.9%	-7 748	-52%	-102	-1%	T1,T2	CS,D
Slovakia	2 797	969	966	0.5%	-1 830	-65%	-3	0%	T1,T2	CS,D
Slovenia	935	939	942	0.5%	6	1%	2	0%	T1,T2	CS,D
Spain	14 367	16 009	16 085	8.7%	1 718	12%	76	0%	CS,T2,T3	CS,D
Sweden	3 275	2 958	2 937	1.6%	-337	-10%	-21	-1%	CS,T1	CS,D
United Kingdom	24 683	21 241	20 938	11.3%	-3 745	-15%	-303	-1%	T1,T3	CS,D
EU-27+UK	**235 807**	**185 594**	**184 956**	**100%**	**-50 850**	**-22%**	**-637**	**0%**	**-**	**-**
Iceland	326	297	291	0.2%	-35	-11%	-5	-2%	T1,T2	CS,D
United Kingdom (KP)	24 683	21 241	20 938	11.3%	-3 745	-15%	-303	-1%	T1,T3	CS,D
EU-KP	**236 133**	**185 890**	**185 248**	**100%**	**-50 885**	**-22%**	**-643**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Total GHG and CH_4 emissions by country from *3.A.1 - Cattle Enteric Fermentation* are shown in Table 5.5 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, CH_4 emission in this source category decreased by 21% or 41.7 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (67%) and in Germany in absolute terms (9 Mt CO_2-eq). From 2019 to 2020 emissions in the current category decreased by 0.4%.

Table 5.5 3.A.1 - Cattle: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4 334	3 538	3 509	2.2%	-825	-19%	-29	-1%	T2	CS
Belgium	4 456	3 760	3 729	2.4%	-727	-16%	-30	-1%	T2	CS
Bulgaria	2 958	1 077	1 139	0.7%	-1 818	-61%	63	6%	T2	CS
Croatia	1 868	801	781	0.5%	-1 087	-58%	-21	-3%	T2	CS
Cyprus	101	161	182	0.1%	81	80%	21	13%	T1,T2	CS,D
Czechia	5 454	2 974	2 974	1.9%	-2 481	-45%	0	0%	T2	CS
Denmark	3 662	3 228	3 183	2.0%	-479	-13%	-45	-1%	T2	CS,D
Estonia	1 169	499	496	0.3%	-673	-58%	-3	-1%	T2	CS,D
Finland	2 221	1 880	1 887	1.2%	-334	-15%	7	0%	T2	CS
France	34 130	30 371	29 850	19.0%	-4 280	-13%	-521	-2%	T2,T3	CS
Germany	31 735	23 111	22 741	14.4%	-8 994	-28%	-370	-2%	T2,T3	CS,D
Greece	1 270	961	945	0.6%	-326	-26%	-17	-2%	T2	CS,D
Hungary	2 876	1 686	1 728	1.1%	-1 148	-40%	42	2%	T2	CS
Ireland	9 210	11 348	11 448	7.3%	2 237	24%	99	1%	CS,T2	CS
Italy	13 164	10 621	10 780	6.8%	-2 384	-18%	160	2%	T2	CS
Latvia	2 118	804	812	0.5%	-1 306	-62%	7	1%	T2	CS
Lithuania	4 146	1 409	1 375	0.9%	-2 771	-67%	-35	-2%	T2	CS
Luxembourg	388	387	395	0.3%	7	2%	9	2%	T2	CS
Malta	44	28	28	0.0%	-15	-35%	0	2%	T2	CS
Netherlands	8 195	7 219	7 297	4.6%	-899	-11%	77	1%	T2,T3	CS
Poland	17 642	12 151	12 337	7.8%	-5 306	-30%	185	2%	T2	CS
Portugal	2 460	2 846	2 868	1.8%	409	17%	22	1%	T2	CS
Romania	11 213	4 750	4 677	3.0%	-6 535	-58%	-73	-2%	T2	CS
Slovakia	2 517	854	863	0.5%	-1 654	-66%	9	1%	T2	CS
Slovenia	904	903	906	0.6%	1	0%	3	0%	T2	CS
Spain	8 978	11 608	11 650	7.4%	2 671	30%	41	0%	CS,T2	CS,D
Sweden	2 884	2 558	2 546	1.6%	-337	-12%	-12	0%	CS	CS
United Kingdom	18 867	16 297	16 130	10.2%	-2 737	-15%	-167	-1%	T3	CS
EU-27+UK	**198 964**	**157 831**	**157 256**	**100%**	**-41 708**	**-21%**	**-575**	**0%**	**-**	**-**
Iceland	109	124	123	0.1%	13	12%	-1	-1%	T2	CS
United Kingdom (KP)	18 867	16 297	16 130	10.2%	-2 737	-15%	-167	-1%	T3	CS
EU-KP	**199 074**	**157 955**	**157 379**	**100%**	**-41 695**	**-21%**	**-576**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'.

Total GHG and CH_4 emissions by country from *3.A.2 - Sheep Enteric Fermentation* are shown in Table 5.6 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, CH_4 emission in this source category decreased by 30% or 7.6 Mt CO_2-eq. The decrease was largest in Poland in relative terms (93%) and in France in absolute terms (1.3 Mt CO_2-eq). From 2019 to 2020 emissions in the current category decreased by 1%.

Table 5.6 3.A.2 - Sheep: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	62	81	79	0.4%	17	27%	-2	-2%	T1	D
Belgium	38	28	25	0.1%	-14	-36%	-3	-10%	T1	D
Bulgaria	1 454	245	242	1.4%	-1 211	-83%	-2	-1%	T2	CS
Croatia	150	131	132	0.7%	-18	-12%	1	1%	T1	D
Cyprus	58	65	66	0.4%	8	13%	1	1%	T1	D
Czechia	86	43	41	0.2%	-45	-53%	-2	-4%	T1	D
Denmark	39	37	34	0.2%	-5	-13%	-3	-9%	T2	D
Estonia	32	16	15	0.1%	-17	-52%	-1	-7%	D,T1	D
Finland	21	31	30	0.2%	9	41%	-1	-3%	CS	CS
France	3 533	2 253	2 237	12.5%	-1 296	-37%	-17	-1%	T2,T3	CS
Germany	518	289	283	1.6%	-235	-45%	-5	-2%	T1	CS,D
Greece	2 054	2 112	2 115	11.8%	61	3%	3	0%	T2	CS,D
Hungary	392	220	200	1.1%	-192	-49%	-20	-9%	T1	D
Ireland	1 176	704	741	4.2%	-435	-37%	37	5%	T1	D
Italy	1 572	1 319	1 317	7.4%	-255	-16%	-2	0%	T2	CS
Latvia	33	20	18	0.1%	-15	-44%	-2	-8%	T1	D
Lithuania	18	44	41	0.2%	22	122%	-3	-7%	T2	CS
Luxembourg	1	1	2	0.0%	0	45%	0	11%	T2	CS
Malta	4	3	3	0.0%	0	-4%	0	0%	T2	CS
Netherlands	340	198	191	1.1%	-150	-44%	-7	-4%	T1	D
Poland	832	55	58	0.3%	-774	-93%	3	5%	T1	D
Portugal	794	551	553	3.1%	-241	-30%	2	0%	T2	CS
Romania	2 778	2 019	2 003	11.2%	-775	-28%	-16	-1%	T2	CS
Slovakia	178	85	79	0.4%	-99	-56%	-6	-7%	T2	CS
Slovenia	3	16	16	0.1%	14	476%	0	1%	T1	D
Spain	3 791	2 937	2 948	16.5%	-843	-22%	11	0%	CS,T2	CS
Sweden	81	110	100	0.6%	19	23%	-10	-9%	T1	D
United Kingdom	5 231	4 283	4 154	23.3%	-1 077	-21%	-129	-3%	T3	CS
EU-27+UK	**25 269**	**17 894**	**17 721**	**99%**	**-7 548**	**-30%**	**-173**	**-1%**	**-**	**-**
Iceland	182	138	133	0.7%	-49	-27%	-5	-4%	T2	CS
United Kingdom (KP)	5 231	4 283	4 154	23.3%	-1 077	-21%	-129	-3%	T3	CS
EU-KP	**25 451**	**18 033**	**17 854**	**100%**	**-7 596**	**-30%**	**-178**	**-1%**	**-**	**-**

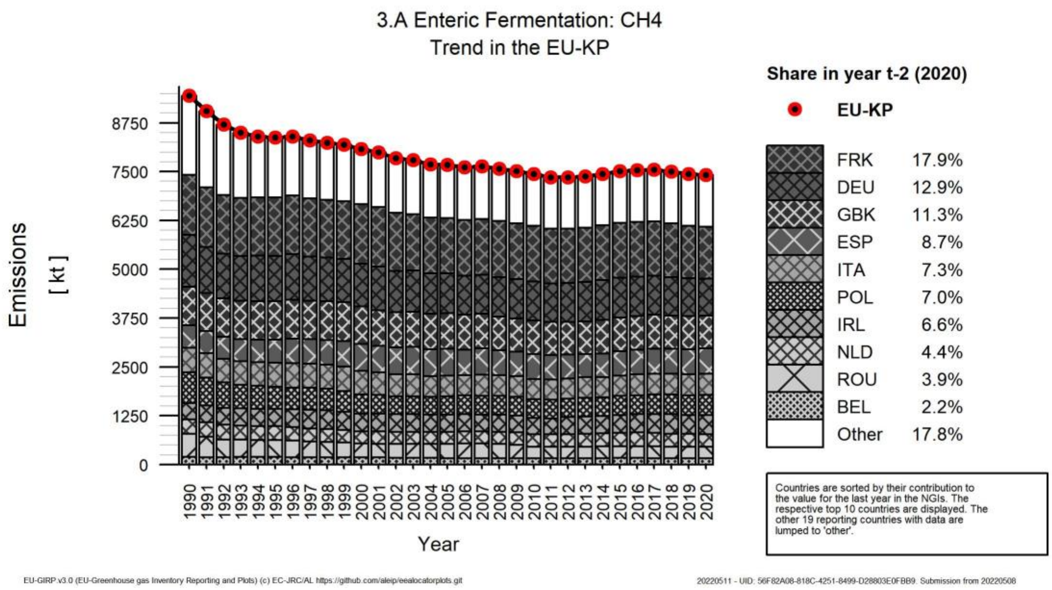
Abbreviations explained in the Chapter 'Units and abbreviations'

5.3.1.1 Trends in Emissions and Activity Data

3.A - Enteric Fermentation - Emissions

Emissions in source category *3.A - Enteric Fermentation* decreased considerably in EU-KP by 22% or 50.9 Mt CO_2-eq in the period 1990 to 2020. Figure 5.6 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 82.2% of the total in 2020.Emissions decreased in 23 countries and increased in six countries. The four countries with the largest decreases were Germany, Romania, Poland and France with a total absolute decrease of 29.3 Mt CO_2-eq. The largest increases occurred in Spain and Ireland, with a total absolute increase of 3.5 Mt CO_2-eq.

Figure 5.6: 3.A: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.A.1 - Cattle - Emissions

Emissions in source category *3.A.1 - Cattle* decreased considerably in EU-KP by 21% or 41.7 Mt CO_2-eq in the period 1990 to 2020. The ten countries with the highest emissions accounted together for 83% of the total in 2020.Emissions decreased in 22 countries and increased in seven countries. The three countries with the largest decreases were Germany, Romania and Poland with a total absolute decrease of 20.8 Mt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 4.9 Mt CO_2-eq.

Emissions in source category *3.A.1.1 - Dairy Cattle* decreased strongly in EU-KP by 27% or 27 Mt CO_2-eq in the period 1990 to 2020. Figure 5.7 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 83.3% of the total in 2020.Emissions decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Poland, Romania and Germany with a total absolute decrease of 12.3 Mt CO_2-eq. The largest increases occurred in the Netherlands and Ireland, with a total absolute increase of 1.5 Mt CO_2-eq.

Emissions in source category *3.A.1.2 - Non-Dairy Cattle* decreased clearly in EU-KP by 15% or 14.7 Mt CO_2-eq in the period 1990 to 2020. Figure 5.8 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 84.5% of the total in 2020.Emissions decreased in 22 countries and increased in seven countries. The largest decreases occurred in Germany and Romania with a total absolute decrease of 7.6 Mt CO_2-eq. The three countries with the largest increases were Portugal, Ireland and Spain, with a total absolute increase of 5.1 Mt CO_2-eq.

3.A.1 - Cattle - Population

The main driver for the decrease of CH_4 emissions from enteric fermentation was the decrease in animal numbers that we can see in Figure 5.9 and Figure 5.10.

Cattle population decreased strongly in EU-KP by 29% or 34.5 million heads in the period 1990 to 2020. The ten countries with the highest population accounted together for 84.1% of the total in 2020.Population decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Germany, France and Poland with a total absolute decrease of 15.6 million heads. The three countries with the largest increases were Portugal, Ireland and Spain, with a total absolute increase of 2.2 million heads.

Figure 5.7: 3.A.1.1 Dairy Cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

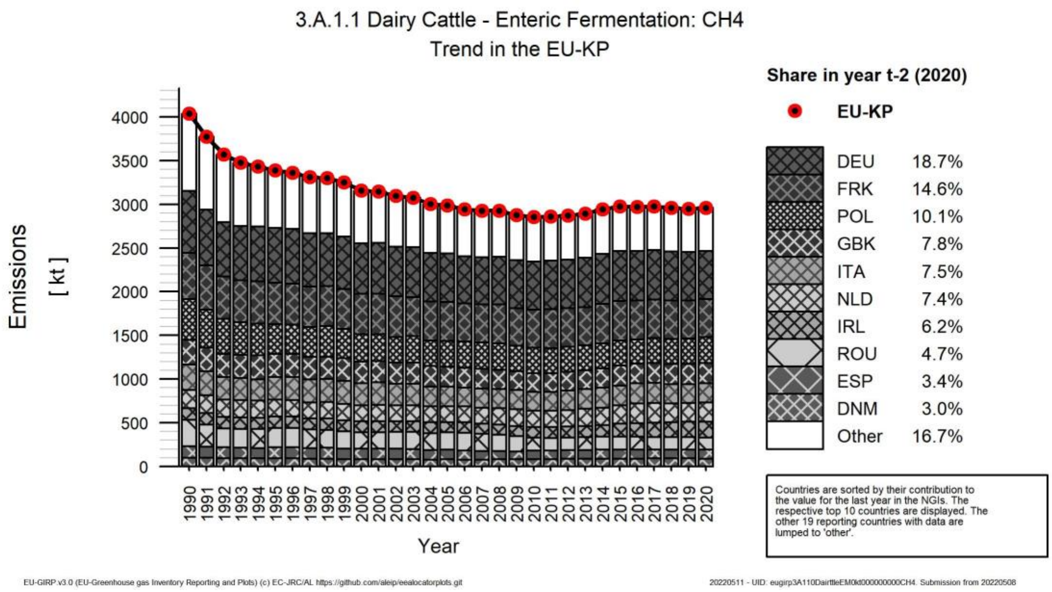


Figure 5.8: 3.A.1.2 Non-Dairy Cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

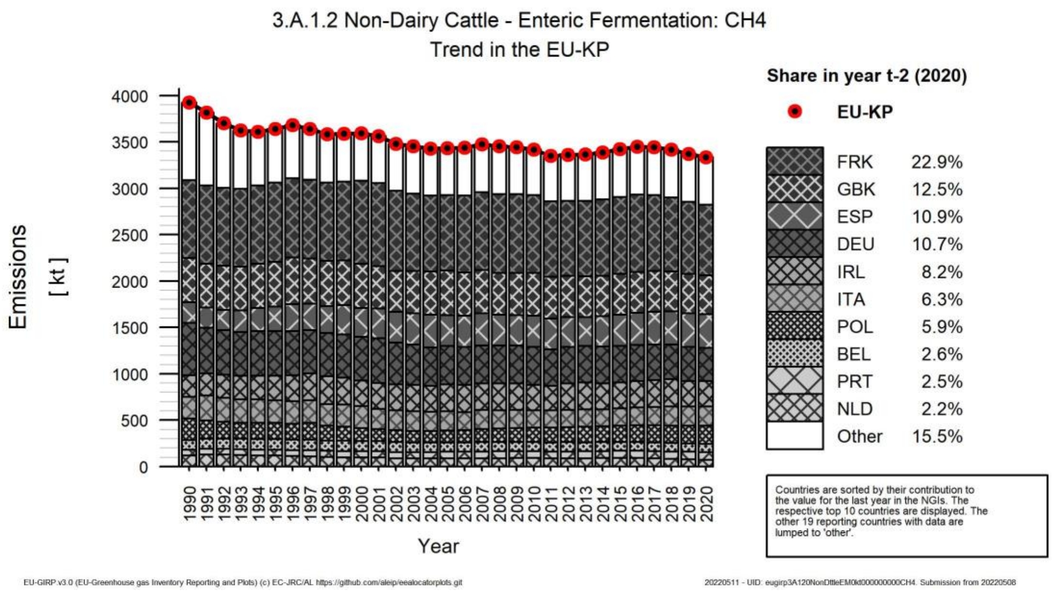


Figure 5.9: 3.A.1 Dairy Cattle: Trend in cattle population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

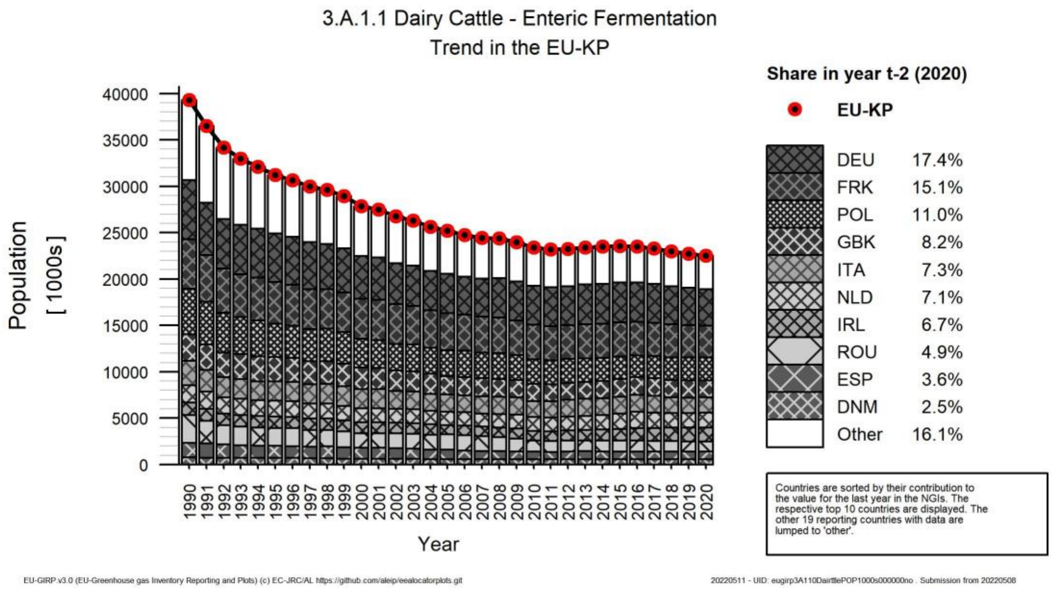
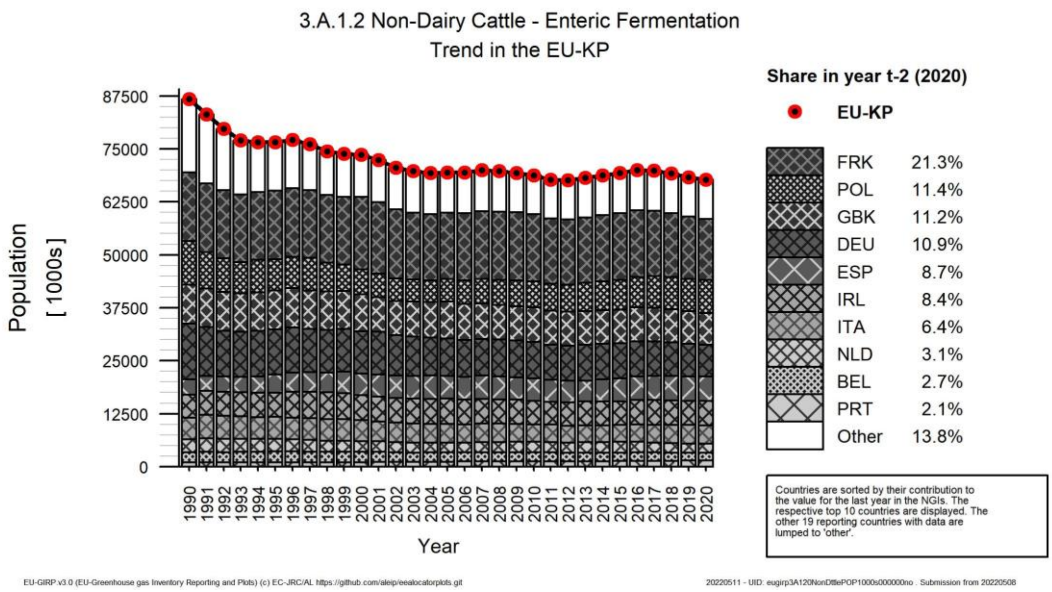


Figure 5.10: 3.A.1 Non-Dairy Cattle: Trend in cattle population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.A.2 - Sheep - Emissions

Emissions in source category *3.A.2 - Sheep* decreased strongly in EU-KP by 30% or 7.6 Mt CO_2-eq in the period 1990 to 2020. Figure 5.11 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 92.9% of the total in 2020.Emissions decreased in 21 countries and increased in eight countries. The five countries with the largest decreases were France, Bulgaria, the United Kingdom, Spain and Romania with a total absolute decrease of 5.2 Mt CO_2-eq. The four countries with the largest increases were Austria, Sweden, Lithuania and Greece, with a total absolute increase of 120 kt CO_2-eq.

3.A.2 - Sheep - Population

The main driver for the decrease of CH_4 emissions from enteric fermentation for sheep was the decrease in animal numbers shown in Figure 5.12.

Sheep population decreased strongly in EU-KP by 33% or 48.9 million heads in the period 1990 to 2020. Figure 5.12 shows the trend of sheep population indicating the countries contributing most to EU-KP total. The figure represents the trend in sheep population for the different countries along the inventory period. The ten countries with the highest population accounted together for 93.8% of the total in 2020.Population decreased in 21 countries and increased in eight countries. The three countries with the largest decreases were the United Kingdom, Spain and Bulgaria with a total absolute decrease of 27.7 million heads. The four countries with the largest increases were Austria, Lithuania, Sweden and Greece, with a total absolute increase of 539 thousand heads.

Figure 5.11: 3.A.2: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

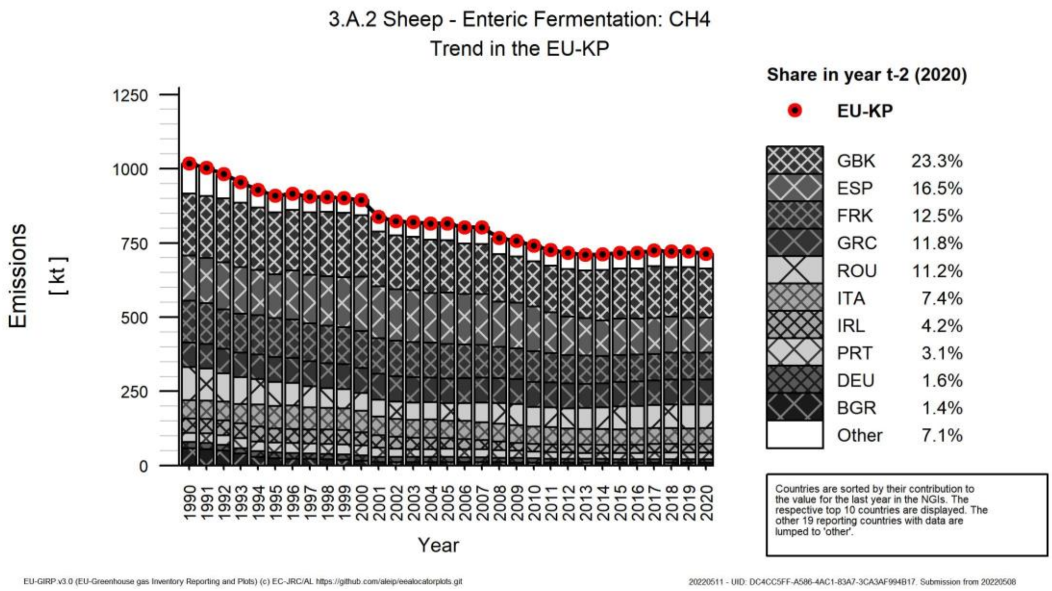
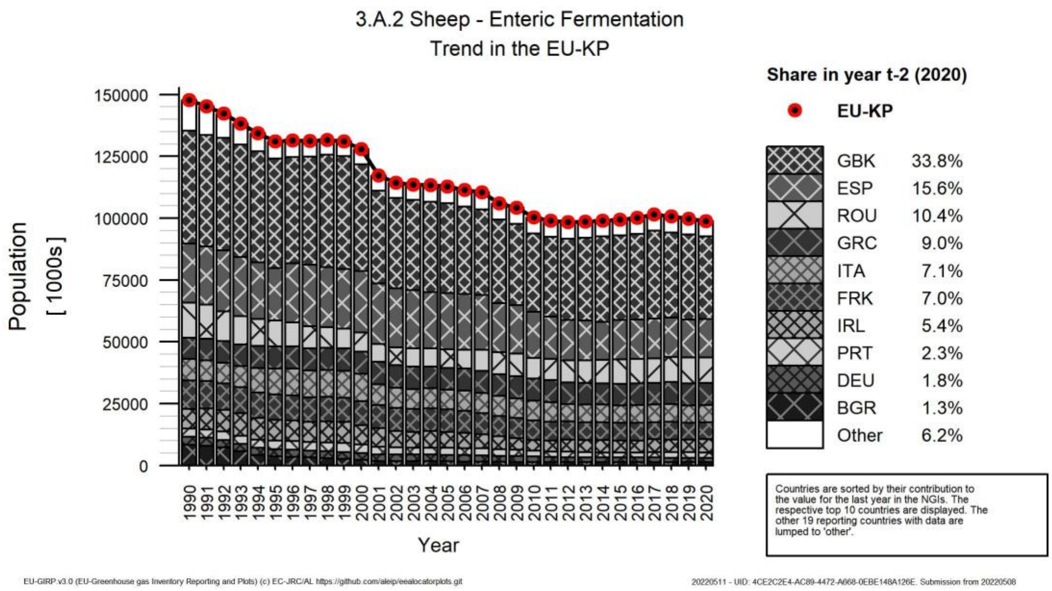


Figure 5.12: 3.A.2: Trend in sheep population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



5.3.1.2 Implied EFs and Methodological Issues

Information for cattle, sheep and swine are reported using national classification of the animals. For example, it is possible to report cattle numbers using one of three options:

- Option A distinguishes ‘Dairy Cattle’ and ‘Non-Dairy Cattle’.
- Option B distinguishes ‘Mature Dairy Cattle’, ‘Other Mature Cattle’ and ‘Growing Cattle’.
- Option C allows for any national classification.

To obtain values that can be aggregated to EU-KP level, data reported under Option B and Option C were converted to Option A categories. ‘Mature Dairy Cattle’ is taken for ‘Dairy Cattle’ and the other two categories under Option B are used for ‘Non-Dairy Cattle’. Also in Option C, dairy cattle can be identified (e.g. ‘Dairy Cows’, ‘Other Dairy Cattle’ etc.) and all other cattle categories have been grouped to the animal type ‘Non-Dairy Cattle’.

In case data were aggregated, this was done on the basis of a weighted average using population data as weighting factors.

In the cases for ‘Sheep’ and ‘Swine’, all animal types reported by countries are aggregated to one single parent category using the same approach.

In this section we discuss the Implied Emission Factor for the main animal types. Furthermore, we present data on the average gross energy intake and - for dairy cattle - also the milk yield.

3.A.1 - Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1 - Cattle* increased in EU-KP clearly between 1990 and 2020 by 10.7% or 7 kg/head/year. Table 5.7 shows the implied emission factor for CH_4 emissions in source category *3.A.1 - Cattle* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in five countries and increased in 24 countries. The three countries with the largest decreases were Croatia, Malta and Portugal with a mean absolute value of 8 kg/head/year. The four countries with the largest increases were Finland, Latvia, the Czech Republic and Denmark with a mean absolute value of 22 kg/head/year.

Table 5.7 3.A.1 - Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2020		Country	1990	2020
Austria	67	76	|	Ireland	54	63
Belgium	55	64	|	Iceland	58	68
Bulgaria	74	84	|	Italy	68	72
Cyprus	74	88	|	Lithuania	70	85
Czech Republic	62	85	|	Luxembourg	71	83
Germany	65	80	|	Latvia	59	81
Denmark	65	85	|	Malta	83	79
Spain	70	70	|	Netherlands	67	78
Estonia	62	78	|	Poland	70	78
Finland	65	89	|	Portugal	72	69
France	63	67	|	Romania	84	101
United Kingdom	62	68	|	Slovakia	64	78
Greece	73	73	|	Slovenia	68	75
Croatia	91	74	|	Sweden	67	70
Hungary	71	75	|	EU-KP	66	73

3.A.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1.1 - Dairy Cattle* increased in EU-KP strongly between 1990 and 2020 by 28% or 29 kg/head/year. Figure 5.13 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.8 shows the implied emission factor for CH_4 emissions in source category *3.A.1.1 - Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in two countries and increased in 27 countries. Decreases occurred in Croatia and Malta with a mean absolute value of 4 kg/head/year. The four countries with the largest increases were the Czech Republic, Estonia, Finland and Latvia with a mean absolute value of 52 kg/head/year.

Figure 5.13: 3.A.1.1 - Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

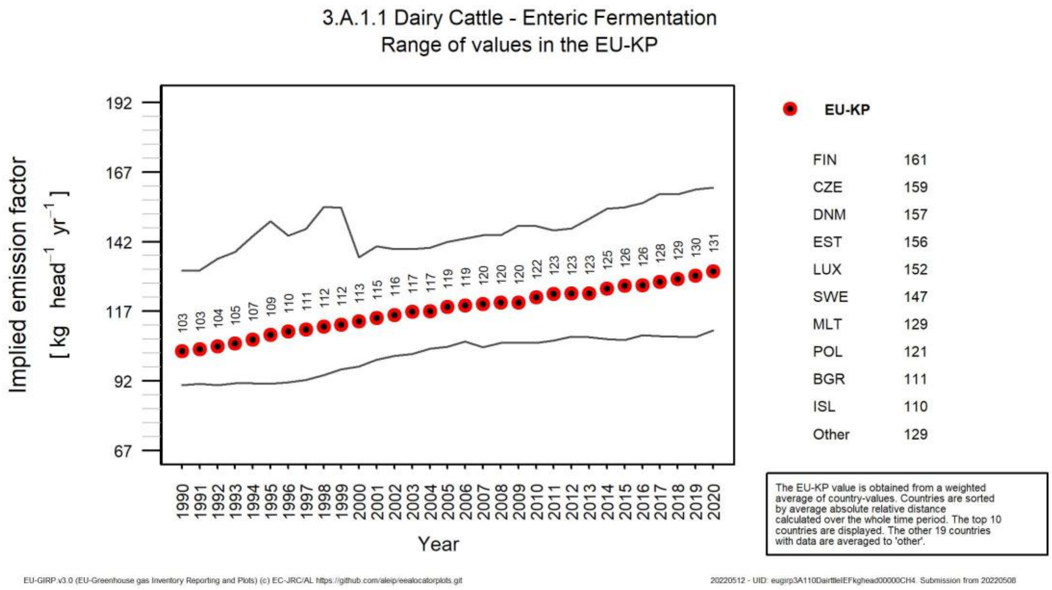


Table 5.8 3.A.1.1 - Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2020	Country	1990	2020
Austria	108	130	Ireland	101	122
Belgium	88	128	Iceland	90	110
Bulgaria	105	111	Italy	111	136
Cyprus	99	122	Lithuania	100	131
Czech Republic	98	159	Luxembourg	115	152
Germany	112	141	Latvia	103	148
Denmark	128	157	Malta	132	129
Spain	86	125	Netherlands	110	137
Estonia	104	156	Poland	96	121
Finland	112	161	Portugal	97	135
France	99	127	Romania	100	125
United Kingdom	98	124	Slovakia	85	122
Greece	109	130	Slovenia	92	127
Croatia	117	112	Sweden	112	147

Country	1990	2020		Country	1990	2020
Hungary	105	129	|	EU-KP	103	131

3.A.1.1 - Dairy Cattle - Gross energy

The gross energy, a parameter used for calculating CH_4 emissions in source category *3.A.1.1 - Dairy Cattle*, increased in EU-KP strongly between 1990 and 2020 by 33.5% or 79 MJ/day. Figure 5.14 shows the trend of the gross energy in EU-KP indicating also the range of values used by the countries. Table 5.9 shows the gross energy in source category *3.A.1.1 - Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. Gross energy decreased in one country and increased in 25 countries. No data were available for three countries (Bulgaria, the Czech Republic and the Netherlands). A decrease occurred in Malta with an absolute value of 6 MJ/day. The four countries with the largest increases were Estonia, Finland, Denmark and Latvia with a mean absolute value of 113 MJ/day.

Figure 5.14: 3.A.1.1 - Dairy Cattle: Trend in gross energy in the EU-KP and range of values reported by countries

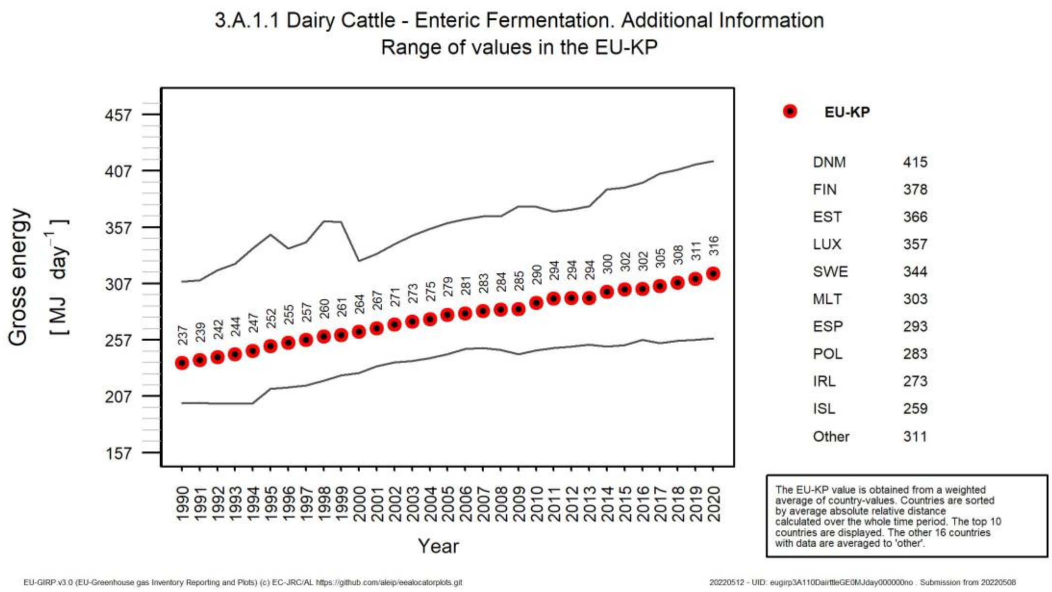


Table 5.9 3.A.1.1 - Dairy Cattle: countries' gross energy (MJ/day)

Country	1990	2020		Country	1990	2020
Austria	254	315	|	Iceland	212	259
Belgium	220	319	|	Italy	261	346
Cyprus	232	286	|	Lithuania	234	307
Germany	241	343	|	Luxembourg	270	357
Denmark	305	415	|	Latvia	242	348
Spain	201	293	|	Malta	309	303
Estonia	245	366	|	Poland	225	283
Finland	263	378	|	Portugal	227	317
France	242	315	|	Romania	233	293
United Kingdom	210	293	|	Slovakia	200	287
Greece	255	304	|	Slovenia	215	299
Croatia	256	275	|	Sweden	271	344

Country	1990	2020		Country	1990	2020
Hungary	255	322	|	EU-KP	237	316
Ireland	226	273	|			

3.A.1.1 - Dairy Cattle - Milk yield

The milk yield, a parameter used for calculating CH_4 emissions in source category *3.A.1.1 - Dairy Cattle*, increased in EU-KP very strongly between 1990 and 2020 by 85% or 9.5 kg/head/day. Figure 5.15 shows the trend of the milk yield in EU-KP indicating also the range of values used by the countries. Table 5.10 shows the milk yield in source category *3.A.1.1 - Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. The reported milk yield increased in all reporting 27 countries. The four countries with the largest increases were Estonia, Spain, the Czech Republic and Slovakia with a mean absolute value of 15 kg/head/day.

Figure 5.15: 3.A.1.1 - Dairy Cattle: Trend in milk yield in the EU-KP and range of values reported by countries

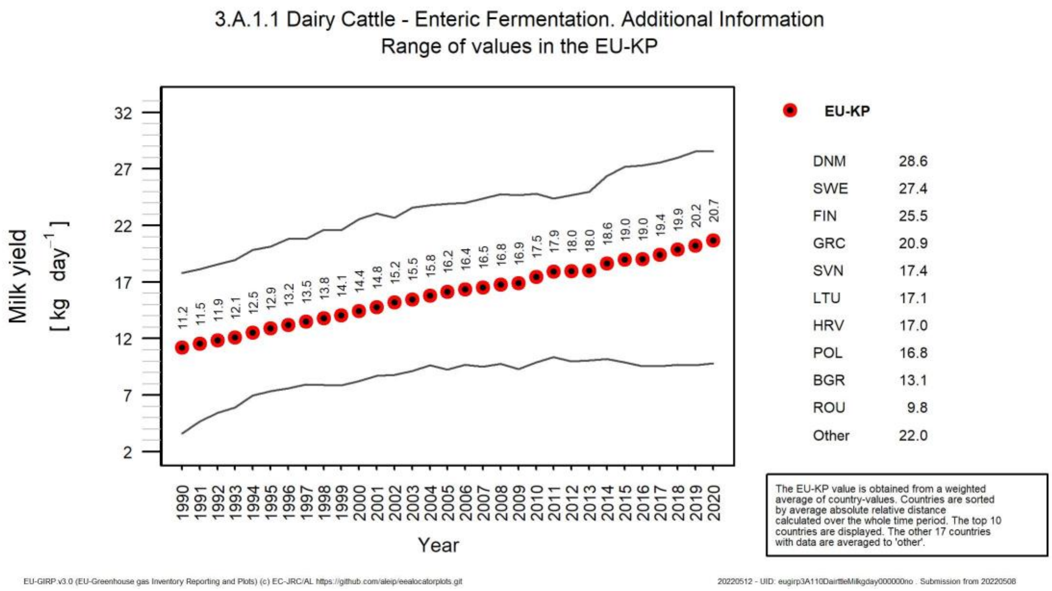


Table 5.10 3.A.1.1 - Dairy Cattle: countries' milk yield (kg/head/day) [39] [40]

Country	1990	2020		Country	1990	2020
Austria	10.4	20.0	|	Hungary	13.8	23.1
Belgium	11.2	24.1	|	Ireland	11.5	16.0
Bulgaria	11.1	13.1	|	Iceland	11.3	17.5
Cyprus	12.2	19.1	|	Italy	11.5	23.7
Czech Republic	11.0	25.0	|	Lithuania	10.2	17.1
Germany	12.9	23.2	|	Latvia	11.3	23.5
Denmark	17.7	28.6	|	Malta	10.1	19.1
Spain	10.1	25.8	|	Poland	8.9	16.8

[39] Note that the Netherlands does not report milk yield in their CRF, but the links to such data are available in their NIR (see also Annex III).

[40] Note that data from Luxembourg are not included in the plot as they are reported in a different unit.

Estonia	11.4	27.2	|	Portugal	12.2	23.5
Finland	15.7	25.5	|	Romania	3.6	9.8
France	13.1	20.3	|	Slovakia	7.0	20.4
United Kingdom	14.1	22.5	|	Slovenia	7.6	17.4
Greece	7.6	20.9	|	Sweden	17.8	27.4
Croatia	7.8	17.0	|	EU-KP	11.2	20.7

3.A.1.2 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1.2 - Non-Dairy Cattle* increased in EU-KP moderately between 1990 and 2020 by 8.7% or 4.2 kg/head/year. Figure 5.16 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.11 shows the implied emission factor for CH_4 emissions in source category *3.A.1.2 - Non-Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in four countries and increased in 25 countries. The three countries with the largest decreases were the Netherlands, Malta and Portugal with a mean absolute value of 4 kg/head/year. The four countries with the largest increases were Finland, the Czech Republic, Latvia and Iceland with a mean absolute value of 14 kg/head/year.

Figure 5.16: 3.A.1.2 - Non-Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

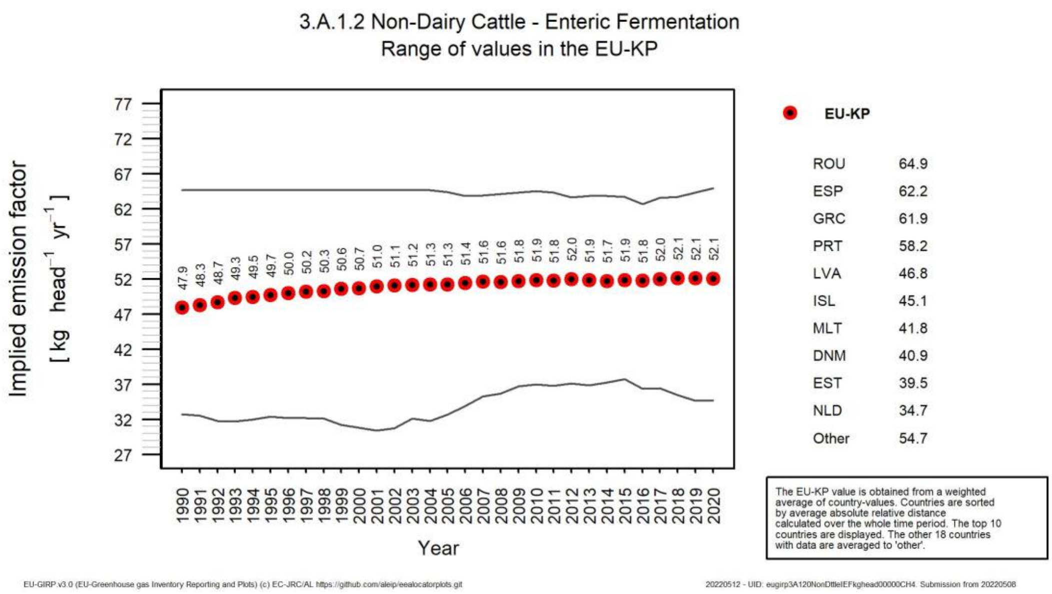


Table 5.11 3.A.1.2 - Non-Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2020		Country	1990	2020
Austria	45	54	|	Ireland	42	48
Belgium	43	46	|	Iceland	35	45
Bulgaria	55	66	|	Italy	46	48
Cyprus	57	57	|	Lithuania	53	59
Czech Republic	44	59	|	Luxembourg	55	58
Germany	43	48	|	Latvia	33	47
Denmark	34	41	|	Malta	45	42
Spain	63	62	|	Netherlands	40	35

Estonia	37	39	Poland	46	51
Finland	39	57	Portugal	62	58
France	52	53	Romania	65	65
United Kingdom	51	55	Slovakia	57	61
Greece	57	62	Slovenia	50	56
Croatia	57	61	Sweden	44	50
Hungary	53	56	EU-KP	48	52

3.A.1.2 - Non-Dairy Cattle - Average gross energy intake

The average gross energy intake, a parameter used for calculating CH_4 emissions in source category *3.A.1.2 - Non-Dairy Cattle*, increased in EU-KP moderately between 1990 and 2020 by 7.9% or 9.1 MJ/head/day. Figure 5.17 shows the trend of the average gross energy intake in EU-KP indicating also the range of values used by the countries. Table 5.12 shows the average gross energy intake in source category *3.A.1.2 - Non-Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. Average gross energy intake decreased in four countries and increased in 24 countries. No data were available for Cyprus. The three countries with the largest decreases were the Netherlands, Malta and Portugal with a mean absolute value of 8 MJ/head/day. The three countries with the largest increases were Finland, the Czech Republic and Latvia with a mean absolute value of 35 MJ/head/day.

Figure 5.17: 3.A.1.2 - Non-Dairy Cattle: Trend in average gross energy intake in the EU-KP and range of values reported by countries

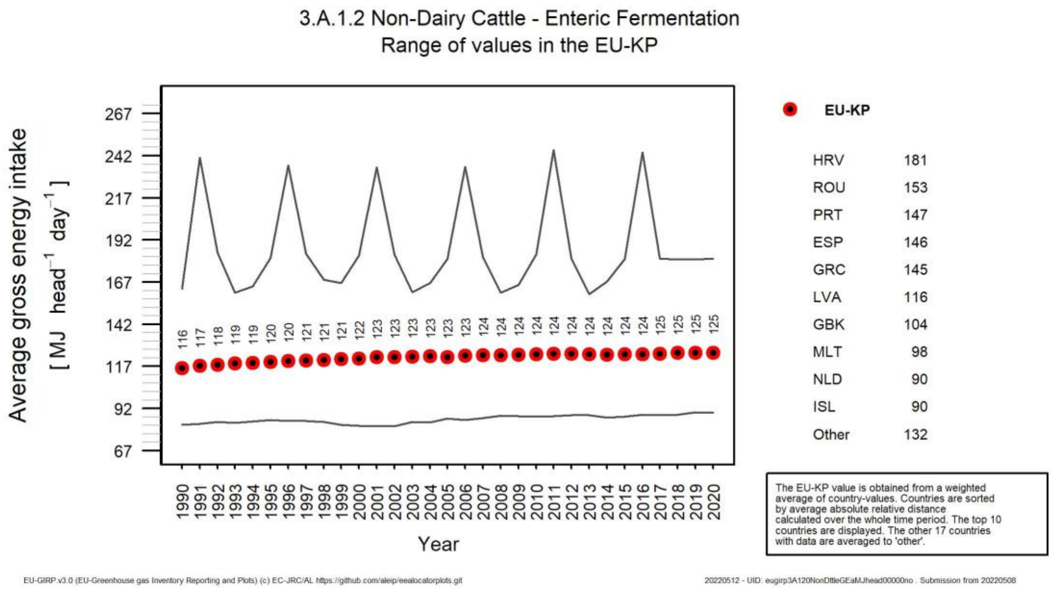


Table 5.12 3.A.1.2 - Non-Dairy Cattle: countries' average gross energy intake (MJ/head/day)

Country	1990	2020	Country	1990	2020
Austria	122	144	Iceland	82	90
Belgium	112	121	Italy	141	144
Bulgaria	129	154	Lithuania	125	134
Czech Republic	116	148	Luxembourg	129	137
Germany	100	111	Latvia	86	116

Country	1990	2020		Country	1990	2020
Denmark	107	130	|	Malta	106	98
Spain	148	146	|	Netherlands	99	90
Estonia	105	107	|	Poland	107	119
Finland	92	134	|	Portugal	151	147
France	122	125	|	Romania	153	153
United Kingdom	94	104	|	Slovakia	136	147
Greece	135	145	|	Slovenia	111	122
Croatia	163	181	|	Sweden	129	139
Hungary	134	138	|	EU-KP	116	125
Ireland	128	130	|			

The factors driving the average methane implied emission factor for dairy cattle are the share of dairy cattle population in each country and the relative change of their implied emissions factor. The increase in the EU-IEF from 1990 to 2020 is 28% is in line with the increase in the IEF of the four countries with the highest population (Germany, France, Poland, United Kingdom) covering together 52% of the EU dairy cattle population. In thirteen countries IEF of dairy cattle increased between 30% and 60% from 1990 to 2020 but they cover only the 15% of dairy cattle population in 2020. The nine countries with the lowest increase of the IEF (less than 23%) represented 23% of the dairy cattle population in 2020.

Table 5.13: Change in dairy cattle population and dairy cattle implied emission factor from 1990 to 2020. Countries are ordered by the share of EU dairy cattle population in 2020

	1990			2020			1990-2020 change	
	POP	POP	IEF	POP	POP	IEF	POP	IEF
Party	1000s	%	kg/head	1000s	%	kg/head	%	%
Germany	6354.6	16.2%	111.5	3921.4	17.4%	140.8	-38.3%	26.2%
France	5309.9	13.5%	99.1	3405.7	15.1%	126.6	-35.9%	27.8%
Poland	4919.0	12.5%	95.8	2468.1	11.0%	120.5	-49.8%	25.8%
United Kingdom	2848.3	7.2%	97.7	1852.6	8.2%	123.8	-35.0%	26.7%
Italy	2641.8	6.7%	111.1	1638.4	7.3%	135.7	-38.0%	22.1%
Netherlands	1877.7	4.8%	110.4	1593.1	7.1%	136.8	-15.2%	23.9%
Ireland	1341.0	3.4%	101.4	1511.9	6.7%	122.2	12.7%	20.6%
Romania	3002.1	7.6%	99.5	1106.9	4.9%	125.1	-63.1%	25.7%
Spain	1587.8	4.0%	85.6	810.5	3.6%	124.8	-49.0%	45.8%
Denmark	753.1	1.9%	127.7	567.0	2.5%	157.4	-24.7%	23.2%
Austria	904.6	2.3%	108.2	524.8	2.3%	130.3	-42.0%	20.4%
Belgium	838.7	2.1%	88.1	498.8	2.2%	127.6	-40.5%	44.9%
Czech Republic	1206.2	3.1%	97.8	359.9	1.6%	159.5	-70.2%	63.0%
Sweden	576.4	1.5%	112.2	303.4	1.3%	146.9	-47.4%	30.9%
Finland	489.9	1.2%	112.0	259.6	1.2%	161.4	-47.0%	44.0%
Hungary	563.6	1.4%	105.3	238.4	1.1%	129.0	-57.7%	22.5%
Lithuania	844.9	2.1%	99.6	236.9	1.1%	131.1	-72.0%	31.7%
Portugal	394.3	1.0%	96.8	233.3	1.0%	135.2	-40.8%	39.6%
Bulgaria	619.1	1.6%	104.7	221.5	1.0%	111.3	-64.2%	6.3%
Latvia	535.1	1.4%	103.0	136.0	0.6%	148.3	-74.6%	44.1%
Slovakia	401.1	1.0%	85.2	122.0	0.5%	122.2	-69.6%	43.4%
Croatia	462.7	1.2%	117.0	109.8	0.5%	111.6	-76.3%	-4.6%

Party		1990			2020		1990-2020 change	
	POP	POP	IEF	POP	POP	IEF	POP	IEF
	1000s	%	kg/head	1000s	%	kg/head	%	%
Slovenia	225.3	0.6%	91.7	99.2	0.4%	127.3	-56.0%	38.7%
Estonia	280.7	0.7%	104.5	84.3	0.4%	156.2	-70.0%	49.6%
Greece	210.0	0.5%	108.9	83.1	0.4%	129.8	-60.4%	19.2%
Luxembourg	58.8	0.1%	115.1	49.5	0.2%	152.0	-15.8%	32.1%
Cyprus	22.4	0.1%	98.8	39.5	0.2%	122.0	76.2%	23.4%
Iceland	31.6	0.1%	90.5	25.8	0.1%	110.2	-18.5%	21.8%
Malta	9.2	0.0%	131.6	6.1	0.0%	129.1	-34.0%	-1.9%
EU-KP	39309.9	100.0%	102.7	22507.3	100.0%	131.4	-42.7%	27.9%

3.A.2 - Sheep - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* increased in EU-KP slightly between 1990 and 2020 by 4.9% or 0.34 kg/head/year. Figure 5.18 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.14 shows the implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in eight countries and increased in fourteen countries. It was in 2020 at the level of 1990 in seven countries. The three countries with the largest decreases were Slovakia, Ireland and Romania with a mean absolute value of 0.5 kg/head/year. The three countries with the largest increases were Malta, Spain and Bulgaria with a mean absolute value of 1 kg/head/year.

Figure 5.18: 3.A.2 - Sheep: Trend in implied emission factor in the EU-KP and range of values reported by countries

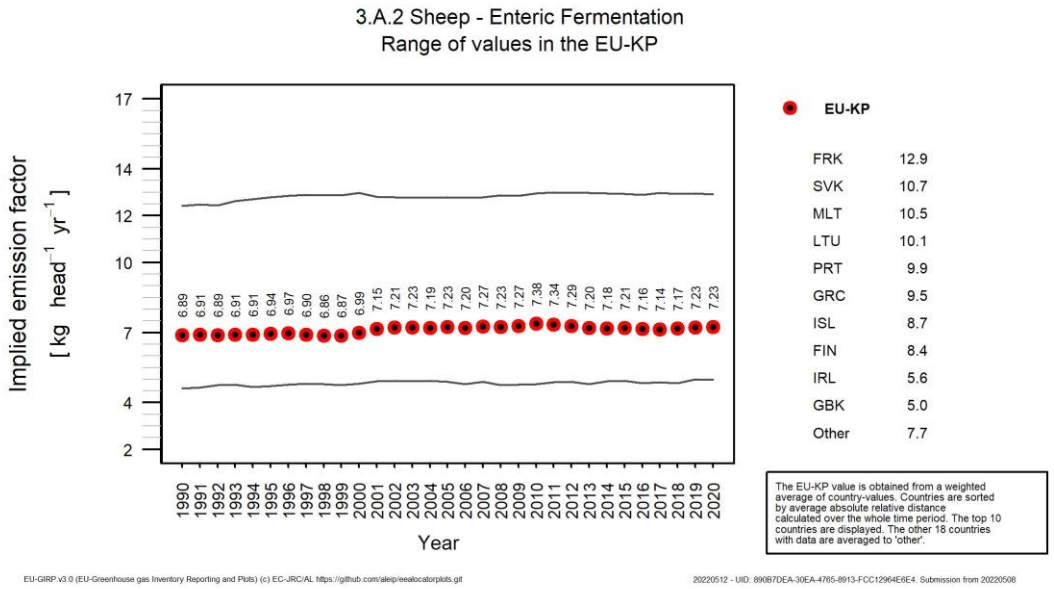


Table 5.14 3.A.2 - Sheep: countries' implied emission factor (kg/head/year)

Country	1990	2020	Country	1990	2020
Austria	8.0	8.0	Ireland	5.9	5.6
Belgium	8.0	8.0	Iceland	8.5	8.7
Bulgaria	6.9	7.5	Italy	7.2	7.5

Country	1990	2020		Country	1990	2020
Cyprus	8.0	8.0	|	Lithuania	10.2	10.1
Czech Republic	8.0	8.0	|	Luxembourg	7.4	7.9
Germany	6.3	6.4	|	Latvia	8.0	8.0
Denmark	6.7	6.7	|	Malta	9.0	10.5
Spain	6.3	7.6	|	Netherlands	8.0	8.0
Estonia	8.0	8.0	|	Poland	8.0	8.0
Finland	8.1	8.4	|	Portugal	9.7	9.9
France	12.4	12.9	|	Romania	7.9	7.8
United Kingdom	4.6	5.0	|	Slovakia	11.8	10.7
Greece	9.5	9.5	|	Slovenia	8.0	8.0
Croatia	8.0	8.0	|	Sweden	8.0	8.0
Hungary	8.0	8.0	|	EU-KP	6.9	7.2

3.A.2 - Sheep - Average gross energy intake

The average gross energy intake, a parameter used for calculating CH_4 emissions in source category *3.A.2 - Sheep*, increased in EU-KP moderately between 1990 and 2020 by 8.5% or 1.4 MJ/head/day. Figure 5.19 shows the trend of the average gross energy intake in EU-KP indicating also the range of values used by the countries. Table 5.15 shows the average gross energy intake in source category *3.A.2 - Sheep* for the years 1990 and 2020 for all countries and EU-KP. Average gross energy intake decreased in five countries and increased in nine countries. It was in 2020 at the level of 1990 in one country. No data were available for fourteen countries (Poland, Austria, Belgium, Cyprus, the Czech Republic, Germany, Estonia, Finland, France, Croatia, Hungary, Latvia, the Netherlands and Slovenia). The three countries with the largest decreases were Slovakia, Romania and Lithuania with a mean absolute value of 1 MJ/head/day. The three countries with the largest increases were Malta, Spain and the United Kingdom with a mean absolute value of 3 MJ/head/day.

Figure 5.19: 3.A.2 - Sheep: Trend in average gross energy intake in the EU-KP and range of values reported by countries

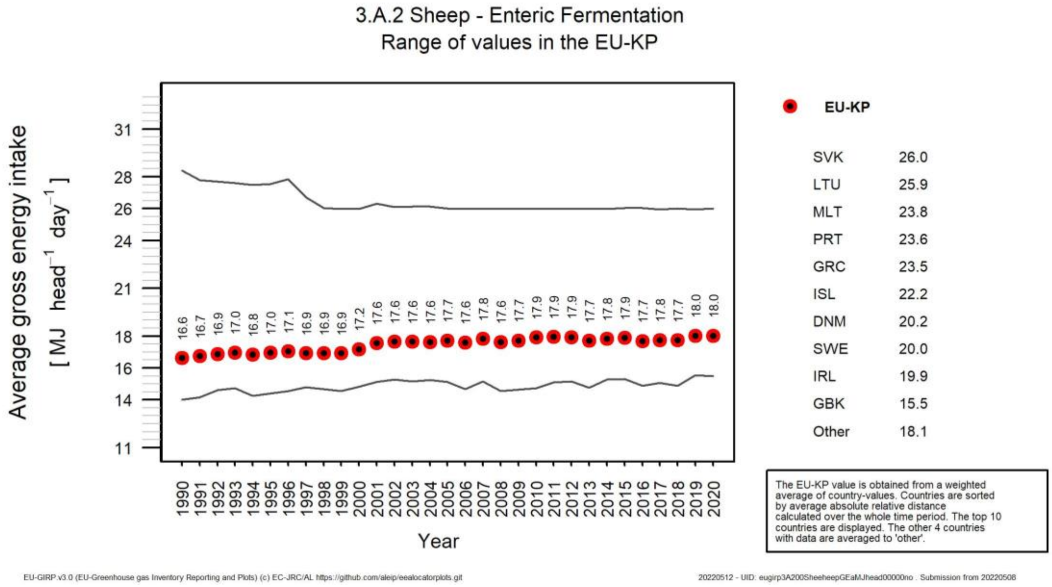


Table 5.15 3.A.2 - Sheep: countries' average gross energy intake (MJ/head/day)

Country	1990	2020		Country	1990	2020
Bulgaria	17	18	|	Lithuania	26	26
Denmark	20	20	|	Luxembourg	19	20
Spain	15	18	|	Malta	20	24
United Kingdom	14	15	|	Portugal	23	24
Greece	23	23	|	Romania	19	18
Ireland	20	20	|	Slovakia	28	26
Iceland	21	22	|	Sweden	20	20
Italy	17	18	|	EU-KP	17	18

5.3.2 Manure Management - CH_4 (CRF Source Category 3B1)

In 2020 CH_4 emissions in source category *3.B.1 - Manure Management* in EU-KP were 41291.9 kt CO_2 equivalent. This corresponds to 1% of total EU-KP GHG emissions and 8.9% of total EU-KP CH_4 emissions. They make 9.7% of total agricultural emissions and 18% of total agricultural CH_4 emissions. The main sub-categories are 3.B.1.3 (Swine), 3.B.1.1.1 (Dairy Cattle) and 3.B.1.1.2 (Non-Dairy Cattle) as shown in Figure 5.20. Emissions are also reported for 3.B.1.4 (Other Livestock and 3.B.1.2 (Sheep). CH_4 emissions from Manure Management for 'Other Livestock' are reported for the categories Buffalo, Deer, Goats, Horses, Mules and Asses, Poultry, and Other Livestock (Fur-bearing animals, Ostrich, Rabbit, Reindeer and Other). Regarding the origin of emissions in the different countries, Figure 5.21 shows the distribution of CH_4 emissions from manure management by livestock category in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting animal types.

Figure 5.20: Share of source category 3.B.1 on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2020.

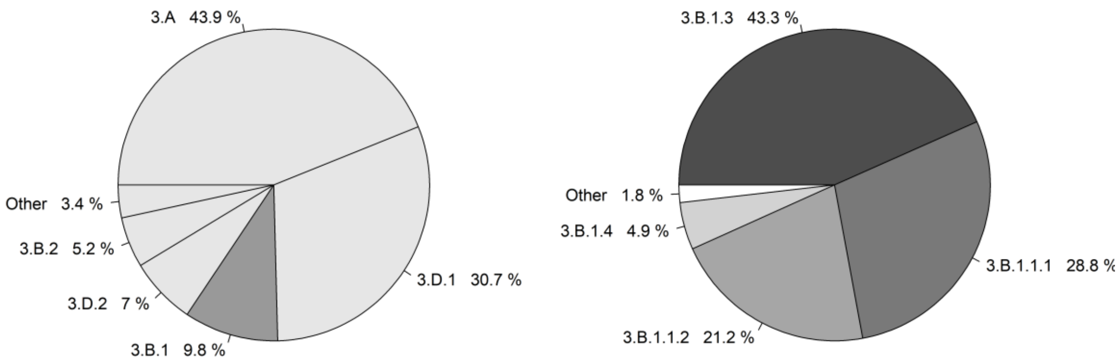
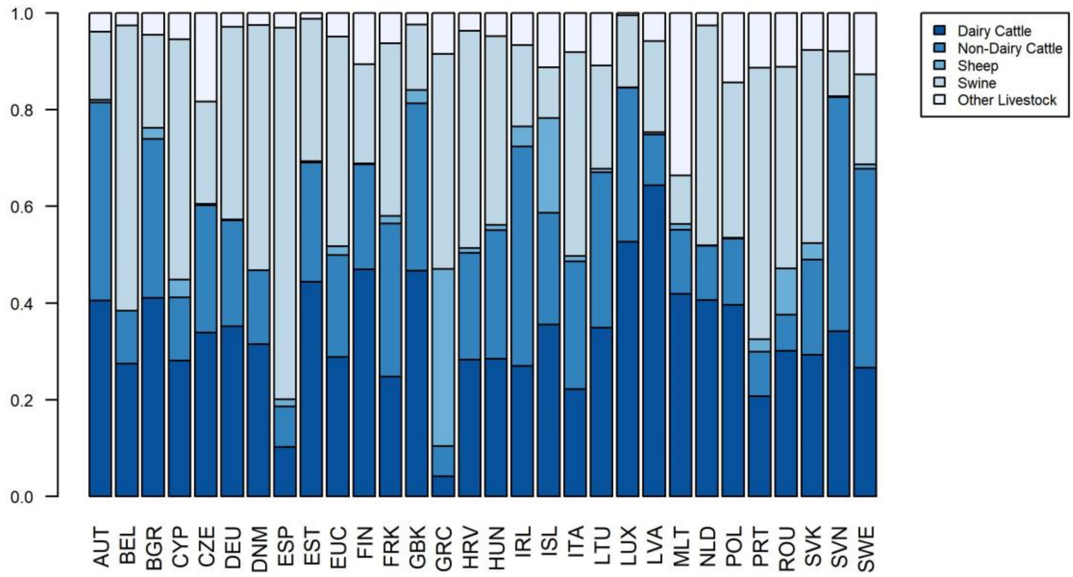


Figure 5.21: Decomposition of emissions in source category 3.B.1 - Manure Management into its sub-categories by country in the year 2020.



Total GHG and CH_4 emissions by country from 3.B.1 *Manure Management* are shown in Table 5.16 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, CH_4 emission in this source category decreased by 17% or 8.6 Mt CO_2-eq. The decrease was largest in Slovakia in relative terms (80%) and in the Netherlands in absolute terms (1.8 Mt CO_2-eq). From 2019 to 2020 emissions in the current category increased by 0.8%.

Table 5.16 3.B.1 - Manure Management: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Information
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	565	557	554	1.3%	-11	-2%	-3	-1%	T1,T2	CS,D
Belgium	1 229	1 176	1 191	2.9%	-38	-3%	14	1%	T1,T2	CS,D
Bulgaria	1 083	303	312	0.8%	-771	-71%	9	3%	T1,T2	CS,D
Croatia	427	386	366	0.9%	-61	-14%	-20	-5%	T2	CS,D
Cyprus	78	57	61	0.1%	-17	-21%	4	7%	T1,T2	D
Czechia	1 547	350	352	0.9%	-1 194	-77%	2	1%	T1,T2	CS,D
Denmark	1 855	2 148	2 198	5.3%	342	18%	49	2%	CS,T2	CS,D
Estonia	165	156	163	0.4%	-1	-1%	7	5%	D,T1,T2,T3	CS,D
Finland	368	453	446	1.1%	78	21%	-8	-2%	T2	CS
France	3 461	3 731	3 796	9.2%	335	10%	65	2%	T2	CS
Germany	7 802	6 446	6 471	15.7%	-1 332	-17%	24	0%	T2	CS,D
Greece	802	630	627	1.5%	-174	-22%	-3	-1%	T1,T2	CS,D
Hungary	1 175	632	639	1.5%	-536	-46%	7	1%	T1,T2	CS,D
Ireland	1 288	1 572	1 597	3.9%	309	24%	26	2%	T1,T2	CS,D
Italy	4 843	4 138	4 147	10.0%	-696	-14%	9	0%	T1,T2	CS,D
Latvia	190	94	89	0.2%	-101	-53%	-6	-6%	T1,T2	CS,D
Lithuania	666	229	232	0.6%	-434	-65%	2	1%	T1,T2	CS,D
Luxembourg	49	60	64	0.2%	15	31%	4	6%	T1,T2	CS,D
Malta	9	5	5	0.0%	-4	-44%	0	3%	T1,T2	CS,D
Netherlands	5 440	3 821	3 689	8.9%	-1 751	-32%	-132	-3%	T1,T2	CS,D
Poland	2 088	1 186	1 222	3.0%	-865	-41%	36	3%	T1,T2	CS,D
Portugal	810	733	743	1.8%	-67	-8%	10	1%	T2	CS,D
Romania	1 847	636	625	1.5%	-1 222	-66%	-11	-2%	T1,T2	CS,D
Slovakia	433	99	87	0.2%	-346	-80%	-12	-12%	T1,T2	CS,D
Slovenia	325	235	231	0.6%	-94	-29%	-4	-2%	T1,T2	CS,D
Spain	6 927	6 946	7 251	17.6%	324	5%	305	4%	T2	CS,D
Sweden	245	266	265	0.6%	20	8%	-1	0%	T1,T2	CS,D
United Kingdom	4 159	3 840	3 812	9.2%	-347	-8%	-28	-1%	T1,T2	CS,D
EU-27+UK	**49 874**	**40 888**	**41 236**	**100%**	**-8 639**	**-17%**	**348**	**1%**	**-**	**-**
Iceland	64	57	56	0.1%	-8	-12%	-1	-2%	T1,T2	CS,D
United Kingdom (KP)	4 159	3 840	3 812	9.2%	-347	-8%	-28	-1%	T1,T2	CS,D
EU-KP	**49 938**	**40 945**	**41 292**	**100%**	**-8 646**	**-17%**	**347**	**1%**	**-**	**-**

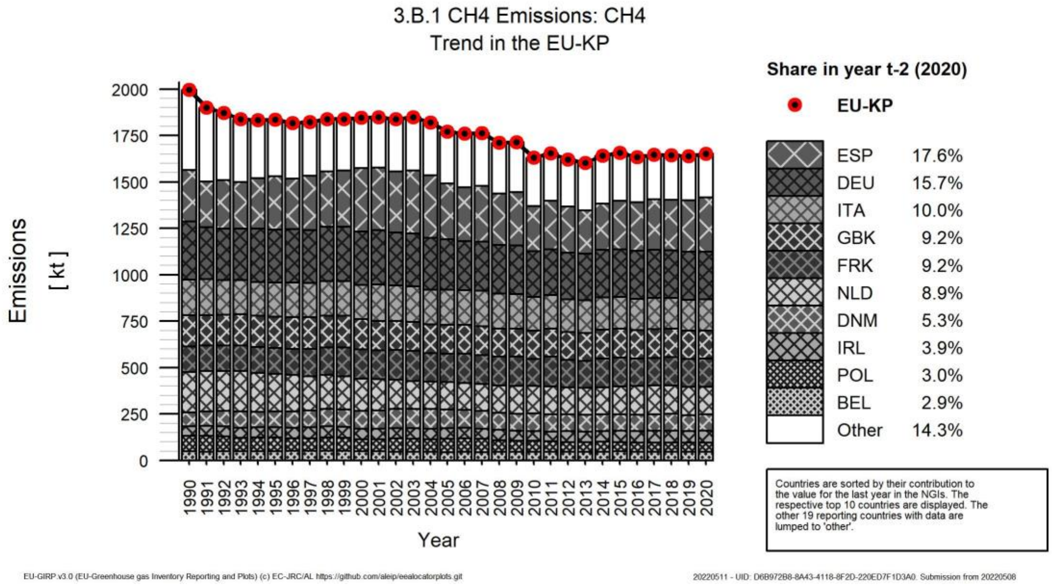
Abbreviations explained in the Chapter 'Units and abbreviations'.

5.3.2.1 Trends in Emissions and Activity Data

3.B.1 - Manure Management - Emissions

Emissions in source category *3.B.1 - Manure Management* decreased considerably in EU-KP by 17% or 8.6 Mt CO_2-eq in the period 1990 to 2020. Figure 5.22 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 85.7% of the total in 2020.Emissions decreased in 22 countries and increased in seven countries. The four countries with the largest decreases were the Netherlands, Germany, Romania and the Czech Republic with a total absolute decrease of 5.5 Mt CO_2-eq. The four countries with the largest increases were Ireland, Spain, France and Denmark, with a total absolute increase of 1.3 Mt CO_2-eq.

Figure 5.22: 3.B.1: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.B.1.1 - Cattle - Emissions

In 2020 CH_4 emissions in source category *3.B.1.1 - Cattle* in EU-KP were 20621.5 kt CO_2 equivalent. This corresponds to 0.5% of total EU-KP GHG emissions and 4.4% of total EU-KP CH_4 emissions. They make 4.9% of total agricultural emissions and 8.9% of total agricultural CH_4 emissions. Figure 5.23 and Figure 5.24 show the trend of emissions for Dairy and Non-Dairy Cattle indicating the countries contributing most to EU-KP.

Total GHG and CH_4 emissions by country from 3.B.1.1 *Manure Management* are shown in Table 5.17 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, CH_4 emission in this source category decreased by 13% or 3.2 Mt CO_2-eq. The decrease was largest in the Czech Republic in relative terms (76%) and in Germany in absolute terms (900 kt CO_2-eq). From 2019 to 2020 emissions in the current category increased by 0.2%. The ten countries with the highest emissions accounted together for 84.9% of the total in 2020.Emissions decreased in fifteen countries and increased in fourteen countries. The three countries with the largest decreases were Germany, Italy and the Czech Republic with a total absolute decrease of 2.4 Mt CO_2-eq. The three countries with the largest increases were Denmark, Ireland and the Netherlands, with a total absolute increase of 678 kt CO_2-eq.

Table 5.17 3.B.1.1 - Cattle: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	417	455	451	2.2%	34	8%	-4	-1%	T2	CS
Belgium	418	452	457	2.2%	38	9%	4	1%	T2	CS
Bulgaria	455	218	231	1.1%	-224	-49%	12	6%	T2	CS
Croatia	224	197	184	0.9%	-39	-18%	-13	-7%	T2	CS,D
Cyprus	18	22	25	0.1%	7	39%	3	12%	T2	D
Czechia	877	212	212	1.0%	-665	-76%	0	0%	T1,T2	CS
Denmark	888	1 025	1 027	5.0%	139	16%	1	0%	CS,T2	CS,D
Estonia	52	111	113	0.5%	61	116%	1	1%	T3	CS,D
Finland	232	301	306	1.5%	74	32%	5	2%	T2	CS
France	2 104	2 074	2 141	10.4%	36	2%	66	3%	T2	CS
Germany	4 592	3 707	3 692	17.9%	-900	-20%	-15	0%	T2	CS
Greece	122	68	65	0.3%	-57	-47%	-2	-4%	T2	CS,D
Hungary	579	344	352	1.7%	-227	-39%	8	2%	T2	CS
Ireland	921	1 140	1 156	5.6%	236	26%	16	1%	T2	CS
Italy	2 836	2 016	2 017	9.8%	-819	-29%	1	0%	T2	CS
Latvia	111	71	66	0.3%	-44	-40%	-4	-6%	T2	CS
Lithuania	252	156	155	0.8%	-96	-38%	-1	0%	T2	CS
Luxembourg	40	50	54	0.3%	14	36%	4	8%	T2	CS
Malta	5	3	3	0.0%	-3	-49%	0	2%	T2	CS
Netherlands	1 608	1 960	1 911	9.3%	303	19%	-48	-2%	T2	CS
Poland	959	641	652	3.2%	-307	-32%	10	2%	T2	CS
Portugal	198	221	223	1.1%	24	12%	2	1%	T2	CS
Romania	651	238	235	1.1%	-416	-64%	-3	-1%	T2	CS
Slovakia	127	42	43	0.2%	-85	-66%	0	0%	T2	CS
Slovenia	163	191	191	0.9%	28	17%	0	0%	T2	CS
Spain	1 652	1 326	1 347	6.5%	-306	-18%	20	2%	T2	CS,D
Sweden	156	182	180	0.9%	24	16%	-2	-1%	T2	CS
United Kingdom	3 081	3 120	3 099	15.0%	18	1%	-20	-1%	T2	CS,D
EU-27+UK	**23 740**	**20 548**	**20 589**	**100%**	**-3 151**	**-13%**	**41**	**0%**	**-**	**-**
Iceland	34	33	33	0.2%	-1	-2%	0	-1%	T2	CS,D
United Kingdom (KP)	3 081	3 120	3 099	15.0%	18	1%	-20	-1%	T2	CS,D
EU-KP	**23 773**	**20 581**	**20 621**	**100%**	**-3 152**	**-13%**	**40**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'

Figure 5.23: 3.B.1.1: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

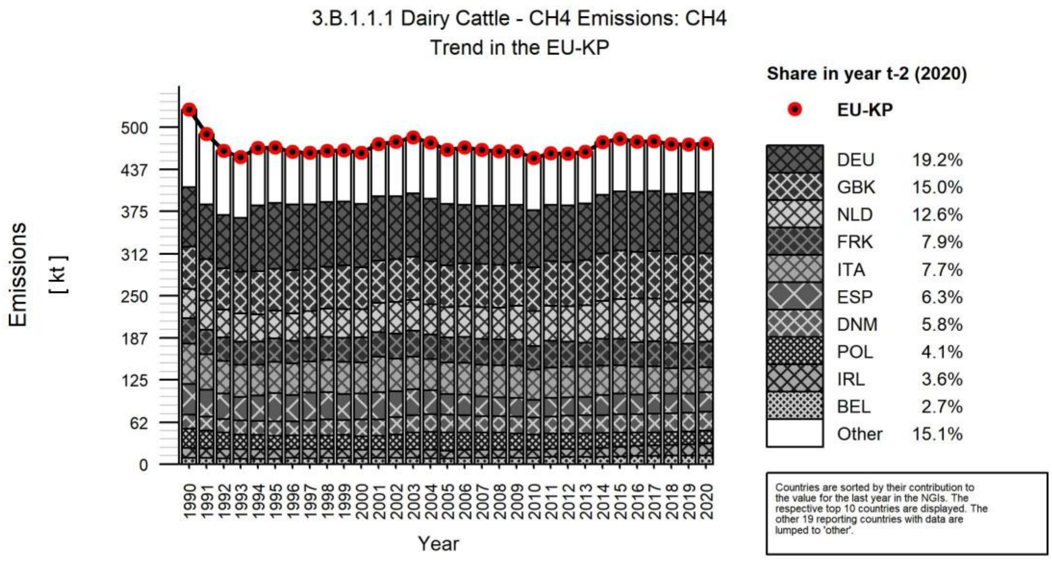
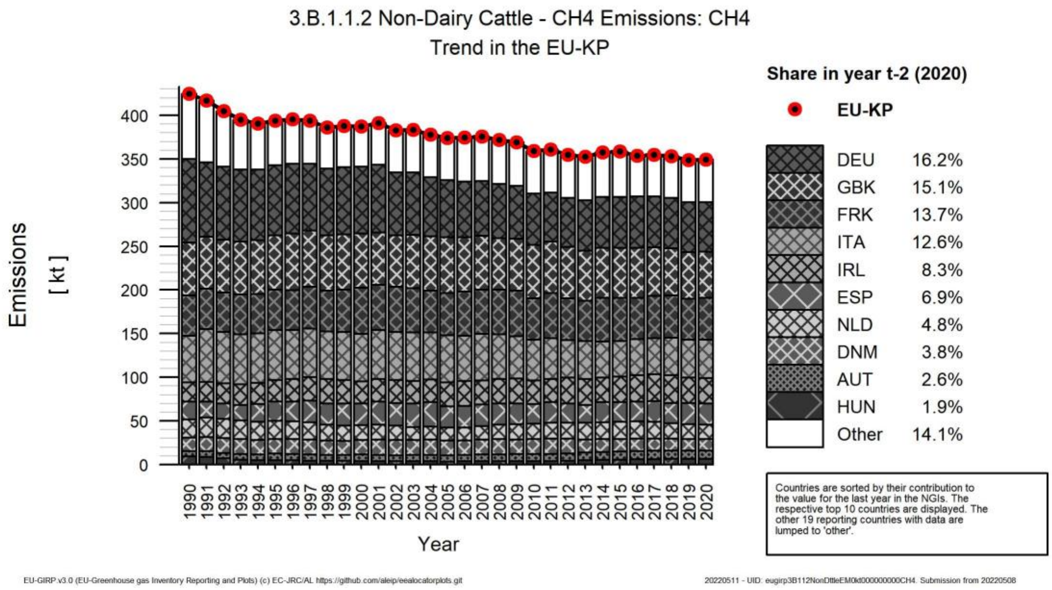


Figure 5.24: 3.B.1.1: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.B.1.1 - Cattle - Activity Data

The main activity data for CH_4 emissions from manure management - cattle are the animal numbers. Cattle numbers are already discussed under source category 3.A Enteric Fermentation and therefore not further discussed here.

Other relevant activity data are the allocation by climate region and the allocation by manure management system (MMS).

3.B.1.3 - Swine - Emissions

In 2020 CH_4 emissions in source category *3.B.1.3 - Swine* in EU-KP were 17887.5 kt CO_2 equivalent. This corresponds to 0.44% of total EU-KP GHG emissions and 3.8% of total EU-KP CH_4 emissions. They make 4.2% of total agricultural emissions and 7.7% of total agricultural CH_4 emissions.

Total GHG and CH_4 emissions by country from 3.B.1.3 *Manure Management* are shown in Table 5.18 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, CH_4 emission in this source category decreased by 22% or 4.9 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (89%) and in the Netherlands in absolute terms (1.7 Mt CO_2-eq). From 2019 to 2020 emissions in the current category increased by 1.8%. Figure 5.25 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in CH_4 emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 90% of the total in 2020.Emissions decreased in 21 countries and increased in eight countries. The largest decreases occurred in the Netherlands and Romania with a total absolute decrease of 2.4 Mt CO_2-eq. The three countries with the largest increases were Denmark, France and Spain, with a total absolute increase of 1.1 Mt CO_2-eq.

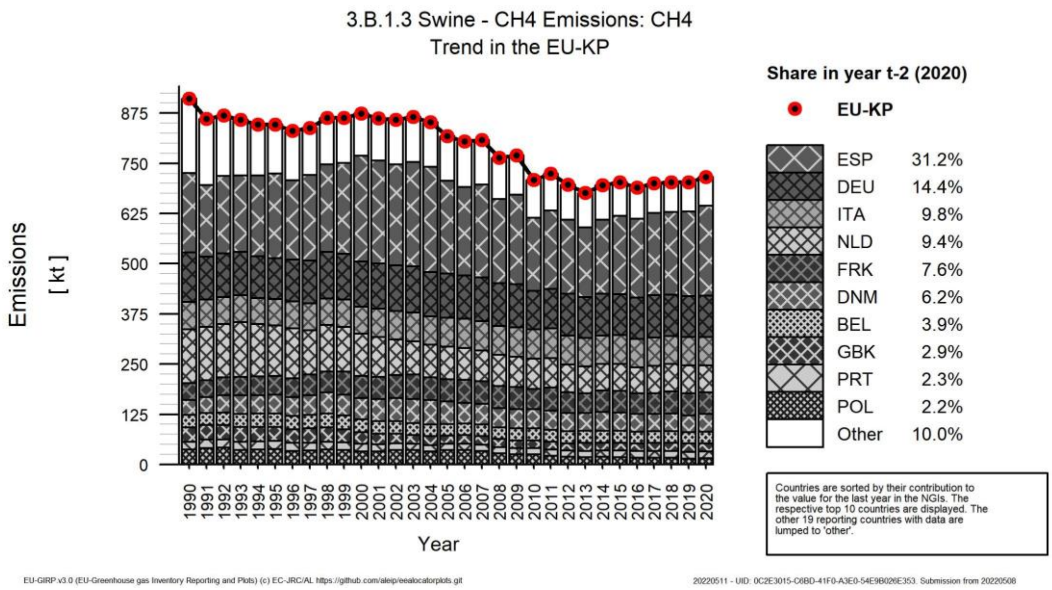
Table 5.18 3.B.1.3 - Swine: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	132	78	78	0.4%	-54	-41%	1	1%	T1	D
Belgium	793	694	702	3.9%	-91	-11%	9	1%	T2	CS
Bulgaria	543	63	60	0.3%	-483	-89%	-3	-5%	T2	CS
Croatia	167	172	165	0.9%	-3	-2%	-7	-4%	T2	CS,D
Cyprus	55	29	30	0.2%	-24	-44%	1	4%	T2	D
Czechia	564	78	75	0.4%	-489	-87%	-3	-4%	T2	CS
Denmark	923	1 065	1 114	6.2%	192	21%	50	5%	CS,T2	CS,D
Estonia	103	42	48	0.3%	-55	-53%	6	14%	T2	CS,D
Finland	68	90	92	0.5%	24	36%	2	2%	T2	CS
France	1 042	1 365	1 356	7.6%	314	30%	-8	-1%	T2	CS
Germany	3 059	2 542	2 583	14.4%	-476	-16%	41	2%	T2	CS
Greece	398	282	279	1.6%	-119	-30%	-3	-1%	T1	D
Hungary	501	246	250	1.4%	-252	-50%	4	1%	T2	CS
Ireland	206	266	270	1.5%	63	31%	3	1%	T2	CS,D
Italy	1 703	1 743	1 752	9.8%	48	3%	9	1%	T2	CS
Latvia	66	18	17	0.1%	-49	-74%	-1	-8%	T2	CS
Lithuania	329	48	49	0.3%	-280	-85%	2	3%	T2	CS
Luxembourg	9	10	10	0.1%	1	8%	0	0%	T2	CS
Malta	1	0	1	0.0%	-1	-60%	0	13%	T2	CS
Netherlands	3 369	1 751	1 679	9.4%	-1 690	-50%	-73	-4%	T2	CS
Poland	913	371	394	2.2%	-519	-57%	22	6%	T1	CS
Portugal	506	415	417	2.3%	-89	-18%	2	1%	T2	CS
Romania	1 021	265	261	1.5%	-759	-74%	-4	-2%	T2	CS
Slovakia	288	45	35	0.2%	-253	-88%	-10	-22%	T2	CS
Slovenia	128	22	21	0.1%	-107	-83%	-1	-4%	T1	D
Spain	4 959	5 294	5 579	31.2%	620	13%	285	5%	T2	CS,D
Sweden	60	48	49	0.3%	-10	-17%	2	3%	T2	CS
United Kingdom	879	518	515	2.9%	-364	-41%	-3	-1%	T2	D
EU-27+UK	**22 785**	**17 561**	**17 882**	**100%**	**-4 903**	**-22%**	**321**	**2%**	**-**	**-**
Iceland	4	6	6	0.0%	1	32%	0	2%	T1	D
United Kingdom (KP)	879	518	515	2.9%	-364	-41%	-3	-1%	T2	D
EU-KP	**22 790**	**17 567**	**17 887**	**100%**	**-4 902**	**-22%**	**321**	**2%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'

Note that some countries are using Tier 1 and default emission factors for 3.B.1.3 category. Although this is a key category for the EU, is not a key category for all countries. For those countries using Tier 1, source category 3.B.1.3 is not a key category.

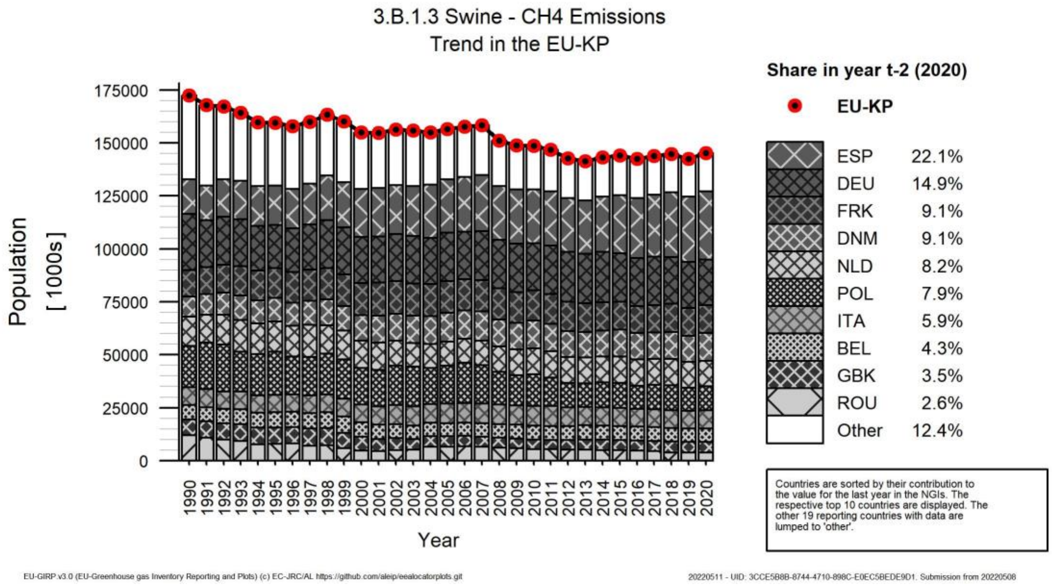
Figure 5.25: 3.B.1.3: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.B.1.3 - Swine - Population

The main activity data for CH_4 emissions from manure management - swine are the animal numbers. As swine are not a main animal type in the source category 3.A Enteric Fermentation its population data is discussed here. Swine population decreased considerably in EU-KP by 16% or 27.3 million heads in the period 1990 to 2020. Figure 5.26 shows the trend of swine population indicating the countries contributing most to EU-KP total. The figure represents the trend in swine population for the different countries along the inventory period. The ten countries with the highest population accounted together for 87.6% of the total in 2020.Population decreased in 21 countries and increased in eight countries. The four countries with the largest decreases were Romania, Poland, Hungary and Germany with a total absolute decrease of 27 million heads. The largest increases occurred in Denmark and Spain, with a total absolute increase of 19.4 million heads.

Figure 5.26: 3.B.1.3: Trend in swine population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



5.3.2.2 Implied EFs and methodological issues

In this section, we discuss the implied emission factor for the category 3.B.1 for the main animal types. Furthermore, we present data on the typical animal mass as reported in CRF Tables 3B(a)s1 and average volatile solid (VS) daily excretion.

3.B.1.1 - Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1 - Cattle* increased in EU-KP considerably between 1990 and 2020 by 21.4% or 1.7 kg/head/year. Table 5.19 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1 - Cattle* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in seven countries and increased in 22 countries. The four countries with the largest decreases were Spain, the Czech Republic, Malta and Greece with a mean absolute value of 3 kg/head/year. The four countries with the largest increases were Estonia, Denmark, Finland and the Netherlands with a mean absolute value of 10 kg/head/year.

Table 5.19 3.B.1.1 - Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2020		Country	1990	2020
Austria	6.5	9.7	|	Ireland	5.4	6.4
Belgium	5.1	7.8	|	Iceland	17.9	18.4

Country	1990	2020		Country	1990	2020
Bulgaria	11.4	17.1	|	Italy	14.6	13.5
Cyprus	13.3	12.2	|	Lithuania	4.2	9.6
Czech Republic	10.0	6.0	|	Luxembourg	7.3	11.3
Germany	9.4	13.1	|	Latvia	3.1	6.7
Denmark	15.9	27.4	|	Malta	10.3	7.7
Spain	12.9	8.1	|	Netherlands	13.1	20.6
Estonia	2.8	17.8	|	Poland	3.8	4.1
Finland	6.8	14.5	|	Portugal	5.8	5.4
France	3.9	4.8	|	Romania	4.9	5.1
United Kingdom	10.2	13.1	|	Slovakia	3.3	3.9
Greece	7.0	5.0	|	Slovenia	12.3	15.7
Croatia	10.9	17.4	|	Sweden	3.6	5.0
Hungary	14.3	15.2	|	EU-KP	7.9	9.5

3.B.1.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle* increased in EU-KP very strongly between 1990 and 2020 by 57.9% or 7.7 kg/head/year. Figure 5.27 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.20 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in five countries and increased in 24 countries. The largest decrease occurred in Malta with an absolute value of 5 kg/head/year. The four countries with the largest increases were Estonia, Croatia, Denmark and Finland with a mean absolute value of 24 kg/head/year.

Figure 5.27: 3.B.1.1.1 - Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

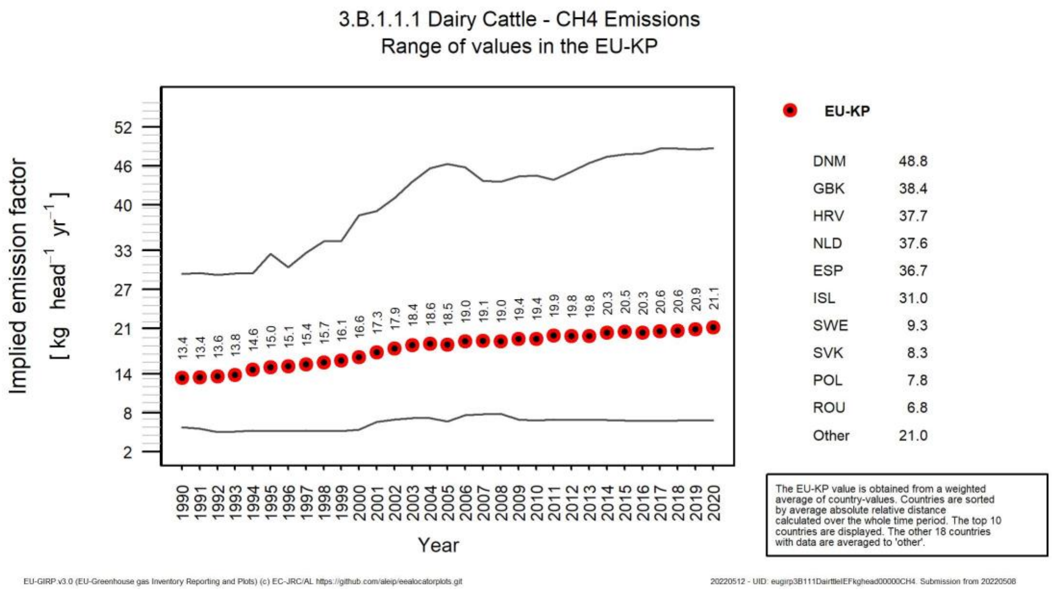


Table 5.20 3.B.1.1.1 - Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2020		Country	1990	2020
Austria	11.3	17.1	|	Ireland	11.2	11.4
Belgium	11.1	26.1	|	Iceland	29.4	31.0
Bulgaria	16.5	23.1	|	Italy	22.5	22.5
Cyprus	20.1	17.4	|	Lithuania	6.0	13.6
Czech Republic	14.1	13.3	|	Luxembourg	13.1	27.3
Germany	13.8	23.2	|	Latvia	6.4	16.8
Denmark	27.3	48.8	|	Malta	18.9	13.9
Spain	28.8	36.7	|	Netherlands	23.1	37.6
Estonia	5.1	34.3	|	Poland	5.8	7.8
Finland	12.4	32.2	|	Portugal	14.6	26.4
France	7.2	11.1	|	Romania	6.5	6.8
United Kingdom	22.1	38.4	|	Slovakia	6.2	8.3
Greece	15.6	12.5	|	Slovenia	19.6	31.9
Croatia	13.9	37.7	|	Sweden	6.6	9.3
Hungary	24.8	30.5	|	EU-KP	13.4	21.1

3.B.1.1.1 - Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle*, increased in EU-KP moderately between 1990 and 2020 by 5.7% or 33 kg. Figure 5.28 shows the trend of the typical animal mass in EU-KP indicating also the range of values used by the countries. Table 5.21 shows the typical animal mass in source category *3.B.1.1.1 - Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. Typical animal mass decreased in two countries and increased in eighteen countries. It was in 2020 at the level of 1990 in nine countries. Decreases occurred in France and Belgium with a mean absolute value of 6 kg. The largest increase occurred in Finland with an absolute value of 167 kg.

Figure 5.28: 3.B.1.1.1 - Dairy Cattle: Trend in typical animal mass in the EU-KP and range of values reported by countries

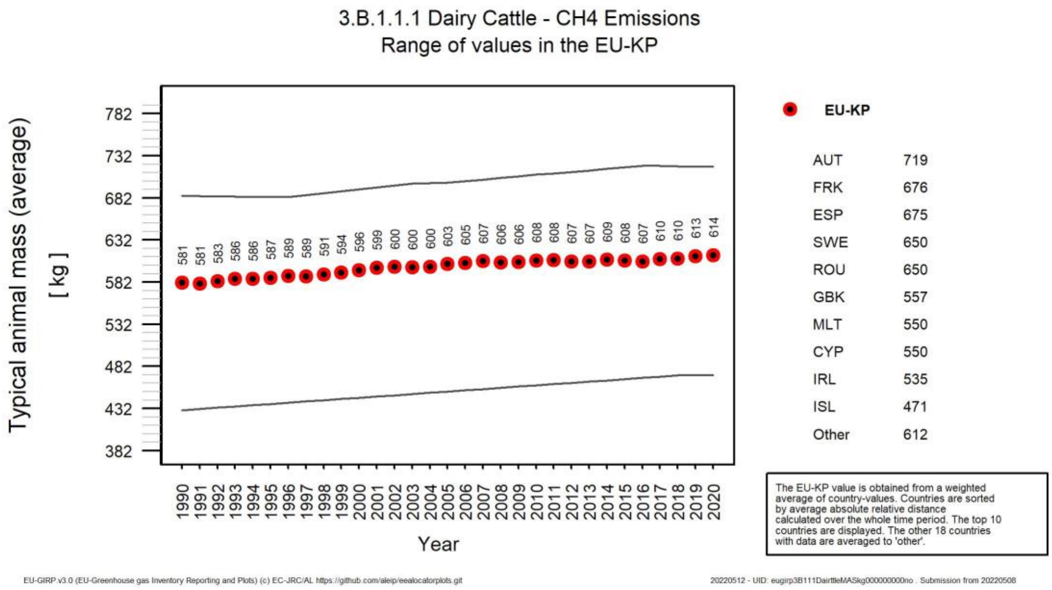


Table 5.21 3.B.1.1.1 - Dairy Cattle: countries' typical animal mass (kg)

Country	1990	2020		Country	1990	2020
Austria	676	719	|	Ireland	535	535
Belgium	623	619	|	Iceland	430	471
Bulgaria	588	588	|	Italy	603	603
Cyprus	550	550	|	Lithuania	575	630
Czech Republic	520	650	|	Luxembourg	650	650
Germany	567	601	|	Latvia	550	570
Denmark	550	580	|	Malta	550	550
Spain	652	675	|	Netherlands	555	589
Estonia	545	636	|	Poland	500	600
Finland	520	687	|	Portugal	600	600
France	685	676	|	Romania	650	650
United Kingdom	466	557	|	Slovakia	589	599
Greece	553	624	|	Slovenia	510	629
Croatia	550	563	|	Sweden	650	650
Hungary	633	643	|	EU-KP	581	614

3.B.1.1.1 - Dairy Cattle - VS daily excretion

The volatile solid (VS) daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.1 - Dairy Cattle*, increased in EU-KP clearly between 1990 and 2020 by 19.9% or 0.82 kg dm/head/day (dm: dry matter). Figure 5.29 shows the trend of the VS daily excretion in EU-KP indicating also the range of values used by the countries. Table 5.22 shows the VS daily excretion in source category *3.B.1.1.1 - Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. VS daily excretion decreased in three countries and increased in 24 countries. It was in 2020 at the level of 1990 in two countries. The largest decrease occurred in Malta with an absolute value of 2 kg dm/head/day. The four countries with the largest increases were Denmark, the Czech Republic, Finland and Latvia with a mean absolute value of 3 kg dm/head/day.

Figure 5.29: 3.B.1.1.1 - Dairy Cattle: Trend in VS daily excretion in the EU-KP and range of values reported by countries

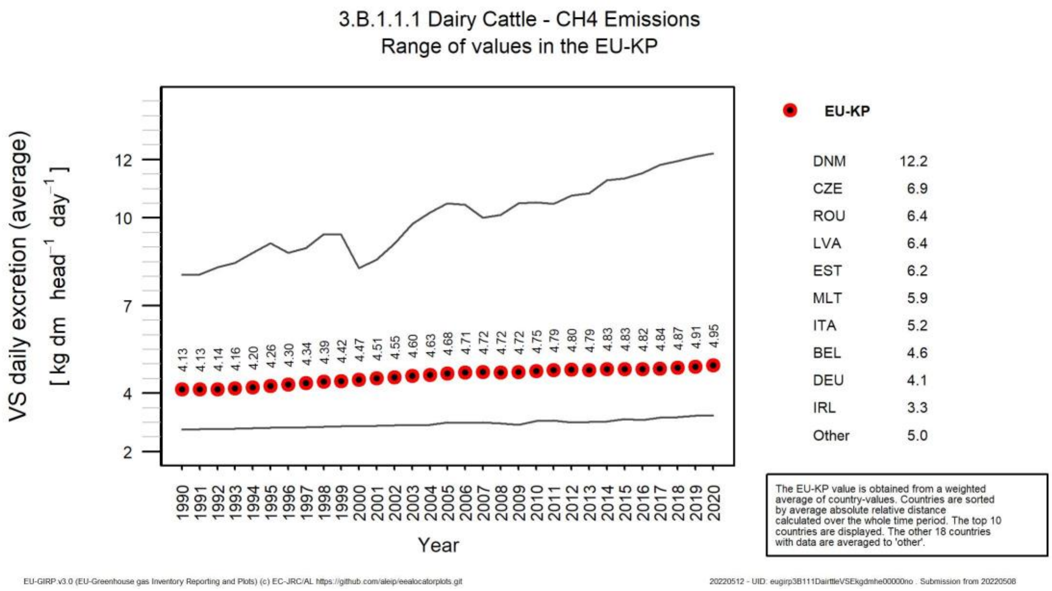


Table 5.22 3.B.1.1.1 - Dairy Cattle: countries' VS daily excretion (kg dm/head/day)

Country	1990	2020	Country	1990	2020
Austria	4.7	5.0	Ireland	2.8	3.3
Belgium	3.2	4.6	Iceland	3.8	4.2
Bulgaria	4.0	4.3	Italy	6.4	5.2
Cyprus	4.5	4.5	Lithuania	4.5	6.0
Czech Republic	4.2	6.9	Luxembourg	4.7	5.9
Germany	2.9	4.1	Latvia	4.7	6.4
Denmark	6.5	12.2	Malta	8.1	5.9
Spain	3.9	5.2	Netherlands	3.8	4.7
Estonia	4.7	6.2	Poland	4.5	4.9
Finland	4.4	6.4	Portugal	3.5	4.9
France	3.5	4.3	Romania	5.1	6.4
United Kingdom	3.9	5.3	Slovakia	3.6	4.5
Greece	5.5	4.4	Slovenia	4.5	5.3
Croatia	5.1	5.1	Sweden	5.1	5.4
Hungary	4.4	5.4	EU-KP	4.1	4.9

3.B.1.1.2 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle* increased in EU-KP slightly between 1990 and 2020 by 4.7% or 0.23 kg/head/year. Figure 5.30 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table

5.23 shows the implied emission factor for CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in ten countries and increased in nineteen countries. The largest decreases occurred in the Czech Republic and Spain with a mean absolute value of 3 kg/head/year. The four countries with the largest increases were Estonia, Bulgaria, Denmark and Lithuania with a mean absolute value of 5 kg/head/year.

Figure 5.30: 3.B.1.1.2 - Non-Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

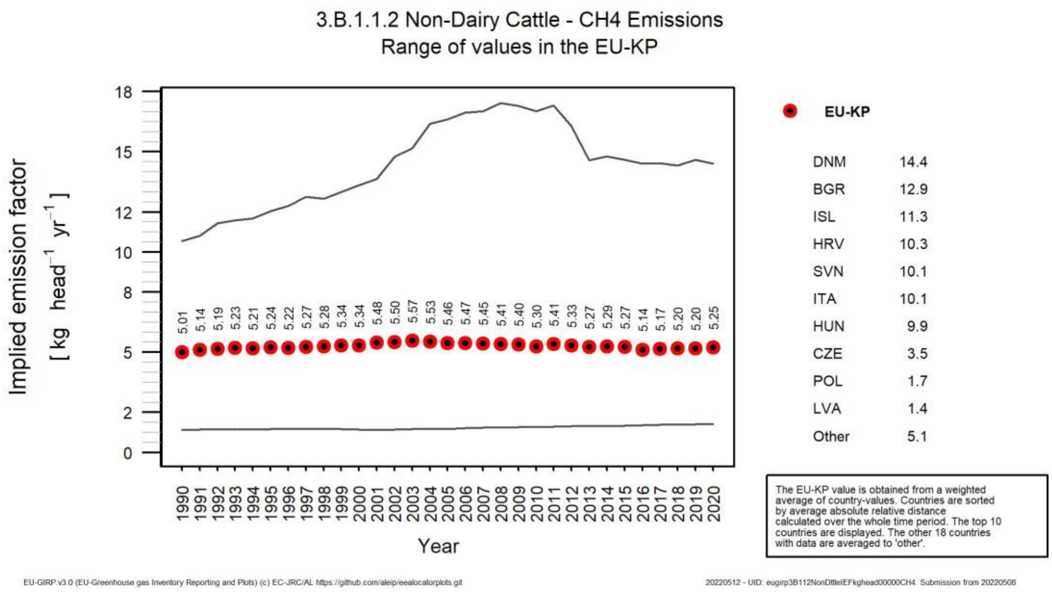


Table 5.23 3.B.1.1.2 - Non-Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2020	Country	1990	2020
Austria	3.8	6.8	Ireland	4.0	5.1
Belgium	3.1	2.8	Iceland	9.5	11.3
Bulgaria	8.2	12.9	Italy	10.5	10.1
Cyprus	8.5	7.4	Lithuania	3.3	7.3
Czech Republic	7.9	3.5	Luxembourg	5.2	5.8
Germany	7.3	7.7	Latvia	1.1	1.4
Denmark	10.1	14.4	Malta	3.7	3.2
Spain	5.8	4.1	Netherlands	6.9	7.8
Estonia	1.4	9.5	Poland	2.0	1.7
Finland	3.7	6.6	Portugal	2.2	1.9
France	2.8	3.3	Romania	2.9	2.5
United Kingdom	6.5	7.0	Slovakia	2.2	2.1
Greece	3.3	3.6	Slovenia	6.9	10.1
Croatia	7.0	10.3	Sweden	2.1	3.8
Hungary	8.7	9.9	EU-KP	5.0	5.2

3.B.1.1.2 - Non-Dairy Cattle - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle*, increased in EU-KP clearly between 1990 and 2020 by 11.3% or 40 kg. Figure 5.31 shows the trend of the typical animal mass in EU-KP indicating also the range of values used by the countries. Table 5.24 shows the typical animal mass in source category *3.B.1.1.2 - Non-Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. Typical animal mass decreased in four countries and increased in 24 countries. No data were available for Sweden. The three countries with the largest decreases were Cyprus, the Netherlands and Malta with a mean absolute value of 28 kg. The four countries with the largest increases were Bulgaria, Finland, Poland and the Czech Republic with a mean absolute value of 120 kg.

Figure 5.31: 3.B.1.1.2 - Non-Dairy Cattle: Trend in typical animal mass in the EU-KP and range of values reported by countries

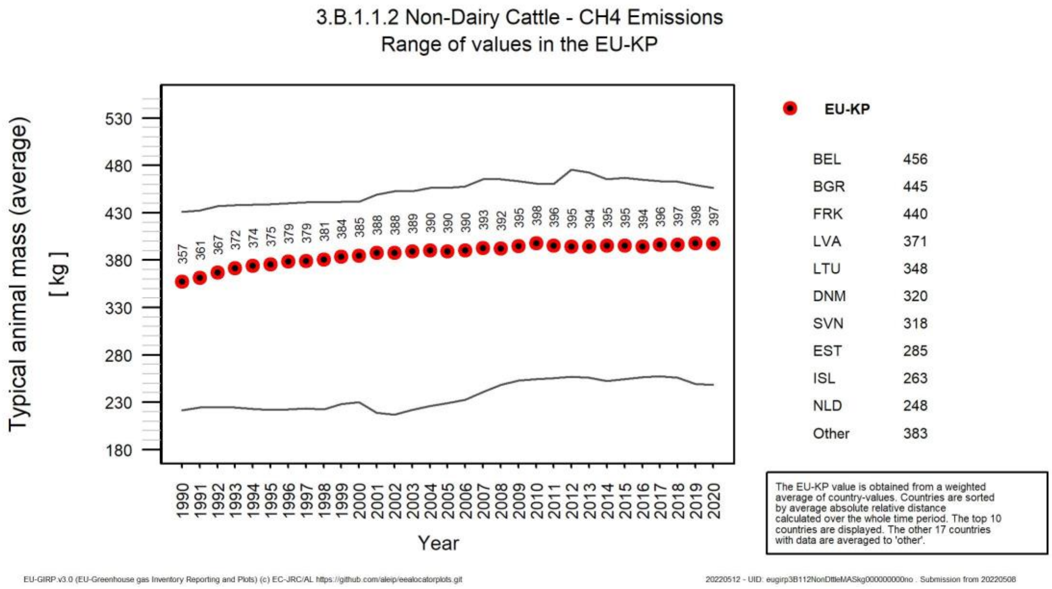


Table 5.24 3.B.1.1.2 - Non-Dairy Cattle: countries' typical animal mass (kg)

Country	1990	2020	Country	1990	2020
Austria	325	384	Ireland	362	347
Belgium	422	456	Iceland	241	263
Bulgaria	298	445	Italy	376	387
Cyprus	359	321	Lithuania	327	348
Czech Republic	326	418	Luxembourg	422	439
Germany	318	348	Latvia	298	371
Denmark	290	320	Malta	371	349
Spain	413	421	Netherlands	272	248
Estonia	222	285	Poland	316	411
Finland	278	424	Portugal	399	443
France	431	440	Romania	338	348
United Kingdom	369	421	Slovakia	330	354
Greece	375	418	Slovenia	289	318
Croatia	330	342	EU-KP	357	397
Hungary	327	372			

3.B.1.1.2 - Non-Dairy Cattle - VS daily excretion

The Volatile Solid (VS) daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.1.2 - Non-Dairy Cattle*, increased in EU-KP slightly between 1990 and 2020 by 2.2% or 0.043 kg dm/head/day. Figure 5.32 shows the trend of the VS daily excretion in EU-KP indicating also the range of values used by the countries. Table 5.25 shows the VS daily excretion in source category *3.B.1.1.2 - Non-Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. VS daily excretion decreased in nine countries and increased in nineteen countries. It was in 2020 at the level of 1990 in one country. The three countries with the largest decreases were Portugal, Italy and Spain with a mean absolute value of 0.4 kg dm/head/day. The four countries with the largest increases were Finland, the Czech Republic, Latvia and Bulgaria with a mean absolute value of 1 kg dm/head/day.

Figure 5.32: 3.B.1.1.2 - Non-Dairy Cattle: Trend in VS daily excretion in the EU-KP and range of values reported by countries

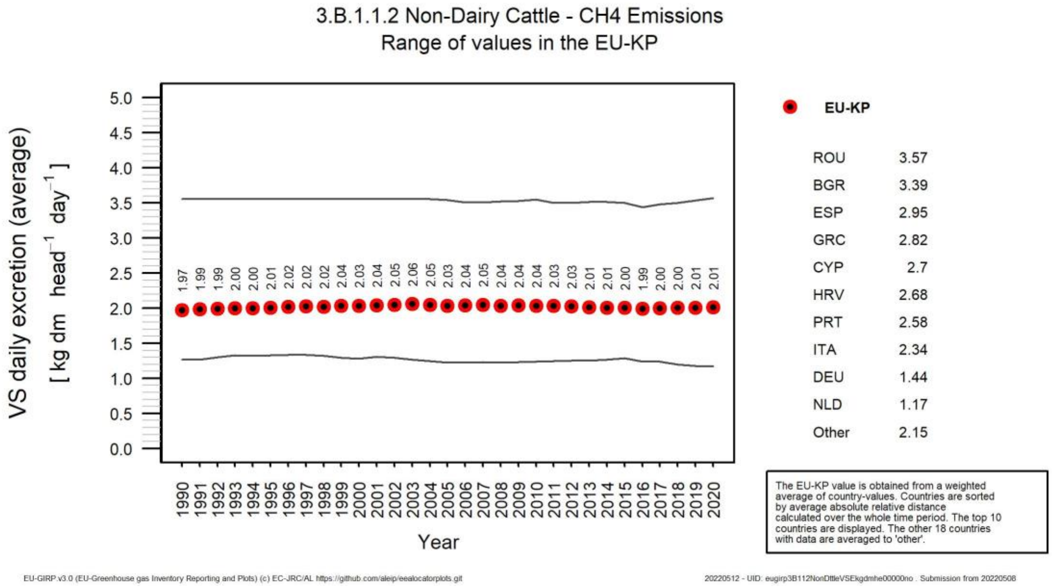


Table 5.25 3.B.1.1.2 - Non-Dairy Cattle: countries' VS daily excretion (kg dm/head/day)

Country	1990	2020		Country	1990	2020
Austria	1.9	2.4	|	Ireland	1.6	1.6
Belgium	1.5	1.5	|	Iceland	1.5	1.6
Bulgaria	2.8	3.4	|	Italy	2.8	2.3
Cyprus	2.7	2.7	|	Lithuania	2.4	2.6
Czech Republic	2.3	3.0	|	Luxembourg	2.2	2.3
Germany	1.3	1.4	|	Latvia	1.7	2.3
Denmark	2.0	2.5	|	Malta	2.1	1.8
Spain	3.2	2.9	|	Netherlands	1.4	1.2
Estonia	2.3	2.1	|	Poland	2.0	1.8
Finland	1.5	2.3	|	Portugal	3.2	2.6
France	1.9	1.9	|	Romania	3.6	3.6
United Kingdom	1.8	2.0	|	Slovakia	2.5	2.6
Greece	2.6	2.8	|	Slovenia	2.1	2.2
Croatia	2.7	2.7	|	Sweden	1.6	1.8

Hungary	2.5	2.6	EU-KP	2.0	2.0

3.B.1.3 - Swine - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.3 - Swine* decreased in EU-KP moderately between 1990 and 2020 by 6.7%. Figure 5.33 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.26 shows the implied emission factor for CH_4 emissions in source category *3.B.1.3 - Swine* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in eighteen countries and increased in ten countries. It was in 2020 at the level of 1990 in one country. The four countries with the largest increases were Croatia, Finland, Estonia and Hungary with a mean absolute value of 1 kg/head/year.

Figure 5.33: 3.B.1.3 - Swine: Trend in implied emission factor in the EU-KP and range of values reported by countries

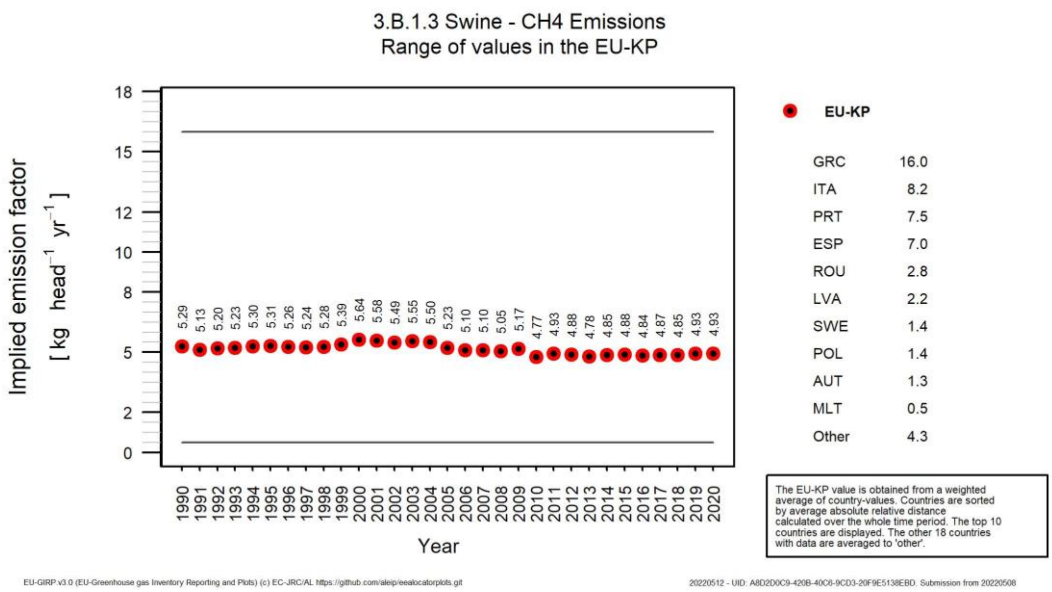


Table 5.26 3.B.1.3 - Swine: countries' implied emission factor (kg/head/year)

Country	1990	2020	Country	1990	2020
Austria	1.5	1.3	Ireland	6.8	6.5
Belgium	4.7	4.5	Iceland	6.0	6.0
Bulgaria	5.1	4.4	Italy	8.1	8.2
Cyprus	7.9	3.4	Lithuania	5.1	3.5
Czech Republic	4.7	2.0	Luxembourg	5.8	5.0
Germany	4.6	4.8	Latvia	1.9	2.2
Denmark	3.9	3.4	Malta	0.5	0.5
Spain	12.1	7.0	Netherlands	9.7	5.7
Estonia	4.8	6.1	Poland	1.9	1.4
Finland	2.0	3.3	Portugal	8.0	7.5
France	3.4	4.1	Romania	3.4	2.8
United Kingdom	4.7	4.1	Slovakia	4.6	2.6
Greece	16.0	16.0	Slovenia	8.7	3.7

Croatia	4.3	6.4	|	Sweden	1.0	1.4
Hungary	2.3	3.5	|	EU-KP	5.3	4.9

3.B.1.3 - Swine - Typical animal mass

The typical animal mass, a parameter used for calculating CH_4 emissions in source category *3.B.1.3 - Swine*, decreased in EU-KP slightly between 1990 and 2020 by 1.2%. Figure 5.34 shows the trend of the typical animal mass in EU-KP indicating also the range of values used by the countries. Table 5.27 shows the typical animal mass in source category *3.B.1.3 - Swine* for the years 1990 and 2020 for all countries and EU-KP. Typical animal mass decreased in fourteen countries and increased in seven countries. It was in 2020 at the level of 1990 in one country. No data were available for seven countries (Cyprus, Finland, the United Kingdom, the Netherlands, Poland, Slovenia and Sweden). The three countries with the largest decreases were Luxembourg, Latvia and Belgium with a mean absolute value of 10 kg. The three countries with the largest increases were Denmark, Estonia and Italy with a mean absolute value of 8 kg.

Figure 5.34: 3.B.1.3 - Swine: Trend in typical animal mass in the EU-KP and range of values reported by countries

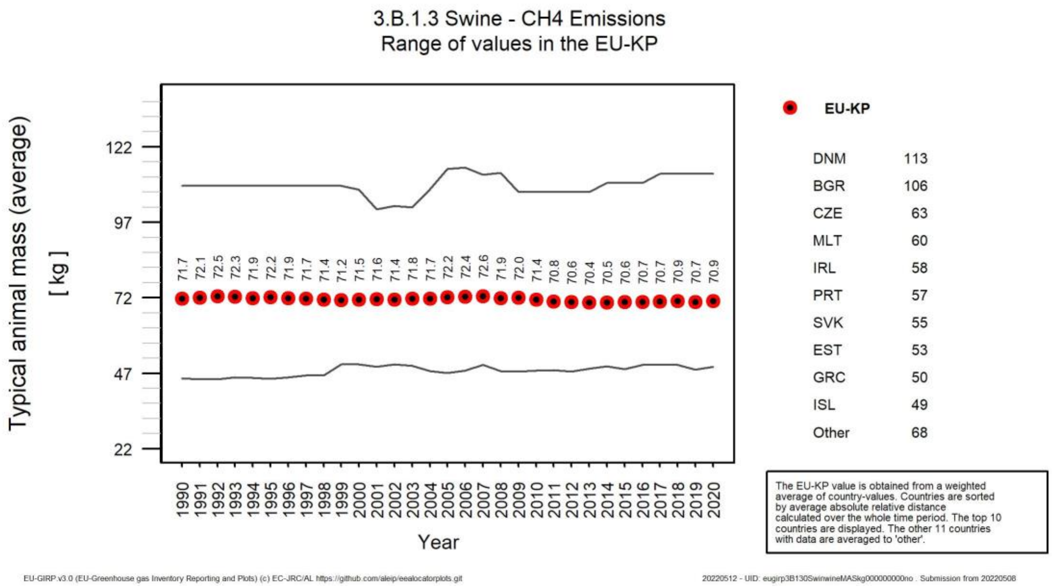


Table 5.27 3.B.1.3 - Swine: countries' typical animal mass (kg)

Country	1990	2020		Country	1990	2020
Austria	75	74	|	Ireland	63	58
Belgium	69	63	|	Iceland	52	49
Bulgaria	109	106	|	Italy	79	81
Czech Republic	62	63	|	Lithuania	65	62
Germany	67	63	|	Luxembourg	87	73
Denmark	98	113	|	Latvia	75	64
Spain	64	62	|	Malta	59	60
Estonia	45	53	|	Portugal	62	57
France	65	65	|	Romania	82	79
Greece	50	50	|	Slovakia	61	55

Country	1990	2020		Country	1990	2020
Croatia	72	66	|	EU-KP	72	71
Hungary	63	64	|			

3.B.1.3 - Swine - VS daily excretion

The Volatile Solid (VS) daily excretion, a parameter used for calculating CH_4 emissions in source category *3.B.1.3 - Swine*, decreased in EU-KP moderately between 1990 and 2020 by 7.6%. Figure 5.35 shows the trend of the VS daily excretion in EU-KP indicating also the range of values used by the countries. Table 5.28 shows the VS daily excretion in source category *3.B.1.3 - Swine* for the years 1990 and 2020 for all countries and EU-KP. VS daily excretion decreased in twenty countries and increased in five countries. It was in 2020 at the level of 1990 in two countries. No data were available for two countries (Iceland and Greece). The largest decreases occurred in Slovakia and the Netherlands with a mean absolute value of 0.2 kg dm/head/day. The three countries with the largest increases were Estonia, Germany and Sweden with a mean absolute value of 0.031 kg dm/head/day.

Figure 5.35: 3.B.1.3 - Swine: Trend in VS daily excretion in the EU-KP and range of values reported by countries

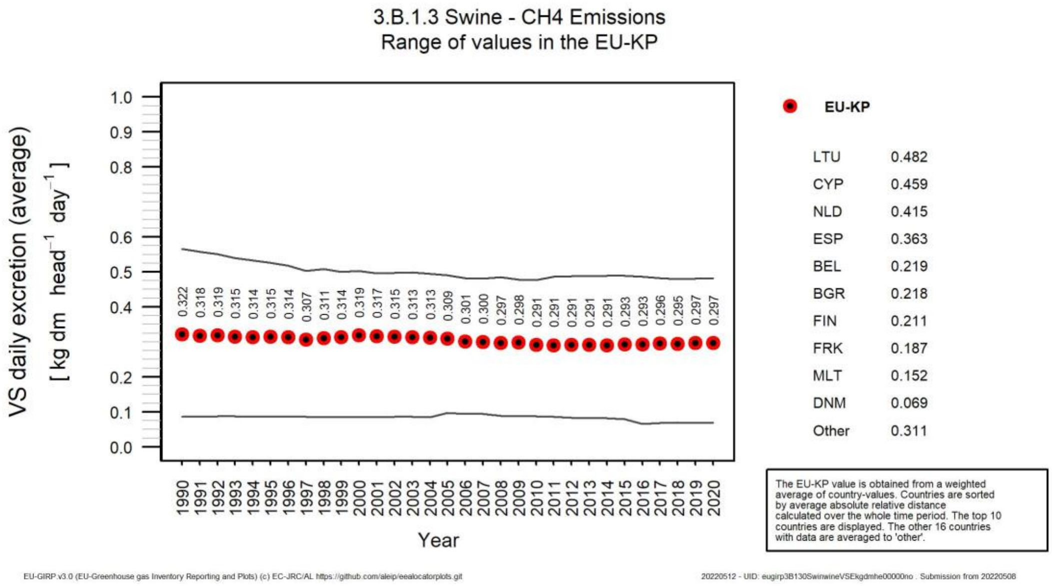


Table 5.28 3.B.1.3 - Swine: countries' VS daily excretion (kg DM/head/day)

Country	1990	2020		Country	1990	2020
Austria	0.326	0.324	|	Ireland	0.361	0.349
Belgium	0.233	0.219	|	Italy	0.370	0.335
Bulgaria	0.252	0.218	|	Lithuania	0.498	0.482
Cyprus	0.446	0.459	|	Luxembourg	0.323	0.309
Czech Republic	0.319	0.314	|	Latvia	0.397	0.348
Germany	0.298	0.332	|	Malta	0.152	0.152
Denmark	0.086	0.069	|	Netherlands	0.566	0.415
Spain	0.440	0.363	|	Poland	0.318	0.314
Estonia	0.291	0.328	|	Portugal	0.282	0.260
Finland	0.218	0.211	|	Romania	0.287	0.278

Country	1990	2020		Country	1990	2020
France	0.172	0.187	|	Slovakia	0.448	0.251
United Kingdom	0.319	0.316	|	Slovenia	0.319	0.311
Croatia	0.324	0.317	|	Sweden	0.276	0.298
Hungary	0.300	0.300	|	EU-KP	0.322	0.297

5.3.3 Manure Management - N_2O (CRF Source Category 3B2)

In 2020 N_2O emissions in source category *3.B.2 - Manure Management* in EU-KP were 22124 kt CO_2 equivalent. This corresponds to 0.54% of total EU-KP GHG emissions and 9% of total EU-KP N_2O emissions. They make 5.2% of total agricultural emissions and 12% of total agricultural N_2O emissions. The main sub-categories are 3.B.2.5 (Indirect Emissions), 3.B.2.1.2 (Non-Dairy Cattle) and 3.B.2.1.1 (Dairy Cattle) as shown in Figure 5.36, but substantial emissions are also reported for Swine, and Poultry.

Regarding the origin of emissions in the different countries, Figure 5.37 shows the distribution of N_2O emissions from manure management by livestock category in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting animal types.

Regarding the handling of manure in the different countries, Figure 5.38 shows the distribution of total manure nitrogen by manure system in all countries and in the EU-KP. Each bar represents the total manure nitrogen handled in the current system for the country, where different shades correspond to the emitting manure systems.

Figure 5.36: Share of source category 3.B.2 on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2020.3.B.2.1-3.B.3.4: emissions by animal types (cattle, sheep, swine, other livestock); 3.B.2.5:Indirect emissions from manure management.

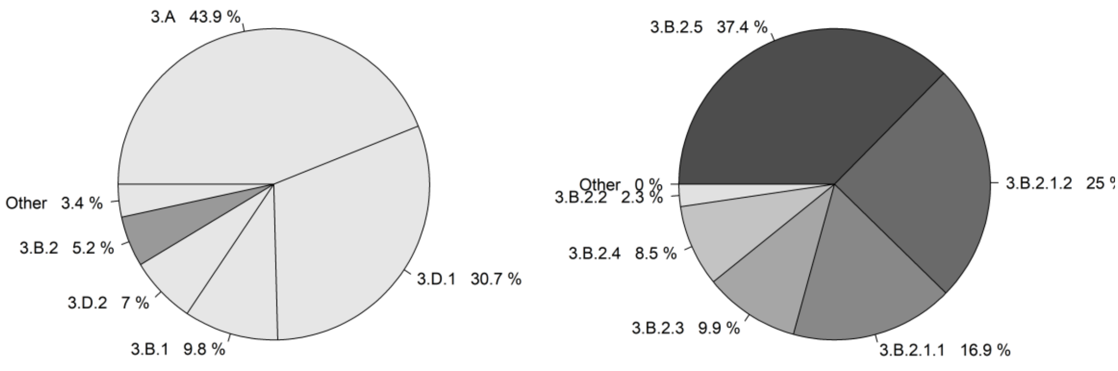


Figure 5.37: Decomposition of emissions in source category 3.B.2 - Manure Management into its sub-categories by country in the year 2020.

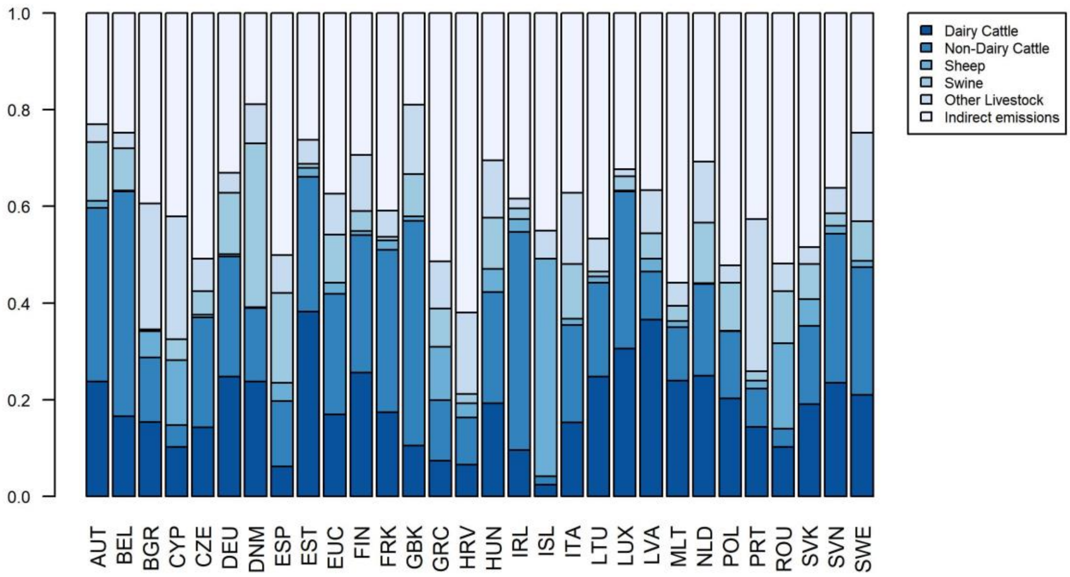
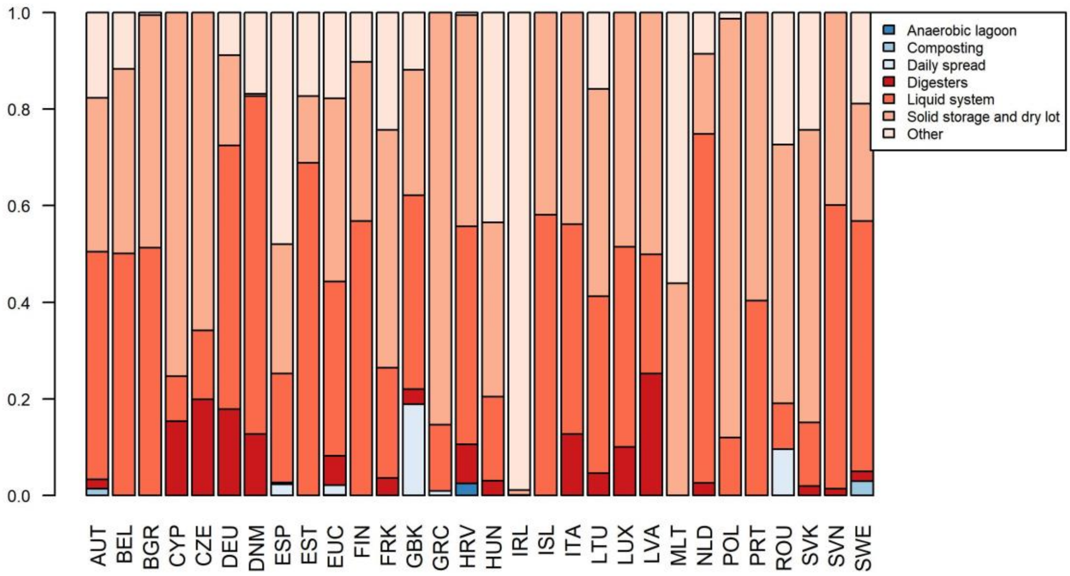


Figure 5.38: Decomposition of manure nitrogen handled in source category 3.B.2 - Manure Management into the different manure management systems by country in the year 2020.



Total GHG and N_2O emissions by country from 3.B.2 *Manure Management* are shown in Table 5.29 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, N_2O emission in this source category decreased by 27% or 8.4 Mt CO_2-eq. The decrease was largest in Latvia in relative terms (74%) and in Poland in absolute terms (1.1 Mt CO_2-eq). From 2019 to 2020 emissions in the current category no changed by 0%.

Table 5.29   3.B.2 - Manure Management: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	572	527	525	2,4%	-47	-8%	-3	0%	T2	CS
Belgium	911	654	647	2,9%	-264	-29%	-6	-1%	T2	D
Bulgaria	889	290	285	1,3%	-604	-68%	-5	-2%	T1,T2	D
Croatia	329	147	142	0,6%	-187	-57%	-5	-4%	T2	CS,D
Cyprus	64	67	70	0,3%	6	9%	3	5%	T1	D
Czechia	1.395	437	435	2,0%	-960	-69%	-2	-1%	T2	CS,D
Denmark	966	682	673	3,0%	-293	-30%	-8	-1%	T2	D
Estonia	110	70	72	0,3%	-38	-34%	2	3%	T1,T2,T3	CS,D
Finland	283	279	270	1,2%	-13	-5%	-9	-3%	T2	D
France	2.819	2.391	2.350	10,6%	-469	-17%	-41	-2%	T2	CS,D
Germany	3.656	2.937	2.908	13,1%	-748	-20%	-29	-1%	T2	CS,D
Greece	340	280	280	1,3%	-60	-18%	0	0%	D	D
Hungary	852	439	435	2,0%	-417	-49%	-4	-1%	T1,T2	CS,D
Ireland	489	597	603	2,7%	114	23%	6	1%	T2	CS,D
Italy	2.833	2.068	2.078	9,4%	-756	-27%	10	0%	T2	CS,D
Latvia	283	77	74	0,3%	-209	-74%	-3	-4%	T1,T2	D
Lithuania	581	182	180	0,8%	-401	-69%	-2	-1%	T1,T2	D
Luxembourg	31	28	28	0,1%	-2	-7%	0	0%	T2	CS
Malta	26	16	16	0,1%	-9	-36%	0	3%	T1,T2	CS,D
Netherlands	938	786	786	3,6%	-152	-16%	0	0%	T1	CS
Poland	4.075	2.799	2.938	13,28%	-1.138	-28%	139	5%	T1,T2	CS,D
Portugal	268	212	221	1,0%	-47	-18%	9	4%	T2	CS,D
Romania	1.982	1.076	1.057	4,8%	-925	-47%	-19	-2%	T2	D
Slovakia	458	163	150	0,7%	-308	-67%	-13	-8%	T1,T2	CS
Slovenia	91	80	80	0,4%	-11	-12%	-1	-1%	T1,T2	CS,D
Spain	1.421	1.637	1.658	7,5%	237	17%	21	1%	T2	D
Sweden	369	330	329	1,5%	-40	-11%	-1	0%	CS,T2	CS,D
United Kingdom	3.434	2.850	2.814	12,7%	-620	-18%	-36	-1%	T2	CS,D
EU-27+UK	**30.466**	**22.103**	**22.106**	**100%**	**-8.360**	**-27%**	**4**	**0%**	**-**	**-**
Iceland	22	18	18	0,1%	-4	-20%	-1	-3%	T1,T2	CS,D
United Kingdom (KP)	3.434	2.850	2.814	12,7%	-620	-18%	-36	-1%	T2	CS,D
EU-KP	**30.488**	**22.121**	**22.124**	**100%**	**-8.364**	**-27%**	**3**	**0%**	**-**	**-**

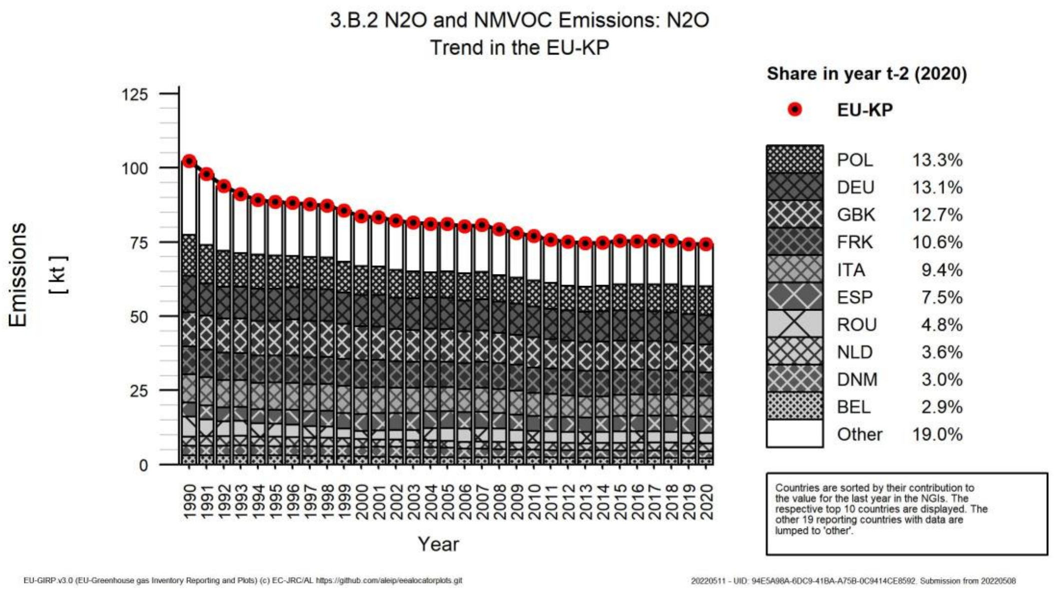
Abbreviations explained in the Chapter 'Units and abbreviations'.

5.3.3.1 Trends in Emissions and Activity Data

3.B.2 - Manure Management - Emissions

Emissions in source category *3.B.2 - Manure Management* decreased strongly in EU-KP by 27% or 8.4 Mt CO_2-eq in the period 1990 to 2020. Figure 5.39 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81% of the total in 2020.Emissions decreased in 26 countries and increased in three countries. The three countries with the largest decreases were Poland, the Czech Republic and Romania with a total absolute decrease of 3 Mt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 351 kt CO_2-eq.

Figure 5.39: 3.B.2 Manure Management: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.B.2.1 - Cattle - Emissions

In 2020 N_2O emissions in source category *3.B.2.1 - Cattle* in EU-KP were 9265.4 kt CO_2 equivalent. This corresponds to 0.23% of total EU-KP GHG emissions and 3.8% of total EU-KP N_2O emissions. They make 2.2% of total agricultural emissions and 5.1% of total agricultural N_2O emissions. Figure 5.40 and Figure 5.41 show the trend of emissions indicating the countries contributing most to the EU-KP total. The figures represent the trend in N_2O emissions from manure management for the different countries along the inventory period.

Total GHG and N_2O emissions by country from 3.B.2.1 *Manure Management* are shown in Table 5.30 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, N_2O emission in this source category decreased by 26% or 3.3 Mt CO_2-eq. The decrease was largest in Croatia in relative terms (77%) and in Germany in absolute terms (497 kt CO_2-eq). From 2019 to 2020 emissions in the current category decreased by 0.5%. The ten countries with the highest emissions accounted together for 83.2% of the total in 2020.Emissions decreased in 22 countries and increased in seven countries. The four countries with the largest decreases were Germany, Italy, Poland and the Czech Republic with a total absolute decrease of 1.7 Mt CO_2-eq. The largest increases occurred in Finland and Ireland, with a total absolute increase of 91 kt CO_2-eq.

Table 5.30 3.B.2.1 - Cattle: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	330	316	313	3,4%	-17	-5%	-3	-1%	T2	CS
Belgium	621	416	409	4,4%	-213	-34%	-8	-2%	T2	D
Bulgaria	213	79	82	0,9%	-131	-62%	2	3%	T2	D
Croatia	99	24	23	0,2%	-76	-77%	-1	-4%	T2	CS,D
Cyprus	7	9	10	0,1%	4	54%	1	13%	T1	D
Czechia	516	163	161	1,7%	-355	-69%	-2	-1%	T2	CS
Denmark	324	267	262	2,8%	-62	-19%	-5	-2%	T2	D
Estonia	60	45	48	0,5%	-12	-20%	2	5%	T2	CS,D
Finland	127	145	146	1,6%	18	15%	1	1%	T2	D
France	1.429	1.226	1.198	12,9%	-230	-16%	-27	-2%	T2	CS,D
Germany	1.939	1.456	1.442	15,6%	-497	-26%	-14	-1%	T2	CS,D
Greece	88	57	56	0,6%	-32	-37%	-1	-2%	D	D
Hungary	279	179	184	2,0%	-95	-34%	5	3%	T2	CS
Ireland	258	328	330	3,6%	72	28%	2	0%	T2	CS,D
Italy	1.201	729	737	8,0%	-464	-39%	8	1%	T2	CS,D
Latvia	121	37	34	0,4%	-86	-71%	-3	-7%	T2	D
Lithuania	206	81	79	0,9%	-126	-61%	-1	-2%	T2	D
Luxembourg	20	18	18	0,2%	-2	-12%	0	0%	T2	CS
Malta	9	6	6	0,1%	-3	-38%	0	2%	T2	CS
Netherlands	342	343	345	3,7%	3	1%	2	1%	T1	CS
Poland	1.412	987	1.002	10,81%	-410	-29%	15	1%	T2	CS
Portugal	78	49	49	0,5%	-29	-37%	0	0%	T2	CS,D
Romania	330	151	148	1,6%	-182	-55%	-3	-2%	T2	D
Slovakia	152	53	53	0,6%	-100	-65%	0	0%	T2	CS
Slovenia	36	43	43	0,5%	7	19%	0	1%	T1,T2	CS,D
Spain	317	332	327	3,5%	11	3%	-4	-1%	T2	D
Sweden	176	157	156	1,7%	-20	-11%	-1	0%	CS,T2	CS,D
United Kingdom	1.891	1.620	1.603	17,3%	-288	-15%	-17	-1%	T2	CS,D
EU-27+UK	**12.581**	**9.315**	**9.265**	**100%**	**-3.316**	**-26%**	**-50**	**-1%**	**-**	**-**
Iceland	1	1	1	0,0%	0	1%	0	-1%	T2	CS,D
United Kingdom (KP)	1.891	1.620	1.603	17,3%	-288	-15%	-17	-1%	T2	CS,D
EU-KP	**12.581**	**9.316**	**9.265**	**100%**	**-3.316**	**-26%**	**-50**	**-1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'

Figure 5.40: 3.B.2.1 - Dairy cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

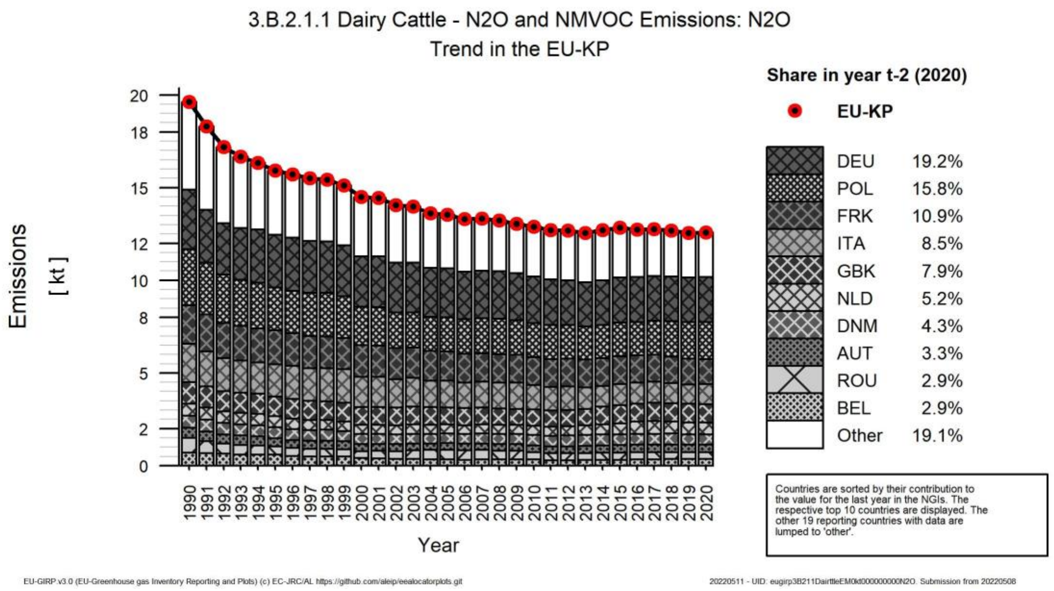
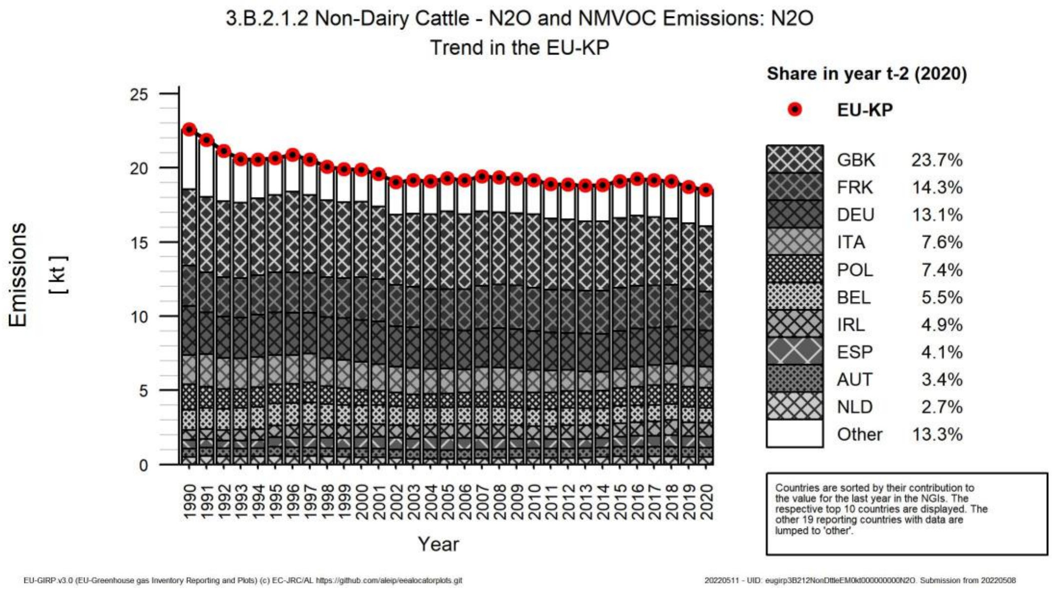


Figure 5.41: 3.B.2.1 - Non-dairy cattle: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.B.2.1 - Cattle - population

One of the main activity data for N_2O emissions from manure management - cattle is the animal numbers. Cattle numbers are already discussed under source category 3.A Enteric Fermentation and therefore not further discussed here.

Other activity data is:

- N-allocation by MMS.

3.B.2.3 - Swine - Emissions

In 2020 N_2O emissions in source category *3.B.2.3 - Swine* in EU-KP were 2198.1 kt CO_2 equivalent. This corresponds to 0.054% of total EU-KP GHG emissions and 0.89% of total EU-KP N_2O emissions. They make 0.52% of total agricultural emissions and 1.2% of total agricultural N_2O emissions. Figure 5.43 shows the trend of emissions indicating the countries contributing most to the EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period.

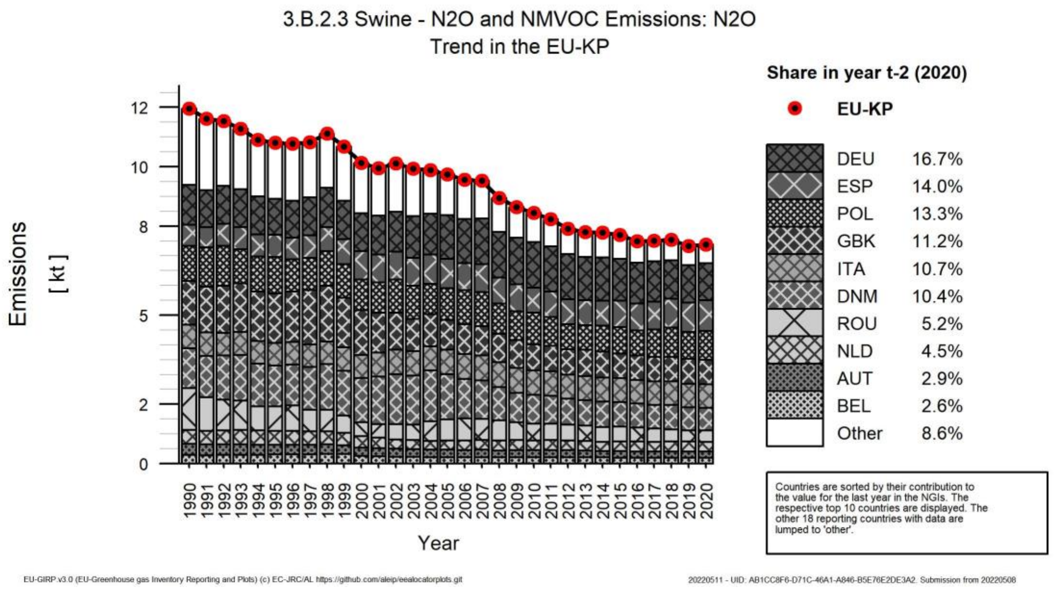
Total GHG and N_2O emissions by country from 3.B.2.3 *Manure Management* are shown in Table 5.31 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, N_2O emission in this source category decreased by 38% or 1.4 Mt CO_2-eq. The decrease was largest in Lithuania in relative terms (98%) and in Romania in absolute terms (308 kt CO_2-eq). From 2019 to 2020 emissions in the current category increased by 0.7%. The ten countries with the highest emissions accounted together for 91.4% of the total in 2020.Emissions decreased in 25 countries and increased in three countries. The four countries with the largest decreases were Romania, the United Kingdom, Denmark and the Czech Republic with a total absolute decrease of 823 kt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 96 kt CO_2-eq.

Table 5.31 3.B.2.3 - Swine: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	111	64	64	2.9%	-47	-42%	0	1%	T2	CS
Belgium	85	56	57	2.6%	-28	-33%	1	2%	T2	D
Bulgaria	10	1	1	0.1%	-9	-88%	0	-5%	T2	D
Croatia	24	3	3	0.1%	-21	-89%	-1	-19%	T2	CS,D
Cyprus	8	3	3	0.1%	-5	-60%	0	3%	T1	D
Czechia	174	22	21	1.0%	-153	-88%	-1	-4%	T2	CS
Denmark	399	230	228	10.4%	-171	-43%	-2	-1%	T2	D
Estonia	2	1	1	0.0%	-2	-74%	0	19%	T3	CS,D
Finland	26	11	11	0.5%	-15	-57%	0	3%	T2	D
France	46	16	16	0.7%	-30	-65%	0	-2%	T2	CS,D
Germany	401	373	368	16.7%	-33	-8%	-5	-1%	T2	CS,D
Greece	31	22	22	1.0%	-9	-30%	0	-1%	D	D
Hungary	158	46	46	2.1%	-112	-71%	0	-1%	T2	CS
Ireland	10	13	13	0.6%	3	29%	0	4%	T2	CS,D
Italy	236	234	234	10.7%	-2	-1%	0	0%	T2	CS,D
Latvia	40	4	4	0.2%	-36	-90%	0	-11%	T2	D
Lithuania	110	2	2	0.1%	-108	-98%	0	-4%	T1	D
Luxembourg	1	1	1	0.0%	0	18%	0	2%	T2	CS
Malta	1	0	1	0.0%	-1	-60%	0	11%	T1	D
Netherlands	140	100	98	4.5%	-42	-30%	-2	-2%	T1	CS
Poland	353	275	292	13.3%	-61	-17%	18	6%	T2	CS
Portugal	11	4	4	0.2%	-7	-61%	0	1%	T2	CS,D
Romania	422	115	114	5.2%	-308	-73%	-1	-1%	T2	D
Slovakia	64	13	11	0.5%	-53	-83%	-2	-15%	T2	CS
Slovenia	7	2	2	0.1%	-5	-71%	0	-5%	T1	D
Spain	213	294	309	14.0%	96	45%	15	5%	T2	D
Sweden	42	27	27	1.2%	-15	-36%	0	1%	CS,NA,T2	CS,D,NA
United Kingdom	436	250	246	11.2%	-190	-44%	-4	-2%	T2	CS,D
EU-27+UK	**3 562**	**2 182**	**2 198**	**100%**	**-1 364**	**-38%**	**16**	**1%**	**-**	**-**
Iceland	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom (KP)	436	250	246	11.2%	-190	-44%	-4	-2%	T2	CS,D
EU-KP	**3 562**	**2 182**	**2 198**	**100%**	**-1 364**	**-38%**	**16**	**1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'

Figure 5.42: 3.B.2.3 - Swine: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.B.2.4 - Other Livestock - Emissions

In 2020 N_2O emissions in source category *3.B.2.4 - Other Livestock* in EU-KP were 1879.6 kt CO_2 equivalent. This corresponds to 0.046% of total EU-KP GHG emissions and 0.76% of total EU-KP N_2O emissions. They make 0.44% of total agricultural emissions and 1% of total agricultural N_2O emissions. N_2O emissions from Manure Management for 'Other Livestock' are reported for the categories Buffalo, Deer, Goats, Horses, Mules and Asses, Poultry, and Other Livestock (Fur-bearing animals, Ostrich, Rabbit, Reindeer and Other).

Total GHG and N_2O emissions by country from 3.B.2.4 *Manure Management* are shown in Table 5.32 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, N_2O emission in this source category decreased by 9% or 177 kt CO_2-eq. The decrease was largest in Estonia in relative terms (72%) and in Bulgaria in absolute terms (110 kt CO_2-eq). From 2019 to 2020 emissions in the current category increased by 0.1%. Figure 5.44 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 79.6% of the total in 2020.Emissions decreased in twelve countries and increased in seventeen countries. The four countries with the largest decreases were Bulgaria, Poland, the Czech Republic and Hungary with a total absolute decrease of 305 kt CO_2-eq. The three countries with the largest increases were Germany, the Netherlands and Spain, with a total absolute increase of 101 kt CO_2-eq.

Table 5.32 3.B.2.4 - Other Livestock: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	9	19	19	1,0%	10	105%	0	1%	T2	CS
Belgium	10	19	20	1,1%	10	101%	1	6%	T2	D
Bulgaria	184	80	74	3,9%	-110	-60%	-5	-7%	T1,T2	D
Croatia	33	24	24	1,3%	-9	-27%	0	1%	T2	CS,D
Cyprus	17	17	18	0,9%	1	3%	1	3%	T1	D
Czechia	100	28	29	1,6%	-70	-71%	2	5%	T2	CS,D
Denmark	45	56	54	2,9%	9	20%	-1	-2%	T2	D
Estonia	13	4	4	0,2%	-9	-72%	0	1%	T1	D
Finland	29	36	31	1,7%	2	9%	-5	-14%	T2	D
France	123	126	128	6,8%	5	4%	2	1%	T2	CS,D
Germany	98	121	120	6,4%	22	22%	-1	-1%	T2	CS,D
Greece	30	27	27	1,5%	-2	-7%	1	2%	D	D
Hungary	103	54	52	2,8%	-51	-50%	-2	-5%	T1,T2	CS,D
Ireland	11	12	12	0,7%	1	10%	0	3%	T2	CS,D
Italy	292	306	306	16,3%	14	5%	1	0%	T2	CS,D
Latvia	20	6	7	0,4%	-13	-67%	1	10%	T1,T2	D
Lithuania	16	12	12	0,6%	-4	-25%	0	1%	T1	D
Luxembourg	0	0	0	0,0%	0	147%	0	0%	T2	CS
Malta	1	1	1	0,0%	0	7%	0	0%	T1	CS,D
Netherlands	61	100	99	5,3%	39	64%	-1	-1%	T1	CS
Poland	178	92	105	5,60%	-73	-41%	13	14%	T1,T2	CS,D
Portugal	60	64	70	3,7%	10	16%	6	9%	T2	CS,D
Romania	80	62	61	3,2%	-19	-24%	-1	-2%	T2	D
Slovakia	9	7	5	0,3%	-4	-41%	-2	-28%	T1	CS
Slovenia	4	4	4	0,2%	0	6%	0	-3%	T1	D
Spain	89	128	129	6,9%	40	45%	2	1%	T2	D
Sweden	46	60	60	3,2%	15	32%	0	0%	T2	D
United Kingdom	394	411	403	21,5%	9	2%	-8	-2%	T2	CS,D
EU-27+UK	**2.055**	**1.877**	**1.879**	**100%**	**-177**	**-9%**	**2**	**0%**	**-**	**-**
Iceland	1	1	1	0,1%	0	-13%	0	-1%	T1	D
United Kingdom (KP)	394	411	403	21,5%	9	2%	-8	-2%	T2	CS,D
EU-KP	**2.057**	**1.878**	**1.880**	**100%**	**-177**	**-9%**	**2**	**0%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'

3.B.2.4.7 - Poultry - Emissions

Largest contribution to other livestock emissions comes from sub-category poultry with 54% of total N_2O emissions. Other animal types with high emissions are horses with a share of 24% and Goats with a share of 10%. Here only the most important animal type Poultry is discussed.

Emissions in source category *3.B.2.4.7 - Poultry* decreased considerably in EU-KP by 18% or 227 kt CO_2-eq in the period 1990 to 2020. Figure 5.45 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 84.5% of the total in 2020.Emissions decreased in eighteen countries and increased in eleven countries. The three countries with the largest decreases were Bulgaria, the Czech Republic and the United Kingdom with a total absolute decrease of 227 kt CO_2-eq. The three countries with the largest increases were Sweden, Portugal and Germany, with a total absolute increase of 61 kt CO_2-eq.

3.A.4.7 - Poultry - Population

As population data for poultry have not yet been discussed, this will be done here. Poultry population increased moderately in EU-KP by 6.2% or 100 million heads in the period 1990 to 2020. Figure 5.46 shows the trend of poultry population indicating the countries contributing most to EU-KP total. The figure represents the trend in poultry population for the different countries along the inventory period. The ten countries with the highest population accounted together for 84.3% of the total in 2020.Population decreased in twelve countries and increased in sixteen countries. The three countries with the largest decreases were Romania, Hungary and Bulgaria with a total absolute decrease of 107 million heads. The three countries with the largest increases were France, the United Kingdom and Germany, with a total absolute increase of 132 million heads.

Other activity data related to this emission category are:

- Nitrogen managed on each manure management system

Figure 5.44: 3.B.2.4 - Other Livestock: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

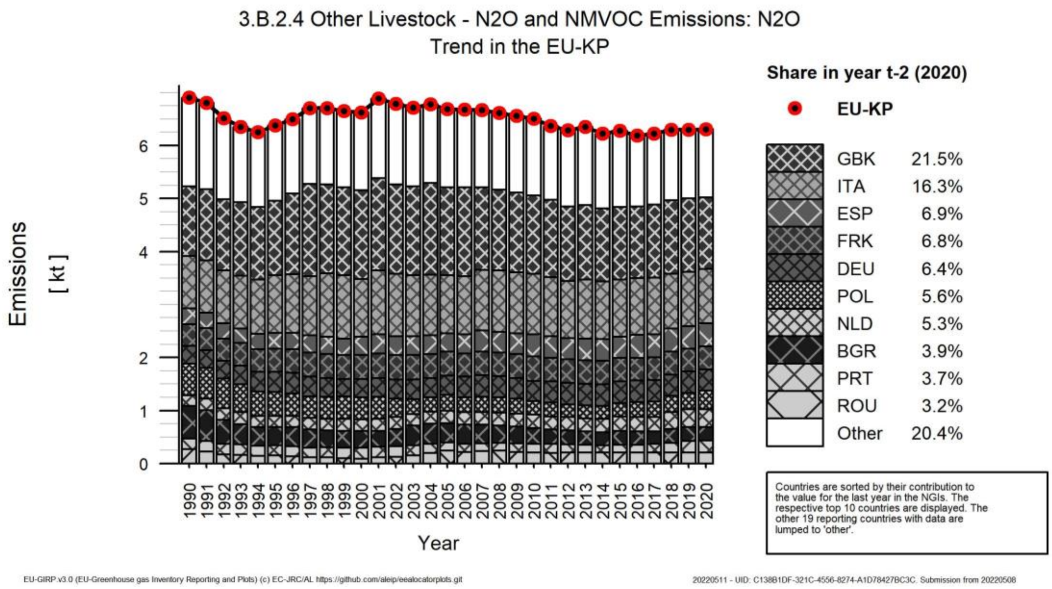


Figure 5.45: 3.B.2.4.7 - Poultry: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

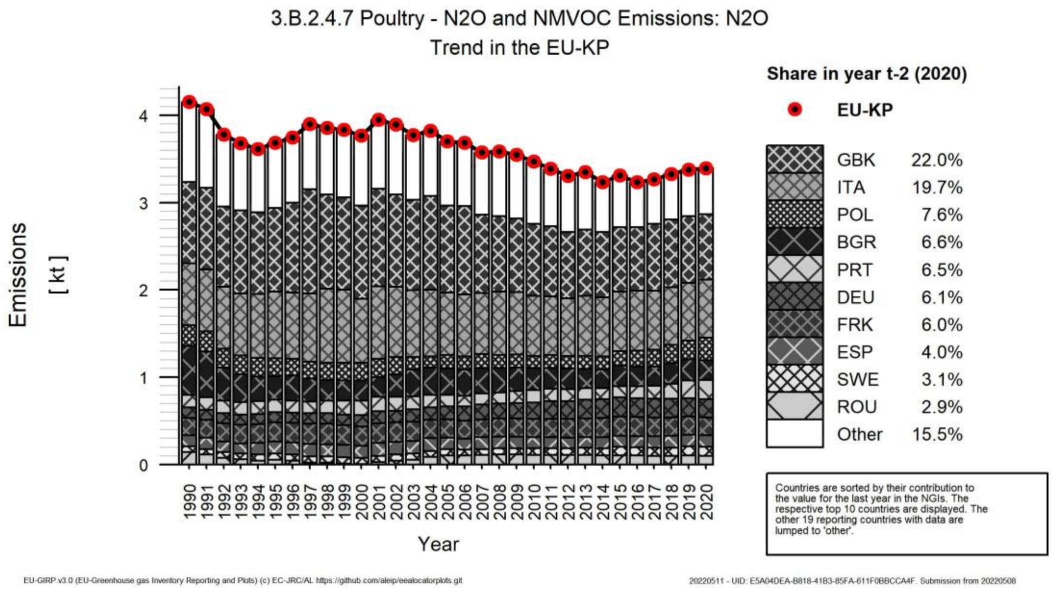
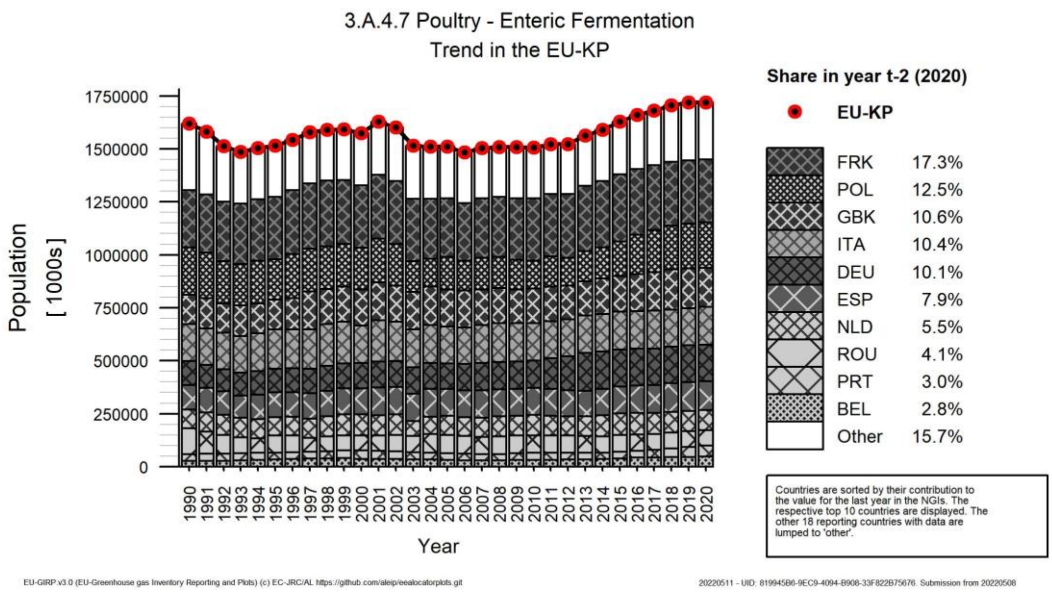


Figure 5.46: 3.A.4.7 - Poultry: Trend in poultry population in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



5.3.3.2 Implied EFs and Methodological Issues

In this section, we discuss the implied emission factor for the main animal types. Furthermore, we present data on the nitrogen excretion rate for the different animal types.

3.B.2.1 - Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1 - Cattle* increased in EU-KP slightly between 1990 and 2020 by 3.1% or 0.011 kg/head/year. Table 5.33 shows the implied emission factor for N_2O emissions in source category *3.B.2.1 - Cattle* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in eight countries and increased in 21 countries. The largest decreases occurred in Croatia and Portugal with a mean absolute value of 0.2 kg/head/year. The four countries with the largest increases were Estonia, Finland, Austria and Lithuania with a mean absolute value of 0.2 kg/head/year.

Table 5.33 3.B.2.1 - Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2020		Country	1990	2020
Austria	0.429	0.566	|	Ireland	0.127	0.153
Belgium	0.642	0.584	|	Iceland	0.033	0.035
Bulgaria	0.448	0.509	|	Italy	0.520	0.413
Cyprus	0.409	0.416	|	Lithuania	0.290	0.413
Czech Republic	0.494	0.385	|	Luxembourg	0.314	0.314
Germany	0.334	0.428	|	Latvia	0.281	0.290
Denmark	0.485	0.586	|	Malta	1.478	1.351
Spain	0.207	0.165	|	Netherlands	0.233	0.311
Estonia	0.265	0.634	|	Poland	0.471	0.530
Finland	0.315	0.579	|	Portugal	0.191	0.099
France	0.222	0.226	|	Romania	0.208	0.268
United Kingdom	0.523	0.570	|	Slovakia	0.327	0.401
Greece	0.424	0.360	|	Slovenia	0.229	0.300
Croatia	0.405	0.184	|	Sweden	0.343	0.360
Hungary	0.578	0.665	|	EU-KP	0.349	0.360

3.B.2.1.1 - Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1.1 - Dairy Cattle* increased in EU-KP clearly between 1990 and 2020 by 11.9% or 0.059 kg/head/year. Figure 5.47 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.34 shows the implied emission factor for N_2O emissions in source category *3.B.2.1.1 - Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in eight countries and increased in 21 countries. The largest decrease occurred in Croatia with an absolute value of 0.3 kg/head/year. The four countries with the largest increases were Estonia, Finland, Slovenia and Hungary with a mean absolute value of 0.4 kg/head/year.

Figure 5.47: 3.B.2.1.1 - Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

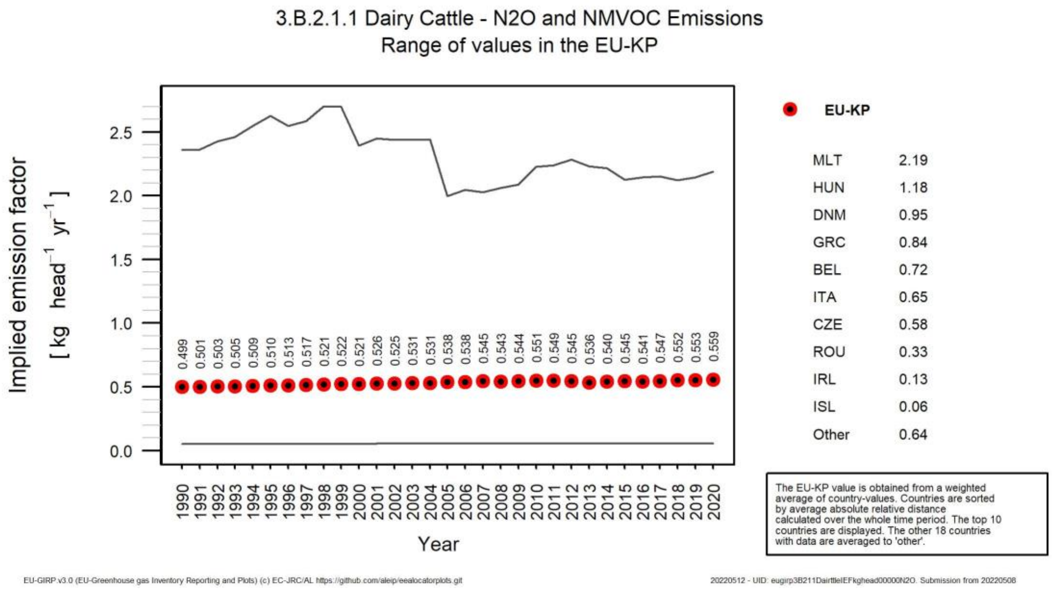


Table 5.34 3.B.2.1.1 - Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2020		Country	1990	2020
Austria	0.601	0.798	|	Ireland	0.140	0.128
Belgium	0.845	0.720	|	Iceland	0.051	0.056
Bulgaria	0.617	0.663	|	Italy	0.783	0.650
Cyprus	0.606	0.606	|	Lithuania	0.375	0.631
Czech Republic	0.724	0.579	|	Luxembourg	0.559	0.588
Germany	0.505	0.617	|	Latvia	0.596	0.669
Denmark	0.869	0.948	|	Malta	2.359	2.188
Spain	0.314	0.421	|	Netherlands	0.340	0.413
Estonia	0.483	1.103	|	Poland	0.613	0.807
Finland	0.477	0.895	|	Portugal	0.472	0.457
France	0.393	0.402	|	Romania	0.261	0.326
United Kingdom	0.412	0.535	|	Slovakia	0.520	0.786
Greece	0.849	0.838	|	Slovenia	0.309	0.633
Croatia	0.538	0.283	|	Sweden	0.609	0.764
Hungary	0.876	1.179	|	EU-KP	0.499	0.559

3.B.2.1.1 - Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.1.1 - Dairy Cattle*, increased in EU-KP considerably between 1990 and 2020 by 20.4% or 20 kg/head/year. Figure 5.48 shows the trend of the nitrogen excretion rate in EU-KP indicating also the range of values used by the countries. Table 5.35 shows the nitrogen excretion rate in source category *3.B.2.1.1 - Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. Nitrogen excretion rate decreased in two countries and increased in 24 countries. It was in 2020 at the level of 1990 in three countries. Decreases occurred in Malta and Greece with a mean absolute value of 6 kg/head/year. The four countries with the largest increases were Estonia, Finland, Hungary and Slovakia with a mean absolute value of 52 kg/head/year.

Figure 5.48: 3.B.2.1.1 - Dairy Cattle: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries

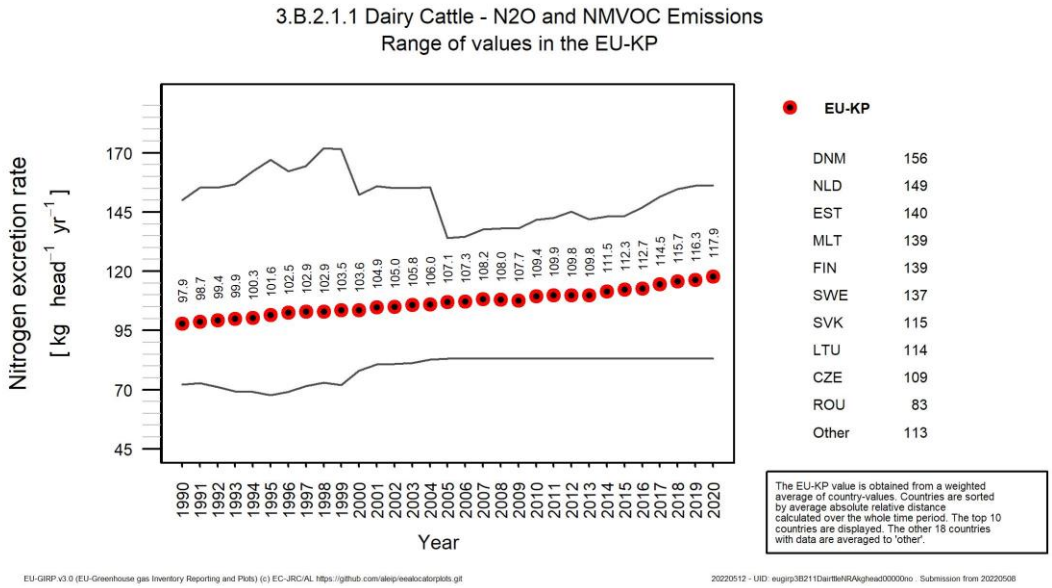


Table 5.35 3.B.2.1.1 - Dairy Cattle: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2020	Country	1990	2020
Austria	91	107	Ireland	98	109
Belgium	114	122	Iceland	87	98
Bulgaria	98	98	Italy	105	109
Cyprus	96	96	Lithuania	80	114
Czech Republic	99	109	Luxembourg	110	122
Germany	92	122	Latvia	86	118
Denmark	129	156	Malta	150	139
Spain	85	113	Netherlands	148	149
Estonia	74	140	Poland	102	115
Finland	90	139	Portugal	86	119
France	102	117	Romania	83	83
United Kingdom	85	114	Slovakia	72	115
Greece	117	116	Slovenia	82	119
Croatia	96	109	Sweden	102	137
Hungary	83	132	EU-KP	98	118

3.B.2.1.2 - Non-Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.1.2 - Non-Dairy Cattle* increased in EU-KP slightly between 1990 and 2020 by 4.7% or 0.013 kg/head/year. Figure 5.49 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.36 shows the implied emission factor for N_2O emissions in source category *3.B.2.1.2 - Non-Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in eleven countries and increased in eighteen countries. The largest decreases occurred in Croatia and Portugal with a mean absolute value of 0.1 kg/head/year. The four countries with the largest increases were Estonia, Finland, Austria and Germany with a mean absolute value of 0.2 kg/head/year.

Figure 5.49: 3.B.2.1.2 - Non-Dairy Cattle: Trend in implied emission factor in the EU-KP and range of values reported by countries

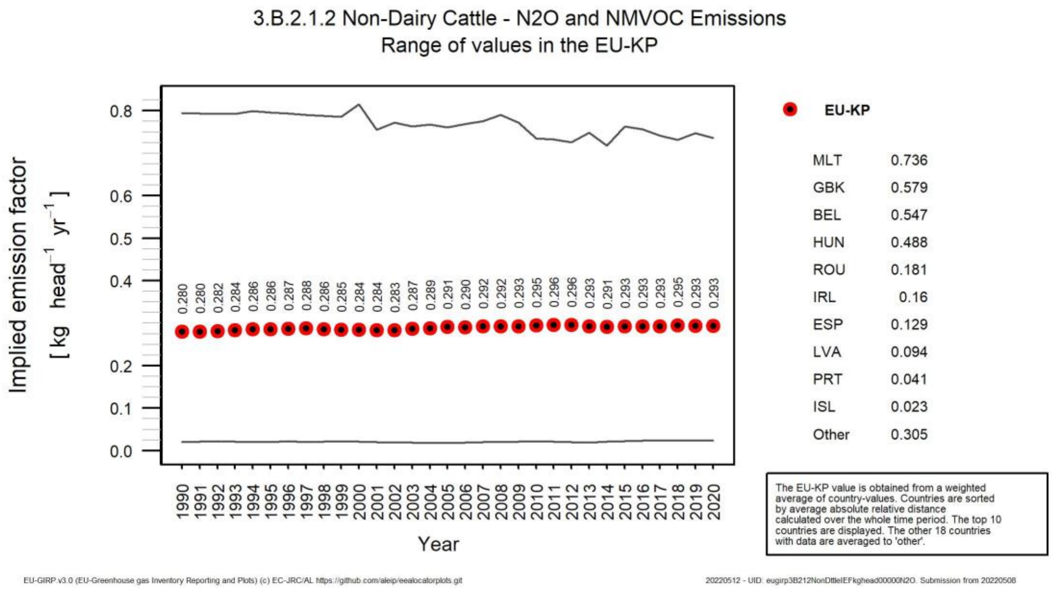


Table 5.36 3.B.2.1.2 - Non-Dairy Cattle: countries' implied emission factor (kg/head/year)

Country	1990	2020	Country	1990	2020
Austria	0.336	0.475	Ireland	0.123	0.160
Belgium	0.571	0.547	Iceland	0.020	0.023
Bulgaria	0.340	0.402	Italy	0.384	0.323
Cyprus	0.272	0.243	Lithuania	0.242	0.287
Czech Republic	0.373	0.317	Luxembourg	0.223	0.219
Germany	0.251	0.328	Latvia	0.095	0.094
Denmark	0.290	0.366	Malta	0.795	0.736
Spain	0.160	0.129	Netherlands	0.167	0.235
Estonia	0.136	0.401	Poland	0.336	0.353
Finland	0.223	0.439	Portugal	0.078	0.041
France	0.167	0.184	Romania	0.140	0.181
United Kingdom	0.558	0.579	Slovakia	0.261	0.255
Greece	0.241	0.269	Slovenia	0.171	0.219
Croatia	0.234	0.149	Sweden	0.209	0.254
Hungary	0.419	0.488	EU-KP	0.280	0.293

3.B.2.1.2 - Non-Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.1.2 - Non-Dairy Cattle*, increased in EU-KP moderately between 1990 and 2020 by 7.7% or 3.7 kg/head/year. Figure 5.50 shows the trend of the nitrogen excretion rate in EU-KP indicating also the range of values used by the countries. Table 5.37 shows the nitrogen excretion rate in source category *3.B.2.1.2 - Non-Dairy Cattle* for the years 1990 and 2020 for all countries and EU-KP. Nitrogen excretion rate decreased in five countries and increased in 23 countries. It was in 2020 at the level of 1990 in one country. The largest decrease occurred in the Netherlands with an absolute value of 18 kg/head/year.

The four countries with the largest increases were Finland, Estonia, Portugal and Latvia with a mean absolute value of 14 kg/head/year.

Figure 5.50: 3.B.2.1.2 - Non-Dairy Cattle: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries

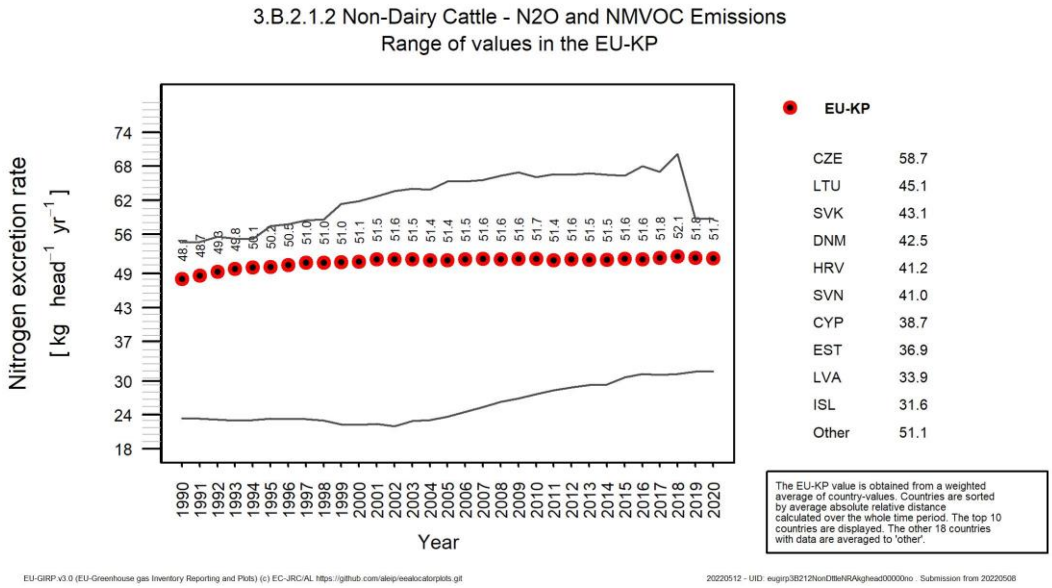


Table 5.37 3.B.2.1.2 - Non-Dairy Cattle: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2020	Country	1990	2020
Austria	44	52	Ireland	52	55
Belgium	54	53	Iceland	29	32
Bulgaria	54	59	Italy	50	52
Cyprus	43	39	Lithuania	41	45
Czech Republic	55	59	Luxembourg	57	59
Germany	38	44	Latvia	23	34
Denmark	36	42	Malta	51	47
Spain	57	57	Netherlands	57	39
Estonia	25	37	Poland	54	51
Finland	34	56	Portugal	44	56
France	58	60	Romania	43	44
United Kingdom	40	44	Slovakia	39	43
Greece	48	53	Slovenia	41	41
Croatia	40	41	Sweden	39	42
Hungary	44	53	EU-KP	48	52

3.B.2.3 - Swine - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.3 - Swine* decreased in EU-KP strongly between 1990 and 2020 by 26.7%. Figure 5.51 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.38 shows the implied emission factor for N_2O emissions in source category *3.B.2.3 - Swine* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in 23 countries and increased in four countries. It was in 2020 at the level of 1990 in one country. No data were available for Iceland. The largest increase occurred in Poland with an absolute value of 0.025 kg/head/year.

Figure 5.51: 3.B.2.3 - Swine: Trend in implied emission factor in the EU-KP and range of values reported by countries

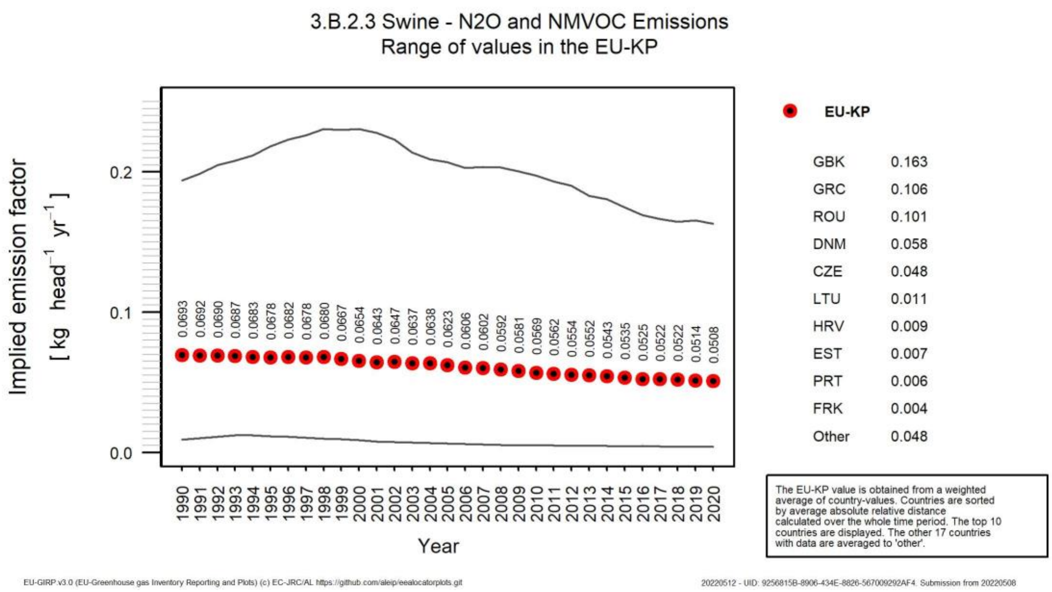


Table 5.38 3.B.2.3 - Swine: countries' implied emission factor (kg/head/year)

Country	1990	2020	Country	1990	2020
Austria	0.1073	0.0860	Ireland	0.0277	0.0264
Belgium	0.0425	0.0304	Italy	0.0944	0.0920
Bulgaria	0.0079	0.0076	Lithuania	0.1437	0.0112
Cyprus	0.0935	0.0287	Luxembourg	0.0393	0.0374
Czech Republic	0.1221	0.0477	Latvia	0.0964	0.0426
Germany	0.0507	0.0571	Malta	0.0434	0.0434
Denmark	0.1410	0.0581	Netherlands	0.0338	0.0277
Spain	0.0437	0.0323	Poland	0.0608	0.0857
Estonia	0.0092	0.0066	Portugal	0.0145	0.0064
Finland	0.0653	0.0341	Romania	0.1180	0.1008
France	0.0124	0.0041	Slovakia	0.0847	0.0678
United Kingdom	0.1940	0.1630	Slovenia	0.0407	0.0305
Greece	0.1061	0.1061	Sweden	0.0607	0.0632
Croatia	0.0503	0.0088	EU-KP	0.0693	0.0508
Hungary	0.0609	0.0543			

3.B.2.3 - Swine - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.3 - Swine*, decreased in EU-KP clearly between 1990 and 2020 by 14.4%. Figure 5.52 shows the trend of the nitrogen excretion rate in EU-KP indicating also the range of values used by the countries. Table

5.39 shows the nitrogen excretion rate in source category *3.B.2.3 - Swine* for the years 1990 and 2020 for all countries and EU-KP. Nitrogen excretion rate decreased in 22 countries and increased in six countries. It was in 2020 at the level of 1990 in one country. The four countries with the largest decreases were Denmark, the Czech Republic, the United Kingdom and Belgium with a mean absolute value of 4 kg/head/year. The three countries with the largest increases were Sweden, Poland and Estonia with a mean absolute value of 1 kg/head/year.

Sweden explains the large increase by an update of nitrogen production data for sows and pigs in 2002, due to more intense swine production. The time trend also shows steps because surveys are only done biannually and small percentage differences in the survey have a significant effect on emissions, as emission factors are differing considerably between the different systems.

Figure 5.52: 3.B.2.3 - Swine: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries

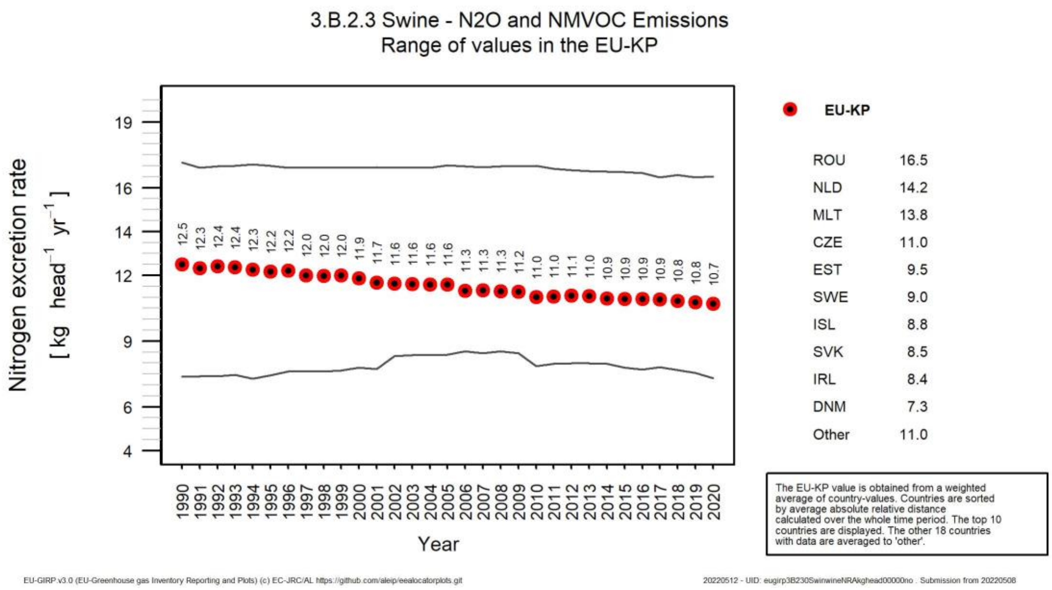


Table 5.39 3.B.2.3 - Swine: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2020		Country	1990	2020
Austria	12.2	10.9	|	Ireland	8.8	8.4
Belgium	12.5	8.9	|	Iceland	9.2	8.8
Bulgaria	12.5	11.8	|	Italy	12.0	12.2
Cyprus	11.9	11.2	|	Lithuania	12.4	11.9
Czech Republic	15.4	11.0	|	Luxembourg	10.6	10.1
Germany	13.0	13.0	|	Latvia	12.3	10.8
Denmark	11.9	7.3	|	Malta	13.8	13.8
Spain	11.9	9.4	|	Netherlands	17.2	14.2
Estonia	8.9	9.5	|	Poland	10.0	10.9
Finland	12.2	11.9	|	Portugal	10.3	9.0
France	10.7	9.5	|	Romania	16.9	16.5
United Kingdom	13.3	9.3	|	Slovakia	10.4	8.5
Greece	13.5	13.5	|	Slovenia	12.7	12.1
Croatia	12.4	11.6	|	Sweden	7.4	9.0
Hungary	9.5	9.3	|	EU-KP	12.5	10.7

3.B.2.4.7 - Poultry - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.2.4.7 - Poultry* decreased slightly between 1990 and 2020 by 18.8% . Table 5.40 shows the implied emission factor for N_2O emissions in source category *3.B.2.4.7 - Poultry* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in twenty countries and increased in seven countries. It was in 2020 at the level of 1990 in one country. No data were available for Malta.

Figure 5.53: 3.B.2.4.7 - Poultry: Trend in implied emission factor in the EU-KP and range of values reported by countries

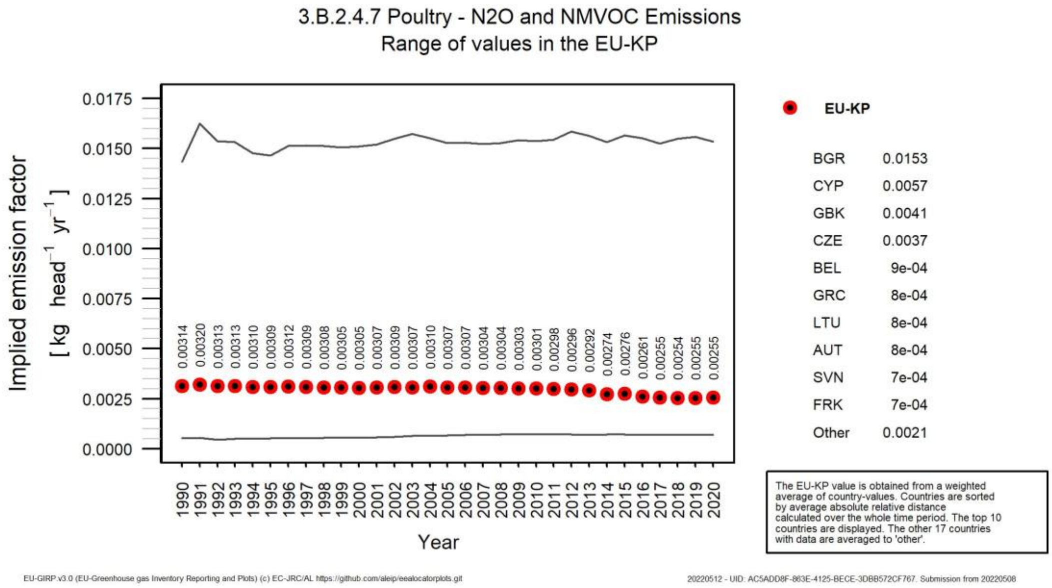


Table 5.40 3.B.2.4.7 - Poultry: countries' implied emission factor (kg/head/year)

Country	1990	2020		Country	1990	2020
Austria	0.00090	0.00080	|	Hungary	0.00232	0.00207
Belgium	0.00094	0.00089	|	Ireland	0.00109	0.00103
Bulgaria	0.01433	0.01534	|	Iceland	0.00198	0.00103
Cyprus	0.00714	0.00573	|	Italy	0.00409	0.00373
Czech Republic	0.01044	0.00373	|	Lithuania	0.00053	0.00082
Germany	0.00108	0.00120	|	Luxembourg	0.00113	0.00115
Denmark	0.00112	0.00074	|	Latvia	0.00342	0.00216
Spain	0.00112	0.00099	|	Netherlands	0.00110	0.00090
Estonia	0.00383	0.00346	|	Poland	0.00107	0.00120
Finland	0.00288	0.00166	|	Portugal	0.00435	0.00418
France	0.00074	0.00069	|	Romania	0.00119	0.00136
United Kingdom	0.00671	0.00408	|	Slovakia	0.00155	0.00143
Greece	0.00085	0.00085	|	Slovenia	0.00068	0.00075
Croatia	0.00448	0.00368	|	Sweden	0.00473	0.00442

3.B.2.4.7 - Poultry - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.2.4.7 - Poultry*, decreased in EU-KP slightly between 1990 and 2020 by 9%. Table 5.41 shows the nitrogen excretion rate in source category *3.B.2.4.7 - Poultry* for the years 1990 and 2020 for all countries and EU-KP. Nitrogen excretion rate decreased in nineteen countries and increased in seven countries. It was in 2020 at the level of 1990 in three countries. The four countries with the largest decreases were Iceland, the United Kingdom, the Czech Republic and Croatia with a mean absolute value of 0.3 kg/head/year. The largest increase occurred in Lithuania with an absolute value of 0.1 kg/head/year.

Figure 5.54: 3.B.2.4.7 - Poultry: Trend in nitrogen excretion rate in the EU-KP and range of values reported by countries

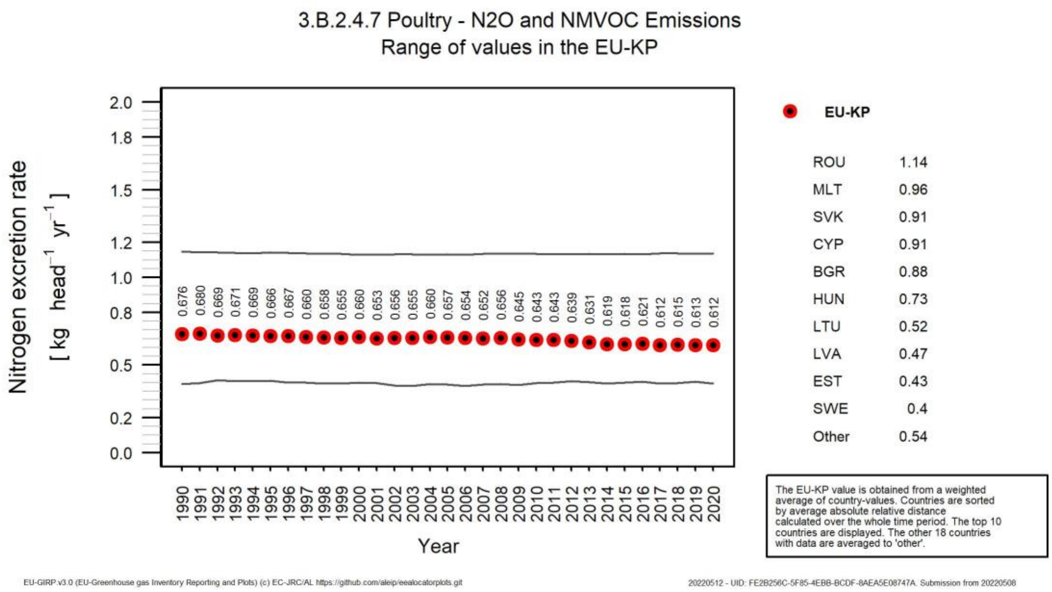


Table 5.41 3.B.2.4.7 - Poultry: countries' nitrogen excretion rate (kg/head/year)

Country	1990	2020	Country	1990	2020
Austria	0.59	0.53	Ireland	0.60	0.55
Belgium	0.60	0.57	Iceland	1.13	0.59
Bulgaria	0.86	0.88	Italy	0.52	0.49
Cyprus	0.91	0.91	Lithuania	0.39	0.52
Czech Republic	0.73	0.50	Luxembourg	0.72	0.73
Germany	0.68	0.66	Latvia	0.45	0.47
Denmark	0.63	0.48	Malta	0.96	0.96
Spain	0.71	0.63	Netherlands	0.68	0.57
Estonia	0.44	0.43	Poland	0.68	0.73
Finland	0.50	0.55	Portugal	0.55	0.54
France	0.49	0.47	Romania	1.15	1.14
United Kingdom	0.78	0.48	Slovakia	0.99	0.91
Greece	0.50	0.50	Slovenia	0.46	0.49
Croatia	0.67	0.49	Sweden	0.43	0.40
Hungary	0.83	0.73			

3.B.2.5 - Manure Management - Indirect Emissions - Emissions

In 2020 N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect Emissions* - *Indirect N_2O emissions* in EU-KP were 8267.9 kt CO_2 equivalent. This corresponds to 0.2% of total EU-KP GHG emissions and 3.4% of total EU-KP N_2O emissions. They make 2% of total agricultural emissions and 4.6% of total agricultural N_2O emissions.

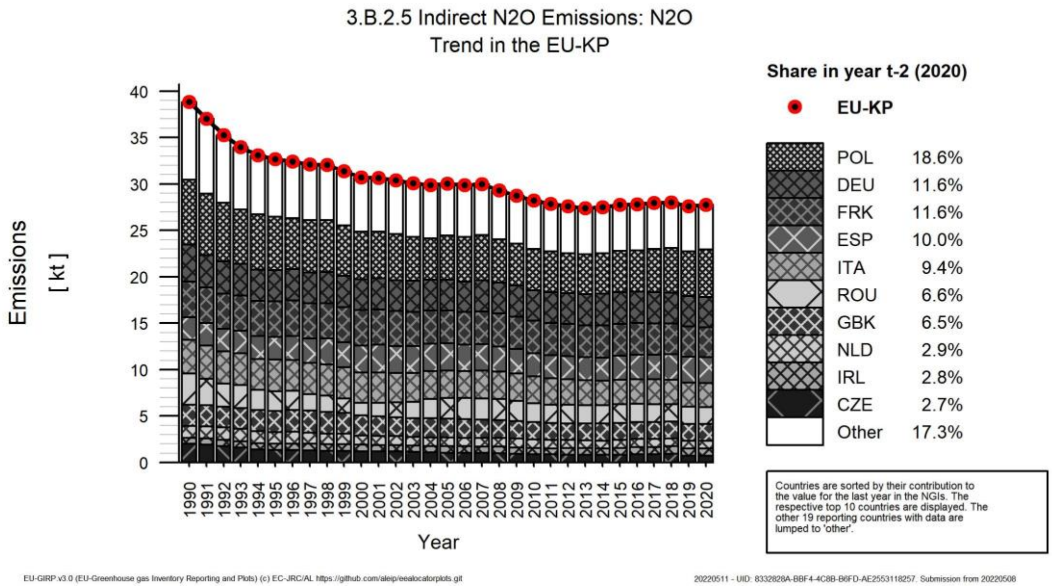
Total GHG and N_2O emissions by country from 3.B.2.5 *Manure Management - Indirect Emissions* are shown in Table 5.42 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, N_2O emission in this source category decreased by 29% or 3.3 Mt CO_2-eq. The decrease was largest in Latvia in relative terms (72%) and in Poland in absolute terms (543 kt CO_2-eq). From 2019 to 2020 emissions in the current category increased by 0.5%. Figure 5.55 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from manure management - indirect emissions for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 82.7% of the total in 2020.Emissions decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Poland, Romania and the Czech Republic with a total absolute decrease of 1.4 Mt CO_2-eq. The largest increases occurred in Ireland and Spain, with a total absolute increase of 144 kt CO_2-eq.

Table 5.42 3.B.2.5 - Manure Management - Indirect Emissions: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	115	121	121	1,5%	6	5%	0	0%
Belgium	194	161	161	1,9%	-33	-17%	-1	0%
Bulgaria	386	114	112	1,4%	-274	-71%	-2	-1%
Croatia	169	92	88	1,1%	-81	-48%	-4	-4%
Cyprus	24	28	29	0,4%	5	23%	1	5%
Czechia	601	222	221	2,7%	-380	-63%	-1	-1%
Denmark	196	127	127	1,5%	-69	-35%	0	0%
Estonia	33	19	19	0,2%	-14	-42%	0	-2%
Finland	99	85	79	1,0%	-19	-20%	-5	-6%
France	1.147	976	961	11,6%	-186	-16%	-15	-2%
Germany	1.190	972	963	11,6%	-227	-19%	-9	-1%
Greece	161	143	144	1,7%	-17	-10%	1	1%
Hungary	279	136	133	1,6%	-147	-53%	-4	-3%
Ireland	187	229	231	2,8%	44	24%	2	1%
Italy	1.070	773	774	9,4%	-297	-28%	1	0%
Latvia	97	28	27	0,3%	-70	-72%	0	-1%
Lithuania	248	85	84	1,0%	-164	-66%	-1	-1%
Luxembourg	9	9	9	0,1%	0	-1%	0	0%
Malta	14	9	9	0,1%	-5	-35%	0	4%
Netherlands	388	241	242	2,9%	-146	-38%	1	0%
Poland	2.078	1.441	1.534	18,56%	-543	-26%	93	6%
Portugal	107	91	94	1,1%	-13	-12%	3	4%
Romania	1.003	561	548	6,6%	-455	-45%	-13	-2%
Slovakia	216	81	73	0,9%	-143	-66%	-9	-11%
Slovenia	43	29	29	0,3%	-14	-33%	-1	-2%
Spain	731	822	831	10,0%	100	14%	9	1%
Sweden	103	82	82	1,0%	-21	-21%	0	0%
United Kingdom	680	541	535	6,5%	-145	-21%	-6	-1%
EU-27+UK	**11.568**	**8.217**	**8.260**	**100%**	**-3.308**	**-29%**	**42**	**1%**
Iceland	9	8	8	0,1%	-1	-13%	0	-2%
United Kingdom (KP)	680	541	535	6,5%	-145	-21%	-6	-1%
EU-KP	**11.577**	**8.226**	**8.268**	**100%**	**-3.309**	**-29%**	**42**	**1%**

Abbreviations explained in the Chapter 'Units and abbreviations'

Figure 5.55: 3.B.2.5 - Manure Management - Indirect Emissions: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.B.2.5 - Manure Management - Indirect N_2O emissions - Atmospheric deposition

The implied emission factor for N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect N_2O emissions* decreased in EU-KP slightly between 1990 and 2020 by 1.3%. Figure 5.56 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.43 shows the implied emission factor for N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect N_2O emissions* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in six countries and increased in three countries. It was in 2020 at the level of 1990 in twenty countries.

Table 5.43 3.B.2.5 - Manure Management: countries' implied emission factor (kg N_2O/kg N)

Country	1990	2020		Country	1990	2020
Austria	0.016	0.016	|	Ireland	0.016	0.016
Belgium	0.016	0.016	|	Iceland	0.016	0.016
Bulgaria	0.016	0.016	|	Italy	0.016	0.016
Cyprus	0.016	0.016	|	Lithuania	0.016	0.016
Czech Republic	0.016	0.016	|	Luxembourg	0.016	0.016
Germany	0.016	0.016	|	Latvia	0.016	0.016
Denmark	0.016	0.016	|	Malta	0.016	0.016
Spain	0.013	0.012	|	Netherlands	0.016	0.016
Estonia	0.016	0.016	|	Poland	0.016	0.016
Finland	0.016	0.016	|	Portugal	0.016	0.016
France	0.016	0.016	|	Romania	0.016	0.016
United Kingdom	0.022	0.022	|	Slovakia	0.016	0.016
Greece	0.016	0.016	|	Slovenia	0.016	0.016
Croatia	0.016	0.016	|	Sweden	0.016	0.016
Hungary	0.016	0.016	|	EU-KP	0.016	0.016

3.B.2.5 - Manure Management - Implied emission factor - Leaching and run-off

The implied emission factor for N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect N_2O emissions* decreased in EU-KP barely between 1990 and 2020 by 0.033%. Figure 5.56 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.43 shows the implied emission factor for N_2O emissions in source category *3.B.2.5 - Manure Management - Indirect N_2O emissions* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in eight countries and increased in three countries. It was in 2020 at the level of 1990 in seven countries. No data were available for eleven countries (Austria, Bulgaria, Germany, Denmark, Ireland, Iceland, Luxembourg, the Netherlands, Slovakia, Slovenia and Sweden).

Figure 5.57: 3.B.2.5 - Manure Management: Trend in implied emission factor in the EU-KP and range of values reported by countries

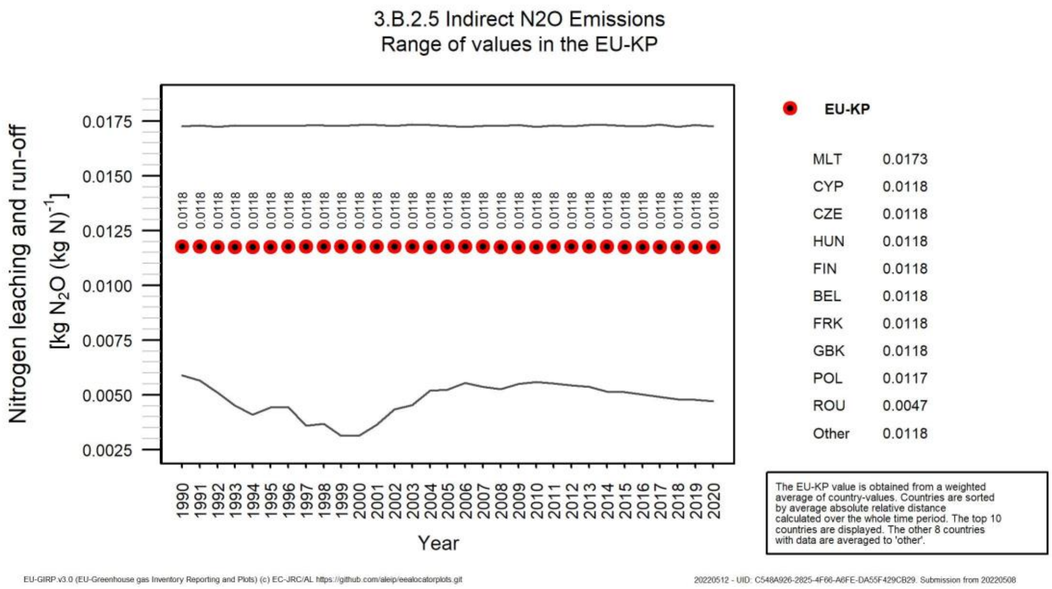


Table 5.44 3.B.2.5 - Manure Management: countries' implied emission factor (kg N_2O/kg N)

Country	1990	2020	Country	1990	2020
Belgium	0.0118	0.0118	Hungary	0.0118	0.0118
Cyprus	0.0118	0.0118	Italy	0.0118	0.0118
Czech Republic	0.0118	0.0118	Lithuania	0.0118	0.0118
Spain	0.0118	0.0118	Latvia	0.0118	0.0118
Estonia	0.0118	0.0118	Malta	0.0172	0.0173
Finland	0.0118	0.0118	Poland	0.0117	0.0117
France	0.0118	0.0118	Portugal	0.0118	0.0118
United Kingdom	0.0118	0.0118	Romania	0.0059	0.0047
Greece	0.0118	0.0118	EU-KP	0.0118	0.0118
Croatia	0.0118	0.0118			

5.3.4 Direct Emissions from Managed Soils - N_2O (CRF Source Category 3D1)

In 2020 N_2O emissions in source category *3.D.1 - Direct N_2O Emissions From Managed Soils* in EU-KP were 129569.5 kt CO_2 equivalent. This corresponds to 3.2% of total EU-KP GHG emissions and 53% of total EU-KP N_2O emissions. They make 30.6% of total agricultural emissions and 71% of total agricultural N_2O emissions. The main sub-categories are 3.D.1.1 (Inorganic N Fertilizers), 3.D.1.2 (Organic N Fertilizers) and 3.D.1.4 (Crop Residues) as shown in Figure 5.58. Regarding the origin of emissions in the different countries, Figure 5.59 shows the distribution of direct N_2O emissions from managed soils by emission source in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the emitting sub-categories.

Figure 5.58: Share of source category 3.D.1 on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2020. Categories 3.D.1.1-3.D.1.5: direct N_2O emissions by N source (inorganic fertilizers, organic fertilizers, urine and dung deposited by grazing animals, crop residues and mineralization of soil organic matter); category 3.D.1.6: cultivation of histosols.

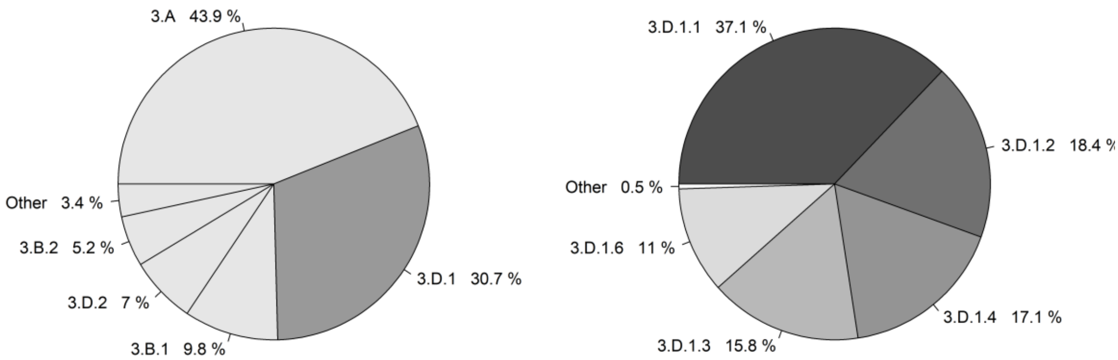
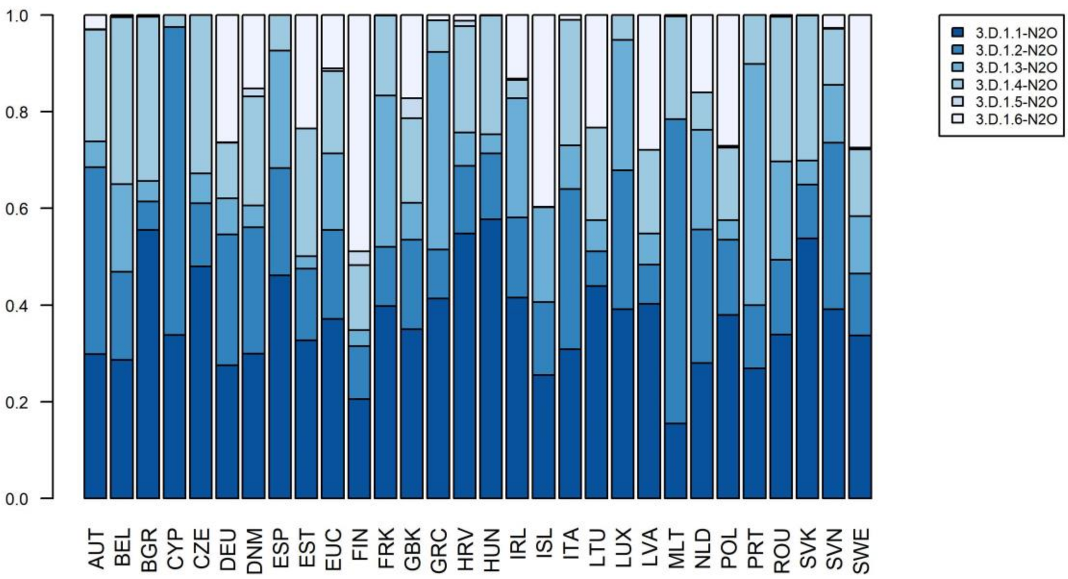


Figure 5.59: Decomposition of emissions in source category 3.D.1 - Direct N_2O Emissions From Managed Soils into its sub-categories by country in the year 2020. 3.D.1.1 inorganic N fertilisers, 3.D.1.2 organic N fertilisers, 3.D.1.3 urine and dung deposited by grazing animals, 3.D.1.4 crop residues incorporated in the soil, 3.D.1.5 mineralisation/immobilisation associated with loss/gain of soil organic matter, and 3.D.1.6 cultivation of organic soils (histosols).



Total GHG and N_2O emissions by country from 3.D.1 *Direct N_2O Emissions From Managed Soils* are shown in Table 5.45 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, N_2O emission in this source category decreased by 17% or 26.9 Mt CO_2-eq. The decrease was largest in the Netherlands in relative terms (39%) and in Romania in absolute terms (4.1 Mt CO_2-eq). From 2019 to 2020 emissions in the current category decreased by 0.3%.

Table 5.45 3.D.1 - Direct N_2O Emissions From Managed Soils: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1.998	1.663	1.680	1,3%	-318	-16%	17	1%	T1	D
Belgium	3.350	2.602	2.569	2,0%	-780	-23%	-33	-1%	T1	D
Bulgaria	4.069	3.162	3.072	2,4%	-997	-25%	-90	-3%	T1	D
Croatia	1.076	829	846	0,7%	-230	-21%	17	2%	T1	D
Cyprus	118	105	108	0,1%	-10	-9%	3	3%	T1	CS,D
Czechia	4.219	2.952	2.789	2,2%	-1.430	-34%	-163	-6%	T1,T2	CS,D
Denmark	4.938	3.935	3.942	3,0%	-996	-20%	7	0%	CS,T1,T2	D
Estonia	884	594	594	0,5%	-290	-33%	0	0%	T1	D
Finland	3.303	3.215	3.176	2,5%	-127	-4%	-39	-1%	T1,T2	CS,D
France	27.839	25.167	23.998	18,5%	-3.841	-14%	-1.169	-5%	T1,T2	D
Germany	16.843	14.196	14.046	10,8%	-2.798	-17%	-150	-1%	T1,T2	CS,D
Greece	3.583	2.240	2.301	1,8%	-1.283	-36%	60	3%	T1	D
Hungary	3.471	3.475	3.596	2,8%	125	4%	122	4%	T1,T2	D
Ireland	5.261	5.163	5.194	4,0%	-67	-1%	31	1%	T1	D
Italy	8.716	7.625	8.458	6,5%	-259	-3%	833	11%	CS,T1	CS,D
Latvia	1.615	952	982	0,8%	-633	-39%	30	3%	T1	D
Lithuania	2.575	1.928	2.122	1,6%	-454	-18%	194	10%	T1,T2	D
Luxembourg	189	162	157	0,1%	-32	-17%	-6	-4%	T1	CS,D
Malta	23	17	18	0,0%	-6	-24%	0	1%	T1	D
Netherlands	7.114	4.301	4.310	3,3%	-2.805	-39%	8	0%	T1,T1b,T2	CS,D
Poland	16.555	12.153	12.766	9,85%	-3.789	-23%	613	5%	T1	CS,D
Portugal	1.799	1.776	1.793	1,4%	-6	0%	17	1%	T1	D
Romania	10.619	7.045	6.488	5,0%	-4.131	-39%	-557	-8%	T1	D
Slovakia	1.752	1.107	1.112	0,9%	-640	-37%	5	0%	T1	CS,D
Slovenia	335	329	331	0,3%	-3	-1%	3	1%	T1,T2	D
Spain	9.079	10.329	10.621	8,2%	1.542	17%	292	3%	CS,T1	D
Sweden	3.229	2.865	2.993	2,3%	-236	-7%	128	4%	T1,T2	CS,D
United Kingdom	11.727	9.827	9.300	7,2%	-2.428	-21%	-527	-5%	T1,T2	CS,D
EU-27+UK	**156.281**	**129.714**	**129.360**	**100%**	**-26.921**	**-17%**	**-354**	**0%**	**-**	**-**
Iceland	206	206	210	0,2%	4	2%	4	2%	T1,T1b,T2	CS,D
United Kingdom (KP)	11.727	9.827	9.300	7,2%	-2.428	-21%	-527	-5%	T1,T2	CS,D
EU-KP	**156.486**	**129.920**	**129.569**	**100%**	**-26.917**	**-17%**	**-351**	**0%**	**-**	**-**

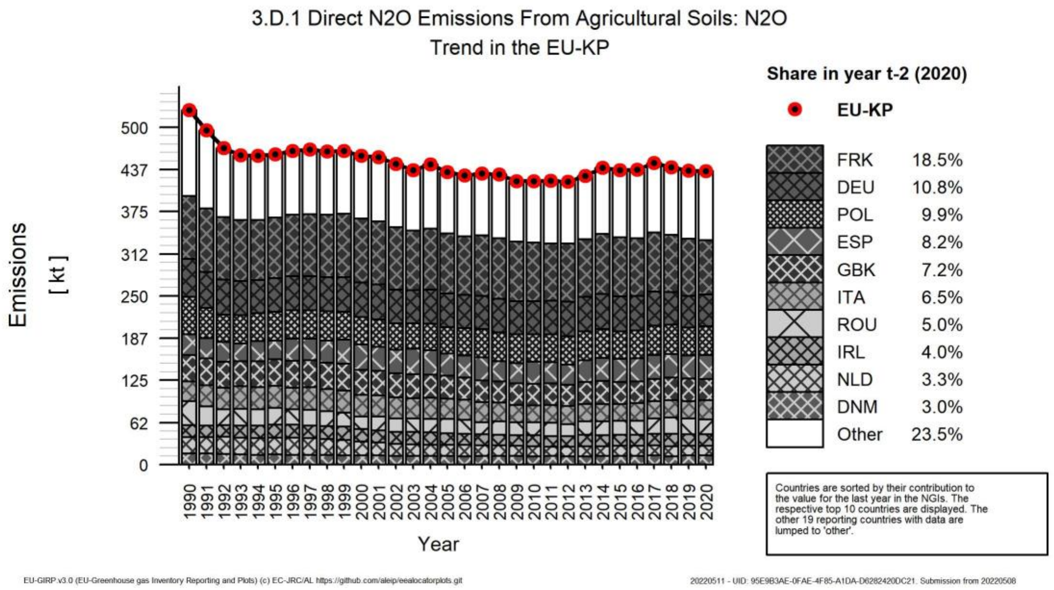
Abbreviations explained in the Chapter 'Units and abbreviations'.

5.3.4.1 Trends in Emissions and Activity Data

3.D.1 - Direct N_2O Emissions From Managed Soils - Emissions

Emissions in source category *3.D.1 - Direct N_2O Emissions From Managed Soils* decreased considerably in EU-KP by 17% or 26.9 Mt CO_2-eq in the period 1990 to 2020. Figure 5.60 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from direct N_2O emissions from managed soils for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 76.5% of the total in 2020.Emissions decreased in 26 countries and increased in three countries. The three countries with the largest decreases were Romania, France and Poland with a total absolute decrease of 11.8 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 1.5 Mt CO_2-eq.

Figure 5.60: 3.D.1 Direct N_2O Emissions From Managed Soils: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



The main driving force of direct N_2O emissions from agricultural soils is the use of nitrogen fertiliser and animal manure, which were 25% and 12% below 1990 levels in 2020, respectively. N_2O emissions from agricultural land can be decreased by overall efficiency improvements of nitrogen uptake by crops, which should lead to lower fertiliser consumption on agricultural land. The decrease of fertiliser use is partly due to the effects of the 1992 reform of the Common Agricultural Policy and the resulting shift from production-based support mechanisms to direct area payments in arable production. This has tended to lead to an optimisation and overall reduction in fertiliser use. In addition, reduction in fertiliser use is also due to directives such as the Nitrate Directive and to the extensification measures included in the Agro-Environment Programmes (EC, 2001).

Another policy affecting GHG emissions, in this case through the application of sewage sludge, is the Urban Wastewater Treatment Directive[41]. In the UK, the input from sewage sludge sharply increased in 2001. This is explained by a step in the UK's estimates of sewage sludge collected around 2001, linked to the Urban Wastewater Treatment Directive, which enforced that all large wastewater treatment plants use secondary treatment. This additional treatment reduces the organic load in the effluent, and to achieve this a higher proportion of the organic load in the wastewater treatment plants as sewage sludge. A similar trend is observed in Ireland, where a significant increase (over double) in the quantity of sewage sludge applied to agricultural land took place around 1998 as a result of its diversion away from disposal at solid waste disposal sites.

3.D.1.1 - Direct N_2O emissions from inorganic N fertilisers - Emissions

Emissions in source category *3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers* decreased considerably in EU-KP by 25% or 15.6 Mt CO_2-eq in the period 1990 to 2020. Figure 5.61 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from inorganic N fertilisers for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 77.3% of the total in 2020.Emissions decreased in 26 countries and increased in three countries. The three countries with the largest decreases were the United Kingdom, France and Germany with a total absolute decrease of 7.7 Mt CO_2-eq. The largest increases occurred in Hungary, with a total absolute increase of 399 kt CO_2-eq.

41 http://ec.europa.eu/environment/water/water-urbanwaste/legislation/directive_en.htm

3.D.1.1 - Direct N_2O emissions from inorganic N fertilisers - Application of inorganic fertilizers

Application of inorganic fertilizers decreased strongly in EU-KP by 25% or 3.7 kt N/year in the period 1990 to 2020. Figure 5.62 shows the trend of application of inorganic fertilizers indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O application of inorganic fertilizers from inorganic N fertilisers for the different countries along the inventory period. The ten countries with the highest application of inorganic fertilizers accounted together for 78.9% of the total in 2020.Application of inorganic fertilizers decreased in 25 countries and increased in four countries. The three countries with the largest decreases were Germany, the United Kingdom and France with a total absolute decrease of 2 kt N/year. The largest increases occurred in Hungary, with a total absolute increase of 85 kt N/year.

Figure 5.61: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

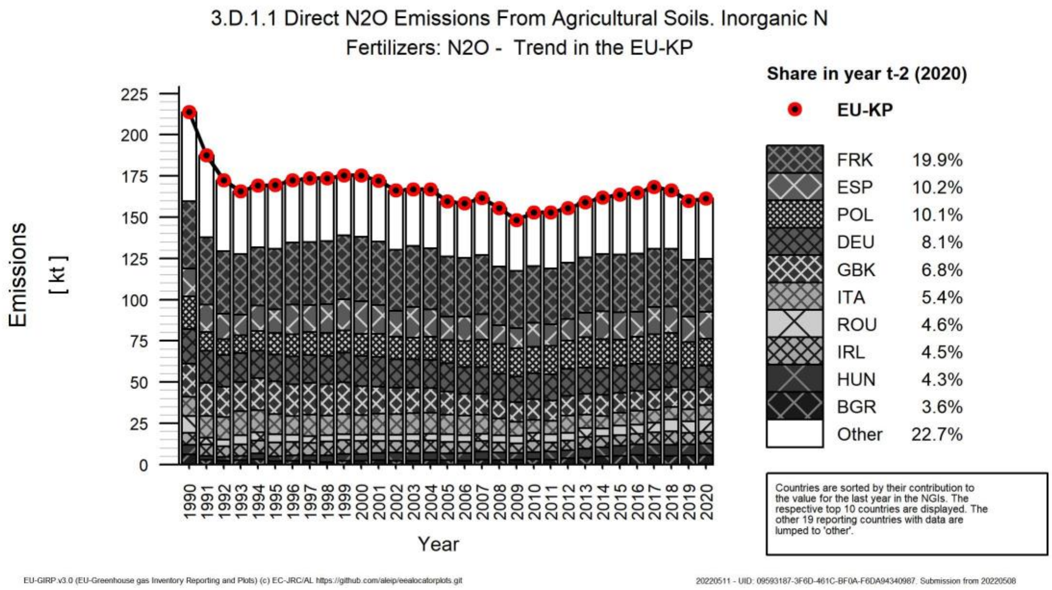
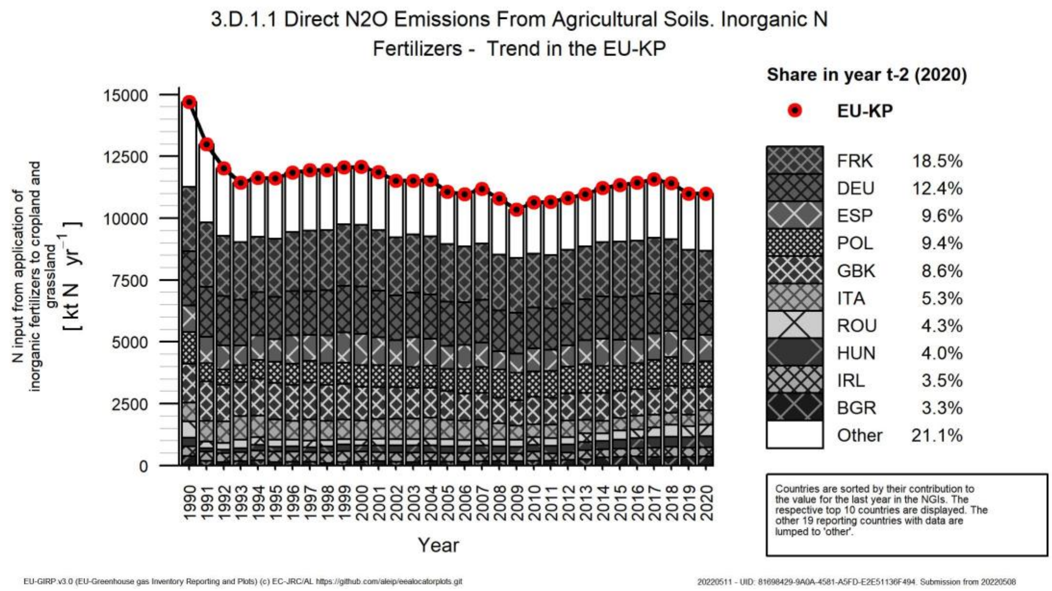


Figure 5.62: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in application of inorganic fertilizers in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.D.1.2 - Direct N_2O emissions from organic N fertilisers - Emissions

Emissions in source category *3.D.1.2 - Direct N_2O Emissions from organic N fertilisers* decreased clearly in EU-KP by 11% or 3 Mt CO_2-eq in the period 1990 to 2020. Figure 5.63 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from organic N fertilisers for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 82.5% of the total in 2020.Emissions decreased in eighteen countries and increased in eleven countries. The largest decreases occurred in Romania and Poland with a total absolute decrease of 2.2 Mt CO_2-eq. The six countries with the largest increases were Ireland, Italy, the United Kingdom, Germany, the Netherlands and Spain, with a total absolute increase of 1.9 Mt CO_2-eq.

3.D.1.2 - Direct N_2O emissions from organic N fertilisers - amount of N applied

N from applied organic N fertilizers decreased clearly in EU-KP by 12% or 816 kt N/year in the period 1990 to 2020. Figure 5.64 shows the trend of N from applied organic N fertilizers indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O N from applied organic N fertilizers from organic N fertilisers for the different countries along the inventory period. The ten countries with the highest N from applied organic N fertilizers accounted together for 84.4% of the total in 2020.N from applied organic N fertilizers decreased in nineteen countries and increased in ten countries. The largest decreases occurred in Romania and Poland with a total absolute decrease of 471 kt N/year. The five countries with the largest increases were the United Kingdom, Ireland, Italy, Spain and Germany, with a total absolute increase of 306 kt N/year.

Figure 5.63: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

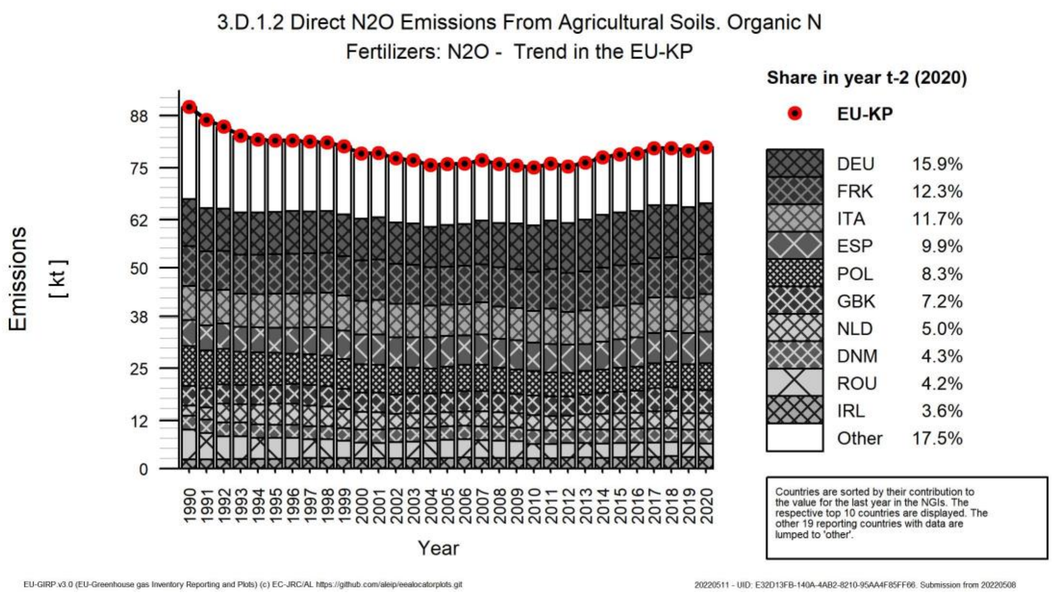
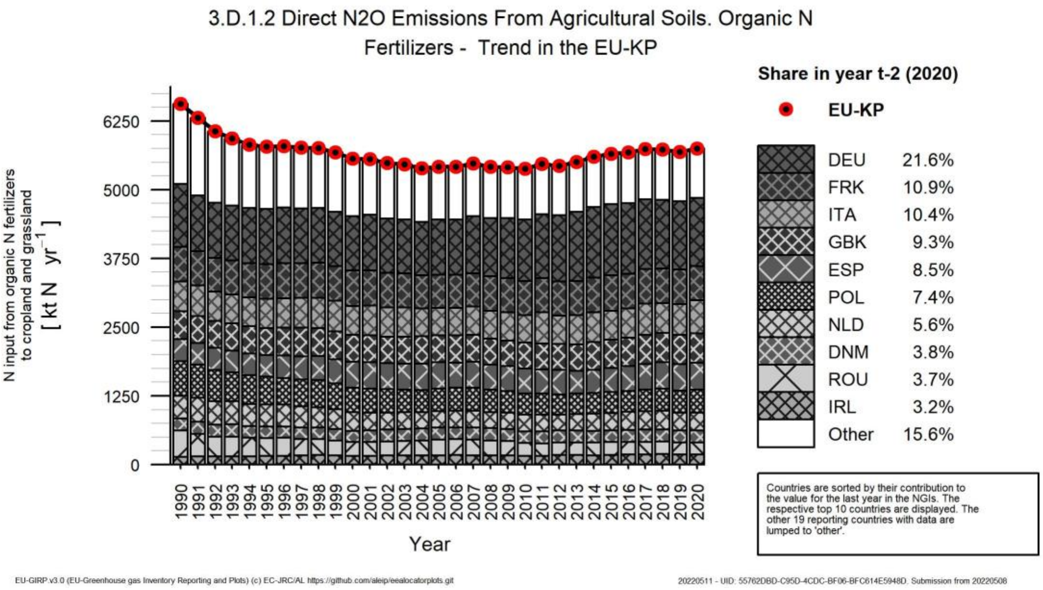


Figure 5.64: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.D.1.3 - Urine and Dung Deposited by Grazing Animals - Emissions

In 2020 N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* in EU-KP were 20536.4 kt CO_2 equivalent. This corresponds to 0.5% of total EU-KP GHG emissions and 8.3% of total EU-KP N_2O emissions. They make 4.8% of total agricultural emissions and 11% of total agricultural N_2O emissions.

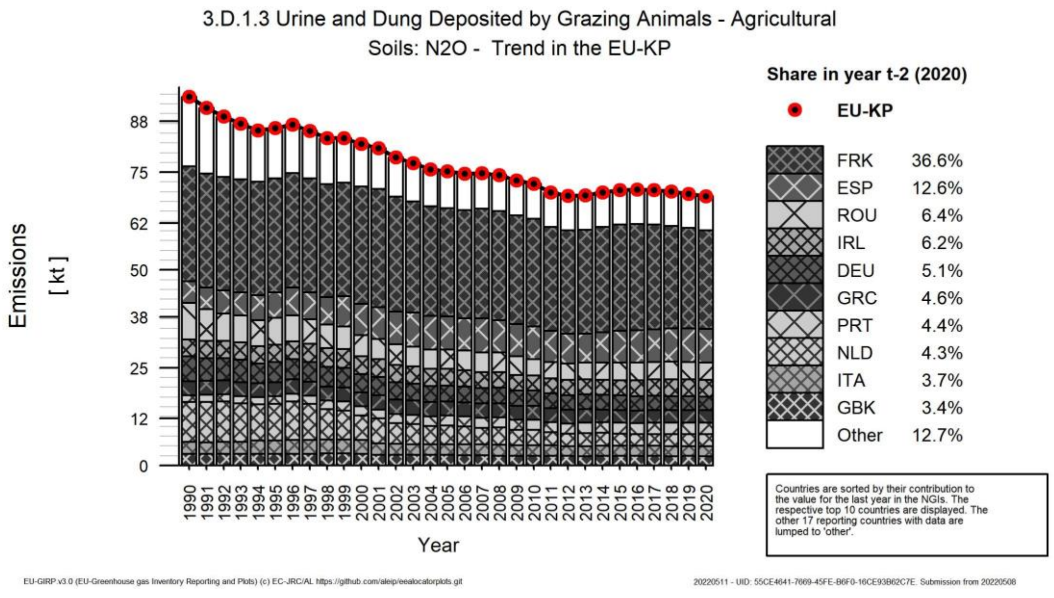
Total GHG and N_2O emissions by country from 3.D.1.3 *Grazing Animals* are shown in Table 5.46 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, N_2O emission in this source category decreased by 27% or 7.6 Mt CO_2-eq. The decrease was largest in Bulgaria in relative terms (79%) and in the Netherlands in absolute terms (2.1 Mt CO_2-eq). From 2019 to 2020 emissions in the current category decreased by 0.8%. Figure 5.65 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from grazing animals for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 87.3% of the total in 2020.Emissions decreased in 22 countries and increased in five countries. The four countries with the largest decreases were the Netherlands, Romania, France and Poland with a total absolute decrease of 5.9 Mt CO_2-eq. The largest increases occurred in Portugal and Spain, with a total absolute increase of 1.3 Mt CO_2-eq.

Table 5.46 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	166	91	90	0.4%	-76	-46%	-1	-1%	T1	D
Belgium	691	477	467	2.3%	-225	-33%	-10	-2%	T1	D
Bulgaria	616	129	129	0.6%	-486	-79%	0	0%	T1	D
Croatia	137	57	58	0.3%	-79	-58%	1	2%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	237	174	172	0.8%	-64	-27%	-2	-1%	T1	D
Denmark	298	173	178	0.9%	-120	-40%	5	3%	T2	D
Estonia	73	17	15	0.1%	-58	-79%	-2	-9%	T1	D
Finland	150	105	105	0.5%	-45	-30%	0	0%	T1	D
France	8 760	7 670	7 515	36.6%	-1 244	-14%	-155	-2%	T1,T2	D
Germany	1 906	1 063	1 039	5.1%	-867	-46%	-24	-2%	T1	D
Greece	1 061	942	942	4.6%	-119	-11%	0	0%	T1	D
Hungary	193	138	142	0.7%	-52	-27%	4	3%	T1	D
Ireland	1 273	1 269	1 281	6.2%	9	1%	12	1%	T1	D
Italy	920	759	764	3.7%	-156	-17%	4	1%	T1	CS,D
Latvia	150	62	63	0.3%	-86	-58%	1	2%	T1	D
Lithuania	420	141	136	0.7%	-284	-68%	-4	-3%	T1	D
Luxembourg	50	44	42	0.2%	-8	-15%	-2	-4%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 028	898	890	4.3%	-2 138	-71%	-8	-1%	T1	D
Poland	1 589	505	513	2.5%	-1 077	-68%	8	2%	T1	CS,D
Portugal	538	889	895	4.4%	356	66%	6	1%	T1	D
Romania	2 785	1 337	1 321	6.4%	-1 464	-53%	-16	-1%	T1	D
Slovakia	109	57	56	0.3%	-53	-49%	-1	-2%	T1	CS
Slovenia	20	40	40	0.2%	20	103%	0	0%	T1	D
Spain	1 656	2 555	2 578	12.6%	922	56%	24	1%	CS,T1	D
Sweden	355	358	356	1.7%	1	0%	-2	-1%	T1	D
United Kingdom	878	720	708	3.4%	-171	-19%	-12	-2%	T2	CS
EU-27+UK	**28 059**	**20 669**	**20 495**	**100%**	**-7 564**	**-27%**	**-174**	**-1%**	**-**	**-**
Iceland	48	42	41	0.2%	-7	-14%	-1	-2%	T1	D
United Kingdom (KP)	878	720	708	3.4%	-171	-19%	-12	-2%	T2	CS
EU-KP	**28 107**	**20 711**	**20 536**	**100%**	**-7 570**	**-27%**	**-174**	**-1%**	**-**	**-**

Abbreviations explained in the Chapter 'Units and abbreviations'

Figure 5.65: 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



5.3.4.2 Implied EFs and Methodological Issues

In this section we discuss the implied emission factor for the main N sources contributing to direct N_2O emissions from managed soils.

3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers* increased in EU-KP barely between 1990 and 2020 by 0.88%. Figure 5.66 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.47 shows the implied emission factor for N_2O emissions in source category *3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in six countries and increased in one country. It was in 2020 at the level of 1990 in 22 countries.

Figure 5.66: 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: Trend in implied emission factor in the EU-KP and range of values reported by countries

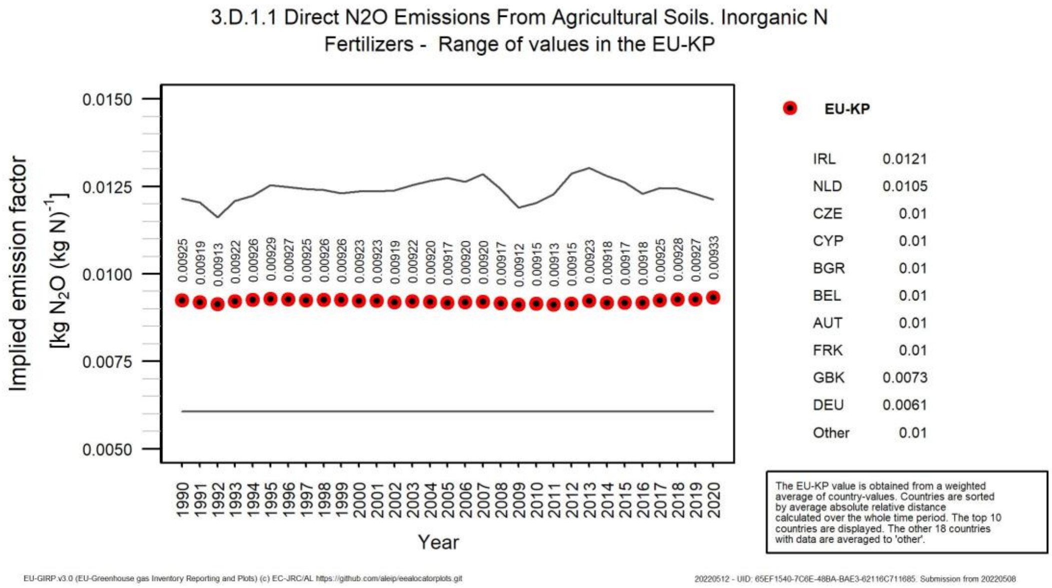


Table 5.47 3.D.1.1 - Direct N_2O Emissions From Inorganic N fertilisers: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2020		Country	1990	2020
Austria	0.0100	0.0100	|	Ireland	0.0122	0.0121
Belgium	0.0100	0.0100	|	Iceland	0.0100	0.0100
Bulgaria	0.0100	0.0100	|	Italy	0.0097	0.0097
Cyprus	0.0100	0.0100	|	Lithuania	0.0100	0.0100
Czech Republic	0.0100	0.0100	|	Luxembourg	0.0100	0.0100
Germany	0.0061	0.0061	|	Latvia	0.0100	0.0100
Denmark	0.0100	0.0100	|	Malta	0.0100	0.0100
Spain	0.0099	0.0099	|	Netherlands	0.0103	0.0105
Estonia	0.0100	0.0100	|	Poland	0.0100	0.0100
Finland	0.0100	0.0100	|	Portugal	0.0098	0.0098
France	0.0100	0.0100	|	Romania	0.0100	0.0100
United Kingdom	0.0081	0.0073	|	Slovakia	0.0100	0.0100
Greece	0.0100	0.0100	|	Slovenia	0.0100	0.0100

Croatia	0.0100	0.0100	Sweden	0.0100	0.0100
Hungary	0.0100	0.0100	EU-KP	0.0093	0.0093

3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers* increased in EU-KP slightly between 1990 and 2020 by 1.5%. Figure 5.67 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.48 shows the implied emission factor for N_2O emissions in source category *3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in three countries and increased in four countries. It was in 2020 at the level of 1990 in 22 countries. The largest increase occurred in the Netherlands with an absolute value of 0.0039 kg N_2O-N/kg N.

Figure 5.67: 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: Trend in implied emission factor in the EU-KP and range of values reported by countries

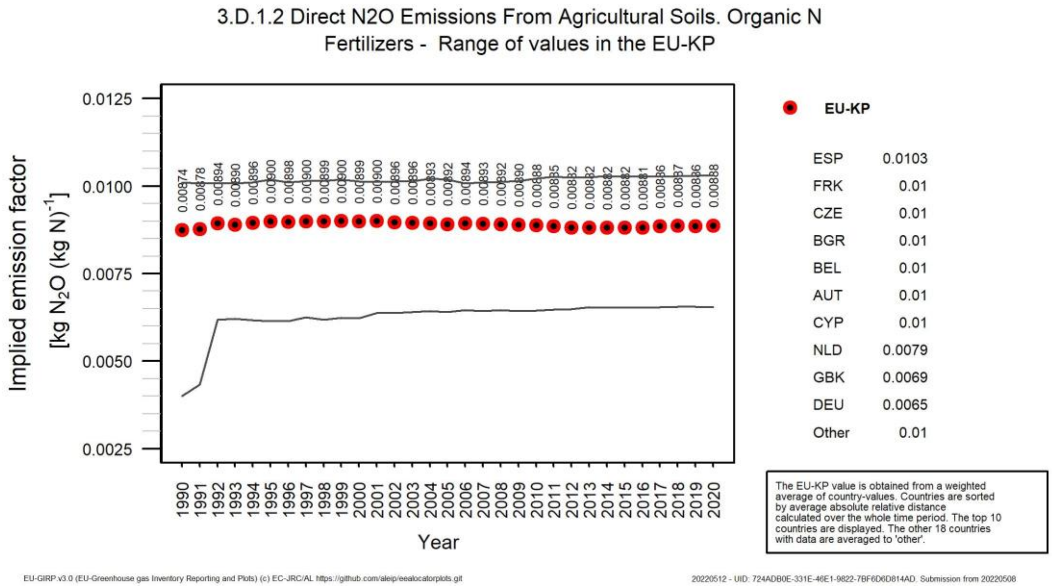


Table 5.48 3.D.1.2 - Direct N_2O Emissions From Organic N fertilisers: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2020	Country	1990	2020
Austria	0.0100	0.0100	Ireland	0.0100	0.0100
Belgium	0.0100	0.0100	Iceland	0.0100	0.0100
Bulgaria	0.0100	0.0100	Italy	0.0100	0.0100
Cyprus	0.0100	0.0100	Lithuania	0.0100	0.0100
Czech Republic	0.0100	0.0100	Luxembourg	0.0100	0.0100
Germany	0.0066	0.0065	Latvia	0.0100	0.0100
Denmark	0.0100	0.0100	Malta	0.0100	0.0100
Spain	0.0101	0.0103	Netherlands	0.0040	0.0079
Estonia	0.0100	0.0100	Poland	0.0100	0.0100
Finland	0.0100	0.0100	Portugal	0.0100	0.0100
France	0.0100	0.0100	Romania	0.0100	0.0100

Country	1990	2020		Country	1990	2020
United Kingdom	0.0062	0.0069	|	Slovakia	0.0100	0.0100
Greece	0.0100	0.0100	|	Slovenia	0.0100	0.0100
Croatia	0.0100	0.0100	|	Sweden	0.0100	0.0100
Hungary	0.0100	0.0099	|	EU-KP	0.0087	0.0089

3.D.1.3 - Urine and Dung Deposited by Grazing Animals - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.D.1.3 - Urine and Dung Deposited by Grazing Animals decreased since 1990 from 0.0150 to 0.0142 kg N_2O-N/kg N at EU28+ISL level.

Table 5.49 shows the implied emission factor for N_2O emissions in source category *3.D.1.3 - Urine and Dung Deposited by Grazing Animals* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in eighteen countries and increased in nine countries. No data were available for two countries (Cyprus and Malta). The three countries with the largest decreases were Croatia, Romania and Estonia with a mean absolute value of 0.0025 kg N_2O-N/kg N. The three countries with the largest increases were Spain, Portugal and Hungary with a mean absolute value of 0.002 kg N_2O-N/kg N.

Table 5.49 3.D.1.3 - Urine and Dung Deposited by Grazing Animals: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2020		Country	1990	2020
Austria	0.0188	0.0169	|	Ireland	0.0088	0.0087
Belgium	0.0197	0.0194	|	Iceland	0.0109	0.0114
Bulgaria	0.0120	0.0126	|	Italy	0.0111	0.0111
Czech Republic	0.0174	0.0189	|	Lithuania	0.0190	0.0190
Germany	0.0191	0.0189	|	Luxembourg	0.0199	0.0196
Denmark	0.0187	0.0176	|	Latvia	0.0196	0.0188
Spain	0.0152	0.0174	|	Netherlands	0.0330	0.0313
Estonia	0.0183	0.0163	|	Poland	0.0185	0.0197
Finland	0.0179	0.0169	|	Portugal	0.0163	0.0182
France	0.0189	0.0191	|	Romania	0.0155	0.0129
United Kingdom	0.0033	0.0033	|	Slovakia	0.0158	0.0161
Greece	0.0104	0.0104	|	Slovenia	0.0185	0.0174
Croatia	0.0136	0.0109	|	Sweden	0.0176	0.0173
Hungary	0.0138	0.0156	|	EU-KP	0.0150	0.0142

3.D.1.4 – Crop residues - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.D.1.4 - Direct N_2O Emissions From Crop Residues increased in EU-KP slightly between 1990 and 2020 by 1.7%, from 0.0093 to 0.0095 kg N_2O-N/kg N. The implied emission factor decreased in one country (the Netherlands, from 0.015 to 0.014 kg N_2O-N/kg N) and increased in one country (Romania, from 0.08 to 0.09 kg N_2O-N/kg N). The implied emission factor remained constant at 1990 levels in 27 countries.

3.D.1.5 – Mineralization of Soil Organic Matter - Implied emission factor

The implied emission factor for N_2O emissions in source category 3.D.1.5 - Direct N_2O Emissions From Mineralization of Soil Organic Matter, did not change in EU-KP and in the 20 countries reporting this category. All countries used the default value of 0.01 kg N_2O-N/kg N.

3.D.1.6 – Cultivation of Organic Soils - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.6 - Direct N_2O Emissions From Cultivation of Organic Soils* in EU-KP decreased by 2.1% between 1990 and 2020. Table 5.50 shows the implied emission factor for N_2O emissions for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in three countries and increased in three countries. It was in 2020 at the level of 1990 in 15 countries. The largest increase occurred in Finland with an absolute value of -0.52 kg N_2O-N/ha and the largest decrease in Latvia with an absolute value of -1.35 kg N_2O-N/ha.

Table 5.50 3.D.1.6 - Cultivation of Organic Soils: countries' implied emission factor (kg N_2O-N/ha)

Country	1990	2020	Country	1990	2020
Austria	8.20	8.20	Ireland	4.30	4.30
Belgium	8.00	8.00	Iceland	0.61	0.55
Bulgaria	8.00	8.00	Italy	8.00	8.00
Germany	6.16	6.17	Lithuania	8.00	8.00
Denmark	8.11	7.43	Latvia	5.01	3.66
Estonia	8.00	8.00	Netherlands	4.45	4.45
Finland	9.31	9.83	Poland	8.00	8.00
France	3.42	3.42	Romania	8.00	8.00
United Kingdom	9.46	9.54	Slovenia	8.00	8.00
Greece	8.00	8.00	Sweden	13.00	13.00
Croatia	8.00	8.00	EU-KP	6.79	6.65

The N_2O IEF for cultivation of organic soils is lower than the range of the IPCC default values for 4 of the 22 member States that reported emissions for this source category (Germany, Iceland, Ireland and Netherlands). The emissions reported by these four member States account for 27 per cent of total EU emissions under this source category. Germany used an average country-specific N_2O EF (6.16 kg N_2O-N/ha), derived by aggregating regional estimates of EFs. Ireland, which used an EF of 4.3 kg N_2O-N/ha, estimated emissions from drainage/management of organic soils using the area of drained/managed organic soils also adopted to estimate emissions and removals for category 4.C (grasslands) and the EF for nutrient-poor grasslands from table 2.5 of the Wetlands Supplement. Iceland used a country-specific EF of 0.55 kg N_2O-N/ha derived from direct measurements of its organic and volcanic soils. The Netherlands, with an EF of 4.45 kg N_2O-N/ha, adopted a Tier 1 approach, together with the IPCC default EFs for temperate and boreal organic nutrient-rich (0.6 kg N_2O-N ha-1) and nutrient-poor (0.1 kg N_2O-N ha-1) forest soils (2006 IPCC Guidelines, vol. 4, table 11.1).

5.3.5 Indirect Emissions from Managed Soils - N_2O (CRF Source Category 3D2)

In 2020 N_2O emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* in EU-KP were 29354.1 kt CO_2 equivalent. This corresponds to 0.71% of total EU-KP GHG emissions and 12%

of total EU-KP N_2O emissions. They make 6.9% of total agricultural emissions and 16% of total agricultural N_2O emissions. The main sub-categories are 3.D.2.2 (Nitrogen Leaching and Run-off), and 3.D.2.1 (Atmospheric Deposition) as shown in Figure 5.68. Regarding the origin of emissions in the different countries, Figure 5.69 shows the distribution of indirect N_2O emissions from managed soils by emission source in all countries and in the EU-KP. Each bar represents the total emissions of a country in the current emission category, where different shades of purple correspond to the emitting sub-categories.

Figure 5.68: Share of source category 3.D.2 on total EU-KP agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2020.

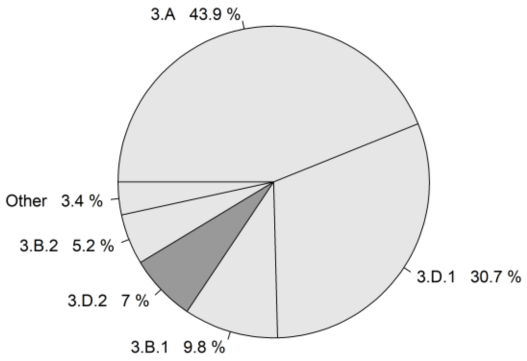
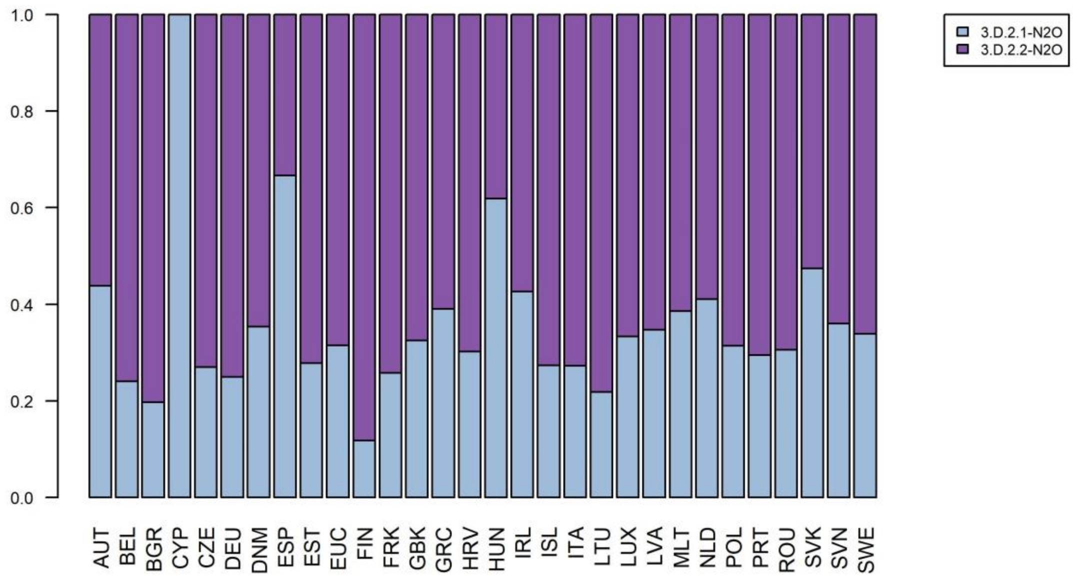


Figure 5.69: Decomposition of emissions in source category 3.D.2 - Indirect Emissions from Managed Soils into its sub-categories by country in the year 2020. 3.D.2.1 Atmospheric Deposition and 3.D.2.2 Nitrogen Leaching and Run-off.



Total GHG and N_2O emissions by country from 3.D.2 *Indirect Emissions from Managed Soils* are shown in Table 5.51 by country plus Iceland and the UK, and the total EU-KP and the total EU+UK for the first and the last year of the inventory (1990 and 2020). Values are given in kt CO_2-eq. Between 1990 and 2020, N_2O emission in this source category decreased by 24% or 9.3 Mt CO_2-eq. The decrease was largest in the Netherlands in relative terms (63%) and in Romania in absolute terms (1.4 Mt CO_2-eq). From 2019 to 2020 emissions in the current category decreased by 1%.

Table 5.51 3.D.2 - Indirect Emissions from Managed Soils: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	383	321	322	1,1%	-61	-16%	1	0%	T1	D
Belgium	1.086	700	691	2,4%	-396	-36%	-9	-1%	T1	D
Bulgaria	1.239	867	850	2,9%	-389	-31%	-17	-2%	T1	D
Croatia	350	264	268	0,9%	-82	-23%	4	1%	T1	D
Cyprus	17	17	17	0,1%	0	3%	1	3%	T1	D
Czechia	1.319	894	834	2,8%	-484	-37%	-60	-7%	T1	D
Denmark	922	533	516	1,8%	-406	-44%	-17	-3%	T2	D
Estonia	229	139	140	0,5%	-89	-39%	0	0%	D,T1	D
Finland	481	405	391	1,3%	-90	-19%	-14	-3%	T1	D
France	6.011	5.452	5.171	17,6%	-840	-14%	-281	-5%	T1,T2	CS,D
Germany	5.925	4.799	4.628	15,8%	-1.298	-22%	-171	-4%	T1	D
Greece	1.248	805	825	2,8%	-422	-34%	20	3%	T1	D
Hungary	362	260	272	0,9%	-90	-25%	11	4%	T1	D
Ireland	556	572	566	1,9%	11	2%	-6	-1%	T1	CS,D
Italy	2.538	2.127	2.363	8,0%	-175	-7%	235	11%	T1	CS,D
Latvia	312	172	179	0,6%	-133	-43%	7	4%	T1	D
Lithuania	587	406	450	1,5%	-137	-23%	44	11%	T1	D
Luxembourg	52	47	46	0,2%	-6	-11%	-1	-3%	T1,T2	D
Malta	9	6	7	0,0%	-2	-27%	0	2%	T1	D
Netherlands	1.603	590	595	2,0%	-1.008	-63%	5	1%	T1	D
Poland	4.120	2.799	2.973	10,13%	-1.147	-28%	174	6%	T1,T3	D
Portugal	494	434	447	1,5%	-47	-9%	13	3%	T1,T2	CS,D
Romania	3.455	2.176	2.048	7,0%	-1.407	-41%	-127	-6%	T1	D
Slovakia	487	166	193	0,7%	-294	-60%	27	16%	T1,T2	CS,D
Slovenia	118	108	109	0,4%	-9	-8%	1	1%	T1	D
Spain	1.483	1.718	1.783	6,1%	300	20%	65	4%	CS,T2	D
Sweden	368	282	284	1,0%	-85	-23%	2	1%	CS	D
United Kingdom	2.825	2.558	2.349	8,0%	-476	-17%	-210	-8%	T1	D
EU-27+UK	**38.577**	**29.619**	**29.316**	**100%**	**-9.260**	**-24%**	**-303**	**-1%**	**-**	**-**
Iceland	43	37	38	0,1%	-5	-12%	1	2%	T1b	D
United Kingdom (KP)	2.825	2.558	2.349	8,0%	-476	-17%	-210	-8%	T1	D
EU-KP	**38.620**	**29.656**	**29.354**	**100%**	**-9.266**	**-24%**	**-302**	**-1%**	**-**	**-**

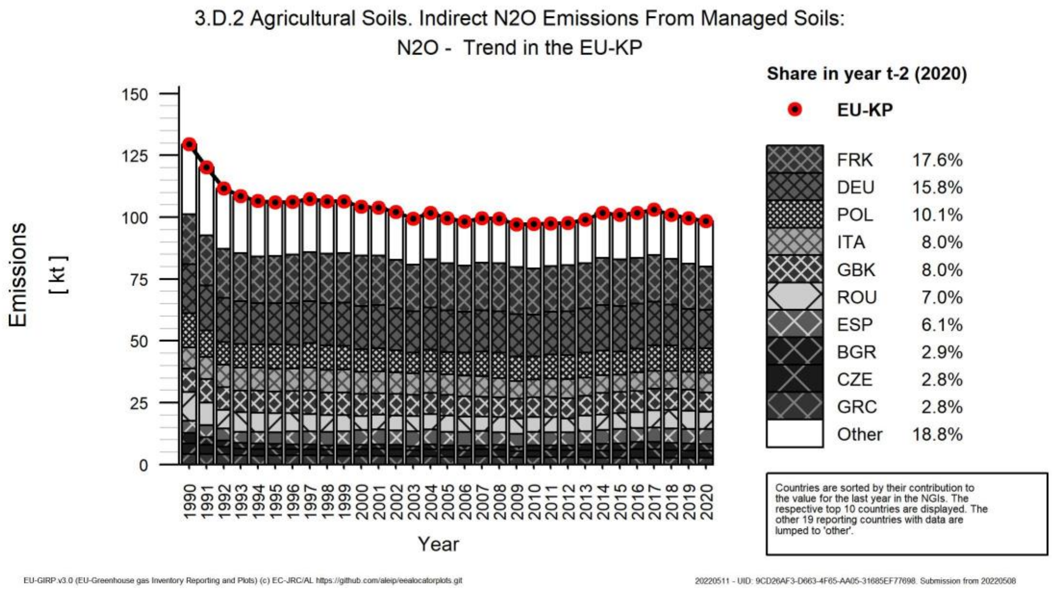
Abbreviations explained in the Chapter 'Units and abbreviations'

5.3.5.1 Trends in Emissions and Activity Data

3.D.2 - Indirect Emissions from Managed Soils - Emissions

Emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* decreased considerably in EU-KP by 24% or 9.3 Mt CO_2-eq in the period 1990 to 2020. Figure 5.70 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from indirect emissions from managed soils for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81.2% of the total in 2020.Emissions decreased in 26 countries and increased in three countries. The four countries with the largest decreases were Romania, Germany, Poland and the Netherlands with a total absolute decrease of 4.9 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 300 kt CO_2-eq.

Figure 5.70: 3.D.2 Indirect Emissions from Managed Soils: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition - Emissions

Emissions in source category *3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition* decreased strongly in EU-KP by 29% or 3.8 Mt CO_2-eq in the period 1990 to 2020. Figure 5.71 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions from atmospheric deposition for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 80.7% of the total in 2020.Emissions decreased in 25 countries and increased in four countries. The four countries with the largest decreases were the Netherlands, Germany, Romania and Poland with a total absolute decrease of 2.2 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 167 kt CO_2-eq.

3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition - Volatilized N from agricultural N inputs

Volatilized N from agricultural N inputs decreased strongly in EU-KP by 30% or 813 kt N/year in the period 1990 to 2020. Figure 5.72 shows the trend of volatilized N from agricultural N inputs indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O volatilized N from agricultural N inputs from atmospheric deposition for the different countries along the inventory period. The ten countries with the highest volatilized N from agricultural N inputs accounted together for 80.8% of the total in 2020.Volatilized N from agricultural N inputs decreased in 25 countries and increased in four countries. The four countries with the largest decreases were the Netherlands, Germany, Romania and Poland with a total absolute decrease of 456 kt N/year. The largest increases occurred in Spain, with a total absolute increase of 36 kt N/year.

Figure 5.71: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

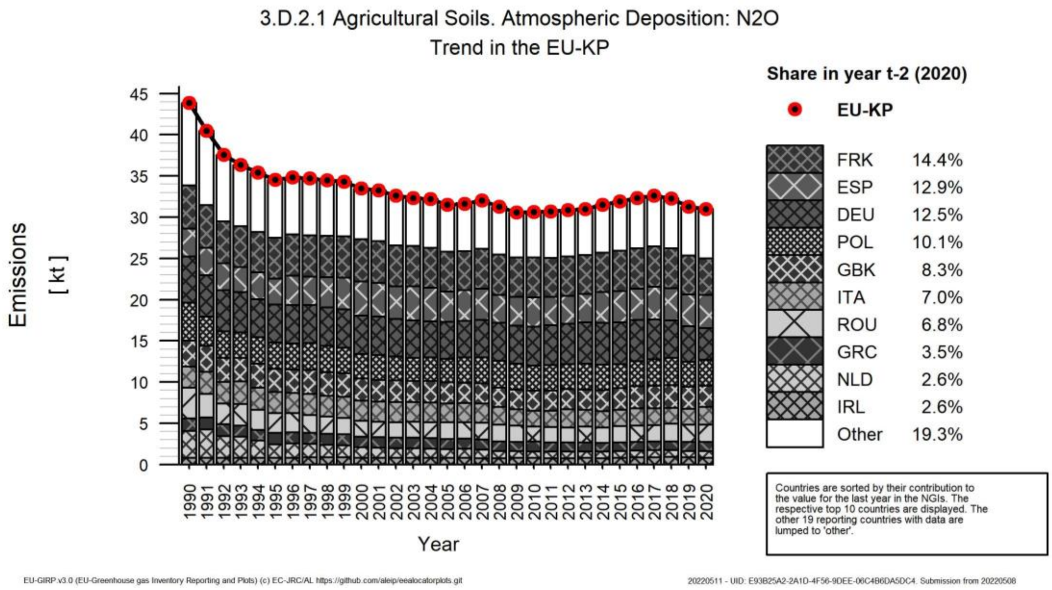
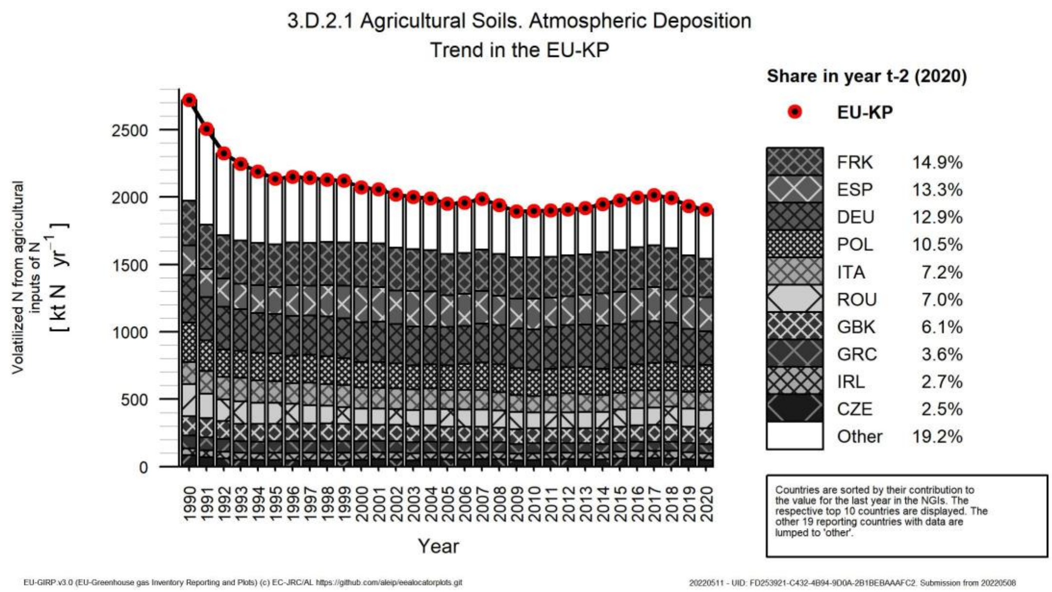


Figure 5.72: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off - Emissions

Emissions in source category *3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off* decreased considerably in EU-KP by 21% or 5.4 Mt CO_2-eq in the period 1990 to 2020. Figure 5.73 shows the trend of emissions indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O emissions for the different countries along the inventory period. The ten countries with the highest emissions accounted together for 81.9% of the total in 2020.Emissions decreased in 26 countries and increased in two countries. The four countries with the largest decreases were Romania, Germany, Poland and France with a total absolute decrease of 3 Mt CO_2-eq. The largest increases occurred in Spain, with a total absolute increase of 133 kt CO_2-eq.

3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off - N from fertilizers and other agricultural inputs that is lost through leaching and run-off

N from fertilizers and other agricultural inputs that is lost through leaching and run-off decreased considerably in EU-KP by 23% or 1.8 kt N/year in the period 1990 to 2020. Figure 5.74 shows the trend of N from fertilizers and other agricultural inputs that is lost through leaching and run-off indicating the countries contributing most to EU-KP total. The figure represents the trend in N_2O N from fertilizers and other agricultural inputs that is lost through leaching and run-off for the different countries along the inventory period. The ten countries with the highest N from fertilizers and other agricultural inputs that is lost through leaching and run-off accounted together for 82.9% of the total in 2020.N from fertilizers and other agricultural inputs that is lost through leaching and run-off decreased in 26 countries and increased in two countries. The four countries with the largest decreases were the Czech Republic, Romania, Germany and Poland with a total absolute decrease of 992 kt N/year. The largest increases occurred in Spain, with a total absolute increase of 38 kt N/year.

Figure 5.73: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend in emissions in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020

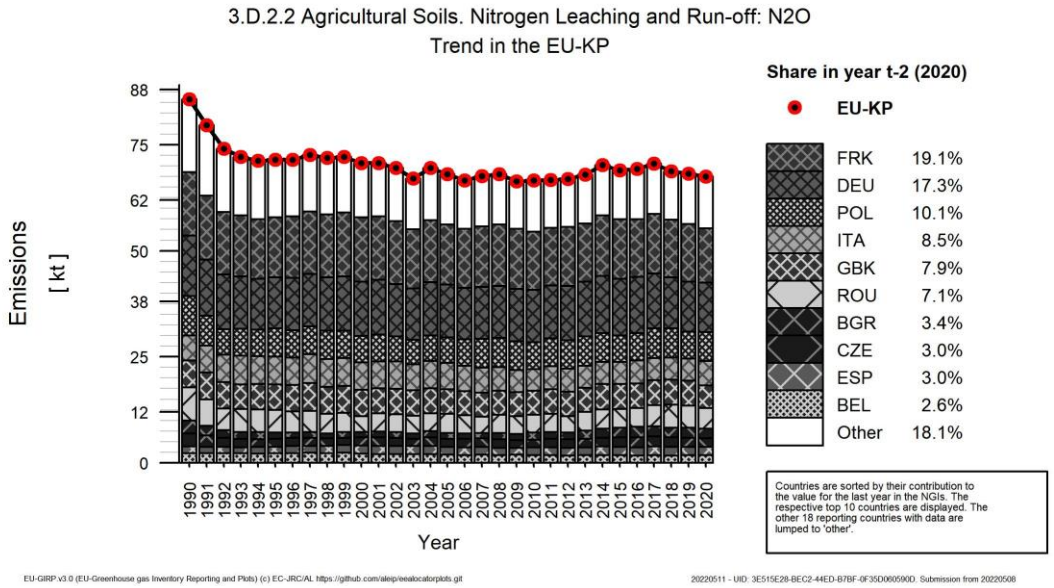
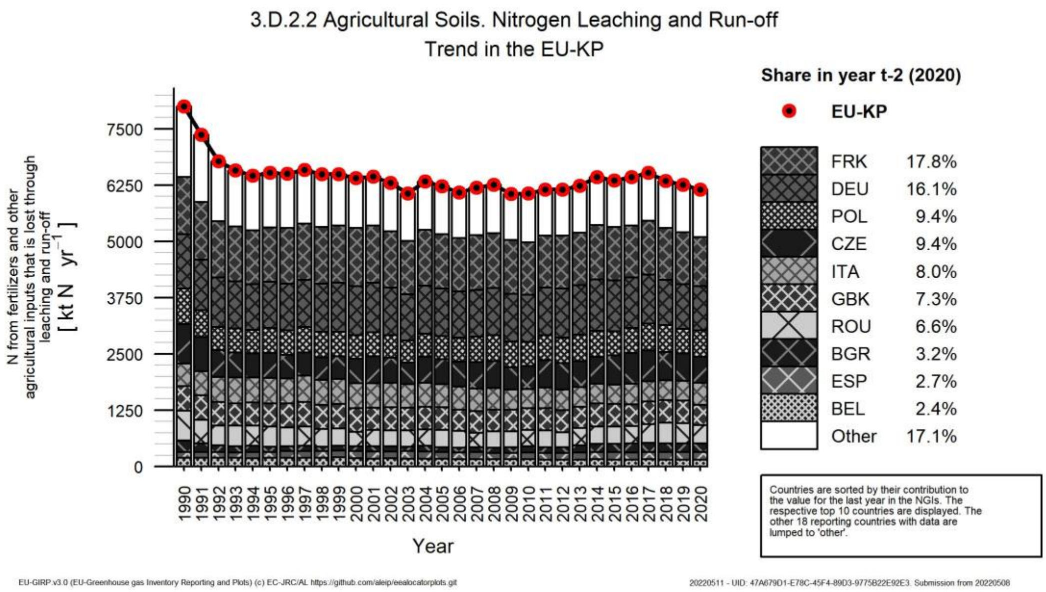


Figure 5.74: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend N leached from fertilisers and other agricultural inputs in the EU-KP and the countries contributing most to EU-KP values including their share to EU-KP emissions in 2020



5.3.5.2 Implied EFs and Methodological Issues

In this section we discuss the implied emission factor for the main N sources contributing to indirect N_2O emissions from managed soils. Furthermore, we present the most relevant parameters related with indirect N_2O emissions:

- $Frac_{GASF}$: Fraction of synthetic fertiliser N applied to soils that volatilises as NH_3 and NO_X
- $Frac_{GASM}$: Fraction of livestock N excretion that volatilises as NH_3 and NO_X
- $Frac_{LEACH}$: Fraction of N input to managed soils that is lost through leaching and run-off.

3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition

The implied emission factor for N_2O emissions in source category *3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition* increased in EU-KP barely between 1990 and 2020 by 0.72%. Figure 5.75 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.52 shows the implied emission factor for N_2O emissions in source category *3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in one country and increased in five countries. It was in 2020 at the level of 1990 in 23 countries. The largest increase occurred in Portugal with an absolute value of 0.0036 kg N_2O-N/kg N.

Figure 5.75: 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: Trend in implied emission factor in the EU-KP and range of values reported by countries

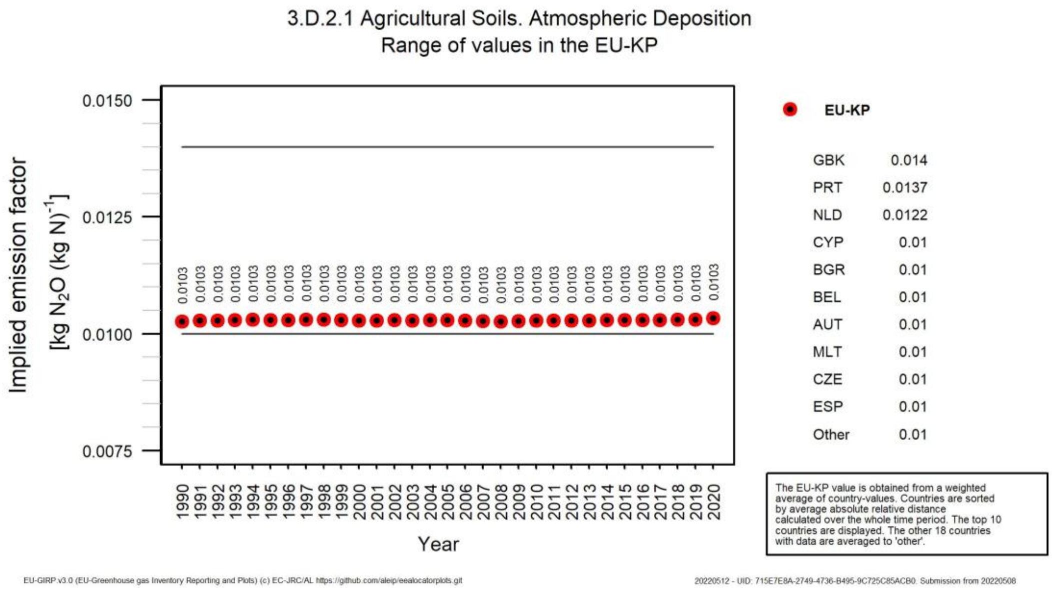


Table 5.52 3.D.2.1 - Indirect N_2O Emissions from Atmospheric Deposition: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2020		Country	1990	2020
Austria	0.010	0.010	|	Ireland	0.010	0.010
Belgium	0.010	0.010	|	Iceland	0.010	0.010
Bulgaria	0.010	0.010	|	Italy	0.010	0.010
Cyprus	0.010	0.010	|	Lithuania	0.010	0.010
Czech Republic	0.010	0.010	|	Luxembourg	0.010	0.010
Germany	0.010	0.010	|	Latvia	0.010	0.010
Denmark	0.010	0.010	|	Malta	0.010	0.010
Spain	0.010	0.010	|	Netherlands	0.011	0.012
Estonia	0.010	0.010	|	Poland	0.010	0.010
Finland	0.010	0.010	|	Portugal	0.010	0.014
France	0.010	0.010	|	Romania	0.010	0.010
United Kingdom	0.014	0.014	|	Slovakia	0.010	0.010
Greece	0.010	0.010	|	Slovenia	0.010	0.010
Croatia	0.010	0.010	|	Sweden	0.010	0.010
Hungary	0.010	0.010	|	EU-KP	0.010	0.010

3.D.2.1 - Indirect emissions from Atmospheric Deposition - $Frac_{GASF}$

The $Frac_{GASF}$, a parameter used for calculating N_2O emissions in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition*, decreased in EU-KP barely between 1990 and 2020 by 0.41%. Table 5.53 shows the $Frac_{GASF}$ in source category *3.D.2.1 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2020 for all countries and EU-KP. The $Frac_{GASF}$ decreased in nine countries and increased in seven countries. It was in 2020 at the level of 1990 in thirteen countries. The three countries with the largest decreases were Hungary, Germany and Portugal with a mean absolute value of 0.0086. The three countries with the largest increases were Italy, the Netherlands and Luxembourg with a mean absolute value of 0.0082.

Table 5.53 3.D.2.1 - Indirect emissions from Atmospheric Deposition: countries' $Frac_{GASF}$ (-)

Country	1990	2020		Country	1990	2020
Austria	0.049	0.051	|	Ireland	0.030	0.025
Belgium	0.064	0.067	|	Iceland	0.022	0.022
Bulgaria	0.064	0.064	|	Italy	0.088	0.099
Cyprus	0.100	0.100	|	Lithuania	0.056	0.057
Czech Republic	0.100	0.100	|	Luxembourg	0.032	0.037
Germany	0.042	0.034	|	Latvia	0.100	0.100
Denmark	0.053	0.052	|	Malta	0.100	0.100
Spain	0.100	0.100	|	Netherlands	0.041	0.049
Estonia	0.100	0.100	|	Poland	0.100	0.100
Finland	0.016	0.015	|	Portugal	0.060	0.054
France	0.060	0.061	|	Romania	0.100	0.100
United Kingdom	0.035	0.034	|	Slovakia	0.100	0.100
Greece	0.100	0.100	|	Slovenia	0.057	0.053
Croatia	0.100	0.100	|	Sweden	0.022	0.019
Hungary	0.064	0.052	|			

3.D.2.2 - Indirect emissions from Atmospheric Deposition - $Frac_{GASM}$

The $Frac_{GASM}$, a parameter used for calculating N_2O emissions in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition*, decreased in EU-KP slightly between 1990 and 2020 by 4.4%. Table 5.54 shows the $Frac_{GASM}$ in source category *3.D.2.2 - Indirect emissions from Atmospheric Deposition* for the years 1990 and 2020 for all countries and EU-KP. The $Frac_{GASM}$ decreased in eight countries and increased in seven countries. It was in 2020 at the level of 1990 in thirteen countries. No data were available for the Netherlands. The largest decreases occurred in Denmark and Hungary with a mean absolute value of 0.1. The three countries with the largest increases were Luxembourg, Finland and Belgium with a mean absolute value of 0.012.

Table 5.54 3.D.2.2 - Indirect emissions from Atmospheric Deposition: countries' $Frac_{GASM}$ (-)

Country	1990	2020		Country	1990	2020
Austria	0.161	0.164	|	Ireland	0.086	0.084
Belgium	0.156	0.167	|	Iceland	0.123	0.133
Bulgaria	0.200	0.200	|	Italy	0.242	0.206
Cyprus	0.200	0.200	|	Lithuania	0.200	0.200
Czech Republic	0.200	0.200	|	Luxembourg	0.179	0.192
Germany	0.194	0.147	|	Latvia	0.200	0.200
Denmark	0.182	0.086	|	Malta	0.200	0.200
Spain	0.200	0.200	|	Poland	0.200	0.200
Estonia	0.200	0.200	|	Portugal	0.141	0.132
Finland	0.076	0.088	|	Romania	0.200	0.200

Country	1990	2020		Country	1990	2020
France	0.109	0.110	|	Slovakia	0.200	0.200
United Kingdom	0.037	0.039	|	Slovenia	0.221	0.191
Greece	0.200	0.200	|	Sweden	0.173	0.159
Croatia	0.200	0.200	|			
Hungary	0.140	0.105	|			

3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off

The implied emission factor for N_2O emissions in source category *3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off* increased in EU-KP slightly between 1990 and 2020 by 2.5%. Figure 5.76 shows the trend of the implied emission factor in EU-KP indicating also the range of values used by the countries. Table 5.55 shows the implied emission factor for N_2O emissions in source category *3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off* for the years 1990 and 2020 for all countries and EU-KP. The implied emission factor decreased in one country and increased in six countries. It was in 2020 at the level of 1990 in 21 countries. No data were available for Cyprus. The largest increase occurred in Portugal with an absolute value of 0.0041 kg N_2O-N/kg N.

Figure 5.76: 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend in implied emission factor in the EU-KP and range of values reported by countries

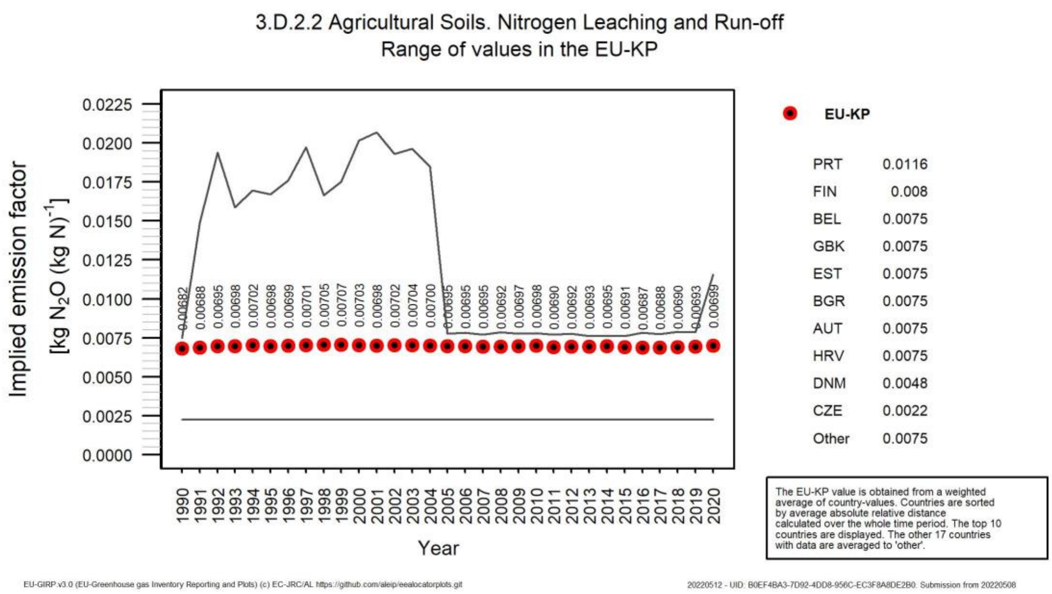


Table 5.55 3.D.2.2 - Indirect N_2O Emissions from Nitrogen leaching and run-off: countries' implied emission factor (kg N_2O-N/kg N)

Country	1990	2020		Country	1990	2020
Austria	0.0075	0.0075	|	Iceland	0.0075	0.0075
Belgium	0.0075	0.0075	|	Italy	0.0075	0.0075
Bulgaria	0.0075	0.0075	|	Lithuania	0.0075	0.0075
Czech Republic	0.0022	0.0022	|	Luxembourg	0.0075	0.0075
Germany	0.0075	0.0075	|	Latvia	0.0075	0.0075
Denmark	0.0044	0.0048	|	Malta	0.0075	0.0075

Spain	0.0075	0.0075	Netherlands	0.0075	0.0075
Estonia	0.0075	0.0075	Poland	0.0075	0.0075
Finland	0.0075	0.0080	Portugal	0.0075	0.0116
France	0.0075	0.0075	Romania	0.0075	0.0075
United Kingdom	0.0075	0.0075	Slovakia	0.0075	0.0075
Greece	0.0075	0.0075	Slovenia	0.0075	0.0075
Croatia	0.0075	0.0075	Sweden	0.0075	0.0075
Hungary	0.0075	0.0075	EU-KP	0.0068	0.0070
Ireland	0.0075	0.0075			

3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off - $Frac_{LEACH}$

The $Frac_{LEACH}$, a parameter used for calculating N_2O emissions in source category *3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off*, decreased in EU-KP slightly between 1990 and 2020 by 3.6%. Table 5.56 shows the $Frac_{LEACH}$ in source category *3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off* for the years 1990 and 2020 for all countries and EU-KP. $Frac_{leach}$ decreased in five countries and increased in two countries. It was in 2020 at the level of 1990 in 21 countries. No data were available for Cyprus. The three countries with the largest decreases were Slovakia, Denmark and Sweden with a mean absolute value of 0.1. Increases occurred in the United Kingdom and Spain with a mean absolute value of 0.0087.

Table 5.56 3.D.2.2 - Indirect emissions from Nitrogen Leaching and Run-off: countries' $Frac_{LEACH}$ (-)

Country	1990	2020	Country	1990	2020
Austria	0.152	0.152	Iceland	0.300	0.300
Belgium	0.300	0.300	Italy	0.274	0.273
Bulgaria	0.300	0.300	Lithuania	0.300	0.300
Czech Republic	0.300	0.300	Luxembourg	0.300	0.300
Germany	0.300	0.300	Latvia	0.230	0.230
Denmark	0.314	0.214	Malta	0.300	0.300
Spain	0.077	0.083	Netherlands	0.150	0.130
Estonia	0.300	0.300	Poland	0.300	0.300
Finland	0.300	0.300	Portugal	0.300	0.300
France	0.251	0.251	Romania	0.300	0.300
United Kingdom	0.179	0.190	Slovakia	0.241	0.124
Greece	0.300	0.300	Slovenia	0.300	0.300
Croatia	0.300	0.300	Sweden	0.166	0.124
Hungary	0.300	0.300			
Ireland	0.100	0.100			

5.3.6 Agriculture- non-key categories

Table 5.57 shows the aggregated GHG emissions of non-key categories from source categories 3C, 3E, 3F and 3G-I by each country for the year 2020. Total CO_2 emissions is around 12.58 kt, with the highest CO_2 emissions by Germany. CH_4 emissions from 'Rice Cultivation' is the largest by Italy (63.33kt), followed by Spain (16.74kt). Total CH_4 emissions from 'Rice Cultivation' is 98.71 kt. CH_4 emissions from 'Field burning of agricultural residues', is the largest by Romania (12.98 kt), whilst total EU-KP is 20.29 kt. Total CH_4 EU-KP emissions ('Rice Cultivation' and Field burning of agricultural residues') is 119 kt, with the highest top emitters being Italy, Romania, Spain. Total N_2O emissions for EU-KP is 0.62 kt in 2020, with Romania having the highest emissions (0.4 kt). CH_4 and N_2O emissions from 'Prescribed burning of savannas' are not reported by the countries.

Table 5.57 Aggregated GHG emissions from non-key categories in the agriculture sector

Country	2020	CO_2 (kt)	CH_4 (kt) Rice Cultivation	CH_4 (kt) Field burning of agricultural residues	N_2O (kt) Field burning of agricultural residues
AUT		150.78	-	0.02	0.00
BEL		182.87	-	-	-
BGR		33.04	4.26	1.17	0.03
CYP		0.23	-	0.02	0.00
CZE		341.93	-	-	-
DEU		2,730.80	-	-	-
DNM		184.71	-	0.15	0.00
ESP		559.56	16.74	0.81	0.02
EST		15.60	-	-	-
FIN		200.18	-	0.08	0.00
FRK		2,032.25	1.56	1.26	0.03
GBE		1,627.65	-	0.00	0.00
GBK		1,627.65	-	0.00	0.00
GRC		34.80	5.53	0.94	0.02
HRV		75.66	-	-	-
HUN		216.83	0.71	0.01	0.00
IRL		435.88	-	-	-
ISL		5.87	-	-	-
ITA		429.58	63.33	0.59	0.01
LTU		28.19	-	-	-
LUX		14.61	-	-	-
LVA		54.87	-	-	-
NLD		85.16	-	-	-
POL		1,122.67	-	0.92	0.04
PRT		41.81	5.41	1.33	0.07
ROU		128.58	1.16	12.98	0.40
SVK		68.25	-	-	-
SVN		28.18	-	-	-
SWE		122.85	-	-	-
EU-KP		12,581.04	98.71	20.29	0.62

5.4 Uncertainties

Table 5.58 shows the total EU-28 uncertainty estimates for the sector Agriculture and the uncertainty estimates for the relevant gases of each source category. The highest-level uncertainty was estimated for N_2O from 3D and the lowest for CH_4 from sector 3A. With regard to the uncertainty on trend N_2O from sector 3J shows the highest uncertainty estimates, CH_4 from sector 3A the lowest. For a description of the Tier 1 uncertainty analysis carried out for the EU-28 see Chapter 1.6.

Table 5.58 Sector Agriculture: EU-28 uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2020	Emission trends Base Year-2020	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
3.A Enteric Fermentation	CO2	0	0	0,0%	0,0%	0,0%
3.A Enteric Fermentation	CH4	236.133	185.248	-21,5%	11,6%	1,3%
3.A Enteric Fermentation	N2O	0	0	0,0%	0,0%	0,0%
3.B Manure Mangement	CO2	0	0	0,0%	0,0%	0,0%
3.B Manure Mangement	CH4	49.938	41.292	-17,3%	18,2%	1,3%
3.B Manure Mangement	N2O	30.488	22.124	-27,4%	57,6%	8,4%
3.C Rice Cultivation	CO2	0	0	0,0%	0,0%	0,0%
3.C Rice Cultivation	CH4	2.446	2.022	-17,3%	18,0%	20,1%
3.C Rice Cultivation	N2O	0	0	0,0%	0,0%	0,0%
3.D Agricultural Soils	CO2	0	0	0,0%	0,0%	0,0%
3.D Agricultural Soils	CH4	0	0	0,0%	0,0%	0,0%
3.D Agricultural Soils	N2O	195.106	158.924	-18,5%	83,1%	8,4%
3.E Prescribed burning of savannas	CO2	0	0	0,0%	0,0%	0,0%
3.E Prescribed burning of savannas	CH4	0	0	0,0%	0,0%	0,0%
3.E Prescribed burning of savannas	N2O	0	0	0,0%	0,0%	0,0%
3.F Field Burning of Agricultural Residues	CO2	0	0	0,0%	0,0%	0,0%
3.F Field Burning of Agricultural Residues	CH4	1.574	701	-55,5%	50,3%	28,7%
3.F Field Burning of Agricultural Residues	N2O	336	251	-25,3%	48,4%	5,1%
3.G Liming	CO2	10.289	6.016	-41,5%	23,0%	5,5%
3.G Liming	CH4	0	0	0,0%	0,0%	0,0%
3.G Liming	N2O	0	0	0,0%	0,0%	0,0%
3.H Urea application	CO2	3.486	3.525	1,1%	23,2%	2,6%
3.H Urea application	CH4	0	0	0,0%	0,0%	0,0%
3.H Urea application	N2O	0	0	0,0%	0,0%	0,0%
3.I Other carbon-containing fertilizers	CO2	967	695	-28,2%	16,0%	4,0%
3.I Other carbon-containing fertilizers	CH4	0	0	0,0%	0,0%	0,0%
3.I Other carbon-containing fertilizers	N2O	0	0	0,0%	0,0%	0,0%
3.J Other	CO2	0	0	0,0%	0,0%	0,0%
3.J Other	CH4	0	1.313	475758,2%	22,4%	106382,8%
3.J Other	N2O	0	253	202928,8%	97,6%	197990,8%
3 (where no subsector data were submitted)	all	1.682	1.406	-16,4%	47,2%	39,1%
Total - 3	**all**	**532.447**	**423.768**	**-20,4%**	**31,9%**	**3,2%**

Note: Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions of the EU-NIR because uncertainty estimates are not available for all source categories in each of this 28 EU countries

5.5 Sector-specific quality assurance and quality control and verification

5.5.1 Introduction

This section gives an overview of the QA/QC procedures applied specifically for the agriculture sector of the EU GHG inventory. It first gives an overview of the development of the agriculture QA/QC system with an outlook of further improvements to be discussed and/or implemented in coming years. A brief description of the QA/QC procedures used to process the data and interact with the countries is given. A brief summary of selected activities that have been carried out in the past to improve and/or verify national and EU wide GHG emissions from agriculture in the frame of the EU GHG inventory system is found in the inventory report of 2020[42].

Main improvements since 2019

Since the 2019 submission, a new check has been introduced on the correlation between milk yield versus feed digestibility and nitrogen excretion rates. Several parts of the code have been revised to align with current programming libraries the system implemented in 2015 was further developed. In

[42] https://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2020

2022, an analysis of the contribution of each member state to the total dairy cattle population of the EU as a driver for the CH_4 IEF for enteric fermentation from dairy cattle was added (Table 5.13), in order to address a recommendation received from the UNFCCC's expert review team (ERT).

5.5.2 QA/QC system in the agriculture sector

Quality checks

Several quality checks are performed in the EU-GIRP[43] software. They are documented in various modules of EU-GIRP and can be examined in the open source repository. The checks include:

- **Recommendations**: Country were checked if they had implemented last years' recommendations from the ESD review and from the UNFCCC review.
- **Check on NEs**[44] and empty cells has been done by extracting all reported 'NE's from the data base.
- **Notation keys**: we identified emission categories where a country reported a notation key, while 22 or more countries reported emission estimates, in order to assess the potential over/underestimations (these also contained in NE checks and reporting of identical values as in previous submission).
- **Outliers in activity data and emissions**: Data were checked on outliers in AD and emissions. For each source category the share of AD and emissions by the countries to total EU-KP values were determined. A share above 95% was further assessed and in case this was not linked to a source category which is dominated by single countries (such as emissions from buffalo, which are dominated by Italy) the country was notified.
- **Check on erroneous units**: In several case, countries report background data using different units (e.g. fractions instead of percent values or vice versa; values per day instead of per year of vice versa; absolute values instead of values per head etc.). While these inconsistencies do not influence the reported emission estimates, a harmonization (at EU-KP level) is important to ensure correct comparison of countries' values and a correct calculation of EU-KP background data. An automated check[45] is carried out detecting *three* cases which can easily be recognised. Other 'mistakes' in units used were detected following the outlier analysis (see below). The countries were notified via the review tool and in many cases corrections have already been implemented.
- **Within-country outliers**: within-country outliers in IEFs and other parameters are detected on the basis of the distribution of the values provided[46]. We used the method based on the mean values and the standard deviation. Specifically, those values were identified as outliers which were more distant from than 1.5 time the standard deviation in the data from the mean (both in positive and negative direction). As an additional criterium, the relation to the median was used. In case the value was within 10% of the median it was not considered as an outlier. This

43 EU-GIRP: EU-Greenhouse gas Inventory Reporting and Plots, see https://github.com/aleip/eealocatorplots.git

44 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checknes.r

45 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkunits.r

46 https://github.com/aleip/eealocatorplots/blob/master/eugirp_checkoutliers.r

removed cases where a country uses a country-specific parameter while most countries use the default value.

- **Identification of potentially significant issues**: For each of the outliers identified it was determined whether or not this could be a potentially significant issue based on the criterium of a share of 0.5% of national total GHG emissions. The 'size' of the possible over- or under-estimation was quantified comparing the reported value with an estimate using the median IEF or parameter as reported by all countries[47]. All outliers were 'manually' cross-checked and analysed. Countries were notified on the results of the analysis.

- **Time series outliers/inconsistencies**: Time series outliers were detected on the basis of the same method as also used for the within-country-outlier check. Basis for the underlying distribution of data in this case, however, was not the values reported from all countries during the whole time series, but only the data reported by the country assessed. Only growth rates larger than ±3% could qualify as 'outliers'. However, this generated a large number of potential outliers which require further assessment. The following types of 'issues' were identified, which might be linked either to an inconsistent time series or be the consequence of 'real' trends:

  – *Period outphased*: Relative constant trend with few years above/below the trend that 'looks plausible'.

  – *Trend break*: Timeseries in steps, in a stair shape: a few similar values, then a jump, and the same again.

  – *One break group trend*: Regular timeseries with a different trend for a group of years, and a step when jumping from/coming back to the general trend.

  – *Inflection point*: Trend suddenly changes from a specific year from which the growth of the values changes sign.

  – *Single outlier*: One or few isolated year(s) where the value is out of the general trend

  – *Smooth group trend change*: A series of years where the trend changes compared to the rest of the time series, but without any jumps

  – *Trend jump*: There is a jump at some point in the time trend but it continues running parallel to the first section, after the jump.

  – *Jump and shape*: There is a jump at some point in the time trend and, after the jump, the trend changes shape

- **Sector-specific checks**: Several checks were performed tailored to the reporting in the sector agriculture[48,49]. First, the data are checked on consistency in reporting of activity data throughout the tables. Further, several other tests are performed:

  – Difference between the sum of nitrogen excreted and reported in the different manure management system (MMS) versus the total reported nitrogen excreted.

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47 See function `ispotentialissue()` in the file https://github.com/aleip/eealocatorplots/blob/master/eugirp_functions.r

48 https://github.com/aleip/eealocatorplots/blob/master/agrichecks1ADs.r

49 https://github.com/aleip/eealocatorplots/blob/master/agrichecks2Nex.r

- Difference between the total nitrogen excreted and the product of animal population and nitrogen excretion rate.
- Difference of the sum of N handled in MMS over animal type vs. total N handled in each MMS.
- Check of the reported IEF per MMS with the total N excreted and the reported emissions.
- Calculation and evaluation of the IEF in category 3.B.2 by animal type and in relation to the total N excreted.
- Check that the sum of manure allocated to climate regions adds up to 100% over all MMS and climate regions.
- Check that compares the Manure ‘managed’ in Pasture Range and Paddock in category 3.B.2 with AD in 3.D.1.3 (Urine and Dung Deposited by Grazing Animals). The sum of FRPR over all animal types should therefore equal the AD in category 3.D.1.3.
- Comparison of the IEF in 3.D.1.3 (N_2O emissions from Urine and Dung Deposited by Grazing Animals) with default IEFs EF3_RPR_CPP for Cattle - Pigs and Poultry (0.02) and, EF3_RPR_SO for Sheep and other animals (0.01) using the shares FracRPR_CPP and FracRPR_SO of manure deposited by the two animal groups.
- Comparison of the fraction of N lost in MMS (via volatilization of NH_3+NO_x) versus total managed manure. According to IPCC Table 50.22[50] most of the loss fractions are between 20% and 45% of N in managed manure and N loss ratios are identified that are higher than 45% or lower than 20%.
- Comparison of the manure ‘managed’ and not lost as NH_3+NO_x or leaching in MMS (3B2) with Animal manure applied to soil (3D12a). Manure available for application is obtained from N managed in MMS and not lost (FracLOSSMS) according to IPCC Table 10.23[51] plus any addition of bedding material. The loss fractions in Table 10.23 include also losses of N2, which are not included in the indirect emissions-volatilisation. Therefore, FAM is expected to be smaller than N managed in MMS minus N lost as NH_3+NO_x+leaching unless bedding material has been accounted for. In case of crop residues as bedding material care has to be taken to avoid double counting.

- **Recalculation**: Countries were asked for justifications of recalculations of more than 0.5% of national total emissions (excluding LULUCF) and above or below the mean recalculations across all MS ±1.5 standard deviations.

A slight higher number of issues were identified (164 for 2020) compared to last year (135 issues were identified for 2019):

- 27 completeness issues (related to ‘NE’/’empty’/’notation keys’)
- 19 country-outlier issues
- 17 time trend issues
- 15 agricheck issues
- 83 recommendations (ESD and UNFCCC review)

[50] IPCC Guidelines 2006, Vol. 4, Chapter 10.

[51] IPCC Guidelines 2006, Vol. 4, Chapter 10.

- 3 recalculation issues

The status of responses as of April 8, 2022 is given in Table 5.59:

Table 5.59 Status of issues as of May 16, 2022

	Resolved	Partially resolved	Unresolved	Not yet responded
Completeness	81%	19%	0%	0%
Outlier	74%	26%	0%	0%
Timeseries	82%	18%	0%	0%
Agricheck	67%	33%	0%	0%
Recommendations	45%	55%	0%	0%
Recalculations	100%	0%	0%	0%

Calculation of EU background data

EU-wide background data were calculated as weighted averages of the parameters provided by the countries, using activity data (animal numbers in category 3A and 3B and N input in category 3D) as weighting factors[52].

Care is being taken to not include in the calculation erroneous values:

- Data which had been identified as being reported with a different unit than the values reported by other countries (see above) were *converted* into the appropriate unit before calculating EU-KP weighted averages
- Data which *obviously* wrong (very large outliers) but for which no clear correction could be identified were *eliminated* from the calculation of the EU-KP weighted averages to avoid biases in the results. Therefore, the EU-KP weighted averages - in some cases - could not represent 100% of EU-KP activity data.

Compilation of the chapter agriculture for the EU-GHG inventory report

The agriculture chapter of the EU-GHG inventory report takes advantage of the data base generated by EU-GIRP. All numeric data presented in the chapter are calculated directly using the processed data as described above, thus eliminating the risk of transcription or copy errors. This does not eliminate the possibility of mistakes completely. Therefore, all values are cross-checked.

5.6 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

Table 5.60 to Table 5.62 provide information on the contribution of Member States to EU-KP recalculations in sectors 3A (CH_4), 3B (CH_4 and N_2O) and 3D (N_2O) for 1990 and 2020 and main explanations for the largest recalculations in absolute terms.

52 https://github.com/aleip/eealocatorplots/blob/master/eugirp_euweightedaverages.r

Table 5.60 3A Enteric fermentation: Contribution of MS to EU-KP recalculations in CH_4 emissions for 1990 and2020 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

Country	1990		2020		Explanations for 1990	Explanations for 2020
	kt CO_2	%	kt CO_2	%		
Austria	-308	-6.4	-299	-7.4	Emissions of cattle and swine were calculated on the basis of the refined methodologies outlined in the IPCC 2019 Refinement to the 2006 IPCC GL allowing a dynamic use of national parameters. Improved feeding and nutrition values were implemented (see above).	
Belgium	-13	-0.3	-21	-0.5	In Flanders, revision of the fat percentage of the milk for dairy cows for the whole time series	
Bulgaria	-	-	-	-		
Croatia	-	-	-	-		
Cyprus	-	-	-	-		
Czechia	-	-	0.6	0.0		
Denmark	-0.0	-0.0	-24	-0.6		Change in the national Ym for dairy cattle for 2018 and 2019.
Estonia	-2.6	-0.2	-19	-3.6	The methodology for calculating the percentage of cows which gave birth in a year was updated for the 2022 submission for 1990-2019.	
Finland	-	-	-0.5	-0.0		Fur-bearing animal numbers were updated for the year 2019
France	-1.5	-0.0	-21	-0.1		- Slight upward revision of milk production for dairy cattle from 2000 to 2007 and in 2019, which leads to a slight increase in EF CH_4. - Other cattle: correction of the population of young cattle in 2007, then from 2011, update of the statistics which redistribute the numbers between sub-categories. - For pigs: revision of the distribution between sub-categories. - For horses, mules, donkeys and goats: revision of the overseas departments (from 2016), and metropolitan France (2019 only)
Germany	347	1.1	528	2.2	update of average total energy intake for cattle and swine	
Greece	86	2.1	-24	-0.7	update of weight and digestibility of feed of dairy cattle.	
Hungary	-	-	24	1.2	update of nutritional values of raw milk and parameters calculated from them, and to correct a previous data entry error.	
Ireland	-	-	-3.3	-0.0		Revised estimates of replacement heifer populations for 2018 and 2019 and revised sheep numbers for 2019
Italy	68	0.4	123	0.9		emissions of dairy cattle since 2004 have been updated, considering weighted average of Ym for lactating and dry cows, as indicated in the 2019 IPCC Refinement; emissions of sheep have been updated for the whole time series, considering weighted average of Ca parameter for time spent on pasture and housing.
Latvia	-	-	-	-		
Lithuania	-	-	-	-		
Luxembourg	4.4	1.1	-7.8	-1.9	Digestibility energy expressed as a percentage of gross energy for lactating dairy cows for the years 1990-2020 was revised.	
Malta	5	10.6	-0.2	-0.4	Update of livestock population and removal of enteric fermentation emissions from poultry.	
Netherlands	0.3	0.0	-	-	The number of mules and asses between 1990 and 2010 has been estimated for the first time.	
Poland	-	-	1.2	0.0		Correction of population of goats and horses.
Portugal	-0.3	-0.0	8.3	0.2		Revision in the livestock numbers from 2017 onwards; Update in the database used for the determination of emission

Country	1990		2020		Explanations for 1990	Explanations for 2020
	kt CO_2	%	kt CO_2	%		
						factors from enteric fermentation of sheep and goats from 1998 onwards.
Romania	0.0	0.0	-	-		
Slovakia	-	-	-	-		
Slovenia	-	-	-0.5	-0.1		The 2017-2019 horse number data has been updated based on the recently released Census of Agriculture 2020 data.
Spain	-	-	-	-		
Sweden	-2.5	-0.1	-1.9	-0.1	- Updated method to estimate number of swine living shorter than one year from slater statistics, from 1990. - Updated time series of number of reindeer from 1990-2015.	
United Kingdom	146	0.6	27	0.1	- Dairy cattle: Revised forage diet composition and use, concentrate composition and feed rates; Revisions to live weights (from 2008), milk yield (from 2016) and milk protein (Guernsey cows 2010); Changes to dairy cattle ages for conception, calving and death and update to dairy cow breakdown across different management regimes (NI only); - Non-dairy cattle: Revised forage diet composition and use, concentrate composition and feed rates for dairy animals; - Sheep: Minor revisions to sheep sector EFs that are derived from statistical analysis of UK field study data. - Goats: Enteric methane EF for goats increased according to IPCC 2019 refinement to GL.	
EU27+UK	**329**	**0.1**	**290**	**0.2**		
Iceland	-0	-0.0	-0.0	-0.0		
United Kingdom (KP)	146	0.6	27	0.1		
EU-KP	**329**	**0.1**	**290**	**0.2**		

Table 5.61 3B Manure Management: Contribution of MS to EU-KP recalculations in CH_4 emissions for 1990 and2020 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	21	3.8	19	3.6	New country-specific study on animal feeding and use of the 2019 Refinement to the IPCC GL	
Belgium	-1.7	-0.1	-4.9	-0.4	In Flanders, revision of the fat percentage of the milk for dairy cows for the whole time series	
Bulgaria	-	-	-	-		
Croatia	-	-	-	-		
Cyprus	8.6	12	8.2	17	The manure management systems have been updated for cattle, swine and poultry due to new information provided by the Department of Environment and the Department of Agriculture.	
Czechia	-198	-11	-164	-32	Upgrade to tier 2 methodology for swine.	
Denmark	2.2	0.1	31	1.4	Changes have been made in configuration of the model IDA so emissions from biogas treated slurry is included in a more suitable constellation. This gives changes in the distribution on manure management systems. Further more updated data from the BIB – register (Biomass Input to Biogas production) for the years 2015-2019 have been received from the Danish Energy Agency.	
Estonia	9.2	6.0	21	15.5	Methane emission factor for manure management for calves aged 0-6 months and calves aged 6-12 months was recalculated for 1990-2019 due to a calculation error Values for distribution of cattle and swine manure management systems were updated for 2015-2019 due to new research (Kaasik, A. 2020).	
Finland	-	-	0.8	0.2		Fur-bearing animal numbers were updated for the year 2019. The distribution of manure management systems for dairy cattle was updated for the period 2013-2019 based on the new farm survey

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						results published by Luke Statistical Services in November 2021.
France	-14	-0.4	3.3	0.1		- For all categories: downward revision of the 2019 average annual temperature, impacting the values of the MCF parameter. - For dairy cows: update of milk production (from 2000 to 2007 and 2019 leading to an increase in VS and Nex) and numbers (in 2018 on the increase). - For other cattle: update of statistics, with a redistribution of numbers between sub-categories - For pigs: update of the distribution between sub-categories- - For sheep, goats, horses: revision of the MCF for the overseas departments.
Germany	386	5.2	613	11		Changes in VS excretion due to changed energy intake and feeding data
Greece	27	3.5	-12	-1.9	update of weight and digestibility of feed of dairy cattle.	
Hungary	15	1.3	-18	-2.8	Animal manure used in “digesters” has been reported at the first time.	
Ireland	-	-	-0.5	-0.0		Revised estimates of replacement heifer populations for 2018 and 2019 and revised sheep numbers for 2019.
Italy	-0.1	-0.0	6.5	0.2	- Recalculated EF CH_4 for grazing for cattle and buffalo since 1990 with average MCF value for cool and temperate zones, based on the distribution of livestock between these zones; - EF CH_4 update from equine and sheep/goat manure management since 1990: EFs are weighted averages of the 2006 IPCC cool and temperate EFs, with updated values assigned to provinces consistent with the update of provincial mean temperatures based on SCIA data; - corrected the provincial distribution of methane emissions from manure management with data from the 2010 census, this resulted in a slight change in the EFs from manure management of sheep, goats and horses; - updated 2019 rabbit data; - corrected the formula for calculating the biogas produced, which affects the estimate of N at digesters the whole time series for dairy cattle and non-dairy cattle and, to a small extent, from 1991 to 2004 also for pigs.	
Latvia	-	-	-	-		
Lithuania	-	-	-3.0	-1.3		More accurate information on usage of anaerobic digester manure management system for swine for the period of 2017 – 2019.
Luxembourg	1.0	2.2	-1.8	-2.9		The manure management system were updated using more recent data, although so far only MMS-pasture using provisional data from the 2020 agriculture census.
Malta	-5.4	-38	-6.3	-57	Implementation of the 2019 IPCC Refinements and recommendations from ESD and UNFCCC.	
Netherlands	-2.0	-0.0	-6.9	-0.2	Not reported in the NIR	
Poland	-	-	0.1	0.0		Correction of population of goats and horses.
Portugal	-4.5	-0.6	4.5	0.6		New distribution between "cool" and "temperate" climatic regions, based on 2019 Agriculture Census data. Update of Daily Volatile solids excreted (VS).
Romania	-	-	-	-		
Slovakia	-	-	-	-		
Slovenia	-	-	-0.1	-0.0		The 2017-2019 horse number data has been updated based on the

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						recently released Census of Agriculture 2020 data.
Spain	0.8	0.0	-6.2	-0.1		Implementation of new zootechnical data for turkeys and ducks.
Sweden	0.2	0.1	-3.0	-1.1	Updated method to estimate number of swine living shorter than one year from slater statistics, from 1990.	
United Kingdom	-103	-2.4	-155	-3.9	- Dairy cattle: revised forage diet composition and use, concentrate composition and feed rates; Revisions to live weights (from 2008), milk yield (from 2016) and milk protein (Guernsey cows 2010); Changes to dairy cattle ages for conception, calving and death and update to dairy cow breakdown across different management regimes (NI only); Update to the amounts of manure going to anaerobic digestion from 2006. - Non-dairy cattle: revised forage diet composition and use, concentrate composition and feed rates for dairy animals; Update to the amounts of manure going to anaerobic digestion from 2006 Sheep: small update in ewe housing period -Swine: Negligible changes to amounts of manure going to anaerobic digestion from 2014. - Goats and Horses: Manure management EF revised according to IPCC 2019 refinement to GL - Poultry: Updated VS excretion rate according to IPCC 2019 refinement to GL; Changes in poultry allocation to housing management systems; Updated quantities of litter going to incineration and anaerobic digestion (from 2016).	
EU27+UK	**142**	**0.3**	**325**	**0.8**		
Iceland	4.9	8.3	1.7	3.0	Update of the gross energy (GE) for mature dairy cattle. An update of GE influences the calculation of the volatile solid excretion rates (VS).	
United Kingdom (KP)	-103	-2.4	-155	-3.9	- Dairy cattle: revised forage diet composition and use, concentrate composition and feed rates; Revisions to live weights (from 2008), milk yield (from 2016) and milk protein (Guernsey cows 2010); Changes to dairy cattle ages for conception, calving and death and update to dairy cow breakdown across different management regimes (NI only); Update to the amounts of manure going to anaerobic digestion from 2006. - Non-dairy cattle: revised forage diet composition and use, concentrate composition and feed rates for dairy animals; Update to the amounts of manure going to anaerobic digestion from 2006 Sheep: small update in ewe housing period -Swine: Negligible changes to amounts of manure going to anaerobic digestion from 2014. - Goats and Horses: Manure management EF revised according to IPCC 2019 refinement to GL	
EU-KP	**147**	**0.3**	**327**	**0.8**		

Table 5.62 3B Manure Management: Contribution of MS to EU-KP recalculations in N_2O emissions for 1990 and2020 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	136	31.3	91	21	New country-specific study on animal feeding and use of the 2019 Refinement to the IPCC GL	
Belgium	-0.1	-0.0	-0.6	-0.1		In Wallonia, there was a revision of the amounts of N loss by deposition & N loss by leakage between 2013 and 2019 due to an update of parameters in NH3 calculations.
Bulgaria	-26	-2.8	-3.9	-1.3		
Croatia	-	-	-	-		
Cyprus	-2.1	-3.2	-2.6	-3.8	The manure management systems have been updated for cattle, swine and poultry due to new information provided by the Department of Environment and the Department of Agriculture.	
Czechia	-2.1	-0.2	-6.3	-1.4	Purpose of this recalculation has been a national ammonia and NOx emissions inventory improvement by utilisation of Tier 2 approach with implementation of some ammonia abatement measures.	

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
					There were made a several changes in calculation with different consequences: AWMS system includes anaerobic digesters since 2016; - Implementation of the new AWMS change the share of nitrogen in solid management system from 82% in submission 2020 to 88% in submission 2021 - Update of FracLOSS recommended by review team for submission 2021, increase the quantity of nitrogen in solid and liquid MS by about 5 % in submission 2021 - Implementation of country specific value of Nex caused decrease of nitrogen available in solid and liquid MS by about 20 % since submission 2021	
Denmark	0.4	0.0	21	3.2	The changes in the configuration of the model IDA mentioned above gives changes in both direct and indirect emission of N_2O from manure management. It increases the emission of direct emission, while the emission of indirect emission is decreased due to a combination of the changes manure management systems and changes in the NH3 emission calculations. The NH3 emission from manure management is changed due to changes in EF and distribution of NH3 reducing technology.	
Estonia	-41	-27	4.3	6.5	Methodology for calculating and the values for nitrogen intake for cattle were updated for 1990-2019 due to new research.	
Finland	-	-	2.7	1.0		Fur-bearing animal numbers were updated for the year 2019. The distribution of manure management systems for dairy cattle was updated for the period 2013-2019 based on the new farm survey results published by Luke Statistical Services in November 2021.
France	0.5	0.0	31	1.3		- For dairy cows: update of milk production (from 2000 to 2007 and 2019 leading to an increase in VS and Nex) - For other cattle: update of statistics, with a redistribution of numbers between sub-categories - For pigs: update of the distribution between sub-categories. - For indirect N_2O emissions linked to redeposition: upward revision of NH3 emissions in broiler chickens.
Germany	33	0.9	-0.2	-0.0	Update of N-excretions, because of the energy requirement and feed-related changes in suckler cows, fattening pigs and fattening chickens as well as the consideration of new data on grazing from the agricultural census 2020.	
Greece	16	4.9	-7.1	-2.5	update of weight and digestibility of feed of dairy cattle.	
Hungary	-3.1	-0.4	-25	-5.5	Animal manure used in “digesters” has been reported at the first time.	
Ireland	-0.1	-0.0	-0.3	-0.0		Revised estimates of replacement heifer populations for 2018 and 2019 and revised sheep numbers for 2019.
Italy	17	0.6	-15	-0.7	- corrected EFs NH3 housing for 2019 for non-dairy cattle and buffaloes categories; - updated equine and sheep and goat housing NH3 emission factors for the whole time series; - modified the formula for estimating NH3 emissions from storage for cattle, pigs and poultry by subtracting from N at housing also the amount of N at digesters before multiplying by the emission factor; - included in storage estimates NH3 emission factors for equine and sheep and goat for the whole time series; - updated N excreted dairy cattle for 2019 based on updated protein percentage in milk; updated 2019 rabbit data; - corrected the formula for calculating the biogas produced, which affects the estimate of N at digesters the whole time series for dairy cattle and non-dairy cattle and, to a small extent, from 1991 to 2004 also for pigs.	
Latvia	1.0	0.3	-0.8	-1.0	Corrected numbers of nitrogen that is lost due to volatilisation of NH3 and NOx due to use EMEP/EEA 2019 Guidelines instead of EMEP/EEA 2016 Guidelines and improvements of calculations.	

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Lithuania	-	-	-0.7	-0.4	- IFA has provided data on inorganic N fertilizers consumption for 2019 only in October of 2021, therefore emissions from the category 3.D.1.1 Inorganic N fertilizer for 2019 was recalculated; - Recalculations for 3.D.1.2.a Animal manure applied to soils were made due to recalculations made in CRF 3.B.2 Manure management category and the emissions from anaerobic digester system of swine category was included, also typing error for non-dairy cattle and swine categories were corrected; - 3.D.1.6 Cultivation of organic soils were made due to recalculations made in the LULUCF sector for the whole period.	
Luxembourg	-0.2	-0.7	0.9	3.4	- Adapted manure management system affected the quantities of animal manure applied to soil, as well as the urine and dung deposited by grazing animals; - The NH3-N Emission factor for grazing for dairy cattle and non-dairy cattle was revised according to the 2019 EMEP/EEA guidelines, affecting the indirect N_2O emissions from atmospheric deposition of N volatilised from managed soils. - Estimates for compost for the year 1993-1999 were derived, impacting the different N emissions in these years, and hence direct and indirect N_2O emissions. - The quantities of digestate originating from energy crops and non-agricultural waste were revised using additional unpublished sources and correcting for missing values, and hence impacting the direct and indirect N_2O emissions. - Estimates on the mineralisation associated with loss of soil organic matter from land use changes were revised for the period 1990-2020, and hence impacting N_2O emissions. - The provisional activity data for sewage sludge for the year 2019 were replaced by published data.	
Malta	8.0	45	3.7	30	Implementation of the 2019 IPCC Refinements and recommendations from ESD and UNFCCC.	
Netherlands	-2.4	-0.3	0.0	0.0	Not reported in the NIR	
Poland	-	-	0.3	0.0		Correction of population of goats and horses.
Portugal	-0.2	-0.1	26	13.9	Not reported in the NIR	
Romania	-	-	-	-		
Slovakia	-	-	-	-		
Slovenia	-1.6	-1.8	-0.4	-0.5	- Emission factors for ammonia from the tied dairy cow housing system were updated. - The percentage of total ammonia-N in the liquid fraction formed in the farmyard manure system was increased - Estimates of indirect nitrous oxide emissions have been revised - The 2017-2019 horse number data has been updated based on the recently released Census of Agriculture 2020 data.	
Spain	-13	-0.9	-5.1	-0.3		Implementation of new zootechnical data for turkeys and ducks.
Sweden	0.3	0.1	-2.9	-0.9	Updated method to estimate number of swine living shorter than one year from slater statistics, from 1990.	
United Kingdom	218	6.8	122	4.5	Revised diet parameters for dairy animals; Small revisions to live weights, milk yield and milk protein; Changes to dairy cattle ages for conception, calving and death and update to dairy cow management regimes (NI only); Update to the amounts of manure going to anaerobic digestion; Small update to straw N content and ewe housing period; Inclusion of Bedding N in emission calculations; Updated poultry allocation to housing management systems; Revision to N excretion rates; Updated EF4; Revised estimates of nitrate leaching.	
EU27+UK	**339**	**1.1**	**232**	**1.1**		
Iceland	-0.4	-1.6	-0.1	-0.4	Update of the N-flow methodology from the 2016 EMEP/ EEA Air Pollution Inventory Guidebook to its newest 2019 edition.	
United Kingdom (KP)	218	6.8	122	4.5	Revised diet parameters for dairy animals; Small revisions to live weights, milk yield and milk protein; Changes to dairy cattle ages for conception, calving and death and update to dairy cow management regimes (NI only); Update to the amounts of manure going to anaerobic digestion; Small update to straw N content and ewe housing period; Inclusion of Bedding N	

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
					in emission calculations; Updated poultry allocation to housing management systems; Revision to N excretion rates; Updated EF4; Revised estimates of nitrate leaching	
EU-KP	**339**	**1.1**	**232**	**1.1**		

Table 5.63 3D Agricultural Soils: Contribution of MS to EU-KP recalculations in N_2O emissions for 1990 and 2020 (difference between latest submission and previous submissions in kt CO_2 equivalents and percent)

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	144	6.5	13	0.7	Revisions have been carried out for the entire time series as a result of the updated livestock data, revised feeding and excretion values for specific animal categories as well as the impro-ved biogas calculation	
Belgium	-0.0	-0.0	35	1.1		In Flanders, update of NH3-N and applied N for inorganic N Fertilizers for 2019. In Flanders, update of amount of animal manure processed and/or exported for 2019. In the Brussels-Capital Region, the revision of the number of animals from 2011 on, and the adaptation of the emission factors for direct N_2O-N emissions from manure management in line with latest version of EMEP 2019 guidebook
Bulgaria	-19	-0.3	-12	-0.3		
Croatia	-	-	-	-		
Cyprus	0.2	0.1	-0.0	-0.0	- Updated Cf for all crops except wheat for emission from crop residues. - The manure management distribution applied to cattle, swine and poultry changed after new information by the Department of Agriculture and the Department of Environment. This had an impact on the N_2O emissions from 3D1.2a Animal Manure Applied to soils for the whole timeseries.	
Czechia	-0.1	-0.0	40	1.1	- Implementation of the new AWMS and use of country specific Nex were also reflected in N_2O emissions from managed soils. - The technical correction of nitrogen loss (FracLOSSMS, T. 10.23, IPCC GL) from manure management was implemented and the double counting in N input from digestate was removed. - Technical correction in calculation of Crop residue N including N-fixing crop - changed AD from the LULUCF sector resulted in revised estimates of N_2O in Category 3.D.a.5. from managed soils and input data, comparison of Submission 2020, Submission 2021 and Submission 2022.	
Denmark	252	4.5	257	6.1	- 3Da1 Emission of N_2O and NOx from inorganic fertiliser for 2019 were in submission 2021 based on an unpublished version of the sales statistics, because this was the only data available. The sales statistics has now been updated and published (DAA, 2021). -3Da2a Emission of N_2O and NOx increases with less than 0.2 % for the years 2005-2019 and this is due to changes in the allocation of NH3 reducing technology, where the emission of NH3 from housing is decreased and the amount of N in manure for application thereby increases. -3Da2b updated values from statistics. In submission 2021 no statistic were available for the amount of N from sewage sludge for 2019 and the amount were therefor based on an average of previous years. - 3Da2c updated data from the BIB – register (Bio-mass Input to Biogas production) for the years 2015-2019 received from the Danish Energy Agency - 3Da4 Changes in the calculation of N content in crop residues - 3Da5 change of a parameter in C-TOOL for the whole time series. -3Da6 In submission 2021 area of organic soils were recalculated in the LULUCF sector and also updated in the agricultural sector - 3Db updated emission of NH3 from manure applied to soil for all the time series, but in 2019 also due to updated data for inorganic fertiliser. Updated data for N-leaching to rivers and estuaries, which is based on data received from the Department of Bioscience, Aarhus University, provided in relation to the national monitoring program (NOVANA).	

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Estonia	-34	-3.0	-1.1	-0.1	- N_2O emissions from Animal Manure Applied to Soils (CRF 3.D.1.2.a) and Other Organic Fertilizers Applied to Soils (3.D.1.2.c) were recalculated for 1990-2019 due to the corrected activity data and corrected methodology in Livestock categories - N_2O emissions from Mineralization/Immobilization Associated with the Loss/Gain of Soil Organic Matter (CRF 3.D.1.5) and from Cultivation of organic soils (CRF 3.D.1.6) – data on areas of organic soils cultivated were updated in the framework of the NFI - N_2O emission from Compost were recalculated for 2019 due to the corrected activity data use in compost calculations for 2019. - N_2O emissions from Urine and Dung Deposited by Grazing Animals (3.D.1.3) were recalculated for 1990-2019 due to the corrected methodology and data usage in Livestock categories - N_2O emissions from Cultivation of Organic Soils (3.D.1.6) were recalculated for 1990-2019.	
Finland	-0	-0.0	1.0	0.0		Fur-bearing animal numbers were updated for the year 2019. The distribution of manure management systems for dairy cattle was updated for the period 2013-2019 based on the new farm survey results published by Luke Statistical Services in November 2021. New area estimates for cropland and grassland were calculated due to the updating of NFI data (see Section 6.2), which affects the emissions from N mineralisation in mineral soils due to loss of soil organic matter and emissions from the cultivation of organic soils.
France	-574	-1.7	-646	-2.1	- Improvement of the calculation of cultivated histosol surfaces and update of emission factors according to the Wetlands supplement of the IPCC (2013) - Downward modification of the nitrogen content of soybean residues and correction of the calculation for the return to the field of potato and beet residues - The redistribution of animal numbers leads overall to a decrease in total nitrogen excreted, an increase in manure spreading and a decrease in the time spent grazing - The nitrogen content of sludge has been revised downwards by including new bibliographical references. - Downward revision of activity data from 1990 to 2007 for digestates excluding livestock manure, and downward revision of compost from 1990 to 1997, then upward from 1998. - Update of mineral fertilizer activity data for the year 2019	
Germany	-6 694	-22.7	-5 970	-23.9	newly applied Tier 2 emission factors instead of Tier 1	
Greece	19	0.4	-31	-1.0	update for weight and digestibility of feed of dairy cattle and for activity data.	
Hungary	0.7	0.0	-3.5	-0.1	Revised emissions from 3.D.1.2a Animal Manure Applied to Soils and 3.D.2 Indirect N_2O Emissions from Managed Soils for the whole time series	
Ireland	-3.8	-0.1	12	0.2		Revised estimates of emissions and removals for 4.B Croplands and 4.C Grasslands and corrected area data for the category Cultivation of Organic soils for the years 1998-2019.
Italy	1 143	11.3	1 722	21	- Update of N_2O emission estimate methodology for calculation of Fcr parameter and in particular estimate of N from belowground residues. - correction of estimated runoff and leached nitrogen (Fracleach) with new data based on the hydrological balance of the national territory	
Latvia	-	-	-0.2	-0.0	update of organic soils cultivated area	
Lithuania	69	2.2	15	0.7		
Luxembourg	1.4	0.6	2.8	1.3		The manure management system were updated using more recent data, although so far only MMS-

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						pasture using provisional data from the 2020 agriculture census
Malta	10	48	5.0	27	Implementation of the 2019 IPCC Refinements and update of 3.D.1.5 for consistency with LULUCF sector.	
Netherlands	-12	-0.1	70	1.5	A new map of the Netherlands with the area of organic soils has been implemented for the entire time series.	
Poland	-	-	57	0.4	Correction of population of goats and horses. Revision of cropland area undergoing mineralization process in mineral soils related to loss of soil C from soil organic matter.	
Portugal	11	0.5	27	1.2		Update for ammonium nitrate, ammonium sulphate, urea and "Other N" fertilizers consumption National Statistics. Update in N content of sludge applied to soils.
Romania	-0.1	-0.0	-10	-0.1		Transcription errors of the N bedding were corrected. Update of the production and area for barley. Change in the areas burned.
Slovakia	-6.3	-0.3	-195	-13	- Straw-based system N inputs from deep bedding in the poultry and swine categories was implemented. - The industrial sludge consumption for agricultural purposes was completed into inventory and revisions were implemented. - The revision of parameters for the estimation of nitrogen content for compost, digestate and green manure were implemented. - The recalculation of crop residues was performed due to the implementation of $Frac_{Remove}$ for cereal crops used for bedding purposes. - The revision of category 3.D.2.1 was performed due to changes in category 3.D.1.1 - Inorganic N Fertilizers from 2000 to 2011 and category 3.D.1.2 - Organic N Fertilizer in all time-series. - The revision of category 3.D.2.2 was performed due to changes in category 3.D.1.1 - Inorganic N Fertilizers in 2000 to 2011, 3.D.1.2 - Organic N Fertilizer in all time-series and 3.D.1.4 - Crop Residues. Correction of used $Frac_{Leach}$ was implemented.	
Slovenia	7.0	1.6	2	0.5	- An error was found and corrected in estimating the amount of N in livestock manure. - Emission factors for ammonia from the tied dairy cow housing system were updated. - Estimates of indirect nitrous oxide emissions from animal houses and manure storage facilities have been revised. - Data on the number of horses and resulting N in animal manures for 2017-2019 have been updated. - Based on new information on C stocks in agricultural soils, C emissions/sinks from cropland were updated.	
Spain	-11	-0.1	-244	-2.0		- Implementation of new zootechnical data for turkeys and ducks. - updated data on the amount of sludge applied to agriculture for the years 2016, 2017 and 2018. - the update of VA data in 2019 for category 3D12c, due to the fact that the amount of compost applied to soils is provided by the source with a delay of two years. - updated data for cultivated area and annual agricultural yield from the Yearbook of MAPA Statistic to estimate the amount of nitrogen from crop residues applied to the field. - methodological change used in the calculation of emissions in category 3D21 motivated by the revision UNFCCC/ARR/2021/ESP A.8 - 3.Db1 Atmospheric deposition –N_2O by which the volatilization fractions are replaced by the amounts of volatilized nitrogen calculated

Country	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						following the methodology of the EMEP/EEA 2019 Guidelines. - update in the data of fraction of nitrogen lost by leaching and runoff;
Sweden	7.2	0.2	-112	-3.4	- The total area of mineral- and organic soils has been updated for several years as a consequence of the method used by the Swedish national inventory of forests. • Change in the methodology to estimate emissions from mineralization of soil organic matter. • The times series for total cropland area has been updated. • Updated time series of number of reindeer from 1990-2015. • Updated method to estimate number of swine living shorter than one year from 1990.	
United Kingdom	293	2.1	135	1.1	Grassland: Implementation of finalised country-specific N_2O from fertiliser regression models; Revisions to BSFP fertiliser dataset; Update of provisional surveyed fertiliser rate for Northern Ireland in 2019; Revisions to EFs that are derived from statistical analysis of UK field study data. Arable: Reworked fertiliser analysis using the same method as for the grassland sector; Forage crops in Wales redefined; Minor changes to crop areas. Emissions from spreading affected by the changes detailed for Manure management. EF for application of FYM revised downwards; EF for application of poultry manure revised upwards. Provisional 2019 sewage sludge data updated. Updated amounts of manure and non-manure based digestate spread to land. Emissions from urine and dung affected by the changes detailed for 'Manure management. Land-use change areas have been significantly updated plus changes to the cropland management soil calculations. Updates to the deforestation areas on organic soils feed through into changes to the total cropland and intensive grassland areas on organic soils over time. N_2O indirect emissions: update of Manure management plus revisions to NO_x ratios for all sectors; Updated indirect N_2O EF4 according to IPCC 2019 refinement to GL.	
EU27+UK	**-5 396**	**-2.7**	**-4 830**	**-2.9**		
Iceland	0.2	0.1	1.0	0.4	Update of parameters and emission factors of the N-flow methodology used to estimate the nitrogen emissions from Manure Management, and from which the quantities of Animal Manure Applied to Soils stem, and the update of activity data (for Sewage Sludge and for Cultivation of Organic Soils) as well as emission factors for the calculations of emissions in cultivated organic soils due to a typo in the emission estimation files.	
United Kingdom (KP)	293	2.1	135	1.1	Grassland: Implementation of finalised country-specific N_2O from fertiliser regression models; Revisions to BSFP fertiliser dataset; Update of provisional surveyed fertiliser rate for Northern Ireland in 2019; Revisions to EFs that are derived from statistical analysis of UK field study data. Arable: Reworked fertiliser analysis using the same method as for the grassland sector; Forage crops in Wales redefined; Minor changes to crop areas. Emissions from spreading affected by the changes detailed for Manure management. EF for application of FYM revised downwards; EF for application of poultry manure revised upwards. Provisional 2019 sewage sludge data updated. Updated amounts of manure and non-manure based digestate spread to land. Emissions from urine and dung affected by the changes detailed for 'Manure management. Land-use change areas have been significantly updated plus changes to the cropland management soil calculations. Updates to the deforestation areas on organic soils feed through into changes to the total cropland and intensive grassland areas on organic soils over time. N_2O indirect emissions: update of Manure management plus revisions to NO_x ratios for all sectors; Updated indirect N_2O EF4 according to IPCC 2019 refinement to GL.	
EU-KP	**-5 396**	**-2.7**	**-4 829**	**-2.9**		

6 LULUCF (CRF SECTOR 4)

Europe is a fine-grained mosaic of different land uses that conforms a highly fragmented landscape, where almost all its lands are under more or less intensive management. This variety is well recognized as valuable in terms of biodiversity and culture but may represent a challenge when compiling a greenhouse gas (GHG) inventory.

Land use, Land-use change, and Forestry (LULUCF) covers anthropogenic GHG emissions, and CO_2 removals that result from land management practices. The impact of these practices on the carbon stock and on the quantity of non- CO_2 gases emitted depends on several factors. While certain patterns prevent the release of carbon, or enhance the carbon sink, others enhance the release of carbon stored in carbon pools.

With more than three-quarters of the European Union (EU) territory covered by forests and agricultural lands, the EU's environmental and agricultural policies have had a paramount impact on the current landscape for many years.

In particular, over the last years, the Common Agricultural Policy and the rural development programs have stimulated less intensive agricultural practices and have implemented measures towards a more sustainable environmental management. Furthermore, with the aim of protecting ecosystems and enhancing their services, the EU environmental policies have resulted in an increase of the area under conservation and have contributed to preserves biodiversity and landscapes.

Overall, throughout the reporting period the land use area-trends have shown a decrease of arable lands while the forests, and to a lesser extent, urban areas, have increased. This land use development is itself one of the main drivers of the final carbon balance on the LULUCF sector. However, of utmost importance is also the fact that at the EU level, wood felling is about one third less than the net annual wood increment. This management has led to a build-up of biomass over time in the forests, and to a notable annual net carbon removals by the EU forests. However, although the LULUCF sector results in a carbon sink for most of the MS, at EU level this sink is experiencing a decline since late 2000s that is mainly attributed to forest aging and the increase in harvest rates.

6.1 Overview of the sector

Complying with relevant EU Regulation No 525/2013[53], the LULUCF sector is a compilation of the inventories submitted by individual EU Member States (MS), UK and Iceland. Individual submissions are used as the primary source of data and information, unless otherwise specified and referenced in the text.

This chapter provides the general trends of GHG emissions and CO_2 removals from LULUCF in the EU, UK and Iceland. It provides general information on the methods used by the countries, and describes the efforts carried out to harmonize and improve the quality of the inventories. More detailed information can be found in national inventory reports (NIRs) and common reporting format (CRF) tables submitted by each EU MS, UK, and Iceland.

In particular, this chapter includes: an overview of LULUCF sector and overall trends, the contribution of land use changes, the completeness of the sector in the individual inventories, the key categories analysis of the EU GHG inventory, general methodological information used to derive GHG emissions by sources and removals by sinks, the trends of net CO_2 emissions or removals, activity data for each land use category, specific methodological information for relevant categories; as well as an overview of cross-cutting issues including uncertainties, QA/QC procedures, time series consistency, recalculations and verification.

[53] *https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32013R0525*

6.1.1 Trends by land use categories

Within the EU GHG inventory, the LULUCF sector shows higher removals by sinks than emissions by sources, a result the sector represents a net carbon sink.

In terms of land use categories, a net carbon sink is reported under Forest land, and, in specific years, under Other land. In addition, Harvested Wood Products also result in a net carbon sink for the EU GHG inventory. Other land use categories are net sources: Cropland is the largest source of emissions, followed by the conversion of lands to Settlements. Grasslands, along with the other categories, represent a smaller source of emissions.

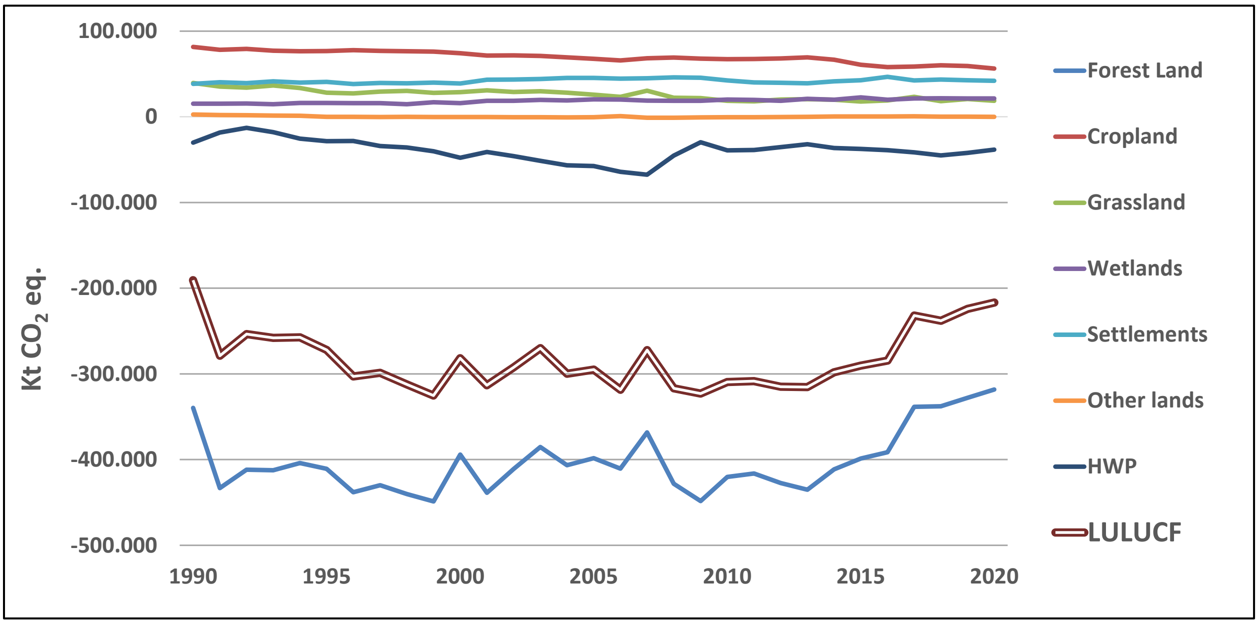
In 2020, the **LULUCF sector** of the **EU MS, UK and ISL** results in a total net sink of **-246.518 kt CO_2**, which represents an increase of 11 % as compared to the net sink reported for the year 1990 (Table 6. 1).

Within the LULUCF sector, the carbon pool Harvested Wood Products is in 2020 reported as a net carbon sink of -38.405 kt CO_2. On the other hand, emissions of CH_4 and N_2O in 2020 represent about 14% of annual net carbon sink.

In terms of CO_2 equivalent *LULUCF* results for the year 2020 in **-216.749 kt CO_2 equivalent**.

Moreover, France, Germany and UK have reported GHG emissions in the CRF table 4, under the category “Other”. France reports CO_2 and CH_4 emissions from Reservoir of Petit-Saut in French Guiana, and biogenic NMVOC emissions from managed forest. In addition, Germany, and UK report in CRF table 4 under “Other”, non- CO_2 emissions from drainage and rewetting and other management of soils under Settlements

Figure 6.1 Sector 4 LULUCF: EU MS, UK and ISL GHG net emissions (+) / removals (-) for 1990–2020, in CO_2 eq. (kt).



Source: EU MS, UK and ISL submissions 2022, CRF Table10s1

The overall trend of the LULUCF sector is largely driven by the Forest Land category.

An increase of the forest carbon sink took place during the 90s mainly due to forest area expansion and to an increase of net forest increment, which has been followed by a decline resulting from a general increase in harvest rates. In the late 2000s harvest rates decreased, mainly due to the economic crisis, and the sink increased again. The last years of the time series are affected by the maturity of the forests leading to lower increment, and by higher harvest rates.

Inter-annual variations are well assumed in the emission-trend of the LULUCF sector and are mainly related to natural disturbance events. Major wind storms that took place in central-western Europe (e.g,1990, 2000, 2005, 2007 and 2009) and severe wildfires (e.g.,1990, 2003, 2005, 2007, 2016 and 2017) in Mediterranean countries are reflected in Figure 6.1. In the recent years, central Europe suffered the effects of droughts that were followed by bark beetle infestations, which required important salvage logging efforts, these events have also contributed to the trend of GHGs in this sector.

Natural disturbances also explain the sharp change in the sink observed in the base year, which result largely from the reporting of Germany. As explained by the Party, in spring 1990, Germany was impacted by a storm that caused an unprecedented number of windfalls (about 70 million m³ of wood), and this explains the notably low LULUCF sink in 1990 for Germany that is reflected in the EU trend.

By last, other drivers of the trend of the LULUCF sector of the EU GHG inventory are (i) the economic crisis that EU economies underwent in 2008, which led to lower forest harvesting rates than usual, and is reflected as a short-time increase of the net LULUCF carbon sink, until the rates were gradually getting back to normal values in subsequent years, and (ii) in some specific years, the methods implemented by countries to derive carbon stock changes, for instance when the stock-difference method is applied..

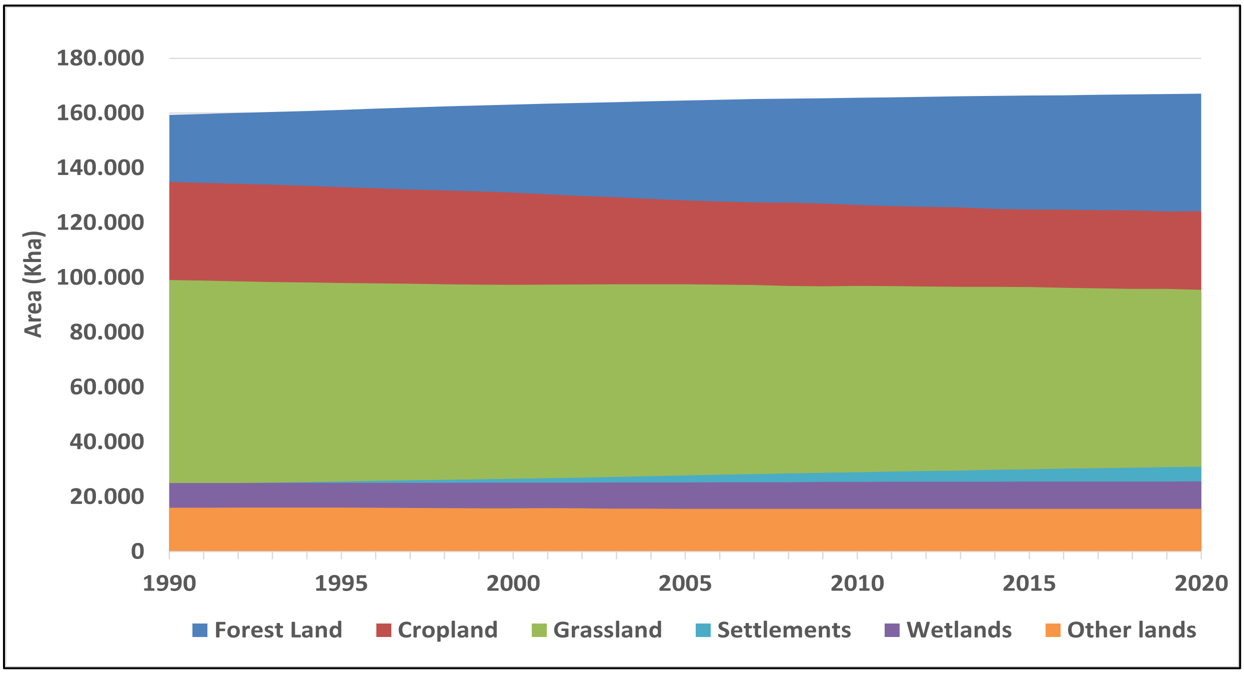
Additional category-specific information on trends and inter-annual variability is provided in the following sections of this chapter.

The total reported area in the EU GHG inventory as the sum of the different land use categories is ca. 459.000 kha. The trends on these categories (

Figure 6. *2*) are in line with the trends known from other EU statistics (e.g., Eurostat). However, absolute numbers may be slightly different due to different definitions used under each dataset.

As compared with the base year, the changes in total area reported in the current inventory for each land use category are Settlements (+26%), Croplands (-8%), Forest land (+5%), Grassland (-4%), Wetlands (2%), Other lands (-3%).

Figure 6. 2 Total area for each of the land use categories (kha), as reported by EU MS, UK, and ISL in 2022.



Although the LULUCF sector results in a net carbon sink at the level of EU MS, UK, and Iceland, the LULUCF sector reported by countries' inventories ranges from a net source to a large net sink. Compared to 1990, individual inventories report this year in some cases a significant increase in the carbon sink, while in other cases there is a substantial reduction. Changes are mainly driven by forest harvest rates and the impact of natural disturbances. More detailed information on drivers of the trend for specific categories is provided the relevant sections for each land use category of this chapter.

Table 6. 1 Sector 4 LULUCF: individual contributions to net CO_2 removals (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	-12 231	-2 800	-1 426	0.6%	10 805	88%	1 374	49%
Belgium	-2 943	-591	-453	0.2%	2 490	85%	138	23%
Bulgaria	-18 248	-10 273	-9 888	4.0%	8 360	46%	385	4%
Croatia	-6 021	-5 479	-5 482	2.2%	539	9%	-3	0%
Cyprus	-305	-350	-350	0.1%	-45	-15%	0	0%
Czechia	-9 031	8 186	12 719	-5.2%	21 751	241%	4 533	55%
Denmark	6 540	2 611	2 821	-1.1%	-3 719	-57%	210	8%
Estonia	-3 487	-699	932	-0.4%	4 419	127%	1 631	233%
Finland	-17 105	-16 375	-20 091	8.1%	-2 986	-17%	-3 716	-23%
France	-28 145	-16 293	-17 961	7.3%	10 184	36%	-1 668	-10%
Germany	24 591	-18 264	-14 650	5.9%	-39 241	-160%	3 613	20%
Greece	-2 177	-3 164	-3 988	1.6%	-1 811	-83%	-823	-26%
Hungary	-3 162	-4 970	-6 873	2.8%	-3 712	-117%	-1 903	-38%
Ireland	5 520	5 874	5 896	-2.4%	376	7%	22	0%
Italy	-5 790	-41 377	-33 089	13.4%	-27 299	-471%	8 288	20%
Latvia	-13 402	-3 804	-759	0.3%	12 643	94%	3 045	80%
Lithuania	-5 661	-5 489	-5 590	2.3%	71	1%	-101	-2%
Luxembourg	147	-273	-346	0.1%	-493	-336%	-73	-27%
Malta	-8	-1	-2	0.0%	6	72%	-1	-54%
Netherlands	5 658	3 491	3 439	-1.4%	-2 219	-39%	-51	-1%
Poland	-32 171	-22 299	-22 945	9.31%	9 226	29%	-645	-3%
Portugal	353	-8 290	-7 281	3.0%	-7 634	-2163%	1 009	12%
Romania	-27 687	-28 507	-32 931	13.4%	-5 245	-19%	-4 424	-16%
Slovakia	-10 285	-6 956	-8 809	3.6%	1 475	14%	-1 853	-27%
Slovenia	-4 444	-4 926	-4 772	1.9%	-327	-7%	154	3%
Spain	-36 682	-37 333	-35 920	14.6%	762	2%	1 413	4%
Sweden	-38 261	-38 456	-41 476	16.8%	-3 215	-8%	-3 020	-8%
United Kingdom	5 916	-2 688	-2 994	1.2%	-8 910	-151%	-307	-11%
EU-27+UK	**-228 520**	**-259 497**	**-252 269**	**102%**	**-23 748**	**-10%**	**7 228**	**3%**
Iceland	5 759	5 662	5 651	-2.3%	-108	-2%	-11	0%
United Kingdom (KP)	5 974	-2 589	-2 894	1.2%	-8 869	-148%	-305	-12%
EU-KP	**-222 703**	**-253 736**	**-246 518**	**100%**	**-23 815**	**-11%**	**7 219**	**3%**

At the EU level, the LULUCF sector offsets about 6% of the total emissions from other sectors (“Total without LULUCF”), with significant differences among MS (Table 6. 2, column a).

Forest Land category is the main driver in the LULUCF sector, offsetting itself about 9% of total emissions from other sectors. This year, the category resulted (in terms of CO_2 equivalent) a net sink for all MS with the exception of Czechia, Denmark, Estonia, Netherlands, Latvia, Ireland (Table 6. 2, column b). The most significant contributors to the total net sink reported for the EU under the category 4A are Germany, France, Sweden, Italy, and Spain (Table 6. 2, column c).

Table 6. 2 Sector 4 LULUCF: Contribution of Sector 4 (column a) and category 4A -Total Forest land - (column b) to total EU GHG inventory emissions without LULUCF (CO_2 eq); and individual contribution to total EU-KP category 4A (column c).

Country	LULUCF over total inventory excluding LULUCF	Category 4A over total inventory excluding LULUCF	Individual contribution to total EU-KP category 4A
	(a)	*(b)*	*(c)*
Austria	-1,7%	-3,3%	0,8%
Belgium	-0,3%	-1,9%	0,6%
Bulgaria	-19,5%	-17,7%	2,7%
Croatia	-22,3%	-24,2%	1,8%
Cyprus	-3,9%	-1,5%	0,0%
Czechia	11,3%	13,1%	-4,6%
Denmark	7,5%	-5,2%	0,7%
Estonia	11,2%	1,2%	0,0%
Finland	-36,3%	-58,2%	8,7%
France	-3,6%	-7,7%	9,6%
Germany	-1,5%	-6,3%	14,4%
Greece	-5,6%	-3,1%	0,7%
Hungary	-10,9%	-10,5%	2,1%
Ireland	12,0%	-3,6%	0,7%
Italy	-8,5%	-7,9%	9,5%
Latvia	6,2%	-25,0%	0,8%
Lithuania	-26,8%	-32,1%	2,0%
Luxembourg	-3,7%	-4,2%	0,1%
Malta	-0,1%	NO,NA	0,0%
Netherlands	2,2%	-1,4%	0,7%
Poland	-5,6%	-5,8%	6,8%
Portugal	-11,8%	-16,0%	2,9%
Romania	-42,7%	-31,4%	7,6%
Slovakia	-23,6%	-20,6%	2,4%
Slovenia	-29,9%	-28,7%	1,4%
Spain	-12,9%	-11,7%	10,1%
Sweden	-85,9%	-82,7%	12,0%
United Kingdom	0,9%	-4,2%	5,4%
Iceland	199,8%	-11,3%	0,2%
EU-KP	**-5,9%**	**-8,7%**	**100%**

Source: EU MS, UK and ISL submissions 2022, CRF Table10s1

6.1.2 Contribution of land use changes

The conversion of lands in the territory of the EU MS, UK and ISL results in net emissions of 23.860 kt CO_2 equivalent (Table 6. 3).

Land use changes represent 10% of the total reported land area. The carbon sink resulting from conversions to Forest Land, Grassland and Other land in this year is by far counterbalanced by emissions from conversions to Cropland, Wetlands, and Settlements.

Table 6. 3 Contribution of land use changes in 2020 for EU MS, UK and ISL, in terms of area (columns a-b) and net CO_2eq. (Columns c-d) (As aggregation of data from CRF Table 4.)

Land use conversions	**(a) land area (Kha)**	**(b) Area % of the corresponding category[1]**	**(c) Emissions (+) and removals (-) (Kt CO_2eq.)**	**(d) Net emissions % of the corresponding category[1,2]**
4A2. Land converted to Forest Land	6 502	4%	-34 117	10%
4B2. Land converted to Cropland	12 523	10%	41 044	76%
4C2. Land converted to Grassland	16 502	17%	-25 140	186%
4D2. Land converted to Wetlands	1 264	5%	4 340	32%
4E2. Land converted to Settlements	6 296	20%	37 928	91%
4F2. Land converted to Other Land	685	4%	- 195	100%
Total land use changes	**43 772**	**10%**	**23 860**	**29%**

[1] The corresponding category is 4A (4.A1 + 4.A2 for Forest land) for 4A2, 4B (4.B1 + 4.B2 for Cropland) for 4B2, etc.

[2] The contribution of emissions from land use changes to the total of each category was obtained by considering separately the absolute values of each subcategory, i.e. (abs 4A2)/(abs 4A1+ abs 4A2) x 100.

On average for this year, from total area under conversion, 38% is reported as converted to Grassland, 29% as converted to Cropland, 15% as converted to Forest land, 14% as converted to Settlements, 3% as converted to Wetlands, and 2 % as converted to Other lands.

6.1.3 Completeness of the sector

Table 6. 4 shows the current status of reporting in terms of quantitative estimates for each of the land use sub-categories. Information is taken from the individual inventories submitted this year.

This table, along with Table 6. 5, aims to provide an overview of the completeness status. Empty cells should not be unequivocally associated with an incomplete reporting because in many cases the carbon stock changes are assumed in balance, in line with the 2006 IPCC guidelines, or no methods exist for their estimation (in these cases, such pools are marked in grey in table 6.4 and 6.5 to facilitate the assessment of the completeness).

It should also be noted that the tables provide information for the main sub-categories “remaining” and “land converted to”. Under the subcategories “land converted to” there are a wide range of methods and status of completeness. For instance, certain carbon pool can be a source in forest converted to grassland, and a sink in cropland converted to grassland. This large variety cannot be displayed given the length that would be required for the tables. However, more information is provided, with a different format, in other sections of this chapter, such as the tables providing information on implied emission factors. Moreover, it is pertinent to highlight here that more detailed explanations can be found in the individual inventories submitted by countries.

For the three main land uses categories, Forest Land, Cropland and Grassland, including their sub-categories, the reporting is mostly complete, and quantitative estimates are reported. However, under certain subcategories of other land uses, there are still some gaps that are largely associated with the lack of IPCC methods for estimating GHG emissions (e.g., Flooded land remaining flooded land, under Wetlands), the assumption of equilibrium under Tier 1 methods (e.g., Dead organic matter in Cropland), or the implementation of the *insignificance* provision in accordance with the Decision 24 CP/19 (e.g., for living woody biomass under Grassland remaining Grassland). Finally, in many cases the lack of quantitative estimates is also associated with an actual absence of lands being converted to certain subcategories or the absence of organic soils under certain land uses.

Thus, any judgement on completeness would require a comprehensive case by case assessment. In this inventory, it is not possible to include such a detailed set of information, and therefore we refer to the country-specific information of the individual GHG inventories.

Table 6. 4 Sector 4 LULUCF: Coverage of CO_2 emissions and removals for each of the LULUCF sub-categories for the inventory year, as derived from individual 2022 GHGI submissions.

Country	Reporting category												
	Forest land		Cropland		Grassland		Wetland		Settlements		Other land		HWP
	4. A.1. F-F	4. A.2. L-F	4. B.1. C-C	4. B.2. L-C	4. C.1. G-G	4. C.2. L-G	4. D.1. W-W	4. D.2. L-W	4. E.1. S-S	4. E.2. L-S	4. F.1. O-O	5. F.2. L-O	
Austria	R	R	R	E	E	E	E	E		E		E	R
Belgium	R	R	E	E	E	E		R		E			E
Bulgaria	R	R	R	E	E	R		E		E			R
Croatia	R	R	E	E	E	R		E		E			R
Cyprus	R	R	R	E	R	E		R		E			E
Czechia	E	R	R	E	R	R		E		E			R
Denmark	R	R	E	E	E	E	E	E		E			R
Estonia	E	R	E	E	E	R	E	E		E		E	R
Finland	R	R	E	E	E	E	E	E		E			R
France	R	R	R	E	R	R		E	E	E			R
Germany	R	E	E	E	E	R	E	E	E	R			R
Greece	R	R	R	E	E	R		E		E		E	E
Hungary	R	R	R	E	R	R	R	R		E			R
Ireland	E	R	R		E	E	E	E		E		E	R
Italy	R	R	R	E	R	R		E		E			R
Latvia	R	R	E	E	E	E	E	E	R	E			R
Lithuania	R	R	R	E		R	E	E		E		E	R
Luxembourg	R	R	E	E		R		E		E		E	R
Malta	R	R	R	E		R	R			E		E	
Netherlands	R	R	E	E	E	R	R	R	E	E		E	E
Poland	R	R	R	E	E	R	E	E	R	E			R

Country	Reporting category												
	Forest land		Cropland		Grassland		Wetland		Settlements		Other land		HWP
	4. A.1. F-F	4. A.2. L-F	4. B.1. C-C	4. B.2. L-C	4. C.1. G-G	4. C.2. L-G	4. D.1. W-W	4. D.2. L-W	4. E.1. S-S	4. E.2. L-S	4. F.1. O-O	5. F.2. L-O	
Portugal	R	R	R	E	R	E		E		E		R	R
Romania	R	R	R	R	R	R		R		E		E	R
Slovakia	R	R	R	E		R				E		E	R
Slovenia	R	R	E	E	R	R		E	R	E		E	R
Spain	R	R	R	E		E	E	E		E			R
Sweden	R	R	E	E	R	E	E		E	E		E	R
UK	R	R	E	E	E	R	E	E	E	E			R
Iceland	R	R	E	E	E	R	R	E		E			R

R = Carbon stock changes in the pool result in net Removals.
E = Carbon stocks change in the pool results in net Emissions.
Empty cells = Quantitative estimates were included elsewhere, or no quantitative estimates are provided in line with Tier 1 assumption, the provision of insignificance, because no land use changes took place, or due to the lack of IPCC methods.

Overall, the reporting of Wetlands, Settlements and Other lands categories is associated with lower Tier methods, in comparison to the main land use categories. This is especially the case when looking at their subcategories “land remaining in”. On the contrary, carbon stock changes are typically estimated and reported for land use changes involving such categories.

Table 6. 5 shows with more detail the completeness of the reporting on carbon stock changes by carbon pools, for the three most important land use categories as reported this year in individual submissions. Compared to the previous years, several MS have increased the number of carbon pools estimated and reported.

As for table 6.4, empty cells in table 6.5 represent carbon pools which are not reported with quantitative estimates (e.g., based on the Tier 1 assumptions, demonstrating the insignificance of the resulting carbon stock changes, because of the lack of 2006 IPCC methods, because of the absence of organic soils, or because the pool is included elsewhere).

Table 6. 5 Sector 4 LULUCF: Quantitative estimates of carbon stock changes on carbon pools for the most important land use subcategories for the current inventory year.

COUNTRY	Reporting category																											
	Forest land										Cropland								Grassland									
	4.A.1. F-F					4.A.2. L-F					4.B.1. C-C				4.B.2. L-C				4.C.1. G-G				4.C.2. L-G			
	LB	DW	LT	SOC min	SOC org	LB	DW	LT	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org	LB	DOM	SOC min	SOC org
AUT	R	R		E		R	R	R	R		E		R		R	E	E				R	E	E	E	R	
BEL	R					R	R	R	R		E		E	E	R		E				E	E	E	E	R	
BGR	R	R				R	R				E		R	E	R		E		R		E	E				E
HRV	R					R	R	R	E		E		E	E	R		E					E	E		R	
CYP	R					R	E	R	R		R				E	E	E		R				E	E	R	
CZE	E	R	R	R		R	R	R	R		R		R		E	E	E				R		R	E	R	
DNM	R	R	R		E	R	R	R	R	E	E		R	E	E	E	E		E			E	E	E	R	E
EST	E	R		R	E	R	R	R	R	E	E		R	E	E	E	E	E	R			E	R	E	R	E
FIN	R			R	E	R			R	E	R		E	E	E	E	E	E	R			E	E	E	R	E
FRA	R	E				R	R	R	R		E		R		E	E	E		R		R		E	E	R	
DEU	R	R	E	R	E	E	R	R	R	E	E		E	E				E	E		R	E				E
GRC	R					R					R			E	R			E	E				E			
HUN	R	R			E	R	R	R	R		E		R		E	E	E				R		E	E	R	
IRL	R		E	E	E	R			R	E	R		R								R	E	E	E	R	E
ITA	R	R	R			R	R	R	R		E		R	E	E		E		R	R	R	R			R	
LVA	R	R			E	R	R	R		E	R	E		E	E	E	E	E	R	R		E	E	E		E
LTU	R	R				R		R	R		E		R		E	E	E						R	R	R	
LUX	R	R				R	R	R	R		E		R		E	E	E						R	E	R	
MLT	R										R		E										R		E	
NLD	R	R	R		E	R			R	E				E	E	E	E	E	R		R	E	R	E	R	E
POL	R	R		R	E	R			R	E	R		E	E			E	E			E	E	R		R	E
PRT	R		E	E		R		R	R		R		R		E	E	E				R		E	E	E	

COUNTRY	Reporting category																																
	Forest land										Cropland								Grassland														
	4.A.1. F-F					4.A.2. L-F					4.B.1. C-C				4.B.2. L-C				4.C.1. G-G				4.C.2. L-G										
	LB	**DW**	**LT**	**SOC min**	**SOC org**	**LB**	**DW**	**LT**	**SOC min**	**SOC org**	**LB**	**DOM**	**SOC min**	**SOC org**	**LB**	**DOM**	**SOC min**	**SOC org**	**LB**	**DOM**	**SOC min**	**SOC org**	**LB**	**DOM**	**SOC min**	**SOC org**							
ROU	R				E	R	R		R		R		R	E	R	E	E		R		R	R	E	E	R								
SVK	R	R				R	R	R	R		R		R				R						E	E	R								
SLV	R	R				R	R	R	R		E	R	R	E	E		E	E	R	R	R		R										
ESP	R					R	R	R	R		R		R		R	E	E						E	E	E								
SWE	R	R	E	R	E	R	R	R	E	E	R	R	R	E	R	E	E	E	R	R	E	E	E	E	R								
UK	R	R	R	R	E	R	R	R	E	E	R		E	E				E	E		R	E											
ISL	R				E	R				E			R	E			R	E	R	R	R	E				E							

Pools: DW-Dead Wood, LT- Litter, LB – Living Biomass, SOCmin – Soil Organic Carbon in mineral soils, SOCorg – Soil Organic Carbon in organic soils.
R: net Removal;
E: net Emission;
Empty cells: Quantitative estimates were included elsewhere, or no quantitative estimates are provided in line with Tier 1 assumption (grey cells indicate carbon pools for which the IPCC tier 1 methods assume the net carbon stock changes in equilibrium), the provision of insignificance, or because the pool is not present (i.e., absence of organic soils under certain land use categories). Only in a few cases the lack of quantitative estimates could be associated with incompleteness. See more details in following sections.

Source: EU MS, UK and Iceland submissions 2022, CRF table 4A-4C

6.1.4 Data and methods

This section provides an overview of the information on methods and data used by the EU MS, UK and Iceland for reporting on emissions by sources and removals by sinks from the three main land use categories. More detailed information regarding methodological issues is included as an annex to this report, and a complete description can be found in individual national inventory reports, which are considered also part of this submission.

Given the heterogeneity among countries in terms of ecological and socio-economic conditions, there is no common definition of land use categories. Methods used to estimate GHG emissions and CO_2 removals from the LULUCF sector also differ among countries and land use categories. The underlying assumption of the EU GHG inventory is that the implementation of country-specific definitions and methods that reflect and capture specific national circumstances (as long as they are in accordance with IPCC guidelines) is likely to result in more accurate estimates than the implementation of a single EU wide approach.

Table 6. 6 is a summary of relevant information on methodologies applied for each individual carbon pool under the three main land use categories of the LULUCF sector as included in individual GHG inventories.

Usually, for reporting carbon stock changes in "lands remaining in the same category", a single data source is used, which facilitate the categorization of the methodologies under a single Tier method. By contrast, multiple data sources are often used to derive emissions from “land converted to” which prevents an easy categorization of the methods under a single Tier. For instance, for estimating carbon stock changes in living biomass from forest land converted to cropland, MS may implement country-specific values for forest land and default factors for cropland.

Furthermore, because the categorization of methods under a single tier for “land converted to” depends also on the categories involved in the conversion (e.g., different approaches and data sources are often used for forest converted to grassland compared to those used for cropland converted to grassland), Table 6. 6 shows a summary of the main information on methods and carbon stock change factors used by individual inventories.

Finally, because of different underlying methods applied by each country, and due to their own national circumstances, the comparison of absolute levels, or trends, of emissions across them should be done carefully to avoid erroneous interpretations. Indeed, in some cases, large differences may be attributable to the different estimating methodologies. For example, (i) the gain-loss and stock-difference methods may lead to different trends in the short term, or (ii) the resulting implied carbon stock change factors may be significantly affected by new areas entering in a given category, or the inclusion of areas subjects to different management practices.

Table 6. 6 Summary of methods and carbon stock change factors used by the EU MS, UK and ISL to calculate CO_2 emissions and removals of different carbon pools in the LULUCF sector, as reported in this year GHGI submissions.

COUNTRY	Forest land								Cropland								Grassland							
	FL-FL				L-FL				CL-CL				L-CL				GL-GL				L-GL			
	LB	DOM (1)	SOC Min	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)	LB (3)	DOM	SOC Min (4)	SOC Org (2)	LB (5)	DOM	SOC Min	SOC Org (2)	LB	DOM	SOC Min (4)	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)
AT	CS	CS,CS	CS	NO	CS	CS	CS	NO	CS	D	CS	NO	CS,CS	CS	CS	NO	D	D	CS	CS	CS	CS	CS	NO
BE	CS	CS,CS	D	NO	CS	D	CS	NO	CS	D	CS	D	CS,NO	CS	CS	NO	D	D	CS	D	CS	CS	CS	NO
BG	CS	D,D	D	NO	CS	CS	CS	NO	D	D	CS	NO	CS,CS	NO	CS	NO	D	D	NO	NO	CS	NO	CS	NO
CY	D	D,D	D	NO	CS	CS	CS	NE	D	NE	NE	NE	CS, D	NE	CS	NE	D	NE	NE	NE	CS	CS	CS	NE
CZ	CS	D,D	D	NO	CS	D	CS	NO	D	D	CS,D	NO	CS,D	CS	CS	NO	D	D	CS,D	NO	CS	CS	CS	NO
DE	CS	CS,CS	CS	CS	CS	CS	CS	CS	NO	D	NO	CS	CS,CS	CS	CS	CS	CS	D	CS	CS	CS	CS	CS	CS
DK	CS	CS,CS	D	CS	CS	CS	CS	CS	CS	D	CS	CS	CS,CS	CS	CS	CS	CS	D	NO	CS	CS	CS	CS	CS
EE	CS	CS,D	CS	CS	CS	CS	CS	CS	CS	D	CS,D	D	CS,CS	CS	CS	CS	CS	CS	CS,D	CS	CS	CS	CS	CS
ES	CS	D,D	D	NO	CS	CS	CS	NO	CS	D	CS,D	NO	CS,CS	CS	CS	NO	D	D	NE	NO	CS	CS	CS	NO
FI	CS	CS,CS	CS	CS	CS	CS	CS	CS	CS	D	CS	CS	CS,CS	CS	CS	CS	CS	D	NO	CS	CS	CS	CS	CS
FR	CS	CS,D	D	NO	CS	CS	CS	CS	D	D	CS	NO	CS,NO	CS	CS	NO	D	D	NO	NO	CS	CS	CS	CS
GR	CS	D,D	D	NO	CS	D	NO	NO	CS	D	NE	D	CS,CS	CS	CS	NO	D	D	NO	NO	NO	NO	CS	NO
HR	CS	D,D	D	NO	CS	D	CS	NO	D	D	CS,D	CS	CS,CS	NO	CS	NO	D	D	NO	CS	CS	NO	CS	NO
HU	CS	D,D	D	CS	CS	CS	CS	NO	CS	D	CD,D	NO	CS,D	CS	CS	NO	D	D	CS,D	NO	CS	CS	CS	NO
IE	CS	CS,CS	D	CS	CS	CS	NO	CS	CS	D	CS,D	NO	NO,NO	NO	NO	NO	D	D	CS,D	CS	CS	CS	NO	CS
IT	CS	CS,CS	D	NO	CS	CS	CS	NO	CS	NO	NO	D	NO,D	NO	CS	NO	CS	CS	NO	NO	CS	NO	CS	NO
LT	CS	CS,D	D	D	CS	D	NO	D	D	D	CS,D	D	NO,CS	D	CS	D	NO	NO	NO	D	NO	NO	CS	D
LU	CS	D,D	D	NO	CS	D	CS	NO	CS	D	CS,D	NO	CS,CS	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
LV	CS	CS,D	D	D	CS	CS	NO	CS	CS	CS	NO	D	NO,NO	NO	CS	D	CS	CS	NO	D	NO	NO	CS	D
MT	CS	D,D	D	NO	NO	NO	NO	NO	D	D	NO	NO	NO,NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

COUNTRY	Forest land								Cropland								Grassland							
	FL-FL				L-FL				CL-CL				L-CL				GL-GL				L-GL			
	LB	DOM (1)	SOC Min	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)	LB (3)	DOM	SOC Min (4)	SOC Org (2)	LB (5)	DOM	SOC Min	SOC Org (2)	LB	DOM	SOC Min (4)	SOC Org (2)	LB	DOM	SOC Min	SOC Org (2)
NL	CS	CS,D	D	NE	CS	D	CS	CS	NE	D	NO	CS	CS,CS	CS	CS	CS	D	D	NO	CS	CS	CS	CS	CS
PL	CS	D,D	D	D	CS	D	D	D	D	D	D,D	D	NO	NO	D	NO	D	D	D,D	D	CS	NO	D	NO
PT	CS	CS,CS	CS	NO	CS	CS	CS	NO	CS	D	CS	NO	CS,CS	CS	CS	NO	D	D	CS	NO	CS	CS	CS	NO
RO	CS	D,D	D	D	CS	CS	CS	NO	CS	CS	CS	CS	CS,CS	CS	CS	NO	CS	D	NO	D	CS	CS	CS	NO
SE	CS	CS,CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS,CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS	CS
SK	CS	D,D	D	NO	CS	CS	CS	NO	D	D	CS,D	NO	CS,CS,	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
SV	CS	CS,D	D	NO	CS	D	CS	NO	D	D	CS,D	D	CS,CS	CS	CS	NO	D	D	NO	NO	CS	CS	CS	NO
UK	CS	CS,CS	CS	CS	CS	CS	CS	CS	D	D	CS	CS	CS,CS	CS	CS	CS	D	D	CS	CS	CS	CS	CS	CS
IS	CS	D,D	D	D	CS	CS	CS	D	D	D	NE	D	CS,CS	CS	CS	D	CS	CS	CS	D	CS	CS	CS	D

Source: submissions 2022, CRF table 4A-4C

(D: default; CS: country-specific; NA: not applicable; NE: not estimated; NO: not occurring). Grey field means that for these carbon pools IPCC TIER 1 allows to assume no net change in C stock. "CS" country-specific data associated either with IPCC method tier 2 or country-specific method tier 3 if data are highly disaggregated or derived using models. Note that sometimes not all parameters involved in the estimation are truly "CS" (e.g., root/shoot ratio and BEF are often taken from IPCC guidelines). However, it is expected that if "CS" is reported in table 6.6, the most important parameters are truly "CS."

"D" means that the default IPCC emission factors are used in the estimation. D is typically associated with IPCC default method (tier 1).
"NE" means either country assumes insignificant emission/removal or not enough data is available for the estimation.
"NO" means emissions or removals "not occurring" in a country (it includes also "NA" - not applicable)
(1) For DOM under "FL r FL" the two notation keys separated by a comma mean: dead wood and litter respectively.
(2) For SOCorg any notation key used under carbon stock changes, if areas of organic soils are reported, should, in principle, be seen as NE. D refers to the use of IPCC default emissions factors
(3) For LB carbon stock change in CL-CL, estimates generally refer only to perennial woody crops. Biomass of annual crops is generally assumed in balance.
(4) For SOCmin on CL and GL, the two notation keys separated by a comma mean that the country uses IPCC default method (which is tier 1 if associated with D data or tier 2 if associated with CS data). In this case, the first notation key refers to "reference C stock", and second to "C stock change factors" (see 2006 IPCC GL for details). A cell with a single "CS" indicates a country-specific method and data (i.e. tier 3 if data are highly disaggregated)
(5) For LB under L – CL, "conversion to cropland", the two notation keys used mean: the first one refers to FL-CL and the second one to GL-CL.

6.1.5 Key categories

The following LULUCF subcategories of the EU GHG inventory were identified to be key categories (Table 6. 7) for the trend (T) and the level assessment (L).

Table 6. 7 Key category analysis for the EU (LULUCF sector excerpt)

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2020		1990	2020
4.A.1 Forest Land: Land Use (CO_2)	-312066	-292922	T	L	L
4.A.2 Forest Land: Land Use (CO_2)	-38448	-34573	T	L	L
4.B.1 Cropland: Land Use (CO_2)	32668	12995	T	L	L
4.B.2 Cropland: Land Use (CO_2)	42700	38304	T	L	L
4.C.1 Grassland: Land Use (CO_2)	53826	38148	T	L	L
4.C.2 Grassland: Land Use (CO_2)	-20999	-25375	T	L	L
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	5431	5954	0	0	L
4.D.1 Wetlands: Land Use (CO_2)	7518	9314	T	0	L
4.D.2 Wetlands: Land Use (CO_2)	828	4262	T	0	0
4.E.2 Settlements: Land Use (CO_2)	31070	34023	T	L	L
4.G Harvested Wood Products: Wood product (CO_2)	-30084	-38405	0	L	L

6.2 Categories and methodological issues

6.2.1 Forest land (CRF 4A)

6.2.1.1 Overview of the Forest land category

Forest land category is by large the main driver in the LULUCF sector. In terms of area, it represents about 36% of the entire territory. Based on individual submissions reported this year, total forest area reached 167.078 kha in 2020, which represents an increase of 5% as compared with 1990.

About 4% of the total forest area is represented by lands under conversion to forest land. This trend of increasing forest land area, which is also reflected in different official statistics of the EU, is a result of the expansion of forests due to less grazing pressure and the abandonment of agricultural activities, which promote natural forest expansion. But an important driver behind the forest area increase has been also the promotion of national afforestation programs, including grant-aid.

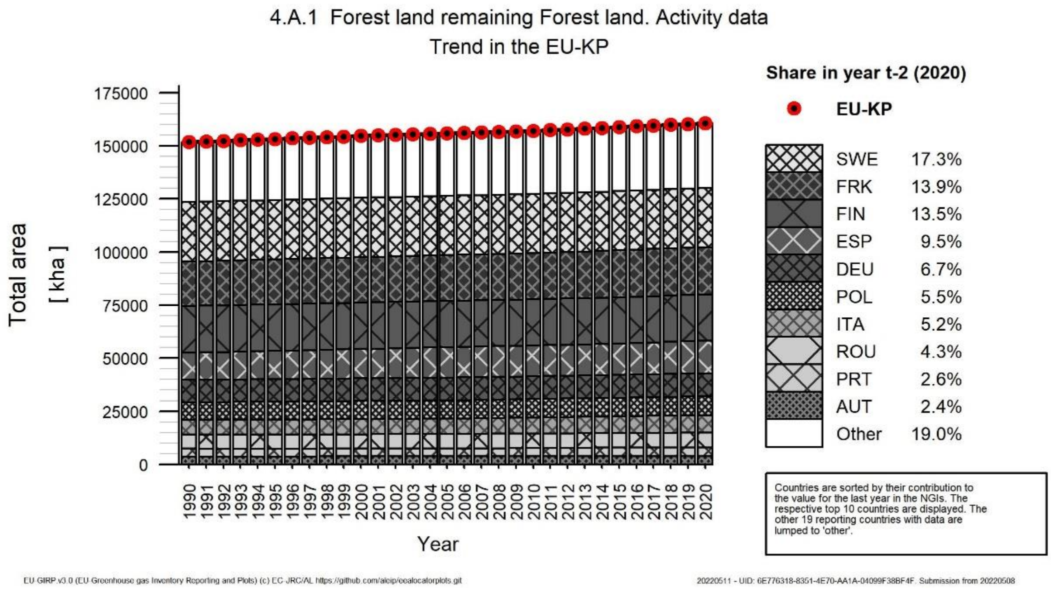
The largest forest areas are reported by Sweden, France and Finland, which together report about 45% of the total forest area at EU level. Deforestation does not appear to be a major issue in Europe. Moreover, the absolute area under conversion from forest is by far compensated by new afforested areas and natural forest expansion.

6.2.1.2 Forest Land remaining Forest Land (CRF 4A1)

Overview of Forest Land remaining Forest Land category

As with the main category, the area of Forest Land remaining Forest Land reported for the inventory year increased by 5% as compared with 1990. However, at the level of individual submissions there are significant differences. For instance, UK reports an increase of about 44%, while Ireland reports a decrease of about 4% respective to the year 1990. The major contributors in terms of area for this subcategory are Sweden, France, and Finland (Figure 6. 3)

Figure 6. 3 Trend of activity data in subcategory 4A1 "Forest land remaining Forest Land" in EU-KP



For this inventory year, the total land area reported under the sub-category 4.A1 by EU MS, UK and ISL reached 160.576 kha, out of which about 80% is attributed to the 10 MS with the higher contribution.

In terms of GHG emissions the category 4.A1 resulted in a net sink of -292.922 kt CO_2, decreasing by 6% as compared in 1990. The largest contributors are Germany, Sweden, and Finland (Table 6. 8).

Table 6. 8 4A1 Forest Land remaining Forest Land: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	-7 865	-733	-733	0.3%	7 133	91%	1	0%
Belgium	-1 903	-1 657	-1 705	0.6%	198	10%	-48	-3%
Bulgaria	-13 584	-8 216	-8 191	2.8%	5 393	40%	26	0%
Croatia	-6 389	-5 445	-5 541	1.9%	848	13%	-96	-2%
Cyprus	-37	-129	-128	0.0%	-92	-251%	1	1%
Czechia	-7 345	10 893	15 313	-5.2%	22 658	308%	4 419	41%
Denmark	-224	-1 231	-1 014	0.3%	-790	-352%	217	18%
Estonia	-4 342	-1 562	161	-0.1%	4 503	104%	1 723	110%
Finland	-22 734	-24 266	-30 147	10.3%	-7 413	-33%	-5 881	-24%
France	-32 357	-22 795	-24 144	8.2%	8 213	25%	-1 349	-6%
Germany	-19 851	-52 899	-46 351	15.8%	-26 500	-133%	6 548	12%
Greece	-1 142	-2 130	-2 174	0.7%	-1 032	-90%	-45	-2%
Hungary	-2 975	-3 630	-5 471	1.9%	-2 495	-84%	-1 841	-51%
Ireland	-2 922	303	565	-0.2%	3 487	119%	263	87%
Italy	-15 002	-30 374	-25 040	8.5%	-10 037	-67%	5 335	18%
Latvia	-17 547	-5 798	-3 408	1.2%	14 139	81%	2 390	41%
Lithuania	-7 363	-5 809	-5 768	2.0%	1 594	22%	40	1%
Luxembourg	138	-305	-369	0.1%	-507	-368%	-64	-21%
Malta	0	0	0	0.0%	0	59%	0	2%
Netherlands	-1 873	-1 751	-1 752	0.6%	122	7%	-1	0%
Poland	-32 608	-18 828	-19 754	6.74%	12 854	39%	-926	-5%
Portugal	-4 088	-8 208	-7 428	2.5%	-3 339	-82%	781	10%
Romania	-23 399	-23 163	-22 634	7.7%	765	3%	529	2%
Slovakia	-6 798	-4 843	-7 295	2.5%	-497	-7%	-2 451	-51%
Slovenia	-4 567	-4 212	-4 270	1.5%	297	7%	-59	-1%
Spain	-21 396	-28 853	-28 991	9.9%	-7 594	-35%	-138	0%
Sweden	-40 102	-37 224	-38 624	13.2%	1 479	4%	-1 399	-4%
United Kingdom	-13 774	-17 790	-17 872	6.1%	-4 098	-30%	-82	0%
EU-27+UK	**-312 052**	**-300 654**	**-292 763**	**100%**	**19 290**	**6%**	**7 891**	**3%**
Iceland	-2	-124	-128	0.0%	-125	-5076%	-3	-3%
United Kingdom (KP)	-13 785	-17 822	-17 904	6.1%	-4 119	-30%	-82	0%
EU-KP	**-312 066**	**-300 810**	**-292 922**	**100%**	**19 143**	**6%**	**7 888**	**3%**

For the year 2020, with the exception of Czechia, Estonia and Ireland, individual submissions report a net carbon sink under Forest Land remaining Forest Land.

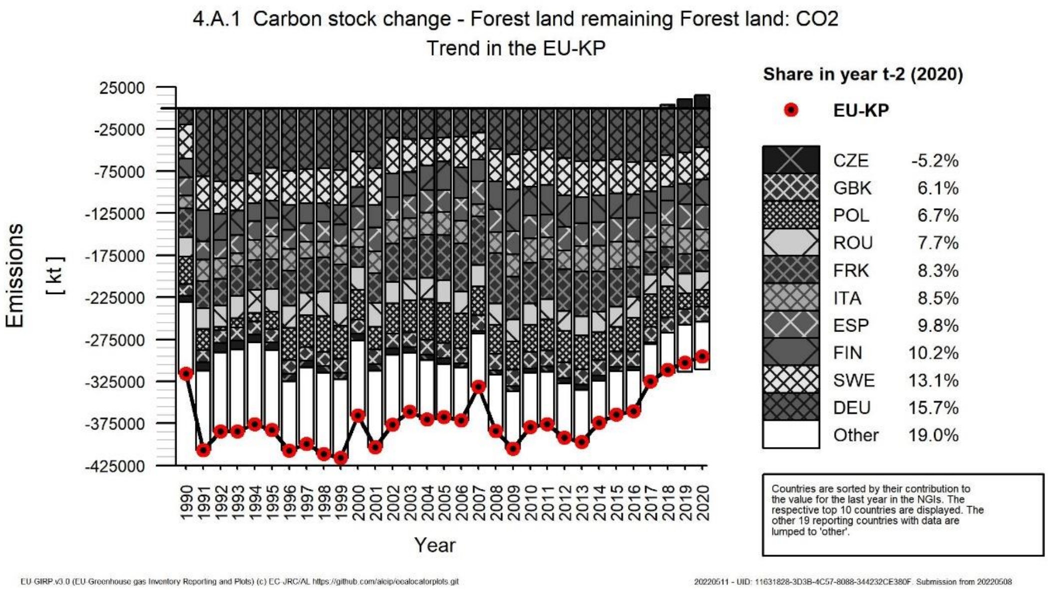
Important changes in terms of reported amounts, as compared with 1990, are mainly due to the increase in harvesting rates as reported by Czechia, which apply significant salvage logging practices after recent bark beetle infestation) or Bulgaria and Latvia. But also, the impact of natural disturbances in forest, as in 1990 as reported by Germany, can explain the changes. By contrast, Italy and Spain report a significant increase of the carbon sink driven by a steady increase of the forest area that results in a net carbon accumulation on Forest Land remaining Forest Land.

In some cases, this category has shifted throughout the years from a net sink to a net source of carbon. This is explained by the impact of natural disturbances and by the age-class distribution of the forests.

A particularity is given by Malta that having small areas of forests (0.089 Kha) until this submission did not report the carbon stock changes in this land use category, following a recommendation of the UN´s expert review team (ERT). Indeed, the ERT noted that the use of IPCC factors, which are not suited for its conditions, results in the absurd estimate of an indefinite net carbon accumulation across time, while carbon pools have physical limits to the amount of carbon stock they may store. In the meantime, Malta has worked on the acquisition of data, and it is reporting for first time emissions and removals in this category in this submission.

In a good match with the share in total areas, the 10 MS with the largest contribution to the total net carbon sink account for about 90% of the EU removals (Figure 6. 4).

Figure 6. 4 Trend of emissions (+)/removals (-) in subcategory 4A1 "Forest land remaining Forest Land" in EU-KP (kt CO_2)



Inter-annual variations in this subcategory are closely related to natural disturbances. In this respect, wildfires, in southern European countries, and windstorms and insect infestations, in several central European countries, resulted in a significant source of GHG emissions directly emitted to the atmosphere, or lagged emissions, via the transfer of carbon to other pools that are reflected in the trend at EU level.

Portugal and Italy report for the year 2017 enormous areas of forests and grasslands affected by wildfires. The impact of these events is about 25.000 kt CO_{2eq} emitted to the atmosphere. Noteworthy is also the significant impact that Germany reports from the massive storm "Vivian" that caused an estimated loss, due to windfalls, of about 70 Mm^3 of wood in 1990 .

The CO_2 emissions from biomass burning are, in many cases, implicitly reported in CRF table 4.A, as part of the "stock-change" approach used to report carbon stock changes, while related non- CO_2 emissions are reported in CRF table 4(V).

Estimation of emissions from forest fires is made with default methods in case of small emissions or with higher Tiers, involving country-specific information, where such emissions have a significant share within the overall carbon budget of the country (e.g., Portugal, Spain).

In general, emissions from natural disturbances that do not necessarily result in instantaneous carbon oxidation(e.g., insect outbreaks) are not easy to quantify as an annual biomass loss, and therefore they are practically not explicitly mentioned in the individual national inventory reports but reflected in the long-term estimation through the national forest inventories.

An exception is given by Czechia that due to exceptionally high sanitation harvest following an unprecedented drought and a bark-beetle outbreak experienced in its forests in recent years, reports a source of emissions from forests that result from this circumstance.

Among the largest inter-annual variability in GHG estimates that affect the EU trend are due to:

- Forest fires (e.g., Portugal in 1990, 2003, 2005 and 2017; Italy in 1990, 1993, 2007 and 2017).
- Windstorms (e.g., Germany 1990, France in 1999 and 2009, and Denmark in 2000, Sweden in 2005, Italy in 2018).

Methodological issues for Forest Land remaining Forest Land category

The definition of forest land is reported by all individual submissions (Table 6. 9; Table 6. 10). The consistency of these definitions with the land representation system is ensured within the national inventory systems in terms of time and space. The forest definitions among countries slightly differ in terms of the quantitative parameters (i.e., crown cover, tree height and minimum area) used to define a land as forest.

In general, these forest definitions are consistent with definitions used by countries under other international reporting frameworks (e.g., Global Forest Resources Assessments FRA (FAO)). For forest administrative purposes, forest lands without tree coverage may be included or not in the forest area, and thus, additional qualitative criteria complement the forest definition. As an example, the definitions may include a reference to forest roads, un-stocked forest areas, nurseries, willow crops, etc.

Few countries have changed their forest definition since 1990, but recalculations of the entire time-series ensured the consistency on activity data. For example, Denmark changed from a questionnaire-based forestry information system to national forest inventory system to collect forest information but implemented methods for ensuring the consistency of the time series in line with the new approach (i.e., reassessment of base year data based on earth observation information).

The overall effect of different forest definitions on carbon stock changes at EU level is difficult to assess because it depends on several factors (e.g., land fragmentation, land use change frequency, transition period, land registry systems, GHG estimation methodology, etc.), but is considered small. Ultimately the implementation of country-specific forest definitions contributes to ensure that the large variety of forest ecosystems, and their management practices, that are in Europe are all considered in the GHG inventories.

Table 6. 9 Quantitative thresholds used to define forests as selected by individual EU MS, UK and Iceland

Country	Crown cover (%)	Height (m)	Area (ha)	Minimal width (m)
Austria	30	2	0.05	10
Belgium	20	5	0.5	-
Bulgaria	10	5	0.1	10
Croatia	10	2	0.1	-
Cyprus	10	5	0,3	-
Czechia	30	2	0.05	-
Denmark	10	5	0.5	20
Estonia	30	2	0.5	-
Finland	10	5	0.25 (0.5)*	20
France	10	5	0.5	20
Germany	10	5	0.1	-
Greece	25	2	0.3	-
Hungary	30	5	0,5	-
Ireland	20	5	0.1	20
Italy	10	5	0.5	-
Latvia	20	5	0.1	20
Lithuania	30	5	0.1	10
Luxembourg	10	5	0.5	-
Malta	30	5	1	-
Netherlands	20	5	0.5	30
Poland	10	2	0.1	10
Portugal	10	5	1	20
Romania	10	5	0.25	20
Slovakia	20	5	0.3	20
Slovenia	10	5	0.25	-
Spain	20	3	1.0	25
Sweden	10	5	0.5	-
UK	20	2	0.1	20
Iceland	10	2	0,5	20

**Finland: According to the national forest land definition, a minimum area for forest is not exactly set, but a guideline of 0.25 ha for a forest stand in Southern Finland and 0.5 ha in Northern Finland is given. The definition does not comply strictly with the FAO definition, but to include all nationally defined forest lands in the GHG inventory under Forest Land category, forest areas smaller than 0.5 ha may be included in the Convention reporting*

Additional information used by the countries to define the area of forests is provided in the table below:

Table 6. 10 Additional qualitative criteria used to define forests complementing quantitative thresholds.

Country	Forest land definition
Austria	Permanently unstocked basal areas that are directly connected with forest in terms of space and forestry enterprise and contribute directly to its management (such as forestall hauling systems, wood storage places, forest glades, forest roads) also represent forests. Areas which are used in short rotation with a rotation period of up to thirty years as well as forest arboretums, forest seed orchards. Christmas tree plantations and plantations of woody plants for the purpose of obtaining fruits such as walnut or sweet chestnut do not account as forests. Rows of trees (except shelter belts for wind protection) and areas with woody plants in a park structure are not forest land.

Country	Forest land definition
Belgium	This category includes all land with woody vegetation consistent with thresholds used to define forest land as described in paragraph 6.1 of the NIR. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category.
Bulgaria	Areas of natural forest regeneration outside urban areas with a size of more than 0.1 ha also represent “forest”. Forests are also: areas which are in a process of recovering and are still under the parameters, but it is expected to reach forest crown cover over 10% and tree height 5 meters; areas, which as the result of anthropogenic factors or natural reasons are temporarily deforested, but will be reforested; protective forest belts, as well as tree lines with an area over 0.1 ha and width over 10 meters; cork oak stands. City parks with trees, forest shelter belts, and single row trees do not fall under the category “forests.
Croatia	Forest includes land under forest management (forest land without tree cover): Productive Forest land without tree cover, non-productive forest land without tree cover, barren wooded land (e.g., forest roads wider than 3 meters, quarries)
Cyprus	Forests include forest roads, cleared tracts, firebreaks and other small open areas within the forest as well as reforested areas or burnt areas or other areas that temporarily have low plant cover due to human intervention or natural causes, but does not include municipal parks and gardens.
Czechia	Forests excludes the areas of permanently unstocked cadastral forest land, such as forest roads, forest nurseries and land under power transmission lines.
Denmark	Temporarily non-wooded areas, fire breaks and other small open areas, that are an integrated part of the forest, are also included. Christmas trees are also included.
Estonia	All temporarily unstocked forest areas and regeneration areas which have yet to reach a crown density of 30 per cent and a tree height of 2 meters are also included as forest, as are areas which are temporarily unstocked as a result of human intervention such as harvesting, or natural causes (fires, etc.) but which are expected to revert to forest.
Finland	Productive forest land, part of the poorly productive forest land and forest roads. Parks and yards are excluded regardless of whether they meet the forest definition.
France	Forest roads, forest openings less than 20 m wide (e.g., for fire control), windbreaks and forest belts, as well as the poplar plantations and short rotations woody crops, if the criteria for Forest land are met. 5% of France’s European forests are unmanaged on lands such as strong slopes or used for loisir, esthétique, cultural or military. Also, 40% of France’s dependencies Forest land is considered as unmanaged.
Germany	Any area of ground covered by forest vegetation, irrespective of the information in the relevant cadastral survey or similar records. “Forest” also refers to cutover or thinned areas, forest tracks, firebreaks, openings and clearings, forest glades, feeding grounds for game, landings, rides located in the forest, further areas linked to and serving the forest including areas with recreation facilities, overgrown heaths and moorland, overgrown former pastures, alpine pastures, and rough pastures, as well as areas of dwarf pines and green alders. Heaths, moorland, pastures, alpine pastures, and rough pastures are considered to be overgrown if the natural forest cover has reached an average age of five years and if at least 50% of the area is covered by forest. Forested areas of less than 1,000 m2 located in farmland or in developed regions, narrow thickets less than 10 m wide, watercourses up to 5 m wide do not break the continuity of a forest area.
Greece	No additional criteria are used.
Hungary	Forest land (includes FL-FL, L-FL sub-categories) includes areas covered by trees, as well as roads and other areas that are under forest management but that are not covered by trees.
Ireland	All public and private plantation forests. Includes recently clear-felled areas. Tree grown for fruits or flowers, and shrub species (furze, rhododendron) are excluded. Includes open areas within forest boundaries.
Italy	Forest roads, cleared tracts, firebreaks and other open areas within the forest as well as protected forest areas are included in forest. Plantations, mainly poplars, characterized by short rotation coppice system and used for energy crops are included and also other plantation as chestnut and cork oak, have been included in forest land.
Latvia	Young natural stands and all plantations established for the forestry purposes, which have to reach a crown density of 20 % or tree height of 5 m are considered under forest land; as well as the areas normally forming part of the forest area, which are temporarily unstocked as a result of human intervention or natural causes, but which are expected to revert to forest.
Lithuania	Tree lines up to 10 meters of width in fields, at roadsides, water bodies, in living areas and cemeteries or planted at the railways protection zones as well as single trees and bushes, parks planted and grown by man in urban and rural areas are not defined as forests.
Malta	No additional criteria are used.
Luxembourg	Permanently unstocked basal areas that are directly connected with forest in terms of space and forestry enterprise and contribute directly to its management (such as forestal hauling systems, wood storage places, forest glades, forest roads) also represent forests. Areas which are used in short rotation with a rotation period of up to thirty years as well as forest arboretums, forest seed orchards, Christmas tree plantations and plantations of woody plants for the purpose of obtaining fruits such as walnut or sweet chestnut do not account as forests but represent cropland. Rows of trees (except shelter belts for wind protection) and areas with woody plants in a park structure are not forest land.
Netherlands	The Netherlands has chosen to define the land-use category “Forest Land” as all land with woody vegetation, now or expected in the near future (e.g., clear-cut areas to be replanted, young afforestation areas)
Poland	Young stands and all plantations that have yet to reach a crown density of 10 percent, or a tree height of 2 m are included under forest. Areas normally forming part of the forest area that are temporarily un-stocked as a result of human intervention, such as harvesting or natural causes such as wind-throw, but which are expected to revert to forest are also included.
Portugal	Forests (areas occupied by forests and woodlands which can be used for the production of timber or other forest products) and agro-forestry areas (annual crops or grazing land under the wooded cover of forestry species). The forest trees are under normal climatic conditions higher than 5 m with at least 30% canopy closure.

Country	Forest land definition
Romania	It comprises deciduous forest, coniferous forest, mixt forests, clear-cut areas and nurseries, as defined by presence of deciduous trees, coniferous trees, deciduous and resinous trees, dead trees, clear-cuts and forest nursery.
Slovakia	This category includes the land covered by all tree species serving for the fulfilment of forest functions and the lands on which the forest stands were temporarily removed with aim of their regeneration or establishment of forest nurseries or forest seed plantation.
Slovenia	It includes abandoned agricultural land with natural expansion of forest. Abandoned agricultural land on area more than 0.5 ha, which have been abandoned for more than 20 years, with minimal tree height 5.00 m and have a tree crown cover between up to 75 % are defined as forests.
Spain	Any land having woody vegetation with no agricultural use/activities fulfilling the threshold of forest and any other land which is expected achieve these parameters (including for “dehesa” where tree cover meets the thresholds)
Sweden	Land which hosts a potential yield of stem-wood exceeding one cubic meter per hectare and year. Meanwhile, the Land which hosts a potential yield of stem-wood lower than one cubic metre per hectare and year are classified as mire (under Wetlands). Permanent forest roads (width>5m) are not considered as forest land. All country forests are considered managed.
UK	Forestry statistics definition used for GHG inventory includes integral open space and felled areas that are waiting restocking.
Iceland	All forested lands, not belonging to Settlement, that is presently covered with trees or woody vegetation that reach the defined thresholds. Natural birch woodland is included in the IFR national forest inventory (NFI). In the NFI the natural birch woodland is defined as one of the two predefined strata to be sampled. The other stratum is the cultivated forest consisting of tree plantation, direct seeding or natural regeneration originating from cultivated forest.

National forest inventories provide fundamental data inputs for both the estimation of areas, and the estimation of forest carbon stocks, and their changes . In very few cases, this information is also taken, or complemented, from data from forest management plan databases (especially when countries experience difficulties to get information for the first years of the time series).

Data collection approach of national forest inventories is typically based on repeated measurements of parameters on permanent sampling plots, but the sampling design differs among MS in terms of sample size, and frequency of the field surveys (e.g., Austria 3 years, Spain 10 years, Lithuania 5 years).

Given that the availability of annual data is barely available for this sector. Partly because it is not cost-efficient to increase the sampling frequency of some parameters since some changes are not captured in an annual basis. Countries have devoted efforts to meet reporting requirements and to ensure the consistency of the time series. Annual values are usually obtained by interpolation and extrapolation of available data sets. The main data source for forest area, the national forest inventories are in many instances complemented with auxiliary information in the form of national statistics (i.e. surveys) or remotely sensed products (i.e. satellite images, aerial photographs).

In this sense, not only for forest, but with a wider focus on acquiring data to monitoring lands and information for a better management, the result of some EU programs is already used by countries to improve their LULUCF reporting information (e.g., Copernicus products or Corine Land Cover data)

Furthermore, countries usually have disaggregated forest areas in various subdivisions according to available datasets. The breakdown criteria differ across countries, although they are consistent across time series. The aim is to differentiate and stratify the forest to capture the impact that specific strata features have on the GHG estimates. Main strata are based on forest types (e.g. broadleaved/coniferous; evergreen/deciduous; species based classification – beech, oak, pine, spruce, etc.); climate conditions (e.g. temperate moist or temperate dry,); soil and site type (e.g. lowlands, mountains), administrative or geographical boundaries (e.g. northern, southern territories), and management type (e.g. coppice, high forest).

For Forest land, definitions of carbon pools are reported by most of the MS (Table 6. 11). Among them, there are slight variations. The impact on the estimates of such variability, even if difficult to assess in quantitative terms, is considered small.

For instance, forest inventories define above-ground biomass carbon pool according to the threshold of minimal diameter of the vegetation that is measured (i.e. DBH– diameter at breast height) ranging from

0 to 7,5 cm. Concerning the below-ground biomass, the information on what exactly is included on this carbon pool is sparse. Dead wood mostly differs in terms of decay time and thresholds of diameters and height/length of wood pieces included in the pool. Litter is either independently assessed or included with soils. In soil organic carbon, carbon stock changes are computed according to various methods and transition periods. Usually, carbon stock in understory biomass is only accounted in principle for estimating forest fires emissions.

Table 6. 11 Explicit information on forest carbon pools definitions as reported by EU MS, UK and Iceland.

Country	***Description***
Above-ground biomass	
Austria	All living biomass (DBH > 5cm) above the soil including stem, stump, branches, seeds, bark and foliage (foliage only of evergreen trees). At ARD sites and LUC from and to forests all forest biomass (shrubs, forest understory) with a DBH > 0 cm to 5 cm is also taken under consideration.
Belgium	Tree and shrub species with circumference exceeding 20/22 cm at 1.50 m height (i.e., 7 cm in diameter), while in coppices the stems under 7 cm diameter are also included.
Denmark	Living trees with a height over 1.3 m, under different recording schemes (i.e., trees larger than 40 cm are measured only within a 15 m circle). Smaller trees, shrubs and other non woody are not counted. Aboveground biomass is defined as living biomass above stump height (1% of tree height).
Finland	Biomass of living trees with a height over 1.35 m, i.e., those trees that are measured in NFIs, including the stem wood, stem bark, living and dead branches, cones, needles/foliage. Understory is counted only to estimate the emission from forest fire.
France	Trees with DBH over 7.5 cm.
Germany	Trees with DBH over 7 cm.
Greece	Trees with DBH over 10 cm, but in cases of degraded forests (e.g., oak) and coppices (e.g., Castanea) the threshold is 4.6 cm. The trees in the sample area under the minimum diameter are not considered. Understory biomass is considered for GHG emissions from wildfires.
Hungary	The total biomass above the stump, including all branches and bark, of trees taller than two meters.
Lithuania	Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage.
Ireland	Modelled individual cycle of living biomass (but not the understory and annual/perennial non woody vegetation).
Italy	Trees with DBH over 3 cm.
Lithuania	Above ground biomass refers to all living biomass above the soil including stem, stump, bark, branches, seeds and foliage.
Luxemburg	Diameter of 4 cm at 3.5 m of the total height (average value)
Portugal	Living biomass above the soil, including stems, stumps, branches, bark and foliage, and forest understory (only for estimation of emissions from forest fires).
Slovakia	Merchantable volume, defined as tree stem and branch volume under bark with a minimum diameter threshold of 7 cm.
Slovenia	Volume over bark of all living trees more than 9.99 cm in diameter at breast height (1.3 m). Includes the stem from ground to a top diameter of 6.99 cm, and also branches to a minimum diameter of 6.99 cm.
Spain	Trees with DBH over 7.5 cm at the ground level are measured, while those under 7.5 cm are only counted.
Sweden	Biomass of living trees with a height over 1.3 m. Small trees, shrubs and other vegetation (i.e., herbs) are not counted. Aboveground biomass is defined as tree part above stump height (1% of tree height).
UK	Modelled living woody biomass (complete individual cycle of trees, it does not include understory and annual/perennial non woody vegetation).
Below-ground biomass	
Austria	All living biomass of live roots with a diameter > 2 mm.
Ireland, UK	Fine roots pool is simulated within integrates models.
Belgium	Diameter of estimated roots > 5 mm.
Denmark	Stumps from harvested trees within a year from the measurement are measured.
France	Fine roots are included with the soil organic matter.
Finland	Stumps and roots down to a minimum diameter of 1cm.
Hungary	The total biomass of the above trees minus their above-ground biomass.
Czechia, Italy, Poland, Spain	Applies a country specific “root- to-shoot” factor.

Country	Description
Lithuania	Below-ground biomass refers to all living biomass of live roots.
Portugal	Living biomass of belowground biomass (the lower limit of root diameter, if any, is not explicitly defined).
Sweden	Biomass of living trees below stump height (1% of tree height) down to a root diameter of 2 mm.
	Dead wood
Austria	All non-living woody b biomass not contained in the litter or soil, standing on the ground, without roots, as they are already considered as part of the litter or soil.
Belgium	Dead wood as measured by NFI, namely standing dead trees and fallen logs and branches. A dead tree is considered as fallen when it tilts at a vertical angle equal or superior to 45°. Dead trees above 20 cm of circumference are measured, under 20 cm are estimated visually.
Denmark	Standing deadwood with a DBH larger than 4 cm. Lying dead wood with a diameter of more than 10 cm, whose length is recorded. The degree of decay is recorded on an ordinal scale.
Finland	Non-living biomass which is not contained in litter (described by model as coarse woody litter input, larger than 10 cm in diameter, from natural mortality of trees and harvesting residues).
France	Standing trees, dead for less than 5 years, plus 10% from the wood which is annually harvested.
Germany	Fallen dead wood with a thicker-end diameter of at least 20 cm; standing dead wood with a diameter of at least 20 cm at breast height and trunks with either a height of at least 50 cm or a cut surface diameter of at least 60 cm. NFI 2008 collected data on all dead-wood objects with a thicker-end diameter of at least 10 cm. Data collection was for both NFIs on 3 species groups and 4 decomposition class.
Ireland, UK	Pool is simulated by models.
Italy	The amount of carbon in dead wood is estimated from the aboveground carbon amount with an expansion factor.
Greece	Dead wood that remains on site after fire is assumed to fully decompose in 10 years.
Lithuania	Dead wood includes total standing and lying volume of dead tree stems.
Slovakia	The dead wood carbon pool contains dead trees from standing, stumps, coarse lying dead wood and small-sized lying dead wood not included in litter or soil carbon pools.
Slovenia	Dead wood content is all non-living woody biomass not contained in the litter, either standing, lying on the ground. According to definition from NFI 2007, dead wood in Slovenia includes: dead trees (DBH > 10 cm); stumps (D > 10 cm and H > 20 cm); snags (D > 10 cm and H > 50 cm); coarse woody debris (D > 10 cm and L > 50 cm).
Sweden	Dead wood is defined as fallen dead wood, snags or stumps including coarse and smaller roots down to a minimum “root diameter” of 2 mm. Dead wood of fallen dead wood or snags should have a minimum “stem diameter” of 100 mm and a length of at least 1.3 m.
Iceland	dead wood meeting the minimum criteria of 10 cm in diameter and 1 m in length
	Litter
Austria	All non-living biomass lying dead in various states of decomposition above the mineral or organic soil.
Austria, Ireland, UK	Litter is simulated by models.
Denmark	Non-living biomass, which is not included in other classes, under various status of decomposition on top of mineral or organic soil. It includes the litter, fumic and humic layers.
Finland	Non-living biomass with a diameter less than 10 cm in various status of decomposition (allocated by model in compartments: fine woody litter, coarse woody litter, extractives, celluloses and lignin-like compound). Biomass of ground vegetation (e.g., moss-, lichen-shrub- and twig vegetation) is not included in the living biomass, but it is included when the litter input to the soil is estimated.
France	Non-living dead wood lying on soil with maximum 7.5 cm diameter, dead leaves, humic and fumic layers, fine roots.
Germany	Dead organic cover with a fraction < 20 mm.
Italy	The amount of carbon in litter is estimated from the aboveground carbon amount with linear relations.
Portugal	Non-living biomass on top of mineral soil, in various stages of decomposition (include fumic, humic) (considered only in forest fires).
Slovakia	The litter pool definition used in the inventory includes all non-living biomass with a size less than the minimum diameter defined for dead wood (1 cm). The small-sized lying dead wood (diameter between 1 and 7 cm), in various states of decomposition above the mineral soil are not a part of litter, because they are included in dead wood. The litter includes the surface organic layer (L, F, H horizons) as usually defined in soil profile description and classification. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter.
Slovenia	The carbon stock in Ol, Of and Oh sub horizon. Volume of roots and coarse fragments (soil skeleton > 2 mm) is not included.
Sweden	Non-living biomass not classified in other classes, under various stages of decomposition, on top of mineral or organic soil: litter, fumic and humic layers. Litter includes, as well: a) live fine roots (<2 mm) from O horizon and b) coarse litter with “wood stem diameter” between 10-100 mm.

Country	Description
	Soil Organic Carbon
Austria	All organic matter in mineral and organic soils (including peat) to a soil depth of 50 cm (forests, LUC from and to forests) or to a soil depth of 30 cm (all other land uses and LUC).
Austria, Finland, UK, Ireland	Pool is simulated by models (undefined depth or dimensions).
Belgium, France, Germany, Italy, Luxemburg, Portugal	Organic carbon in 0-30 cm topsoil.
Bulgaria	Organic carbon in 0-40 cm topsoil, also includes the C stock of the litter layer (humus layer).
Croatia	Organic carbon in 0-40 cm topsoil.
Czechia	Soil organic carbon in 0-30 cm, including the upper organic horizon.
Denmark	Organic carbon in the mineral soils below the litter, fumic and humic layers and all organic carbon in soils classified as Histosols. It is for 30 cm depth between top of the mineral soil or, alternatively, from the soil surface (if Histosols).
Hungary	The soil carbon stocks were determined from humus content (Hu) values (Filep, 1999) that were measured for the uppermost 30 cm of the soil.
Slovakia	Organic carbon in the mineral soils 0-20 cm.
Slovenia	Carbon stock in mineral part of soil (SOM) in 0–40 cm soil depth.
Spain	Organic carbon in the mineral soils down to 30 cm.
Estonia, Sweden	Organic carbon in the mineral soils below the litter, fumic and humic layers and all organic carbon in soils classified as Histosols, down to a depth of 50 cm.

When assessing inventory completeness, it should be noted that what is not reported under a pool, is reported under another one (e.g., fine roots are reported either as litter or as soil organic matter), so that no bias in the overall estimation is expected to occur.

Individual submissions of GHG inventories follow 2006 IPCC guidelines for estimating the carbon stock changes in forest carbon pools. For living biomass, methodologies are based either on the "stock difference" or "gain-loss" methods (

Table 6. 12).

Table 6. 12 IPCC Method used for estimating carbon stock changes in forest aboveground biomass.

Country	IPCC method
Austria	*Gain-loss*
Belgium	*Stock-difference*
Bulgaria	*Stock-difference*
Croatia	*Gain-loss*
Cyprus	*Gain-loss*
Czechia	*Gain-loss*
Denmark	*Stock-difference*
Estonia	*Stock-difference*
Finland	*Gain-loss*
France	*Gain-loss*
Germany	*Stock-difference*
Greece	*Stock-difference*
Hungary	*Stock-difference*
Ireland	*Gain-loss*
Italy	*Gain-loss*

Country	IPCC method
Latvia	*Gain-loss*
Lithuania	*Stock-difference*
Luxemburg	*Gain-loss*
Malta	*Gain-loss*
Netherlands	*Gain-loss*
Poland	*Stock-difference*
Portugal	*Gain-loss*
Romania	*Gain-loss*
Slovakia	*Gain-loss*
Slovenia	*Stock-difference*
Spain	*Stock-difference*
Sweden	*Stock-difference*
UK	*Gain-loss*
Iceland	*Stock-difference*

Data sources for the estimation of carbon stock changes in living biomass also differ among countries, upon data availability. Nowadays, NFIs represent the primary source of information for most of MS, while others rely on other forestry statistics and yield tables. In addition, forest fire statistics complement both data sources. Data collection and data analysis programs are ongoing in most of the countries to further improve the completeness and accuracy of the estimates, primarily of carbon stock changes.

The implied carbon stock change factors reported for net carbon stock changes in living biomass for this inventory year range from -2.17 to 1.54 T C ha^{-1} (Table 6. 13). Generally, low values of IEFs are shown by countries with high harvesting rates or with less favorable climatic conditions (i.e., lower growth and also more losses by natural disturbances); while higher values are reported by countries where planting combined with relatively short forest rotation times is the main instrument to ensure forest regrowth.

Table 6. 13 Implied carbon stock change factors for living biomass pool in 4A1 (t C ha-1 year-1) reported in individual GHGI 2022.

Country	Net carbon stock change factor in living biomass (t C/ha)	
	1990	2020
AUT	0,76	0,23
BEL	0,74	0,68
BGR	1,07	0,50
HRV	0,75	0,69
CYP	0,06	0,23
CZE	0,57	-2,17
DNM	0,16	0,15
EST	0,40	-0,12
FIN	0,31	0,36
FRK	0,44	0,32
DEU	0,15	0,75
GRC	0,10	0,18
HUN	0,44	0,75
IRL	2,57	0,70
ITA	0,55	0,80
LVA	1,54	0,25
LTU	0,96	0,65
LUX	-0,50	0,98
MLT	0,04	0,02
NLD	1,37	1,26
POL	1,04	0,40
PRT	0,40	0,56
ROU	0,96	0,90
SVK	0,95	0,93
SVN	1,18	0,82
ESP	0,46	0,52
SWE	0,35	0,30
GBK	1,13	0,79
ISL	0,01	0,39

Changes of organic carbon stored in mineral soils and dead organic matter are mostly reported by applying Tier 1 method, which assumes for this land use subcategory that these carbon pools are in equilibrium, and therefore no net carbon stock changes occur in long term. In these cases, notation keys are used in the corresponding CRF table 4.A (see also Table 6. 5 and Table 6. 6).

When they are estimated, countries mainly rely on data collected in the course of the national forest inventories. However, it should be noted that the widespread use of the Tier 1 assumption is due to the lack of appropriate data, and the high costs associated with systems that would allow a proper collection of this information, in other cases also to the very high uncertainty of the existing data.

Nevertheless, an increasing number of countries document ongoing efforts to estimate emissions and removals from dead organic matter and mineral soils in forest. This has resulted in more countries reporting for first time carbon stock changes in these pools using country-specific data.

When data on soil organic carbon content is available from two measurement cycles, they are often directly used for estimating carbon stock changes using stock difference approaches. In few cases, data is also integrated in models. Moreover, depending on the availability of datasets in individual countries, carbon stock changes in dead organic matter are often disaggregated between dead wood and litter or some countries include their estimates within soil organic carbon pool (e.g., Finland).

Finally, a particularity is reported by France that reports carbon stock changes in dead organic matter only for part of the time-series. In line with the 2006 IPCC guidelines, France reports carbon stock changes in the pool starting in 1999 as a result of the significant carbon inputs that entered into the pool after a windstorm that affected dramatically the forest area in that year.

Table 6. 14 Implied carbon stock change factors in DOM carbon pool in 4A1 (t C ha-1 yr-1) reported in individual *GHGI 2022.*

Country	Net carbon stock change in dead wood per area (t C/ha)		Net carbon stock change in litter per area (t C/ha)	
	1990	2020	1990	2020
AUT	0,02	0,01	NE,IE	NE,IE
BEL	NA	NA	NA	NA
BGR	0,03	0,08	NA	NA
HRV	NA	NA	NA	NA
CYP	NO	NO	NO	NO
CZE	0,06	0,15	0,16	0,41
DNM	0,01	0,07	0,07	0,36
EST	0,02	0,01	NA	NA
FIN	IE	IE	IE	IE
FRK	NA	-0,02	NA	NA
DEU	0,04	0,09	-0,01	-0,01
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	0,03	0,03	NE	NE
IRL	IE	IE	0,18	-0,03
ITA	0,02	0,01	0,03	0,01
LVA	0,05	0,12	NA	NA
LTU	0,07	0,10	NA	NA
LUX	0,09	0,10	NO	NO
MLT	NA	NA	NA	NA
NLD	0,08	0,13	0,29	0,14
POL	NO	0,14	NO	NO
PRT	IE	IE	0,00	0,00
ROU	NE	NE	NE	NE
SVK	0,08	0,08	NA	NA
SVN	0,10	0,18	NA	NA
ESP	NA	NA	NA	NA
SWE	0,05	0,06	-0,10	-0,03
GBK	0,27	0,30	0,06	0,04
ISL	NO,IE	NO,IE	NA	NA

Carbon stock changes in mineral soils under forest land remaining forest land in this submission are quantitatively estimated generally as a small net sink of carbon. (Table 6. 15).

Most of the countries report absence or insignificant areas of organic soils under this land use subcategory. However, when organic soils are present, they are reported in most of the cases as resulting in a net source of emissions.

CO_2 emissions from organic soils are associated with managed forests (e.g., drainage of soils to establish plantations)

Table 6. 15 Implied carbon stock change factors in mineral and organic soils in 4A1 (t C ha-1 yr-1) reported in individuals GHGI 2022.

Country	Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2020	1990	2020
AUT	-0,19	-0,18	NO	NO
BEL	NA	NA	NO	NO
BGR	NA	NA	NO	NO
HRV	NA	NA	NO	NO
CYP	NO	NO	NO	NO
CZE	-0,01	0,03	NO	NO
DNM	NA	NA	-1,95	-1,30
EST	0,16	0,16	-0,16	-0,16
FIN	0,17	0,09	-0,55	-0,17
FRK	NA	NA	NO	NO
DEU	0,41	0,41	-2,65	-2,65
GRC	NA,NO	NO,NA	NA,NO	NO,NA
HUN	NE	NE	-2,60	-2,60
IRL	-0,05	-0,05	-1,61	-1,60
ITA	NO,NA	NO,NA	NO	NO
LVA	NA	NA	-0,52	-0,52
LTU	NE	NE	IE	IE
LUX	NO	NO	NO	NO
MLT	NA	NA	NO	NO
NLD	NA	NA	-1,03	-0,92
POL	0,05	0,09	-0,68	-0,68
PRT	0,02	-0,01	NO	NO
ROU	NE	NE	-2,60	-2,60
SVK	NA	NA	NO	NO
SVN	NA	NA	NO	NO
ESP	NA	NA	NO	NO
SWE	0,17	0,13	-0,37	-0,36
GBK	0,24	0,39	-0,58	-0,00
ISL	NA	NA	-0,37	-0,37

6.2.1.3 Land converted to Forest Land (CRF 4A2)

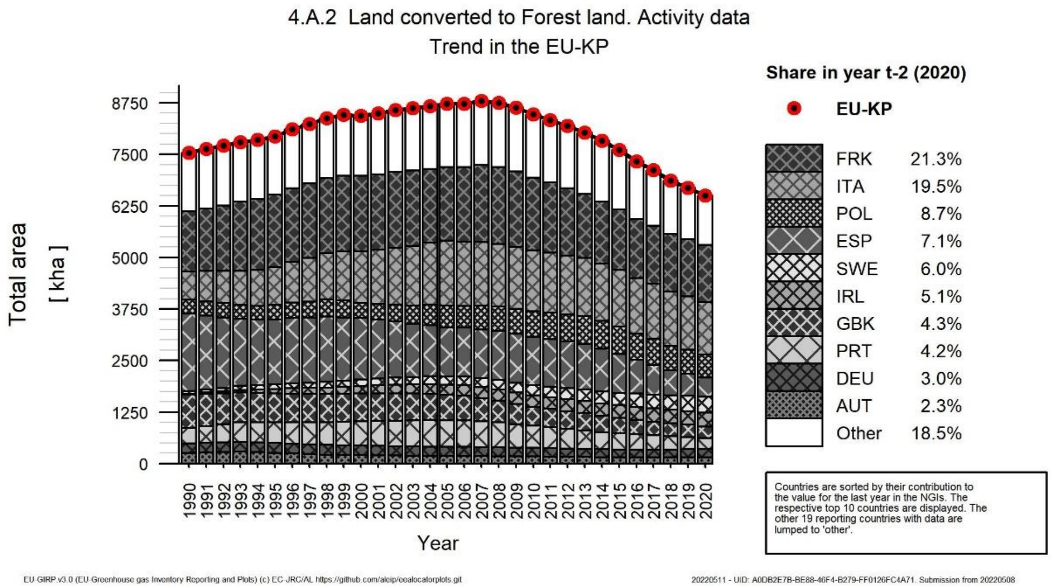
Overview of Land converted to Forest Land category

In this submission, the area reported under this subcategory represents 4% of the total Forest Land area. This subcategory has decreased by 14% as compared with 1990 (Figure 6. 5), from 7.541 kha in 1990 to 6.502 kha in 2020.

Most of the new forest lands are converted from Grassland and Cropland areas, and although within the overall category they have a low share in terms of areas, they contribute by 11% to the total carbon sink of the European forests.

In term of areas, Italy, France, Poland and Spain together contribute with about 55% of the total areas being converted to forest land.

Figure 6. 5 Trend of activity data in subcategory 4A2 "Land converted to Forest Land" in EU-KP (kha)



This subcategory has been always reported as a net carbon sink. In this submission, it reaches -34.573 kt CO_2, which represents a decrease of the sink by 10% as compared with 1990. This trend in removals is well associated with the trend on areas (Figure 6. 6; Table 6. 16).

Nevertheless, some MS (e.g., Finland and Sweden) have reported this subcategory as a net source of emissions for the first years of the time series or as a very small sink. This fact is explained by the emissions caused during the preparatory practices of soils that preceded the afforestation or reforestation activities. The absence of such emissions is often associated with natural expansion of forest areas.

Table 6. 16 4A2 Land converted to Forest Land: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	-3 043	-1 723	-1 717	5.0%	1 326	44%	6	0%
Belgium	-11	-290	-296	0.9%	-285	-2563%	-6	-2%
Bulgaria	-2 883	-552	-545	1.6%	2 338	81%	7	1%
Croatia	-29	-254	-260	0.8%	-231	-799%	-6	-2%
Cyprus	0	-5	-5	0.0%	-5	-2296%	0	-8%
Czechia	-237	-600	-581	1.7%	-344	-145%	20	3%
Denmark	-1 037	-1 287	-1 187	3.4%	-150	-14%	101	8%
Estonia	-11	-389	-354	1.0%	-343	-3112%	34	9%
Finland	3	-205	-205	0.6%	-208	-7077%	0	0%
France	-7 256	-7 274	-7 245	21.0%	11	0%	29	0%
Germany	144	121	99	-0.3%	-45	-31%	-22	-19%
Greece	NO,NE	-32	-29	0.1%	-29	-∞	3	10%
Hungary	-315	-1 208	-1 143	3.3%	-829	-263%	65	5%
Ireland	167	-2 555	-2 984	8.6%	-3 152	-1883%	-429	-17%
Italy	-2 849	-5 993	-5 221	15.1%	-2 372	-83%	772	13%
Latvia	-14	-198	-189	0.5%	-175	-1249%	9	4%
Lithuania	-783	-1 099	-1 129	3.3%	-346	-44%	-30	-3%
Luxembourg	-33	-15	-14	0.0%	19	58%	1	8%
Malta	NO	0	0	0.0%	0	-∞	0	-110%
Netherlands	-577	-505	-504	1.5%	73	13%	2	0%
Poland	-1 317	-2 199	-2 206	6.38%	-890	-68%	-7	0%
Portugal	-2 138	-2 174	-1 904	5.5%	234	11%	270	12%
Romania	-2 199	-1 651	-1 601	4.6%	598	27%	50	3%
Slovakia	-2 263	-358	-351	1.0%	1 912	84%	7	2%
Slovenia	-233	-378	-278	0.8%	-45	-19%	101	27%
Spain	-11 369	-3 922	-3 273	9.5%	8 096	71%	649	17%
Sweden	69	-893	-1 037	3.0%	-1 106	-1610%	-144	-16%
United Kingdom	-177	-117	-26	0.1%	151	85%	91	78%
EU-27+UK	**-38 389**	**-35 755**	**-34 185**	**99%**	**4 204**	**11%**	**1 570**	**4%**
Iceland	-28	-368	-385	1.1%	-357	-1285%	-17	-5%
United Kingdom (KP)	-207	-121	-30	0.1%	177	86%	91	75%
EU-KP	**-38 448**	**-36 127**	**-34 573**	**100%**	**3 874**	**10%**	**1 553**	**4%**

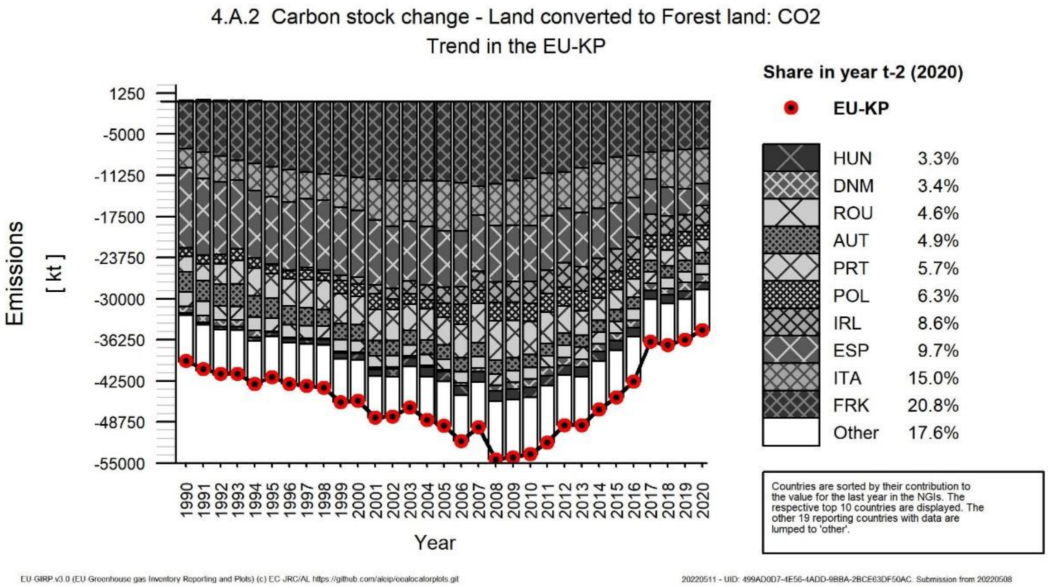
As shown in Table 6. 16, some MS reported significant changes in this subcategory as compared with 1990, for instance, Finland, Sweden, Ireland, and Spain.

In the case of Finland, this is given by the net result of summing up under the category 4A.2 emissions and removals from all land uses converted to forest. While in 1990 emissions from drained organic soils in lands converted to forests counterbalanced the removals; much less drainage of organic soils occurs in the last years of the time series and therefore a larger sink was reported as a result of the carbon accumulation in living biomass.

In the case of Ireland, the increase on removals by the post-1990 forest is due to an increase in forest area, and their productivity as new established forests mature. The slight decrease in the slope of the change in removals from 2007 onward is due to thinning harvests in productive forests at age 17 years old and onwards.

Finally, the changes in the carbon sink reported by Sweden and Spain are driven by the trend of the area in this category. While Sweden reports a constant increase of land converted to forests, Spain reports a constant decrease that is well reflected in a lower the sink at the end of the time series as compared with the base year.

Figure 6. 6 Trend of emissions (+)/removals (-) in subcategory 4A2 "Land converted to Forest Land" in EU-KP (kt CO_2)



For this year, about 45% of total carbon sink reported in the subcategory 4A.2 was reported by France, Italy, and Spain while the 10 MS with the larger contribution represent about the 85% of the total sink of the new forest areas.

Methodological issues for Land converted to Forest Land category

Methods used to identify and represent the areas converted to forests, as well as to report the associated GHG emissions and CO_2 removals from these areas, are generally the same as the ones used for the subcategory 4.A.1. Nevertheless, different parameters are involved under each subcategory due to differences among other in growth rates and management practices of these young forests.

In this sense and following past recommendations from the ERTs of the EU GHG inventory, in the last year, Italy was requested to prove that its method does not result in biased estimates for land converted to forest land. Italy has informed that the For-est model in its current version does not differentiate between forest land remaining forest land and land converted to forest land since all variables are calculated (current increment, mortality) or collected (harvest, burnt area) at the landscape level. The apportioning among forest land remaining forest land for the increment is made on the basis of the area proportion of this category over the entire forest area. Regarding losses, the harvest is all assigned to forest land remaining forest land, while the burnt area is divided between subcategories on the basis of the percentage of area of each subcategory in a yearly basis. Moreover, Italy stated to have performed an analysis across European forest reports that showed that its approach does not cause any bias in the GHG estimates, so far as can be judged.

Most of the countries have developed land identification systems that are able to identify and track land use conversions to, and from, forests. Mainly, as already mentioned, these methods are based on information collected by the national forest inventories on systematic sampling grids, and that, in many cases, is complemented by auxiliary information on the form of satellites images, remote sensing analysis, aerial photography, or national registries.

Estimates of GHG emissions and CO_2 removals from this subcategory are usually reported using tier 2 methods involving country-specific data collected during the national forest inventories. Under this subcategory, living biomass and dead organic matter carbon pools are in most of the cases reported as a net carbon sink. Mineral soils are reported either as a net source or a net sink of emissions depending on whether there is presence or absence of disturbed soils on new forest areas (i.e., natural regeneration or, soils management practices that enhance carbon oxidation).

Concerning organic soils, countries have reported this carbon pool as a net source of emissions whenever new forest areas were established in this type of soils.

Nevertheless, it should be noted that the heterogeneity in approaches used by the countries under 4A.2 suggests caution in interpreting differences in the implied carbon stock change factors among carbon pools. For instance, possible reasons of differences may include the length of the time series on activity data and their starting point, the use of time-averaged annual biomass growth, or the quantity of CO_2 emissions estimated from the land that is converted to forests, including lagged emissions.

6.2.2 Cropland (CRF 4B)

6.2.2.1 Overview of the Cropland category

Subject to intensive agriculture practices, Cropland category is an important contributor to the EU GHG budget. This category, which includes arable lands for annual crops, permanent crops, set aside lands and rice-fields, represents the largest source of emissions among the six land use categories.

Based on individual submissions reported this year, Cropland areas covered in 2020 a total of 124.198 kha, which represent 27% of the lands reported by EU MS, UK and Iceland. However, the category shows a steady decreasing trend. For this inventory year the area is about 8% less than in the year 1990.

6.2.2.2 Cropland remaining Cropland (CRF 4B1)

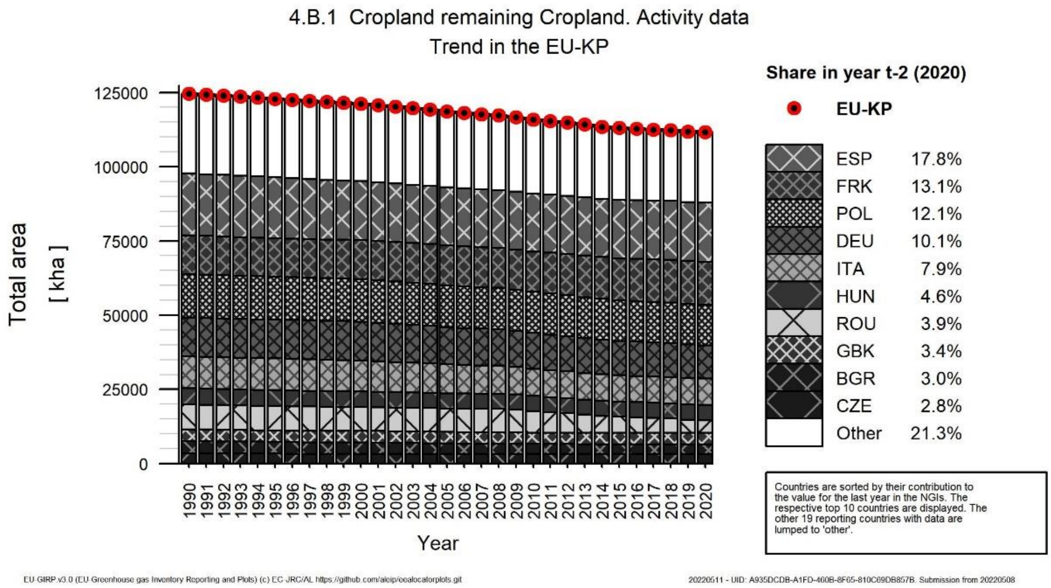
Overview of Cropland remaining Cropland category

In line with the overall category, this subcategory has constantly decreased since 1990 (Figure 6. 7) from 124.655 kha in 1990 to 111.675 kha in 2020. This represents a decrease of 10%.

With the exception of France, Malta, Slovakia and Iceland, countries report a decrease of Cropland area as compared with 1990.

The overall trend of this subcategory is driven by 10 MS which together contribute to about 80% of the total area, and more specifically, Spain, France, Poland, and Germany which represent about half of the area reported under this subcategory.

Figure 6. 7 Trend of activity data in subcategory 4B1 “Cropland remaining Cropland” in EU-KP (kha)



In terms of emissions, at the EU level this subcategory has been always reported as a net source of GHG emissions.

For the year 2020, based on individual submissions, GHG emissions from Cropland remaining Cropland reached 12.995 kt CO_2 which represents a decrease of 60% as compared to 1990 (Table 6. 17).

This trend is mainly driven by Germany, UK and Finland that report the largest emissions from this subcategory (Figure 6. 8). In general, emissions are the result of the oxidation of soils organic matter, which are particularly important in those MS with presence of cultivated areas on organic soils.

Nevertheless, some MS report a considerable carbon sink in Cropland remaining Cropland. For instance, France, Romania, and Spain report a substantial net carbon sink in mineral soils and, in some cases, also in the living biomass carbon pool. This is generally justified by the implementation of IPCC methodologies (i.e. tier 1 and tier 2) that result in a net sink when current management practices of soils are less intensive than those implemented 20 years before. In addition, net carbon sink may occur in countries with significant areas of woody crops (i.e., orchards, vineyards, Christmas trees, fruits, bushes, and olive trees) that provide a net sink resulting from carbon accumulation in the living biomass pool.

A particular case is Romania, which reports a significant sink in this subcategory because, as explained in its NIR, Cropland areas include lands that are subject to Revegetation activities under the KP. Such areas are reported as tree plantations, but they are managed as part of the agricultural land, mainly arable. Tree plantations classified as revegetated areas “behave” as forest plantations with regard to change in each carbon pools, therefore resulting in a net carbon sink.

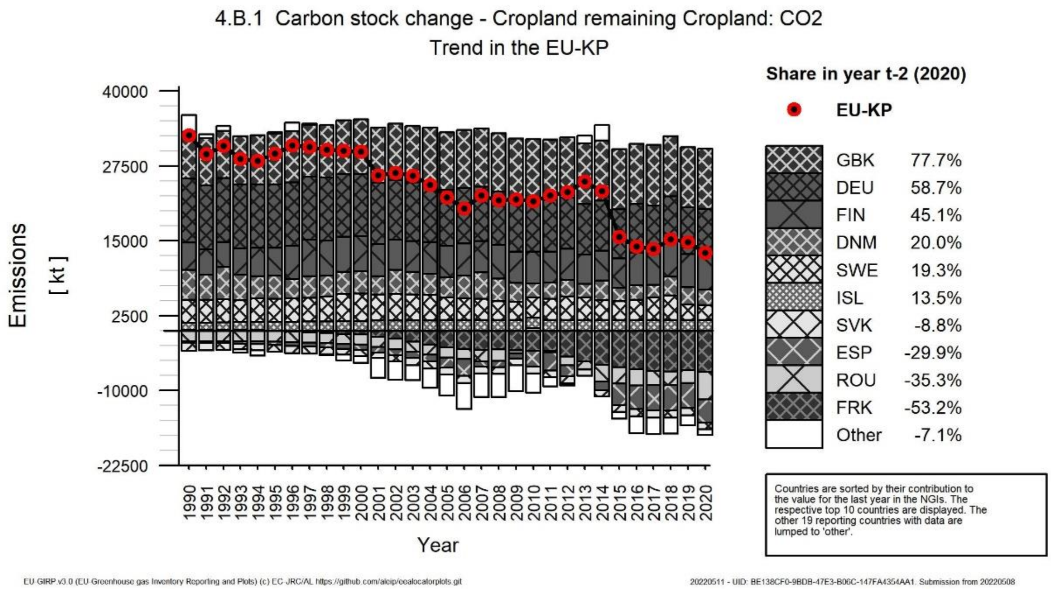
Table 6. 17 4B1 Cropland remaining Cropland: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	-17	-104	-63	-0.5%	-46	-269%	41	39%
Belgium	213	114	115	0.9%	-98	-46%	1	1%
Bulgaria	-851	-503	-496	-3.8%	355	42%	7	1%
Croatia	433	445	442	3.4%	9	2%	-3	-1%
Cyprus	-136	-135	-135	-1.0%	1	1%	0	0%
Czechia	-25	-17	-20	-0.2%	6	22%	-3	-19%
Denmark	4 966	2 875	2 594	20.0%	-2 372	-48%	-281	-10%
Estonia	667	276	323	2.5%	-344	-52%	47	17%
Finland	4 536	5 589	5 854	45.1%	1 318	29%	265	5%
France	77	-6 619	-6 896	-53.1%	-6 974	-9000%	-277	-4%
Germany	10 700	7 740	7 611	58.6%	-3 088	-29%	-129	-2%
Greece	-808	581	-89	-0.7%	719	89%	-670	-115%
Hungary	25	-321	-316	-2.4%	-341	-1353%	5	2%
Ireland	-100	-140	-111	-0.9%	-10	-10%	29	21%
Italy	774	-1 651	-317	-2.4%	-1 091	-141%	1 334	81%
Latvia	2 364	1 175	1 140	8.8%	-1 224	-52%	-36	-3%
Lithuania	78	-1 066	-1 072	-8.2%	-1 150	-1482%	-6	-1%
Luxembourg	0	2	2	0.0%	2	159740%	0	-1%
Malta	0	-1	-1	0.0%	-1	-369%	0	-1%
Netherlands	1 132	515	499	3.8%	-633	-56%	-16	-3%
Poland	-906	-732	-729	-5.61%	177	20%	3	0%
Portugal	21	-182	-151	-1.2%	-172	-819%	31	17%
Romania	-1 800	-2 154	-4 583	-35.3%	-2 783	-155%	-2 428	-113%
Slovakia	-1 391	-1 212	-1 147	-8.8%	244	18%	65	5%
Slovenia	65	85	86	0.7%	21	32%	1	2%
Spain	-203	-4 159	-3 881	-29.9%	-3 678	-1810%	278	7%
Sweden	3 860	2 564	2 502	19.3%	-1 359	-35%	-62	-2%
United Kingdom	7 763	10 067	10 065	77.5%	2 302	30%	-2	0%
EU-27+UK	**31 436**	**13 034**	**11 230**	**86%**	**-20 206**	**-64%**	**-1 804**	**-14%**
Iceland	1 221	1 753	1 753	13.5%	532	44%	0	0%
United Kingdom (KP)	7 774	10 079	10 077	77.5%	2 303	30%	-2	0%
EU-KP	**32 668**	**14 799**	**12 995**	**100%**	**-19 673**	**-60%**	**-1 805**	**-12%**

Information above shows that as compared with the year 1990, France and Spain have reported in this submission a significant increase of removals in Cropland remaining cropland. This results mainly from an increase in soil organic carbon in mineral soils which is driven by changes in management practices. However, larger sink in living biomass of woody crops at the end of the time series also contributes to the overall trend. By contrary, UK has reported a significant increase of emissions as compared with the base year, driven also by larger emissions from mineral soils due to management practices.

Germany reports a significant decrease of emissions from Cropland that is mainly driven by a constant decrease of cropland areas after 2000, and by agricultural practices that result in lower emissions, for instance lower area of cultivation of histosoils.

Figure 6. 8 Trend of emissions (+)/removals (-) in subcategory 4B1 “Cropland remaining Cropland” in EU KP (kt CO_2)



Methodological issues for Cropland remaining Cropland category

Lands included under this category generally are in line with the IPCC definition (Table 6. 18). However, there could be national particularities (e.g., treatment of some woody crops) that result in small differences among countries.

In some cases, because of the absence of annual information on activity data, coupled with the fact that management practices include crops-rotation cycles and fallow lands, some cropland areas may not be clearly separated from grassland areas. In these cases, countries have defined the number of years before a land is shifted from/to cropland and grassland.

Table 6. 18 Definitions of lands included under the category 4B: Cropland.

Country	*Definition*
Austria	Arable land, including annual and perennial crops (rotation period of up to thirty years), as well as forest arboretums, forest seed orchards, Christmas tree plantations and orchards (e.g., walnut, or sweet chestnut) and rows of trees and areas with woody plants in parks and green areas, and house garden.

Country	Definition
Belgium	Tillage land and agroforestry systems with vegetation falling below the thresholds for forests.
Bulgaria	Cropland consists of annual crops (cornfields and kitchen gardens) and perennials (vineyards, fruit and berry plantation and nurseries). Arable land is the land worked regularly, generally under a system of crop rotation - area with annual crops, set - aside area as well as area with seeds and seedlings. Perennial crops include fruit and berry plantation, vineyards and other permanent crops, nurseries for wine, fruits, ornamental plants, forest trees etc. The orchard is a uniformly kept plantation (by annual pruning and regular treatment for protection from diseases and insects) of fruit trees (pip- trees, stone-trees and nut-trees).
Croatia	Cropland category includes non-irrigated arable land, permanently irrigated arable land, vineyards, fruit trees and berry plantations, olive groves, annual crops associated with permanent crops (Complex cultivation patterns).
Cyprus	This category contains cropped land, including lands with woody vegetation (i.e., fruit trees) where the vegetation does not meet the definition of forest. In particular, this category includes land principally occupied by agriculture, including arable land, annual and permanent crops as well as vineyards, fruit trees and berry plantations, olive groves and other similar types of cultivation.
Czechia	Cropland is predominantly represented by arable land (92.6%), while the remaining area includes hop-fields, vineyards, gardens and orchards.
Denmark	Annual crops, wooden perennial crops, hedgerows and “other agricultural area” (i.e., small undefined areas lying inside the cropland area). It includes farmlands, commercial plantations with perennial crops (fruit trees, orchards and willow), house gardens, hedgerows (perennial trees/bushes not meeting the forest definition) in the agricultural landscape, as well as willow plantations on agricultural land for bioenergy purposes.
Estonia	Cropland is arable land, area where annual or perennial crops are growing (incl. fallow, orchards, short-term and long-term cultural grasslands and temporary greenhouses). It does not include built garden land under 0.3 ha (that is included in Settlements). Abandoned cropland is classified as cropland until it has not lost arable land features – changes in soil and vegetation have not taken place and the land is still usable as cropland without the implementation of specific treatments.
Finland	Arable crops, grass covered (for less than 5 years), set-aside, permanent horticultural crops, greenhouses, and kitchen gardens.
France	Annual crops, temporary pastures (which last for maximum 6 annual harvests) and permanent crops (orchards, vineyards, olives, etc.).
Germany	Annual crops and cropland with perennial crops (long-lived crops: fruit crops, osiers, poplars, Christmas tree farms, nurseries) and lands for cultivation of vegetables, fruit and flowers.
Greece	Annual and perennial crops, temporary fallow land and perennial woody crops, i.e., tree crops and vineyards.
Hungary	Cropland contains arable lands, vegetable gardens, orchards and the vineyard areas, as well as set-aside croplands. Arable lands are any land area under regular cultivation irrespective of the rate or method of soil cultivation and whether the area is under crop production or not due to any reason, such as temporary inland waters or fallow. Areas under tree nurseries (including ornamental and orchard tree nurseries, vineyard nurseries, forest tree nurseries excluding those for the own requirements of forestry companies grown in the forest), permanent crops (e.g., alfalfa and strawberries), herbs and aromatic crops are included. Vegetable gardens are areas around residential houses where, in addition to meeting the owners’ demand may produce some surplus of low amount which is usually traded. Orchards are land under fruit trees and bushes that may include several fruit species (e.g.: apples, pears, cherries, etc.). Included are non-productive orchards and orchards of systematic layout in vegetable gardens if the area is 200 m^2 or above in case of berries and 400 m^2 or above in case of fruit trees. Vineyards are areas where grapes are planted in equal row width and planting space and include non-productive areas and vineyards in vegetable gardens (e.g., trellises) if grapes are planted in equal row width and planting space, and the size of the area is at least 200 m^2. Set-aside cropland is land that is abandoned but not converted to any other land use.
Ireland	Permanent crops and tillage land, including set-aside, as recorded by annual statistics.
Italy	Annual crops and perennial woody crops (e.g., woody plantations, that don’t meet national forest definition, olive groves or vineyards).
Latvia	The cropland refers to the area of arable land, including orchards and extensively managed arable lands. Cropland also includes animal feeding glades, which according to national land use classification belong to forest land.
Lithuania	The area of cropland comprises of the area under arable crops as well as orchards and berry plantations. Arable land is continuously managed or temporary unmanaged land, used and suitable to use for cultivation of agricultural crops, also fallows, inspects, plastic cover greenhouses, strawberry and raspberry plantations, areas for production of flowers and decorative plants. Arable land set aside to rest for one or several years (<5 years) before being cultivated again as part of an annual crop-pasture rotation is still included under cropland. Orchards and berry plantations are areas planted with fruit trees and fruit bushes (apple-trees, pear-trees, plum-trees, cherry-trees, currants, gooseberry, quince and others).
Luxemburg	Agro-forestry systems where tree cover falls below the forest thresholds, respectively covered by permanent crops, annual crops, artificial meadows (not permanent) and lands temporarily set aside.
Malta	In Malta cropland can be split into three types: arable area which is cultivated under a system of crop rotation; kitchen gardens that include small plots of cultivated land, in which most of the products are intended for consumption by the farmer; land under permanent crops where the crop occupies the same land for a period of time, normally 5 years or more. For inventory purposes, local cropland was split into two: annual crops and perennial woody crops. The main perennial crops considered for this inventory are vines, being the most cultivated crop.

Country	Definition
Netherlands	Arable and tillage land, including rice-fields, and agro-forestry systems where the vegetation structure falls below the thresholds for forest and nurseries (including tree nurseries).
Poland	Agricultural land considered as cropland consists of arable land includes land, which is cultivated, i.e., sowed and fallow land. Arable land should be maintained in good agricultural condition. Cultivated arable land is understood as land sowed or planted with agricultural or horticultural products, willow and hops plantations, area of greenhouses, area under cover and area of less than 1000 m^2, planted with fruit trees and bushes, as well as green manure, fallow land includes arable land which are not used for production purposes but are maintained in good agricultural condition; orchards include land with the area of at least 1000 m^2, planted with fruit trees and bushes.
Portugal	Rain-fed annual crops (without irrigation and fallow-land integrated into crop-rotations), irrigated annual crops (under irrigation, greenhouses), rice cultivation lands, wine yards, olives and other species of woody crops
Romania	Cropland includes agricultural lands, i.e., lands covered or temporary uncovered by agricultural crops (major crops and horticultural plants cultures). It includes 3 groups (non-woody crops, woody crops and other wooded land and trees outside forests (which do not meet the forest definition parameters, e.g., forest belts which are narrower than 20m) with 9 categories: orchard, vineyard, shrubs, cultivated land agricultural, temporary fallow land, deciduous tree, coniferous tree, deciduous and resinous trees and dead trees.
Slovakia	Cropland includes lands for growing cereals, root-crops, industrial crops, vegetables and other kinds of agricultural crops; perennial woody crops; lands temporary overgrown with grass or used for growing of fodder lasting several years; hotbeds and greenhouses if they are built up on the arable land; fallow land which is arable land left for regeneration for one growing season during which were not sow specific crops or just crops for green manure, eventually it is covered by spontaneous vegetation, which would be ploughed in.
Slovenia	Annual: arable land breeds more than 2 meters and grows the non-woody vegetation (cereals, potatoes, forage crops, vegetable crops, oilseed, ornamental plants, herbs, strawberries, hop fields) and agricultural fallow ground. Also, temporary meadows and greenhouses. Perennial: permanent crops on arable land such as vineyards, extensive and intensive orchards, olive groves, nursery (for grapevines, fruit and forest trees), forest plantations and forest trees on agricultural land.
Spain	Annual crops and fallow land, perennial crops (olive groves, wines and other woody crops) and mix of annual and permanent crops (except when they qualify as forest land, i.e., in "dehesa").
Sweden	Regularly tilled agricultural land.
UK	Arable and horticultural land.
Iceland	All cultivated land not included under Settlements or Forest land and at least 0.5 ha in continuous area and minimum width 20 m. This category includes harvested hayfields with perennial grasses. Two subcategories of Cropland are defined on the Land use map, "Cropland" and "Cropland on drained soils".

Overall, following the IPCC approach, the living biomass carbon pool is assumed in balance for annual crops, while carbon stock changes are reported for conversions among annual and woody crops (e.g., Austria, Croatia, and Bulgaria). Concerning carbon stock changes in woody crops, countries often implement the IPCC approach, either by using country-specific data on biomass accumulation from growth and maturity cycles, or by using default data. However, what is not always transparently provided is how the lands in which woody crops have reached maturity are identified and excluded from those that are still accumulating carbon.

Carbon stock changes in dead organic matter are in most of the cases reported following the IPCC assumption that the dead organic matter stocks are not present in croplands, or they are in equilibrium. In some cases, however, some MS have reported this pool as a net sink (e.g., Sweden) or as a net source (e.g., Romania).

A particular case is given by Finland which reports the notation key IE since the net carbon stock change in dead organic matter is included in losses in living biomass, explaining that the number of dead branches of currants and apple trees in modern orchards is very low and they are usually chipped and left to decay in the orchards.

With regard to carbon stock change in soils, these have been reported under mineral soils as either a net source or a net sink of carbon. The final net result is typically associated with an increase or decrease of the intensity in the soil management practices along the time series. By contrary, as reported by all countries, for cultivated organic soils the net result of carbon stock changes is associated with a source of CO_2 emissions. Methodologies for reporting this carbon pool follow, in most of the cases, IPCC tier 1 or tier 2 approaches, where carbon stock changes are estimated as the difference on the carbon stock in soils at two moments in time. In a few cases, carbon stock changes have been estimated by using models (e.g., C-tool by Denmark and ICBM by Sweden).

Applied Tier 2 methods consist often on the use of country-specific soil organic carbon reference values along with IPCC default values for relative change factors (i.e., for Fmg, Flu, Fi). In some cases, IPCC default relative change factors have been slightly modified to adapt them to national circumstances, but changes rely more on expert judgment than on a statistical analysis or systematic measurements. An exception is given by Austria, who derived own factors by close comparison with IPCC similar strata.

Parameters to estimate carbon stock change for living biomass of permanent crops vary depending on the types of crops and management practices across Europe, from North (i.e., bush-type currant crops) to South (i.e., olives trees and agroforestry systems).

Table 6. 19 Implied net carbon stock change factor for carbon pools in 4B1 (t C ha-1 yr-1) reported by individual submissions GHGI 2022.

Country	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2020	1990	2020	1990	2020	1990	2020
AUT	0,003	-0,001	NO	NO	0,000	0,015	NO	NO
BEL	NO	0,000	NO	NO	-0,041	-0,014	-10,000	-10,000
BGR	0,000	-0,009	NA	NA	0,058	0,052	-7,900	-7,900
HRV	-0,058	-0,054	NO	NO	0,000	-0,011	-10,000	-10,000
CYP	0,145	0,147	NO	NO	NO	NO	NO	NO
CZE	0,001	0,001	NO	NO	0,001	0,001	NO	NO
DNM	-0,007	-0,015	NA	NA	-0,091	0,011	-8,076	-7,532
EST	0,000	-0,003	NE	NE	NO	0,080	-6,100	-6,100
FIN	0,000	0,000	IE	IE	0,004	-0,118	-6,468	-6,532
FRK	-0,002	-0,002	NA	NA	0,001	0,131	IE	IE
DEU	-0,001	0,000	NO,IE,NA	NO,IE,NA	-0,002	-0,001	-9,239	-9,425
GRC	0,073	0,030	NO	NO	NO	NO	-10,000	-10,000
HUN	-0,002	0,000	NO	NO	0,001	0,018	NO	NO
IRL	0,004	0,002	NO	NO	0,033	0,039	NO	NO
ITA	-0,030	-0,040	NA	NA	0,031	0,074	-10,000	-10,000
LVA	0,001	0,009	0,000	0,000	NA	NA	-4,800	-4,800
LTU	-0,015	-0,009	NA	NA	NO	0,232	IE	IE
LUX	0,000	-0,015	NO	NO	0,000	0,001	NO	NO
MLT	0,014	0,040	NE,NA	NE,NA	-0,006	-0,007	NO	NO
NLD	NA	NA	NA	NA	NA	NA	-4,204	-3,515
POL	0,030	0,034	NA	NA	-0,002	-0,008	-1,000	-1,000
PRT	-0,002	0,017	NO	NO	NO	0,001	NO	NO
ROU	0,008	0,039	NA	NA	0,056	0,261	-10,000	-10,000
SVK	0,245	0,194	NA	NA	0,009	0,015	NE	NE
SVN	0,013	-0,004	0,001	0,001	-0,002	0,003	-10,000	-10,000
ESP	0,003	0,027	NA	NA	NO	0,027	NO	NO
SWE	0,002	0,026	0,002	0,001	-0,042	0,021	-6,100	-6,100
GBR	-0,002	0,000	NA	NA	-0,135	-0,337	-8,184	-8,184
ISL	NA	NA	NA	NA	0,153	0,153	-7,900	-7,900

Whenever the Tier 1 assumption of "equilibrium" for carbon stock changes in living biomass of annual crops or dead organic matter was implemented, countries used the notation key NO, NE, or NA. Efforts have been devoted to follow the recommendation from the UN ERT on the use of NA when the assumption of equilibrium is applied. As a result, more MS are now using the notation key NA. Nevertheless, it should be noted a full harmonization on the use of the notation key NA across MS is not possible since some countries have received from their UN ERT a different recommendation on which notation key should be used in this case.

6.2.2.3 Land converted to Cropland (CRF 4B2)

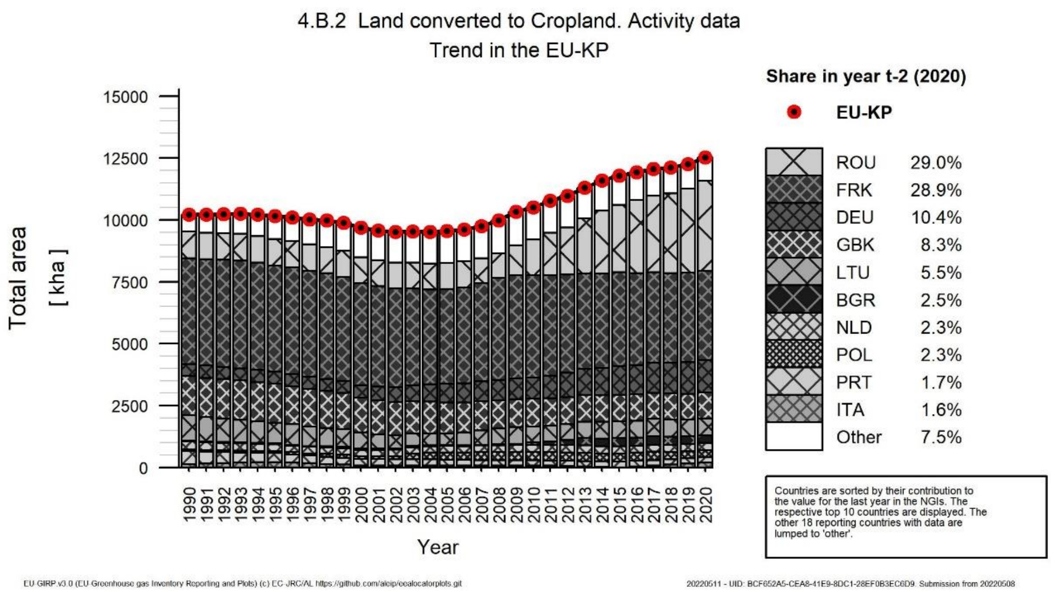
Overview of Land converted to Cropland category.

In terms of area, this subcategory represents 10% of the total cropland areas reported at the level of EU MS, UK, and Iceland. However, it accounts for 76% of the net CO_2 emissions that are reported in Cropland.

In overall, for this inventory year the area increased by 23% as compared with 1990, from 10.217 kha reported for the year 1990, to 12.523 Kha in 2020 (Figure 6. 9).

Main conversions of lands to Cropland take place from areas of Grassland and Forest land. The trend in this subcategory is mainly driven by France, Germany and Romania which report more than 60% of total area of new Croplands, often associated with rotation of crops and grasses on the same land.

Figure 6. 9 Trend of activity data in subcategory 4B2 "Land converted to Cropland" in EU KP (kha)



In terms of emissions, this subcategory is reported as a net source of emissions that for the current inventory year reaches 38.304 Kt CO_2. This represents a decrease of 10% as compared to 1990 (Table 6. 20). The largest emissions are reported by France, which reports about 48 % of the total emissions in this subcategory; followed by Germany and UK (Figure 6.10).

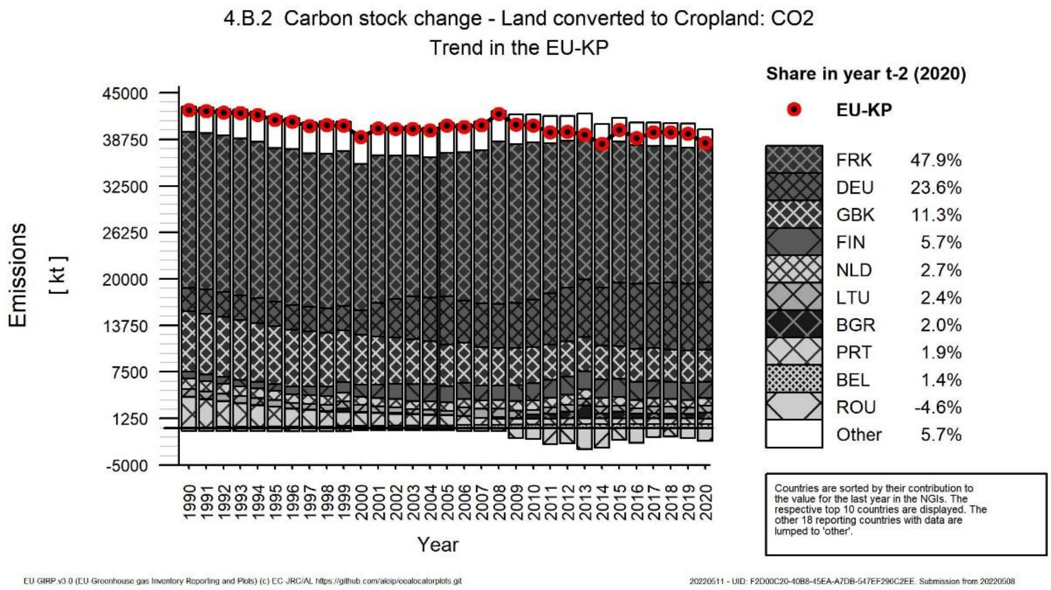
Nevertheless, some individual inventories report this subcategory as a carbon sink, as a result of removals from the living biomass carbon pool when lands are converted to Croplands with woody vegetation (e.g., Cyprus and Romania). With some few exceptions, all the other carbon pools are reported by the countries as a net source of emissions.

Table 6. 20 4B2 Land converted to Cropland: EU-KP contributions to net CO_2 emissions (+)/ removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	313	416	420	1.1%	107	34%	4	1%
Belgium	41	508	519	1.4%	478	1157%	12	2%
Bulgaria	75	619	780	2.0%	705	938%	161	26%
Croatia	26	131	127	0.3%	101	391%	-4	-3%
Cyprus	0	1	1	0.0%	1	1289%	0	-7%
Czechia	116	47	50	0.1%	-66	-57%	3	7%
Denmark	89	6	88	0.2%	-1	-1%	82	1490%
Estonia	NO,NE	104	91	0.2%	91	∞	-14	-13%
Finland	853	2 313	2 188	5.7%	1 335	157%	-125	-5%
France	20 999	18 291	18 340	47.9%	-2 660	-13%	48	0%
Germany	3 063	9 009	9 045	23.6%	5 982	195%	36	0%
Greece	52	16	16	0.0%	-36	-69%	0	1%
Hungary	120	296	239	0.6%	119	99%	-57	-19%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	857	1 044	284	0.7%	-573	-67%	-760	-73%
Latvia	7	267	270	0.7%	263	3842%	3	1%
Lithuania	1 062	845	916	2.4%	-146	-14%	72	8%
Luxembourg	45	25	25	0.1%	-20	-44%	0	0%
Malta	-2	1	0	0.0%	2	110%	-1	-84%
Netherlands	1 427	1 048	1 050	2.7%	-377	-26%	2	0%
Poland	261	117	117	0.30%	-144	-55%	0	0%
Portugal	4 048	724	710	1.9%	-3 338	-82%	-14	-2%
Romania	-403	-1 367	-1 762	-4.6%	-1 359	-338%	-394	-29%
Slovakia	466	59	52	0.1%	-414	-89%	-6	-10%
Slovenia	200	101	102	0.3%	-98	-49%	1	1%
Spain	171	296	159	0.4%	-12	-7%	-137	-46%
Sweden	6	189	59	0.2%	54	923%	-130	-69%
United Kingdom	8 173	4 283	4 311	11.3%	-3 861	-47%	28	1%
EU-27+UK	**42 065**	**39 387**	**38 197**	**100%**	**-3 867**	**-9%**	**-1 190**	**-3%**
Iceland	635	91	91	0.2%	-544	-86%	0	0%
United Kingdom (KP)	8 173	4 297	4 327	11.3%	-3 846	-47%	30	1%
EU-KP	**42 700**	**39 492**	**38 304**	**100%**	**-4 396**	**-10%**	**-1 189**	**-3%**

As in other land use subcategories that involve the conversion of areas, the trends in the time series of emissions from Land converted to Cropland have been driven by the activity data. As for instance, in the case of Belgium, Bulgaria and Latvia that report an increase of the area converted to cropland under the subcategory 4B.2, which associate with a constant increase of the emissions in this subcategory. The opposite scenario is given by Portugal, France, and UK, which report significant reduction of emissions in this category driven by the trend in areas.

Figure 6. 10 Trend of emissions (+)/ removals (-) in subcategory 4B2 "Land converted to Cropland" in EU KP (kt CO_2)



Methodological issues for Land converted to Cropland.

For estimating and reporting carbon stock changes in this subcategory, the countries generally use the IPCC default methodology. However, implementation of country-specific or default emissions factors depends on which type of lands is being converted to Cropland, and the estimated carbon pool. For instance, concerning the living biomass carbon pool, some countries consider the carbon stocks from one year of growth in Cropland following conversion, while others only consider the oxidation of the carbon stock in the land that is converted to cropland.

Usually, it is assumed that the carbon stored in living biomass and dead organic matter is lost in the year of the conversion, while for soil organic carbon in mineral soils, following IPCC methodology, countries often apply a 20-year transition period before the carbon stock of the soils converted to cropland reach the equilibrium.

In recent years, improvements have been implemented also in this subcategory, including the use of higher methods (as requested by the ERT), which have resulted in an overall increase of accuracy and completeness of the sector.

For instance, Latvia also used country-specific data and Biosoil Project's results to report carbon stock changes from DOM following the conversion from Forest land to Cropland. Also, Poland improved the completeness of this category's reporting with the inclusion of carbon stock changes in living biomass following the conversion from Grassland to Cropland.

On the contrary, France reports the notation key NE for carbon stock changes considered insignificant that occurs in a very small area identified as Other Land converted to Cropland, also noting that as defined, Other land category are areas with none or insignificant carbon stock.

Portugal estimates emission or sequestration factors from soils following land use conversions based on data measurements from three data sets: (i) measurements made over the ICP Forests grid (1995 and 2005); (ii) Project Biosoil (1999); LUCAS soil assessment (2009). These factors were calculated for all possible land-use changes that led to significant changes in average carbon stocks. Since the conversion among cropland and grassland does not lead to significant carbon changes according to their significance test, the notation key NO was used in accordance.

The UN ERT included in its 2020 ARR of the EU GHG inventory the recommendation of use higher tiers methods for reporting carbon stock changes in this subcategory. And specifically, it mentioned Luxembourg and Italy, noting that for Italy this subcategory was identified as key.

In order to follow the recommendation of the UN ERT the EU has followed the reporting of this category by those MS and notes that in their 2022 GHG inventories, these countries do not identify this subcategory as a key. In addition, the estimation of carbon stock changes from living biomass and from soil organic carbon that result from the conversion of land into cropland is done using for the most important parameters country specific information. As for instance, Luxembourg uses information on SOC from its Mapping Topsoil Organic Carbon Content in the Grand-Duchy of Luxembourg and “Mapping Topsoil Organic Carbon Stocks in the Grand-Duchy of Luxembourg, or Italy that uses information from the LIFE project MEDINET (*Mediterranean Network for Reporting Emissions and Removals in Cropland and Grassland*) that was carried out in its country and other of the Mediterranean basin.

6.2.3 Grassland (CRF 4C)

6.2.3.1 Overview of Grassland category (CRF 4C)

Under this category are included lands covered by natural and artificial meadows, range lands, moors and forage crops. They can be subject to economic activities (e.g., grazing lands), or be considered unmanaged lands. In several instances, Grassland areas cover also woody lands (i.e., trees and shrub lands) when they do not fall into the thresholds used to define forest lands.

In overall, these areas represent a net source of emissions that are below the emissions from Settlements (i.e., conversions of lands to Settlements), and far below the emissions reported under Cropland.

Based on individual submissions, for the current inventory year total Grassland covers 95.482 kha. This represents 21% of the total territory of EU MS, UK and ISL. However, as for Cropland, these areas have constantly decreased, and nowadays these ecosystems cover 4% less area than in the base year.

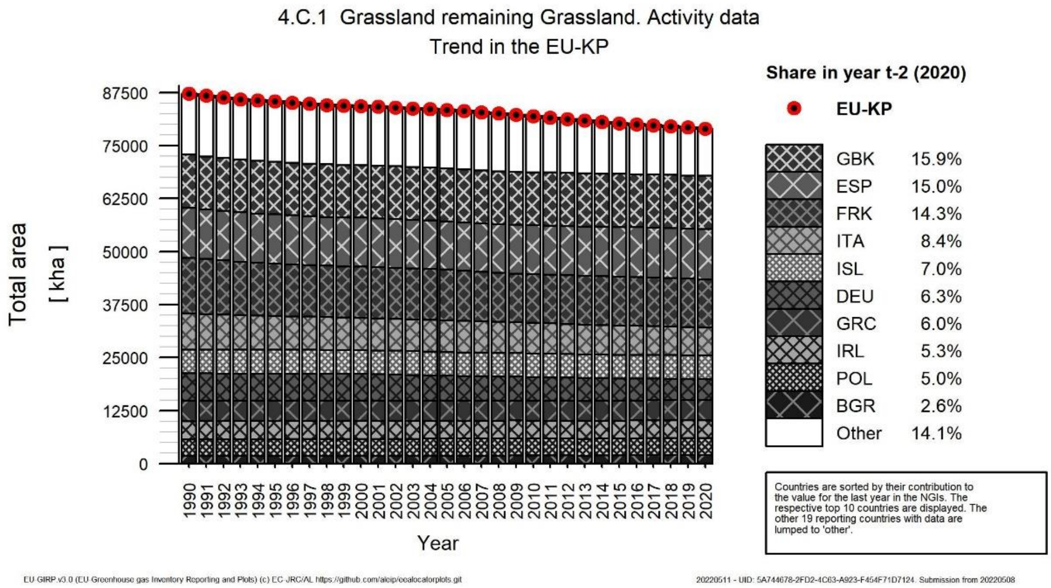
6.2.3.2 Grassland remaining Grassland (CRF 4C1)

Overview of Grassland remaining Grassland category

For the year 2020, total area reported under this subcategory reaches 78.980 kha. Following the general trend of these lands, this subcategory has also constantly decreased since 1990, and in 2020 it represents 9% less than in 1990 (Figure 6. 11).

UK, Spain, and France reported together about 45% of the total area of Grassland remaining Grassland, while the 10 MS with the larger contribution account for more than 85 % of the total area.

Figure 6. 11 Trend of activity data in subcategory 4C1 “Grassland remaining Grassland” in EU-KP (kha)



In terms of emissions, this subcategory has always resulted in a net source at the level of EU MS, UK and ISL. In the current inventory year, the reported emissions reached 38.148 kt CO_2, which represents a decrease of 29% as compared with the year 1990 (Table 6. 21).

Nevertheless, individual inventories have reported this subcategory either as a net source or as a net sink of carbon.

As in the case of cropland areas, the net result of the carbon stock change in grassland depends on the one hand on whether these areas are subject to agricultural activities, and particularly if they occur in organic soil areas, but also on the presence or absence of significant woody biomass and the intensity and variation of management practices over the years.

Table 6. 21 4C1 Grassland remaining Grassland: EU-KP contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

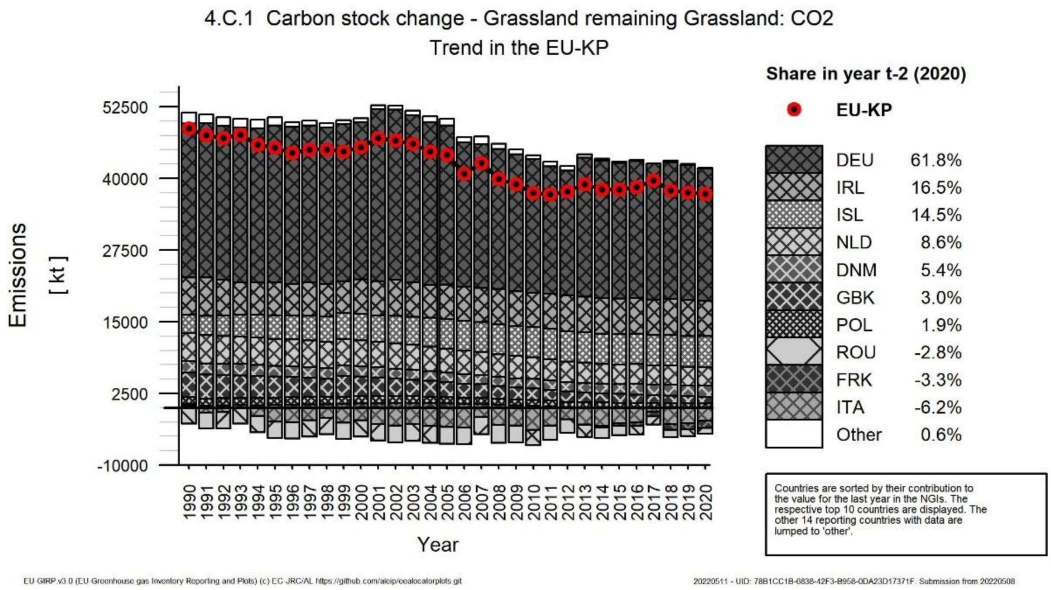
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	294	297	297	0.8%	3	1%	0	0%
Belgium	28	214	212	0.6%	184	645%	-2	-1%
Bulgaria	201	101	96	0.3%	-105	-52%	-4	-4%
Croatia	2	2	2	0.0%	0	0%	0	0%
Cyprus	-134	-118	-118	-0.3%	16	12%	0	0%
Czechia	0	-292	-306	-0.8%	-306	-100%	-15	-5%
Denmark	1 982	1 908	2 004	5.3%	22	1%	96	5%
Estonia	47	45	46	0.1%	-1	-1%	1	2%
Finland	852	534	542	1.4%	-310	-36%	8	1%
France	301	-1 092	-1 247	-3.3%	-1 548	-514%	-155	-14%
Germany	26 793	23 558	23 068	60.5%	-3 725	-14%	-490	-2%
Greece	0	0	0	0.0%	0	-3%	0	-34%
Hungary	48	2	-2	0.0%	-50	-104%	-4	-200%
Ireland	6 591	6 288	6 141	16.1%	-450	-7%	-147	-2%
Italy	5 358	-2 026	-1 468	-3.8%	-6 826	-127%	558	28%
Latvia	935	391	410	1.1%	-524	-56%	19	5%
Lithuania	NO,NE,IE,NA	NO,NE,IE,NA	NO,NE,IE,NA	-	-	-	-	-
Luxembourg	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Malta	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Netherlands	4 937	3 251	3 220	8.4%	-1 717	-35%	-31	-1%
Poland	1 309	775	726	1.9%	-583	-45%	-50	-6%
Portugal	NO	-365	-345	-0.9%	-345	-∞	19	5%
Romania	-2 806	-1 203	-1 026	-2.7%	1 780	63%	177	15%
Slovakia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovenia	195	-374	-359	-0.9%	-553	-284%	15	4%
Spain	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
Sweden	-518	-263	-256	-0.7%	262	51%	7	3%
United Kingdom	4 272	1 226	1 116	2.9%	-3 156	-74%	-110	-9%
EU-27+UK	**50 686**	**32 860**	**32 752**	**86%**	**-17 934**	**-35%**	**-108**	**0%**
Iceland	3 134	5 349	5 390	14.1%	2 256	72%	41	1%
United Kingdom (KP)	4 277	1 232	1 121	2.9%	-3 156	-74%	-110	-9%
EU-KP	**53 826**	**38 215**	**38 148**	**100%**	**-15 678**	**-29%**	**-67**	**0%**

The EU trend in emissions from this subcategory is largely affected by Germany, Ireland, Iceland and Netherlands (Figure 6. 12). While for some of these countries, the overall share in areas of grassland remaining grassland is not significant at EU level, all of them report important areas of grasslands managed on organic soils that generate significant emissions.

By contrary some other MS have reported this subcategory as a net carbon sink. Examples are Romania that reports a significant carbon sink from woody vegetation on grassland areas, and Italy that reports a net sink from living biomass in woody vegetation and from mineral soils in grazing areas.

In Mediterranean countries, this subcategory shows significant inter-annual variability driven by wildfires affecting woody biomass in grassland areas. These episodes, at present occurring erratically, are expected to increase because of the climate change.

Figure 6. 12 Trend of emissions (+)/removals (-) in subcategory 4C1 "Grassland remaining Grassland" in EU-KP (kt CO_2)



Methodological issues for Grassland remaining Grassland category

Despite of different eco-regions and management approaches among the countries, Grassland definitions show a good match with the IPCC land use definition (Table 6. 22). One of the most significant differences that should be considered when comparing implied emissions factors is the presence or absence of reported unmanaged grassland and the presence or absence of woody vegetation.

In general, there is a wide-spread use of the Tier 1 method for reporting carbon stock changes in living biomass and dead organic matter, which assumes no net carbon stock changes for these pools. However, some countries have developed country-specific data and (or) methodologies to assess the changes in these pools (e.g., Italy, Latvia, and Sweden). When this is the case, these pools are generally reported as a net sink that is associated with the presence of woody biomass on grassland areas.

Under mineral soils, a significant number of individual submissions have demonstrated that there are no changes over the time in the type of management practices that impact the carbon storage in the soils. In few cases also the absence of managed soils was argued. In these cases, quantitative estimates were not provided, and the notation keys were used instead. However, some other countries report this carbon pool by using IPCC methodology, with country-specific or default data.

For those countries that report presence of organic soils areas under managed grassland, this carbon pool is reported as a net source of emissions that result from the oxidation of the soil organic matter (Table 6. 23).

Table 6. 22 Definitions of lands included under the category 4C: Grasslands.

Country	*Definition*
Austria	Meadows cut once/twice/several times, cultivated pastures, litter meadows, rough pastures, alpine meadows and pastures and abandoned grassland.
Belgium	Rangelands and pastureland that is not considered under cropland. It also includes systems with vegetation that fall below the threshold of forest land category and are not expected to exceed it, without human intervention.
Bulgaria	Grassland includes the permanent grasslands – natural meadows, low productive grasslands, permanent lawns and grassland which are not used for production purposes.
Croatia	Grassland includes pastures, land principally occupied by agriculture, with significant areas of natural vegetation, natural grasslands, moors and heathland, sclerophyllous vegetation.

Country	*Definition*
Cyprus	This category includes rangelands and pastureland that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as bushes and sclerophyllous vegetation that fall below the threshold values used in the Forest Land category. The category also includes all pastures, natural grassland and scarcely vegetated areas.
Czechia	Grassland as defined in this inventory is mostly used as pastures for cattle and meadows for growing feed. Additionally, the fraction of permanently unstocked cadastral FL is also included under Grassland. This is because it predominantly has the attributes of Grassland (such as land under power transmission lines).
Denmark	Land defined as grazing land under LPIS, heath land which may or may not be used for sheep grazing, as well as all other areas not meeting the definitions of forest land. The area of grassland is divided in “grazing land” and “other grassland”.
Estonia	Grassland includes rangelands and pasture, land that is not considered cropland nor forest land: land with perennial grasses that is proper for mow and pasture, smaller fallows and former cultural grasslands that have lost arable land features and grassland from wild lands (natural grassland). Overgrown wooded pasture with canopy cover between 30 and 50% is classified as grassland or forest, depending on the mainland-use purpose. The national land cover class ‘bushes’ (area covered with natural or wildered cultivated bush and shrub species where canopy cover is over 50%) is included into GL.
Finland	Grassland includes areas of extensive grass, ditches associated with agricultural land, areas of bioenergy plants and abandoned arable land. In this context, abandoned arable land refers to fields that are no longer used for agricultural production and where natural reforestation is possible or is already taking place.
France	Land covered by natural and seeded herbaceous for more than 5 years. Includes areas covered trees and bushes being under the forest definition or not included under land category.
Germany	Meadow and pasture areas that cannot be considered cropland. Includes land covered with trees and shrubs that does not fall within the definition of "forest", as well as natural grassland and recreational areas.
Greece	Rangeland and pasture with vegetation that falls below the threshold of national forest definition and are not expected to exceed that without human intervention. Pastures that have been fertilized or sown are considered as cropland.
Hungary	Grassland includes meadows, i.e., land under grass (artificial planting included) where the production is utilized by cutting, irrespective of whether it is used for grazing sometimes, and pasture, i.e., land under grass (artificial planting included) that is utilized for grazing irrespective of whether it is used for cutting sometimes. Grassland includes areas with trees which are utilized for grazing and unmanaged grasslands which are not in use for agricultural purposes.
Ireland	Improved grassland (pasture and areas used for the harvesting of hay and silage) and unimproved grassland (rough grazing) in use as recorded by annual statistics.
Italy	Grazing lands, forage crops, permanent pastures, and set-aside lands since 1970, all shrub lands (data derived from NFI) and other woodlands that do not fulfil forest definition.
Latvia	The grassland category consists of lands used as pastures, as well as glades and bushland which do not fit to forest definition, vegetated areas on non-forest lands complying to forest definition where land use type can be easily switched back to grassland without legal requirement of transformation of the land use, but except grassland used in forage production and extensively managed cropland.
Lithuania	Grassland includes meadows and natural pastures planted with perennial grasses or naturally developed, on a regular basis used for moving and grazing. Grasslands cultivated for less than 5 years, in order to increase ground vegetation, still remain grasslands.
Luxemburg	All grasslands that are not considered as cropland including systems with vegetation or tree cover below forest threshold, natural grassland, recreational areas as well as agricultural systems. It includes one cut meadows; two and more cut meadows, cultivated pastures, litter meadows, rough pastures and pastures and abandoned grassland.
Malta	This category is split into other grassland and maquis. On the basis of expert judgement, it was decided that maquis will be included in this category. The data of this category was derived from the Corine Land Cover 1996, 2000, 2006 under the sclerophyllous vegetation and Grassland.
Netherlands	Under Grassland (non-TOF) any type of terrain which is predominantly covered by grass vegetation is reported. It also includes vegetation that falls below the threshold used in the forest land category and is not expected to exceed the threshold used in the forest land category. It is further stratified in: 'Grassland vegetation', 'Nature', ‘Orchards’. Trees outside forests (TOF) are wooded areas that comply with the forest definition except for their surface area (< 0.5 ha or less than 30 m width). These represent fragmented forest plots as well as groups of trees in parks and nature terrains and most woody vegetation lining roads and fields.
Poland	Grassland consists of permanent meadow and pastures include land permanently covered with grass, but does not include arable land sown with grass as part of crop rotation; permanent meadow is understood as the land permanently covered with grass and mown in principle in mountain area; also, the area permanent pastures are understood as the land permanently covered with grass not mown but grazed in principle in mountain area; also the area of grazed pastures and meadows.
Portugal	Lands covered by permanent herbaceous cover.
Romania	Grassland includes land whose destination is grazing or mowing hay for livestock production, as well as other wooded land and trees outside forests (which do not meet forest definition parameters, e.g., forest belts which are narrower than 20m). It includes pastures, hayfields in hilly and mountainous areas and meadows in lowlands.

Country	*Definition*
Slovakia	This category includes permanent grasslands and meadows used for the pasture or hay production, which is not considered as cropland.
Slovenia	Agricultural areas grown by grass and other herbs that are regularly cut or grazed. These areas are not in tillage or fallow ground. Included are areas covered with some of forest trees (less than 50 trees/ha) and the alpine pastures too. In this class there are swamp pastures and meadows on organic or mineral-organic soils, where the groundwater rises few times in the year. It includes also uncultivated agriculture land.
Spain	Pastureland, including grazing land not included in cropland. It includes also pastures and meadows in the dehesa (forested pasture) that do not comply with the definition of forest.
Sweden	Agricultural land that is not regularly tilled. This corresponds to natural grazing land. All grasslands are assumed managed.
UK	Area classified as following broad habitats: improved grassland, natural grassland, calcareous grassland, acid grassland, bracken, dwarf shrub heath, fen/marsh/swamp, bogs and mountains.
Iceland	All land where vascular plant cover is >20% and not included under the SL, FL, CL or WL categories. This category includes as subcategory land which is being revegetated and meeting the definition of the activity and does not fall into other categories. Drained wetlands not falling into other categories are included in this category. Grassland is represented by five subcategories on the Land use map, i.e. "Other grassland", "Land re-vegetated before 1990", "Land re-vegetated since 1990", "Grassland on drained soils", and "Natural birch shrubland".

Table 6. 23 Implied net carbon stock change factors for carbon pools in 4C1 (t C ha-1 yr-1) reported by individual submissions in the GHGI 2022.

Country	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2020	1990	2020	1990	2020	1990	2020
AUT	NA	NA	NO	NO	0,002	0,002	-6,402	-6,402
BEL	NO	NO	NO	NO	-0,008	-0,102	-1,521	-1,891
BGR	0,003	0,000	NE,NA	NE,NA	-0,028	-0,008	-6,100	-6,100
HRV	NO	NO	NO	NO	NO	NO	-2,500	-2,500
CYP	0,278	0,250	NO	NO	NO	NO	NO	NO
CZE	NO	NO	NO	NO	0,000	0,091	NO	NO
DNM	-0,017	-0,443	NA	NA	IE	IE	-6,602	-6,412
EST	NO	NO	NO	NO	NA	NA	-0,238	-0,248
FIN	0,119	0,182	NE	NE	NA	NA	-3,500	-3,500
FRK	-0,007	0,030	NA	NA	0,001	0,000	IE	IE
DEU	-0,015	-0,018	IE	IE	0,011	0,008	-7,494	-7,394
GRC	0,000	0,000	NO	NO	NO	NO	NO	NO
HUN	NA	NA	NA	NA	-0,011	0,000	NO	NA
IRL	NO	NO	NO	NO	-0,009	0,162	-4,671	-6,784
ITA	-0,011	0,065	0,004	0,004	-0,004	0,025	2,500	2,500
LVA	0,010	0,084	0,002	0,012	NA	NA	-4,400	-4,400
LTU	NA	NA	NA	NA	NE	NE	IE	IE
LUX	NA	NA	NA	NA	NA	NA	NA	NA
MLT	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO	NO
NLD	0,009	0,009	NA	NA	0,001	0,004	-4,568	-4,072
POL	NA	NA	NA	NA	-0,043	-0,001	-0,250	-0,250
PRT	NO	NO	NO	NO	NO	0,206	NO	NO
ROU	0,008	0,012	NA	NA	0,207	0,207	2,500	2,500
SVK	NA	NO	NA	NO	NA	NA	NO	NO
SVN	-0,082	0,220	-0,018	0,056	-0,012	0,005	NO	NO

Country	Net carbon stock change in living biomass per area (t C/ha)		Net carbon stock change in dead organic matter per area (t C/ha)		Net carbon stock change in mineral soils per area (t C/ha)		Net carbon stock change in organic soils per area (t C/ha)	
	1990	2020	1990	2020	1990	2020	1990	2020
ESP	NE	NE	NA	NA	NE	NE	NO	NO
SWE	0,155	0,212	0,140	0,164	0,183	-0,045	-1,537	-1,676
GBR	0,014	-0,001	NA	NA	0,045	0,130	-0,657	-0,588
ISL	0,000	0,001	0,000	0,000	0,000	0,000	-5,691	-5,689

6.2.3.3 Land converted to Grassland (CRF 4C2)

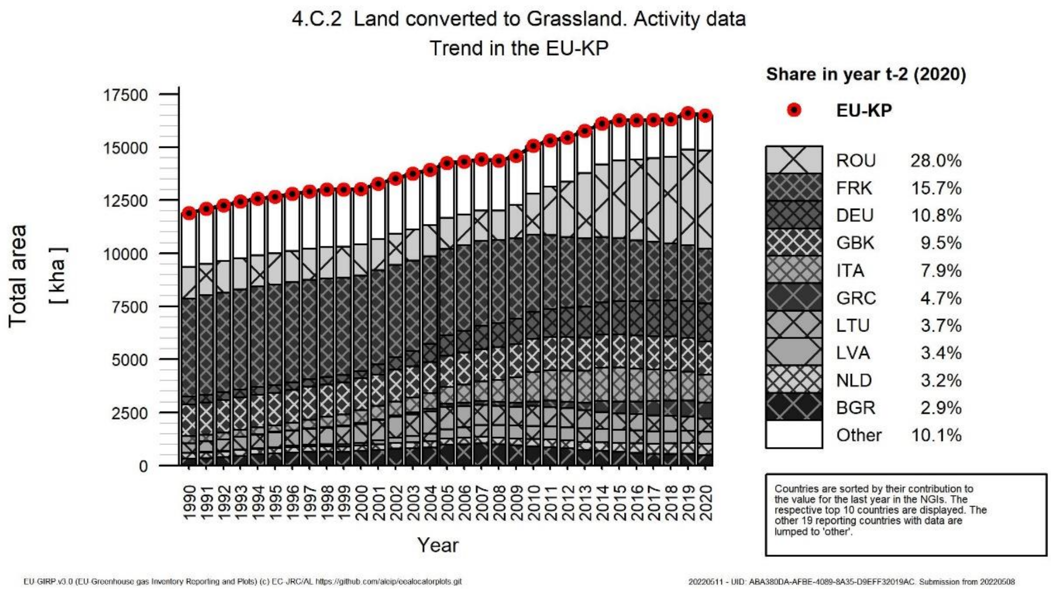
Overview of Land converted to Grassland category.

In terms of area, this subcategory represents 17% of the total grassland areas; however, the carbon sink reported offsets about 70% of the emissions resulting from grassland remaining grassland.

The area reported under this subcategory for this inventory year reaches 16.502 kha, which represents an increase of 39% as compared with 1990 (Figure 6. 13). Main conversions to grassland areas have origin in former croplands and, to a lesser extent, on forests land.

The main drivers of the EU trend on new grassland areas originate from the reporting of Romania, France, UK and Germany, which together report about 55% of the total area converted to Grassland.

Figure 6. 13 Trend of activity data in subcategory 4C2 "Land converted to Grassland" in EU-KP (kha)



In terms of emissions, lands converted to Grassland represent in the current inventory year a total net sink of -25.375 kt CO_2, which corresponds to an increase of about 21% compared to the year 1990 (Table 6. 24).

The trend in GHG emissions for this subcategory is driven by France, which together with Italy and UK report a significant carbon sink on mineral soils a result of the conversion of croplands areas to grassland. By contrary, final net emissions from this subcategory, as it has been reported for several countries (e.g., Romania and Sweden), are associated with emissions from the conversion of Forest land, and to a lesser extent, from woody crops to Grassland.

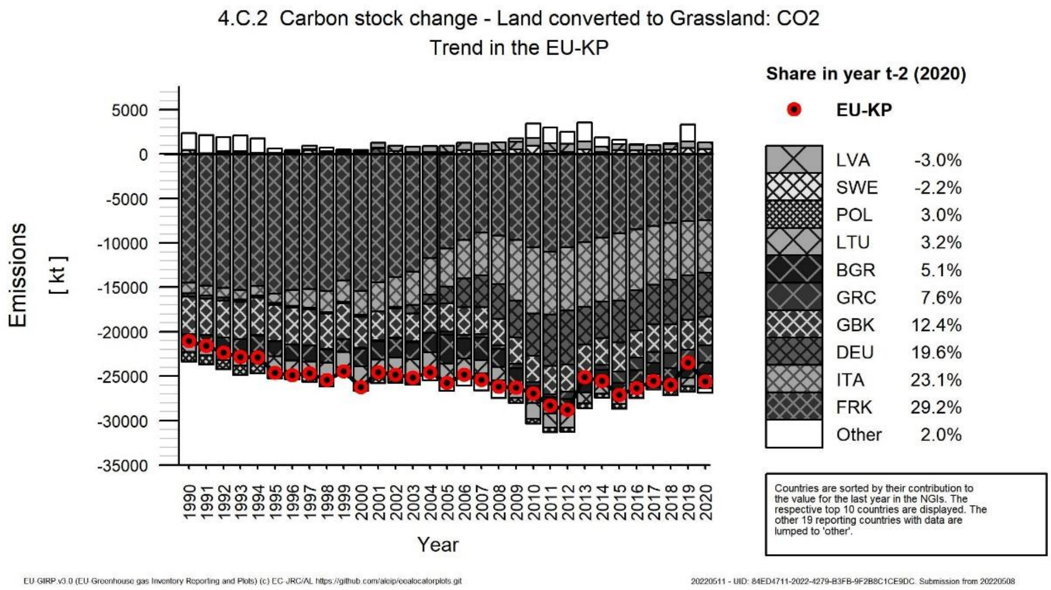
Table 6. 24 4C2 Land converted to Grassland: EU-KP contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	331	10	8	0.0%	-323	-98%	-2	-21%
Belgium	52	79	80	-0.3%	28	54%	1	2%
Bulgaria	-1 142	-1 410	-1 301	5.1%	-159	-14%	109	8%
Croatia	-10	-317	-313	1.2%	-303	-3049%	4	1%
Cyprus	-2	0	0	0.0%	2	102%	0	89%
Czechia	-157	-194	-187	0.7%	-30	-19%	7	4%
Denmark	56	44	45	-0.2%	-11	-20%	1	2%
Estonia	0	25	18	-0.1%	18	12055%	-7	-28%
Finland	167	246	226	-0.9%	59	35%	-20	-8%
France	-14 484	-7 561	-7 457	29.4%	7 027	49%	104	1%
Germany	-409	-4 967	-4 999	19.7%	-4 590	-1122%	-32	-1%
Greece	0	-1 771	-1 945	7.7%	-1 945	-6935146%	-175	-10%
Hungary	-33	-81	-102	0.4%	-69	-210%	-21	-26%
Ireland	3	5	6	0.0%	3	104%	1	20%
Italy	-1 180	-6 140	-5 896	23.2%	-4 716	-400%	244	4%
Latvia	8	764	758	-3.0%	750	9125%	-6	-1%
Lithuania	-869	-897	-816	3.2%	53	6%	81	9%
Luxembourg	-35	-28	-28	0.1%	7	19%	0	0%
Malta	-9	-2	-2	0.0%	7	82%	0	13%
Netherlands	-315	-385	-401	1.6%	-86	-27%	-16	-4%
Poland	-1 113	-680	-765	3.0%	347	31%	-85	-13%
Portugal	3 228	428	417	-1.6%	-2 811	-87%	-11	-3%
Romania	270	2 186	-262	1.0%	-532	-197%	-2 447	-112%
Slovakia	-206	-119	-93	0.4%	112	55%	26	22%
Slovenia	-472	-46	-46	0.2%	426	90%	0	1%
Spain	-2 696	167	295	-1.2%	2 991	111%	128	77%
Sweden	424	682	550	-2.2%	126	30%	-133	-19%
United Kingdom	-4 155	-3 215	-2 975	11.7%	1 180	28%	240	7%
EU-27+UK	**-22 748**	**-23 177**	**-25 186**	**99%**	**-2 438**	**-11%**	**-2 009**	**-9%**
Iceland	1 757	-138	-169	0.7%	-1 926	-110%	-32	-23%
United Kingdom (KP)	-4 163	-3 235	-2 995	11.8%	1 168	28%	240	7%
EU-KP	**-20 999**	**-23 335**	**-25 375**	**100%**	**-4 377**	**-21%**	**-2 040**	**-9%**

Major changes in the time series of emissions from Land converted to Grassland have been reported by Germany, France, Portugal, and Spain, mainly driven by the activity data.

New grassland areas are associated with the abandonment of cropland areas that result in a larger carbon sink reported in mineral soils at the end of the time series as compared with the base year. This is for instance reported by Germany. By contrary, some countries report a significant decrease of the carbon sink in these lands driven by the decrease of these areas but also when they are affected by wildfires in specific years.

Figure 6. 14 Trend of emissions (+)/removals (-) in subcategory 4C2 "Land converted to Grassland" in EU-KP (kt CO_2)



Methodological issues for Land converted to Grassland category.

For estimating and reporting carbon stocks changes in this subcategory, IPCC default methodology is generally used. The implementation of country-specific emission factors or default factors depends on which type of lands are being converted to Grassland, and on the estimated carbon pool. For instance, while some countries only consider a gross quantity of carbon loss from the conversion of forest lands to grassland, some others provide a net estimate on this carbon pool, by also considering one year of growth after the establishment of the grassland.

Usually, it is assumed that the carbon stored in living biomass and dead organic matter is lost in the year of the conversion, while for soil organic carbon in mineral soils, following IPCC methodology, countries often apply a 20-year transition period before the carbon stock of the soils converted to Grassland reach equilibrium.

During the las years, the efforts devoted by the countries to assess soils organic carbon contents in these areas, have resulted in more accurate quantification of the carbon stock change that occur in managed grassland and as a result of the conversion to and from grasslands.

6.2.4 Wetlands, Settlements and Other land (CRF Tables 4D, 4E, 4F)

6.2.4.1 Wetlands (CRF 4D)

In terms of area, Wetlands represents 25.587 kha, which is 7% of the total area reported by EU MS, UK, and Iceland together. The category has shown a constant slight increase, resulting in 2% more area in the reporting year, as compared to the base year.

The trend in areas is strongly dominated by Sweden and Finland which, as the other individuals inventories, have reported rather constant values across the time series, and mainly for the dominant subcategory of Wetlands remaining Wetlands (

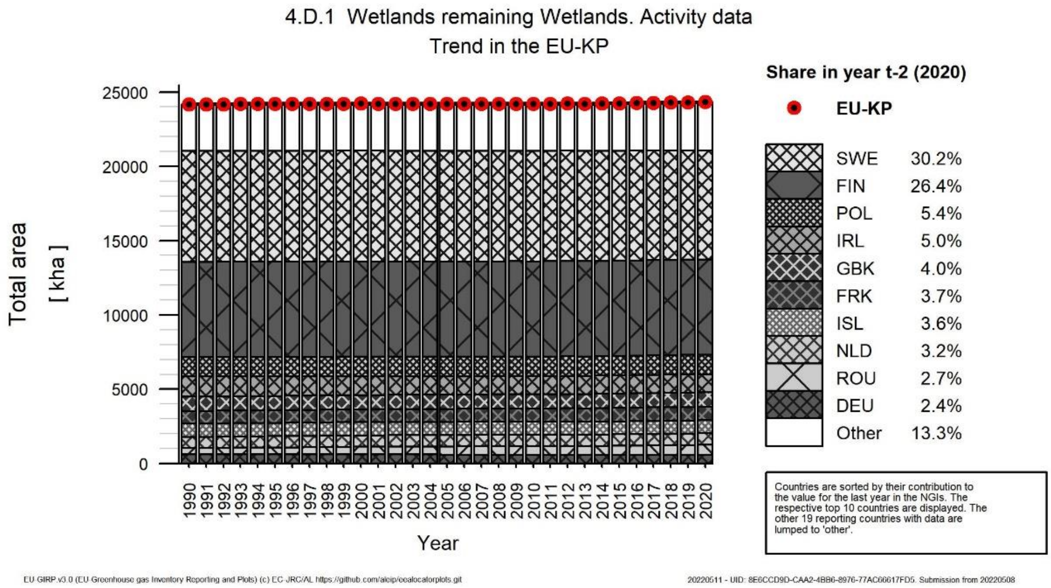
Figure 6. *15*).

In terms of emissions, Wetlands remaining Wetlands reaches for this inventory year about 9.314 kt CO_2. Subcategories, 4D1 and 4D2, have been in overall reported as a net source of emissions, resulting mostly from countries reporting the productive management activities of peatland areas. On the other hand, in some countries these subcategories have been also reported as a net carbon sink.

The main driver of emissions is indeed peat extraction, which – even if affecting relatively small areas at country level – has a big impact on the overall emissions. Within the EU, Germany, Ireland, Finland, and Estonia are the main contributors of the emissions from Wetlands remaining wetlands.

By contrary, an exception is represented by Iceland, which under 4D1 reports significant carbon removals taking place in organic soils from intact mires areas.

Figure 6. 15 Trend of activity data and emissions (+)/removals (-) in subcategory 4D1 "Wetlands remaining Wetlands" in EU-KP (kha, Kt CO_2)



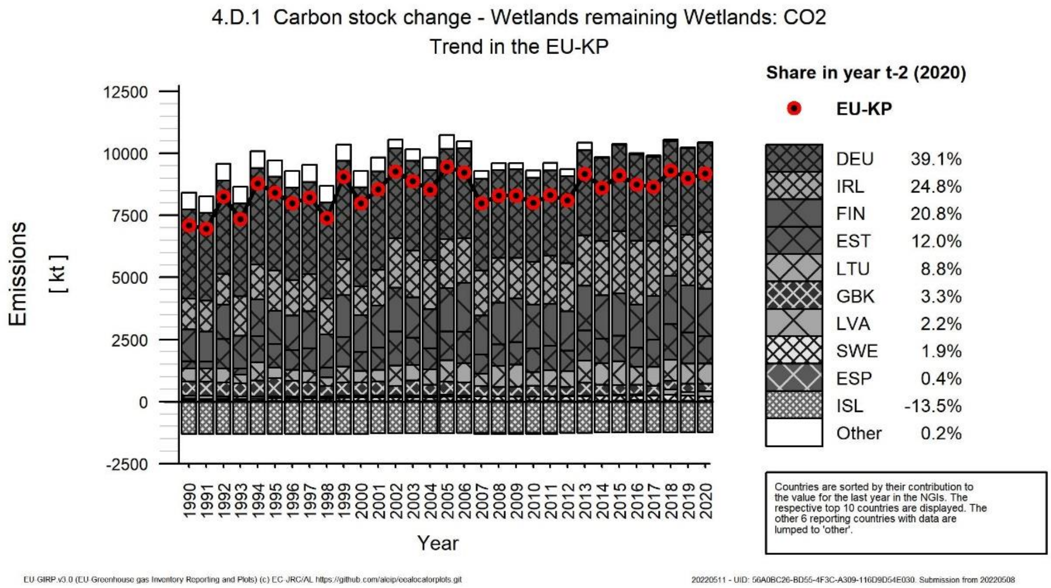


Table 6. 25 CO_2 Emissions and removals from 4.D.1 wetlands remaining wetlands contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

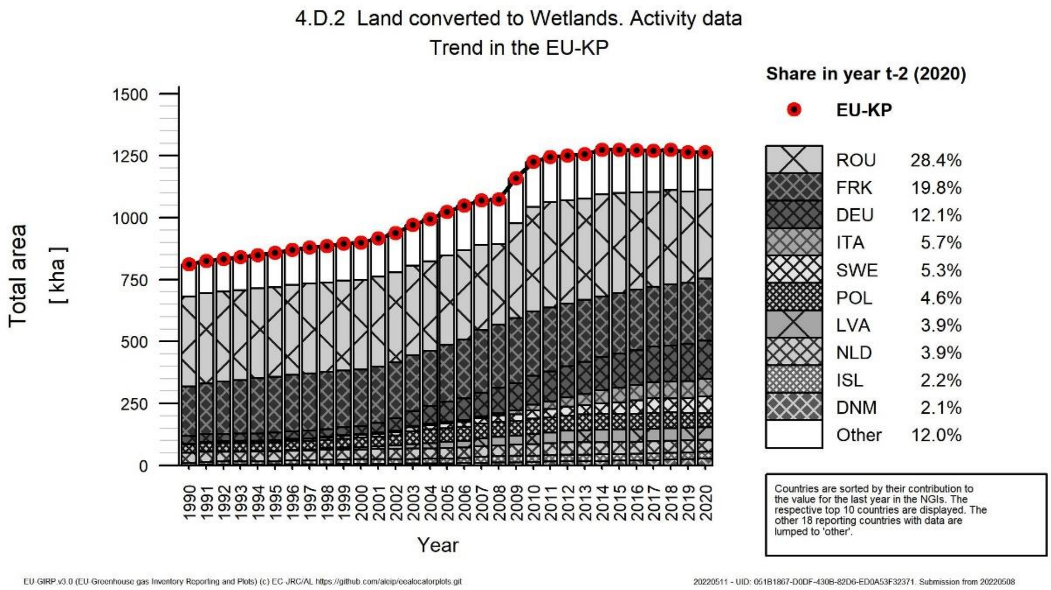
Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	NE,NO	NO,NE	2	0.0%	2	∞	2	∞
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NA	NA	NA	-	-	-	-	-
Denmark	100	30	8	0.1%	-91	-92%	-21	-72%
Estonia	299	1 255	1 104	11.9%	806	270%	-150	-12%
Finland	1 269	1 884	1 915	20.6%	646	51%	31	2%
France	O,NE,IE,NA	O,NE,IE,NA	O,NE,IE,NA	-	-	-	-	-
Germany	3 598	3 483	3 593	38.6%	-4	0%	110	3%
Greece	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Hungary	10	1	0	0.0%	-10	-103%	-1	-149%
Ireland	1 656	2 187	2 402	25.8%	746	45%	214	10%
Italy	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Latvia	131	171	199	2.1%	69	53%	28	16%
Lithuania	517	817	810	8.7%	292	57%	-7	-1%
Luxembourg	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Malta	0	0	0	0.0%	0	0%	0	0%
Netherlands	0	-2	-2	0.0%	-2	-17194%	0	-1%
Poland	578	14	14	0.1%	-564	-98%	0	0%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	-3	NO	NO	-	3	100%	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO,NE,NA	NO,NE,NA	NO,NE,NA	-	-	-	-	-
Spain	31	35	35	0.4%	5	16%	0	0%
Sweden	73	185	175	1.9%	102	139%	-10	-5%
United Kingdom	570	326	304	3.3%	-267	-47%	-23	-7%
EU-27+UK	**8 827**	**10 386**	**10 559**	**113%**	**1 732**	**20%**	**174**	**2%**
Iceland	-1 310	-1 246	-1 245	-13.4%	64	5%	1	0%
United Kingdom (KP)	570	326	304	3.3%	-267	-47%	-23	-7%
EU-KP	**7 518**	**9 140**	**9 314**	**100%**	**1 796**	**24%**	**174**	**2%**

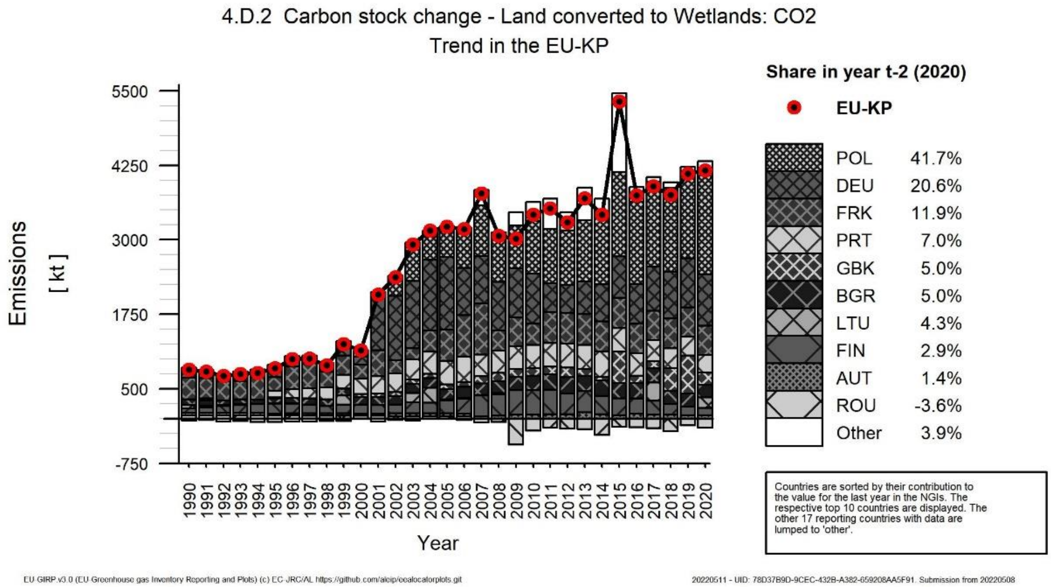
The other subcategory, Land converted to wetlands, represents only 5% of the wetlands area but results in about 32% of the final net emissions reported within the category. For the current inventory year, this subcategory category has reached respectively 1.264 kha, and 4.262 kt CO_2. In terms of emissions this represents about five times more than the reported emissions in the base year. The main driver is Poland that reports since 2001 a significant increase of land area in conversion to wetlands which in particular is done by clearing the grassland.

The area of land converted to wetlands is dominated by Romania and France. Overall, this area has increased by 56% as compared with 1990, mainly driven by new areas reported by Sweden, Germany and Italy in the second half of the time series (Figure 6.17).

Nevertheless, these new areas are not always linked to carbon stock changes, as in some cases new wetlands areas are the result of the conversion of lands with insignificant carbon stocks to Other wetlands (i.e. mires and areas saturated by fresh water).

Figure 6. 16 Trend of activity data and emissions (+) / removals (-) in subcategory 4D2 "Lands converted to Wetlands" in EU-KP (kha, Kt CO_2)





Emissions in this subcategory are mainly reported by Poland and Germany as a result of the loss of carbon from the living biomass existing in the lands that area converted to wetlands. In previous submissions, Romania played an important role in the overall EU trend of the category, but the Party has introduced in this submission important recalculations in activity data and methods foe estimating emissions in this category that are reflected at EU level. (See table 6.47 for further information)

Table 6.1 CO_2 Emissions and removals from 4.D.2 land converted to wetlands contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	42	60	57	1.3%	15	35%	-3	-4%
Belgium	11	-3	-4	-0.1%	-15	-134%	0	-8%
Bulgaria	95	220	208	4.9%	114	120%	-11	-5%
Croatia	77	11	11	0.3%	-66	-85%	0	3%
Cyprus	0	-1	-1	0.0%	-1	-100%	0	-4%
Czechia	22	23	34	0.8%	12	56%	12	52%
Denmark	3	14	35	0.8%	32	995%	21	147%
Estonia	10	29	24	0.6%	14	145%	-5	-17%
Finland	65	143	120	2.8%	54	83%	-23	-16%
France	358	495	495	11.6%	137	38%	0	0%
Germany	108	826	859	20.2%	751	694%	33	4%
Greece	NO	0	0	0.0%	0	∞	0	87%
Hungary	3	-4	-4	-0.1%	-7	-248%	0	-9%
Ireland	NO,IE	11	11	0.3%	11	∞	0	-1%
Italy	NO	32	32	0.7%	32	∞	0	0%
Latvia	0	19	20	0.5%	20	15695%	0	2%
Lithuania	63	NO,NE	179	4.2%	116	184%	179	∞
Luxembourg	0	2	2	0.0%	2	1311%	0	0%
Malta	0	NO	NO	-	0	100%	-	-
Netherlands	7	-45	-46	-1.1%	-53	-808%	-1	-3%
Poland	68	1 408	1 741	40.8%	1 673	2456%	332	24%
Portugal	NO,IE	311	290	6.8%	290	∞	-21	-7%
Romania	58	-114	-151	-3.5%	-209	-358%	-37	-33%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	2	2	2	0.1%	0	-6%	0	-4%
Spain	-167	28	39	0.9%	206	124%	12	42%
Sweden	NO,NA	NO,NA	NO,NA	-	-	-	-	-
United Kingdom	1	971	302	7.1%	301	35802%	-668	-69%
EU-27+UK	**827**	**4 438**	**4 257**	**100%**	**3 429**	**415%**	**-181**	**-4%**
Iceland	1	5	5	0.1%	4	871%	-1	-10%
United Kingdom (KP)	1	971	302	7.1%	301	35802%	-668	-69%
EU-KP	**828**	**4 443**	**4 262**	**100%**	**3 434**	**415%**	**-182**	**-4%**

Under this category, countries include different lands that are not always subject to management practices. This explains why countries with the largest share on areas not always report the largest emissions. For instance, this happens when areas within wetlands include flooded lands, or other wetlands that are not subject to management activities. Carbon fluxes are not reported in these areas, mainly due to lack of IPCC methods and the absence of country specific data.

Table 6.26 Definitions of lands included under the category 4D: Wetlands.

Country	*Definition*
Austria	Rivers, lakes, mires and peat areas (protected areas, in general) as classified by national statistical system.
Belgium	Land covered or saturated by water for all or part of the year (e.g., peatland) and that does not fall into the other land category. It includes reservoirs as a managed subdivision and natural rivers and lakes as unmanaged subdivisions.
Bulgaria	Wetlands category - wetlands surface water areas are included (wetlands) – covered with water or water saturated lands (throughout the year or partially in the year) which does not fall in the other categories. These are natural or artificial watercourses serving as water drainage channels, natural or artificial stretches of water, coastal lagoons, wetlands areas and peatbogs.

Country	*Definition*
Croatia	Inland marshes, salt marshes, salines, intertidal flats, water courses, water bodies, coastal lagoons
Cyprus	This category contains areas of land that is covered or saturated by water for all or part of the year and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories. In particular, it contains inland and salt marshes, water courses and water bodies.
Czechia	Category Wetlands includes riverbeds, and water reservoirs such as lakes and ponds, wetlands and swamps.
Denmark	Permanent wetlands, wetlands for peat extraction and re-established anthropogenic wetlands. Several subdivisions may be distinguished: unmanaged fully water covered wetlands (lakes and rivers); unmanaged partly water covered wetlands (fens and bogs); managed drained land for peat extraction; managed partly water covered wetlands (re-established wetlands on primarily former cropland and grassland).
Estonia	Land permanently saturated by water and/or areas where the peat layer is at least 30 cm, and the minimum potential tree height does not conform to the forest land definition. It does include smaller bog holes.
Finland	Inland waters (reservoirs, natural lakes and rivers), peat extraction areas and peatlands which do not fulfil the definition of other land uses.
Germany	Reporting in the wetlands category primarily covers emissions from organic soils that are released during peat extraction, covering: CO_2 losses from extraction areas, and during extraction and spreading of peat. Also, it includes (but they are not estimated) the few non-drained semi-natural bogs that have been largely free of anthropogenic impacts, flooded lands, water-storage facilities (dams, reservoirs, etc.) and settling basins that are used for energy production, irrigation, shipping and recreation, and that are flooded or drained, or that otherwise have large water-level fluctuations.
Greece	Land that is covered or saturated by water for all or the greatest part of the year (e.g., lakes, reservoirs, marshes), riverbed (including torrent beds) and that does not fall into the forest land, cropland, grassland or settlements categories.
France	Lands covered or saturated by water all year long or part of it.
Hungary	Wetland includes the wetlands and water bodies as defined by the CORINE land-cover databases and contain inland marshes (low-lying land usually flooded in winter, and more or less saturated by water all year round), peat bogs (peat land consisting mainly decomposed moss and vegetable matter), water courses (natural or artificial watercourses including those serving as water drainage) and water bodies (natural or artificial lakes, ponds etc.).
Ireland	Natural unexploited wetlands and areas commercially exploited for public and private extraction of peat and areas used for domestic harvesting of peat.
Italy	Lands covered or saturated by water, for all or part of the year, have been included in this category (MAMB, 1992). Reservoirs or water bodies regulated by human activities have not been considered.
Latvia	Wetlands category includes all inland water bodies (rivers, ponds, and lakes), swamps (constantly wet areas where height of trees cannot reach more than 5 m in height and ground vegetation consists mostly of sphagnum and different sword grasses), flood-lands (small areas) and alluvial lands (larger flood-lands).
Lithuania	Wetlands include peat extraction areas and peat lands which do not fulfil the definition of other categories. Water bodies and swamps (bogs) are also included under this category. Peat extraction areas are considered as managed land.
Luxemburg	Land that is covered or saturated by water for all or part of the year (e.g., peat land, reservoirs) and that does not fall into other categories.
Malta	In the Maltese islands wetlands are mostly saline.
Netherlands	Land covered or saturated with water for all or part of the year and does not fall into the other land category. It includes reservoirs as a managed sub-division and natural lakes and rivers as unmanaged, including natural open water in rivers, but also man-made open water in channels, ditches and artificial lakes.
Poland	Wetland consists of marine internal; surface flowing waters, which covers land under waters flowing in rivers, mountain streams, channels, and other water courses, permanently or seasonally and their sources as well as land under lakes and artificial water reservoirs. from or to which the water course flow; land under surface lentic water which covers land under water in lakes and reservoirs other than those described above, land under ponds including water reservoirs (excluding lakes and dam reservoirs for water level adjustment) including ditches and areas adjacent and related to ponds; land under ditches including open ditches acting as land improvement facilities for land used.
Portugal	Inland wetlands, coastal wetlands, salt marshes, saline and intertidal flats.
Romania	Wetlands includes all lands covered by water (rivers, ponds, dams, swimming pools, etc.) and land affected by humidity (caused by water stagnation, marshy areas, etc.), with the exception of agricultural land. It contains two sections (waters and wetlands) and 11 categories (permanent streams, temporary streams, lakes, dams, floating vegetation, hydrophilic vegetation (stubble etc.), harbours, temporarily flooded areas, bogs, channels and piers.
Slovakia	The wetlands include artificial reservoirs and dam lakes, natural lakes, rivers and swamps.
Slovenia	Wetlands are defined as land that is temporarily or permanently saturated by water. Wetlands include lands such as fens, marshes, bogs and reeds and are not under agricultural use. Inland water bodies (major rivers, lakes and water reservoirs) are also part of Wetlands. Although there are small areas of raised bogs, all Wetlands are assumed managed.
Spain	Includes the lands covered or saturated by water all year long or part of it.

Country	Definition
Sweden	Wetlands is assumed unmanaged (mires and areas saturated by fresh water) and managed (cca 10 000 ha used for peat extraction).
UK	Includes reservoirs and peat extraction sites currently registered for commercial extraction where extraction activity is visible on recent aerial/satellite photographs or by field visits. The areas of inland water exceeding 1km2 are included also in this category.
Iceland	All land that is covered or saturated by water for all or part of the year and does not fall into the SL, FL and CL categories. It includes intact mires and reservoirs as managed subdivisions and natural rivers and lakes as unmanaged subdivision. Wetland is in the land use map represented as three classes; "Lakes and rivers", "Reservoirs", and "Other Wetland".

6.2.4.2 Settlements (CRF 4E)

In terms of area, this land use category represents 30.958 kha, which is 7% of the total reported area. For the year 2020, Settlements areas have resulted in an increase of 26 % as compared with 1990.

The expansion of these areas, which generally include urban areas, either paved or unpaved, transport infrastructures, and industrial and commercial units, has been mainly driven by the urban expansion on abandonment of agricultural lands.

In terms of emissions, this land use category is reported as a net source that reaches 37.857 kt CO_2 in 2020. Out of this, 90% are due to emissions resulting from Land converted to Settlement, which although in terms of area represents only 20% of the total category, results in significant emissions when forest, other woody lands, or high-carbon content soils are converted to urban areas.

Definitions of lands included under this category vary across individual inventories (Table 6.27).

Table 6.27 Definitions of lands included under the category 4E: Settlements.

Country	Definition
Austria	Includes buildings land: sealed, partly sealed and unsealed areas; parks and gardens; roads and railway tracks; excavation areas, and other not further differentiated settlement area.
Belgium	All developed land, including transportation infrastructure and human settlements of any size (i.e., including roadsides) unless they are already included under other categories.
Bulgaria	The Settlements refer to all classes of urban formation. These are areas that are functionally or administratively associated with public or private land in cities, villages or other settlement types.
Croatia	Continuous and discontinuous urban fabric area, industrial or commercial units, road and rail networks and associated land, port areas, airports, mineral extraction sites, dump sites, construction sites, green urban areas, sport and leisure facilities.
Cyprus	All developed land, including transportation infrastructure and human settlements of any size. It contains industrial and commercial units, urban areas, port areas, airports, construction, mineral extraction and waste dump sites.
Czechia	Settlements include two categories built-up areas and courtyards and other lands. Other lands include all types of land-use were included with the exception of "unproductive land", which corresponds to category 4.F Other Land. Hence, the Settlements category also includes all land used for infrastructure, as well as that of industrial zones and city parks.
Denmark	Urban cores, industrial areas, roads, high and low build-up areas. Low build-up areas are characterized as single-family houses surrounded by gardens, graveyards, sports facilities, etc. (estimates are reported only for low build-up areas).
Estonia	Built-up areas, with roads, streets and squares, traffic and power lines, urban parks, industrial and manufacturing land, sports facilities, airports, legal waste down points, construction sites and buildings with up to 0.3 ha of garden yard (including permanent greenhouses), and open cast areas (except peat extraction areas) are included into this land-use category
Finland	Combined area of NFI built-up land, traffic lines and power lines. Includes parks, yards, farm roads and barns.
France	Artificialized land (settlements, parks, roads and infrastructure, etc.).
Germany	Open settlement and transport areas.
Greece	Developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other land-use categories.
Hungary	Settlements comprises the urban areas, industrial, commercial and transport units, as well as mines, dump and construction sites and artificial non-agricultural vegetated areas.
Ireland	Urban areas, roads, airports and the footprint of industrial commercial/institutional and residential buildings.

Country	*Definition*
Italy	Artificial surfaces, transportation infrastructures (urban and rural), power lines and human settlements of any size, comprising also parks.
Latvia	According to national definitions settlements include land under buildings including yards and gardens as well as land necessary to maintain and to access those buildings; land under roads including buffer zones; forest infrastructure excluding ditches and other wetlands, but including seed orchards, forest nurseries and firebreaks; other infrastructure – buffer zones of industrial networks, quarries etc.
Lithuania	All urban territories, power lines, traffic lines and roads are included under this category as well as orchards and berry plantations planted in small size household areas and only used for householders' meanings.
Luxemburg	Developed land, including transportation and any size of human settlement unless already included under other category.
Malta	The land-use category Settlements includes all classes of urban tree formations, namely trees grown along roads and streets, in public and private gardens, and in cemeteries, airports, construction sites, dumpsites, industrial or commercial units, port areas and sport and leisure facilities.
Netherlands	Developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.
Poland	Settlements consists of: residential areas include land not used for agricultural and forest production, put under dwelling buildings, devices functionally related to dwelling buildings (yards, drives, passages, playgrounds adjacent to houses), as well as gardens adjacent to houses; industrial areas include land put under buildings and devices serving the purpose of industrial production; other built-up areas include land put under buildings and devices related to administration; undeveloped urbanised areas include land that is not built over, allocated in spatial management plans to building development and excluded from agricultural and forest production; recreational and resting areas comprise the following types of land not put under buildings; areas of recreational centres,. children playgrounds, beaches, arranged parks, squares, lawns (outside street lanes); areas of historical significance: ruins of castles, strongholds, etc.; sport grounds: stadiums, football fields, ski-jumping take-offs, toboggan-run, sports rifle ranges, public baths etc.; area for entertainment purposes: amusement, grounds, funfairs etc.; zoological and botanical gardens; areas of non-arranged greenery, not listed under woodlands or land planted with trees or shrubbery; transport areas including land put under: roads; stopping yards next to railway stations, bus stations and airports, maritime and river ports and other ports, as well as universal accesses to unloading platforms and storage yards; railway grounds; other transport grounds.
Portugal	Includes all artificial territories, including cities and villages, industry, roads and railway, ports and airports.
Romania	Settlements has 3 groups (urban/rural, buildings and infrastructure) and includes: fenced and constructed areas, sealed lands (e.g., car parks, roundabouts, platforms), urban/rural lawns, playgrounds in green areas, beach lawn and other areas with lawn, dwellings, industrial and administration buildings (e.g., banks, churches, railway stations, restaurants), warehouses, huts, ruins, greenhouses, graveyards, dirt roads, trails, rail roads and roads (street, sidewalk, square), bridges and dams.
Slovakia	The settlements include all developed land, including transportation infrastructure and human settlements of any size.
Slovenia	Settlements are all piece of land where the buildings, roads, parking places, mines, stone pits and all other infrastructure are in human use.
Spain	All developed land, transport infrastructure and establishments of any size, unless they are included in other categories.
Sweden	Infrastructure such as roads and railways, power lines, municipality areas, gardens and gravel pits.
UK	Covers urban and rural settlements, farm buildings, caravan parks and other man-made built structures such as industrial estates, retail parks, waste and derelict ground, urban parkland and urban transport infrastructure. It also includes domestic gardens and allotments, linearly arranged landscape features such as hedgerows, walls, stone and earth banks, grass strips and dry ditches.
Iceland	All areas included within map layers "Towns and villages" and "Airports" as defined in the IS geographical database. Also included as Settlement are roads classified with 15 m wide road zone, including primary and secondary roads. Roads within forest land are excluded as road zone does not reach 20 m. Settlement is in the land use map represented as two classes; "Settlements towns" and "Settlements other".

As regards the methods used for reporting carbon stock changes in these areas, often countries used the Tier 1 assumption of equilibrium under the subcategory 4E1, therefore no carbon stock changes are reported, and notation keys are accordingly included in the CRF tables.

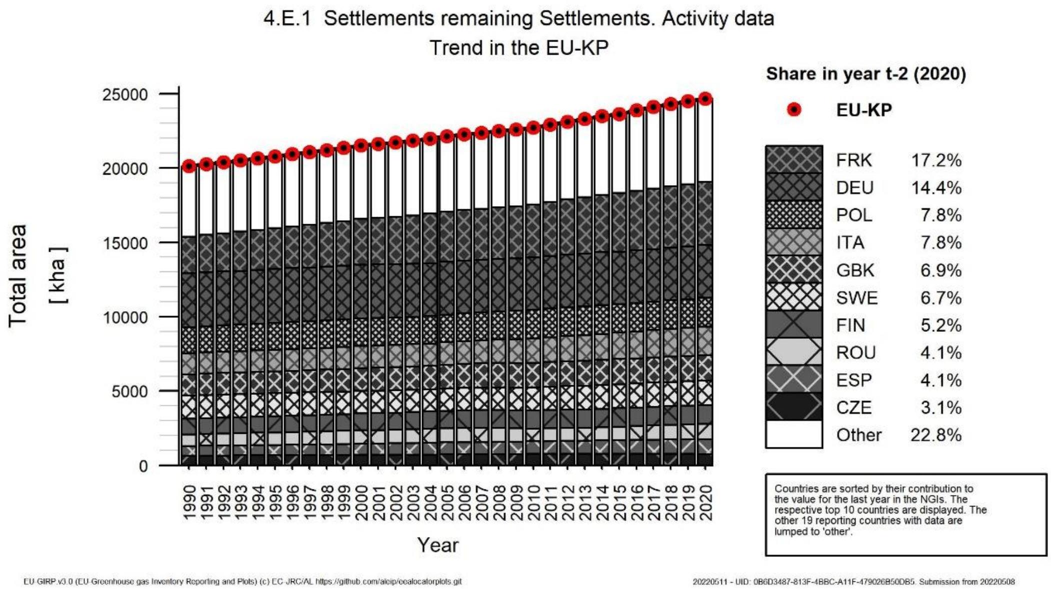
Nevertheless, a few countries have reported this subcategory as a net source of GHG emissions. For instance, Germany, France, and Netherlands have reported emissions as a result of disturbed organic soils in these areas, while UK reports emissions from disturbed mineral soils.

By contrary, Latvia, Poland and Slovenia have reported the subcategory 4E1 as a net sink of carbon due to carbon accumulation from living biomass on green urban areas (

Figure 6.17; Figure 6.18).

A particular case is Latvia that reports a remarkable increase in the sink of this category in 2012. It is explained because carbon stock changes in living biomass and dead organic matter for different land use categories are calculated using the most recent available national forest inventory data “floating NFI cycle” and then with average values used for different periods. The increase of carbon stock in living biomass in settlements reflects an increase of age and gross increment of trees growing on settlements, as well as increased area of settlements covered by woody vegetation. Reduction of increment in 2017 is a result of changes in age structure of woody vegetation, caused by more intensive extraction of trees in settlement areas such as roadsides, buffer zones of drainage ditches and other settlements. The losses due to extraction of wood in settlements are accounted using instant oxidation method due to lack of knowledge about further use of biomass.

Figure 6.17 Trend of activity data and emissions (+)/removals (-) in subcategory 4E1 “Settlements remaining Settlements” in EU-KP (kha, kt CO_2)



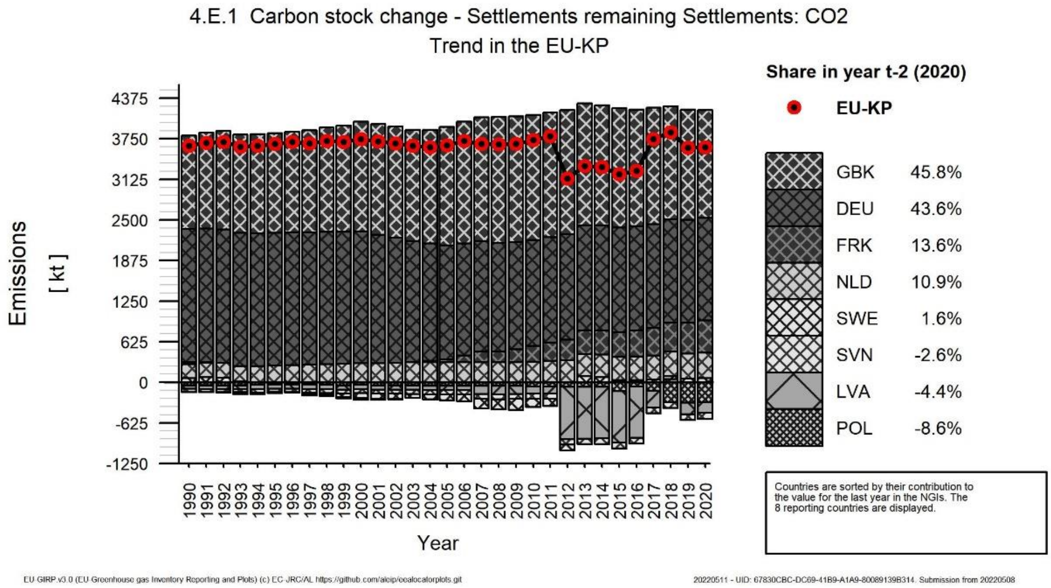
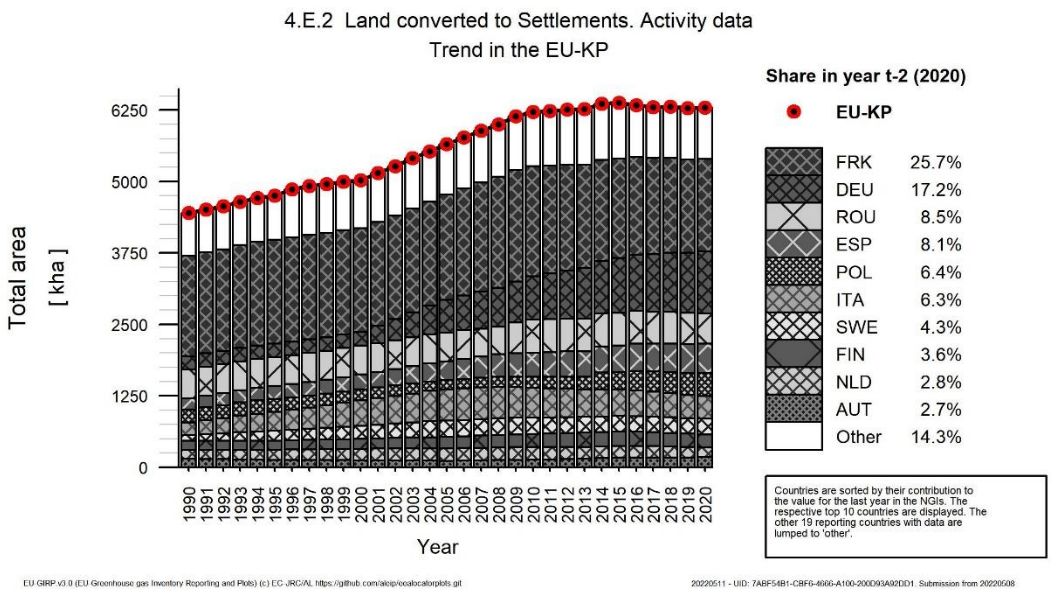
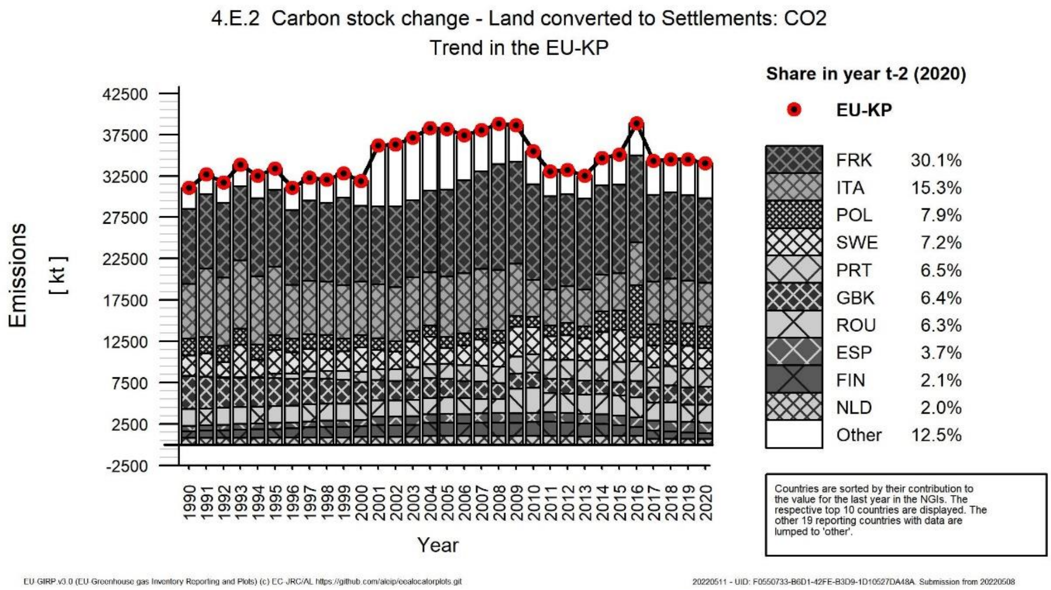


Figure 6.18 Trend of activity data and emissions (+)/removals (-) in subcategory 4E2 "Land converted to Settlements" in EU-KP kha, kt CO_2)





As regards the subcategory 4E2, annual emissions from Land converted to Settlements have increased by 9% since 1990 (Table 6.28). For the year 2020 this subcategory was reported as a net source of emissions, reaching 34.023 kt CO_2.

Emissions are mainly the result of disturbed mineral soils and loss of carbon from living biomass when forests are converted to urban areas (e.g., France, Italy, Romania and UK). In fact, the conversion of forests to Settlements is an important component of the total deforestation. It represents around 30% of total area reported as deforested; and 15% of the Land converted to Settlements. While conversions to Wetland or Other land may be caused by natural effects, a conversion to Settlement is by definition the result of human actions.

When a land is converted to Settlements, carbon pools are not uniformly disturbed over the whole area. For instance, usually only part of the converted area is paved, trees or upper soils layer is removed, and carbon stored in dead organic matter and soil organic matter diminish significantly. To address this issue, carbon stock changes associated with these deforestation events are reported using country-specific data and approaches.

Table 6.28 4E2 Land converted to Settlements: EU-KP contributions to the net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	392	179	232	0.7%	-160	-41%	53	30%
Belgium	143	500	504	1.5%	360	252%	3	1%
Bulgaria	425	737	586	1.7%	161	38%	-150	-20%
Croatia	187	619	622	1.8%	435	233%	3	0%
Cyprus	0	13	13	0.0%	13	138711%	0	0%
Czechia	276	140	146	0.4%	-129	-47%	7	5%
Denmark	428	197	225	0.7%	-204	-48%	28	14%
Estonia	NO	425	376	1.1%	376	∞	-49	-12%
Finland	835	766	712	2.1%	-122	-15%	-53	-7%
France	9 067	10 288	10 250	30.1%	1 183	13%	-37	0%
Germany	-281	-656	-506	-1.5%	-225	-80%	151	23%
Greece	50	126	126	0.4%	76	153%	0	0%
Hungary	109	284	211	0.6%	102	93%	-73	-26%
Ireland	80	120	162	0.5%	82	102%	43	36%
Italy	6 640	5 201	5 207	15.3%	-1 433	-22%	6	0%
Latvia	81	626	645	1.9%	564	696%	19	3%
Lithuania	38	719	548	1.6%	510	1324%	-171	-24%
Luxembourg	29	40	40	0.1%	10	36%	0	0%
Malta	2	0	0	0.0%	-2	-96%	0	-26%
Netherlands	785	694	686	2.0%	-99	-13%	-8	-1%
Poland	2 065	2 705	2 673	7.9%	609	29%	-32	-1%
Portugal	30	2 274	2 228	6.5%	2 198	7208%	-46	-2%
Romania	2 053	2 146	2 156	6.3%	103	5%	9	0%
Slovakia	96	83	78	0.2%	-17	-18%	-5	-5%
Slovenia	466	239	224	0.7%	-242	-52%	-15	-6%
Spain	657	1 249	1 263	3.7%	606	92%	14	1%
Sweden	2 457	2 728	2 449	7.2%	-8	0%	-279	-10%
United Kingdom	3 853	2 013	2 099	6.2%	-1 754	-46%	86	4%
EU-27+UK	**30 965**	**34 454**	**33 956**	**100%**	**2 991**	**10%**	**-498**	**-1%**
Iceland	22	4	4	0.0%	-18	-82%	0	3%
United Kingdom (KP)	3 937	2 078	2 163	6.4%	-1 774	-45%	85	4%
EU-KP	**31 070**	**34 522**	**34 023**	**100%**	**2 953**	**10%**	**-499**	**-1%**

Major changes in the time series in Land converted to Settlements have been reported by Lithuania and Portugal, driven by the activity data. And, specifically for an increase in the conversion of areas that has associated large carbon stocks and therefore more carbon is lost from their conversions.

Noteworthy is also Poland, which reports for the year 2016 a significant increase of emissions from 4E.2 that is reflected in the overall trend of the LULUCF sector at EU level. Such increase results from significant conversion of forest lands used for expanding infrastructures required to support the growing population.

For reporting carbon stock changes in dead organic matter, it is generally assumed that all the carbon stock in the pool is instantaneously oxidized in the moment of conversion from Forest land to Settlements. It is also assumed that there is no dead wood and litter on Settlements. Emissions are estimated based on average carbon stock per area of these carbon pools, determined either at national or regional scale or specific to each deforestation site.

For reporting soil organic matter, different assumptions have been implemented by MS. These are generally based on expert judgment or, occasionally, on scientific studies. For instance, in Sweden the carbon stock in Settlements is estimated as the weighted average of carbon stocks in two strata: unpaved and paved. Unpaved area is usually considered to cover 40-60% of national settlements area (e.g. Austria, Luxembourg), going down to 2-3% in other cities (i.e. Bulgaria). Associated carbon stocks are derived from one of the following options (depending on MS):

- data from measurements in green area of the city (from scientific studies);
- same carbon stock as under 'GL remaining GL' (assuming that under national circumstances GL is the source of land for Settlement's expansion);
- lowest carbon stock value among the major land categories Forest land, Cropland and Grassland (assuming limited change of carbon stock in the soil under construction);
- applying a factor against carbon stock in previous land use (e.g., constant loss of 50%).

6.2.4.3 Other land (CRF 4F)

The land use category Other land reached in this reporting year 15.583 Kha, which represents about 3% of the total reported area. This land use category has been reported rather constant across the time series because of the balance among the decrease in the subcategory 4F1 and the increase in the subcategory 4F2 (Figure 6.19).

The largest areas under the category 4F1 are reported by Sweden and Iceland, while new Other lands areas in the subcategory 4F2 are mainly reported by Portugal, France and Bulgaria, although without a common pattern on the origin of these lands.

In terms of emissions, inter-annual variations at EU level are due to Portugal, Bulgaria and Ireland.

In the case of Portugal, the trend of GHG fluxes is dominated by the trend on activity data. Cropland and Grassland are the main categories being converted to Other Land. However, the Forest land category also plays an important role at the beginning of the time series. Consequently, this category is reported as a net source of emissions for the years 1990, 1991 and 1992 due to the loss of carbon in living biomass, and then as a net sink of carbon, which increases until 2009 and then decreases, following the trend in agricultural areas under conversion. The net sink is the result of abandonment of agricultural areas that resulted in net carbon accumulation in soils under Other Land.

Noteworthy is the case of Ireland, which reports for the year 2006 significant emissions from Forest land converted to Other land. This is due to a former area of peat extraction (pre-1990) that was abandoned and then (since 1990) classified as forest. Subsequently, a dump was built on the land, and the area was reclassified as Other land. Ireland has informed that a process is ongoing to improve the reporting of these areas.

Finally, Poland calculates the area in this category as the difference of the area of all land-use categories and the whole area of the country, thereby intending to avoid double accounting or omission of areas. Due to the land representation system, the year 2000 represents a change in the land use matrix. Starting from that year, Poland reports a leap on activity data of "Land converted to Other Land" that is reflected in the EU trend.

Definitions of Other land are close to each other among countries and overall match the IPCC general description (Table 6. 29). In most of the cases, following the IPCC approach, this category is used to ensure that the total area reported under LULUCF remains constant along the time series, and matches official country area. To this aim, this land category is on a lower level of hierarchy and includes all the areas that were not identified under any other land use category, and that are in all cases considered unmanaged. Following a recommendation from the ERT the definitions of the category have been updated to better reflect lands that are included in the category. Furthermore, following a recommendation of the previous ERT, Finland, UK and Portugal confirmed that all the areas included in this category are unmanaged.

As regards Finland, which includes under this category "mineral soils on poorly productive forest lands", it should be noted that such lands correspond with a national category definition of its national forest inventory that are unmanaged. Those areas do not fulfil the threshold values for Forest Land and do not meet the criteria for any other land use category; therefore, these lands are included into the Other land category following the 2006 IPCC.

In the case of UK, this category is defined as areas that do not fall into the other land use categories. These areas contain unmanaged lands that include inland rock, standing water, and canals, rivers and streams broad habitat types that do not fall under Wetland category.

A particular case is given by Portugal that included shrubland areas under this category. This country-specific definition, although different to the one provided by IPCC, is consistently applied across the time series. Portugal provided in its NIR specific information on this land use category and on the methods used to estimate carbon stock changes in these areas.

Portugal is working to reclassify shrubland areas under the land use category Grassland. As an interim solution in the current reporting, carbon stock changes from Other land remaining Other land were included in land converted to Other land in order to ensure the completeness of the inventory.

The EU has closely followed this issue with Portugal, which has informed that once the improvement plan is implemented, Grassland will contain 2 sub-categories: pastures and shrubland. For this submission, Portugal stated that new 2018 and 2015 land-use maps and revisions of the maps for 1995, 2007, 2010 from their National Cartography Authority (DGT) are ready and that a revision of the full time series of land-use changes will be soon carried out. As part of this task the relocation of shrubland from “Other land” to “Grassland” will be implemented.

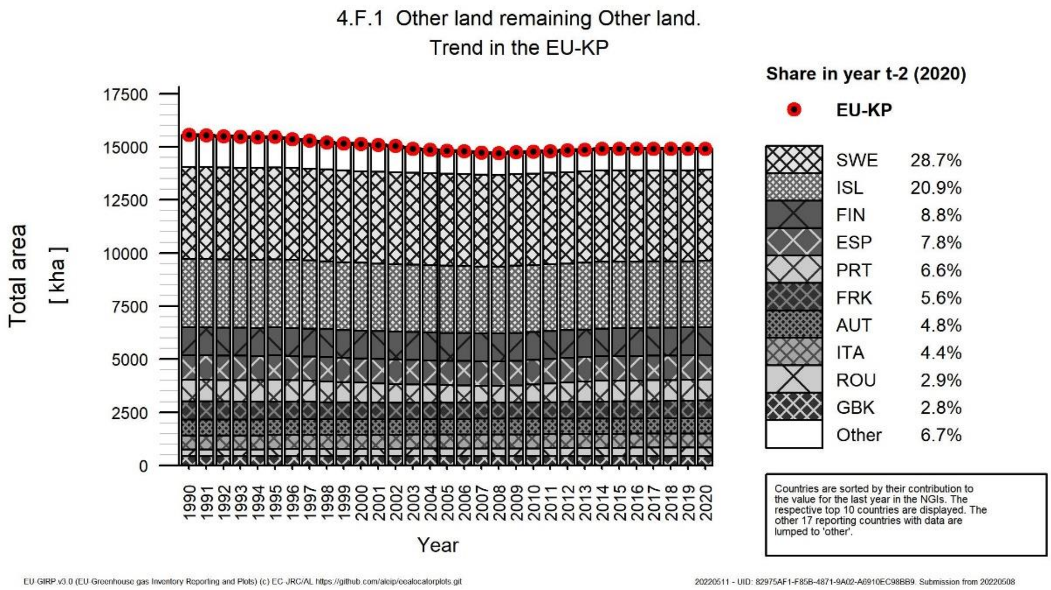
Table 6. 29 Definitions of lands included under the category 4F: Other lands.

Country	*Definition*
Austria	Area with i) rocks and screes, ii) glaciers and iii) unmanaged alpine dwarf shrub heaths. It is calculated as the difference of total country area and all other land uses, showing max 2% difference by relevant cadastral data.
Belgium	Bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories.
Bulgaria	Other land category includes bare soil, rock and all area that do not fall into any of other five land-use categories.
Croatia	Other land category represents a difference between the total area of Croatia and sum of all other land use categories.
Cyprus	Bare soil, rock, beaches, dunes and sand plains and all land areas that do not fall into any of the other five categories.
Czechia	Other land is not represented by any land use category within the Czech conditions and the national system of land use representation and land use change identification.
Denmark	Unmanaged area like moors, fens, beaches, sand dunes and other areas without human interference.
Estonia	Land areas that do not fall into any of the other five land-use categories.
Finland	Mineral soils on poorly productive forest land, which do not fulfil the threshold values for forest, unproductive lands on mineral soils on rocky lands and treeless mountain areas.
France	All lands that do not correspond to any other land use categories (e.g., rock areas). Other lands (flush rocks, etc.) cover around 0.9 million hectares, and are the lowest source of emissions due to low soil disturbance. This is land with no significant carbon stock, neither in soils nor in biomass.
Germany	Waste and swaths/aisles, glacier areas, scree slopes and sand bars and other land which cannot be allocated under other land categories. "Other land" consists of areas that are neither influenced nor cultivated by people.
Greece	All land areas that do not fall into any of other land-use categories (e.g., rocky areas, bare soil, mine and quarry land).
Hungary	Other Land includes comprises any area not included in another categories.
Ireland	Residual lands that are determinate when all other land use areas have been determined.
Italy	Other Land includes comprises any area not included in another categories. It is included to match overall consistency of country land area.
Latvia	According to the national land use statistics other lands include unmanaged lands, wetlands and settlements (1 459.3 mill. ha in 2008). Instead of the official statistics since 2009 the NFI is used to estimate area of other lands. It is assumed that other lands are dunes not covered by woody vegetation.
Lithuania	All other land which is not assigned to any other category such as quarries, sand - dunes and rocky areas is defined as Other land.
Luxemburg	This category includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area.
Malta	This category includes bare soil, rock, and all unmanaged land areas that do not fall into any of the other five categories. Mineral extraction sites in Malta are included under this land-use category.
Netherlands	Surfaces of bare soil which are not included in any other category like: bare sands and the earliest stages of succession from sand in the coastal areas (beaches, dunes and sandy roads) or uncultivated land alongside rivers. It does not include bare areas that emerge from shrinking and expanding water surfaces (which are included in wetlands).
Poland	Other Land includes comprises any area not included in another categories. It is included to match overall consistency of country land area.
Portugal	Shrubland - includes all lands covered in woody vegetation that do not meet the forest or permanent crop definitions and Other land - includes all lands that do not meet the previous definitions, such as lands covered in rocks, sand dunes, etc.
Romania	Other land includes following categories: rocky areas, excavations, stone quarries (active, closed), stony debris, gravel/sand/earth pits, drilling perimeters and locally degraded lands.
Slovakia	Other land represents bare soil, rock and all unmanaged land areas that do not fall into any of the other categories.
Slovenia	Other land includes non-forest land covered with vegetation lover than 2 m or covered less than 75%, which is not used in agriculture. There are inbuilt areas with little or no vegetation as rocks, sands, sand banks (bigger than 5000 m2), waste and other opened areas. This is all land that is not classified in other land use definitions.
Spain	Bare soil, rock areas, ice and other areas of land that do not fall into any of the other land category.
Sweden	Waste land and most of the mountain area in northwest Sweden. It is assumed unmanaged.
UK	For pre-1980 Other Land is the sum of the bare rock, sand/shingle, inland water and coastal water land. For Post-1980, Other Land contains the inland rock, standing water and canals and rivers and streams.
Iceland	Other Land is defined as areas that do not fall into the other land use categories. Other Land contains the inland rock, standing water and canals and rivers and streams broad habitat types in the Countryside Survey (Jackson, 2000). Areas of inland water exceeding 1km2 are included in 4D Wetlands, but water bodies below this threshold would still be included under Other Land.

In terms of emissions, Other land represents a small net sink resulting from the conversion from other categories with intense soil management to Other land. It reaches a sink of -195 kt CO_2 for the year 2020, contrary to the small source reported for 2019. This is due to the reporting of Romania and Lithuania. Romania reports this year significant downwards recalculations for the entire time series driven by the new method for acquiring activity data information. Lithuania reports two CO_2 emissions increase peaks in 1994 and 2019 due to forest land converted to other land that were deforested for the National Defence purposes.

Countries generally report emissions as a result of carbon oxidation from living biomass and soils when lands are converted to Other land. However, some have also reported a net sink of carbon in mineral soils following such conversions. As explained above, this is the case of Portugal that reports all the carbon pools as being a net sink under 4F.2 due to the woody biomass that is presented in this category according with the country's definition of Other land.

Figure 6.19 Trend of activity data in subcategories 4F1 and 4F2 "Other land remaining Other Land" and "Land converted to Other land" in EU-KP (kha, kt CO_2)



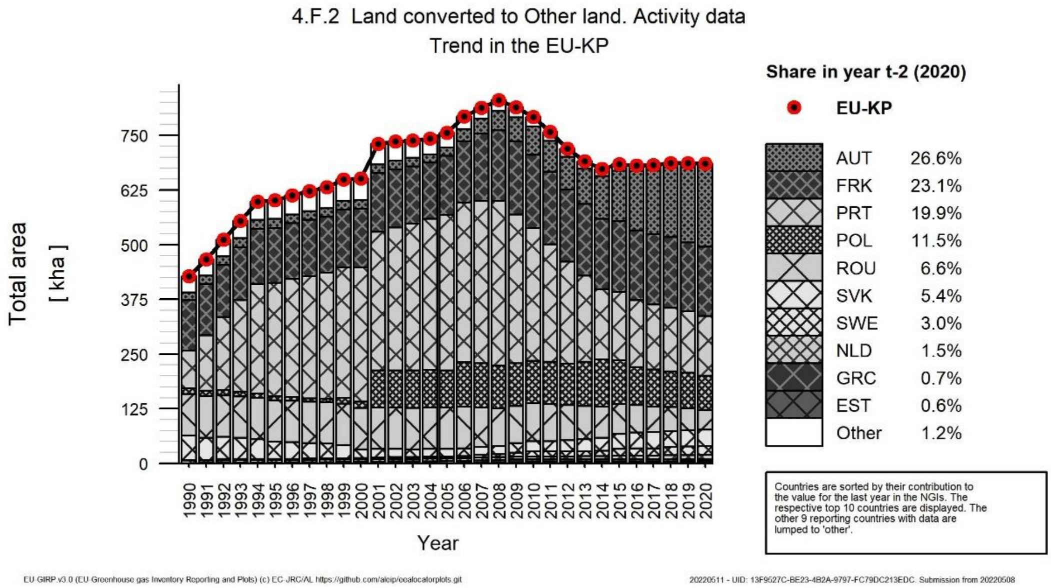
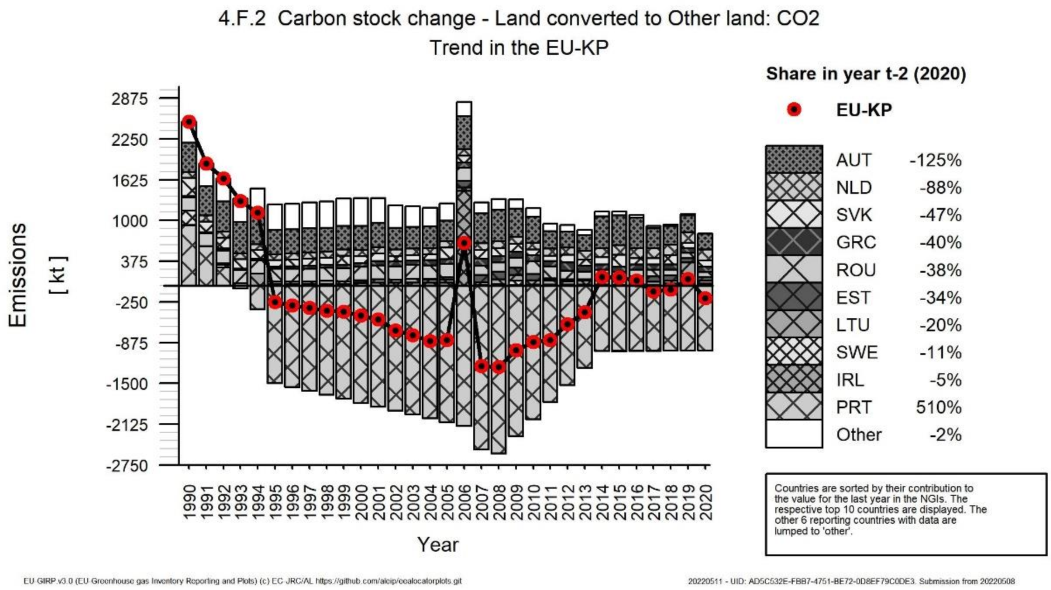


Figure 6.20 Trend of emissions (+)/removals (-) in subcategory 4F2, "Land converted to Other lands" in EU-KP (kt CO_2)



6.2.5 Harvest Wood Products (CRF 4G)

6.2.5.1 Overview of the Harvest Wood Products category

This carbon pool covers emissions and removals from carbon stock changes in harvested wood products (HWPs). The net contribution of this pool is the result of the annual carbon inflow to the pool (i.e., gains), and carbon outflow from the pool (i.e., losses).

According to the 2006 IPCC guidelines, HWPs includes all wood material (including bark) that leaves harvest sites, where this removal is initially counted as a loss of carbon from living biomass. Slash and other material left at harvest sites should be regarded as dead organic matter in the associated land use category and not as HWP. The inflow of biomass into the HWPs is counted as a gain in the HWPs category.

HWPs represent at the level of EU MS, UK, and Iceland a net carbon sink of -38.405 kt CO_2 in the current inventory year. Most of the countries reported this carbon pool as a net sink; however, Cyprus, Belgium, Greece, and Netherlands, estimated HWPs as a net source of emissions for the inventory year.

The main contributors to the carbon sink are Sweden, Poland, and Germany.

Belgium, that in previous submissions reported only HWPs from 2000 onwards, has increased the accuracy and consistency of the reporting of this pool covering the whole time series as requested by the ERT.

The methods and data sources for estimating carbon stock changes in HWPs are consistent with methodologies provided by 2006 IPCC GL. Individual inventories implemented the IPCC Approach B (i.e., production approach) to provide estimates on HWPs consistently with the reporting of the carbon pool under the KP reporting.

Countries reported carbon stock changes in HWPs considering individual estimates for the semi-finished wood products categories of (i) Solid wood, disaggregated into Sawn wood and wood panels, and (ii) Paper and paperboard. To this aim, the IPCC default half-life values have been used by all individual inventories.

A particular case is given by Malta that has stated that carbon stock changes in HWPs pool, as considered under the Approach B, do not exist, as commercial logging does not occur in its territory.

With regards to the activity data, most of the MS have based their estimates on the information provided by the FAOSTAT database, the TIMBER database of the United Nations Economic Commission for Europe (UNECE, 2011), national statistics when available, or, in specific cases, on information collected by surveying wood industries.

Table 6.29 4G Harvest Wood Products: contributions to net CO_2 emissions (+)/removals (-) (CRF table 4)

Member State	CO2 Emissions in kt				Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	1995	2019	2020		kt CO2	%	kt CO2	%
Austria	-3 122	-2 569	-1 462	-173	0.4%	2 950	94%	1 289	88%
Belgium	-1 517	-937	-55	122	-0.3%	1 639	108%	177	320%
Bulgaria	-583	344	-1 267	-1 026	2.7%	-443	-76%	242	19%
Croatia	-318	-55	-672	-573	1.5%	-255	-80%	99	15%
Cyprus	3	4	24	23	-0.1%	20	605%	-1	-3%
Czechia	-1 680	-827	-1 813	-1 730	4.5%	-50	-3%	83	5%
Denmark	-2	-116	-85	-118	0.3%	-115	-4869%	-33	-39%
Estonia	-156	-29	-972	-922	2.4%	-766	-490%	49	5%
Finland	-2 952	-4 904	-3 381	-1 297	3.4%	1 655	56%	2 084	62%
France	-5 100	-3 042	-768	-814	2.1%	4 286	84%	-47	-6%
Germany	-1 330	-2 728	-6 067	-8 651	22.5%	-7 321	-550%	-2 584	-43%
Greece	-349	-351	-32	28	-0.1%	377	108%	61	187%
Hungary	-335	110	-335	-337	0.9%	-2	-1%	-2	-1%
Ireland	-413	-680	-858	-819	2.1%	-406	-98%	39	5%
Italy	-388	-706	-1 469	-669	1.7%	-281	-72%	801	54%
Latvia	-166	-475	-2 333	-1 726	4.5%	-1 560	-939%	606	26%
Lithuania	-253	-830	-808	-784	2.0%	-531	-210%	24	3%
Luxembourg	2	-12	5	-5	0.0%	-7	-332%	-10	-190%
Malta	NO	NO	NO	NO	-	-	-	-	-
Netherlands	-174	75	116	121	-0.3%	295	170%	5	5%
Poland	-459	-942	-4 565	-4 449	11.58%	-3 989	-869%	117	3%
Portugal	-1 674	-945	-104	-105	0.3%	1 569	94%	-1	-1%
Romania	342	1 627	-3 268	-3 143	8.2%	-3 485	-1018%	125	4%
Slovakia	-470	-59	-645	-147	0.4%	324	69%	498	77%
Slovenia	-67	28	-253	-142	0.4%	-75	-112%	111	44%
Spain	-2 020	-2 182	-2 186	-1 567	4.1%	453	22%	619	28%
Sweden	-4 815	-6 051	-6 490	-7 375	19.2%	-2 560	-53%	-886	-14%
United Kingdom	-2 088	-2 277	-2 301	-2 129	5.5%	-41	-2%	172	7%
EU-27+UK	**-30 084**	**-28 530**	**-42 043**	**-38 405**	**100%**	**-8 321**	**-28%**	**3 638**	**9%**
Iceland	NO,NA	NO,NA	0	0	0.0%	0	-∞	0	47%
United Kingdom (KP)	-2 088	-2 277	-2 301	-2 129	5.5%	-41	-2%	172	7%
EU-KP	**-30 084**	**-28 530**	**-42 043**	**-38 405**	**100%**	**-8 321**	**-28%**	**3 638**	**9%**

6.2.6 LULUCF – non-key categories

In this section, a general overview of emissions and removals for non-key categories is provided.

Table 6. 30 Aggregated GHG emission from non-key categories in the LULUCF sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 4. LULUCF in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	2 021.9	1 539.5	1 549.1	-0.72%	-473	-23%	9.6	1%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	336.7	466.7	472.1	-0.22%	135	40%	5.4	1%
4.A Forest Land: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	5 056.1	5 045.9	5 034.7	-2.35%	-21	0%	-11.2	0%
4.A.1 Forest Land: Land Use (CH_4)	1 753.5	984.6	1 083.7	-0.51%	-670	-38%	99.1	10%
4.A.1 Forest Land: Land Use (N_2O)	823.4	549.5	618.4	-0.29%	-205	-25%	68.9	13%
4.A.2 Forest Land: Land Use (CH_4)	113.2	23.3	33.6	-0.02%	-80	-70%	10.3	44%
4.A.2 Forest Land: Land Use (N_2O)	693.9	421.9	423.3	-0.20%	-271	-39%	1.4	0%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	1 092.3	915.0	905.6	-0.42%	-187	-17%	-9.4	-1%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	1 642.3	1 201.0	1 204.8	-0.56%	-437	-27%	3.8	0%
4.B Cropland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
4.B.1 Cropland: Land Use (CH_4)	89.3	73.1	69.5	-0.03%	-20	-22%	-3.6	-5%
4.B.1 Cropland: Land Use (N_2O)	56.3	48.6	44.6	-0.02%	-12	-21%	-4.0	-8%
4.B.2 Cropland: Land Use (CH_4)	57.9	52.0	52.1	-0.02%	-6	-10%	0.1	0%
4.B.2 Cropland: Land Use (N_2O)	3 197.9	2 747.2	2 687.2	-1.25%	-511	-16%	-60.0	-2%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	4 238.0	4 371.9	4 413.5	-2.06%	175	4%	41.6	1%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	765.3	805.3	813.4	-0.38%	48	6%	8.2	1%
4.C Grassland: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	57.8	29.1	28.1	-0.01%	-30	-51%	-1.1	-4%
4.C.1 Grassland: Land Use (CH_4)	851.8	262.3	230.0	-0.11%	-622	-73%	-32.2	-12%
4.C.1 Grassland: Land Use (N_2O)	427.4	258.4	257.9	-0.12%	-170	-40%	-0.5	0%
4.C.2 Grassland: Land Use (CH_4)	44.4	39.1	43.1	-0.02%	-1	-3%	3.9	10%
4.C.2 Grassland: Land Use (N_2O)	289.0	197.1	192.4	-0.09%	-97	-33%	-4.7	-2.4%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CO_2)	1 330.9	1 522.9	1 543.5	-0.72%	213	16%	20.5	1.3%
4.D Wetlands: Emissions and removals from drainage and rewetting and other management of organic and mineral soils (N_2O)	155.7	186.9	186.3	-0.09%	31	20%	-0.6	0%
4.D.1 Wetlands: Land Use (CH_4)	68.2	24.1	19.8	-0.01%	-48	-71%	-4.3	-18%
4.D.1 Wetlands: Land Use (N_2O)	20.4	7.3	6.0	0.00%	-14	-71%	-1.3	-18%
4.D.2 Wetlands: Land Use (CH_4)	6.9	34.0	15.8	-0.01%	9	130%	-18.2	-53%
4.D.2 Wetlands: Land Use (N_2O)	36.5	72.7	62.9	-0.03%	26	72%	-9.8	-14%
4.E Settlements: Biomass Burning (CH_4)	52.8	74.0	74.2	-0.03%	21	41%	0.1	0%
4.E Settlements: Biomass Burning (CO_2)	48.9	208.8	210.6	-0.10%	162	331%	1.8	1%
4.E Settlements: Biomass Burning (N_2O)	4.2	13.3	13.4	-0.01%	9	219%	0.1	1%
4.E.1 Settlements: Land Use (CH_4)	45.3	40.2	39.9	-0.02%	-5	-12%	-0.2	-1%

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 4. LULUCF in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
4.E.1 Settlements: Land Use (CO_2)	3 644.6	3 615.8	3 623.3	-1.69%	-21	-1%	7.4	0%
4.E.1 Settlements: Land Use (N_2O)	122.0	150.9	148.0	-0.07%	26	21%	-2.9	-2%
4.E.2 Settlements: Land Use (CH_4)	2.7	25.8	25.3	-0.01%	23	827%	-0.5	-2%
4.E.2 Settlements: Land Use (N_2O)	3 523.1	3 889.3	3 878.9	-1.81%	356	10%	-10.4	0%
4.F.2 Other Land: Land Use (CH_4)	0.0	0.0	0.0	0.00%	0	0%	0.0	0%
4.F.2 Other Land: Land Use (CO_2)	2 515.1	100.7	-194.8	0.09%	-2 710	-108%	-295.5	-293%
4.F.2 Other Land: Land Use (N_2O)	0.0	0.0	0.0	0.00%	0.0	-100%	0.0	0%
4.F.3 Other Land: Direct N_2O Emissions from N Mineralization/Immobilization (N_2O)	54.5	106.7	102.9	-0.05%	48	89%	-3.7	-4%
4.F.4 Other Land: Biomass Burning (CH_4)	137.2	50.6	71.3	-0.03%	-65.8	-48%	20.7	41%
4.F.4 Other Land: Biomass Burning (CO_2)	0.0	0.0	0.0	0.00%	0	0%	0.0	0%
4.F.4 Other Land: Biomass Burning (N_2O)	22.5	8.3	11.7	-0.01%	-11	-48%	3.4	41%
4.G Atmospheric Deposition: Land Use (N_2O)	-	-	-	-	-	-	-	-
4.G Nitrogen Leaching and Run-off: Land Use (N_2O)	-	-	-	-	-	-	-	-
4.H Other LULUCF: Land Use (CH_4)	12.6	232.6	232.6	-0.11%	220	1739%	0.0	0%
4.H Other LULUCF: Land Use (CO_2)	0.0	45.7	39.8	-0.02%	40	100%	-5.8	-13%
4.H Other LULUCF: Land Use (N_2O)	323.0	313.2	313.6	-0.15%	-9	-3%	0.4	0.1%

6.2.7 Other sources of emissions: Tables 4(I)-4(V)

6.2.7.1 Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (CRF Table 4(I))

Under CRF table 4(I) countries reports N_2O emissions resulting from the addition of organic and inorganic fertilizers to managed soils under land use categories other than Cropland and Grassland.

The majority of countries have stated that fertilization is not part of the management practices of forests, while, if any, emissions from the addition of nitrogen inputs in Wetlands, Settlements, or in a few cases also under forests, are reported under Agriculture sector when it is not possible to separate emissions from fertilization among the land use categories. Therefore, under the LULUCF almost all the countries have reported these emissions using the notation key NO or IE (Table 6. 31).

Exceptions are Finland, Sweden, UK that report N_2O emissions under this source category due to forest fertilization. Sweden reports emissions from nitrogen fertilization as a result of nitrogen inputs occasionally applied to increase the wood production in older forests stands. Finland reports also notable emissions in this category as a result of forest growth fertilization and, to a lesser extent, vitality fertilization.

UK reports low emissions in this source as a result of inorganic nitrogen fertilizers applied to forest e.g. during the first rotation on 'poor' soils, such as reclaimed slag heaps, impoverished brown field sites and upland organic soils. Iceland reports emissions from fertilization of cultivated forest at the planting stage.

In addition, Ireland reports N_2O emissions resulting from the addition of organic fertilizers in Settlements areas.

Activity data for reporting this source of emissions results from national or sectorial statistics (e.g. sales statistics), which provide the total amount and type of fertilizer. Then, the IPCC default value of 0.01 kg N_2O-N/kg N yr^{-1} is usually used to derive N_2O emissions from nitrogen inputs to managed soils.

For this inventory year, this source of emissions reaches 74 kt CO_2 equivalents, which is about 9% less than in 1990.

Table 6. 31 4 LULUCF Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Estonia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Finland	21	35	38	51.5%	18	86%	3	8%
France	NO	NO	NO	-	-	-	-	-
Germany	NO	NO	NO	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Ireland	NO,IE	6	6	7.5%	6	∞	0	0%
Italy	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Latvia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NA,NO	NO	NO	-	-	-	-	-
Netherlands	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Poland	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Portugal	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Romania	D,NE,IE,NA	D,NE,IE,NA	D,NE,IE,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	49	25	30	40.0%	-19	-40%	4	18%
United Kingdom	12	1	1	1.1%	-11	-93%	0	30%
EU-27+UK	**82**	**67**	**74**	**100%**	**-8**	**-9%**	**8**	**11%**
Iceland	NE,IE,NA	NE,IE,NA	NE,IE,NA	-	-	-	-	-
United Kingdom (KP)	12	1	1	1.1%	-11	-93%	0	30%
EU-KP	**82**	**67**	**74**	**100%**	**-8**	**-9%**	**8**	**11%**

6.2.7.2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CRF Table 4(II))

Under CRF table 4(II), CO_2, CH_4 and N_2O emissions and removals from drainage and rewetting and other management of organic and mineral soils areas are reported. However, part of these emissions is already covered under other sectors, so countries need to avoid double counting (e.g., nitrous oxide emissions from drained cropland and grassland soils are covered in the agriculture sector) or they may be reported under other tables within the LULUCF (e.g., CO_2 emissions or removals from drainage of wetlands areas are often already included in CRF tables 4.A to 4.F).

For this year, total emissions from this source reached 22.433 kt CO_2 equivalent (tables 6.34, 6.35 and 6.36) that occurred mostly in organic soils and that are mainly reported by UK, Finland, Sweden, Lithuania, Latvia and Iceland.

Table 6. 32 4 LULUCF CO_2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt CO_2 eq.)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	180	141	140	3.5%	-40	-22%	-1	0%
Estonia	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Finland	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
France	224	224	224	5.6%	0	0%	0	0%
Germany	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	180	25	52	1.3%	-129	-71%	26	105%
Ireland	457	504	513	12.7%	56	12%	10	2%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	856	1 288	1 282	31.8%	426	50%	-6	0%
Lithuania	1 848	1 479	1 487	36.9%	-361	-20%	8	1%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0	0	0	0.0%	0	16%	0	0%
Sweden	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
United Kingdom	O,NE,IE,NA	O,NE,IE,NA	O,NE,IE,NA	-	-	-	-	-
EU-27+UK	**3 745**	**3 661**	**3 698**	**92%**	**-47**	**-1%**	**38**	**1%**
Iceland	330	335	336	8.3%	5	2%	0	0%
United Kingdom (KP)	O,NE,IE,NA	O,NE,IE,NA	O,NE,IE,NA	-	-	-	-	-
EU-KP	**4 075**	**3 996**	**4 034**	**100%**	**-41**	**-1%**	**38**	**1%**

Table 6. 33 4 LULUCF N_2O Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	27	24	24	0.4%	-2	-9%	0	0%
Estonia	263	268	268	4.8%	5	2%	0	0%
Finland	2 081	1 953	1 952	35.1%	-129	-6%	-1	0%
France	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Germany	581	589	591	10.6%	10	2%	2	0%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	0	0	0	0.0%	0	239%	0	36%
Ireland	173	271	271	4.9%	98	57%	0	0%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	541	511	507	9.1%	-33	-6%	-4	-1%
Lithuania	34	34	34	0.6%	1	2%	0	0%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	1	1	1	0.0%	0	-3%	0	-1%
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0	0	0	0.0%	0	16%	0	0%
Sweden	1 107	1 113	1 106	19.9%	-1	0%	-7	-1%
United Kingdom	784	808	805	14.5%	21	3%	-3	0%
EU-27+UK	**5 592**	**5 573**	**5 561**	**100%**	**-31**	**-1%**	**-12**	**0%**
Iceland	0	1	1	0.0%	1	596%	0	1%
United Kingdom (KP)	785	809	806	14.5%	21	3%	-3	0%
EU-KP	**5 593**	**5 575**	**5 563**	**100%**	**-30**	**-1%**	**-12**	**0%**

Table 6. 34 4 LULUCF CH_4 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (kt CO_2 eq.)

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	24	24	24	0.2%	0	0%	0	0%
Belgium	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Bulgaria	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Denmark	262	237	238	1.9%	-24	-9%	1	1%
Estonia	64	66	66	0.5%	2	3%	0	0%
Finland	1 529	764	763	5.9%	-766	-50%	-1	0%
France	10	10	10	0.1%	0	0%	0	0%
Germany	1 386	1 791	1 806	14.1%	420	30%	15	1%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Ireland	365	511	539	4.2%	174	48%	28	6%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	530	757	771	6.0%	241	45%	14	2%
Lithuania	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	0	NO	NO	-	0	-100%	-	-
Netherlands	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO,NA	NO,NA	NO,NA	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0	0	0	0.0%	0	16%	0	0%
Sweden	461	445	441	3.4%	-21	-4%	-4	-1%
United Kingdom	4 724	4 807	4 820	37.5%	96	2%	13	0%
EU-27+UK	**9 356**	**9 412**	**9 478**	**74%**	**122**	**1%**	**66**	**1%**
Iceland	3 439	3 357	3 357	26.2%	-82	-2%	0	0%
United Kingdom (KP)	4 725	4 808	4 821	37.6%	96	2%	13	0%
EU-KP	**12 796**	**12 770**	**12 836**	**100%**	**40**	**0%**	**67**	**1%**

6.2.7.3 Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils (CRF Table 4(III))

Under CRF table 4(III), direct nitrous oxide emissions from nitrogen mineralization associated with loss of soil organic matter resulting from change of land use or management of mineral soils are reported by almost all countries. This indicates significant efforts devoted by countries to increase the completeness of reporting for this source of emissions during the last years.

For this year, net emissions from this source category reached 7.606 kt CO_2 equivalent, which represent a decrease of 4% as compared to 1990. Significant emissions under this category are reported by France, Germany, Romania, Poland and UK (Table 6. 35) and in most of the cases they were estimated using IPCC methodologies and default emissions factors.

Table 6. 35 Direct nitrous oxide (N_2O) emissions from nitrogen (N) mineralization/immobilization associated with loss/gain of soil organic matter resulting from change of land use or management of mineral soils (kt CO_2eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	127	132	134	1.8%	7	5%	2	1%
Belgium	5	97	96	1.3%	90	1673%	-1	-1%
Bulgaria	290	215	214	2.8%	-76	-26%	0	0%
Croatia	47	121	121	1.6%	74	156%	0	0%
Cyprus	NE,NO	NO,NE	NO,NE	-	-	-	-	-
Czechia	9	2	2	0.0%	-7	-74%	0	0%
Denmark	44	21	23	0.3%	-21	-47%	3	13%
Estonia	0	24	25	0.3%	25	201428%	0	2%
Finland	27	30	29	0.4%	2	8%	-1	-5%
France	2 214	1 985	1 985	26.1%	-229	-10%	0	0%
Germany	314	738	751	9.9%	436	139%	13	2%
Greece	1	14	14	0.2%	13	980%	0	-1%
Hungary	22	29	27	0.4%	6	27%	-2	-7%
Ireland	18	189	179	2.3%	160	877%	-10	-5%
Italy	578	442	377	5.0%	-201	-35%	-65	-15%
Latvia	2	106	112	1.5%	109	4893%	5	5%
Lithuania	74	123	121	1.6%	47	64%	-2	-2%
Luxembourg	7	6	6	0.1%	-1	-7%	0	0%
Malta	0	0	0	0.0%	0	-26%	0	-4%
Netherlands	109	90	90	1.2%	-19	-17%	0	0%
Poland	1 856	1 934	1 936	25.45%	80	4%	2	0%
Portugal	507	298	290	3.8%	-218	-43%	-9	-3%
Romania	39	24	24	0.3%	-15	-38%	0	1%
Slovakia	111	22	21	0.3%	-89	-81%	-1	-6%
Slovenia	62	30	28	0.4%	-33	-54%	-2	-6%
Spain	83	118	105	1.4%	22	27%	-12	-11%
Sweden	43	129	128	1.7%	85	200%	-1	-1%
United Kingdom	1 338	760	762	10.0%	-576	-43%	2	0%
EU-27+UK	**7 927**	**7 681**	**7 600**	**100%**	**-327**	**-4%**	**-81**	**-1.1%**
Iceland	0	0	0	0.0%	0	93%	0	0%
United Kingdom (KP)	1 339	766	768	10.1%	-571	-43%	2	0%
EU-KP	**7 929**	**7 687**	**7 606**	**100%**	**-322**	**-4%**	**-81**	**-1.1%**

6.2.7.4 Indirect nitrous oxide (N_2O) emissions from managed soils (CRF Table 4(IV))

This category covers indirect N_2O emissions from managed soils. Under certain conditions and land use categories, these emissions can be reported under Agriculture sector. Examples of such cases are emissions associated with the addition on nitrogen inputs on Cropland and Grassland or with the mineralization of nitrogen associated with loss of soil organic matter resulting from change of land use or management on mineral soils in Cropland remaining Cropland. Moreover, if the sources of nitrogen cannot be separated in any other way than between cropland and grassland, these emissions were reported under the Agriculture sector.

Therefore, given that according to the CRF table 4 (I) most of the fertilizer are added in Cropland and Grassland areas, and that direct nitrogen emissions are mostly reported so far under Cropland remaining Cropland, an important number of countries have reported in the CRF table 4(IV) the notation key IE (i.e., included elsewhere).

Nevertheless, the completeness reporting of these emissions has also undergone a significant increase in the last year submission following recommendations provided during the EU QA/QC checks.

For this inventory year, indirect N_2O emissions reported under LULUCF reached 953 kt CO_2 equivalent (Table 6. 36). These emissions are mainly reported by France, UK and Germany. Others MS have provided for first time also minor quantities of indirect N_2O emissions.

Table 6. 36 Indirect nitrous oxide (N_2O) emissions from managed soils (kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	14	15	15	1.6%	1	5%	0	1%
Belgium	1	22	21	2.2%	20	1659%	0	-1%
Bulgaria	65	48	48	5.1%	-17	-26%	0	0%
Croatia	IE	IE	IE	-	-	-	-	-
Cyprus	NE	NE	NE	-	-	-	-	-
Czechia	2	1	1	0.1%	-1	-74%	0	0%
Denmark	IE	IE	IE	-	-	-	-	-
Estonia	0	5	6	0.6%	6	201428%	0	2%
Finland	2	2	2	0.2%	0	7%	0	-8%
France	498	447	447	46.9%	-52	-10%	0	0%
Germany	71	166	169	17.7%	98	139%	3	2%
Greece	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Hungary	3	5	4	0.4%	1	33%	0	-9%
Ireland	IE	IE	IE	-	-	-	-	-
Italy	16	18	3	0.3%	-13	-80%	-15	-82%
Latvia	IE,NA	2	3	0.3%	3	∞	0	5%
Lithuania	17	28	27	2.9%	11	64%	-1	-2%
Luxembourg	5	3	3	0.3%	-1	-29%	0	0%
Malta	IE	IE	IE	-	-	-	-	-
Netherlands	IE	IE	IE	-	-	-	-	-
Poland	IE	IE	IE	-	-	-	-	-
Portugal	20	10	11	1.2%	-9	-45%	2	18%
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	15	5	5	0.5%	-10	-67%	0	-1%
Slovenia	14	7	7	0.7%	-8	-54%	0	-6%
Spain	3	4	4	0.4%	1	27%	0	-11%
Sweden	8	4	5	0.5%	-3	-38%	1	17%
United Kingdom	305	171	172	18.0%	-134	-44%	0	0%
EU-27+UK	**1 060**	**963**	**952**	**100%**	**-108**	**-10%**	**-11**	**-1%**
Iceland	IE	IE	IE	-	-	-	-	-
United Kingdom (KP)	305	171	172	18.0%	-134	-44%	0	0%
EU-KP	**1 060**	**963**	**952**	**100%**	**-108**	**-10%**	**-11**	**-1%**

6.2.7.5 CO_2, CH_4 & N_2O emissions from Biomass Burning (CRF Table 4(V))

This source category covers CO_2, and non- CO_2 emissions from biomass burning because of wildfires and controlled burning, affecting all land use categories.

Following the IPCC approach, many countries that implement the stock-different method to estimate carbon stock changes in forest living biomass use the notation key IE in the CRF table 4(V), so avoiding double counting of CO_2 emissions. In addition, countries have also used the notation keys NO or NA when wildfires or controlled burning have not taken place under certain categories, or NE for those land use categories for which the IPCC does not provide methods. An example is the reporting of emissions from biomass burning in Settlement (e.g., Estonia).

In general, countries informed that controlled burning on managed lands is not a common practice. With few exceptions for confined areas that are reported by Finland, Sweden, and UK in forest lands and, Spain and UK in grasslands. In general, northern countries report generally low emissions from biomass burning (i.e., controlled burning and wildfires).

Methodologies used to report CO_2 emissions from fires are always based on Tier 2 methods by using information on activity data provided by national statistics and country-specific emission factors. By contrary, Tier 1 methodologies are used for estimation of CH_4 and N_2O emissions resulting from fires.

Overall, emissions from biomass burning decreased in 2020 compared to 1990, reaching in this inventory year 6.354 kt CO_2 equivalent (Table 6. 37, Table 6. 38 and Table 6. 39). However, emissions from biomass burning do not show a clear trend since their occurrence is in many case beyond the control of the countries. In Mediterranean territories the occurrence of wildfires in certain years result in enormous GHG emissions that are clearly identified in the trend of the LULUCF sector.

Overall, this source of emissions presents a very variable trend and interannual variability that is related to several factors, in many cases driven by climate conditions. It is well known that the countries that often report the larger quantities of emissions from biomass burning are Italy, France, Spain, and Greece. However, it is remarkable that during the last years more central and northern countries are also reporting significant number of emissions from this source (e.g., Ireland, Germany) as a result of the impact of wildfires in their territories.

Table 6. 37 CO_2 emissions from Biomass Burning (in kt CO_2)

Member State	CO2 Emissions in kt			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2	%	kt CO2	%
Austria	NO,IE	NO,IE	2	0.1%	2	∞	2	∞
Belgium	NO,NE,IE	NO	NO	-	-	-	-	-
Bulgaria	NO,IE	NO,IE	NO,IE	-	-	-	-	-
Croatia	15	31	388	9.9%	373	2487%	356	1139%
Cyprus	0	5	6	0.2%	5	1120%	1	22%
Czechia	16	62	58	1.5%	42	260%	-4	-7%
Denmark	IE,NA	IE,NA	IE,NA	-	-	-	-	-
Estonia	NO,NE,IE	NO,NE,IE	NO,NE,IE	-	-	-	-	-
Finland	0	NE,IE,NA	0	0.0%	0	-96%	0	∞
France	1 881	635	456	11.7%	-1 425	-76%	-179	-28%
Germany	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Greece	146	65	26	0.7%	-121	-82%	-39	-60%
Hungary	NO,IE,NA	NO,IE,NA	NO,IE,NA	-	-	-	-	-
Ireland	510	157	183	4.7%	-328	-64%	26	16%
Italy	5 072	668	862	22.1%	-4 210	-83%	193	29%
Latvia	24	117	43	1.1%	19	77%	-73	-63%
Lithuania	1	3	1	0.0%	0	-19%	-2	-62%
Luxembourg	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	5	7	7	0.2%	2	38%	0	1%
Poland	107	41	15	0.4%	-92	-86%	-26	-64%
Portugal	1 723	483	910	23.3%	-813	-47%	427	88%
Romania	9	51	106	2.7%	97	1031%	55	107%
Slovakia	43	125	128	3.3%	86	202%	3	2%
Slovenia	35	7	7	0.2%	-28	-80%	0	2%
Spain	843	36	83	2.1%	-761	-90%	47	129%
Sweden	NO,IE	NO,IE	NO,IE	-	-	-	-	-
United Kingdom	108	976	618	15.8%	510	472%	-358	-37%
EU-27+UK	**10 540**	**3 469**	**3 898**	**100%**	**-6 642**	**-63%**	**429**	**12%**
Iceland	IE,NA	IE,NA	0	0.0%	0	∞	0	∞
United Kingdom (KP)	112	979	621	15.9%	509	456%	-358	-37%
EU-KP	**10 544**	**3 471**	**3 901**	**100%**	**-6 643**	**-63%**	**429**	**12%**

Table 6. 38 CH_4 emissions from Biomass Burning (in kt CO_2 eq.)

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0	0	0	0.0%	0	-48%	0	153%
Belgium	0	NO	NO	-	0	-100%	-	-
Bulgaria	2	13	12	0.7%	10	405%	-1	-8%
Croatia	1	3	33	1.9%	31	2544%	30	1072%
Cyprus	0	1	1	0.0%	1	1120%	0	22%
Czechia	51	28	30	1.8%	-21	-41%	2	7%
Denmark	1	0	0	0.0%	-1	-100%	0	-99%
Estonia	0	0	0	0.0%	0	0%	0	189%
Finland	3	1	2	0.1%	0	-16%	2	218%
France	922	909	877	51.8%	-45	-5%	-32	-3%
Germany	7	13	2	0.1%	-5	-73%	-11	-86%
Greece	63	78	19	1.1%	-44	-70%	-59	-76%
Hungary	23	16	11	0.6%	-12	-52%	-5	-33%
Ireland	91	29	29	1.7%	-62	-68%	0	1%
Italy	1 286	203	263	15.5%	-1 023	-80%	60	29%
Latvia	25	19	12	0.7%	-14	-54%	-7	-38%
Lithuania	3	1	0	0.0%	-3	-88%	-1	-68%
Luxembourg	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	40%	0	1%
Poland	49	25	19	1.1%	-30	-61%	-6	-23%
Portugal	300	98	158	9.3%	-141	-47%	60	61%
Romania	1	4	8	0.5%	7	1031%	4	107%
Slovakia	10	25	22	1.3%	12	120%	-2	-10%
Slovenia	3	1	1	0.0%	-2	-80%	0	2%
Spain	314	54	136	8.0%	-178	-57%	82	152%
Sweden	2	3	2	0.1%	0	-21%	-1	-44%
United Kingdom	17	94	55	3.3%	38	220%	-38	-41%
EU-27+UK	**3 174**	**1 616**	**1 692**	**100%**	**-1 482**	**-47%**	**76**	**5%**
Iceland	IE,NA	IE,NA	0	0.0%	0	∞	0	∞
United Kingdom (KP)	18	95	56	3.3%	38	206%	-38	-41%
EU-KP	**3 175**	**1 617**	**1 693**	**100%**	**-1 482**	**-47%**	**76**	**5%**

Table 6. 39 N_2O emissions from Biomass Burning (in kt CO_2 eq.)

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0	0	0	0.0%	0	-58%	0	104%
Belgium	0	NO	NO	-	0	-100%	-	-
Bulgaria	2	9	8	1.1%	6	405%	-1	-8%
Croatia	1	2	23	3.0%	22	2576%	21	1038%
Cyprus	0	0	0	0.0%	0	1120%	0	22%
Czechia	33	18	20	2.6%	-14	-41%	1	7%
Denmark	0	0	0	0.0%	0	-100%	0	-99%
Estonia	0	0	0	0.0%	0	315%	0	1091%
Finland	2	1	2	0.2%	0	-16%	1	216%
France	514	436	418	55.1%	-95	-19%	-17	-4%
Germany	4	9	1	0.2%	-3	-73%	-8	-86%
Greece	5	6	2	0.2%	-4	-70%	-5	-76%
Hungary	15	11	7	1.0%	-7	-50%	-4	-35%
Ireland	25	8	7	0.9%	-18	-71%	-1	-14%
Italy	261	35	45	5.9%	-217	-83%	10	29%
Latvia	3	2	1	0.2%	-2	-52%	-1	-40%
Lithuania	3	1	0	0.0%	-3	-90%	-1	-68%
Luxembourg	NO,NE	NO,NE	NO,NE	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	39%	0	1%
Poland	32	16	13	1.7%	-20	-61%	-4	-23%
Portugal	49	16	26	3.4%	-23	-47%	10	61%
Romania	0	3	5	0.7%	5	1031%	3	107%
Slovakia	7	16	15	1.9%	8	120%	-2	-10%
Slovenia	2	0	0	0.0%	-1	-80%	0	2%
Spain	285	52	126	16.6%	-159	-56%	74	142%
Sweden	0	0	0	0.0%	0	-21%	0	-44%
United Kingdom	15	67	39	5.1%	24	160%	-28	-42%
EU-27+UK	**1 260**	**710**	**759**	**100%**	**-501**	**-40%**	**49**	**7%**
Iceland	IE,NA	IE,NA	0	0.0%	0	∞	0	∞
United Kingdom (KP)	16	68	40	5.3%	24	150%	-28	-41%
EU-KP	**1 261**	**711**	**760**	**100%**	**-501**	**-40%**	**49**	**7%**

6.2.8 Emissions from organic soils in the EU GHG inventory

Area of organic soils reported by EU MS, UK and ISL under the three main land use categories (i.e., Forest land, Cropland and Grassland) cover about 20.300 kha that are mainly located in northern countries.

Total CO_2 emissions linked to that area in in the inventory year reached 108.982 kt CO_2 (Table 6. 40), which correspond to an amount of about 40% of total EU net removals from LULUCF. Emissions from organic soils in these land categories decreased as compared with 1990. Finland and Sweden report together more than half of the total area of organic soil in these categories.

Organic soils are an important source of emissions when they are under management practices that disturb the organic matter stored in the soil. In general, emissions from these soils are reported using country-specific values when they represent an important source within the total budget of GHG emissions. In contrast, countries with small areas of organic soil often use default IPCC factors to report emissions from this carbon pool.

Overall, among Forest land, Cropland and Grassland, most of the organic soil area is reported under Forest land, although most of the emissions are due to managed organic soils in Grasslands and Croplands (Table 6. 40).

In Finland, organic soil areas are derived from national forest inventory database and a geo-referenced soil database across all land uses. In Sweden, data is also provided by national forest inventory, combined with Swedish Forest Soil Inventory. Emission factors are derived based on field measurements from systematic monitoring system.

Organic soils in Forest land show the lowest values of implied emission factors due to the fact that not the entire area of organic soils under forest land is drained.

Table 6. 40 Area, CO_2 emissions and maximum and minimum value of implied C stock change factors in the EU MS, UK and Iceland reported for the year 2020 for organic soils.

Land use subcategory	Area (Kha)	ICECF (tC/ha)	Emissions from Org. Soils. (Kt CO_2)
4A1	12 554	[-2.65; -0.004]	15 150
4A2	435		2 035
4B1	1 250	[-10.00; -7.90]	29 808
4B2	268		6 079
4C1	5 445	[-7,30; -6,10]	50 098
4C2	335		5 811

6.3 Uncertainties

For the year 2020, LULUCF uncertainty was estimated in 23.7 % for the uncertainty of the level and 9.8 % for the uncertainty of the trend (0).

For more information on the uncertainty analysis please refer to chapter 1.6.

Table 6. 41 Level and trend uncertainty assessment of the annual EU-KP emission/removal on LULUCF land subcategories and GHG sources.

Source category	Gas	Emissions Base Year	Emissions 2020	Emission trends Base Year-2020	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
4.A Forest Land	CO2	-328 070	-309 104	-5.8%	2.1%	3.0%
4.A Forest Land	CH4	1 957	1 628	-16.8%	86.0%	23.2%
4.A Forest Land	N2O	3 828	3 660	-4.4%	80.7%	3.5%
4.B Cropland	CO2	76 254	51 372	-32.6%	38.6%	3.9%
4.B Cropland	CH4	1 001	835	-16.6%	51.2%	11.6%
4.B Cropland	N2O	3 059	2 509	-18.0%	88.5%	21.0%
4.C Grasland	CO2	27 490	8 241	-70.0%	191.0%	46.7%
4.C Grasland	CH4	4 326	3 838	-11.3%	100.2%	8.5%
4.C Grasland	N2O	698	358	-48.6%	76.6%	19.2%
4.D Wetlands	CO2	7 574	12 059	59.2%	60.2%	21.3%
4.D Wetlands	CH4	2 355	2 834	20.3%	36.6%	9.1%
4.D Wetlands	N2O	87	112	29.3%	67.4%	20.2%
4.E Settlements	CO2	34 120	36 845	8.0%	34.3%	6.3%
4.E Settlements	CH4	101	139	38.3%	61.5%	14.7%
4.E Settlements	N2O	3 394	3 614	6.5%	94.1%	10.3%
4.F Other Land	CO2	2 514	-204	-108.1%	490.6%	58.6%
4.F Other Land	CH4	137	71	-48.0%	10.7%	5.1%
4.F Other Land	N2O	24	56	138.4%	64.1%	137.7%
4.G Harvested wood products	CO2	-23 943	-28 866	20.6%	0.4%	4.9%
4.G Harvested wood products	CH4	0	0	0.0%	0.0%	0.0%
4.G Harvested wood products	N2O	0	0	0.0%	0.0%	0.0%
4.H Other	CO2	0	40	Inf	30.4%	Inf
4.H Other	CH4	0	218	Inf	100.0%	Inf
4.H Other	N2O	0	0	0.0%	0.0%	0.0%
4.I	CO2	0	0	0.0%	0.0%	0.0%
4.I	CH4	0	0	0.0%	0.0%	0.0%
4.I	N2O	21	38	85.5%	198.0%	169.3%
4.II	CO2	2 358	1 963	-16.7%	46.8%	8.7%
4.II	CH4	5 230	4 359	-16.7%	181.5%	17.9%
4.II	N2O	2 142	2 012	-6.1%	112.4%	6.9%
4.III	CO2	0	0	0.0%	0.0%	0.0%
4.III	CH4	0	0	0.0%	0.0%	0.0%
4.III	N2O	228	194	-15.0%	79.8%	30.4%
4.IV	CO2	0	0	0.0%	0.0%	0.0%
4.IV	CH4	0	0	0.0%	0.0%	0.0%
4.IV	N2O	355	223	-37.2%	104.5%	44.8%
4.V	CO2	57	516	797.3%	66.6%	460.6%
4.V	CH4	15	57	278.7%	57.2%	196.9%
4.V	N2O	10	39	296.5%	59.2%	214.4%
4 (where no subsector data were submitted)	*all*	*-18 080*	*-16 405*	-9.3%	*61.7%*	*46.1%*
Total - 4	**all**	**-190 759**	**-216 749**	**13.6%**	**23.7%**	**9.8%**

6.4 Sector-specific quality assurance and quality control and verification

6.4.1 Time series consistency

The EU greenhouse gas inventory is compiled rigorously by aggregation of national inventories; thus, its consistency strictly depends on the consistency of the individual inventories.

The time-series consistency is checked every year for each individual submission as part of the quality control procedures implemented under the EU GHG Monitoring Mechanism Regulation[54]. Consistency is checked, in terms of each land use subcategory, and the overall land representation system, across time and space. Ensuring for instance, that the sum of all land use areas is constant over time and matches the official country area. Moreover, there are no circumstances that can justify discontinuities of areas across years. Therefore, the area for each land use category, and KP activity, at the end of one year must be the same as the area at the beginning of the next year.

For the sake of consistency, all parameters used to estimate GHG fluxes are checked. In this sense, activity data, implied carbon stock change factors, and emissions or removals reported for each land use subcategory across the years of the time series are checked to discard errors, identify outliers and to ensure the plausibility of their trends.

Countries provide early submissions to the European Commission (EC) that undergo quality control procedures. As regards with LULUCF and KP-LULUCF information these control checks are implemented by the JRC[55] and aim to ensure the consistency and completeness of the information. But also, to increase the accuracy, transparency, and comparability of the inventories. For each potential issue identified during this phase, a dialogue is established with the country to discuss the best way to resolve the issue, if any.

One of the key features of the methodologies implemented by national systems is to ensure full consistency in definitions, parameters and datasets used for preparing the entire time series for the LULUCF sector. The main challenge is to ensure consistency when historical data are not fully adequate to fulfill reporting requirements or when data is not available on an annual basis.

Land use definitions are not identical among countries. As shown in the previous chapters, each country has its own definition according with its land representation and data collection systems. However, they all are in accordance with IPCC definitions. Differences are caused by small variations in the treatment of particular lands and are in many cases related to historical definitions and available datasets. Some examples are the different thresholds used to define forest; the categorization of hedges or bush areas under Cropland, Grassland or Forest land; or the inclusion of woody plantations either under Cropland or Forest land.

After years implementing QA/QC procedures, and undoubtedly because of the efforts devoted by countries to overcome identified issues, and to improve their inventories in line with the IPCC methods and UNFCCC reporting guidelines, it is undeniable that EU LULUCF information has shown significant improvements during the last years.

Moreover, during the recent years the EC and MS have put in place projects to improve the LULUCF information, and currently better data is available to further improve the land representation system and the estimation of carbon stock changes and other GHG emissions. These improvements are also visible in the recalculations implemented every year by the countries.

6.4.2 Quality Assurance and Quality Control

Information submitted under the LULUCF sector by EU MS, UK and Iceland are under a double QA/QC system. One implemented at country level, and another one, carried out in the context of the EU GHG Monitoring Mechanism Regulation (MMR), which is performed for this sector by the Joint Research Centre (JRC) of the European Commission in collaboration with the

[54] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0525

[55] https://joint-research-centre.ec.europa.eu/jrc-sites-across-europe/jrc-ispra-italy_en

countries, the EEA, DG CLIMA and European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM)

Under the MMR, the checks focus on early versions of national GHG inventories that are submitted by 15th January. The checks aim to assess and improve the completeness and consistency, but also the accuracy, transparency, and to the extent possible the comparability of the inventories. A second round of submissions received in March is also checked in terms of the implementation status of issues previously identified and the reasons for recalculations among the January and March submission.

Ultimately, the checks are intended to identify and resolve calculation errors, to provide suggestions to address completeness issues, to identify the need for further information and to amend the lack of transparency, and to spot outliers on time-series that hamper the consistency, and to identify discrepancies among data included on the different sections of the submission. In all the cases, QA/QC procedures are implemented by interacting with national experts to get clarifications and to plan possible improvements.

During the analysis of this year submissions, around 140 findings (i.e., potential issues) were communicated to the countries. Examples of issues include the use and justifications of notations keys, potential inconsistencies in land representation, wrong interpretation of how to fill in the tables, inconsistent reporting of activity data among CRF tables and between CRF tables and NIR, outliers in IEFs values for different categories, and lack of transparency in specific national circumstances that affected the EU trend.

The following list aims to provide an overview of the checks that are implemented on the LULUCF and KP-LULUCF data submitted by countries, but it does not intend to represent an exhaustive description of the checks

1. Completeness check: the use of any notation key “NE”, but also possible inappropriate use of “NA”, “NO”, “IE”, whenever IPCC methods are available, is monitored and followed up with the relevant countries. Furthermore, the check also aims to identify empty cells that should have been filled in with information.
2. Time-series check of activity data information:
    a. The sum of areas reported for each land use category is constant over time.
    b. The feasibility of the time series of area and land use changes occurring in a single year.
    c. The area at the end of the previous year (t-1) matches the area at the beginning of the current year (t).
    d. Check to ensure that only annual land use changes from one year to another are reported in the CRF table 4.1.
3. Time-series check of emissions/removals and implied carbon stock change factors (ICSCF):
    a. Check the feasibility of potential discontinuities in ICSCF and emissions or removals.
    b. Check for outliers in ICSCF and emissions or removals.
    c. Check the coherence of emissions and removals with activity data.
    d. Check the plausibility of constant values of emissions and removals across years.
4. Check the consistency of areas reported across different CRF tables:
    a. The sum of total area reported under the CRF table 4.1 matches the total area reported under the CRF table NIR-2 (using the cell “Other”).
    b. The area reported for each land use category in CRF table 4.1 matches the area reported under the sectorial background data tables (i.e. 4.A-4.F). (**To note**: Despite this check and the recommendation provided by the EU in the context of the QAQC procedures to ensure the consistency among tables, following a recommendation from the 2016 ERT, Estonia is not reporting unmanaged wetlands under “other wetlands” in the CRF table 4.D; however, those areas are included in CRF 4.1. This leads to an

inconsistency among the information of these tables that is directly translated to the LULUCF sector of the EU GHG inventory.

   c. The area reported for each KP activity in CRF NIR-2 matches the area reported under the sectorial background data tables (i.e. 4(KP-I) A.1- 4(KP-I) B-5).

5. Check the consistency among LULUCF and Agriculture: Histosols areas reported in Agriculture are equal or less than organic soils areas reported in Cropland plus Grassland (N.B.: organic soils areas for non-cultivated grasslands (no matter whether considered managed or unmanaged) are reported in LULUCF sector but not in Agriculture)
6. Additional checks implemented on LULUCF and KP-LULUCF information:
   a. Check that adequate information on recalculations is included in the NIR.
   b. Check that FMRL value matches the value inscribed in the appendix to the annex of decision 2/CMP.7.
   c. Check that the Cap value is included in the CRF “accounting” table and that, in line with Decision 6/CMP9, matches the value included in the report submitted to facilitate the calculation of a Party’s assigned amount for the second commitment period, considering any corrections or adjustments made during the review process of that report.
   d. Check that information on key category analysis is provided. (**To note:** some MS have stated that bugs in the CRF Reporter software prevent the inclusion of this information on the CRF table NIR-3)
   e. Check that unresolved and partially resolved issues from previous year are addressed.
   f. Check that ERT team’s recommendation that concern country ‘submissions are addressed.
   g. Check that HWP information on LULUCF is complete and properly allocated under the correct approach.
   h. Check the coherence among units and activity data used for reporting Biomass burning in CRF table 4(V)

In addition to the routine implementation of QA/QC checks, some additional activities have been implemented during the past years that were meant to improve the quality of both national, and EU GHG inventories, as follows:

- In 2012 an exercise was carried out involving LULUCF reviewers that participate in the UNFCCC review process to assess the reporting of dead organic matter and soils and identify common issues and alternative solutions. Some decision trees were created and shared with inventory compilers. (E.g. is the “not a source” provision properly applied?)
- In 2014 and 2015 two assessments were carried out to verify data on burned areas reported by individual GHG inventories and those reported in EFFIS[56].
- The JRC have collaborated during the past years, and continues to do so, on several capacity building projects launched by DG CLIMA to support the LULUCF reporting on MS.

Furthermore, with the purpose of enhancing the LULUCF reporting, sharing experiences amongst countries, and the harmonization of methods for estimating GHG emissions and CO_2 removals in the sector, a series of technical workshops dedicated to UNFCCC reporting (including Kyoto Protocol), under the auspices of the Joint Research Centre have been organized.

- JRC virtual technical workshop: LULUCF in transition: present and future challenges for reporting and accounting 7-8 June 2021
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol 28-29 May 2019, Varese (VA), Italy.

[56] http://forest.jrc.ec.europa.eu/effis/

- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 16-17 May 2018 Arona (NO), Italy
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 April 2017 Stresa (NO), Italy
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 02-03 May 2016 Stresa (NO), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 26-27 May 2015 Arona (NO), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 05-07 May 2014, Arona (NO), Italy.
- II JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 04-06 November 2013, Arona (NO), Italy.
- JRC technical workshop on LULUCF reporting under the Kyoto Protocol, 27 February-1 March 2013, Ispra (VA), Italy.
- “JRC technical workshop on LULUCF issues under the Kyoto Protocol”, held in Brussels, November 21, 2011.
- “JRC technical workshop on LULUCF issues under the Kyoto Protocol”, held in Brussels, November 9-10, 2010.
- Technical workshop on projections of GHG emissions and removals in the LULUCF sector, Ispra (VA), Italy. 27-28 January 2010.
- Technical workshop on LULUCF reporting issues under the Kyoto Protocol, Ispra (VA), Italy. November 13-14, 2008.
- “Technical meeting on specific forestry issues related to reporting and accounting under the Kyoto Protocol” Ispra (VA), Italy. 27-29 November 2006).
- “Improving the Quality of Community GHG Inventories and Projections for the LULUCF Sector”. Ispra (VA), Italy. September 22-23, 2005.

For further information on these workshops and additional activities see:
http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/.

6.4.3 Verification

Relatively little information on verification is included in national GHG inventories. For forest land, the JRC has implemented the Carbon Budget Model (CBM), a forest growth model developed by the Canadian Forest Service and adapted to the EU conditions (Pilli et al. 2014[57], Pilli et al. 2016[58],[59]), to estimate carbon stock changes in all forest carbon pools for 26 MS (all EU countries except Malta and Cyprus, and the UK). Overall, at EU level, the results from CBM were very close to the sum of individual inventories (a difference of only 3% for the average sink 2000-2015 in the category “forest land remaining forest land”). However, for few MS the differences were larger and deserve further investigations. The results of this modeling have been offered to MS as a potential verification exercise (see Bulgaria’s NIR); in some cases the comparison of model results with GHG inventories resulted in identifying errors in the GHG inventory. It is expected that more comparisons of national GHG inventories with CBM results will be carried out in coming years.

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[57] Pilli R., Grassi G., Kurz W.A., Smyth C.E. and Blujdea V. (2013). Application of the CBM-CFS model to estimate Italy’s forest carbon budget, 1995 to 2020. Ecological modelling. 266, 144-171.

[58] Pilli, R., Grassi, G., Kurz, W., Abad Viñas, R., Guerrero Hue, N. (2016) Modelling forest carbon stock changes as affected by harvest and natural disturbances. I. Comparison with countries’ estimates for forest management. Carbon Balance and Management vol. 11 no. 1 p. 5. doi: 10.1186/s13021-016-0047-8

[59] Pilli, R., Grassi, G., Kurz, W., Moris, J., Abad Viñas, R. (2016) Modelling forest carbon stock changes as affected by harvest and natural disturbances. II. EU-level analysis Carbon Balance and Management vol. 11 no. 1 p. 20. doi:10.1186/s13021-016-0059-4

Besides that, a comprehensive analysis of individual submissions has been also carried out in 2015[60]. In this context, some inconsistencies were found that were communicated to concerned country during the 2016 QA/QC process. Finally, the JRC recommended to national LULUCF experts to verify, where available data allow, the gain-loss methodology applied for estimating their forest land with an alternative estimate prepared by applying the stock-difference method, and vice versa.

6.4.4 Improvement status and plan

6.4.4.1 Improvements and major changes introduced in this chapter from previous submissions

For this year submission, a revision of the entire chapter has been carried out by a person not involved in the compilation of the information.

The following improvements have been introduced in the GHG inventory submission 2022 to address recommendations received from the UNFCCC's expert review team (ERT), to correct issues identified during our internal quality control process, and/or to introduce developments identified during our internal peer review:

- More information has been provided to enhance the transparency on how the EU, in collaboration with countries, works to address issues identified by the UN´s ERT. For instance, the EU GHG inventory provides now explicit information on the reporting of the category 4.B.2 by Portugal, and France with the intention to explain the rationale of the use of the notation key. (Section 6.2.2.3)
- New and better explanations, when necessary, on the reasons for changes in trends and inter-annual variability of the emissions and removals across the lands use categories have been added in specific land use sections.
- Correction of identified typo errors that were found across the chapter.
- New template for some tables has been used in this submission (see for instance table 6.10).
- New design has been used for figure 6.2 in this submission.
- Following the recommendation of the ERT the EU requested to the countries the use of the notation key NA for carbon pools considered in balance or equilibrium. MS agreed with the use of this NK, with the exception of those countries that have received different recommendation from their own ERT, and have changed accordingly their inventories. ***(EU ARR 2020/L.5).***
- The further correction of inconsistencies identified across the activity data reported in CRF tables 4.1 and 4.A-4.F. The EU has been working during the last years with its MSs in order to address this issue. As a result, in this submission differences on areas between these tables is for each of the land use categories reduced to less than 10 kha, which has an insignificant impact in the EU GHG inventory in terms of emissions and removals. Also, because in most of the cases the differences for the land use category area are less than 1 Kha. An exception is the reporting of Wetlands due to the reporting of Estonia that follows a different recommendation from its UN ERT. (See section 6.4.2) ***(EU ARR 2020/L.4).***
- The improvement plan of Portugal for the reporting of the category 4.F has been tracked and information accordingly included in the land use category section.
- As every year the EU LULUCF inventory has increased its completeness and improve the accuracy as a result of the efforts implemented by MS to improve the LULUCF information, as well as the support provided to the countries by the EU. Notable examples in this submission are: (I) Czechia implemented this year a new tier 3 method for estimating carbon stock changes in forest land, (ii) Malta reports for first time emissions/removals from forest land. However, these are just some examples for this year but the recommendation of *"Work with the member States to improve the completeness of their reporting and use higher-tier methods in order to*

[60] Viorel NB Blujdea, Raúl Abad Viñas, Sandro Federici & Giacomo Grassi (2016): The EU greenhouse gas inventory for the LULUCF sector: I. Overview and comparative analysis of methods used by EU member states, Carbon Management, DOI: 10.1080/17583004.2016.1151504

enhance accuracy" comes from 2012, and since then the EU has worked hard with the MS to address the recommendation of the ERTs, and ultimately to enhance the quality of the LULUCF information to allow a better identification of needs for climate change related policies. ***(EU ARR 2020/L.8).***

- New information has been added in section 6.2.2.3 related to the methods used by Italy and Luxembourg to explain the use of the notation key by these countries and address the recommendation from the UN ERT. ***(EU ARR 2020/L.8).***
- Romania has recalculated its inventory ensuring the consistency of the time series and to enhance the activity data information with the inclusion of spatially explicit information to derive activity data. Along with other improvements (see further details in section 6.5). With this improvement the inconsistency identified by the ERT is no longer reported and the accuracy of the inventory enhanced. ***(EU ARR 2020/L.11 and EU ARR 2020/L.8).***

6.4.4.2 Planned improvements

The following improvements are foreseen for next submission:

- Follow up individual submissions to ensure that the small differences on areas that remain in the reporting of the information in CRF table 4.1 and 4.A - 4.F, that were not resolved this year are addressed.
- Follow up the submission of Portugal to track the planned improvement to be implemented in the reporting of Grassland and Other land (see section 6.2.4.3).
- Continue working with MS to increase the accuracy, and completeness, and reduce uncertainty of the LULUCF information, as far as can be achieved, as part of the continue efforts to achieve a better LULUCF data.

6.5 Sector-specific recalculations, including changes in response of to the review process and impact on emission trend

Table 6. 42 to Table 6. 47 provide information on the contribution of EU MS, UK and ISL to the recalculations in sectors 4A, 4B, 4C, 4D, 4E and 4F (all GHGs) for 1990 and 2019 and main explanations for the largest recalculations in absolute terms.

Table 6. 42 4A Forest Land: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Austria	-	-	1 869	43	The intermediate increment, drain and dead wood results of the NFI 2016/21 for the measurement period 2016 to 2018 were taken to update the time series for the Forest land category for the years since 2009. This caused a reduction on the annual net removals of the Forest land category by 1 868.7 kt CO_2e per year for the time series since 2009 compared to the last submission in 2021.
Belgium	0.2	0.0	-66	-3.5	Wallonia: The changes in carbon stocks since 2013 were updated using a model combined with the forest inventory data. The land-use matrix has been updated. Brussels: Matrix update: 2020 was added National: The emissions of wildfires have been recalculated
Bulgaria	850	4.9	-364	-4.3	Improved estimates of the area of LUC to FL: The changes came as a result of reassement of the afforestation and reforestation areas in relation with the accounting of the KP activities. The racalculations affected mostly the area representation of forest land category and the sub-category of Shrubs and grassland. However, small changes in area representation and land-use changes are present in almost all land categories, which affected also the emissions estimates in all categories. There are also updated information on the carbon stock changes in living biomass and dead wood for the years 2016-2020 due to newly available data on growing stock.
Croatia	326	4.8	93	1.6	In this year submission, some recalculations have been done. Corrections in the emissions from biomass was done. On that basis new calculation was performed. Estimation in LULUCF sector for NIR 2022 has been performed by using the nationally determined value for CS in biomass pool of perennial Cropland instead of using the value prescribed by 2006 GL. This influenced emissions/removals in all land categories where LUC from or to CL occurs. The result of the performed recalculation can be seen in Figure 6.4-3.
Cyprus	8.8	19	25	16	Change of BCEFI (biomass conversion and expansion factor for increment) from 0.645 tC/m3 to the default value 0.450 tC/m3 (Table 6.4.5, p. 4.51, value for Mediterranean, dry tropical and subtropical coniferous forest). Use of interpolated and extrapolated data provided in Table 6.6 to cover the entire period from 1990 to the reported year instead of using an average (0.844 m3/ha/yr) for the entire period (coniferous forest). Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category.
Czechia	-1 851	-32	-4 748	-32	Methodological update; higher Tier method introduced. Since the last submission, the emission estimates were recalculated for the entire category of 4.A Forest land and reporting period. The improvements implemented in this inventory submission are mostly related to upgrading several estimates to Tier 3 approaches by using the nationally calibrated CBM-CFS3 model (Kurz et al. 2009, Kull et al. 2016), abbreviated also as CBM in this document.
Denmark	23	1.8	63	2.4	In this reporting some recalculations have been implemented. In the following some key points are highlighted, mainly affecting afforestation (as also de-scribed in chapter
Estonia	-227	-5.5	181	8.5	The entire time series of activity data is annually recalculated for all areas of land categories and land-use conversions, since new data about land-use transitions is collected every year and new estimates will be integrated into overall activity data. Changes in living biomass C pool compared to the previous submission have resulted from the recalculation of average growing stocks and changes in methodology for Land converted to forest land areas. After the transition to Forest land, average growing stock was assumed to increase at rate of 3.04 m3 ha-1 yr-1. Soil emission factors were updated for Land remaining forest land and Land converted to forest land. Emissions from mineral and organic soils under Forest land remaining forest land have significantly decreased because of updated emission factors.
Finland	0.8	0.0	1 000	3.9	In the LULUCF sector, the areas of all land-use categories were recalculated and hence also all carbon stock changes for which activity data are areas and are computed from the NFI data. New NFI data were applied to estimate the gains in living biomass for forest land remaining forest land. New BCEFs were applied to estimate losses in living biomass on forest land remaining forest land from 2009 onwards. Recalculations in the biomass stocks due to new NFI data caused a recalculation to the litter input to soils. Losses in living biomass on land converted to forest land were recalculated due to new NFI data.

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
France	1 025	2.5	22 023	42	In the 2021 edition of the NIR, the latest National Forest Inventory (IFN) campaign was not available and the values concerning growth and mortality in the forest could not be updated for recent years. For the 2022 edition, the last two IFN campaigns (2014-2018 relative to 2016; 2015-2019 relative to 2017) were taken into account to estimate the years 2016 and 2017. This update has very strong impacts on the forest balance sheet. • Wood energy consumption has been updated to be in line with the energy report (and in particular its Overseas section). • For French Guiana: the forest balance has been adjusted by linking forest damage to harvest data and by including a gradual reduction in the proportion of damage caused. The harvests have been updated by integrating the actual annual harvests.
Germany	2 359	11	4 677	8.1	Update of whole time series due to improved data basis, this concerns: adjustment of the sampling for land use and land use change, changed emission factors for biomass, data correction for dead wood, amendment of emission factors for land use changes (grassland to forest)
Greece	-	-	-453	-26	Activity data were updated regarding afforestation (year 2019) and deforestation (years 2018 -2019). Information on the estimation methodology of biomass burning in grassland remaining grassland were included in the NIR Inconsistencies between final areas in CRF table 4.1 and total areas reported in the background tables 4.A-4.E have been resolved. A section on planned improvements was added to the NIR A reference was added to 9.4.5 to note that Greece does not estimate emissions from HWP in solid waste disposal sites or from wood harvested for energy purposes.
Hungary	165	4.8	764	14	(1)Due to the revision of the area data in the 4.A.1 and 4.A.2 category, all the related emissions in the biomass losses ,deadwood, litter and soil pools were recalculated.(2) Due to the revision of the ratio of the succsessfull initial planting the emission of the biomass gain pool in 4.A.2 was also recalculated.
Ireland	1 108	29	2 435	52	Use of a new Tier 2 emission factor for drained organic soils and application of this EF to all drained productive organic areas. This resulted in an average increase in emissions of 1,102 kt CO_2 emissions per year on average from drained organics soils. Plus sme minor adjustments.
Italy	-0.0	-0.0	900	2.4	Activity data (area) has been updated, based on the NFI outcomes (NFI2015).
Latvia	-0.0	-0.0	-1 062	-22	Recalculations are made due to to improvement of NFI based activity data. Addition 20% of NFI sample plots are surveyed annually, every year acquired cummulative LUC area data is extrapolated to whole country area - recalculations made till all NFI sample plots are suveyed in period of 5 years.
Lithuania	1.9	0.0	153	2.3	Difference in total GHG removals from forest land resulted in adjustment of living biomass carbon stock change in forest land remaining forest land due to the newest growing stock volume data applied - extrapolated values for year 2017 were replaced with actual values. In addition to this, calculation errors in carbon stock changes in living biomass of forest land remaining forest land were corrected as a resulted of additional internal QA/QC procedure.
Luxembourg	294	156	57	15	The LULUCF sector has had some major changes which have led to important changes in emissions and removals for the whole timeseries. The changes were essentially driven by a revised estimation of land use changes. Previous estimation of land use changes was based on spatially explicit data existing for the country, namely the OBS (Occupation Biophysique du Sol) maps for the reference years of 1989, 1999, and 2007, as well as a land use map of 2012, specifically updated for the National Inventory Report. Since then, new and more recent land use and land cover data sets have been produced for the whole Luxembourg for the years 2015 and 2018. In order to integrate those new datasets a new study was commissioned which has led to the recalculations.
Malta	-0.0	100	-0	100	Recalculations for the Forest Land category are found to be unnecessary for this year's submission, since in the previous submission there were no estimates calculated from this category
Netherlands	-402	-20	-412	-22	The new methodology for the estimation of carbon in forest biomass and deadwood results in recalculations of carbon stock changes for biomass and dead wood in land converted to Forest land, Forest land remaining forest land, Forest land converted to other land-use categories (deforestation) and emissions from wildfires along the whole time series from 1990 onwards

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Poland	143	0.4	-5 866	-39	It has be noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO_2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before
Portugal	-	-	-	-	
Romania	5 080	17	1 814	6.8	New L-FL and FL-L conversions areas have been estimated for the all-time series. Much smaller sizes reported for both L-FL and FL-L categories for 2022 submission have driven a decrease in CO_2 stock in the FLFL (i.e., from 3672 kt CO_2 to 2660 kt CO_2 in L-FL and a "transfer" of C loss from deforestation to the FLFL).
Slovakia	-504	-5.9	-546	-12	In the category 4.A, both subcategories 4.A.1 Forest Land remaining Forest Land and 4.A.2 Land converted to Forest Land was recalculated for the whole time period since 1990. The main reason for recalculation in 4.A.1 and 4.A.2 included the calculation of CSC in DW carbon pools following the ERT recommendation. Another reasons of recalculation in 4.A.1 was change and correction of root-to-shoot ratios (using only 0.2 for coniferous and 0.24 for broadleaved; no specific value for oaks following the ERT recommendation.
Slovenia	-20	-0.4	-4 824	-2 066	The total forest area was carefully stratified into forest land remainig forest land and land converted to forest land. Sampling plots of the national forest inventory were assigned to each subcategory, and carbon stocks in the living biomass were recalculated accordingly. Based on the carbon stock changes for the 2007-2012 and 2012-2018 inventory cycles, new emission factors were calculated for each subcategory. Second, following the recommendation of the ERT, the new BCEF factors were used to convert volume to biomass. The BCEF factors were calculated as the product of basic wood density (D) of each tree species and the biomass expansions factors (BEF) dependent on the growing stock using the equations proposed by Teobaldelli et al. (2009). Recalculations in this category were also made due to the inclusion of two carbon pools, litter and dead wood, in the mass of available fuel in relative to emissions from wildfires (biomass burning), as recommended by the ERT.
Spain	-	-	607	1.8	New estimate of the C content of living biomass in category 4A1, due to the incorporation of provincial living biomass data from the fourth National Forest Inventory (IFN4) of Salamanca, Burgos, Segovia and Soria, which involves a recalculation of the period 2003-2019. New data available on subsidized afforestation for the years 2018 and 2019 and non-subsidized afforestation for the years 2016-2019. New fire data available for the year 2019, which replace the average of the last available decade (2009-2018) used in the 2021 edition of the National Inventory (1990-2019 series).
Sweden	270	0.7	958	2.5	Recalculations due to updated NFI data which affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land-use changes may affect estimates for earlier years, especially for categories using area as activity data. recalculations related to extended datasets for litter and soil from the SFSI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series but quantitatively important recalculations are expected because of phasing in new data on carbon stock changes.
United Kingdom	371	2.6	-771	-4.5	Minor changes to activity data based on the latest Forestry Statistics. Modification to calculation of adjustment of reported areas (meeting definition of forest) to stocked areas (treed areas excluding integral open space). Collation of Northern Ireland data now consistent with other nations. Minor change to calculation of water saturation of drained organic soils.
EU27+UK	**9 024**	**2.5**	**18 507**	**5.2**	
Iceland	13	30.6	-44	-9.8	Area dependent sources as removal to litter and soil and emission from drained organic soil have been changed in relation to changes in the area estimate for each category and each year. The C-stock changes in biomass in CF are based on direct stock measurements (Tier 3) as in last year's submission. They are recalculated for 2019 due to new data from NFI measurements in 2021. Estimates of the net gain of biomass

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
					of the natural birch forest are totally revised in this year submission built on new data from the newly conducted NFI (2015-2021) of the natural birch woodland
United Kingdom (KP)	372	2.6	-769	-4.5	see above
EU-KP	**9 038**	**2.5**	**18 464**	**5.2**	

Table 6. 43 4B Cropland: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Austria	119	67.3	188	150.4	The land-use changes between grassland and cropland were assessed by a changed method based on IACS/LPIS data. The land parcel numbers of the digital cadastral map are no more available in the IACS/LPIS system, so the assessment for the whole time series was changed to a grid point survey by using the INSPIRE grid of 100 x 100 m to sample geographic land use information in IACS/LPIS. In addition, the vineyards area trend was harmonized by using just the results of the vineyard surveys since 2009. These area changes had an impact on the emissions/removals of these categories.
Belgium	8	3.3	-189	-23.3	Wallonia: The changes in carbon stocks since 2013 were updated using a model combined with the forest inventory data. The land-use matrix has been updated. Brussels: Matrix update: 2020 was added National: The emissions of wildfires have been recalculated
Bulgaria	57	6.9	12	11.7	Information on organic soils have been reported in CL and GL categories in relation to a recommendation to ensure the consistency between LULUCF and Agriculture sectors.
Croatia	236	106.0	129	28.8	For this reporting Croatia uses revisioned CLC change databases. Changes in Activity data (areas) can result with differences in emissions/removals. Estimation in LULUCF sector for NIR 2022 has been performed by using the nationally determined value for CS in biomass pool of perennial Cropland instead of using the value prescribed by 2006 GL. This influenced emissions/removals in all land categories where LUC from or to CL occurs.
Cyprus	3	2.2	18	11.9	Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category. The correction reflects the implementation of the rule of 20-year transition period to Forest Land.
Czechia	-116	-56.0	-70	-69.9	Since the last submission, the emission estimates related to soil carbon stock changes were recalculated for both the categories 4.B.1 Cropland remaining Cropland and 4.B.2 Land converted to Cropland, due to the revised activity data on soil carbon and emission factors and corrections for subcategory 4.B.2.1 involving conversion from Forest land, respectively. Overall, the estimated emissions decreased by 42% for the entire category 4.B. In 4.B.1, the estimates represent 5% of the previous values, while emissions increase by 2% for 4.B.2 when comparing the identical period (1990-2019).None of the individual emission categories of Cropland qualifies among the key categories by quantity or trend in this inventory submission.
Denmark	348	7.2	176	6.3	An error were found in the cereal/straw relation for winter wheat. The error overestimated the amount of wheat straw and thus the annual C input from biomass to the soils in the modelling. The consequence of lowering the C in-put, mainly the loamy soils where wheat is grown, is that the soils are turned into sources where it is difficult to maintain the current C stock. The overall effect is a larger emissions for all years. This change has been implemented for all years. A minor redistribution of the area with new hedges between 2018 and 2019 has been made.
Estonia	4	0.6	28	8.0	A quantitative overview of recalculations is shown in Table 6.22, except for recalculations of direct N_2O emissions which are presented in Chapter 6.8.5. The entire time series of activity data are annually recalculated for all areas of land categories and land-use conversions since new data about land-use transitions is collected every year and new estimates will be integrated into overall activity data. Also, average growing stocks in Forest land

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
					and Grassland are updated annually, which has resulted in somewhat higher losses in living biomass after land use change to croplands.
Finland	-2	-0.0	-35	-0.4	New area estimates were calculated due to the update of the NFI data (see Section 6.2). This resulted in recalculation for the cropland areas since 2013 and all carbon stock changes were recalculated accordingly (Table 6.5-3). Soil carbon emissions in cropland were recalculated as there was an error in the number of fur animals, which has an effect on the amount of manure derived soil carbon input. Furthermore, manure production of livestock was updated and corresponds to the one used in the Agriculture sector.
France	-2 359	-10.0	-2 466	-17.4	The areas of cultivated histosols have been recalculated and revised downwards, for the grasslands and crops sub-categories. The associated emissions are therefore significantly reduced. • The areas of deforestation in Guyana after 2015 have been recalculated, which slightly impacts the results of land becoming crops from 2016..
Germany	251	1.9	412	2.5	Update of whole time series due to improved data basis, this concerns: adjustment of the sampling for land use and land use change, changed emission factors for biomass, data correction for dead wood, amendment of emission factors for land use changes
Greece	-	-	961	264.6	Activity data were updated regarding afforestation (year 2019) and deforestation (years 2018 -2019). The list of parameters used to estimate carbon loss in living biomass from wildfires was added to section 6.3.2. Information on the estimation methodology of biomass burning in grassland remaining grassland were included in the NIR (6.5.2.1) Inconsistencies between final areas in CRF table 4.1 and total areas reported in the background tables 4.A-4.E have been resolved. A section on planned improvements was added to the NIR (§6.1.6) A reference was added to §9.4.5 to note that Greece does not estimate emissions from HWP in solid waste disposal sites or from wood harvested for energy purposes.
Hungary	0	0.1	84	77.1	There are two main reasons for the recalculations. One is related to that, in preparation for the last year of the second commitment period of the Kyoto Protocol, we wanted to make sure that our estimates are as accurate as possible. For this reason, we continued our work, which was started in 2020, to revise all forest-related data and developed a new calculation system that automates all calculations. This means that the entire time series data are recalculated for each inventory year by MS Excel formulas instead of assessing figures of the current inventory year only and adding them to the former time series as was the case earlier (except for recalculations when the complete time series were recalculated).
Ireland	-121	-596.1	-29	-26.7	The recalculations in 4.B Cropland relate to the refinement of LPIS data. This has led to recalculation of emissions and removals for all years in the reporting period. Figure 6.27 shows a comparison between 2021 and 2022 submissions of estimated total emissions and removals associated with Croplands. The difference is driven by the impact of the refinement of the analysis of the LPIS spatial dataset. While the revised analysis of croplands over the last number of submissions is a more accurate assessment of impact of the management of croplands, it also reflects a high degree of inter-annual variability within the category.
Italy	-662	-28.9	-467	-334.5	Recalculations occur in the 2022 submission, comparing to the 2021 submission, as shown in tables 6.23 and 6.24, for living biomass and mineral soils, affecting both cropland remaining cropland and land converted to cropland. For living biomass, the recalculation is due to an update of the activity data and the consequent smoothing process affecting the 2016-2019 period.
Latvia	-	-	11	0.7	Recalculations are done due to continuous improvement of activity data including area of cropland remaining cropland and land converted to cropland. In 2019, net aggregated emissions in cropland slightly increased by 10.60 kt CO_2 eq. The main reason for recalculation of activity data (area) is delayed accumulation of land use changes data (addition 20% of NFI sample plots are surveyed annually, acquired cumulative data are extrapolated to whole country area) till final recalculation of NFI data at the end of every 5 years period (completed NFI cycle with 100% sample plots surveyed).
Lithuania	0	0.0	-16	-2.0	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. Database review was done (started in 2017) taking into account NFI field measurement data, National Paying Agency data of

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
					declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation, which resulted in slightly different areas of mineral and organic soils of land converted to cropland, used to estimate carbon stock changes in mineral soils, CO_2 emissions from drainage and direct N_2O emissions due to the N mineralization/immobilization.
Luxembourg	-26	-36.4	-4	-13.2	The LULUCF sector has had some major changes which have led to important changes in emissions and removals for the whole timeseries. The changes were essentially driven by a revised estimation of land use changes. Previous estimation of land use changes was based on spatially explicit data existing for the country, namely the OBS (Occupation Biophysique du Sol) maps for the reference years of 1989, 1999, and 2007, as well as a land use map of 2012, specifically updated for the National Inventory Report. Since then, new and more recent land use and land cover data sets have been produced for the whole Luxembourg for the years 2015 and 2018..
Malta	-0	-32.7	1	93.0	As explained the land area representation, and eventually the land use matrix, were updated during 2021 with the assistance of Aether Limited, to reflect the additions of areas in Forest Land and Wetland, and as a result updating the whole land areas and land use matrix for this category. To this end the estimations in the Cropland category were recalculated.
Netherlands	-5	-0.2	-11	-0.7	The new methodology for the estimation of carbon in forest biomass and deadwood will result in recalculations of carbon stock changes in Forest land converted to Cropland along the whole time series from 1990 onwards.
Poland	-101	-18.6	309	33.4	It has be noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO_2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before.
Portugal	-	-	-	-	
Romania	-756	-52.3	4 690	57.1	Compared to previous NIR report, a maintenance of sink behavior is observed for CL. The differences in removals levels for 2019 (NIR 2021 vs. NIR 2022) are represented by the following drivers: 1. AD (kha) developed using the type 3 approach; 2. CS EF's: FMG, FLU, FI and SOCref; 3. reassessed values of C stock in all carbon pools: LB, DOM and Soil. 4. for the march submission, land use areas were recalculated, taking into account the transition period of 20 years, because in some cases, negative areas were reached.
Slovakia	0	0.0	0	0.0	In the category 4.B, subcategory 4.B.2 Land converted to Cropland was recalculated for the whole time period since 1990. The main reason for recalculation 4.B.2 category included the recalculation of CSC in DW carbon pools (FL converted to CL) following the ERT recommendation and also recalculation of direct N_2O emissions from N mineralization/immobilization.
Slovenia	12	4.9	13	7.5	Recalculations in cropland remaining cropland were made due to improved stratification of perennial cropland and improved calculation of emission factors for perennial (woody) cropland types, such as vineyards, intensive and extensive orchards, olive groves and other perennial crops. Recalculations for land converted to cropland were made based on updated emission factors for litter in perennial cropland and new estimates of the country-specific carbon stock for annual cropland. In addition, figures have been recalculated separately for living biomass gains and losses using equations 2.15 and 2.16 in accordance with the 2006 Guidelines to increase transparency, as suggested by the ERT. Recalculations for land converted to cropland are also due to updated emission factors for conversion from forest land to cropland.

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Spain	-	-	53	1.4	New estimate of the C content of living biomass in category 4A1 (indicated in section 6.2.4), with implications for the CSC of LB in the transition FL → CL. New data available on afforestation of agricultural land subsidized by the CAP for the years 2018 and 2019.
Sweden	-35	-0.9	-1 351	-32.9	Updated activity data (areas) for land use resulting in updated estimates for emissions from all carbon pools and updated activity data (areas and production data) for land use resulting in updated estimates for emissions from all carbon pools.
United Kingdom	-4 363	-21.5	-792	-5.2	Methodological update to land-use change activity data used on soils and non-forest biomass models. Inclusion of bioenergy crops under cropland management.
EU27+UK	**-7 507**	**-9.1**	**1 653**	**3.2**	
Iceland	4	0.2	63	3.5	The C-stock chance factor for mineral soils in “Cropland active” and “Cropland inactive (Fallow)” was revised and corrected from t C ha-1yr-1 0.17 to t C ha-1yr-1 0.15 for the 2022 Submission.
United Kingdom (KP)	-4 362	-21.5	-799	-5.3	see above
EU-KP	**-7 501**	**-8.9**	**1 709**	**3.2**	

Table 6. 44 4C Grassland: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Austria	-1.4	-0.2	20	-1.4	The land-use changes between grassland and cropland were assessed by a changed method based on IACS/LPIS data. The land parcel numbers of the digital cadastral map are no more available in the IACS/LPIS system, so the assessment for the whole time series was changed to a grid point survey by using the INSPIRE grid of 100 x 100 m to sample geographic land use information in IACS/LPIS. In addition, the vineyards area trend was harmonized by using just the results of the vineyard surveys since 2009. These area changes had an impact on the emissions/removals of these categories..
Belgium	459	121	1 020	459	Wallonia: The changes in carbon stocks since 2013 were updated using a model combined with the forest inventory data. The land-use matrix has been updated. Brussels: Matrix update: 2020 was added National: The emissions of wildfires have been recalculated
Bulgaria	156	14.2	-55	156	Information on organic soils have been reported in CL and GL categories in relation to a recommendation to ensure the consistency between LULUCF and Agriculture sectors.
Croatia	-0.0	-0.0	-8	-0.0	For this reporting Croatia uses revisioned CLC change databases. Changes in Activity data (areas) can result with differences in emissions/removals. Estimation in LULUCF sector for NIR 2022 has been performed by using the nationally determined value for CS in biomass pool of perennial Cropland instead of using the value prescribed by 2006 GL. This influenced emissions/removals in all land categories where LUC from or to CL occurs.
Cyprus	-2.1	-1.6	7	-2.1	Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category. The correction reflects the implementation of the rule of 20-year transition period to Forest Land.
Czechia	-47	-42	-210	-47	Since the last submission, the emission estimates related to soil carbon stock changes were recalculated for both 4.C.1 and 4.C.2 subcategories of Grassland. This was due to the revised activity data on areas under grassland management and emission factors. The subcategory 4.C.2 was affected by changes in estimates for 4.C.2.1 involving conversion from Forest land. These changes resulted in altered emissions for the entire category 4.C Grassland. On average, the revised emission sink estimates in 4.C quantitatively differ by +19% as compared to the previously reported estimates as assessed on the comparable period of 1990 to 2019.
Denmark	0.0	0.0	-0.8	0.0	An error were found in the cereal/straw relation for winter wheat. The error overestimated the amount of wheat straw and thus the annual C input from biomass to the soils in the modelling. The consequence of lowering the C in-put, mainly the loamy soils where

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
					wheat is grown, is that the soils are turned into sources where it is difficult to maintain the current C stock. The overall effect is a larger emissions for all years. This change has been implemented for all years. A minor redistribution of the area with new hedges between 2018 and 2019 has been made.
Estonia	1.6	3.6	2.1	1.6	Activity data from NFI is updated and if necessary, corrected every year. Emissions and removals from/by living biomass have changed compared to the previous submission, both for Grassland remaining grassland and Land converted to grassland subcategories (Table 6.27) due to the recalculation of average growing stocks in Grassland and Forest land. Emissions from organic soils under Land converted to grasslands have significantly decreased because of updated emission factor for Cropland converted to grassland areas. To harmonise the reporting, in the current submission the same emission factor was used for all grassland organic soils.
Finland	121	13	79	121	New area estimates were calculated due to the updating of NFI data and corrections were done to grassland subdivisions of lands with tree cover and open land. This resulted in minor recalculation of grassland time series and all carbon stock changes were recalculated accordingly An error was corrected in the calculation of emission factors for gains and losses in living tree biomass for grassland remaining grassland for the whole time series. This resulted in an increase in net emissions from grassland
France	-682	-5.1	-699	-682	The areas of cultivated histosols have been recalculated and revised downwards, for the grasslands and crops sub-categories. The associated emissions are therefore significantly reduced. The areas of deforestation in Guyana after 2015 have been recalculated, which slightly impacts the results of land becoming grassland from 2016..
Germany	289	1.1	1 584	289	update of whole time series due to improved data sources (e.g. update of land use matrix), changes in methodologies (e.g. calculation of phytomass, new emission factors for dead wood) and correction of errors
Greece	-	-	-47	-	Activity data were updated regarding afforestation (year 2019) and deforestation (years 2018 -2019). The list of parameters used to estimate carbon loss in living biomass from wildfires was added to section 6.3.2. Information on the estimation methodology of biomass burning in grassland remaining grassland were included in the NIR (6.5.2.1) Inconsistencies between final areas in CRF table 4.1 and total areas reported in the background tables 4.A-4.E have been resolved. A section on planned improvements was added to the NIR (§6.1.6) A reference was added to §9.4.5 to note that Greece does not estimate emissions from HWP in solid waste disposal sites or from wood harvested for energy purposes.
Hungary	0	0.2	0.6	0	There are two main reasons for the recalculations. One is related to that, in preparation for the last year of the second commitment period of the Kyoto Protocol, we wanted to make sure that our estimates are as accurate as possible. For this reason, we continued our work, which was started in 2020, to revise all forest-related data and developed a new calculation system that automates all calculations. This means that the entire time series data are recalculated for each inventory year by MS Excel formulas instead of assessing figures of the current inventory year only and adding them to the former time series as was the case earlier (except for recalculations when the complete time series were recalculated). Copying the earlier time series data had led to some minor errors because in some cases formulas had not been applied consistently throughout the time series or because of copying errors. Furthermore, the new system automatically generates CRF tables by MS Excel Visual Basic macros and in this way, eliminates 'copy-paste' errors.
Ireland	-	-	-0.2	-	Recalculations to emissions and removals in the Grassland category in this submission are due to a revised assessment of the areas associated with biomass burning on grasslands. The net effect of these recalculations is minor resulting in a 0.01 per cent reduction in emissions on average across the 1990-2019 timeseries.
Italy	574	16	98	574	An error, related to the soil carbon stock estimation for the whole time series, was detected in previous submission and fixed.
Latvia	-	-	205	-	The implementation of improved quantitative results of Yasso modelling to characterize CSCs in mineral soils according to improvement plan; Elaboration of model based estimates of GHG

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
					emissions and activity data for organic soil in grassland (LIFE OrgBalt project, since 2025).
Lithuania	-103	-14.5	13	-103	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. Database review was done (started in 2017) taking into account NFI field measurement data, National Paying Agency data of declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation, which resulted in slightly different areas of mineral and organic soils of land converted to cropland, used to estimate carbon stock changes in mineral soils, CO_2 emissions from drainage and direct N_2O emissions due to the N mineralization/immobilization.
Luxembourg	-56	-262	12	-56	The LULUCF sector has had some major changes which have led to important changes in emissions and removals for the whole timeseries. The changes were essentially driven by a revised estimation of land use changes. Previous estimation of land use changes was based on spatially explicit data existing for the country, namely the OBS (Occupation Biophysique du Sol) maps for the reference years of 1989, 1999, and 2007, as well as a land use map of 2012, specifically updated for the National Inventory Report. Since then, new and more recent land use and land cover data sets have been produced for the whole Luxembourg for the years 2015 and 2018. In order to integrate those new datasets a new study was commissioned which has led to the recalculations.
Malta	-10	-856	-1.9	-10	Data that is input in the working spreadsheet such as the activity data and the emissions factors are double-checked to ensure accuracy with the data entry, and moreover, the methodology is checked with the IPCC Guidelines data. Please refer to Table 6.6 for the complete list of QA/QC checks produced, which is relevant for the Activity Data and Emissions Factors of all categories.
Netherlands	-70	-1.5	-34	-70	The new methodology for the estimation of carbon in forest biomass and deadwood will result in recalculations of carbon stock changes in Forest land converted to Grassland along thewhole time series from 1990 onwards.
Poland	112	133	201	112	It has be noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO_2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before
Portugal	-	-	-	-	
Romania	-2 950	-713	171	-2 950	Compared to previous NIR report, a maintenance of source behavior is observed for GL. The differences in emissionss levels for 2019 (NIR 2021 vs. NIR 2022) are represented by the following drivers: 1. AD (kha) developed using the type 3 approach; 2. CS EF's: FMG, FLU, FI and SOCref; 3. reassessed values of C stock in all carbon pools: LB, DOM and Soil. 4. for the march submission, land use areas were recalculated, taking into account the transition period of 20 years, because in some cases, negative areas were reached.
Slovakia	0.7	0.3	0.2	0.7	In the category 4.C, subcategory 4.C.2 Land converted to Grassland was recalculated for the whole time period since 1990. The reason of recalculations included the recalculation of CSC in DW carbon pools (FL converted to GL) following the ERT recommendation.
Slovenia	-72	-35	-55	-72	Due to updated emissions factors for living biomass, recalculations were made for land converted to grassland. In this context, additional plots were include in the estimation of the country-specific mean carbon stock for perennial grassland. Recalculations for land converted to grassland were made based on the correct application of equations 2.15 and 2.16 (as for land converted to cropland), where the carbon stock immediately after

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
					conversion was set to zero and gains and losses were estimated separately, taking into account the area converted in a certain year and the area, subject to conversion throughout the entire transition period (i.e. 20 years).
Spain	-	-	-2.1	-	New estimate of the C content of living biomass in category 4A1 (indicated in section 6.2.4), with implications for the CSC of LB in the transition FL → GL. New data available on afforestation of agricultural land subsidized by the CAP for the years 2018 and 2019.
Sweden	-236	-166	-551	-236	Recalculations due to updated NFI data which affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land-use changes may affect estimates for earlier years, especially for categories using area as activity data. recalculations related to extended datasets for litter and soil from the SFSI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series but quantitatively important recalculations are expected because of phasing in new data on carbon stock changes.
United Kingdom	591	124.7	1 659	591	Methodological update to land-use change activity data used on soils and non-forest biomass models. Updated deforestation activity data.
EU27+UK	**-1 926**	**-6.3**	**3 408**	**-1 926**	
Iceland	3.7	0.1	-50	3.7	For Natural birch shrubland were C-stock changes in biomass were totally revised as described in Chapter 6.5 above. Changes in values between 2021 and 2022 submissions are related to new areas emerged from the new map layers through the IGLUD process.
United Kingdom (KP)	597	124	1 672	597	see above
EU-KP	**-1 916**	**-5.4**	**3 371**	**-1 916**	

Table 6. 45 4D Wetlands: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Austria	-	-	-	-	
Belgium	0.0	0.1	-2.1	-164	soil C in 'settlements remaining settlements' was set equal to soil C in 'cropland remaining cropland' for the entire time series, in line with the assumption explained in section 6.3.8 above. Formerly, an average value was used in settlements, but this brought minor C stock changes as the soil C in cropland is evolving. Update of areas in the three regions following last data available. Brussels region: Matrix update: 2020 was added
Bulgaria	-1.3	-1.4	-1.0	-0.5	The main recalculations in Submission 2022 are related with an improved estimates of the area of LUC to FL. The changes came as a result of reassement of the afforestation and reforestation areas in relation with the accounting of the KP activities. The racalculations affected mostly the area representation of forest land category and the sub-category of Shrubs and grassland. However, small changes in area representation and land-use changes are present in almost all land categories, which affected also the emissions estimates in all categories.
Croatia	-6.2	-7.5	-1.3	-10.4	For this reporting Croatia uses revisioned CLC change databases. Changes in Activity data (areas) can result with differences in emissions/removals. Estimation in LULUCF sector for NIR 2022 has been performed by using the nationally determined value for CS in biomass pool of perennial Cropland instead of using the value prescribed by 2006 GL. This influenced emissions/removals in all land categories where LUC from or to CL occurs.
Cyprus	1.0	100	-0.8	100	Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category. The correction reflects the implementation of the rule of 20-year transition period to Forest Land.
Czechia	0.3	1.2	1.0	4.4	The emission estimates for the category 4.D Wetlands were recalculated in its subcategory 4.D.2. This was due to the changes implemented in 4.D.2.1 involving conversion from Forest land. These changes increased emissions for category 4.D (4.D.2) by 4% relative to the previous NIR submission.

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
					None of the individual emission categories of Wetlands qualifies among the key categories by quantity or trend in this inventory submission.
Denmark	-6.0	-5.5	-	-	An error were found in the cereal/straw relation for winter wheat. The error overestimated the amount of wheat straw and thus the annual C input from biomass to the soils in the modelling. The consequence of lowering the C in-put, mainly the loamy soils where wheat is grown, is that the soils are turned into sources where it is difficult to maintain the current C stock. The overall effect is a larger emissions for all years. This change has been implemented for all years. A minor redistribution of the area with new hedges between 2018 and 2019 has been made.
Estonia	27	9.6	41	3.3	Updated activity data, growing stocks and deadwood volumes from the NFI were used for estimating GHG emissions from peatlands and land converted to wetlands. As recalculated peatland areas have increased compared to the previous submission, also GHG emissions from the Wetlands category are higher
Finland	-	-	-27	-1.3	Area estimates were recalculated due to the updated data and corrections to it. This resulted in recalculation of the time series and all carbon stock changes were recalculated accordingly
France	-	-	-16	-3.0	The areas of deforestation in Guyana after 2015 have been recalculated, which slightly impacts the results of land becoming wetlands from 2016..
Germany	37	1.0	-25	-0.6	Update of whole time series due to improved data basis, this concerns: adjustment of the sampling for land use and land use change, changed emission factors for biomass, data correction for dead wood, amendment of emission factors for land use changes
Greece	-	-	-0.0	-1.5	Activity data were updated regarding afforestation (year 2019) and deforestation (years 2018 -2019). The list of parameters used to estimate carbon loss in living biomass from wildfires was added to section 6.3.2. Information on the estimation methodology of biomass burning in grassland remaining grassland were included in the NIR (6.5.2.1) Inconsistencies between final areas in CRF table 4.1 and total areas reported in the background tables 4.A-4.E have been resolved. A section on planned improvements was added to the NIR (§6.1.6) A reference was added to §9.4.5 to note that Greece does not estimate emissions from HWP in solid waste disposal sites or from wood harvested for energy purposes.
Hungary	-589	-74	-140	-78	There are two main reasons for the recalculations. One is related to that, in preparation for the last year of the second commitment period of the Kyoto Protocol, we wanted to make sure that our estimates are as accurate as possible. For this reason, we continued our work, which was started in 2020, to revise all forest-related data and developed a new calculation system that automates all calculations. This means that the entire time series data are recalculated for each inventory year by MS Excel formulas instead of assessing figures of the current inventory year only and adding them to the former time series as was the case earlier (except for recalculations when the complete time series were recalculated).
Ireland	7.7	0.4	99	4.5	The main source of recalculations in Wetlands is associated with an update to the areas of land that have been rewetted/taken out of production across the timeseries (Figure 6.38). These areas of peatland under the Tier 1 approach continue to emit carbon (at a reduced rate) and also give rise to offsite CH_4. The average recalculation across the timeseries is 2.3 per cent increase in emissions with some interannual variability evident across the timeseries.
Italy	-	-	-7.9	-20	The recalculation is due to an update of the activity data and the consequent smoothing process affecting the 2016-2019 period.
Latvia	0.0	0.0	0.1	0.0	Recalculations are done due to continuous improvement of activity data.
Lithuania	-	-	-7.9	-1.0	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. Database review was done (started in 2017) taking into account NFI field measurement data, National Paying Agency data of declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation, which resulted in slightly different areas of mineral and organic soils of land converted to cropland, used to estimate carbon stock changes in mineral soils, CO_2 emissions from drainage and direct N_2O emissions due to the N mineralization/immobilization.

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Luxembourg	-15	-99	-1.2	-37	The LULUCF sector has had some major changes which have led to important changes in emissions and removals for the whole timeseries. The changes were essentially driven by a revised estimation of land use changes. Previous estimation of land use changes was based on spatially explicit data existing for the country, namely the OBS (Occupation Biophysique du Sol) maps for the reference years of 1989, 1999, and 2007, as well as a land use map of 2012, specifically updated for the National Inventory Report. Since then, new and more recent land use and land cover data sets have been produced for the whole Luxembourg for the years 2015 and 2018. In order to integrate those new datasets a new study was commissioned which has led to the recalculations.
Malta	-0.1	100	-0.0	100	Recalculations for the Wetlands category are found to be unnecessary for this year’s submission, since in the previous submission there were no estimates calculated from this category.
Netherlands	-73	-92	-72	-288	There are no category-specific recalculations. The correction of an error in the carbon stock losses resulting from loss of litter in the dead organic matter (DOM) pool resulted in recalculations of the category forest land converted to wetlands for the years 2017 and 2018.
Poland	-	-	-4.3	-0.3	It has be noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO_2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before
Portugal	-	-	-	-	
Romania	-1 379	-96.2	-810	-116.3	Compared to previous NIR report, a maintenance of source behavior is observed for WL. The differences in emissionss levels for 2019 (NIR 2021 vs. NIR 2022) are represented by the following drivers: 1. AD (kha) developed using the type 3 approach; 2. CS EF's: FMG, FLU, FI and SOCref; 3. reassessed values of C stock in all carbon pools: LB, DOM and Soil
Slovakia	-	-	-	-	
Slovenia	-0.0	-1.3	0.0	1.0	Recalculations for land converted to wetlands were performed based on updated emission factors for living biomass and litter for transitions from forest land, perennial grassland and cropland to wetlands.
Spain	-	-	-5.8	-8.4	Nueva estimación del contenido de C de la biomasa viva en la categoría 4A1 (indicada en el apartado 6.2.4), con implicaciones en el CSC de LB en la transición FL → WL. Nuevos datos disopnibles de forestaciones de tierras agrícolas subvencionadas por la PAC para los años 2018 y 2019
Sweden	-	-	-	-	
United Kingdom	-0.8	-0.1	-111	-7.9	New activity data for off-site peat emissions: new data on volumes of peat sold 2014-2020 reported by Growing Media Association (2021) for England, Scotland and Wales replaced the values previously extrapolated from the 2014 value last reported in the UK Minerals Yearbook.
EU27+UK	**-1 997**	**-16**	**-1 092**	**-6.3**	
Iceland	12	1.1	11	1.1	No specific recalculation was performed for Wetlands remaining wetlands sub-categories. Changes in values between 2021 and 2022 submissions are related to new areas emerged from the new map layers through the IGLUD process.
United Kingdom (KP)	-0.8	-0.1	-111	-7.9	See above
EU-KP	**-1 985**	**-17.0**	**-1 080**	**-6.7**	

Table 6. 46 4E Settlements: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Austria	-0.1	-0.0	-128	-42	The land-use changes between grassland and cropland were assessed by a changed method based on IACS/LPIS data (see above at the Cropland and Grassland categories). For area consistency in the LUC matrices, these LUC area changes also had an impact on the LUC areas from Cropland and Grassland to Settlements. For Settlements the annual emissions/removals are in the range of -132.0 kt CO_2e per year lower to 2.3 kt CO_2e per year higher compared to the last submission in 2021.
Belgium	-0.1	-0.1	-20	-3.9	soil C in 'settlements remaining settlements' was set equal to soil C in 'cropland remaining cropland' for the entire time series, in line with the assumption explained in section 6.3.8 above. Formerly, an average value was used in settlements, but this brought minor C stock changes as the soil C in cropland is evolving. Update of areas in the three regions following last data available. Brussels region: Matrix update: 2020 was added
Bulgaria	-3.0	-0.7	0.1	0.0	The main recalculations in Submission 2022 are related with an improved estimates of the area of LUC to FL. The changes came as a result of reassement of the afforestation and reforestation areas in relation with the accounting of the KP activities. The racalculations affected mostly the area representation of forest land category and the sub-category of Shrubs and grassland. However, small changes in area representation and land-use changes are present in almost all land categories, which affected also the emissions estimates in all categories.
Croatia	-64	-25.6	-59.9	-8.8	In this year submission, some recalculations have been done. Corrections in the emissions from biomass was done. On that basis new calculation was performed. Estimation in LULUCF sector for NIR 2022 has been performed by using the nationally determined value for CS in biomass pool of perennial Cropland instead of using the value prescribed by 2006 GL. This influenced emissions/removals in all land categories where LUC from or to CL occurs
Cyprus	-1.8	-101	-7.3	-36	Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category. The correction reflects the implementation of the rule of 20-year transition period to Forest Land.
Czechia	4.8	1.8	5.9	4.4	The emission estimates for the category 4.E Settlements were recalculated in its subcategory 4.E.2. This was due to the changes implemented in 4.E.2.1 involving conversion from Forest land. These changes increased emissions for category 4.E (4.E.2) by 3% relative to the previous NIR submission. None of the individual emission categories of Settlements qualifies among the key categories by quantity or trend in this inventory submission.
Denmark	0.0	0.0	-9.5	-4.6	An error were found in the cereal/straw relation for winter wheat. The error overestimated the amount of wheat straw and thus the annual C input from biomass to the soils in the modelling. The consequence of lowering the C in-put, mainly the loamy soils where wheat is grown, is that the soils are turned into sources where it is difficult to maintain the current C stock. The overall effect is a larger emissions for all years. This change has been implemented for all years. A minor redistribution of the area with new hedges between 2018 and 2019 has been made.
Estonia	-	-	88	26	Updated activity data, growing stocks and deadwood volumes from the NFI were used for estimating carbon losses due to land conversion to Settlements. In Table 6.34 a quantitative overview of recalculations is shown, except for recalculations of direct N_2O emissions which are presented in Chapter 6.8.5. The most significant changes compared to the previous submission have occurred in the living biomass pool, mainly due to the recalculation of average growing stock in grasslands and increase in land areas under Forest land and Grassland converted to settlements subcategories for the last five years
Finland	-13	-1.6	104	16	New area estimates were calculated the for the years 2011 to 2019 due to new data, updating of NFI data and corrections to the data. This resulted in recalculations for the time series and all carbon stock changes were updated accordingly
France	-	-	-79	-0.7	The areas of deforestation in Guyana after 2015 have been recalculated, which slightly impacts the results of land becoming settlements from 2016..

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Germany	-653	-27	-3 190	-77	update of whole time series due to improved data sources (e.g. update of land use matrix), changes in methodologies (e.g. calculation of phytomass, new emission factors for dead wood) and correction of errors
Greece	-	-	-2.9	-2.2	Activity data were updated regarding afforestation (year 2019) and deforestation (years 2018 -2019). The list of parameters used to estimate carbon loss in living biomass from wildfires was added to section 6.3.2. Information on the estimation methodology of biomass burning in grassland remaining grassland were included in the NIR (6.5.2.1) Inconsistencies between final areas in CRF table 4.1 and total areas reported in the background tables 4.A-4.E have been resolved. A section on planned improvements was added to the NIR (§6.1.6) A reference was added to §9.4.5 to note that Greece does not estimate emissions from HWP in solid waste disposal sites or from wood harvested for energy purposes.
Hungary	0	0.3	3.8	1.4	There are two main reasons for the recalculations. One is related to that, in preparation for the last year of the second commitment period of the Kyoto Protocol, we wanted to make sure that our estimates are as accurate as possible. For this reason, we continued our work, which was started in 2020, to revise all forest-related data and developed a new calculation system that automates all calculations. This means that the entire time series data are recalculated for each inventory year by MS Excel formulas instead of assessing figures of the current inventory year only and adding them to the former time series as was the case earlier (except for recalculations when the complete time series were recalculated).
Ireland	-	-	-10	-7.6	Recalculations were undertaken for the years 2018 and 2019, on foot of updated statistics on sealed surface estimates. The net effect of these recalculations is a 3.2 per cent reduction in emissions in 2018 and 5.0 per cent decrease in 2019.
Italy	-0.0	-0.0	5.9	0.1	Slight recalculation (0.03% in 2019) occurs in 2022 submission compared to the 2021 one, due to the updated activity data.
Latvia	0.0	0.0	-124	-22	Recalculations (Figure 6.23) are done due to continuous improvement of activity data including area of settlements remaining settlements and land converted to settlements. In 2019, net aggregated emissions in settlements decreased by 128.4 kt CO_2 eq. The main reason for recalculation of activity data (area) is delayed accumulation of land use changes data (addition 20% of NFI sample plots are surveyed annually, acquired cumulative data are extrapolated to whole country area) till final recalculation of NFI data at the end of every 5 years period (completed NFI cycle with 100% sample plots surveyed).
Lithuania	22	139	-0	-0.0	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. Database review was done (started in 2017) taking into account NFI field measurement data, National Paying Agency data of declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation, which resulted in slightly different areas of mineral and organic soils of land converted to cropland, used to estimate carbon stock changes in mineral soils, CO_2 emissions from drainage and direct N_2O emissions due to the N mineralization/immobilization.
Luxembourg	-113	-79	-13	-24	The LULUCF sector has had some major changes which have led to important changes in emissions and removals for the whole timeseries. The changes were essentially driven by a revised estimation of land use changes. Previous estimation of land use changes was based on spatially explicit data existing for the country, namely the OBS (Occupation Biophysique du Sol) maps for the reference years of 1989, 1999, and 2007, as well as a land use map of 2012, specifically updated for the National Inventory Report. Since then, new and more recent land use and land cover data sets have been produced for the whole Luxembourg for the years 2015 and 2018. In order to integrate those new datasets a new study was commissioned which has led to the recalculations.
Malta	-4.0	-66	-0.7	-87	Data that is input in the working spreadsheet such as the activity data and the emissions factors are double-checked to ensure accuracy with the data entry, and moreover, the methodology is checked with the IPCC Guidelines data. Please refer to Table 6.6 for the complete list of QA/QC checks produced, which is relevant for the Activity Data and Emissions Factors of all categories.

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Netherlands	154	18.1	-396	-27	The new methodology for the estimation of carbon in forest biomass and deadwood will result in recalculations of carbon stock changes in Forest land converted to Settlements along the whole time series from 1990 onwards.
Poland	-61	-2.9	-17	-0.7	It has be noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO_2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before
Portugal	-	-	-	-	
Romania	-1 553	-43.1	-1 785	-45.4	Compared to previous NIR report, a maintenance of source behavior is observed for SL. The differences in emissionss levels for 2019 (NIR 2021 vs. NIR 2022) are represented by the following drivers: 1. AD (kha) developed using the type 3 approach; 2. CS EF's: FMG, FLU, FI and SOCref; 3. reassessed values of C stock in all carbon pools: LB, DOM and Soil.
Slovakia	0.1	0.1	0.3	0.3	In the category 4.E, subcategory 4.E.2 Land converted to Settlements was recalculated for the whole time period since 1990. The reason of recalculations included the recalculation of CSC in DW carbon pools (FL converted to SL) following the ERT recommendation.
Slovenia	115	38	73	99	Recalculations in settlements remaining settlements were made based on updated default average removal factor for tree biomass (CRW) (Nowak et al., 2013) according to 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Spain	-	-	-0.0	-0.0	Nueva estimación del contenido de C de la biomasa viva en la categoría 4A1 (indicada en el apartado 6.2.4), con implicaciones en el CSC de LB en la transición FL → SL. Nuevos datos disponibles de forestaciones de tierras agrícolas subvencionadas por la PAC para los años 2018 y 2019.
Sweden	-40	-1.6	-175	-5.9	Recalculations due to updated NFI data which affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land-use changes may affect estimates for earlier years, especially for categories using area as activity data. recalculations related to extended datasets for litter and soil from the SFSI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series but quantitatively important recalculations are expected because of phasing in new data on carbon stock changes.
United Kingdom	-999	-15.8	-1 569	-29	Methodological update to land-use change activity data used on soils and non-forest biomass models. Updated deforestation activity data.
EU27+UK	**-3 209**	**-8.5**	**-7 307**	**-16**	
Iceland	5.4	33.2	-2.2	-37	Changes in values between 2021 and 2022 submissions are related to new areas emerged from the new map layers through the IGLUD process.
United Kingdom (KP)	-999	-16	-1 569	-28	see above
EU-KP	**-3 204**	**-8.4**	**-7 309**	**-16**	

Table 6. 47 4F Other land: Contribution of countries to EU-KP Recalculations in CO_2 for 1990 and 2019 (difference between latest submission and previous submissions in kt CO_2 and percent)

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
Austria	-	-	20	8.5	The land-use changes between grassland and cropland were assessed by a changed method based on IACS/LPIS data (see above at the Cropland and Grassland categories). For area con-sistency in the LUC matrices, these LUC area changes also had an impact on the LUC areas from Grassland to Other land. These

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
					area changes had an impact on the emissions/removals of the Other land category. For Other land the annual emissions/removals are in the range of -101.8 CO_2e per year lower to 20.3 kt CO_2e per year higher for the time series since 2006 compared to the last submission in 2021.
Belgium	-	-	-	-	
Bulgaria	-	-	-	-	
Croatia	-	-	-	-	
Cyprus	-95	-99	-6.5	-100	Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category. The correction reflects the implementation of the rule of 20-year transition period to Forest Land.
Czechia	-	-	-	-	
Denmark	-	-	-	-	
Estonia	-	-	2.9	4.6	Updated activity data, growing stocks and deadwood volumes from the NFI were used for estimating carbon losses due to land conversion to Other land. In Table 6.37 a quantitative overview of recalculations is shown, except for recalculations of direct N_2O emissions which are presented in Chapter 6.8.5.
Finland	-	-	-	-	
France	-	-	-	-	
Germany	-	-	-	-	
Greece	-	-	4.9	6.8	Activity data were updated regarding afforestation (year 2019) and deforestation (years 2018 -2019). The list of parameters used to estimate carbon loss in living biomass from wildfires was added to section 6.3.2. Information on the estimation methodology of biomass burning in grassland remaining grassland were included in the NIR (6.5.2.1) Inconsistencies between final areas in CRF table 4.1 and total areas reported in the background tables 4.A-4.E have been resolved. A section on planned improvements was added to the NIR (§6.1.6) A reference was added to §9.4.5 to note that Greece does not estimate emissions from HWP in solid waste disposal sites or from wood harvested for energy purposes.
Hungary	-	-	0.0	0.1	There are two main reasons for the recalculations. One is related to that, in preparation for the last year of the second commitment period of the Kyoto Protocol, we wanted to make sure that our estimates are as accurate as possible. For this reason, we continued our work, which was started in 2020, to revise all forest-related data and developed a new calculation system that automates all calculations. This means that the entire time series data are recalculated for each inventory year by MS Excel formulas instead of assessing figures of the current inventory year only and adding them to the former time series as was the case earlier (except for recalculations when the complete time series were recalculated
Ireland	-	-	-	-	
Italy	-	-	-	-	
Latvia	-	-	-	-	
Lithuania	-	-	-12	-3.4	Recalculations were done as a result of continued internal land use and land-use change database review in State Forest Service. Database review was done (started in 2017) taking into account NFI field measurement data, National Paying Agency data of declared agricultural land and the initial data from studies (Study 1 and Study 2) conducted in 2012, in order to improve accuracy in land-use matrix preparation, which resulted in slightly different areas of mineral and organic soils of land converted to cropland, used to estimate carbon stock changes in mineral soils, CO_2 emissions from drainage and direct N_2O emissions due to the N mineralization/immobilization.
Luxembourg	-1.6	-97	0.1	69	The LULUCF sector has had some major changes which have led to important changes in emissions and removals for the whole

	1990		2019		Explanations for major changes in 2019
	kt CO_2	%	kt CO_2	%	
					timeseries. The changes were essentially driven by a revised estimation of land use changes. Previous estimation of land use changes was based on spatially explicit data existing for the country, namely the OBS (Occupation Biophysique du Sol) maps for the reference years of 1989, 1999, and 2007, as well as a land use map of 2012, specifically updated for the National Inventory Report. Since then, new and more recent land use and land cover data sets have been produced for the whole Luxembourg for the years 2015 and 2018. In order to integrate those new datasets a new study was commissioned which has led to the recalculations.
Malta	-0.1	-15	-0.4	-42	Data that is input in the working spreadsheet such as the activity data and the emissions factors are double-checked to ensure accuracy with the data entry, and moreover, the methodology is checked with the IPCC Guidelines data. Please refer to Table 6.6 for the complete list of QA/QC checks produced, which is relevant for the Activity Data and Emissions Factors of all categories.
Netherlands	72	334	-9.2	-5.2	The new methodology for the estimation of carbon in forest biomass and deadwood will result in recalculations of carbon stock changes in Forest land converted to Other land along the whole time series from 1990 onwards.
Poland	-	-	-	-	
Portugal	-	-	-	-	
Romania	-580	-74	-398	-83	The changes in absolute values of the GHG E(+)/R(-) levels, Figure 6.34, are due to a basket of variables/drivers, respectively: (i) explicit geospatial maps, approach 3, by updating AD(kha) surfaces using LPIS/IACS [2008-2019] and CLC [reference year 1990; 2006; 2012; 2018] technologies, detailed in Chapter 6.3.1., paragraph Combining, processing and querying information; (ii) re-estimation of the parameters specific to carbon pools, LB and DOM.
Slovakia	0.8	0.3	0.2	0.3	In the category 4.F, subcategory 4.F.2 Land converted to Other Land was recalculated for the whole time period since 1990. The reason of recalculations included the recalculation of CSC in DW carbon pools (FL converted to OL) following the ERT recommendation
Slovenia	-	-	-0.9	-18	Recalculations for land converted to other land were made based on updated emission factors for living biomass and litter for transitions from forest land, perennial grassland and cropland to other land.
Spain	-	-	-	-	
Sweden	0.6	0.3	13	5 704	Recalculations due to updated NFI data which affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land-use changes may affect estimates for earlier years, especially for categories using area as activity data. recalculations related to extended datasets for litter and soil from the SFSI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series but quantitatively important recalculations are expected because of phasing in new data on carbon stock changes.
United Kingdom	-	-	-	-	
EU27+UK	**-603**	**-19**	**-386**	**-79**	
Iceland	-	-	-	-	
United Kingdom (KP)	-	-	-	-	
EU-KP	**-603**	**-19.3**	**-386**	**-79**	

7 WASTE (CRF SECTOR 5)

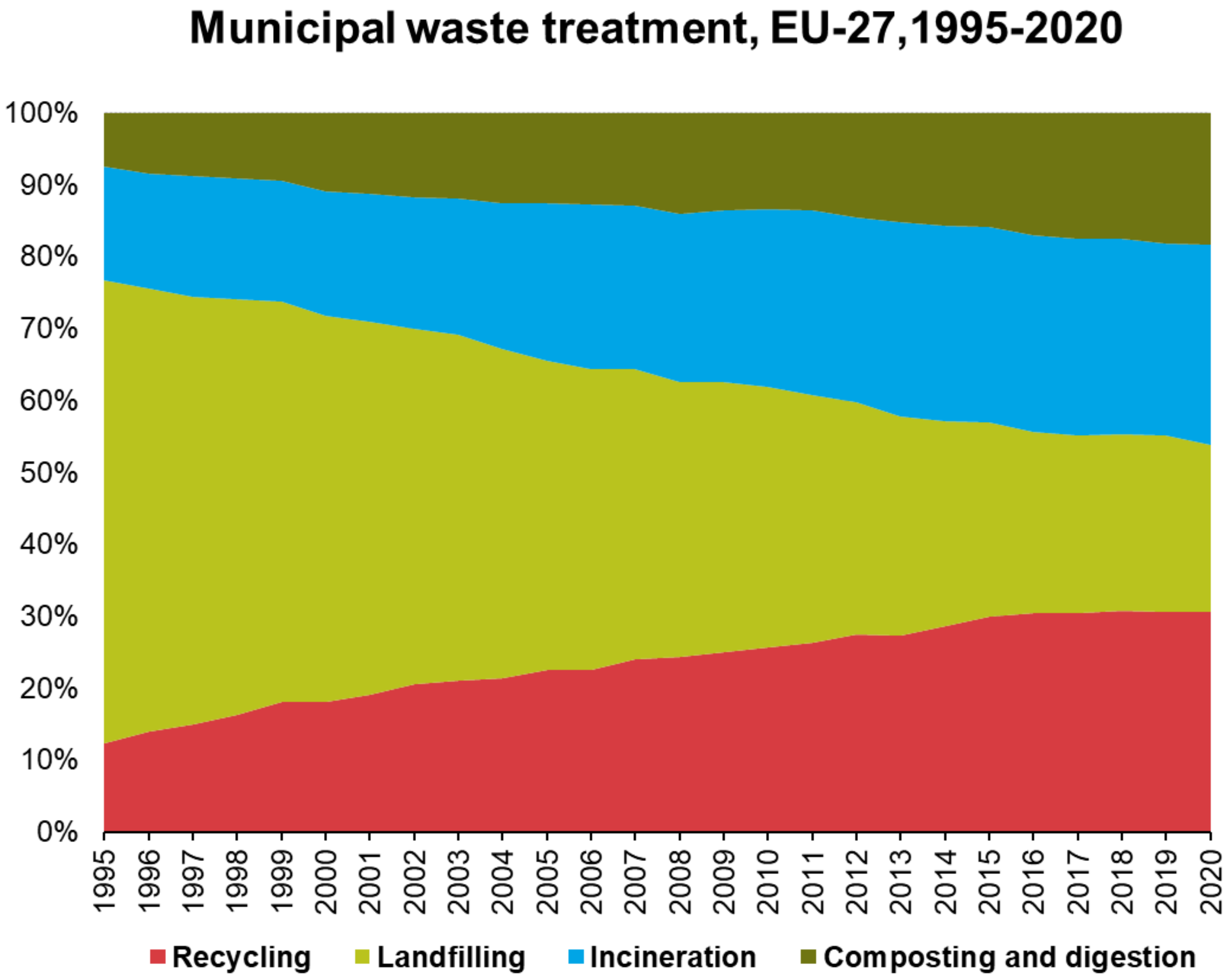
GHG emissions in the waste sector are generated from the treatment and disposal of liquid and solid waste. According to the IPCC 2006 Guidelines emission estimates in the waste sector need to be carried out for four subcategories:

- 5.A Solid waste disposal
- 5.B Biological treatment of solid waste
- 5.C Incineration and open burning of waste
- 5.D Wastewater treatment and discharge.

Of the above, the first three categories mainly refer to possible routes for treatment and disposal of solid waste. Solid waste can be recycled, landfilled, incinerated and biological treated. The decrease of total GHG emissions in the waste sector is mainly driven by the development of the different waste treatment routes. Figure 7.1 shows the share of the Municipal Solid Waste (MSW) treatments over the time series 1995 to 2020 based on activity data for municipal solid waste as published in 2021. The figure is based on Eurostat data as there is a common definition for the reporting of municipal waste to Eurostat and information on waste recycling is also included. On the basis of the Regulation on waste statistics (EC) No. 2150/2002, amended by Commission Regulation (EU) No. 849/2010, data on the generation and treatment of waste is collected from the Member States. The information on waste treatment reported to Eurostat is broken down to five treatment types (recovery, incineration with energy recovery, other incineration, disposal on land, biological treatment) and in waste categories. Eurostat data shown in the figures below include only information for municipal waste treatment, while in the GHG inventory also industrial waste, sludge and hazardous waste are reported by some countries under the categories solid waste disposal, biological treatment and waste incineration. However, the Eurostat data is used to show the overall trend of waste treatment in the European Union.

Between 1995 and 2020 the amount of municipal solid waste landfilled is continuously decreasing in the 27 EU countries and other waste treatment methods like recycling, biological treatment of waste and waste incineration with energy recovery are applied more. In 1995, 65 % of waste has been landfilled, 16 % was incinerated (with and without energy recovery), 12 % recycled and only 8 % of the municipal solid waste has been composted or digested. In 2020, the share of waste landfilled decreased to 23 % of total waste treated while incineration including energy recovery increased to 28%, recycling increased to 31 % and biological treatment of waste makes up 18 % of total municipal solid waste treated.

Figure 7.1 Sector 5 Waste: Development of municipal waste treatment in the EU-27



Note: estimated by Eurostat.

Source: Eurostat (online data code: env_wasmun)

Many countries experienced a reduction of waste landfilled and an increase of recycling, composting, landfill gas recovery and waste incineration with energy recovery. These trends have already started before the Landfill Directive 1999/31/EC and the Directive on packaging waste 94/62/EC and 2008/98/EC, but are further supported by these directives.

Regarding Iceland, between 1995 and 2020, waste landfilled decreased from 78% to 70% and incineration (with and without energy recovery) from 14% to 6%, while recycling increased from 6 to 17% and biological treatment from 2% to 7%.

The share of the single municipal waste treatment routes differs significantly among countries in 2020 (comparison in Figure 7.2). Indeed, the waste management practices and policies which determine the fraction of municipal solid waste (MSW) disposed to solid waste disposal sites (SWDS), the fraction of waste incinerated and the fraction of waste recycled or with biological treatment differ significantly between the countries. For example, disposing municipal waste on SWDS is the predominant (>60%) municipal waste disposal route in Bulgaria, Greece, Croatia, Cyprus, Malta and Romania with correspondingly fewer quantities of waste incinerated, recycled or biological treated. In Belgium, Denmark, Germany, Luxembourg, the Netherlands, Austria, Slovenia, Finland, Sweden and the United Kingdom, it is the opposite (<20%). Since 2005, landfills in Germany remaining in operation may only store waste that conforms to strict categorization criteria. Landfills also must reduce landfill gas formation from such waste by more than 90 % compared to gas production from untreated waste. In the Netherlands (also in Belgium), waste policy also has the aim of reducing landfilling by introducing bans for the landfilling of certain categories of waste, e.g. by limiting the authorized organic fraction of landfilled waste and by raising the landfill tariff to shift waste streams to other treatment routes.

Figure 7.2 Waste management practices in the EU-KP (shares) in 2020

7.1 Overview of sector

CRF Sector 5 Waste is the fourth largest sector in the EU-KP, after energy, agriculture and industrial processes, contributing 3.6% to total GHG emissions without LULUCF in 2020. Total emissions from waste decreased by 45,2 % from 238 Mt in 1990 to 130 Mt in 2020 (Figure 7.3). In 2020, emissions decreased by 1.8 % compared to 2020.

The strong decrease of emissions from the waste sector is mainly influenced by a strong decline of emissions in the waste sector from the United Kingdom, Germany, the Netherlands and Poland. Reductions from category 5.A solid waste disposal on land make up 86 % of total emission reductions in the waste sector (between 1990 and 2020). Emissions from the waste sector show a continuously decreasing trend during the last years, but as many countries with large emissions from this sector already decreased emissions since 1990 by more than 70 % and most technical mitigation options are implemented in those big countries, the declining emission trend is slowing down.

Figure 7.3 Sector 5 Waste: EU-KP GHG emissions, 1990-2020

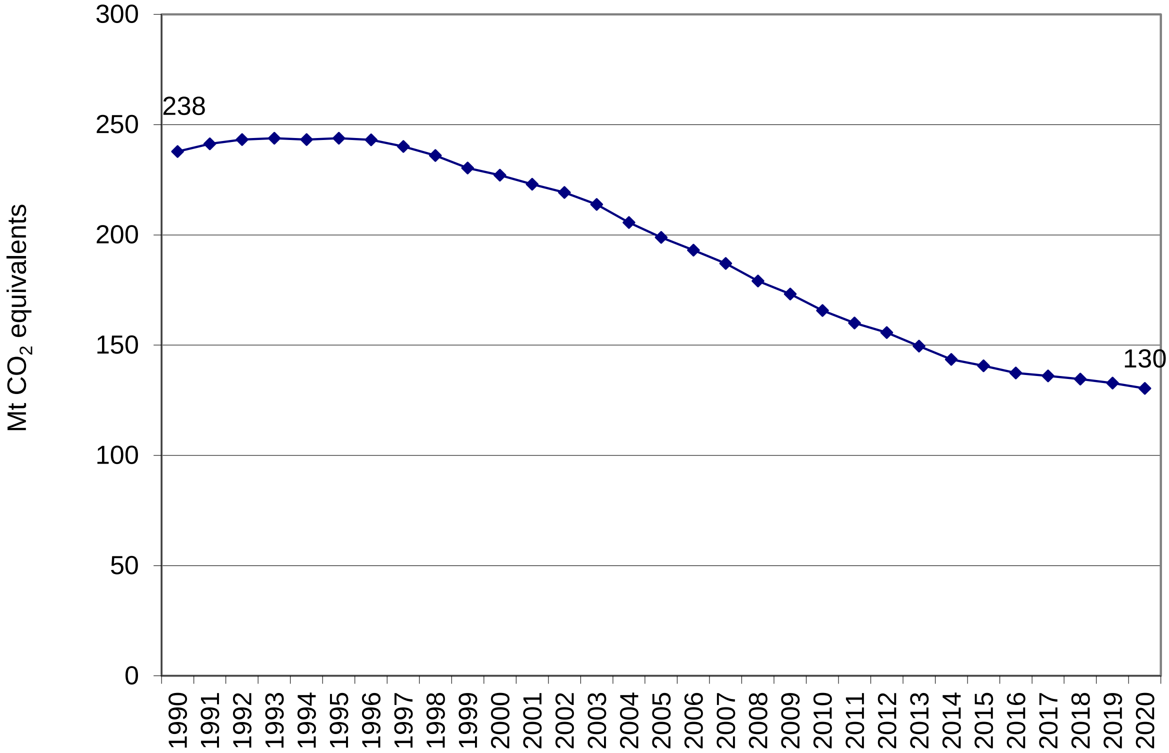
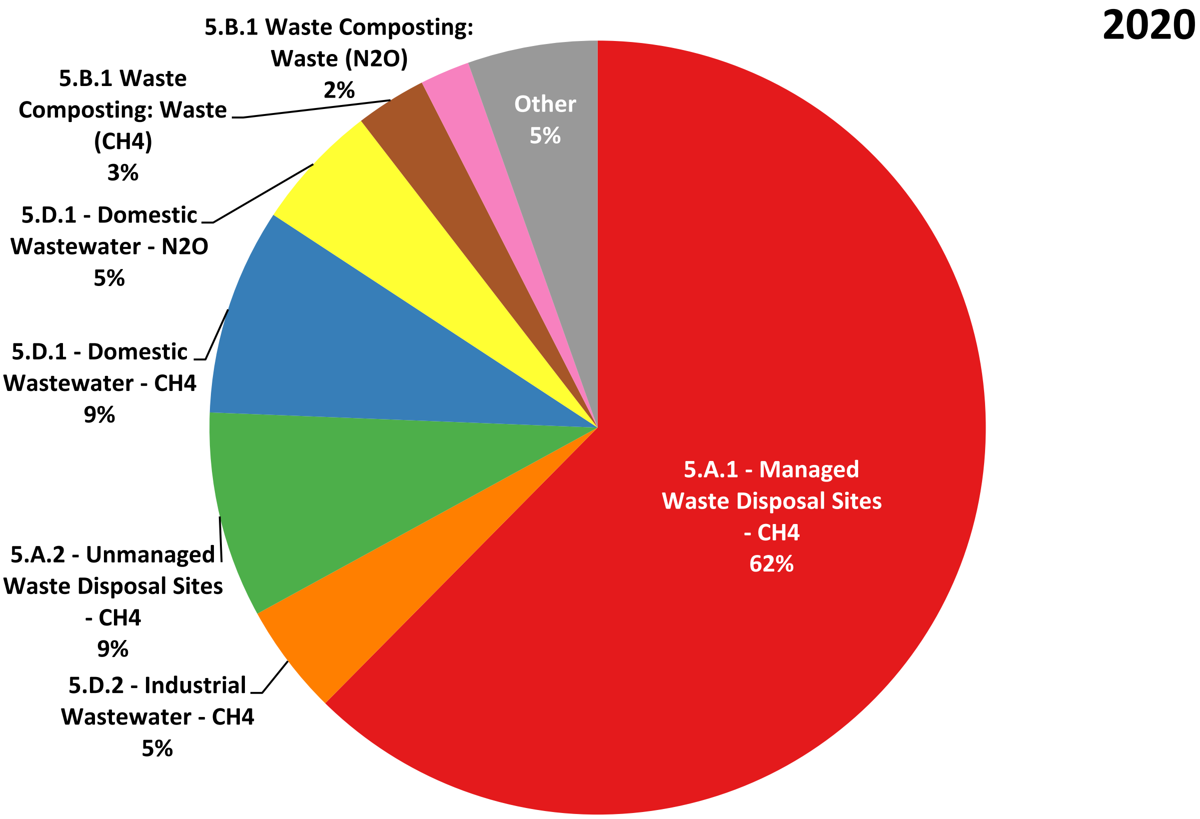


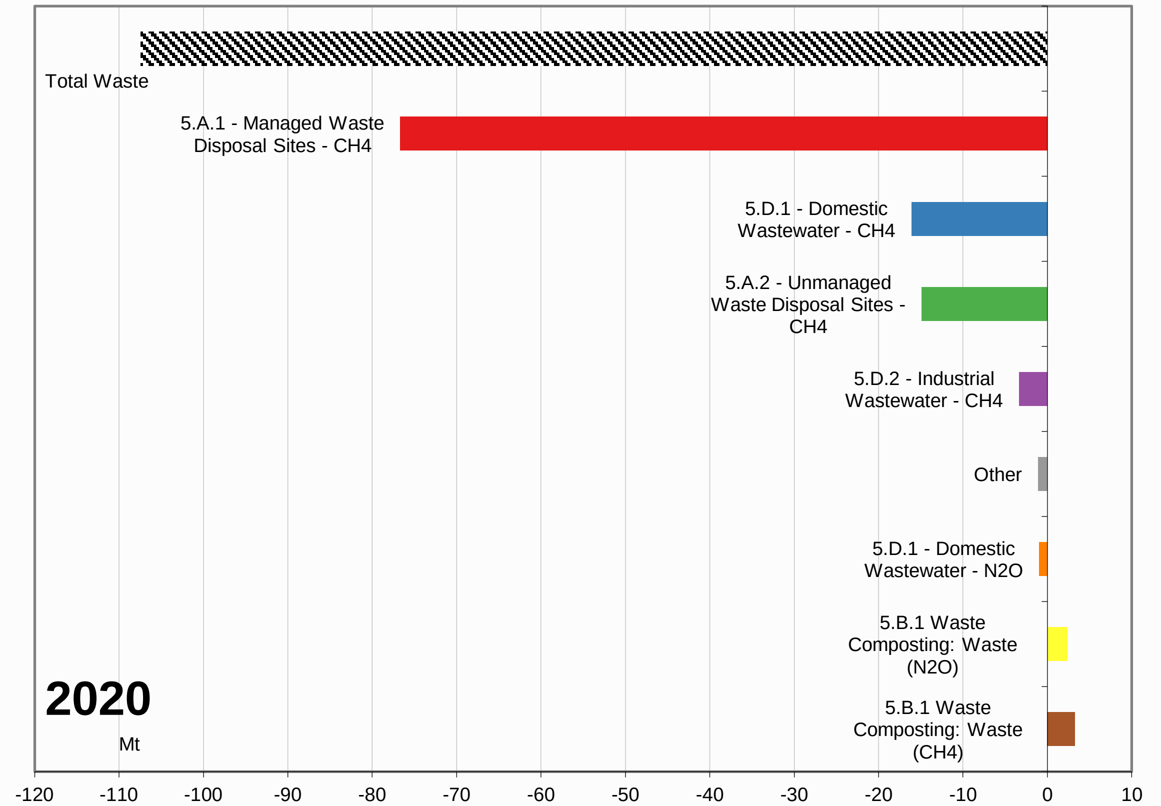
Figure 7.5 shows that CH_4 emissions from 5A1 Managed Waste Disposal on Land had the greatest decrease of all waste-related emissions, but still accounts for 62 % of waste-related GHG emissions in the EU-KP in 2020 as shown in Figure 7.4.

Figure 7.4 Sector 5 Waste: Share of key source categories and all remaining categories in 2020 for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

Figure 7.5 Sector 5 Waste: Absolute change between 1990 and 2020 of GHG emissions (in CO_2 equivalents) by large key source categories for EU-KP



Note: Other is calculated by subtracting the presented categories from the sector total

7.2 Source categories and methodological issues

This chapter includes information on emission levels and emission trends for all 28 countries (EU27 + UK) plus Iceland for the EU key source categories. Additionally, information for EU key source categories on national methods and circumstances, which are available in the countries' national inventory reports, are provided in the Annex III.

In this section we present information relevant for the EU-KP key source categories in the sector 5 Waste. Source categories considered in detail are:

Table 7.1 Key source categories for level and/or trend analyses and share of MS emissions using higher tier methods

Source category gas	kt CO_2 eq.		Trend	Level		share of higher Tier
	1990	2020		1990	2020	
5.A.1 Managed Waste Disposal Sites: Waste (CH_4)	158011	81344	T	L	L	95,9%
5.A.2 Unmanaged Waste Disposal Sites: Waste (CH_4)	26131	11227	T	L	L	94.8%
5.B.1 Waste Composting: Waste (CH_4)	596	3854	T	0	0	45,5%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (CH_4)	27361	11269	T	L	L	49.1%
5.D.1 Wastewater Treatment and Discharge: Domestic Wastewater (N_2O)	7853	6908	0	0	L	21,9%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (CH_4)	9385	6041	0	L	L	53,5%

The share of higher Tier corresponds to the share of EU emissions documented by countries reporting the method as an IPCC Tier 2 method (T2) or a country-specific method (CS), or countries reporting EF as country-specific (CS).

Almost all countries report CH_4 emissions from solid waste disposal on managed and unmanaged landfills 5.A using a Tier 2 methodology. In all other source categories in the waste sector the share of countries using a higher Tier method is much lower.

For CH_4 emissions from composting (5.B.1) France and Germany mainly influence the share of higher Tiers because they have one of the highest shares for this gas, respectively 28.3% and 8.0% in this category and are using a higher Tier. However, UK which has the second highest share of CH_4 from composting (25,9%) is applying a Tier 1.

For CH_4 emissions from domestic wastewater treatment (5.D.1), Poland, which represents 15,6% of the EU emissions from this category, mainly influence the share of higher Tiers. However, France and Italy, which represent respectively 19,9% and 8,9% of CH_4 from the category are applying a Tier 1. Regarding N_2O emissions from domestic wastewater treatment (5.D.1), Italy, United Kingdom (KP), Spain and Poland, which represents respectively 16,9%, 12,8%, 13,2% and 11,4% of the EU emissions from this category, are applying Tier1. On the other hand, 9 countries, with lower contribution the EU emissions from this category, are applying higher Tier.

For CH_4 emissions from industrial wastewater, Greece contributes almost to 15,1% to the 53,5% of CH_4 emissions that are reported in this sub-category using higher Tiers. Italy, which contributes to 22,8% of CH_4 emissions from industrial wastewater, applies a Tier 1.

Other source categories in the waste sector are not contributing to a key source and only information on total emissions from these categories is provided for completeness reasons (see chapter 3.2.8). Further information on emission trends and methodological information on other source categories from the waste sector are not provided.

7.2.1 Solid waste disposal on land (CRF Source Category 5A)

Methane is produced from anaerobic microbial decomposition of organic matter in solid waste disposal sites. This source category includes two key categories: CH_4 from 5A1 Managed waste disposal on land and CH_4 from 5.A.2 Unmanaged waste disposal on land. In addition, source category 5A includes the category 5.A.3 CH_4 emissions from uncategorized landfills, but only Estonia (1990-1993) and Poland (1990-2020) report emissions from this category. As this is no EU key category no further information on 5.A.3 is included in the following chapters.

The source category 5A contributes 2.5 % to total GHG emissions without LULUCF in 2020.

The methane recovery that takes place in the managed or unmanaged solid waste landfills is also reported in CRF-table 5A but those amounts are not included in the reported CH_4-emissions, as prescribed by the IPCC guidelines. In the unmanaged solid waste landfills, mainly no CH_4-recovery is taken place. Only Ireland (1996-1998) and Latvia (2002-2017) report CH_4 recovery from unmanaged landfills for a few years in the time series.

Table 7.2 provides total greenhouse gas and CH_4 emissions by Member State from 5A Solid Waste Disposal on Land. CH_4 emissions from this category decreased by 50 % between 1990 and 2020 in the

EU-KP. Fourteen EU-KP countries reduced their emissions from this source, while Bulgaria, Croatia, Cyprus, the Czech Republic, France, Greece, Hungary, Italy, Latvia, Malta, Portugal, Romania, Slovakia, Spain and Iceland did not. In many of these countries waste disposal changed from unmanaged to managed landfills during the time period 1990 and 20120 which leads to increasing CH_4 emissions from managed landfills. In 2020, CH_4 emissions from landfills decreased by 2.3% compared to 2019.

Table 7.2 5A Solid Waste Disposal on Land: Countries contributions to total GHG emissions and CH_4 emissions

Member State	GHG emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020
Austria	3 644	831	3 644	831
Belgium	2 967	575	2 967	575
Bulgaria	1 875	2 058	1 875	2 058
Croatia	328	1 220	328	1 220
Cyprus	269	541	269	541
Czechia	1 793	3 294	1 793	3 294
Denmark	1 536	537	1 536	537
Estonia	214	174	214	174
Finland	4 328	1 385	4 328	1 385
France	12 563	11 965	12 563	11 965
Germany	34 200	6 770	34 200	6 770
Greece	2 243	3 431	2 243	3 431
Hungary	2 533	2 907	2 533	2 907
Ireland	1 318	668	1 318	668
Italy	12 206	14 253	12 206	14 253
Latvia	315	379	315	379
Lithuania	1 029	563	1 029	563
Luxembourg	92	45	92	45
Malta	41	145	41	145
Netherlands	13 679	2 212	13 679	2 212
Poland	14 078	7 544	14 078	7 544
Portugal	2 387	3 388	2 387	3 388
Romania	1 372	3 872	1 372	3 872
Slovakia	698	1 121	698	1 121
Slovenia	373	206	373	206
Spain	5 474	9 485	5 474	9 485
Sweden	3 422	578	3 422	578
United Kingdom	60 203	12 770	60 203	12 770
EU-27+UK	**185 179**	**92 916**	**185 179**	**92 916**
Iceland	150	187	150	187
United Kingdom (KP)	60 324	12 896	60 324	12 896
EU-KP	**185 449**	**93 230**	**185 449**	**93 230**

Note: The first two column show total emissions from 5A reported in kt CO_2 eq. The last two columns show CH_4 emissions in kt CO_2 eq. As only CH_4 emissions are reported under 5.A the figures in the columns are identical
Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.1.1 Managed waste disposal sites (CRF Source Category 5A1)

Table 7.3 provides information on emission trends of the key source CH_4 from 5A1 Managed Waste Disposal on Land by Member State. CH_4 emissions from this source account for 2.2 % of total EU-KP GHG emissions in 2020. Between 1990 and 2020, CH_4 emissions from managed landfills declined by 48,5 % in the EU-KP.

Thirteen EU-KP countries reduced their emissions from this source during that period while Croatia, the Czech Republic, Greece, Hungary, Italy, Portugal, Slovakia, Spain and Iceland did not. Bulgaria, Cyprus, Estonia, Ireland, Latvia, Malta, and Romania did not report CH_4 emissions from managed landfills in 1990. In 2020, CH_4 emissions from managed landfills decreased by 1.7% compared to 2019.

Table 7.3 5A1 Managed Waste Disposal on Land: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	3 644	882	831	1.0%	-2 813	-77%	-51	-6%	T2	CS,D
Belgium	2 967	648	575	0.7%	-2 393	-81%	-73	-11%	T2	D
Bulgaria	NO	1 070	1 087	1.3%	1 087	∞	17	2%	T2	CS,D
Croatia	16	1 145	1 162	1.4%	1 146	7059%	17	1%	T2	CS
Cyprus	NO	112	139	0.2%	139	∞	27	24%	T2	D
Czechia	1 793	3 262	3 294	4.0%	1 501	84%	32	1%	T1	D
Denmark	1 536	534	537	0.7%	-999	-65%	3	0%	CS,T2	CS,D
Estonia	NO	182	174	0.2%	174	∞	-8	-4%	T2	D
Finland	4 328	1 426	1 385	1.7%	-2 943	-68%	-41	-3%	T2	CS,D
France	12 563	12 372	11 965	14.7%	-598	-5%	-407	-3%	T2	CS,D
Germany	34 200	7 187	6 770	8.3%	-27 431	-80%	-417	-6%	T2	CS
Greece	80	1 926	2 084	2.6%	2 004	2505%	158	8%	T2	CS,D
Hungary	393	1 757	1 788	2.2%	1 396	355%	31	2%	T2	D
Ireland	NO	677	668	0.8%	668	∞	-9	-1%	T2	CS,D
Italy	6 386	11 443	12 339	15.2%	5 952	93%	896	8%	T2	CS
Latvia	NO	254	263	0.3%	263	∞	9	3%	T2	D
Lithuania	684	437	439	0.5%	-245	-36%	1	0%	T2	D
Luxembourg	92	46	45	0.1%	-47	-51%	-1	-3%	T1	D
Malta	NO	134	138	0.2%	138	∞	4	3%	T2	M
Netherlands	13 679	2 372	2 212	2.7%	-11 467	-84%	-160	-7%	T2	CS
Poland	5 829	4 743	4 608	5.7%	-1 221	-21%	-135	-3%	T2	CS,D
Portugal	663	2 879	2 813	3.5%	2 150	324%	-66	-2%	T2	CS,D
Romania	NO	2 025	2 167	2.7%	2 167	∞	142	7%	T2	CS,D
Slovakia	698	1 129	1 121	1.4%	423	61%	-8	-1%	T2	CS
Slovenia	373	225	206	0.3%	-167	-45%	-19	-9%	T2	CS,D
Spain	4 324	8 984	8 894	10.9%	4 571	106%	-90	-1%	T2	CS,D,OTH
Sweden	3 422	634	578	0.7%	-2 844	-83%	-56	-9%	T2	CS,D
United Kingdom	60 203	14 011	12 770	15.7%	-47 434	-79%	-1 241	-9%	T2	CS
EU-27+UK	**157 874**	**82 498**	**81 052**	**100%**	**-76 822**	**-49%**	**-1 446**	**-2%**	**-**	**-**
Iceland	17	139	166	0.2%	149	887%	26	19%	T2	CS,D
United Kingdom (KP)	60 324	14 136	12 896	15.9%	-47 427	-79%	-1 240	-9%	T2	CS
EU-KP	**158 011**	**82 762**	**81 344**	**100%**	**-76 667**	**-49%**	**-1 418**	**-2%**	**-**	**-**

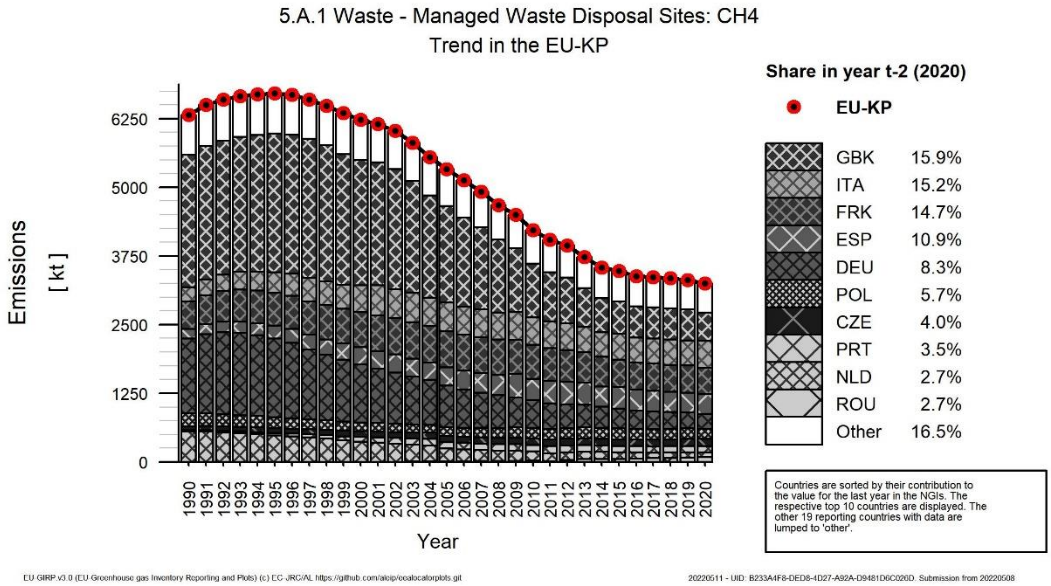
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from solid waste disposal on managed land decreased considerably between 1990 and 2020 by 48,5 %. *Figure 7.6* shows the trend of emissions indicating the countries contributing most to EU-KP total.

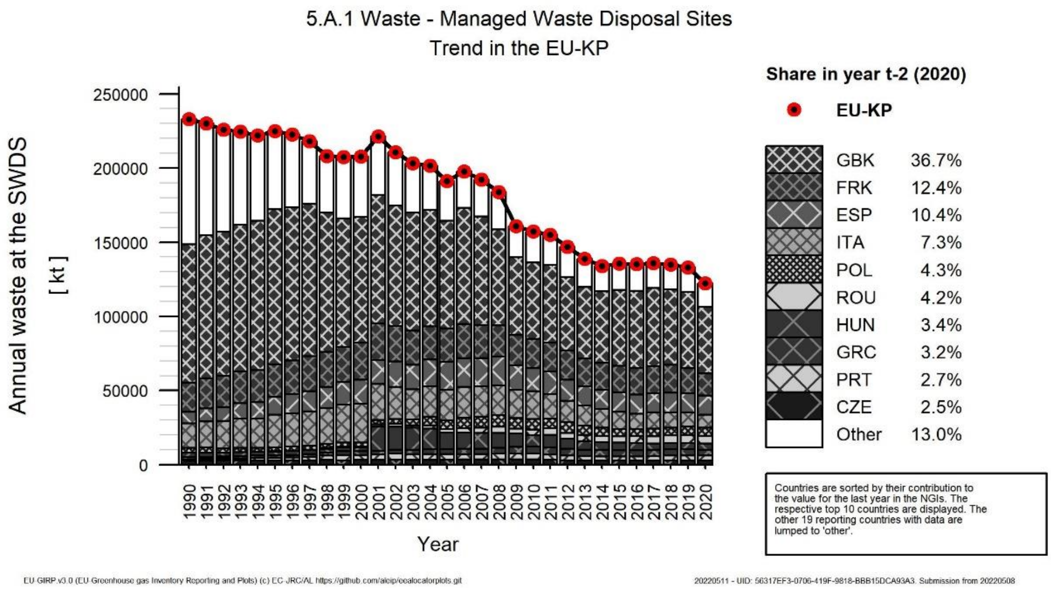
The countries with highest emissions from this source in 2020 were the United Kingdom, France, Italy, Spain and Germany. These MS account for 65% of EU-KP CH_4 emissions from 5A1. The largest reductions in absolute terms between 1990 and 2020 were reported by the United Kingdom (–47,4 Mt CO_2 equiv.) and Germany (–27,4 Mt CO_2 equiv.). The emission reductions are partly due to the (early) implementation of the landfill waste directive or similar legislation in these countries. The landfill waste directive was adopted in 1999 and requires the Member States to reduce the amount of biodegradable waste disposed untreated to landfills and to install landfill gas recovery at all new sites.

Figure 7.6 5A1 Managed waste disposal on land: CH_4 emissions (Trend in relevant countries)



A main driving force of CH_4 emissions from managed waste disposal on land is the amount of waste, especially of biodegradable waste going to landfills. According to the CRF Tables submitted in 2022 the yearly total amount of waste disposal on managed landfills declined by 47,5 % between 1990 and 2020 (see *Figure 7.7*). In addition, CH_4 emissions from landfills are influenced by the amount of CH_4 recovered and utilized or flared. The share of CH_4 recovery has increased significantly in EU-KP since 1990 (see Figure 7.8).

Figure 7.7 5A1 Managed waste disposal on land: Waste disposal (Trend in relevant countries)



In the following description more information is provided for the countries that are contributing most to the trend of this key category on the level of the EU-KP.

The **United Kingdom (KP)** has a high share of CH_4 emissions from managed landfills among countries contributing 15,9 % to EU-KP emissions in 2020. From 1996 onwards CH_4 emission decreased continuously due to a reduction of the amount of waste landfilled and also due to very high amounts of CH_4 recovery. Since 2012 the amount of CH_4 recovery shows a declining trend, with a decrease of CH_4 emissions by 8.8% between 2019 and 2020. This decline can be explained by the decrease of methane generates (due to a reduction of the amount of waste landfilled) and by the increase of methane collection efficiency (up by 3.2% compared to 2019).

France, contributing with 14.7 % to EU-KP emissions in 2020, increased its emissions from managed solid waste disposal sites steadily until 2003; followed by a declining trend until 2015 and a steady trend thereafter. Emissions followed the increased amount of municipal waste going to landfills until 2000, which decreased until 2016. Between 2016 and 2018, the amount of municipal waste going to landfills increased temporary before decreasing sharply since 2018. This situation over recent years leads to a decrease in CH_4 emissions by 3.3% between 2019 and 2020. Small amounts of CH_4 have been flared and recovered already in 1990, increasing up to 2015. , Since 2015 a steady amount of CH_4 recovery can be found despite a decrease of 2,2% between 2019 and 2020.

Italy, contributing with 15,2 % to EU-KP emissions in 2020, featured a rapid increasing trend of CH_4 emissions from landfills until 2001 and a slow decreasing trend thereafter. This is driven, inter alia, by the increasing amount of waste landfilled until 2000 and a decrease thereafter. Also, CH_4 recovery has increased throughout the time series up to 2013 and decrease onward. The key drivers for the fall in emissions are the national policy diverting solid waste from landfill to waste incineration plants and waste diversion measures (composting and mechanical and biological treatment have showing a remarkable rise due to the enforcement of legislation). Anyway, in 2020, CH_4 emissions from managed solid waste disposal increased by 7.8 % compared to 2019 because in of a significant decrease in biogas collection in 2020.

CH_4 emissions in **Spain**, contributing with 10.9 % to EU-KP emissions in 2020, increased almost continuously between 1990 and 2009 due to a growth of the annual municipal solid waste going to solid waste disposal sites. Key drivers are a growing population and the shift of waste disposal from unmanaged to managed landfills. CH_4 emissions are decreasing since 2009 with fluctuations from 2008 to 2015 due to fluctuations in the amount of CH_4 recovery. CH_4 recovery and flaring of CH_4 has already been practiced in earlier years and increased significantly from 2002 to 2009. In 2020, CH_4 emissions from solid waste disposal decreased slightly by 1.0 % compared to 2019.

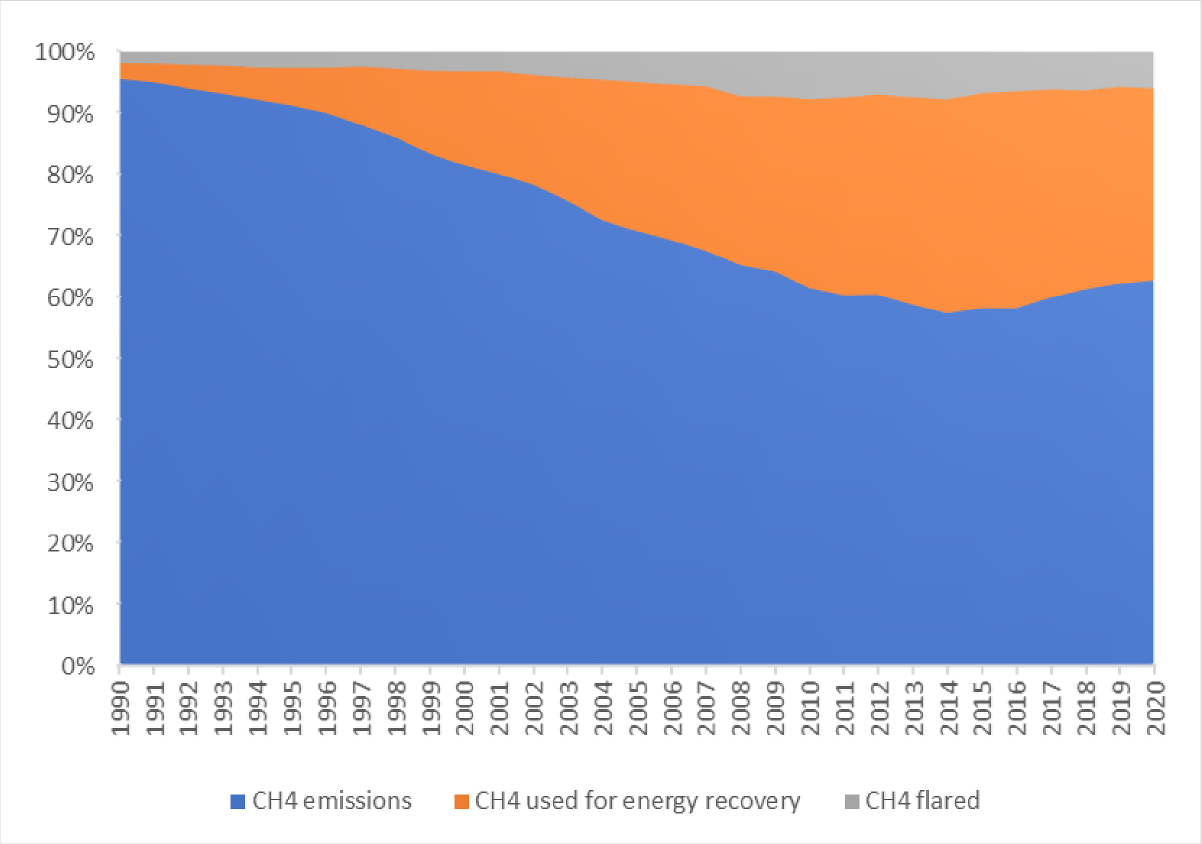
Germany, contributing with 8.3 % to EU-KP emissions in 2020, managed to reduce CH_4 emissions steadily until now from 1993 onwards. The amount of waste disposed on landfills shows a strong decrease from 1990 onwards, while in parallel CH_4 recovery increased. The highest share of CH_4 recovery could be found in 2002 and declined thereafter due to a strong decreasing amount of waste landfilled.

Methane recovery and flaring

Besides lower quantities of organic carbon deposited on landfills, the major determining factor for the decrease in net CH_4 emissions are increasing methane recovery rates from landfills and flaring of CH_4.

CH_4 recovery and flaring of CH_4 in EU-KP increased from 4.0 % of the total amount of CH_4 generated ("generated" = CH_4 emitted / (1-Ox) + CH_4 flared + CH_4 recovered where the oxidation factor Ox = 0.9) in managed landfills (only 5A1) in 1990 to 34,9 % in 2020 (Figure 7.8, Figure 1.9). Methane recovery is further promoted by the Landfill Directive, and monitoring programs are established. The recovery potential depends on the waste management strategies, e.g. diverting organic fractions to composting leaves more inert materials on landfills and reduces the potentials to recover and use CH_4. Compared to 2019, CH_4 for energy recovery decreased by 4.9% and CH_4 flaring increased by 1.3% in 2020 in managed landfills. This is caused by reduced amounts of waste landfilled and the ban of organic material in the landfilled waste.

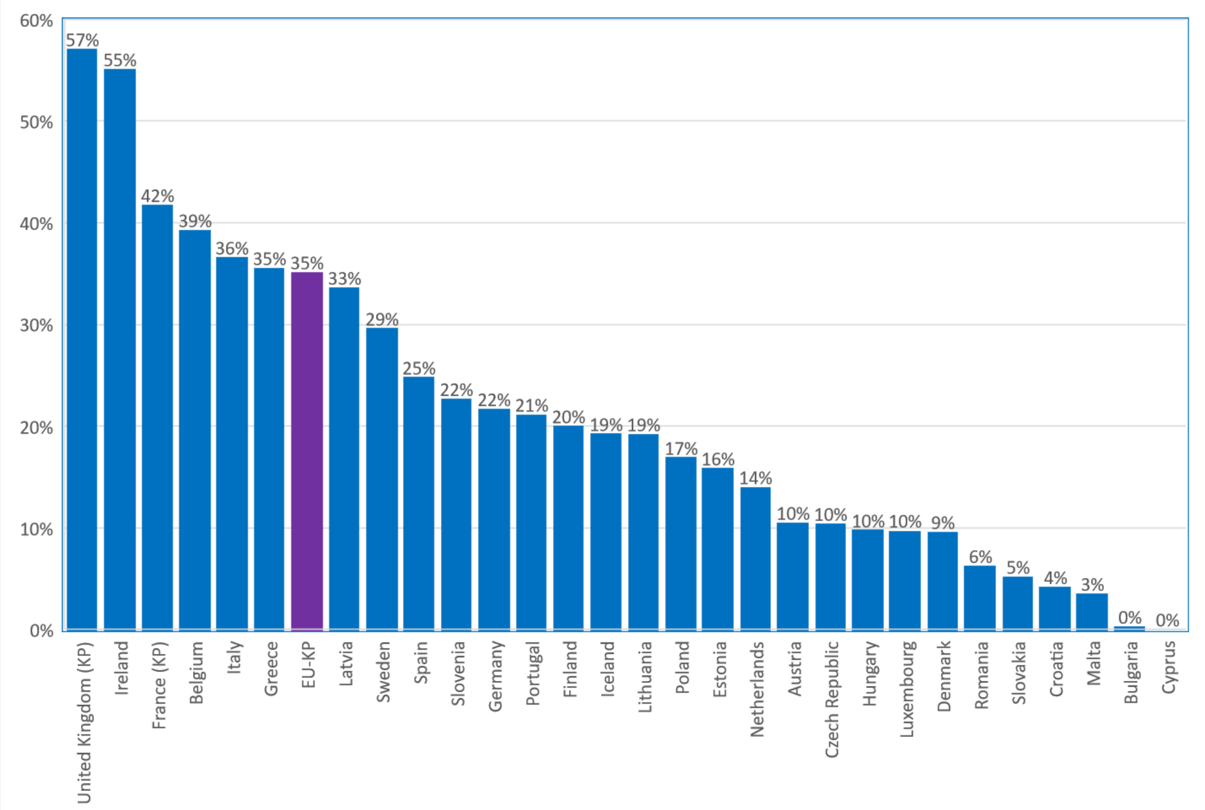
Figure 7.8 5A1 Managed Solid Waste Disposal: Evolution of the share of methane used for energy recovery, methane flared and CH_4 emissions in managed landfills in the EU-KP



Source: CRF 2022, Table 5A

The recovered CH_4 is the amount of CH_4 that is captured for energy use and is a country-specific value which has significant influence on the emission level. Additionally, the amount of CH_4 flared is considered. The percentage of CH_4 recovered and flared, in Figure 7.9, varies among the countries between 0 % in Cyprus and 57 % in UK (KP) and depends - amongst other - on the share of solid waste disposal sites where recovery installations exist. Cyprus does not report any data under 5.A CH_4 recovery and flaring in 2020. For 2011 - 2014 and since 2017 Malta reported a small amount of CH_4 flared and reported a small amount for CH_4 recovery in 2013 and 2014and since 2017.

Figure 7.9 5A1 Managed Solid Waste Disposal: Methane recovery fraction (energy recovery and flaring) for 2020



CH_4 recovery and flaring in % = (CH_4 recovery in Gg + CH_4 flared in Gg)/ (CH_4 recovery in Gg + CH_4 flared in Gg + CH_4 emissions 5A1/0,9 in Gg)
CH_4 emissions from 5A2 unmanaged landfills are not included in this calculation
Source: CRF 2022 Table 5A

Methodological issues

For key sources in the source category 5A it is good practice to use the First Order Decay (FOD) method to calculate the emissions and to display emission trends over time. According to Table 7.3 the Czech Republic and Luxembourg apply a Tier 1 method to estimate CH_4 emissions from solid waste disposal on managed landfills. Giving the IPCC 2006 Guidelines for National Greenhouse Gas Inventories, the First Order Decay (FOD) method that accounts for the fact that the degradable organic components decay slowly over decades, has to be applied for all Tier levels. The Tier 1 method applies mainly default parameters and default activity data. The Tier 2 FOD method requires data on current as well as historic waste quantities, composition and disposal practices for several decades. Historical waste disposal data for 10 years or more should be based on country-specific statistics, surveys or other similar sources. In the following, a short overview of the most important parameters and methodological aspects of the FOD method is presented. The main factors influencing the quantity of CH_4 produced are the amount of waste disposed on land and the concentration of biodegradable carbon in that waste. Further methodological information for all EU countries and Iceland is provided in the Annex III of this submission.

Municipal Waste landfilled

The amount of waste disposed on SWDS depends on the total amount of waste generated and the share of waste disposed. The total amount of waste disposed can be calculated by using total population numbers, waste generation rate per capita and the share of waste disposed. The FOD method requires historic data on waste generation and the share of waste landfilled over decades but it is difficult to achieve consistent time series for the activity data over such long periods.

countries that do not have historic data on waste generation and waste disposal available use the default IPCC values for the waste generation rate per capita and the share of waste disposed and apply inter- or extrapolation methods to create a time series. Recent data on waste generation and waste disposal is available in most EU countries and Iceland and is not estimated based on the per capita waste generation rate and a share of waste landfilled, but on direct measurements.

The data sources used for generating time series of activity data by the countries and Iceland are summarized in the Annex III.

Industrial waste

Data on industrial waste may be difficult to obtain in many countries and there are only very few default values available. Only industrial waste that contains organic or fossil carbon fractions needs to be included in the inventory. Many countries do not provide any information on industrial waste landfilled, while other countries report that industrial waste is not reported separately and included under municipal solid waste. Further information on the reporting of industrial waste by the countries and Iceland is summarized in the Annex III.

Sludge

Some countries dispose of sludge from domestic and industrial wastewater plants in landfills. The amount of sludge from domestic wastewater might be included under municipal waste or sludge from industrial wastewater may be included under industrial waste. Double counting needs to be avoided by reporting a consistent amount of sludge that is disposed of on SWDS; only sludge that goes along with solid waste has to be accounted under this category. All other sludge that is composted, incinerated, treated in wastewater plants or applied to agricultural land should be accounted under other categories. There is no IPCC default activity data available. If no country-specific activity data is available on the amount of sludge that is disposed, composted, incinerated or spread on agricultural land, all emissions from sludge are included under wastewater treatment.

Waste composition

The amount of methane generated on SWDS depends strongly on the waste composition. Disposing waste with no or hardly degradable carbon (e.g. metal or plastics) does not contribute to CH_4 emissions, but the disposal of paper or food waste with large degradable organic carbon fractions leads to high CH_4 emissions. The composition of the waste landfilled is strongly influenced by waste management practices, such as recycling or composting. This leads also to varying waste compositions along the time series. Based on the information provided in the CRF tables and the NIR it is not possible to conduct a time series for waste composition in the EU-KP. Country specific information on waste composition is provided in the Annex III.

Landfill gas recovery

Countries use different methods to determine CH_4 recovery. Several countries combine different methods and sources to estimate the amounts of CH_4 recovered for flaring or for energy purposes, while other countries are using only one method. Data on landfill gas recovery can be based on measured plant specific data, questionnaires and surveys or can be taken from the energy statistics. Further information on CH_4 recovery in the country is provided in the Annex III of this submission.

Emission factors and parameters

Besides information on the amount of waste landfilled, the waste composition and the amounts of CH_4 recovered, other parameters are relevant for the calculation of CH_4 emissions from waste disposal. The fraction of degradable organic carbon (DOC) dissimilated in the individual waste fractions and the methane generation rate constant, which reflects the years necessary for the degradable organic carbon to decompose, are the most relevant parameters for calculating CH_4 emissions. Further parameters included in the calculation are the methane correction factor (MCF), the fraction of DOC that decomposes, the fraction of CH_4 in generated landfill gas and the oxidation factor.

Fraction of Degradable Organic Carbon (DOC): There are default IPCC values for DOC of the different waste fractions available (paper, food waste etc.). Some countries have conducted own chemical analysis to determine the DOC value of different waste fractions. The DOC content of total landfilled waste is based on the composition of waste and can be calculated from a weighted average of the carbon content of various components of the waste. Countries have MSW with widely differing waste compositions. If large amounts of organic waste is composted and waste is pretreated before disposed on landfills the average DOC is very low, even if still a high amount of waste is disposed. As waste composition varies over time and single DOC values are used for individual waste fractions the DOC-values also vary over time. A few examples: in the case of the United Kingdom, a detailed review of waste composition with regard to materials, moisture content and decomposable degradable organic carbon was carried out. For Austria composting became a more important waste treatment method. Consequently, considerable amounts of waste with high DOC are excluded from category 5A which results in a lower DOC for the remaining MSW. In addition, the DOC reflects the considerable reductions achieved in diverting biodegradable waste to other waste management methods such as composting or mechanical-biological treatment. Within this submission a table in Annex III is provided containing detailed information on the DOC values extracted from the NIR.

Methane generation rate constant: CH_4 is emitted on SWDS over a long period of time rather than instantaneously. The FOD model can be used to model landfill gas generation rate curves for individual landfills over time. One important parameter is the methane generation rate constant (also referred to as k-value or half-life value). It is determined by a large number of factors associated with the composition of waste and the conditions at the site. The restructured CRF tables do not include information on the methane generation rate constant anymore. Within this submission a table in the Annex III is provided that contains corresponding detailed information on the methane generation rate constant extracted from the individual NIRs from the countries.

7.2.1.2 Unmanaged waste disposal sites (CRF Source Category 5A2)

CH_4 emissions from 5A2 Unmanaged Waste Disposal on Land account for 0.3 % of total EU-KP GHG emissions in 2020. Between 1990 and 2020, CH_4 emissions from this source decreased by 57.0 % (Table 7.4). In 2020, CH_4 emissions from unmanaged landfills decreased by 5.5 % compared to 2019. Almost all countries with unmanaged waste disposal feature a decreasing emission trend, due to a decreasing amount of municipal waste going to unmanaged waste disposal sites. Only Cyprus and Romania showed an increase of CH_4 emissions from unmanaged landfills between 1990 and 2020 (respectively +49.7% and +24.3 %). In Romania CH_4 emissions from unmanaged waste disposal sites increased until 2010, but showed a decreasing trend from 2010 onwards. Between 2010 and 2020 the CH_4 emissions decreased by 32.4 %. In Cyprus, CH_4 emissions from unmanaged waste disposal sites increased until 2010, and showed a steady trend from 2010 onwards.

Table 7.4 5A2 Unmanaged Waste Disposal on Land: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	1 875	1 054	971	8.6%	-904	-48%	-83	-8%	T2	CS,D
Croatia	312	77	58	0.5%	-254	-81%	-19	-25%	T2	CS
Cyprus	269	422	403	3.6%	134	50%	-19	-5%	T2	D
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	IE	NO	NO	-	-	-	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	NA	NA
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	2 163	1 398	1 347	12.0%	-816	-38%	-52	-4%	T2	CS,D
Hungary	2 140	1 169	1 118	10.0%	-1 022	-48%	-51	-4%	T2	D
Ireland	1 318	IE	IE	-	-1 318	-100%	-	-	NA	NA
Italy	5 820	2 001	1 914	17.1%	-3 905	-67%	-87	-4%	T2	CS
Latvia	315	129	116	1.0%	-199	-63%	-13	-10%	T2	CS,D
Lithuania	345	136	124	1.1%	-220	-64%	-12	-8%	T2	D
Luxembourg	IE	IE	IE	-	-	-	-	-	NA	NA
Malta	41	8	7	0.1%	-34	-82%	0	-2%	M	M
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	7 156	2 438	2 277	20.3%	-4 879	-68%	-161	-7%	T2	CS,D
Portugal	1 723	617	575	5.1%	-1 148	-67%	-42	-7%	-	-
Romania	1 372	1 793	1 705	15.2%	334	24%	-88	-5%	T2	CS,D
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1 150	620	590	5.3%	-560	-49%	-30	-5%	T2	D
Sweden	NO	NO	NO	-	-	-	-	-	NA	NA
United Kingdom	NO	NO	NO	-	-	-	-	-	NA	NA
EU-27+UK	**25 998**	**11 862**	**11 206**	**100%**	**-14 792**	**-57%**	**-656**	**-6%**	**-**	**-**
Iceland	133	22	21	0.2%	-112	-84%	-1	-5%	T2	CS,D
United Kingdom (KP)	NO	NO	NO	-	-	-	-	-	NA	NA
EU-KP	**26 131**	**11 884**	**11 227**	**100%**	**-14 904**	**-57%**	**-657**	**-6%**	**-**	**-**

Note: According to the MS NIR Ireland, Portugal and Malta apply a Tier 2 method to calculate CH_4 emissions from waste disposal on unmanaged landfills.
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from unmanaged solid waste disposal sites decreased considerably between 1990 and 2020 by 57 %. *Figure 7.10* shows the trend of emissions indicating the countries contributing most to

EU-KP total. In comparison to the rather drastic decrease of the amount of waste disposed on unmanaged landfills (see *Figure 7.11*) CH_4 emissions from unmanaged landfills show only a moderate decrease during the time series.

Not all countries reported emissions from this source since all waste disposal sites in the countries are managed (Austria, Belgium, the Czech Republic, Denmark, Estonia, France, Germany, the Netherlands, Slovakia, Slovenia, Sweden and the United Kingdom) or they are included elsewhere (Finland, Ireland, Luxembourg). Poland, Italy, Romania, Greece and Bulgaria are responsible for about 73 % of the total EU-KP emissions from unmanaged waste disposal sites in 2020. Poland andItaly, representing respectively 20,3% and 17,1% of CH_4 emissions of the category in 2020,show the larger absolute reductions between 1990 and 2020.

Figure 7.10 5A2 Waste disposal on unmanaged landfills: CH_4 emissions (Trend in relevant countries)

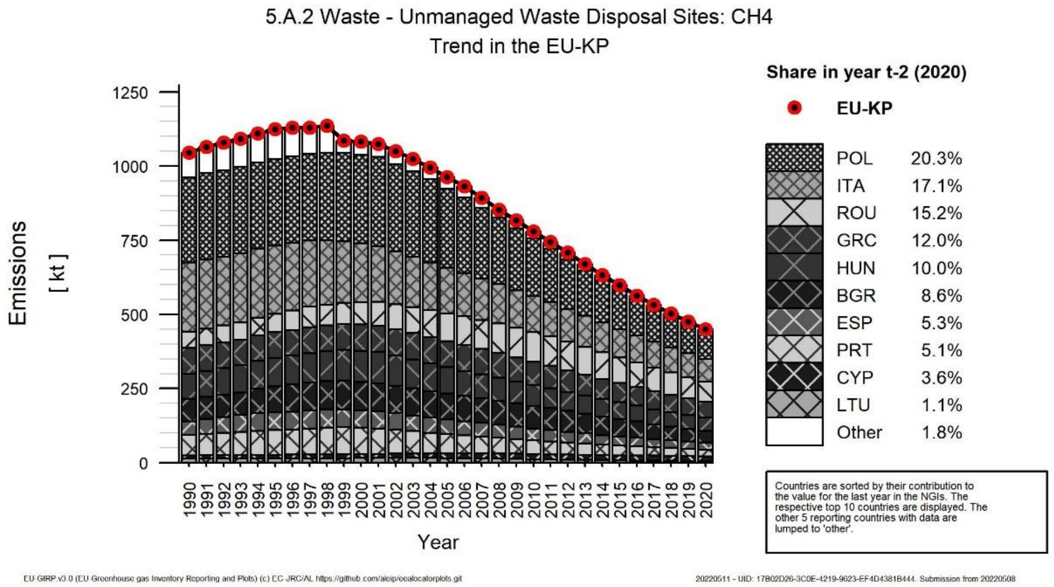
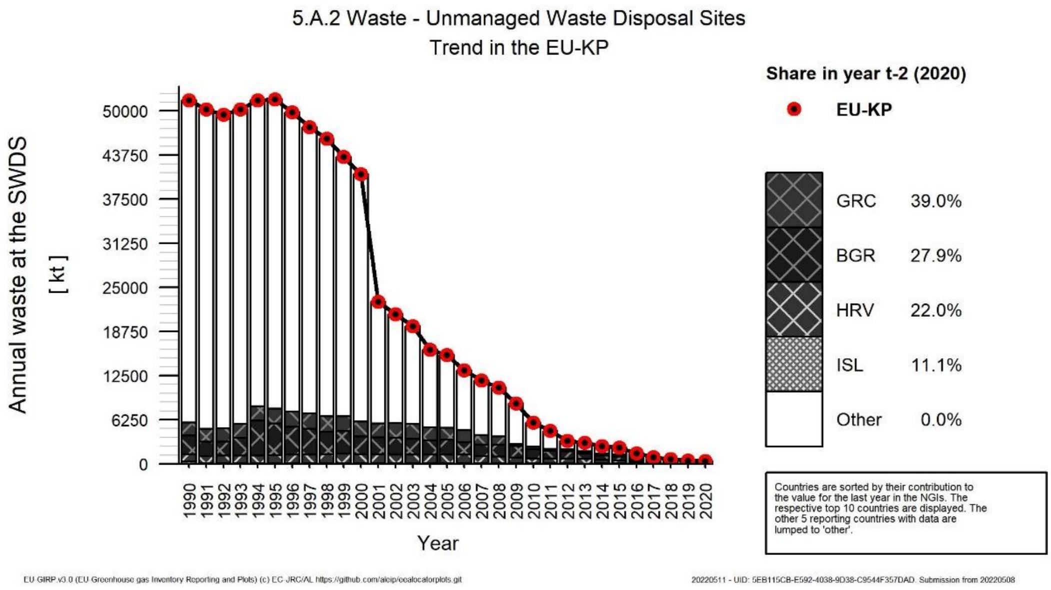


Figure 7.11 shows the relevant trends for the amount of waste disposed on unmanaged landfills. In the description below Figure 1.11 we focus on the countries with the highest CH_4 emissions from unmanaged SWDS in 2019. Note that, in some countries, waste disposal in unmanaged landfills was practiced but does not occur anymore. However, emissions are still produced from the waste disposed in the past. For the following countries, there are still emissions, but no more waste is disposed on the unmanaged landfills as from the year mentioned: Ireland since 1999, Italy since 2000, Hungary since 2001, Finland since 2002, Portugal and Malta since 2005, Slovakia since 2010, Poland since 2012, Latvia and Spain since 2013, Romania in 2018, Cyprus since 2019 and Lithuania since 2020.

For countries still using unmanaged landfills (Bulgaria, Croatia, Greece, Iceland), solid waste disposal on unmanaged landfillsites is still practiced, but the amount of waste disposed is considerably decreasing since 1992. The highest reductions in the amount of waste disposed between 1990 and 2020 are found for Bulgaria and Greece. In countries which still dispose waste in unmanaged landfills in 2020, the relative decrease of waste disposed is higher than 90% in comparison with 1990, except for in Iceland (-84%) .

Figure 7.11 5A2 Waste disposal on unmanaged landfills: Total waste disposed on unmanaged landfills (Trend in relevant countries)



Poland's CH_4 emissions from the disposal of solid waste on unmanaged landfills contribute 20.3 % to EU-KP emissions from this source category in 2020. Since 2001 the emissions show a decreasing trend. Key drivers for this decrease are the implementation of the landfill directive 1999/31/EC and the introduction of new waste treatment technologies that reduce the amount of waste disposed on unmanaged landfills (zero disposal on unmanaged SWDS in Poland since 2012).

Italy, contributing with 17.1 % to EU-KP emissions in 2020, managed to reduce CH_4 emissions from solid waste disposal on unmanaged landfills already from 1991 onwards. The reduction of emissions from unmanaged waste disposal on land is caused by legal acts. The first legal provision concerning waste management was issued in 1982. In this decree, uncontrolled waste dumping as well as unmanaged landfilling is forbidden, but the enforcement of these measures was concluded only in 2000. Thus the share of waste disposed on uncontrolled landfills gradually decreased, and in the year 2000 it is assumed to be zero; nevertheless emissions still occur due to the waste disposed in the past years.

Romania is contributing with 15.2% to EU-KP CH_4 emissions from unmanaged landfills in 2020. From 2010 CH_4 emissions are declining. The amount of waste disposed on unmanaged landfills is zero since 2018.

Greece is contributing with 12.0 % to EU-KP CH_4 emissions from unmanaged landfills in 2020. CH_4 emissions are declining over the time series especially since 2004, due to an important reduction of waste disposed on unmanaged landfills. After a sharp reduction, the amount of wastedisposed on uncontrolled landfillsis steady. b.

Methodological issues

CH_4 emissions from unmanaged solid waste disposal sites were reported in 13 EU countries (Bulgaria, Croatia, Cyprus, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Romania and Spain) and Iceland. Only three of these EU countries (Bulgaria, Croatia, and Greece) and Iceland still dispose MSW to unmanaged SWDS, although in small quantities, while in all other countries waste disposal from the past still cause emissions in 2020 (see Table 7.4). 100% of all EU-KP emissions from this category are calculated using higher tier methods.

CH_4 emissions from waste disposal on unmanaged landfills are calculated similar to CH_4 emissions from managed landfills, using the amount of waste disposed on unmanaged landfills. If no other data is available the same data on waste composition and the same parameters as used for managed landfills can be applied in the calculation. The Methane Correction Factor (MCF) is the relevant parameter that differentiates between managed and unmanaged landfills. The Methane Correction Factor reflects the way in which a SWDS is managed and the effect of management practices on CH_4 generation. According to the 2006 IPCC Guidelines, the MCF for unmanaged disposal of solid waste depends of the type of site – shallow or deep. The IPCC default MCF for deep unmanaged landfills is 0.8, while shallow unmanaged landfills have an MCF of only 0.4 as in shallow landfills more waste decomposes aerobically. Table 7.5 shows the different MCFs used by countries to estimate CH_4 emissions from waste disposal on unmanaged landfills in 2018. All countries use a MCF between 0.6 and 0.8, except for Iceland (MCF = 0.2). Iceland refers to two landfill gas studies that found out that unmanaged landfills in Iceland have reduced CH_4 production in comparison to the default IPCC MCF value.

Table 7.5 5A2 Waste disposal on unmanaged landfills: MCFs applied by countries in 2020

Member State	MCF
Bulgaria	0.8
Croatia	0.8
Greece	0.8
Iceland	0.2
Lithuania	0.56

Source: CRF Table 5.A 2020

7.2.1.3 Recalculations (CRF Source Category 5A)

Table 7.6 provides information on the contribution of Countries to EU recalculations in CH_4 emissions from 5A Solid Waste Disposal on Land for 1990 and 2019 and main explanations (as available in the national inventory reports) for the largest recalculations in absolute terms. Countries contributing most to the recalculations in the year 2019 for the sector 5.A in absolute terms are France and Italy.

Table 7.6: 5A Solid Waste Disposal on Land: Contribution of countries to EU recalculations in CH_4 emissions for 1990 and 2019 (difference between latest submission and previous submission)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	0.005	0.001	-	Minor revisions are reported for category 5.A Solid Waste Disposal for the years 2016-2019 (e.g.

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						2019: +0.005 kt CO_2e) due to slightly revised activity data.
Belgium	-	-	-	-	-	-
Bulgaria	-1 559	-45	-432	-17	A new regression analysis of the generated, collected and disposed waste for the period 1950-1998 was provided by NSI and it was made a recalculation for the whole time series. The amount for Sludge was extrapolated for the period 1988-2004. The amount of methane recovery was recalculated due to updated AD and methodology.	
Croatia	1.5	0.5	19	1.6	A new CS-value for DOC in industrial waste has been used.	
Cyprus	5.2	2.0	35	7.0	Revised activity data of non-municipal solid waste	
Czechia	-	-	-132	-3.9	-	updated activity data. Research on waste composition was finalised and new composition values are the reason for the recalculation.
Denmark	-	-	-	-	-	-
Estonia	-	-	-0.0001	-0.00004	-	-
Finland	-	-	3.0	0.2	-	- Recalculations have been made for the years 2006-2019 due to minor corrections made to the activity data of landfilled wastes including also data from Åland (Westerberg 2022) and due to updating the preliminary data on gas recovery in 2019.
France	0.0	0.0	-362	-2.8	-	Consideration of a new waste characterization survey (MODECOM 2017) Correction of the estimates of the quantities of methane captured (flared or recovered) over the period 2008 – 2019.
Germany	-	-	-2.7	-0.04	-	-
Greece	-	-	-	-	-	-
Hungary	-	-	-	-	-	-
Ireland	-	-	-	-	-	-
Italy	-	-	-215	-1.6	-	update of type of waste AD disposed of
Latvia	-	-	-28	-6.9	-	Waste composition was updated in IPCC model for managed sites because there was a mistake for 2019
Lithuania	-	-	0.4	0.1	-	The data on sewage sludge storage and disposal were reviewed and corrected resulting in light increase of emissions.
Luxembourg	-0.8	-0.9	-	-	Revision of the CH_4 emissions for the years 1990-2018, following an error correction.	-
Malta	-	-	-	-	-	-
Netherlands	0.1	0.0	1.6	0.1	-	Compared with the previous submission, minor recalculations for the years 2018 and 2019 in the data have been corrected in this submission.
Poland	-	-	-	-	-	-

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Portugal	-434	-15	-74	-2.1	Major revision of the time series on solid industrial waste disposal for historical years (1960-1998). Previous assumptions on annual growth rates used to estimate historical years, were replaced by another approach based on the evolution of Portuguese GDP. This change impacted the CH_4 emission estimates for the whole reporting period due to the FOD methodology.	
Romania	-	-	-	-	-	-
Slovakia	-0.0	-0.0	7.3	0.6	-	Sewage sludge landfilled was recalculated in time series, therefore CH_4 emissions were recalculated in time series.
Slovenia	-	-	-	-	-	-
Spain	-	-	-256	-2.6	-	Recalculation of VA for period 2009-2018 due to outdated data. In addition, year 2019 has been updated in line with new information provided from the focal point SGR (MITECO) with one year-lag
Sweden	-	-	0.8	0.1	-	*Not available*
United Kingdom	-	-	-195	-1.4	-	Revised waste landfilled and flaring data
EU27+UK	**-1 987**	**-1.1**	**-1 629**	**-1.7**		
Iceland	-0.0	-0.0	-1.0	-0.6	-	Addition of methane collection in Fiflholt
United Kingdom (KP)	-0.0	-0.0	-195	-1.4	-	Revised waste landfilled and flaring data
EU-KP	**-1 987**	**-1.1**	**-1 630**	**-1.7**		

7.2.2 Biological treatment of solid waste (CRF Source Category 5B)

Source category 5B Biological treatment of solid waste includes the key source CH_4 from 5B1 Composting. Besides composting the source category 5B includes the subcategory 5B2 anaerobic digestion and also emissions from mechanical-biological treatment according to the IPCC 2006 Guidelines. The whole sector 5.B contributes only 0.2 % to EU-KP total GHG emissions without LULUCF in 2020. Decomposition of biomass during biological treatment is much faster than on landfills and the CH_4 emissions are estimated on an annual basis without the need for long time series as in the case of landfills. For composting the decomposition of the organic waste fraction takes place under aerobic conditions. In anaerobic digestion processes the decomposition takes place without oxygen. Further information on emission trends and methodologies is only provided for source category composting 5B1, as anaerobic digestion 5B2 is no EU key source.

Table 7.7 provides total GHG and CH_4 and N_2O emissions by Member State and Iceland from 5B Biological treatment of solid waste. Total emissions from this category increased considerably since 1990. Thirteen countries (Bulgaria, Croatia, Cyprus, Czech Republic, Greece, Iceland, Ireland, Luxembourg, Malta, Lithania, Romania and Slovenia) did not practice this kind of waste treatment in 1990. Due to landfill regulations etc. this type of waste treatment increased considerably during the last years and all countries report emissions from this category since 2011.

Table 7.7 5B Biological treatment of solid waste: Countries contributions to total GHG emissions and CH_4 and N_2O emissions

Member State	GHG emissions in kt CO2 equivalents		N2O emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020
Austria	36	185	23	101	13	83
Belgium	7	59	4	35	3	23
Bulgaria	NO	30	NO	12	NO	17
Croatia	IE,NO	22	NO,IE	7	NO,IE	15
Cyprus	NO	10	NO	4	NO	6
Czechia	NE,IE	736	NE,IE	74	NE,IE	661
Denmark	55	447	22	73	32	374
Estonia	1	31	0	13	1	18
Finland	44	115	18	43	26	72
France	295	1 340	49	215	245	1 125
Germany	41	1 024	16	310	25	714
Greece	0	98	NO	18	0	80
Hungary	9	147	4	44	5	103
Ireland	NO	48	NO	19	NO	29
Italy	25	601	20	488	5	113
Latvia	29	63	12	19	17	44
Lithuania	0	91	0	26	0	65
Luxembourg	NE,IE,NO	23	NO,NE	5	NO,IE	18
Malta	NO	1	NO	NO,NA	NO	1
Netherlands	11	207	7	90	4	117
Poland	22	281	9	117	13	164
Portugal	9	42	4	16	5	26
Romania	NA,NO	83	NO,NA	27	NO	57
Slovakia	111	233	46	97	65	136
Slovenia	NO	19	NO	8	NO	11
Spain	204	533	85	213	119	320
Sweden	12	96	5	25	7	71
United Kingdom	31	1 928	13	713	18	1 215
EU-27+UK	**942**	**8 492**	**338**	**2 814**	**604**	**5 677**
Iceland	NA,NO	5	NO,NA	2	NO,NA	3
United Kingdom (KP)	31	1 930	13	714	18	1 216
EU-KP	**942**	**8 499**	**338**	**2 817**	**604**	**5 681**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.2.1 Waste Composting (CRF Source Category 5B1)

Emission and Trends

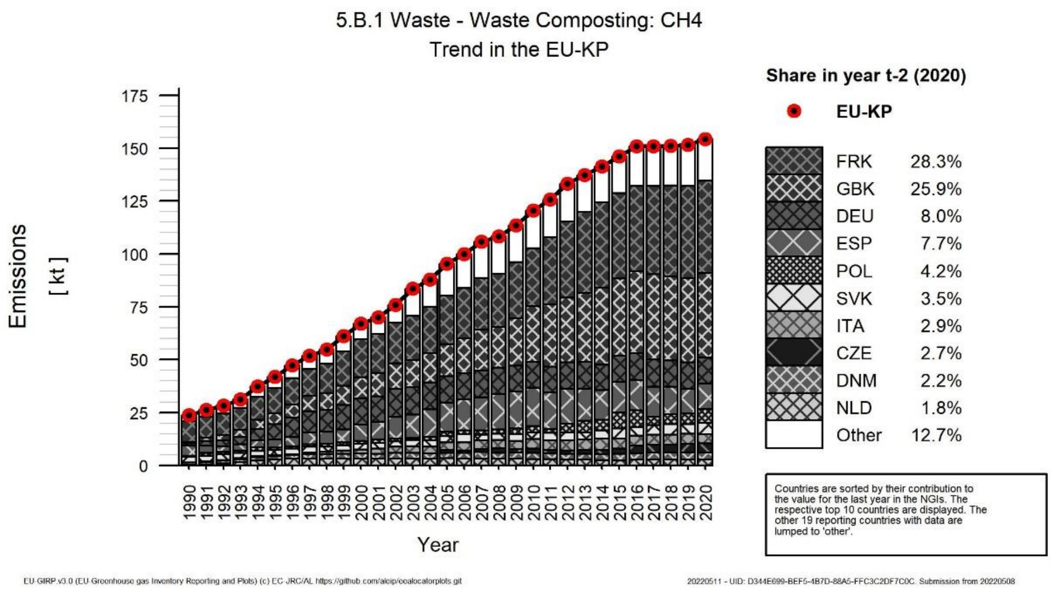
CH_4 emissions from 5B1 Composting account for 0.11 % of total EU-KP GHG emissions in 2020. Between 1990 and 2020, CH_4 emissions from this source increased considerably from 596 kt CO_2 equivalents to 3850 kt CO_2 equivalents in 2020 (Table 7.8). Malta reports emissions from composting only in the period 1993 - 2006. All countries that practice composting feature an increasing emission trend from 1990 onwards. Nevertheless between 2019 and 2020 nine countries experienced a decrease in CH_4 emissions from composting, among which five experienced a decrease higher than 7% (Bulgaria, Estonia, Finland, Greece and Lithuania). Total CH_4 emissions from composting in EU-KP increased slightly by 1.7% between 2019 and 2020 with the most important increase in Poland (34.2%).

Table 7.8: 5B1 Waste Composting: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	13	61	62	1.6%	49	377%	1	2%	T2	CS
Belgium	3	23	23	0.6%	21	798%	0	2%	T1	CS
Bulgaria	NO	19	17	0.4%	17	∞	-1	-7%	T1	D
Croatia	NO,IE	6	10	0.3%	10	∞	3	51%	T1	D
Cyprus	NO	6	6	0.2%	6	∞	0	-2%	T1	D
Czechia	NE	103	104	2.7%	104	∞	1	1%	T1	D
Denmark	27	86	85	2.2%	58	219%	-1	-1%	T1,T2	CS,D
Estonia	1	20	18	0.5%	18	2586%	-2	-9%	T1	D
Finland	26	69	61	1.6%	35	136%	-8	-12%	T1	D
France	244	1 083	1 091	28.3%	847	347%	9	1%	T2	CS
Germany	25	310	308	8.0%	283	1117%	-1	0%	T2	CS
Greece	NO	28	25	0.7%	25	∞	-3	-10%	D	D
Hungary	5	58	61	1.6%	56	1130%	3	6%	T1	D
Ireland	NO	26	26	0.7%	26	∞	0	0%	T1	D
Italy	5	115	111	2.9%	106	2302%	-4	-4%	D	CS
Latvia	17	25	27	0.7%	10	61%	2	9%	D	D
Lithuania	0	41	37	1.0%	37	17967%	-4	-11%	T1	D
Luxembourg	NO	7	7	0.2%	7	∞	0	-3%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	4	67	69	1.8%	65	1520%	2	3%	T1	CS
Poland	13	122	164	4.2%	151	1188%	42	34%	T1	D
Portugal	5	19	22	0.6%	17	338%	3	13%	T1	D
Romania	NO	33	37	1.0%	37	∞	5	14%	T1	D
Slovakia	65	118	136	3.5%	71	109%	18	15%	T1	D
Slovenia	NO	11	11	0.3%	11	∞	0	4%	T1	D
Spain	119	297	297	7.7%	178	149%	0	0%	T1	D
Sweden	7	35	35	0.9%	28	398%	0	0%	T1	D
United Kingdom	18	998	998	25.9%	979	5401%	0	0%	T1	D
EU-27+UK	**596**	**3 787**	**3 850**	**100%**	**3 254**	**546%**	**63**	**2%**	**-**	**-**
Iceland	NO,NA	2	3	0.1%	3	∞	1	30%	T1	CS,D
United Kingdom (KP)	18	999	999	25.9%	980	5408%	0	0%	T1	D
EU-KP	**596**	**3 790**	**3 854**	**100%**	**3 258**	**546%**	**64**	**2%**	**-**	**-**

Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter ‘Units and abbreviations’.

Figure 7.12 5B1 Waste Composting: CH_4 emissions (Trend in relevant countries)



Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Emissions from 5.B.1 relate with composting of municipal (5.B.1.a) and composting of other waste (5.B.1.b). As stated in figure ***Figure 7.14 5B1b Waste Composting of other waste : CH4 emissions (Trend in relevant countries)***, only 11 countries (Denmark, Slovakia, the Netherlands, Czech Republic, Finland, Hungary, Estonia, Lithuania, Poland, Latvia and Luxembourg) report emissions from other waste composting. Other countries generally report emissions from composting of all types of waste (municipal, industrial, sludge…) in the category 5.B.1.a since statistal data concerning composting generally relate to total waste and do not make a distinction between the various types of waste.

Figure 7.13 5B1a Waste Composting of municipal waste: CH_4 emissions (Trend in relevant countries)

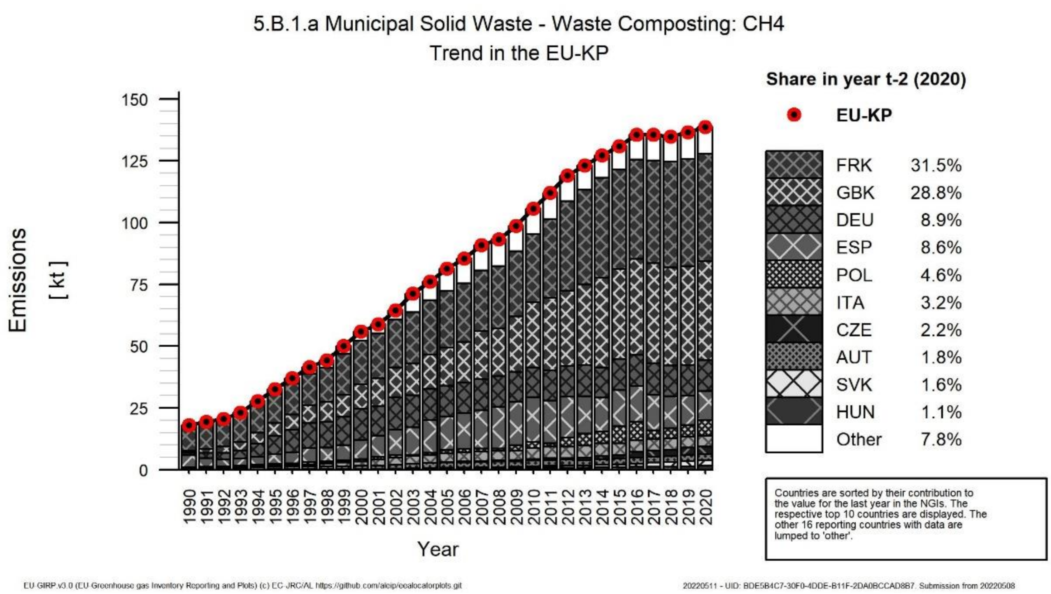
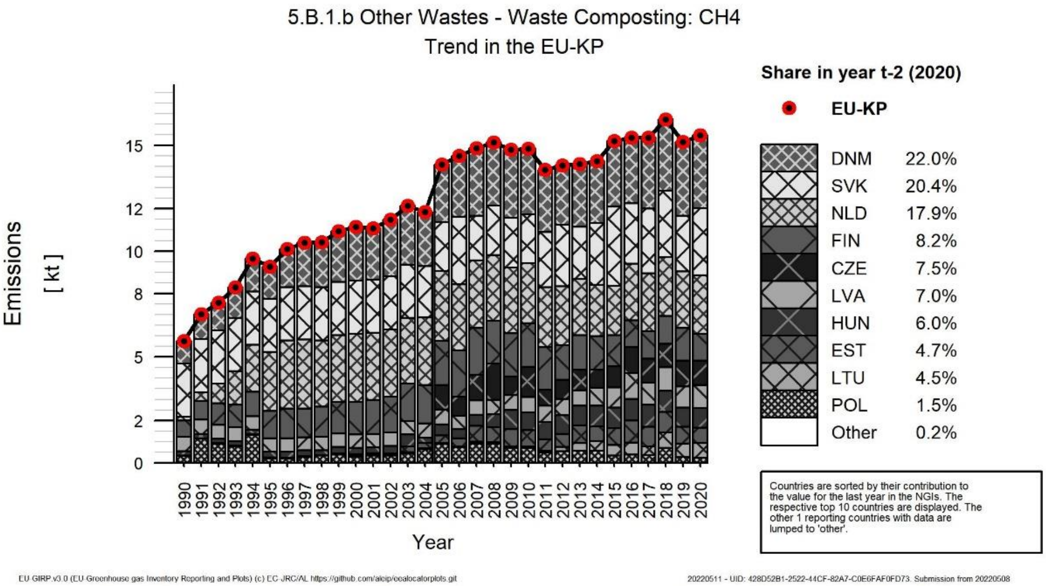


Figure 7.14 5B1b Waste Composting of other waste : CH_4 emissions (Trend in relevant countries)



Methodological information

According to the IPCC 2006 Guidelines CH_4 from composting is estimated by using the quantity of organic waste processed by composting and the respective emission factor. The application of a Tier 2 method requires the use of a country specific emission factor based on representative measurements. The IPCC default emission factor for CH_4 emissions from composting is 10 g CH_4/kg waste treated on a dry weight basis and 4 g CH_4/kg based on a wet weight basis. The range of this emission factor is very high and varies between 0.08 and 20 g CH_4/kg waste treated. Most countries apply the default EF for CH_4 emissions (see

Table 7.9). In all cases the EFs (wet vs. dry) applied by the countries are consistent with the unit of AD (wet vs. dry), even if few Member States (Cyprus and Czechia) reported on a wet basis in the CRF tables although dry basis should be reported. Only Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, Poland and Sweden present IEFs different from the default one and these EFs are within the interval indicated in the 2006 IPCC guidelines. In most cases country specific EFs are much lower than the IPCC default EF.

Table 7.9 5B1 Composting: EFs applied by countries in 2020 in g CH_4/kg waste treated (dry basis)

Member State	CH4 IEF g/kg dry matter		Member State	CH4 IEF g/kg dry matter
Austria	1.8		Ireland	10.0
Belgium	0.75		Italy	1.63
Bulgaria	10.0		Latvia	10.0
Croatia	10.0		Lithuania	10.0
Cyprus	4.55		Luxembourg	10.0
Czech Republic	4		Malta	NO
Denmark	NO,NE		Netherlands	0.81
Estonia	10.0		Poland	6.67
Finland	5.6		Portugal	10.0
France	8.43		Romania	10.0
Germany	1.4		Slovakia	10.0
Great Britain	10.0		Slovenia	10.0
Greece	10.0		Spain	10.0
Hungary	10.0		Sweden	11.43
Iceland	10.0		United Kingdom (new_KP)	10.01

Further methodological information for all countries is provided in the Annex of this submission

7.2.2.2 Recalculations (CRF Source Category 5B)

Table 7.10 provides information on the contribution of countries to EU recalculations in CH_4 from 5B Biological treatment of solid waste for 1990 and 2020and main explanations (if available in countries' inventories) for the largest recalculations in absolute terms.

Table 7.10: 5B Biological treatment: Contribution of countries to EU recalculations in CH_4 for 1990 and 2019 (difference between latest submission and previous submission)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	0.1	0.2	-	Not documented (impact lower than 500 kt CO_2eq. Or 0,05% of the national total)
Belgium	-	-	-	-	-	-
Bulgaria	-	-	9.1	95	-	Not documented (impact lower than 500 kt CO_2eq. Or 0,05% of the national total)
Croatia	-	-	6.3	127	-	The implementation of the inventory improvement project has collected activity data on the plant level, which affects their transparency, accuracy and completeness. The improvement resulted in an increase in CH_4 and N_2O emissions in the source category CRF 5.B.1 by 100% in the period from 1994 to 2006, while in the period from 2007 to 2019 the difference in emissions has a fluctuating trend and ranges from -49 % to 260%. For the source category CRF 5.B.2, CH_4 emissions have not been calculated so far. The anaerobic digestion process has been applied in the Republic of Croatia since 2009. The improvement resulted in an increase in CH_4 emissions

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						in the source category CRF 5.B.2 by 100% in the period from 2009 to 2019. The implementation of the inventory improvement project collected activity data on the plant level, which affects their transparency, accuracy and completeness.
Cyprus	-	-	-	-	-	-
Czechia	-	-	-	-	-	-
Denmark	-	-	-77	-19		For 2010-2020, improved quality of the composting data has been achieved through detailed data on the waste type garden and park waste, sludge and organic waste (Nissen, 2017a).
Estonia	-	-	-2.2	-10	-	In 2019 CH_4 and N_2O emissions are recalculated, due to the activity data error (Table 7.18). The quantity of sludge from one company were counted twice.
Finland	-	-	-	-	-	-
France	-16	-6.2	28	2.5	Change in the amount of waste composted on industrial sites in 2019. The quantity of composted waste in 2019 in the last inventory was partly based on projections made by the Ministry. Since the value previously considered contradicted the trend In order to take into account the results of the biannual ADEME surveys, it was decided to consider a stagnation of the quantity of composted waste on sites while waiting for the 2022 survey on waste treatment in 2020. This change implies a change in CH_4 and N_2O emissions for 2019. In parallel, the methodology for estimating the amount of waste composted by households (domestic management) has been revised. Historically, data from ADEME was used to estimate the quantity of domestic waste managed by domestic management in 2008 and the proportion of this waste composted in gardens. The quantities composted for the other years were then estimated in proportion to the number of main houses in France (INSEE data). Now, new data allow to estimate the quantities of household waste composted in the garden for the years 2013 and 2020. Between 2008 and 2020, for the years where no data is available, the quantities of waste composted at home are estimated by linear interpolation. As a first approach, the temporal evolution over the period prior to 2008 is carried out by indexing the quantities of green waste composted by individuals on the number of main houses in France (INSEE data). All the methodological changes relating to domestic and industrial composting lead to changes in the estimated emissions between 1990 and 2019. Concerning waste digestion, emissions were estimated according to a national method based on the biogas generation rate (320 m3 /tonne of raw material) in household waste methanisation centres and on the CH_4 content of biogas from waste methanisation (60% [237]) and a leakage rate of the biogas produced. This leakage rate (5%) was taken from the 2006 IPCC Guidelines [359]. The method was revised following discussions with international review.	
Germany	-	-	11	1.6	-	When compiling the current inventory data, statistical data on the quantities of waste deposited are always only available for the previous reporting year, as the waste statistics of the Federal Statistical Office are published two years in arrears. The current reporting year is therefore extrapolated, as described above, on the basis of the trend of the activity data of the past three years. This extrapolation is replaced in the following year by the data then collected statistically. For this reason, annual back-calculations for the previous year are necessary.

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Greece	-	-	-	-	-	-
Hungary	-	-	-13.6	-11.9	-	Data of biogas produced have been revised. Biogas from manure management has been subtracted from biogas accounted for under 5.B.2.b as it is accounted for under the Agriculture sector. In agreement with the agriculture expert, and on the basis of feedstock data from the period 2017-2020, it is assumed that 25% of all biogas is produced from manure.
Ireland	-	-	2.5	9.3	-	Improved estimates of material composted at treatment facilities and bio stabilisation of organic fines were received from the EPA's Waste Statistics team for years 2004-2019. An average recalculation to emissions of 76.1 per cent can be seen for years 2004-2019 due to this updated activity data.
Italy	-	-	3.1	2.7	-	Recalculations occur in 2019 because of the update of activity data for mechanical biological treatments.
Latvia	-	-	-	-	-	-
Lithuania	-	-	6.4	10.5	-	Some wastes can be sent for composting directly after collection (e.g. green waste) or sorting in MBT facilities. Waste remaining after completion of anaerobic digestion is also directed for composting. This portion of waste was omitted from calculations in the previous submission. In this submission, data on waste biological treatment for 2018 and 2019 were reviewed and updated (data on composting and anaerobic digestion separately are available only from 2018).
Luxembourg	-	-	-0.5	-2.8	-	For the years 2016-2019, the activity data of some composting facility has been revised which has led to a recalculation in category 5.B.1.a – Composting - Municipal Solid Waste. A mistake in the reporting from the facilities led to an overestimation of the composted waste.
Malta	-	-	-	-	-	-
Netherlands	-	-	-4.5	-4.0	-	Compared with the previous submission, minor recalculations for the year 2019 in the data have been corrected in this submission. Additionally, CH_4 emissions from the digesting of manure (category 5B2) have been added from the starting year 2006.
Poland	-	-	-	-	-	-
Portugal	-	-	-0.0	-0.0		-
Romania	-	-	20	60		CH_4 emissions from anaerobic digestion at biogas plants have been estimated for the first time.
Slovakia	-	-	8.0	7.3	-	Emissions of CH_4 and N_2O for category 5.B – Biological Treatment of Solid

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						Waste were recalculated in this submission due to changes in activity data on composting of sewage sludge from the municipal waste WTP. The Water Research Institute is the source of activity data. In the previous submissions, the municipal sewage sludge used for composting were not considered. Recalculations increased CH_4 and N_2O emissions in this category for time series since the year 1993.
Slovenia	-	-	-	-	-	-
Spain	-	-	-30	-8.6	-	As it is the case for other categories for which the SGEC is the focal point, the 2019 emissions have been recalculated for both composting and biomethanisation as updated information for that year is available. This is due to the time lag between the year of time lag between the reference year for the waste data and the last year reported by the National Inventory. In addition, information on a biomethanisation plant has been included for the period 2016-2019, as well as for the period 2016-2019.
Sweden	-	-	-13	-15.5	-	Recalculations has been done for methane from CRF 5.B.2 Anaerobic digestion at biogas facilities for the years 2005-2019. The reasons for doing the recalculations are that newly developed368 country-specific emission factors for the years 2005-2019 are available. The changes of the emission estimates varies between (–47%) and (+ 30%).
United Kingdom	-	-	-21	-1.7	-	The inputs to anaerobic digestion plant s has been revised and the historic timeline updated. This resulted in an incre ase in the quantity of waste assumed to be processed at anaerobic digestion facilities , and associated methane
EU27+UK	**-16**	**-2.6**	**-67**	**-1.2**		
Iceland	-	-	-	-	-	-
United Kingdom (KP)	-	-	-21	-1.7	-	The inputs to anaerobic digestion plant s has been revised and the historic timeline updated. This resulted in an incre ase in the quantity of waste assumed to be processed at anaerobic digestion facilities , and associated methane
EU-KP	**-16**	**-2.6**	**-67**	**-1.2**		

7.2.3 Incineration and open burning of waste (CRF Source Category 5.C)

This category includes incineration and open burning of waste. Emissions from waste incinerated for energy use are reported under 1A Fuel combustion activities. Emissions from on field burning of agricultural wastes should be reported under 3 Agriculture.

Incineration and open burning of waste is not a key category for the European Union. Some additional information can be found in the chapter 3.2.8 dedicated to waste- non key categories.

7.2.4 Wastewater treatment and discharge (CRF Source Category 5D)

Source category 5D includes the CH_4 and N_2O emissions from domestic and industrial and other wastewater treatment and discharge. Methane and nitrous oxide are produced from microbial processes (anaerobic decomposition of organic matter, nitrification) in sewage systems and facilities. N_2O is also indirectly released from disposal of wastewater effluents into aquatic environments[61]. According to the key category analysis CH_4 and N_2O emissions from 5D1 Domestic wastewater and CH_4 emissions from 5D2 Industrial wastewater are an EU key source and analysed in more detail in this chapter. N_2O emissions from industrial wastewater are not a EU key source and are therefore not further analysed in this chapter.

Domestic wastewater includes the handling of liquid wastes and sludges from housing and commercial sources through wastewater collection and treatment, open pits/latrines, ponds, or discharge into surface waters. Industrial wastewater can also be released into domestic sewer systems and resulting emissions are in that case included under domestic wastewater. On the other hand, industrial wastewater can be treated on the industrial site and then the resulting emissions will be accounted under the separate category 5D2 industrial wastewater.

Total emissions from 5D wastewater handling, including N_2O and CH_4 emissions account for 0.7 % of total EU-KP GHG emissions in 2020. Table 7.11 shows total GHG, CH_4 and N_2O emissions by Member State from 5D Wastewater Handling. Between 1990 and 2020, total emissions from wastewater handling decreased by 45.7 % in EU-KP. All countries except for France and Ireland decreased their emissions from wastewater treatment and discharge between 1990 and 2020. Due to the implementation of new wastewater treatment technologies CH_4 emission decreased considerably by 53,0% between 1990 and 2020, while N_2O emissions decreased moderately by 13.9%.

[61] In most countries, indirect N_2O emissions from disposal of wastewater effluents are the major source of N_2O emissions from wastewater handling, whereas direct N_2O emissions from wastewater treatment plants are small or not relevant.

Table 7.11 5D Wastewater handling: Countries' contributions to total GHG, CH_4 and N_2O emissions from 5D

Member State	GHG emissions in kt CO2 equivalents		N2O emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents	
	1990	2020	1990	2020	1990	2020
Austria	219	191	96	169	122	22
Belgium	1 068	330	138	102	930	228
Bulgaria	2 842	533	198	136	2 644	397
Croatia	656	537	67	90	589	447
Cyprus	127	63	11	16	116	47
Czechia	1 201	993	234	198	967	795
Denmark	280	200	239	147	41	53
Estonia	151	85	39	32	113	53
Finland	297	236	76	75	221	162
France	2 062	2 649	571	319	1 491	2 330
Germany	3 762	941	1 189	458	2 572	483
Greece	2 621	1 348	280	287	2 341	1 061
Hungary	1 050	322	148	87	902	235
Ireland	136	160	75	107	61	53
Italy	4 459	3 592	1 259	1 217	3 200	2 375
Latvia	388	105	53	32	335	72
Lithuania	490	165	67	47	423	118
Luxembourg	13	7	5	4	8	2
Malta	27	12	10	7	17	6
Netherlands	481	313	172	77	309	236
Poland	7 041	2 819	723	787	6 318	2 032
Portugal	1 717	889	200	192	1 517	697
Romania	3 714	1 949	397	425	3 317	1 524
Slovakia	596	329	130	50	466	279
Slovenia	324	170	39	38	285	132
Spain	6 043	2 631	863	914	5 180	1 717
Sweden	263	227	226	197	37	30
United Kingdom	3 137	2 675	875	993	2 262	1 682
EU-27+UK	**45 165**	**24 471**	**8 380**	**7 205**	**36 785**	**17 266**
Iceland	55	48	5	6	50	42
United Kingdom (KP)	3 161	2 711	889	1 013	2 272	1 698
EU-KP	**45 244**	**24 555**	**8 400**	**7 231**	**36 845**	**17 325**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.4.1 Domestic wastewater (CRF Source Category 5D1)

CH_4 emissions

CH_4 emissions from 5D1 Domestic Wastewater account for 0.31 % of total EU-KP GHG emissions without LULUCF in 2020. Between 1990 and 2020, CH_4 emissions decreased by 58.8% (Table 7.12). Key drivers for the large emission reduction are the development of centralized wastewater treatment plants (especially implementing aerobic treatments) and an increase of CH_4 recovery and flaring on anaerobic systems (see ***Figure 7.16***). In 2020, CH_4 emissions decreased by 1.9 % in comparison to 2019.

Table 7.12 5D1 Domestic and commercial wastewater: Countries' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	121	19	19	0.2%	-102	-84%	0	-1%	T2	CS,D
Belgium	930	239	228	2.0%	-703	-76%	-12	-5%	CR,T1	CR,D
Bulgaria	422	235	229	2.0%	-193	-46%	-6	-3%	T2	D
Croatia	492	334	334	3.0%	-159	-32%	0	0%	T1	D
Cyprus	92	15	15	0.1%	-77	-84%	0	1%	T1	D
Czechia	604	370	363	3.2%	-241	-40%	-7	-2%	T1	D
Denmark	41	52	53	0.5%	12	29%	1	1%	CS	CS
Estonia	113	49	49	0.4%	-64	-57%	0	0%	T1	D
Finland	194	141	139	1.2%	-55	-29%	-2	-1%	CS,T2	CS,D
France	1 402	2 221	2 245	19.9%	843	60%	24	1%	T1	D
Germany	2 563	451	436	3.9%	-2 128	-83%	-15	-3%	CS,D	CS,D
Greece	1 520	154	151	1.3%	-1 369	-90%	-3	-2%	D	D
Hungary	767	213	210	1.9%	-557	-73%	-3	-1%	T1	D
Ireland	61	51	53	0.5%	-8	-13%	2	4%	T1,T2	CS,D
Italy	1 680	1 012	999	8.9%	-680	-40%	-13	-1%	T1	D
Latvia	198	74	69	0.6%	-129	-65%	-5	-7%	T2	CS
Lithuania	423	120	118	1.0%	-305	-72%	-2	-2%	T1	D
Luxembourg	8	2	2	0.0%	-6	-73%	0	-4%	T1	CS
Malta	17	7	6	0.0%	-12	-67%	-2	-24%	D	CS
Netherlands	203	204	212	1.9%	8	4%	8	4%	T2	CS,D
Poland	5 692	1 852	1 755	15.6%	-3 937	-69%	-96	-5%	T1,T2	CS,D
Portugal	1 258	518	506	4.5%	-753	-60%	-12	-2%	T2	CS,D
Romania	2 939	1 395	1 331	11.8%	-1 608	-55%	-64	-5%	D	D
Slovakia	437	280	274	2.4%	-162	-37%	-5	-2%	T2	D
Slovenia	186	124	124	1.1%	-62	-33%	0	0%	T1	CS,D
Spain	3 461	553	556	4.9%	-2 905	-84%	3	0%	T2	D
Sweden	31	24	25	0.2%	-7	-22%	0	1%	T2	CS
United Kingdom	1 476	735	728	6.5%	-749	-51%	-7	-1%	CS	CS
EU-27+UK	**27 334**	**11 444**	**11 228**	**100%**	**-16 105**	**-59%**	**-216**	**-2%**	**-**	**-**
Iceland	18	24	25	0.2%	7	40%	0	2%	T1	CS,D
United Kingdom (KP)	1 486	751	744	6.6%	-742	-50%	-7	-1%	CS	CS
EU-KP	**27 361**	**11 485**	**11 269**	**100%**	**-16 092**	**-59%**	**-216**	**-2%**	**-**	**-**

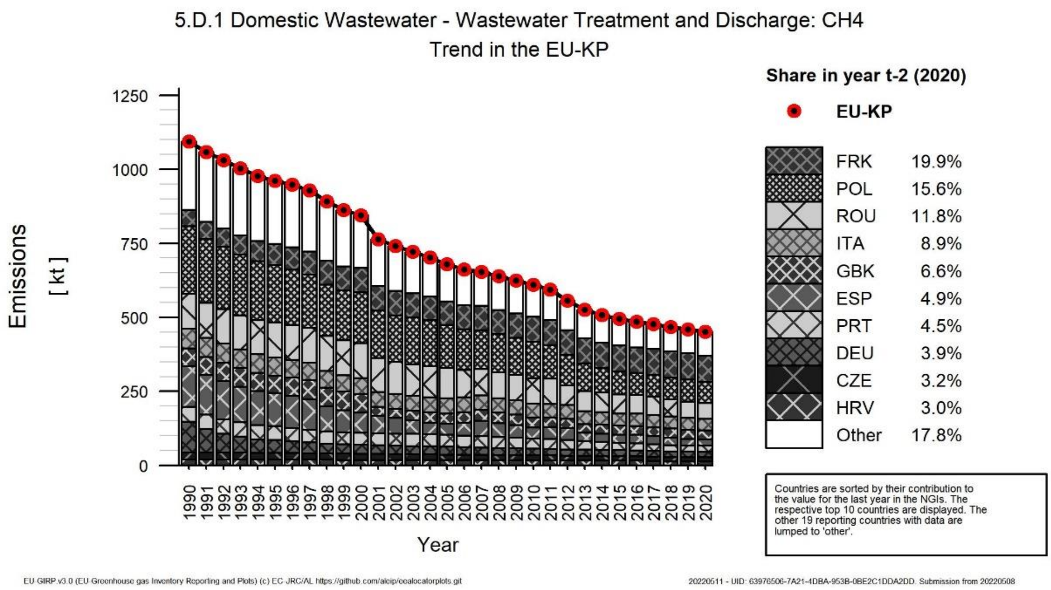
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for CH_4 emissions from domestic wastewater

CH_4 emissions from domestic wastewater treatment and discharge decreased considerably between 1990 and 2020 by 58.8%. Figure 7.15 shows the trend of emissions indicating the countries contributing most to EU-KP total.

Large decreases in absolute terms between 1990 and 2020 are reported by Poland, Spain, Germany, Romania and Greece, contributing together to only 37.5 % of EU-KP emissions from source 5D1 in 2020. Whereas France shows significant emission increases (Table 7.12) between 1990 and 2020. France is responsible for 19.9 %, Poland for 15.6 %, Romania for 11.8 % and Italy for 8.9 % of EU-KP emissions from this source in 2020. Although France increased its emissions between 1990 and 2020 by 60.1 %, the trend of EU-KP emissions is dominated by the large emission reductions in Poland, Germany, Greece, and Romania. Also the United Kingdom, Portugal, Belgium, Italy, Spain and Hungary achieved significant reductions in emissions compared to 1990.

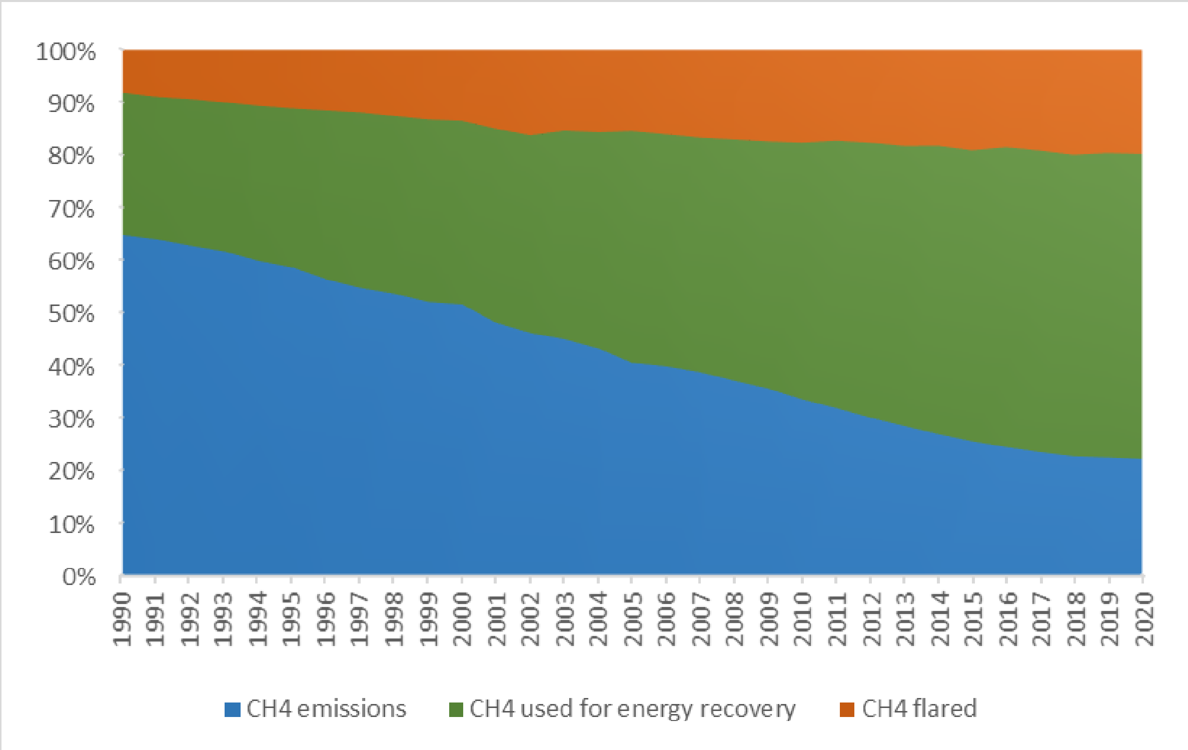
Figure 7.15 5D1 Domestic wastewater: CH_4 emissions (Trend in relevant countries)



The decreasing trend of CH_4 emissions from wastewater is not related to a decreasing quantity of wastewater and the amount of the total organic product in the wastewater. In fact the decrease is based on several reasons:

- Improvements of wastewater disposal routes with the development of centralized wastewater treatment plants, especially applying aerobic processes
- Amount of sludge removed
- Increased share of CH_4 flared or recovered (see *Figure 7.16*) on anaerobic wastewater and sludge treatment systems

Figure 7.16 5D1 Domestic wastewater: Share of CH_4 recovered or flared and CH_4 emissions on total CH_4 produced from domestic wastewater handling



Source: CRF 2022, Table 5D

In 2020, 19.8 % of the CH_4-emissions generated by Domestic Wastewater Handling were flared and 58.2 % was recovered for energy purposes.

An important driver for the total CH_4 emissions from 5D Wastewater Handling for the EU-KP are CH_4 emissions from 5D1 Domestic Wastewater in France, Germany, Greece, Poland, Italy and Romania. Therefore, more information about the development of CH_4 emissions from wastewater handling in these and other important countries is presented.

France's CH_4 emissions from domestic wastewater (5D1) show an increasing trend from 1990 to 1998, remain at a rather constant level between 1998 and 2005 and show a slight and regular increase since 2006. One driver influencing the trend is the share of population connected to different wastewater treatment systems. The share of the population connected to septic tanks increased from 1990 to 2000 (from 13 % in 1990 to 18 % in 2000), ,and remained almost constant thereafter (17 % average 2001-2020).In the same period, the share of the population with direct discharge of wastewater decreased from 8 % in 1990 to 2 % in 2005 and to 1% in 2020. Wastewater treatment in collective systems increased slightly from 79 % in 1990 to 81 % since 2005 and to 82% in 2020, but the share of anaerobic lagooning is rather high. Furthermore, France applies CH_4 recovery for generated CH_4 from wastewater since 1990.

CH_4 emissions from domestic wastewater are continuously decreasing from 1999 onwards in **Romania**. The amount of wastewater that underlies sufficient treatment increases over the years. About 80 % of the total wastewater has been treated appropriate, 9.8 % remained untreated and 10,2 % of total wastewater received only insufficient treatment in 2020. Between 2000 and 2020 public sewage systems have been expanded and modernized.

Germany's reduction in CH_4 emissions from domestic and commercial wastewater (5D1) occurred mainly between 1990 and 1998. The decrease of 69 % in that period was due to the legal requirement to connect households to decentralised wastewater treatment plants. The basis for legal requirements for the collection and treatment of domestic and commercial wastewater is the Council directive 91/271/EWG concerning urban wastewater treatment from 1991. Many wastewater plants had to be built in the former GDR after the German reunification, as most households were not connected to a sewage system, but used septic tanks.

The **Greek** CH_4 emissions from 5D1 decreased mainly between 1990 and 2007 (-89 %) due to the increased number of wastewater handling facilities with aerobic conditions. Domestic wastewater handling in aerobic treatment facilities shows a substantial increase since 1999.

Italian CH_4 emissions from domestic wastewater handling decreased slightly throughout the time series. In 1990, 57 % of population was served by sewer systems and only 52 % of the population was served by wastewater treatment plants. In 2020, more than 99 % of population was served by sewer systems and about 85 % of population is served by wastewater treatment plants.

CH_4 emissions from domestic wastewater handling in **Poland** decreased continuously throughout the time series. The share of rural population using autonomous treatments (septic tanks or latrines) for domestic wastewater decreased from 98 % in 1990 to 55% in 2020 and the share of urban populations using autonomous treatments decreased from 55 % to 5.3% in the same period. The treatment pathway using advanced wastewater treatment plants increased from 0 % to about 60.5 % between 1990 and 2020.

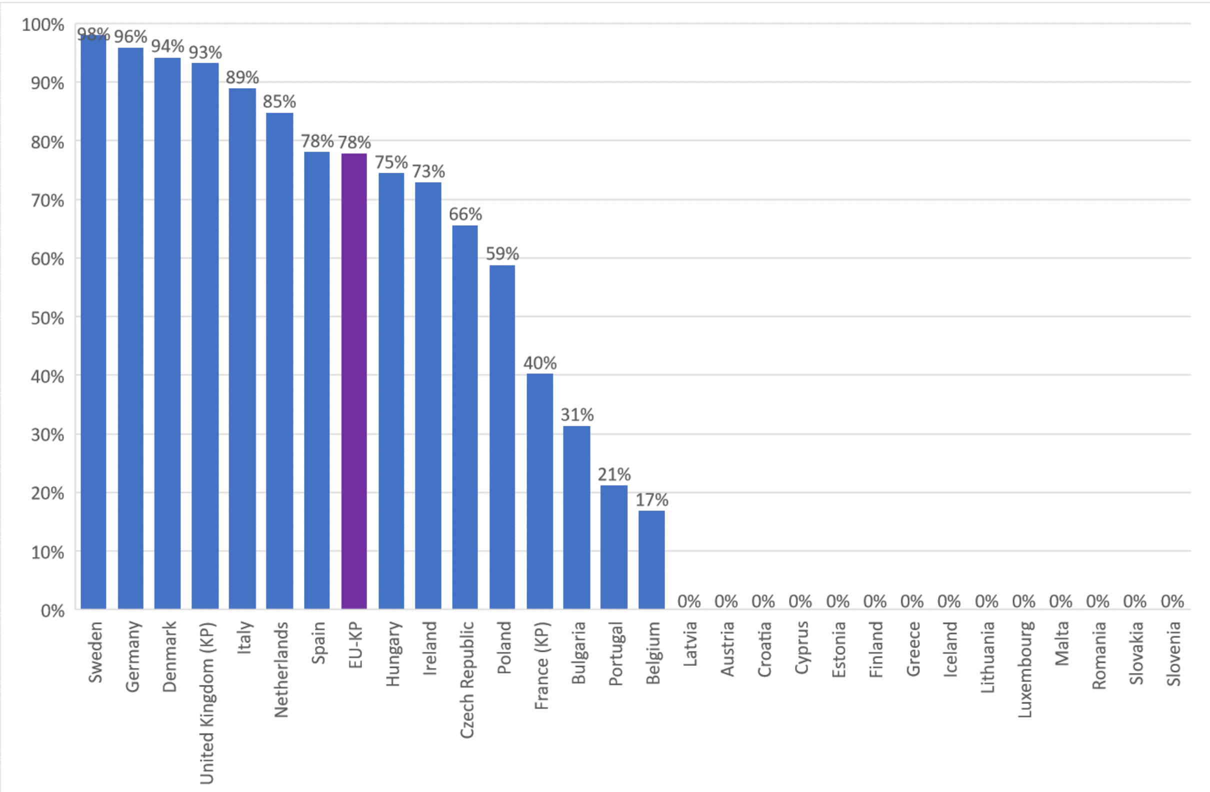
Methodological information for CH_4 emissions from domestic wastewater

All wastewater generated by households as well as any wastewater not disposed on-site in industrial installations is reported as domestic wastewater. CH_4 emissions from wastewater are formed by anaerobic conditions, these can originate during all stages: from wastewater generation to final disposal. CH_4 emissions from domestic wastewater handling (5D1) are a significant emission source in category 5D and key source in the EU. The IPCC 2006 Guidelines introduce three different Tier methods to calculate CH_4 emissions from waste water handling. Activity data needed to estimate CH_4 emissions from domestic wastewater handling is the amount of total degradable organic carbon (TOW) produced in a country. The TOW needs to be calculated based on the total population and the quantity of carbon discharged per person and day expressed in Biochemical Oxygen Demand (BOD). Many countries apply the default value for BOD (0.6 kg CH_4/kg BOD) to estimate the total degradable organic carbon. Furthermore, the country specific share of the different treatment pathways and systems of wastewater need to be identified. This is mainly done by analyzing wastewater statistics and determining the share of the population that is connected to the central sewage system and remaining wastewater that is treated in septic tanks or other wastewater treatment plants. The IPCC 2006 Guidelines provide default MCFs (methane correction factor) for each pathway, but also country specific MCFs can be applied. In the Annex III of this submission a table on countries specific methodology is provided.

If methane is recovered and burned (see *Figure 7.16*), the emissions from wastewater need to be adjusted accordingly. If sludge is removed from the wastewater, a corresponding quantity needs to be deducted from the Total Organically Degradable Content (TOW). Emissions from sludge decomposition are reported under solid waste disposal, biological treatment, burning or in the AFOLU sector depending on the disposal method.

An important remark in the interpretation of data on CH_4-recovery that are reported in the EU's CRF tables (and the countries CRF tables) for wastewater treatment (5D) is that, not all countries are reporting data related to CH_4 recovery, (for energy use of flaring) in CRF table 5D. The reported CH_4 recovery is generally recovered during sludge digestion for biogas production in a follow-up step of aerated wastewater treatment plants. On the opposite, CH_4 emissions relate mainly to anaerobic treatment systems (septic tanks and natural lagoons). Therefore, comparing CH_4 emissions to CH_4 recovery is meaningless. Three countries are reporting this information as included elsewhere (notation key IE), whereas others countries are reporting not occurring (NO), not applicable (NA) or not estimated (NE). Moreover, information related to the amount of CH_4 recovered on sludge digesters is not necessary to apply the 2006 IPCC Guidelines to estimate CH_4 emissions neither from wastewater treatment nor from sludge digestion. Therefore, not reporting any CH_4 recovered doesn't mean that sludge digestion is not occurring (NO) but that the information is not used for the CH_4 estimate from 5D1.

Figure 7.17 5D1 Managed Solid Waste Disposal: Methane recovery fraction (energy use and flaring) for 2020



Further methodological information for all countries is provided in the Annex III of this submission.

N_2O emissions

Table 7.13 5D1 Domestic and commercial wastewater: Countries' contributions to N_2O emissions

Member State	N2O Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	96	169	168	2.4%	72	75%	0	0%	CS	CS,D
Belgium	138	102	102	1.5%	-36	-26%	0	0%	D	D
Bulgaria	198	137	136	2.0%	-62	-31%	-1	-1%	T1	D
Croatia	67	90	90	1.3%	23	35%	1	1%	T1	D
Cyprus	11	16	16	0.2%	5	51%	0	1%	T1	D
Czechia	234	198	198	2.9%	-36	-15%	1	0%	T1	CS,D
Denmark	113	132	133	1.9%	20	18%	1	1%	CS	CS
Estonia	39	32	32	0.5%	-7	-18%	0	-1%	T1	D
Finland	56	62	63	0.9%	8	14%	1	1%	CS,T1	D
France	537	294	294	4.2%	-244	-45%	-1	0%	T1	D
Germany	1 157	427	432	6.2%	-726	-63%	5	1%	CS,D	CS,D
Greece	274	286	281	4.1%	6	2%	-5	-2%	D	CS
Hungary	148	87	87	1.3%	-61	-41%	0	0%	CS	D
Ireland	75	106	107	1.5%	32	42%	1	1%	T1	D
Italy	1 191	1 202	1 168	16.9%	-23	-2%	-34	-3%	T1	D
Latvia	50	32	32	0.5%	-18	-36%	0	0%	D	D
Lithuania	67	46	47	0.7%	-20	-30%	1	1%	T1	D
Luxembourg	5	5	4	0.1%	-1	-15%	0	-10%	T1	D
Malta	10	7	7	0.1%	-3	-34%	-1	-9%	D	D
Netherlands	23	26	26	0.4%	3	14%	0	1%	T1	D
Poland	723	789	787	11.4%	64	9%	-2	0%	T1	D
Portugal	200	193	192	2.8%	-8	-4%	-1	0%	D	CS,D
Romania	397	429	425	6.2%	28	7%	-4	-1%	D	D
Slovakia	119	49	49	0.7%	-70	-59%	0	0%	T2	D
Slovenia	39	38	38	0.6%	-1	-3%	0	1%	T1	D
Spain	863	807	914	13.2%	51	6%	107	13%	D	D
Sweden	208	190	190	2.7%	-18	-9%	0	0%	T1	CS,D
United Kingdom	795	860	864	12.5%	69	9%	4	1%	T1	D
EU-27+UK	**7 834**	**6 809**	**6 882**	**100%**	**-952**	**-12%**	**72**	**1%**	**-**	**-**
Iceland	5	6	6	0.1%	1	32%	0	2%	T1	D
United Kingdom (KP)	809	880	884	12.8%	75	9%	4	0%	T1	D
EU-KP	**7 853**	**6 836**	**6 908**	**100%**	**-945**	**-12%**	**72**	**1%**	**-**	**-**

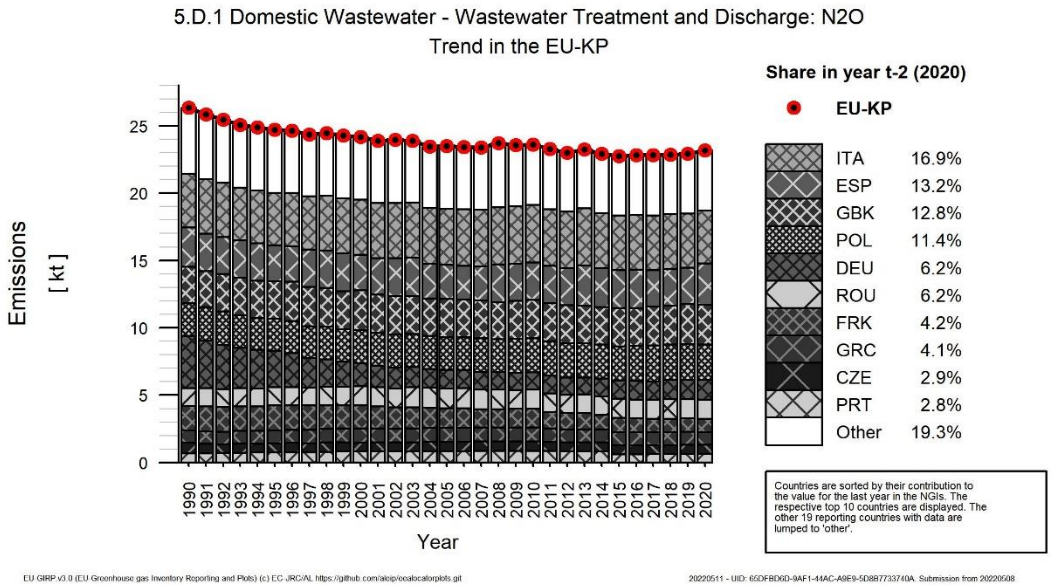
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for N_2O emissions

N_2O emissions from 5D1 Domestic Wastewater account for 0.19 % of total EU-KP GHG emissions in 2020. N_2O emissions from domestic wastewater treatment and discharge decreased moderately between 1990 and 2020 by 12.0 % (Table 7.13). *Figure 7.18* shows the trend of emissions indicating the countries contributing most to EU-KP total. The countries contributing most to the observed decrease between 1990 and 2020 are Germany and France. Key drivers for the emission reduction are the development of centralized wastewater treatment plants with nitrogen abatement technologies. In 2020, N_2O emissions increased by 1.1% in comparison to 2019 because of the important increase observed for Spain (+13.3%).

Countries with large population have a high share of EU-KP N_2O emissions from this source in general. In 2020, Italy is responsible for 16.9 %, Spain for 13.2 %, Poland for 11.4 % of EU-KP N_2O emissions from domestic wastewater treatment (see Table 7.13). Large decreases in absolute terms are reported by Germany and France between 1990 and 2020, as the amount of wastewater treated in advanced centralized wastewater treatment plants with nitrogen abatement increased over the years.

Figure 7.18 5D1 Domestic wastewater: N_2O emissions (Trend in relevant countries)



Methodological information for N_2O emissions from domestic wastewater

Direct emissions of N_2O during processing only occur in countries with predominantly advanced centralized wastewater treatment plants with nitrification and denitrification steps. Indirect emissions come from wastewater treatment effluent discharged into aquatic environments. For direct emissions the quantity of wastewater treated in such facilities needs to be multiplied with a default emission factor. For indirect emissions, it is necessary to estimate the nitrogen in wastewater based on protein intake per person and correction factors to reflect non-consumed proteins and industrial/commercial co-discharged into the sewer system. If sludge is removed, a corresponding quantity of nitrogen needs to be deducted.

For the calculation of N_2O emissions from domestic wastewater no different tier levels are provided in the IPCC 2006 Guidelines and it is good practice to estimate N_2O emissions from domestic wastewater effluent by applying the methodology provided in the 2006 IPCC Guidelines. According to Table 7.13 only Austria, Denmark, Finland, Germany, Hungary and Slovakia apply a country specific methodology and/or emission factor, and Czechia, Greece, Portugal and Sweden apply country specific emission factors.

Further methodological information for all countries is provided in the Annex III of this submission.

7.2.4.2 Industrial wastewater (CRF Source Category 5D2)

CH_4 emissions from 5D2 Industrial Wastewater account for 0.2 % of total EU-KP GHG emissions in 2020. Between 1990 and 2020, CH_4 emissions decreased by 35.6 %. Key drivers for the development of CH_4 emissions are primarily economic activities and the share of CH_4 flared or recovered. CH_4 emissions are related to production data in certain industries with high organic contents in the wastewater. Therefore, the trend in CH_4 emissions is fluctuating throughout the time series based on the economic situation in the countries. In 2020, CH_4 emissions from 5D2 Industrial Wastewater decreased of 4.8% in comparison to 2019 (see Table 7.14).

Table 7.14 5D2 Industrial wastewater: Countries' contributions to CH_4 emissions

Member State	CH4 Emissions in kt CO2 equiv.			Share in EU-KP Emissions in 2020	Change 1990-2020		Change 2019-2020		Method	Emission factor Informa-tion
	1990	2019	2020		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1	3	3	0.1%	2	286%	0	-3%	-	-
Belgium	IE,NE	IE,NE	IE,NE	-	-	-	-	-	NA	NA
Bulgaria	2 221	165	168	2.8%	-2 053	-92%	3	2%	T2	D
Croatia	97	116	113	1.9%	17	17%	-2	-2%	T1	D
Cyprus	24	32	32	0.5%	7	30%	0	0%	T1	D
Czechia	363	466	432	7.2%	69	19%	-34	-7%	CS,T1	CS,D
Denmark	IE	IE	IE	-	-	-	-	-	NA	NA
Estonia	NO	5	4	0.1%	4	∞	-1	-13%	T1	D
Finland	27	24	23	0.4%	-4	-15%	-2	-7%	CS,T2	CS,D
France	88	85	85	1.4%	-3	-4%	0	0%	T1	D
Germany	9	46	47	0.8%	38	410%	1	2%	CS,T2	CS
Greece	821	1 005	910	15.1%	89	11%	-96	-10%	CS,D	CS,D
Hungary	135	25	25	0.4%	-110	-81%	0	0%	T1	D
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 520	1 428	1 375	22.8%	-145	-10%	-52	-4%	T1	D
Latvia	137	2	3	0.1%	-134	-98%	1	62%	T1	PS
Lithuania	IE	IE	IE	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	7	10	10	0.2%	3	42%	0	0%	T2	CS
Poland	627	272	277	4.6%	-350	-56%	5	2%	T1	CS,D
Portugal	259	218	191	3.2%	-68	-26%	-27	-12%	T2	CS,D
Romania	378	213	192	3.2%	-186	-49%	-20	-9%	D	D
Slovakia	29	5	4	0.1%	-25	-86%	-1	-12%	T1	D
Slovenia	99	8	8	0.1%	-91	-92%	-1	-9%	T1	CS,D
Spain	1 719	1 212	1 162	19.2%	-558	-32%	-50	-4%	T1	CS,D
Sweden	6	5	5	0.1%	-1	-17%	0	-5%	T2	CS
United Kingdom	786	982	954	15.8%	168	21%	-28	-3%	T1	D
EU-27+UK	**9 353**	**6 327**	**6 024**	**100%**	**-3 329**	**-36%**	**-304**	**-5%**	**-**	**-**
Iceland	32	18	17	0.3%	-15	-47%	0	-2%	NA	NA
United Kingdom (KP)	786	982	954	15.8%	168	21%	-28	-3%	T1	D
EU-KP	**9 385**	**6 345**	**6 041**	**100%**	**-3 344**	**-36%**	**-304**	**-5%**	**-**	**-**

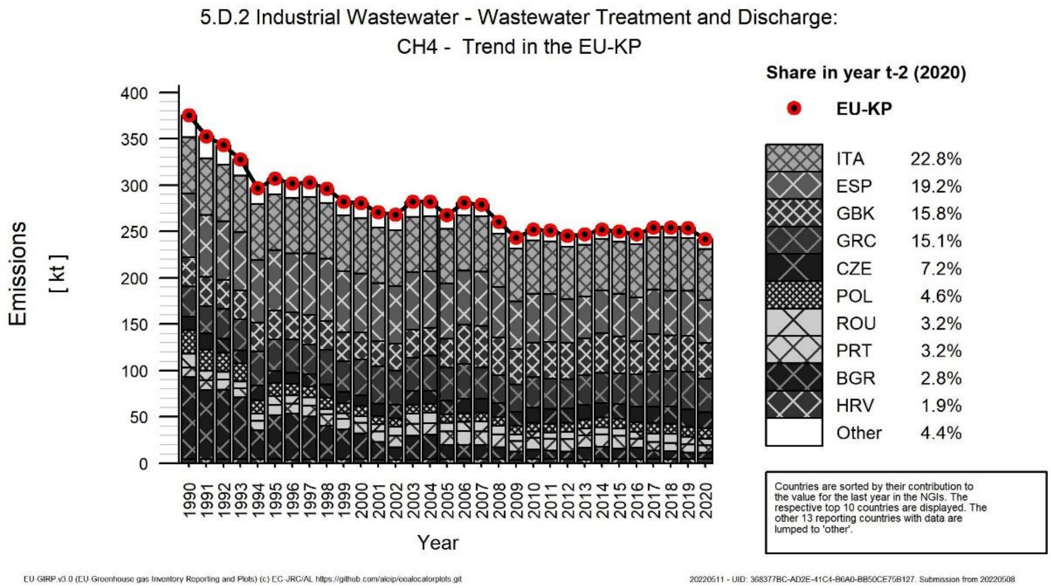
Presented methods and emission factor information refer to the last inventory year.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

CH_4 emissions from industrial wastewater treatment and discharge decreased by 35.6 % between 1990 and 2020 *Figure 7.19* shows the trend of emissions indicating the countries contributing most to EU-KP total.

The largest decrease in absolute terms is reported by Bulgaria, followed far below by Spain and Poland contributing together 26.6 % of EU-KP emissions from source 5D2 in 2020, whereas United Kingdom (KP) and Greece show the largest, but moderate, absolute emission increases between 1990 and 2020 (Table 7.14). Italy is responsible for 22.8%, Spain for 19.2%, United Kingdom for 15.8% and Greece for 15.1% of EU-KP CH_4 emissions from this source in 2020. The emission trends in this sector are mainly influenced by the strong decrease in Bulgaria.

Figure 7.19 5D2 Industrial wastewater: CH_4 emissions (Trend in relevant countries)



Bulgaria decreased its CH_4 emissions from industrial wastewater until 2005 and remains rather constant in the following years with little annual variations. In 2003 and 2004 CH_4 emissions show a peak compared to the preceding years due to the discharge of industrial wastewater into several big tailing ponds by mining companies. The strong decrease of CH_4 emissions from industrial wastewater between 1990 and 2005 is caused by decreasing quantities of organic load inindustrial wastewater in the country, which decreased from 1769 kt COD in 1990 159 kt COD in 2020. Moreover, between 1990 and 2020 the fraction discharged in stagnant sewer decreased from 8.2% to 0.7%. As a consequence, CH_4 emissions decreased by 92.4 % between 1990 and 2020.

In **Spain**, CH_4 emissions from industrial wastewater decreased by 32.4 % in 2020 in comparison to 1990. Industries with high organic loads that have on-site wastewater treatment are the oil refining industry and the pulp and paper production industry. Other industries with high organic loads are the food- and drink processing industry and the organic chemical industry. Due to changes in production levels CH_4 emissions from this source are also slightly fluctuating throughout the time series in Spain.

In Italy, which represents 22.8% of EU-KP CH_4 emissions from this source in 2020**,** CH_4 emissions from industrial wastewater decreased only slightly by 9.5% between 1990 and 2020. This is caused by a decreasing amount of wastewater from industries. Main reductions in industrial wastewater load can be found in the pulp and paper and in the textiles industry.

CH_4 emissions from industrial wastewater in **Poland** decreased by 55.8 % between 1990 and 2020, due to a reduction in wastewater production by industries. Main reduction of wastewater production took place in the mining and quarrying industry, the iron and steel industry and in the wood and paper industry.

In **Greece**, CH_4 emissions from industrial wastewater increased by 10.8 % between 1990 and 2020 due to the increase of the organic load from organic chemical industries and other industries despite the increase of the organic load removed as sludge.

CH_4 emissions from industrial wastewater in the **United Kingdom** increased by 21,4% throughout the time series 1990 and 2020 with two main quite steady period: 1990-2005 and 2006-2019. Lowest emissions during the economic break down from 2008 to 2010 are observed.

In **France,** CH_4 emissions from industrial wastewater decreased only slightly by 3.9% between 1990 and 2020. As all in-situ wastewater treatment plants are considered to be well managed in France, only natural lagoon treatment plants have a non-zero MCF and are considered as a source of CH_4 in the French inventory. Only Food & Beverage industry is using natural lagoon because this type of treatment is not adapted to high COD load.

Methodological information

Emissions from industrial wastewater include all wastewater that is treated/disposed on-site and not sent to public sewers. The main sources for methane emissions from industrial wastewater are:

- pulp and paper manufacture;
- food and drink processing (e.g. meat and poultry processing, alcohol/starch production and dairy products); and
- Organic chemicals production.

Activity data is based on production output from the relevant industries and a Chemical Oxygen Demand per unit of output for each industry. Default IPCC values are provided and it is good practice to use them in the absence of national data.

CH_4 emissions from industrial wastewater handling are reported by 22 countries, while Belgium reports CH_4 emissions as Included Elsewhere/Not estimated (IE/NE) because the same methodology is not applied in its 3 regions, Luxembourg reports CH_4 emissions under 5D2 as not occurring (NO) and Denmark, Ireland, Lithuania and Malta report CH_4 emissions from industrial wastewater as included elsewhere (IE).

According to the IPCC 2006 Guidelines, the emission factor for determining CH_4 emissions from wastewater is composed of the maximum methane producing potential (B0) and the methane conversion factor (MCF). There is an IPCC default value available for the maximum methane producing potential which is applied in most of the countries. In contrast, the MCF has to be determined country specifically and varies strongly among the countries depending on wastewater treatment systems used.

7.2.4.3 Recalculations CH_4 and N_2O emissions (CRF Source Category 5D)

Table 7.15: 5D Waste water treatment: Contribution of EU-KP countries to recalculations in CH_4 for 1990 and 2019 (difference between latest submission and previous submission)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	-0.1	-0.6	-	For 5.D.1 domestic wastewater recalculations were carried out for 2019 as new data on the connection rate for 2020 became available and affected 2019 due to the interpolation between 2018 and 2020.
Belgium	-	-	-0.0	-0.0	-	-

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Bulgaria	-	-	0.8	0.2	-	Not documented (impact lower than 500 kt CO_2eq. Or 0,05% of the national total)
Croatia	-	-	-1.6	-0.3	-	New data on industrial output (tonne/yr) for Manufacture of food products and beverages was included in the emission calculation for 2019. New data on organic component removed as sludge that is disposed at landfills and used for other purposes (composting, agriculture application) were excluded from the total organic product for the period 2008 - 2019. Therefore, recalculations of CH_4 emissions were made for the period 2008 - 2019.
Cyprus	-	-	0.8	1.9	-	Emissions from Industrial Wastewater Treatment and Discharge (5D2) were recalculated for the year 2019 due to revision of the activity data of solid waste production by the Statistical Service.
Czechia	77	8.7	-68	-7.5	Emissions of CH_4 changed, because of the CS methane correction factors for uncollected and treated wastewater. The whole timeline changed.	
Denmark	-	-	-	-	-	-
Estonia	-	-	1.1	2.0	-	Due to the transition to the new database, degree of utilization have been specified and CH_4 emission from domestic wastewater have been recalculated for 2010-2019
Finland	-	-	0.0	0.0	-	-
France	-0.1	-0.0	48	2.1	5D1: A new and more complete dataset than the one used before led to an increase of the collective COD quantities at WWTP outlet over the whole period with the change of methodology (use of the GEREP database instead of IREP). 5D2: Update of COD quantities at the outlet of industrial WWTPs over the whole period with the change of methodology (GEREP instead of IREP) which contributes to the decrease of CH_4 emissions.	
Germany	-0.0	-0.0	-0.0	-0.0	-	-
Greece	-	-	29	2.6	-	Updated activity data have been utilized for the estimation of CH_4 and N_2O emissions from wastewater handling for 2019.
Hungary	-	-	-	-	-	-
Ireland	-	-	-	-	-	-
Italy	-8.9	-0.3	-7.5	-0.3	The main recalculation regards the population: the time series have been revised because of un update by the National Institute of Statistics	
Latvia	-	-	-	-	-	-
Lithuania	-	-	-	-	-	-
Luxembourg	-	-	-	-	-	-
Malta	-	-	-	-	-	-
Netherlands	-	-	-2.5	-1.1	-	Due to final activity data on wastewater and sludge treatment, the CH_4 emissions from domestic wastewater treatment (5D1)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						decreased in 2019 compared with the previous submission
Poland	-	-	-463	-17.9	-	- application of default IPCC 2006 MCF for domestic wastewater treatment since 2005, - update of population using latrines. PL 5D 2022 0002 related to sludge paramerters was resolved
Portugal	-	-	1.0	0.1	-	5.D.2: revision of AD for some industrial sectors (years 2018-2019).
Romania	-	-	-29	-1.8	-	Recalculations have been performed for CH_4 emissions from domestic and commercial wastewater, for the 2018-2019 years, at the level of MCF-centralised WWTP. The values have been changed from 0.0152 for centralised aerobic treatment to updated values derived from the UWWTD website for 2018 -2019 years. For 2017-2019 period data regarding total population are updated by NIS.
Slovakia	-	-	-	-	-	-
Slovenia	-	-	-	-	-	-
Spain	-	-	-1.6	-0.1	-	,- Update of the percentages of infiltration systems, septic tanks and imhoff tanks for the year 2019 used in the estimation of CH_4 emissions for the untreated population. This update is due to new information received from the focal point (CNV). - ,for the period 2015-2019 there has been a recalculation due to the correction of errors with respect to the treated and untreated equivalent inhabitants.
Sweden	-0.4	-1.0	-0.2	-0.7	Recalculations has been done for emissions of methane from CRF 5.D.2 Industrial wastewater for the years 1990-2019 due to the results of a new study on anaerobic digestion of sludge within the food industry plants with internal wastewater treatment. The emissions decreased by between 2.97% and 5.76% for the years 1990-2019.	
United Kingdom	113	5.2	67	4.1	See UK (KP)	
EU27+UK	**180**	**0.5**	**-426**	**-2.3**		
Iceland	-	-	0.0	0.0	-	-
United Kingdom (KP)	113	5.2	67	4.0	Estimates for CH_4 and N_2O emissions from industrial wastewater treatment for 5D2 have been revised in this submission. This is primarily due to the adjustment to the activity data (e.g. the industrial production estimates for various products allocated to industry) and the correction to the calculations of the COD treated by industry. This is to accommodate a revised tier 1 methodology, developed with respect to previous review comments. As a consequence, CH_4 emissions have increased between this submission and the previous in the 2020 NIR while N_2O emissions from industrial wastewater treatment have significantly reduced in this submission.	
EU-KP	**180**	**0.5**	**-426**	**-2.3**		

Table 7.16: 5D Waste water treatment: Contribution of EU-KP countries to recalculations in N_2O for 1990 and 2019 (difference between latest submission and previous submission)

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Austria	-	-	0.01	0.01	-	-
Belgium	-	-	0.01	0.01	-	-
Bulgaria	-	-	-0.8	-0.6	-	There is a recalculation for the period 2010-2019 due to updated FAO data of protein/gr/day.
Croatia	-	-	-1.6	-1.8	-	New data on protein intake value (PIV), for the period 2014 - 2018, were obtained by the FAOSTAT Statistical Database. Extrapolation method has been used for calculation of insufficient data. The pattern from 2015 to 2018 has been used for calculation of insufficient data for 2019 and 2020.
Cyprus	-1.3	-10	-0.7	-4.3	-	Emissions from Industrial Wastewater Treatment and Discharge (5D2) were recalculated for the year 2019 due to revision of the activity data of solid waste production by the Statistical Service.
Czechia	-	-	-0.7	-0.3	-	Recalculation of N_2O emissions were made for the years 2017-2019 in the category 5.D.1 because of new available data from FAOSTAT on the protein consumption per capita for the year 2017. The values of the years 2018 and 2019 were also recalculated using the 2017 value
Denmark	-	-	-	-	-	-
Estonia	-	-	-1.0	-2.9	-	Due to the updated protein supply information, N_2O emission are recalculated.
Finland	-	-	0.1	0.2	-	Recalculations have been made for the years 2016-2019 due to corrected and reallocated activity data in collected domestic wastewater and in industrial wastewater. In fish farming these activity corrections have been made for the years 2014-2019. Also, recalculations have been made in uncollected domestic wastewater for the years 2010-2019 due to updated protein consumption data from FAO statistics.
France	-153	-21.1	-77.9	-19.6	5D1: In this new edition of the inventory, protein consumption is considered (previously protein availability was considered). This methodological change contributes to the decrease of N_2O emissions. 5D2: Update of nitrogen quantities at industrial WWTP outlets over the whole period with the change of methodology (GEREP instead of IREP) which contributes to the decrease of N_2O emissions.	
Germany	-232	-16.4	-59	-11.4	The values for sewage sludge production and losses for the year 2019 were updated in the last report using the values for 2018. In the meantime, the Federal Statistical Office has made the values for 2019 available, so that these values can now be used.	
Greece	-	-	0.1	0.05	-	-
Hungary	-	-	1.6	1.9	-	Protein consumption data and the amount of wastewater undergoing tertiary treatment has been updated for year 2019.

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
Ireland	-	-	6	5.9	-	5D1 : There were slight recalculations for this category for years 2012-2019 due to updated activity data relating to per capita protein consumption sourced from FAOSTAT.
Italy	-6.9	-0.5	-86	-6.4	The main recalculation regards the population: the time series have been revised because of un update by the National Institute of StatisticsMinor recalculations regard the annual per capita protein consumption value from 2014 to 2019, because un update of FAO Food Balance (FAO, several years);	
Latvia	-0.0	-0.0	-0.0	-0.0	-	-
Lithuania	-	-	3.7	8.8	-	Nitrous oxide emissions for 2014-2019 were recalculated using linear interpolation of experimental protein consumption data from 2013 and new data for 2020.
Luxembourg	-	-	0.01	0.1	-	-
Malta	-0.0	-0.2	-0.8	-9.9	Due to updates in the activity data from Swine manure N going to sewers N (kt) and from the protein consumption, recalculations for N_2O emissions were required, which also affected the total emissions from the Wastewater category, throughout the whole timeseries, as illustrated in the below tables.	
Netherlands	-	-	0.9	1.2	-	Due to final activity data on total N discharges, the indirect N_2O emissions from surface water as a result of the discharge of domestic and industrial effluents (5D3, Wastewater effluents) has decreased in 2018 and has increased in 2019 compared with the previous submission.
Poland	-	-	18	2.4	-	Recalculations resulting from the update of data on protein consumption in the FAOSTAT database since 2014.
Portugal	-	-	13	7.3	-	5.D.1: - revision of per capita protein intake (years 2012-2019) - agricultural recovery of sludge : AD and total N concentration: revision of 2018-2019 years based on the average values of 2017 and 2020 years.
Romania	-	-	-2.3	-0.5	-	For the calculation of indirect N_2O emissions from 5D1 the final data associated to protein consumption were updated by NIS for 2019 year (the value was exchanged from 43.11 kg protein/person/yr to 42.96 kg protein/person/yr). For 2017-2019 period data regarding total population are updated by NIS.
Slovakia	-	-	1.7	3.4	-	The Statistical Office of the Slovak Republic provided new data on protein consumption for the year 2019, which led to the recalculation of N_2O emissions in the domestic wastewater.
Slovenia	-	-	0.1	0.2		5.D.1: Emissions of N_2O have been recalculated for the period 2014-2019 due to new values on protein consumption applied.
Spain	-	-	-5.8	-0.7	-	,- for the period 2015-2019 there has been a recalculation due to the correction of errors with respect to the treated and untreated equivalent inhabitants.

	1990		2019		Explanations for 1990	Explanations for 2019
	kt CO_2	%	kt CO_2	%		
						- for the period 2013-2019, an update of sludge generated in the water treatment systems due to new treatment systems due to new information received by the focal point (NLR).
Sweden	-	-	-1.0	-0.5	-	Recalculation was also made for emissions of nitrous oxide from CRF 5.D.2 Industrial wastewater for the year 2019 due to new data on discharges of nitrogen from the pulp- and paper industry. The emission decreased by 12.09% for the year 2019.
United Kingdom	-50	-5.4	-18	-1.8	See EU KP	
EU27+UK	**-443**	**-5.0**	**-209**	**-2.9**		
Iceland	-	-	-0.01	-0.2	-	The sewage sludge used in Agriculture for land restoration purposes (CRF 3.D.1.2.b) has been added to the amount of sludge removed in response to a question raised during the 2021 Centralised UNFCCC review (2021ISLQA115). This implies recalculations for the amount of sewage sludge removed and consequently for the N_2O emissions from 2012-2019.
United Kingdom (KP)	-50	-5.3	-18	-1.7	Estimates for CH_4 and N_2O emissions from industrial wastewater treatment for 5D2 have been revised in this submission. This is primarily due to the adjustment to the activity data (e.g. the industrial production estimates for various products allocated to industry) and the correction to the calculations of the COD treated by industry. This is to accommodate a revised tier 1 methodology, developed with respect to previous review comments. As a consequence, CH_4 emissions have increased between this submission and the previous in the 2020 NIR while N_2O emissions from industrial wastewater treatment have significantly reduced in this submission.	
EU-KP	**-443**	**-5.0**	**-209**	**-2.8**		

7.2.5 Waste – non-key categories

Table 7.17 Aggregated GHG emission from non-key categories in the waste sector

EU-KP	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 5. Waste in 2020	Change 1990-2020		Change 2019-2020	
	1990	2019	2020		kt CO_2 equ.	%	kt CO_2 equ.	%
5.A.3 Uncategorized Waste Disposal Sites: Waste (CH4)	1 307.1	719.0	658.8	0.51%	-648	-50%	-60.2	-8%
5.A.3 Uncategorized Waste Disposal Sites: Waste (CO2)	0.0	0.0	0.0	0.00%	0	0%	0.0	0%
5.B.1 Waste Composting: Waste (N2O)	338.0	2 666.3	2 694.5	2.07%	2 356	697%	28.2	1%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (CH4)	7.3	1 753.8	1 841.0	1.41%	1 834	25145%	87.2	5%
5.B.2 Anaerobic Digestion at Biogas Facilities: Waste (N2O)	0.0	122.3	123.0	0.09%	123	100%	0.7	1%
5.C.1 Waste Incineration: Waste (CH4)	112.3	3.1	2.8	0.00%	-109	-97%	-0.3	-8%
5.C.1 Waste Incineration: Waste (CO2)	5 078.9	3 165.6	3 121.6	2.39%	-1 957	-39%	-44.0	-1%
5.C.1 Waste Incineration: Waste (N2O)	249.9	189.6	192.2	0.15%	-58	-23%	2.6	1%
5.C.2 Open Burning of Waste: Waste (CH4)	322.9	376.2	375.5	0.29%	53	16%	-0.8	0%
5.C.2 Open Burning of Waste: Waste (CO2)	90.7	38.5	36.3	0.03%	-54	-60%	-2.1	-6%
5.C.2 Open Burning of Waste: Waste (N2O)	243.8	316.2	315.0	0.24%	71	29%	-1.2	0%
5.D.2 Wastewater Treatment and Discharge: Industrial Wastewater (N2O)	393.1	263.0	270.3	0.21%	-123	-31%	7.3	3%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (CH4)	98.2	14.2	14.3	0.01%	-84	-85%	0.1	1%
5.D.3 Wastewater Treatment and Discharge: Other Wastewater (N2O)	153.4	52.2	52.3	0.04%	-101	-66%	0.0	0%
5.E Other Disposal: Waste (CH4)	46.6	5.8	5.8	0.00%	-41	-88%	0.0	0%
5.E Other Disposal: Waste (CO2)	21.8	23.0	23.0	0.02%	1	5%	-0.1	0%
5.E Other Disposal: Waste (N2O)	0.0	33.8	33.6	0.03%	34	100%	-0.2	-1%

7.3 EU-KP uncertainty estimates

Table 7.18 shows the total EU-27+UK and Iceland uncertainty estimates for the sector Waste and the uncertainty estimates for the relevant gases of each source category. The highest level uncertainty was estimated for N_2O from 5D and CO_2 and CH_4 from 5E. Unexpectedly CH_4 from 5A has one of the lower uncertainties. Regarding the uncertainty on trend, N_2O from 5D and N_2O from 5B show the highest uncertainty estimates, followed by CH_4 from 5B. For a description of the Tier 1 uncertainty analysis carried out for the EU-KP see Chapter 1.6.

Table 7.18 Sector 5 -Waste: EU-KP uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2020	Emission trends Base Year-2020	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
5.A Solid Waste Disposal	CO2	0	0	0.0%	0.0%	0.0%
5.A Solid Waste Disposal	CH4	185 449	93 230	-49.7%	37.7%	14.8%
5.A Solid Waste Disposal	N2O	0	0	0.0%	0.0%	0.0%
5.B Biological treatment of solid waste	CO2	0	0	0.0%	0.0%	0.0%
5.B Biological treatment of solid waste	CH4	604	5 681	841.4%	62.1%	361.8%
5.B Biological treatment of solid waste	N2O	253	2 605	930.5%	70.2%	390.8%
5.C Waste Incineration	CO2	5 045	3 158	-37.4%	39.2%	66.8%
5.C Waste Incineration	CH4	219	107	-51.1%	34.4%	30.7%
5.C Waste Incineration	N2O	264	195	-26.0%	86.3%	43.7%
5.D Wastewater treatment and discharge	CO2	0	0	0.0%	0.0%	0.0%
5.D Wastewater treatment and discharge	CH4	36 845	17 325	-53.0%	56.3%	13.3%
5.D Wastewater treatment and discharge	N2O	8 227	7 154	-13.0%	437.4%	343.3%
5.E Other	CO2	22	23	5.4%	300.2%	16.3%
5.E Other	CH4	3	5	92.8%	269.0%	25.5%
5.E Other	N2O	0	34	Inf	20.1%	Inf
5 (where no subsector data were submitted	all	893	880	-1.5%	100.0%	91.8%
Total - 5	**all**	**237 823**	**130 397**	**-45.2%**	**37.7%**	**16.8%**

***Note**: Emissions are in Gg CO_2 equivalents; trend uncertainty is presented as percentage points; the sum of the source category emissions may not be the total sector emissions of the EU-NIR because uncertainty estimates are not available for all source categories in all countries;*

7.4 Sector-specific quality assurance and quality control

There are several activities for improving the quality of estimating and reporting GHG emissions from waste: Before and during the compilation of the EU GHG inventory, several checks are made of the countries data in particular for completeness, time series consistency of emissions and implied emission factors, comparisons of implied emission factors across countries and checks of internal consistency.

In the second half of the year, the EU internal review is carried out for selected source categories. In 2005, the EU internal review was carried out for the first time. In 2012 a comprehensive review was carried out for all sectors and all EU countries in order to Source category Gas Emissions fix the base year 2020 under the EU Effort Sharing Decision. (ESD review 2012). This review also covered the waste sector of the MS GHG inventories (peer review). In 2015, a few countries volunteered to be reviewed under step 2 of the ESD trial review for the sector waste. In 2016, again a comprehensive review was carried out for all sectors and all EU countries with a focus on the years 2005, 2008-2010, 2013 and 2014 in order to track progress of the EU countries under the EU Effort Sharing Decision. (ESD review 2016).

In March 2016, during the WG1-meeting, a note/paper on wastewater treatment and discharge was discussed with the countries. This note/paper reflects a number of concerns raised during the ESD 2015 trial review. In connection to the ESD review further capacity building activities between the ESD review team and EU sectoral experts have taken place via webinars and distribution of working papers on the main conclusions from the ESD reviews.

In September 2017 a capacity building webinar related to the waste sector was organized between the ESD review team and the countries. Several aspects on solid waste disposal, biological treatment and wastewater treatment were discussed. A second webinar took place in November 2017 in order to discuss in more detail the different interpretations when using equations 6.1-6.3 of the IPCC 2006 guidelines (Volume 5, chapter 6) for calculating emissions from wastewater treatment. An elaborated spreadsheet, along with a brief explanation of the spreadsheet was presented and explained during the webinar.

In the autumn of 2018 a capacity building webinar related to the waste sector was organized where the ESD review team informed the Countries on specific aspects that were handled and discussed during the ESD review round in 2018.

In the autumn of 2019 a capacity building webinar related to the waste sector was organized where the ESD review team informed the Countries on specific aspects that were handled and discussed during the ESD review round in 2019.

In the autumn of 2020 a capacity building webinar related to the waste sector was organized where the ESD review team informed the Countries on specific aspects that were handled and discussed during the ESD review round in 2020.

In the autumn of 2021 a capacity building webinar related to the waste sector was organized where the ESD review team informed the Countries on specific aspects that were handled and discussed during the ESD review round in 2021.

7.5 Sector-specific improvements

After the implementation of the new IPCC guidelines in 2015 and the subsequent changes to the sector, chapters had to be re-written in 2016, and certain methodological changes had to be applied, which have been reviewed in the 2016 ESD review.

Explanations for recalculations were further elaborated in 5.B Biological treatment to increase transparency.

In 2016, 2017, 2018, 2019, 2020, 2021 and 2022 additional quality checks of the EU NIR chapter waste were carried out in order to improve the consistency between the CRF tables and the EU NIR and consistency of tables and figures with text in the EU NIR.

8 OTHER

Sector Other is not an EU key category (see Annex 1.1) and does not include any emissions in 2020.

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9 INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS

9.1 Description of sources of indirect emissions in the GHG inventory

The CO_2 resulting from the atmospheric oxidation of CH_4, CO and NMVOC is referred to as indirect CO_2. Indirect CO_2 resulting from the oxidation of CH_4, CO and NMVOCs produced by fossil fuel combustion are included in the general methodological approach which assumes that all the carbon in the fuel (minus the portion that remains as soot or ash) is oxidized to CO_2 whereas actually a fraction of this carbon is initially emitted as CH_4, CO or NMVOC.

Other sources of indirect CO_2 emissions are not yet captured by the general inventory methodologies. According to the 2006 IPCC Guidelines such sources include:

- Fugitive emissions from energy use, e.g. NMVOC emissions from oil refineries, storage of chemicals at refineries, road traffic evaporative emissions from cars, emissions from gasoline distribution network and refuelling of cars, ships and aircrafts, CH_4 emissions from natural gas transmission and distribution or coke production.
- Carbon from Non-energy products from fuels and solvent use in IPPU: The production and use of asphalt for road paving and roofing and the use of solvents derived from petroleum and coal are sometimes substantial sources of NMVOC and CO emissions, which oxidise to CO_2 in the atmosphere. The resulting CO_2 input can be estimated from the emissions of these non- CO_2 gases.
- AFOLU emissions where non- CO_2 gases have been explicitly deducted (Such NMVOC emissions are considered as biogenic in MS reporting and resulting indirect CO_2 emissions are not included in MS GHG inventories).

Indirect N_2O emissions in the agriculture sector address nitrous oxide (N_2O) emissions that result from the deposition of the nitrogen emitted as nitrogen oxides (NO_x) and ammonia (NH_3). N_2O is produced in soils through the biological processes of nitrification and denitrification. One of the main controlling factors in this reaction is the availability of inorganic nitrogen in the soil and therefore deposition of nitrogen resulting from NO_x and NH_3 will enhance emissions.

The Revised 1996 IPCC Guidelines only estimated indirect N_2O emissions from agricultural sources of nitrogen. The 2006 IPCC Guidelines include guidance for estimating N_2O emissions resulting from nitrogen deposition of all anthropogenic sources of NO_x and NH_3 (in particular from sources in the energy and IPPU sectors).The 2006 IPCC Guidelines, Volume 5, also address indirect N_2O emissions which occur from the release of wastewater effluents into waterways, lakes or the sea.

The EU national total includes indirect CO_2 if these emissions were reported by countries. Both national totals, including and excluding indirect CO_2, are reported in the CRF tables. This is to ensure consistency with the scope of reported greenhouse gas emissions during the first commitment period. Indirect N_2O emissions reported in Summary 1 are not included in national totals. This chapter refers to the indirect emissions that are reported in Table 6 of the EU CRF tables. Indirect emissions may also be included in other sectors, such as indirect CO_2 in IPPU (i.e. under ‘2D Non-energy products from fuels and solvents‘) and indirect N_2O in the agriculture and LULUCF sectors (i.e. in CRF tables 3.D and 3.B.b or table 4(IV)). These emissions are dealt with in the corresponding sectoral chapters.

9.2 Methodological issues

Table 9.1 summarizes indirect CO_2 and nitrous oxide emissions reported from the EU countries [not directly included with other sectors]. Eight countries provided values for indirect CO_2 emissions. The highest shares of the EU-KP total of indirect CO_2 emissions are held by Czechia (37 %) and the Netherlands (29 %). Ten countries reported indirect N_2O emissions in 2022, with Bulgaria, Romania, Italy and the UK accounting for 87% of the total EU-KP indirect N_2O emissions.

Indirect CO_2 is not an EU key category.

Table 9.1 Indirect CO_2 and N_2O emission for EU-KP in 2020

Countries	indirect CO_2 [kt CO_2 equ.]	Share in EU-KP [%]	indirect N_2O [kt CO_2 equ.]	Share in EU-KP [%]
Austria	NO,NE,IE,NA	-	15	0.2%
Belgium	NO,NE	-	NO,NE	-
Bulgaria	NO	-	1 011	16%
Croatia	NO,NA	-	NO,NA	-
Cyprus	7	0.5%	NE	-
Czechia	550	37%	222	4%
Denmark	237	16%	230	4%
Estonia	NO,NE,IE	-	NO,NE	-
Finland	66	4%	137	2%
France	NO,IE,NA	-	NO,NE	-
Germany	NO,NE	-	NO,NE,IE	-
Greece	NO,NE	-	NO,NE	-
Hungary	NO,NE	-	NO,NE	-
Ireland	NO,NE,IE	-	NO,NE	-
Italy	NO,IE	-	829	13%
Latvia	13	1%	NO,IE,NA	-
Lithuania	NO,NE	-	NO,NE	-
Luxembourg	NO,NE	-	NO,NE	-
Malta	NO,NE,NA	-	16	0%
Netherlands	419	29%	NO,NE	-
Poland	NA	-	NA	-
Portugal	132	9%	NO,NE,NA	-
Romania	NO,NE	-	2 596	41%
Slovakia	46	3%	NO,NE	-
Slovenia	NO,NE	-	NO,NE	-
Spain	NE,IE	-	NE,NA	-
Sweden	NO	-	174	3%
United Kingdom	NO,NE	-	1 086	17%
EU-27+UK	**1 470**	**100%**	**6 317**	**100%**
United Kingdom (KP)	NO,NE	-	1 098	17%
Iceland	NE,NA	-	NE,NA	-
EU-KP	**1 470**	**100%**	**6 329**	**100%**

In general, the methodologies for the estimation of indirect emissions in EU countries are in line with the 2006 IPCC Guidelines.

For the estimation of indirect CO_2 emissions EU countries follow the basic principle proposed by the IPCC for calculating the CO_2 inputs from the atmospheric oxidation of CH_4, CO or NMVOC (2006 IPCC Guidelines, Volume 1, Chapter 7, p. 7.6):

From CH_4: $Inputs_{CO2} = Emissions_{CH4} \bullet 44/16$

From CO: $Inputs_{CO2} = Emissions_{CO} \bullet 44/28$

From NMVOC: $Inputs_{CO2} = Emissions_{NMVOC} \bullet C \bullet 44/12$

Where C is the fraction carbon in NMVOC by mass (default = 0.6)

Some countries (i.e. CZ, DK) explicitly mention that the precursor gases emissions (CO, NOx and NMVOC) used in the above equations are consistent with the precursor gases emissions reported under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the CH_4 emissions reported to the UNFCCC.

In general, emissions reported in table 6 refer to indirect emissions from energy, IPPU and waste, while some countries report the indirect CO_2 emissions in other categories too (mainly in IPPU category 2.D.3).

9.3 Uncertainties and time-series consistency

Indirect CO_2 emissions have decreased since 1990 in all countries but Portugal (+53%) and Cyprus (+6%). The highest percentage decrease has been noted in Denmark (-79%), while in absolute terms Czechia had the biggest share in the EU reduction, decreasing its indirect CO_2 emissions by more than 1.3 Mt. The main reason for the decrease in indirect CO_2 emissions is the decrease of the precursor gases emissions. The uncertainty of the indirect emission estimates is also based on the calculation of emissions from these gases.

9.4 Category specific planned improvements

The separate reporting of indirect CO_2 and nitrous oxide emissions (from sources other than agriculture and LULUCF)[62] to the UNFCCC under CRF Table 6 has been performed for the first time in 2015 and is in line with paragraph 29 of the UNFCCC reporting guidelines (Decision 24/CP.19). Following this reporting the EU team analysed the ways that countries reported these emissions and presented the results in Working Group 1. The different approaches have been discussed and guidance was provided to Member States in order to improve the consistency in the reporting of these emissions.

[62] As explained in paragraph 9.1, methodologies for the indirect nitrous oxide emissions from agriculture and LULUCF were available in the 1996 IPCC Guidelines as well.

10 RECALCULATIONS AND IMPROVEMENTS

10.1 Main recalculations

Table 10.1 to Table 10.2 provide an overview for the largest recalculations (>+/- 500 kt CO_2 equiv.) in the year 1990 and 2019 for the EU-27 Member States and the UK. For explanations of the recalculations see the sectoral chapters of the EU NIR and the information provided in the Member States' submissions.

Recalculations presented are calculated from countries submissions used for the EU submission in May 2021 and MS submissions received until 8 May 2022.

Table 10.1 Main recalculations by source category for 1990 (>+/-500 kt CO_2 eq.)

Category	MS	1990	
		kt CO_2 equiv.	%
1A1_Energy Industries CO_2	United Kingdom (KP)	2 250	1.0
1A2_Manufacturing Industries and Construction CO_2	Estonia	-742	-17.6
1A2_Manufacturing Industries and Construction CO_2	France	-578	-0.9
1A2_Manufacturing Industries and Construction CO_2	Romania	-16 608	-24.4
1A2_Manufacturing Industries and Construction CO_2	United Kingdom (KP)	-18 237	-19.1
1A3_Transport CO_2	Sweden	994	5.3
1A4_Other sectors CO_2	France	1 203	1.3
1A5_Other CO_2	Sweden	-845	-100.0
1B2_Oil and natural gas CO_2	United Kingdom (KP)	-689	-11.9
2C_Metal industry CO_2	United Kingdom (KP)	18 059	245.0
3D_Agricultural soils N_2O	France	-574	-1.7
3D_Agricultural soils N_2O	Germany	-6 694	-22.7
3D_Agricultural soils N_2O	Italy	1 143	11.3
4A_Forest land CO_2	Bulgaria	850	4.9
4A_Forest land CO_2	Czechia	-1 851	-32.3
4A_Forest land CO_2	France	1 025	2.5
4A_Forest land CO_2	Germany	2 359	10.7
4A_Forest land CO_2	Ireland	1 108	28.7
4A_Forest land CO_2	Romania	5 080	16.6
4A_Forest land CO_2	Slovakia	-504	-5.9
4B_Cropland CO_2	France	-2 359	-10.0
4B_Cropland CO_2	Italy	-662	-28.9
4B_Cropland CO_2	Romania	-756	-52.3
4B_Cropland CO_2	United Kingdom (KP)	-4 362	-21.5
4C_Grassland CO_2	France	-682	-5.1
4C_Grassland CO_2	Italy	574	15.9
4C_Grassland CO_2	Romania	-2 950	-712.6
4C_Grassland CO_2	United Kingdom (KP)	597	123.8
4D_Wetlands CO_2	Hungary	-589	-73.7
4D_Wetlands CO_2	Romania	-1 379	-96.2
4E_Settlements CO_2	Germany	-653	-26.9
4E_Settlements CO_2	Romania	-1 553	-43.1
4E_Settlements CO_2	United Kingdom (KP)	-999	-15.6
4F_Other land CO_2	Romania	-580	-74.4
4G_Harvested wood products CO_2	Romania	1 159	141.9
5A_Solid waste disposal on land CH_4	Bulgaria	-1 559	-45.4

Table 10.2 Main recalculations by source category for 2019 (>+/-500 kt CO_2 eq.)

Category	MS	2019	
		kt CO_2 equiv.	%
1A1_Energy Industries CO_2	France	3 462	9.1
1A1_Energy Industries CO_2	Germany	1 330	0.5

Category	MS	2019	
		kt CO_2 equiv.	%
1A1_Energy Industries CO_2	Romania	710	3.3
1A1_Energy Industries CO_2	Spain	936	1.7
1A2_Manufacturing Industries and Construction CO_2	France	-3 419	-7.2
1A2_Manufacturing Industries and Construction CO_2	Germany	-1 906	-1.5
1A2_Manufacturing Industries and Construction CO_2	Romania	-884	-6.1
1A2_Manufacturing Industries and Construction CO_2	Spain	-831	-1.8
1A2_Manufacturing Industries and Construction CO_2	United Kingdom (KP)	-8 726	-17.4
1A3_Transport CO_2	France	-593	-0.5
1A3_Transport CO_2	Sweden	560	3.5
1A4_Other sectors CO_2	France	721	1.0
1A4_Other sectors CO_2	Germany	-2 154	-1.7
1A4_Other sectors CO_2	Italy	-634	-0.8
1A4_Other sectors CO_2	Poland	-1 068	-2.2
1A4_Other sectors CO_2	United Kingdom (KP)	-3 673	-4.0
1B2_Oil and natural gas CH_4	Italy	-894	-19.0
2B_Chemical industries N_2O	Bulgaria	-694	-89.0
2C_Metal industry CO_2	Germany	-1 144	-6.0
2C_Metal industry CO_2	United Kingdom (KP)	8 320	370.3
2F_Product uses as substitute for ODS HFC	Bulgaria	4 650	255.7
2F_Product uses as substitute for ODS HFC	Croatia	998	180.7
2F_Product uses as substitute for ODS HFC	France	-1 153	-8.2
2F_Product uses as substitute for ODS HFC	Poland	1 667	44.5
3A_Enteric fermentation CH_4	Germany	528	2.2
3B_Manure management CH_4	Germany	613	10.5
3D_Agricultural soils N_2O	France	-646	-2.1
3D_Agricultural soils N_2O	Germany	-5 970	-23.9
3D_Agricultural soils N_2O	Italy	1 722	21.4
4A_Forest land CO_2	Austria	1 869	43.2
4A_Forest land CO_2	Czechia	-4 748	-31.6
4A_Forest land CO_2	Finland	1 000	3.9
4A_Forest land CO_2	France	22 023	42.3
4A_Forest land CO_2	Germany	4 677	8.1
4A_Forest land CO_2	Hungary	764	13.6
4A_Forest land CO_2	Ireland	2 435	51.9
4A_Forest land CO_2	Italy	900	2.4
4A_Forest land CO_2	Latvia	-1 062	-22.0
4A_Forest land CO_2	Poland	-5 866	-38.7
4A_Forest land CO_2	Romania	1 814	6.8
4A_Forest land CO_2	Slovakia	-546	-11.7
4A_Forest land CO_2	Slovenia	-4 824	-2 066.1
4A_Forest land CO_2	Spain	607	1.8
4A_Forest land CO_2	Sweden	958	2.5
4A_Forest land CO_2	United Kingdom (KP)	-769	-4.5
4B_Cropland CO_2	France	-2 466	-17.4
4B_Cropland CO_2	Greece	961	264.6
4B_Cropland CO_2	Romania	4 690	57.1
4B_Cropland CO_2	Sweden	-1 351	-32.9
4B_Cropland CO_2	United Kingdom (KP)	-799	-5.3
4C_Grassland CO_2	Belgium	1 020	140.4
4C_Grassland CO_2	France	-699	-9.0
4C_Grassland CO_2	Germany	1 584	9.3
4C_Grassland CO_2	Sweden	-551	-56.8
4C_Grassland CO_2	United Kingdom (KP)	1 672	45.5
4D_Wetlands CO_2	Romania	-810	-116.3
4E_Settlements CO_2	Germany	-3 190	-77.4
4E_Settlements CO_2	Romania	-1 785	-45.4
4E_Settlements CO_2	United Kingdom (KP)	-1 569	-28.3
4G_Harvested wood products CO_2	Germany	-1 916	-46.2
4G_Harvested wood products CO_2	Romania	586	15.2

10.2 Implications for emission levels

Table 10.3 provides the differences in total GHG emissions between the latest submission and the previous submission in absolute and relative terms for EU-27, United Kingdom and Iceland (EU-KP). The table shows that due to recalculations, total 1990 GHG emissions with indirect CO_2 excluding

LULUCF have decreased in the latest submission compared to the previous submission by 22 202 kt (-0.4 %). EU-KP GHG emissions for 2019 decreased by 13 389 kt (-0.3 %) due to recalculations.

Table 10.3 Overview of recalculations of EU-KP total GHG emissions (difference between latest submission and previous submission in kt CO_2 equivalents)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total CO_2 equivalent emissions including LULUCF (absolute in kt)	-29011	-4521	-1055	-5200	521	-4748	-3786	-6736	-12031	-7982	-8346
Total CO_2 equivalent emissions including LULUCF (percent)	-0.5	-0.1	0.0	-0.1	0.0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2
Total CO_2 equivalent emissions excluding LULUCF (absolute in kt)	-22201	-6282	-4270	-3002	-4092	-5550	-4846	-4896	-5176	1397	3110
Total CO_2 equivalent emissions excluding LULUCF (percent)	-0.4	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Total CO_2 equivalent emissions including LULUCF (absolute in kt)	-7964	-10291	-12463	-12602	-12333	-14986	-13373	-6634	4997	4734	-3502
Total CO_2 equivalent emissions including LULUCF (percent)	-0.2	-0.2	-0.3	-0.3	-0.3	-0.4	-0.3	-0.2	0.1	0.1	-0.1
Total CO_2 equivalent emissions excluding LULUCF (absolute in kt)	1972	-614	-1701	-2027	-3977	-5033	-5942	-4099	-4859	-4595	-13389
Total CO_2 equivalent emissions excluding LULUCF (percent)	0.0	0.0	0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.11	-0.3

Table 10.4 provides an overview of recalculations for the key categories for 1990 and 2019. The table shows that the largest recalculations in absolute terms were made in the key category CO_2 from '1A2 Manufacturing Industries" for 1990 and as well as in 2019, followed by CO_2 recalculations in the category '2C Metal Industry'.

Table 10.5 and Table 10.6 give an overview of absolute and relative changes of Member States' emissions due to recalculations for 1990 and 2019. Recalculations of more than 2 million tonnes of CO_2 equivalents were made by Germany, Romania and the United Kingdom. Recalculations in relative terms of more than 2 % were made in Bulgaria, Croatia, Estonia, Malta and Romania.

Table 10.4 Recalculations for EU-KP key source categories 1990 and 2019 (difference between latest submission and previous submission in kt of CO_2 equivalents and in percentage)

Greenhouse Gas Source Categories	Gas	Recalculations 1990		Recalculations 2019	
		(kt CO_2 equivalents)	(%)	(kt CO_2 equivalents)	(%)
1.A.1. Energy Industries	CO_2	2 176	0.1%	6 181	0.6%
1.A.2. Manufacturing Industries	CO_2	- 36 025	-4.3%	- 15 231	-3.2%
1.A.3. Transport	CO_2	654	0.1%	- 5	0.0%
1.A.3. Transport	CH_4	58	0.8%	- 20	-1.5%
1.A.3. Transport	N_2O	- 18	-0.2%	- 48	-0.5%
1.A.4. Other Sectors	CO_2	1 071	0.1%	- 7 513	-1.3%
1.A.4. Other Sectors	CH_4	16	0.1%	- 682	-4.2%
1.A.5. Other	CO_2	- 899	-3.2%	- 391	-4.7%
1.B.1. Solid Fuels	CH_4	-	0.0%	366	1.5%
1.B.2. Oil and Natural Gas	CH_4	- 372	-0.6%	- 1 093	-4.3%
1.B.2. Oil and Natural Gas	CO_2	- 696	-3.1%	286	1.3%
2.A. Mineral Industry	CO_2	345	0.2%	314	0.3%
2.B. Chemical Industry	CO_2	49	0.1%	- 81	-0.2%
2.B. Chemical Industry	Unspecified mix of HFCs and PFCs	-	0.0%	-	0.0%
2.B. Chemical Industry	N_2O	19	0.0%	- 873	-13.4%
2.B. Chemical Industry	HFCs	-	0.0%	- 8	-0.5%
2.C. Metal Industry	CO_2	18 201	14.9%	6 946	8.7%
2.C. Metal Industry	PFC	0	0.0%	- 0	0.0%
2.D. Non-energy products from fuels and solvent u	CO_2	24	0.2%	- 111	-1.2%
2.F. Product uses as substitute for ODS	HFC	0	0.3%	5 929	6.4%
3.A. Enteric Fermentation	CH_4	329	0.1%	290	0.2%
3.B. Manure Management	CH_4	147	0.3%	327	0.8%
3.B. Manure Management	N_2O	340	1.1%	234	1.1%
3.D. Agricultural Soils	N_2O	- 5 398	-2.7%	- 4 827	-2.9%
5.A. Solid Waste Disposal	CH_4	- 1 987	-1.1%	- 1 630	-1.7%
5.B. Biological Treatment of Solid Waste	CH_4	- 16	-2.6%	- 67	-1.2%
5.D. Waste Water treatment and discharge	CH_4	180	0.5%	- 426	-2.3%
5.D. Waste Water treatment and discharge	N_2O	- 443	-5.0%	- 209	-2.8%

Note: Many of these source categories are more aggregated than the EU-KP key source categories identified in Section 1.5.

Table 10.5 Contribution of countries to EU-KP recalculations of total GHG emissions with indirect CO_2 and without LULUCF for 1990–2019 (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Austria	3	45	-44	-118	-122	-143	-181	-195	-186	-120	-122	-45	-4	25	-3	-70	-70	-102
Belgium	-33	-23	-4	-12	-8	1	9	29	12	-1	-24	15	36	-5	-271	-326	-301	-203
Bulgaria	-1 621	-1 232	-899	-648	-600	-553	-495	-526	-475	-446	-428	697	888	931	1 340	2 184	3 028	3 517
Croatia	29	12	-74	-67	-37	10	77	163	178	216	272	281	400	437	609	741	864	1 017
Cyprus	6	13	-10	12	17	20	26	22	24	7	12	1	-2	6	14	27	45	57
Czechia	-101	-4	325	382	430	362	230	-111	-60	44	33	216	164	185	-94	90	176	254
Denmark	249	256	281	272	321	284	285	300	274	284	284	286	336	317	324	319	278	263
Estonia	-870	-193	-16	-100	-97	-101	-33	-91	-37	-152	-91	-89	-72	-103	-87	-101	-81	-63
Finland	-59	-30	-32	-1	-21	-8	2	-32	-18	-39	-112	-72	-112	-116	-138	-173	-156	-284
France	41	-83	565	156	149	688	2 351	1 789	-711	-151	-35	-175	-9	273	-696	-863	-1 269	-1 459
Germany	-6 658	-5 250	-5 686	-5 820	-5 616	-5 729	-5 845	-5 946	-6 037	-6 030	-6 441	-6 432	-6 791	-6 308	-6 526	-6 346	-5 348	-10 065
Greece	161	88	61	-9	-24	0	-29	-32	11	-43	-34	-23	-1	-39	-13	-7	9	-27
Hungary	34	1	12	-4	-26	-22	-24	-45	-35	-45	-42	-35	-6	-21	-2	12	21	148
Ireland	-5	5	2	33	23	23	28	26	-1	-51	-20	-20	-56	45	239	-48	-174	78
Italy	1 187	1 872	1 824	1 837	1 683	1 656	1 438	1 322	1 330	1 496	1 662	1 255	1 410	1 322	1 578	768	1 075	72
Latvia	0	1	0	-7	-5	-9	-13	-16	-18	-19	-21	-21	-23	-22	-23	-24	-26	-29
Lithuania	69	32	15	14	13	11	11	9	8	5	5	3	9	21	15	10	9	-7
Luxembourg	6	7	6	2	2	2	2	1	-8	0	2	6	-10	-7	-4	-5	-4	-10
Malta	4	-3	-24	-5	1	-3	-5	-4	-24	-22	-49	-76	-105	-97	-67	-43	-11	-43
Netherlands	-8	-14	-73	-106	-112	-110	-103	-106	-92	-83	-72	-45	-68	-64	-43	1	-722	-471
Poland	10	40	86	-23	-30	-54	-76	960	-600	-668	-732	-1 535	-1 720	-1 667	-356	-424	1 276	-206
Portugal	-420	-359	-267	-141	-136	-124	-117	-39	-1	-77	-91	-94	-61	-52	-47	-32	-40	-2
Romania	-16 675	-2 488	-2 749	-2 231	-2 412	3 626	3 991	3 328	4 544	3 180	3 635	1 063	69	-1 533	-78	-266	-567	70
Slovakia	-11	-49	34	138	37	96	203	108	260	87	-72	53	97	-54	15	-11	-77	-172
Slovenia	19	-8	0	29	29	29	29	30	30	27	26	29	31	33	41	31	33	9
Spain	102	694	-120	246	273	358	353	288	281	264	318	305	285	421	162	107	1	-700
Sweden	202	178	189	165	160	160	164	156	156	141	132	124	111	107	130	90	-20	-109
United Kingdom	2 067	131	2 249	1 092	932	911	859	586	571	469	-81	273	169	-8	-168	-556	-2 666	-4 947
EU27+UK	**-22 273**	**-6 359**	**-4 347**	**-4 911**	**-5 176**	**1 380**	**3 136**	**1 976**	**-624**	**-1 727**	**-2 085**	**-4 057**	**-5 035**	**-5 971**	**-4 148**	**-4 916**	**-4 716**	**-13 415**
Iceland	-8	-7	-7	-4	2	6	0	3	-1	-1	-4	7	-24	-18	-24	-18	25	-9
United Kingdom (KP)	2 147	215	2 334	1 111	929	923	833	579	583	496	-18	346	195	39	-95	-481	-2 570	-4 911
EU-KP	**-22 201**	**-6 282**	**-4 270**	**-4 896**	**-5 176**	**1 397**	**3 110**	**1 972**	**-614**	**-1 701**	**-2 027**	**-3 977**	**-5 033**	**-5 942**	**-4 099**	**-4 859**	**-4 595**	**-13 389**

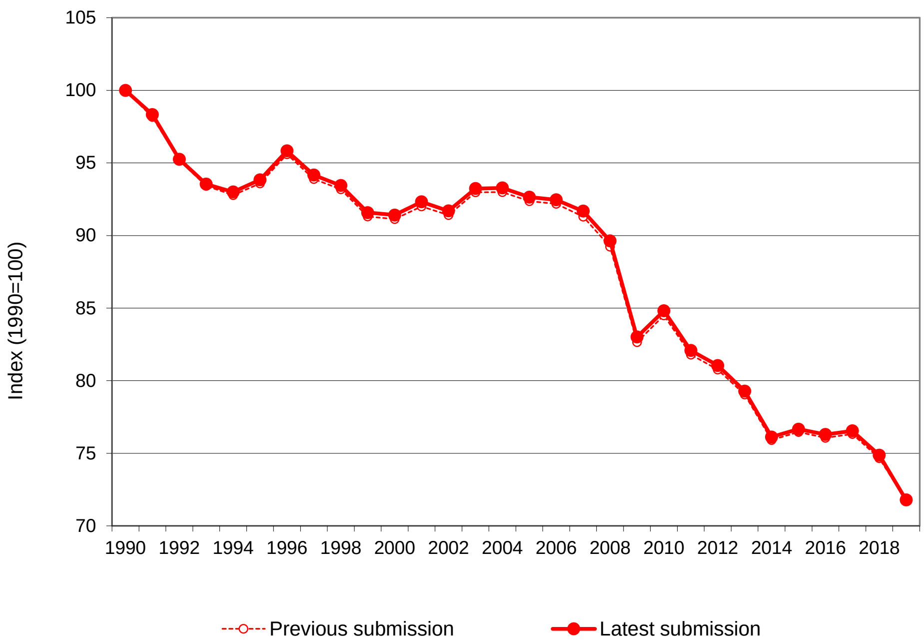
Table 10.6 Contribution of Member States to EU-KP recalculations of total GHG emissions with indirect CO_2 and without LULUCF for 1990–2019 (difference between latest submission and previous submission in percentage)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Austria	0.00	0.06	-0.06	-0.13	-0.14	-0.16	-0.21	-0.24	-0.22	-0.15	-0.15	-0.06	0.00	0.03	0.00	-0.09	-0.09	-0.13
Belgium	-0.02	-0.02	0.00	-0.01	-0.01	0.00	0.01	0.02	0.01	0.00	-0.02	0.01	0.03	0.00	-0.23	-0.28	-0.26	-0.17
Bulgaria	-1.62	-1.69	-1.55	-1.03	-0.95	-0.82	-0.75	-0.92	-0.79	-0.69	-0.71	1.27	1.53	1.52	2.28	3.57	5.29	6.29
Croatia	0.09	0.05	-0.29	-0.23	-0.12	0.03	0.25	0.58	0.64	0.79	1.06	1.16	1.71	1.83	2.54	3.00	3.67	4.31
Cyprus	0.10	0.18	-0.12	0.13	0.18	0.20	0.26	0.22	0.25	0.08	0.14	0.01	-0.02	0.08	0.16	0.30	0.51	0.65
Czechia	-0.05	0.00	0.22	0.26	0.29	0.24	0.16	-0.08	-0.04	0.03	0.02	0.17	0.13	0.14	-0.07	0.07	0.14	0.21
Denmark	0.35	0.33	0.39	0.41	0.43	0.41	0.43	0.47	0.43	0.49	0.53	0.52	0.66	0.65	0.64	0.66	0.58	0.59
Estonia	-2.12	-0.95	-0.09	-0.52	-0.52	-0.46	-0.17	-0.54	-0.18	-0.71	-0.45	-0.40	-0.34	-0.57	-0.44	-0.48	-0.40	-0.43
Finland	-0.08	-0.04	-0.05	0.00	-0.03	-0.01	0.00	-0.05	-0.02	-0.06	-0.18	-0.12	-0.19	-0.21	-0.24	-0.31	-0.28	-0.54
France	0.01	-0.02	0.10	0.03	0.03	0.13	0.45	0.36	-0.14	-0.03	-0.01	-0.04	0.00	0.06	-0.15	-0.19	-0.29	-0.33
Germany	-0.53	-0.47	-0.55	-0.59	-0.56	-0.59	-0.60	-0.65	-0.64	-0.66	-0.70	-0.68	-0.75	-0.70	-0.72	-0.71	-0.62	-1.24
Greece	0.16	0.08	0.05	-0.01	-0.02	0.00	-0.02	-0.03	0.01	-0.04	-0.03	-0.02	0.00	-0.04	-0.01	-0.01	0.01	-0.03
Hungary	0.04	0.00	0.02	-0.01	-0.03	-0.03	-0.03	-0.07	-0.05	-0.07	-0.07	-0.06	-0.01	-0.03	0.00	0.02	0.03	0.23
Ireland	-0.01	0.01	0.00	0.05	0.03	0.03	0.04	0.04	0.00	-0.09	-0.03	-0.03	-0.10	0.07	0.38	-0.08	-0.28	0.13
Italy	0.23	0.35	0.33	0.31	0.29	0.29	0.26	0.26	0.26	0.30	0.34	0.28	0.33	0.30	0.36	0.18	0.25	0.02
Latvia	0.00	0.00	0.00	-0.06	-0.05	-0.07	-0.11	-0.15	-0.15	-0.17	-0.19	-0.20	-0.22	-0.20	-0.22	-0.22	-0.23	-0.26
Lithuania	0.14	0.14	0.08	0.06	0.06	0.05	0.05	0.05	0.04	0.02	0.02	0.01	0.05	0.10	0.07	0.05	0.04	-0.04
Luxembourg	0.04	0.07	0.07	0.01	0.01	0.02	0.02	0.01	-0.06	0.00	0.02	0.06	-0.09	-0.06	-0.04	-0.05	-0.04	-0.09
Malta	0.15	-0.12	-0.84	-0.15	0.03	-0.11	-0.16	-0.15	-0.79	-0.74	-1.54	-2.66	-3.60	-4.38	-3.51	-2.08	-0.55	-1.98
Netherlands	0.00	-0.01	-0.03	-0.05	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.02	-0.04	-0.03	-0.02	0.00	-0.39	-0.26
Poland	0.00	0.01	0.02	-0.01	-0.01	-0.01	-0.02	0.24	-0.15	-0.16	-0.18	-0.38	-0.44	-0.43	-0.09	-0.10	0.31	-0.05
Portugal	-0.71	-0.52	-0.33	-0.16	-0.17	-0.16	-0.15	-0.05	0.00	-0.11	-0.14	-0.15	-0.10	-0.08	-0.07	-0.05	-0.06	0.00
Romania	-6.26	-1.33	-1.94	-1.50	-1.60	2.45	2.77	2.69	3.84	2.51	2.93	0.92	0.06	-1.32	-0.07	-0.23	-0.48	0.06
Slovakia	-0.02	-0.09	0.07	0.27	0.07	0.20	0.41	0.24	0.57	0.20	-0.17	0.13	0.24	-0.13	0.04	-0.03	-0.18	-0.43
Slovenia	0.10	-0.04	0.00	0.14	0.14	0.14	0.14	0.15	0.15	0.14	0.14	0.16	0.19	0.19	0.23	0.17	0.19	0.05
Spain	0.04	0.21	-0.03	0.06	0.06	0.08	0.09	0.08	0.08	0.07	0.09	0.09	0.09	0.13	0.05	0.03	0.00	-0.22
Sweden	0.28	0.24	0.28	0.25	0.24	0.24	0.26	0.27	0.24	0.23	0.23	0.22	0.21	0.20	0.24	0.17	-0.04	-0.21
United Kingdom	0.26	0.02	0.32	0.16	0.14	0.14	0.13	0.10	0.09	0.08	-0.01	0.05	0.03	0.00	-0.04	-0.12	-0.58	-1.10
EU27+UK	**-0.39**	**-0.12**	**-0.08**	**-0.09**	**-0.10**	**0.03**	**0.06**	**0.04**	**-0.01**	**-0.04**	**-0.05**	**-0.09**	**-0.12**	**-0.14**	**-0.10**	**-0.11**	**-0.11**	**-0.33**
Iceland	-0.23	-0.20	-0.18	-0.10	0.05	0.11	0.00	0.06	-0.03	-0.01	-0.09	0.14	-0.52	-0.38	-0.51	-0.38	0.52	-0.20
United Kingdom (KP)	0.27	0.03	0.33	0.16	0.14	0.14	0.13	0.10	0.10	0.09	0.00	0.06	0.04	0.01	-0.02	-0.10	-0.55	-1.09
EU-KP	**-0.39**	**-0.12**	**-0.08**	**-0.09**	**-0.10**	**0.03**	**0.06**	**0.04**	**-0.01**	**-0.04**	**-0.04**	**-0.09**	**-0.12**	**-0.14**	**-0.10**	**-0.11**	**-0.11**	**-0.33**

10.3 Implications for emission trends, including time series consistency

Figure 10.1 shows that due to the fact that both 1990 and 2019 emissions have been recalculated in the same order of magnitude the emission trend in the EU-KP did hardly change, and the trends are therefore largerely overlapping. In the previous submission the trend of GHG with indirect CO_2 and excluding LULUCF between 1990 and 2019 was -28.3 %. In the latest submission the trend is - 28.2 %.

Figure 10.1: Comparison of EU-KP GHG emission trends 1990–2019 (with indirect CO_2, excl. LULUCF) of the latest and the previous submission



10.4 Recalculations, including in response to the review process, and planned improvements to the inventory

10.4.1 EU response to UNFCCC review

A list of recommendations and improvements is presented in Annex V. The tables in Annex V focus on UNFCCC recommendations from the review report 2020.

10.4.2 Improvements planned at EU level

The following activities are planned at EU level with a view to improving the EU GHG inventory:

- Include new key categories in the NIR giving detailed information like for other key categories
- Further implement the recommendations from the past reviews;
- Continue sector-specific QA/QC activities within the EU internal review (ESD review);

11 KP-LULUCF

For each Article 3(3), and Article 3(4) activities, estimates reported in the EU GHG inventory result from summing up all GHG emissions and CO_2 removals reported by individual EU Member States (MS), UK and Iceland. For the voluntary activities under the Article 3(4), information is included only for those countries that elected to account for these activities during the second commitment period (CP2) of the Kyoto Protocol (KP).

It is important to note that each country will account for net emissions and removals for each activity under Article 3(3), and 3(4) if elected, by issuing removals units (RMUs) or cancelling KP units based on their own reported emissions and removals from their activities, and the specific accounting rules.

The EU will neither issue, nor cancel units based on reported emissions and removals from activities under Article 3(3) and (4).

This chapter provides an overview of relevant supplementary information for KP-LULUCF activities, as reported by EU MS, UK and Iceland.

In the absence of an official annotated outline for the provision of supplementary information under the KP-CP2, the JRC[63] provided to the countries a proposal on the outline for reporting supplementary information on KP-LULUCF within the national inventory reports (NIRs). Nevertheless, the type and amount of information reported by individual inventories slightly differs among countries. Therefore, note that this chapter does not aim to provide an exhaustive compilation of all supplementary information reported by EU MS, UK and Iceland, but an overview of the most important elements on KP-LULUCF as included in the individual inventories. For more detailed information, we encourage readers to refer to information included in the NIR of the countries.

In particular, this chapter includes:

- General information concerning KP-LULUCF activities, (i.e., 3(3) and elected activities under Article 3(4), completeness of reporting of carbon pools and other sources of GHG emissions, areas reported under each activity, accounting quantities, key category analysis, definition of forest used by EU MS, UK and Iceland).
- Information related to the land representation approach for KP-LULUCF activities.
- Activity-specific information, (i.e., methodologies for estimating carbon stock changes and other sources of GHG emissions, justification for omitting carbon pools, information on whether indirect and natural CO_2 removals have been factored out, information on the year of the onset of the activity, and information on other methodological issues).
- A synthesis of supplementary information required for Article 3(3) and 3(4) activities (i.e., information on natural disturbances, information on HWP, methods for constructing the FMRLs, and their technical corrections, and information about conversion from natural to planted forests).

[63] Joint Research Centre of the European Commission. https://joint-research-centre.ec.europa.eu/index_en

The main postulation when reporting under the KP is that the consistency of the information reported in the EU GHG inventory with the IPCC good practices is ensured when individual GHG inventories are consistent with these practices. To achieve and ensure such assumption, the consistency of the GHG inventories of EU MS, UK and Iceland with the IPCC good practices is checked twice every year before national GHG inventories are officially submitted to the UNFCCC. A first check is carried out at country level as part of the QA/QC procedures implemented by the countries, and a second one in the context of the EU's QA/QC procedures as implemented by the JRC experts pursuant the Regulation 525/2013 (see section 6.4 on QAQC procedures implemented for LULUCF and KP-LULUCF)

11.1 General information

11.1.1 Elected activities under Article 3(4) of the Kyoto Protocol

As shown in Table 11.1, with regard to voluntary activities under the Article 3(4) during the CP2; 6 EU MS and UK have elected to account for Cropland Management, 5 EU MS and UK for Grazing Land Management, 1 EU MS and Iceland for Revegetation, and only UK for Wetland Drainage and Rewetting. Concerning the accounting frequency, with the exception of 2 EU MS, all countries have elected to account at the end of the commitment period.

Table 11.1 Activities elected under Art. 3(4), and accounting frequency. FM: forest management, CM: cropland management, GM: grazing land management, RV: revegetation, WDR: wetlands drainage and rewetting.

Country	Elected activities under Art 3(4) 1	Accounting frequency
Austria	---	end of CP
Belgium	---	end of CP
Bulgaria	---	end of CP
Croatia	---	end of CP
Cyprus	---	end of CP
Czechia	---	end of CP
Denmark	CM, GM	annual
Estonia	---	end of CP
Finland	---	end of CP
France	---	end of CP
Germany	CM, GM	end of CP
Greece	---	end of CP
Hungary	---	annual
Ireland	CM, GM	end of CP
Italy	CM, GM	end of CP
Latvia	---	end of CP
Lithuania	---	end of CP
Luxembourg	---	end of CP
Malta	---	end of CP
Netherlands	---	end of CP
Poland	---	end of CP
Portugal	CM, GM	end of CP
Romania	RV	end of CP
Slovakia	---	end of CP
Slovenia	---	end of CP
Spain	CM	end of CP
Sweden	---	end of CP
UK	CM, GM, WDR	end of CP
Iceland	RV	end of CP

[1]*FM activity became a mandatory reporting activity for the KP- CP2.*

11.1.2 Activity coverage under Article 3(3) and Article 3(4) (CRF table NIR-1)

Table 11.2 presents an assessment of completeness of carbon pools and GHG emissions reported by EU MS, UK and Iceland for each mandatory and elected activity.

Carbon stock changes are estimated in all cases for living biomass pool. For dead organic matter and soil organic carbon pools notation keys are also used. “NE”, “NO” “NA” are used mainly when the “not a source” provision is applied, while “IE” is mainly used for belowground biomass being included under aboveground biomass, or for "gain" or "losses" in living biomass when the stock-difference method is applied, and therefore, only a net gain, or net loss, is reported.

In addition, "IE" is also used when carbon stock changes in litter and dead wood are reported together, or when dead organic matter and soil organic carbon pools are estimated by using models not capable to apportion net carbon stock changes among these pools.

Despite of the continuous improvements implemented by EU MS, UK and Iceland in their GHG inventories, when implementing the "not a source" provision, both the EU QA/QC procedures and the UNFCCC expert review teams highlighted the need of providing more transparent information to demonstrate that omitted carbon pools are not a net source of emissions. After such recommendations more detailed information has been provided in individual inventories during the recent years, and a synthesis of such information is presented in Table 11.17.

Concerning other sources of GHG emissions, individual inventories have also introduced significant improvements, especially with regard to N_2O emissions from management of soils. But notation keys are also used when a specific source of GHG emissions does not occur within the national territories (e.g., fertilization of natural forests) or when such emissions are already reported under the agriculture sector. An example is given, following IPCC methods, when the source of information does not allow to separate between LULUCF and Agriculture the final destination of nitrogen fertilizers.

Table 11.2 Synthesis of carbon pools and other sources of GHG emissions reported for KP-LULUCF activities in EU MS, UK and Iceland, based on table NIR-1 and sectorial tables for the current inventory year.

Country	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Afforestation/Reforestation															
Austria	R	R	R	R	R	NO	R	NO	NO	NO	R	IE	NO	NO	NO
Belgium	R	R	R	R	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	NO	R	NO	R	NO	NO	NO	NO	NO	IE	R	R
Croatia	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	R	R	R
Cyprus	R	R	R	NO	NR	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	R	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO
Denmark	R	R	R	R	R	R	R	IE	R	R	NO	R	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	R	R	NO	NO	IE	R	R
Finland	R	R	IE	IE	R	R	R	R	R	R	R	R	R	R	R
France	R	R	R	R	R	NO	NO	NO	NO	NO	R	NE	R	R	R
Germany	R	R	R	R	R	R	IE	NO	R	R	R	R	IE,NO	IE,NO	IE,NO
Greece	R	R	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	R	R	R
Hungary	R	R	NR	NR	NR	NO	IE	IE	NO	NO	NO	NO	IE	R	R
Ireland	R	R	R	R	R	R	R	IE	R	R	NO	IE	R	R	R
Italy	R	R	R	R	R	NO	R	NO	NO	NO	R	R	R	R	R

Country	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Latvia	R	R	R	R	NO	R	NO	NO	R	R	NO	NO	NO	NO	NO
Lithuania	R	R	R	NO	R	R	IE	NO	R	R	NO	NO	R	R	R
Luxembourg	R	R	R	R	R	NO	IO	NO	NO	NO	NO	NO	NO	NO	NO
Malta	R	R	NR	NR	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	R	R	R	R	IE	NO	NE	R	R	NO	R	R	R
Poland	R	R	NR	NR	R	R	NO	NO	NO	NO	NO	NO	R	R	R
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	IE	R	IE	R	NO	IE	IE	NO	NO	NO	NO	IE	IE	IE
Slovakia	R	R	R	R	R	NO,NR	NR	NO	NO	NO	NO	NO	R	R	R
Slovenia	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Spain	R	IE	NR,R	NR,R	NR,R	NO	NR	NO	NO	NO	NE,R	IE,NE	IE,NO,R	NO,R	NO,R
Sweden	R	R	R	R	R	R	R	NO	R	R	R	R	NO	NO	NO
UK	R	R	R	R	R	R	R	R	R	R	R	NE	R	R	R
Iceland	R	R	R	NO	R	R	NO	R	R	R	NO	NO	NO	NO	NO
Deforestation															
Austria	R	R	R	R	R	NO	IO	NO	NO	NO	R	IE	NO	NO	NO
Belgium	R	R	R	R	R	NO	R	IE	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Croatia	R	R	R	R	R	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Cyprus	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	R	R	R	R	R	R	R	NO	NO	NO	R	NO	NO	NO	NO
Denmark	R	R	R	R	R	R	R	R	R	R	R	IE	NO	NO	NO
Estonia	R	R	R	R	R	R	R	NO	NE	NE	R	NO	NO	NO	NO
Finland	R	R	IE	IE,R	R	R	IO	IE	R	R	R	IE	R	R	R
France	R	R	R	R	R	NO	IO	NO	NO	NO	R	NE	R	R	R
Germany	R	R	R	R	R	R	NO	NO	R	R	R	R	NO	NO	NO
Greece	R	R	R	R	R	NO	NO	NO	NO	NO	R	NO	NO	NO	NO
Hungary	R	R	R	R	R	NO	IO	IE	NO	NO	R	R	IE	R	R
Ireland	R	R	R	R	R	R	IO	IE	R	R	R	IE	NO	NO	NO
Italy	R	R	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Latvia	R	R	R	R	R	R	R	IE	R	R	R	R	NO	NO	NO
Lithuania	R	R	R	R	R	R	IO	NO	NO	NO	R	NO	NO	NO	NO
Luxembourg	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Malta	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	R	R	R	R	IO	IE	NE	IE	R	IE	R	R	R
Poland	R	R	R	R	R	R	NO	NO	NO	NO	NO	NO	NO	NO	NO
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R

Country	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Romania	R	IE	R	IE	R	NO	IO	IE	NO	NO	R	R	NO	NO	NO
Slovakia	R	R	R	R	R	NO,NR	NR	NO	NO	NO	NO	NO	NO	NO	NO
Slovenia	R	R	R	R	R	NO	IO	NO	NO	NO	R	NO	NO	NO	NO
Spain	NR,R	IE,NR	NR,R	NR,R	NR,R	NO	NR	NO	NO	NO	NE,R	IE,NE	NO,R	IE,NO,R	IE,NO,R
Sweden	R	R	R	R	R	R	IO	NO	R	R	R	R	NO	NO	NO
UK	R	IE	R	R	R	R	IO	NO	NO	NO	NO	NO	R	R	R
Iceland	R	NO	NO	NO	R	R	NO	NO	R	R	R	NO	R	R	R
Forest Management															
Austria	R	R	IE	R	R	NO	R	NO	NO	NO	NO	NO	IE	R	R
Belgium	R	R	NO	NO	NO	NO	R	NO	NO	NO	R	NO	NO	NO	NO
Bulgaria	R	IE	NA	R	NA	NO	R	NO	NO	NO	NO	NO	IE	R	R
Croatia	R	R	NA	NA	NA	NO	R	NO	NO	NO	NO	NO	R	R	R
Cyprus	R	R	NO	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Czechia	R	R	R	R	R	R	R	NO	NO	NO	NO	NO	R	R	R
Denmark	R	R	R	R	R	R	R	R	R	R	NO	R	R	R	R
Estonia	R	R	IE	R	R	NO	R	NO	NO	NO	NO	NO	IE	R	R
Finland	R	R	IE	IE	R	R	R	R	R	R	R	R	R	R	R
France	R	R	R	R	R	NO	R	NO	NO	NO	R	NE	R	R	R
Germany	R	R	R	R	R	R	R	NO	R	R	R	R	IE,NO	R	R
Greece	R	R	NR	NR	NR	NO	R	NO	NO	NO	NO	NO	R	R	R
Hungary	R	R	NR	NR	NR	R	R	IE	NO	NO	NO	NO	IE	R	R
Ireland	R	R	R	R	R	R	R	IE	R	R	NO	IE	R	R	R
Italy	R	R	R	R	NR	NR	R	NO	NO	NO	NO	NO	R	R	R
Latvia	R	R	R	R	NO	R	R	NO	R	R	NO	NO	R	R	R
Lithuania	R	R	R	R	NO	R	R	NO	R	R	NO	NO	R	R	R
Luxembourg	R	R	R	R	R	NO	IO	NO	NO	NO	NO	NO	NE	NE	NE
Malta	R	R	NR	NR	NR	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Netherlands	R	R	NR	R	R	R	R	NO	NE	R	R	NO	R	R	R
Poland	R	R	NR	R	R	R	R	NO	NO	NO	NO	NO	R	R	R
Portugal	R	R	R	IE	R	NO	R	IE	NO	NO	R	IE	R	R	R
Romania	R	IE	NR	NR	NR	R	R	IE	NO	NO	NO	NO	R	R	R
Slovakia	R	R	R	NO,NR	NO,NR	NO,NR	R	NO	NO	NO	NO	NO	R	R	R
Slovenia	R	R	NR	R	NR	NO	R	NO	NO	NO	NO	NO	R	R	R
Spain	R	IE	NR	NR	NR	NO	R	NO	NO	NO	NE	NE	IE	R	R
Sweden	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
UK	R	IE	R	R	R	R	R	NO	R	R	R	NO	R	R	R
Iceland	R	R	R	R	R	R	R	NO	R	R	NO	NO	NO	NO	NO

Country	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	AGB	BGB	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N_2O emissions from managed soil	Biomass burning		
					Min	Org		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Cropland Management															
Denmark	R	R	NO	NO	R	R			R		R		NO	NO	NO
Germany	R	R	IE	IE	R	R			R		R		NO	NO	NO
Ireland	R	IE	NO	NO	R	NO			NO		IE		NO	R	R
Italy	R	R	NO	NO	R	R			NO		R		R	R	R
Portugal	R	R	R	NO	R	NO			NO		R		R	R	R
Spain	R	IE	NR,R	NR	R	NO			NO		NE,R		NO,R	IE,NO,R	IE,NO,R
UK	R	IE	NR	NR	R	R			R		R		NE,NO	R	R
Grassland Management															
Denmark	R	R	NO	NO	R	R			R		R		NO	NO	NO
Germany	R	R	IE	IE	R	R			R		R		NO	NO	NO
Ireland	R	IE	NO	NO	R	NO			NO		IE		NO	R	R
Italy	R	R	NO	NO	R	R			NO		R		R	R	R
Portugal	R	R	R	NO	R	NO			NO		R		R	R	R
UK	R	IE	NR	NR	R	R			R		R		NE,NO	R	R
Revegetation Management															
Romania	R	IE	R	IE	R	NO		IE	NO	NO	NO	NO	NO	NO	NO
Iceland	R	IE	IE	NO	R	NO		R	NO	NO	IE	IE	NE	R	R
Wetlands Drainage and Rewetting															
UK	NR	NR	NR	NR		R		NE	R	R		NE	NE	NE	NE

Notation keys: R – carbon stock changes or GHG emissions from other sources are reported; NR – the pool is not reported (mainly under assumption of "not a source"); NE – removals/emissions are not estimated; IE – included elsewhere; NO –not occurring; NA – not applicable.

11.1.3 Areas reported under the KP-LULUCF activities (KP CRF table NIR-2)

Total land area reported under KP-LULUCF activities by EU MS, UK and Iceland is about 251.000 kha, which is approximately 55% of the total area reported under the Convention (Table 11.3

The activity that covers the largest area is Forest Management (61%), followed by Cropland Management (21%), Grazing land Management (12%), Afforestation/Reforestation (4%) and Deforestation (1%), while Revegetation and Wetlands Drainage and Rewetting together cover less than 1% of the area reported under the KP. But it should be noted that not all activities are elected by all MS.

With the exception of Finland, Netherlands, Romania, and Sweden all individual GHG inventories report larger areas under Afforestation/Reforestation than under Deforestation. Consequently, forest area reported under KP increases over time.

Regardless of specific activities, most of the area under the KP accounting is reported by Spain, Germany, Sweden, Italy, France, UK. The largest area under AR, and D is reported by France, and the largest under FM is reported by Sweden. For CM and GM, respectively Spain and UK report the largest area.

Table 11.3 Synthesis of total area (kha) reported under KP-LULUCF activities by EU MS, UK, and Iceland in the CRF table NIR-2. Grey cells indicate that the activity has not been elected.

Country	Art. 3.3 activities		Art. 3.4 activities					TOTAL Area under KP
	AR	D	FM	CM	GM	RV	WDR	
Austria	254,24	82,31	3.803,63					4.140,18
Belgium	35,02	33,97	672,78					741,77
Bulgaria	120,45	6,46	3.798,67					3.925,58
Croatia	65,86	4,77	2.321,42					2.392,05
Cyprus	0,42	0,03	157,86					158,31
Czech Republic	69,48	19,61	2.607,85					2.696,94
Denmark	112,33	15,54	529,00	2.857,41	181,90			3.696,17
Estonia	56,70	34,11	2.386,83					2.477,64
Finland	212,09	472,90	21.605,56					22.290,55
France	2.396,26	1.153,08	20.592,92					24.142,27
Germany	325,82	135,61	10.692,49	13.279,33	7.022,03			31.455,27
Greece	35,31	5,86	1.247,69					1.288,86
Hungary	177,94	46,55	1.879,07					2.103,55
Ireland	333,00	20,75	445,99	743,90	4.220,41			5.764,05
Italy	2.136,60	69,95	7.441,90	8.999,78	3.948,68			22.596,90
Latvia	120,63	103,25	3.120,87					3.344,76
Lithuania	57,33	5,72	2.164,94					2.227,99
Luxembourg	1,43	1,41	91,58					94,43
Malta	0,06	NO,NA	0,09					0,14
Netherlands	48,45	79,29	305,70					433,44
Poland	797,34	29,79	8.645,54					9.472,66
Portugal	642,32	391,83	3.728,44	2.345,55	587,91			7.696,06
Romania	46,87	80,48	6.946,03			94,44		7.167,82
Slovakia	50,95	9,13	1.976,90					2.036,98
Slovenia	NO,NA	27,30	1.164,19					1.191,48
Spain	1.276,96	131,06	14.418,67	20.192,02				36.018,71
Sweden	334,09	350,17	27.902,17					28.586,43
EU	**9.707,94**	**3.310,93**	**150.648,77**	**48.417,99**	**15.960,93**	**94,44**		**228.141,00**
United Kingdom	621,25	86,59	3.001,23	4.857,04	14.188,10		25,82	22.780,03
Iceland	49,90	0,07	93,99			325,90		469,85
EU +UK+ Iceland	**10.379,08**	**3.397,59**	**153.743,99**	**53.275,03**	**30.149,03**	**420,34**	25,82	**251.390,88**

11.1.4 Summary overview of key categories for KP-LULUCF activities (KP CRF table NIR-3)

Information included in Table 11.4 relies on the information reported by EU MS, UK and Iceland in CRF table NIR-3. However, in some cases the information was taken from the NIR because, as explained by some countries during the EU QA/QC procedures, remaining open issues in the CRF Reporter prevented the provision of this information in table NIR-3.

Table 11.4 Synthesis of KP-LULUCF activities being key category as reported by EU MS, UK and Iceland (from table NIR-3). "KC" indicates a key category.

Country	Art. 3.3 activities		Art. 3.4 activities				
	AR	D	FM	CM	GM	RV	WDR
Austria	*KC*	*KC*	*KC*				
Belgium	*KC*	*KC*	*KC*				
Bulgaria	*KC*	*KC*	*KC*				
Croatia	*KC*	*KC*	*KC*				
Cyprus	*KC*	*KC*	*KC*				
Czech Republic			*KC*				
Denmark			*KC*	*KC*	*KC*		
Estonia	*KC*	*KC*	*KC*				
Finland	*KC*	*KC*	*KC*				
France	*KC*	*KC*	*KC*				
Germany	*KC*	*KC*	*KC*	*KC*	*KC*		
Greece			*KC*				
Hungary	*KC*	*KC*	*KC*				
Ireland	*KC*		*KC*		*KC*		
Italy	*KC*	*KC*	*KC*	*KC*	*KC*		
Latvia	*KC*	*KC*	*KC*				
Lithuania	*KC*	*KC*	*KC*				
Luxembourg	*KC*	*KC*	*KC*				
Malta	*KC*		*KC*				
Netherlands	*KC*	*KC*	*KC*				
Poland			*KC*				
Portugal	*KC*	*KC*	*KC*	*KC*	*KC*		
Romania	*KC*		*KC*			*KC*	
Slovakia	*KC*		*KC*				
Slovenia		*KC*	*KC*				
Spain	*KC*	*KC*	*KC*	*KC*			
Sweden	*KC*	*KC*	*KC*				
UK	*KC*	*KC*	*KC*	*KC*	*KC*		*KC*
Iceland	*KC*		*KC*			*KC*	

11.1.5 Summary of net emissions and removals (kt CO_2 eq.), and accounting quantities for KP-LULUCF activities (KP CRF table "Accounting")

Tables 11.5 and Table 11.6 show respectively: (i) reported net emissions and removals, and (ii) accounted quantities, as reported by EU MS, UK and Iceland for each of the KP activities; and the sum for total EU and total EU plus UK plus Iceland, when relevant.

The total net accounted amount at EU level, as reported so far for the KP-CP2 by EU MS in the accounting tables is: -779.073,36 CO_2eq. With the addition of UK and Iceland the total net accounting results in a net sink of - 820.117,73 CO_2eq.

Emissions from Deforestation offset about 74% of the removals accounted in Afforestation/Reforestation. By far, the largest contributors to emissions from deforestation are France, Finland and Sweden that are responsible of about 55% of total GHG emissions from this activity in (see table 11.6)

Tables 11.5 Net emissions and removals (kt CO_2eq.) from KP-LULUCF activities for the period 2013-2020, as reported by EU MS, UK and Iceland. Based on information reported in CRF Accounting table

Country	Net emissions (+) and removals (-), kt CO_2eq.															
	Art 3.3 activities															
	A.1 Afforestation/reforestation								**A.2 Deforestation**							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
AUT	-2.017,4	-2.031,2	-2.065,0	-2.098,2	-2.142,1	-2.181,1	-2.207,4	-2.219,4	536,5	524,8	518,3	511,9	505,4	499,0	492,6	486,1
BEL	-242,6	-252,3	-262,0	-276,7	-283,8	-290,8	-289,8	-296,7	421,8	424,0	426,8	730,3	740,3	749,8	734,8	743,6
BGR	-885,1	-952,2	-1.006,6	-1.071,8	-1.134,5	-1.202,2	-1.256,9	-1.327,7	161,3	74,8	210,8	177,9	189,5	86,6	243,5	119,9
HRV	-92,2	-103,8	-146,3	-234,6	-185,4	-258,7	-272,8	-280,6	43,8	25,3	56,1	26,2	20,3	19,2	24,9	20,9
CYP	-1,8	-5,8	-6,1	-5,7	-6,5	-6,7	-7,1	-7,3	0,2	0,2	0,3	0,3	0,3	0,3	0,3	0,3
CZE	-517,1	-551,3	-586,0	-608,9	-641,4	-664,0	-699,2	-712,0	257,8	256,2	215,2	244,1	259,5	198,2	201,9	247,9
DNM	-110,0	-221,2	-287,3	-278,2	-343,1	-484,8	-610,4	-275,0	70,2	170,7	677,9	563,3	44,7	415,6	213,9	514,7
EST	-292,7	-282,3	-268,6	-253,4	-235,9	-218,8	-202,7	-187,3	554,7	588,1	617,0	679,2	679,5	647,8	548,2	478,2
FIN	-720,1	-783,8	-583,4	-608,8	-578,9	-525,5	-53,9	-550,2	4.307,6	4.121,6	3.943,2	3.819,8	3.644,6	3.543,9	3.528,0	3.359,4
FRA	-13.871,1	-13.967,9	-13.392,1	-13.737,9	-13.442,6	-13.845,6	-13.862,1	-14.196,0	11.686,9	11.787,5	11.888,2	11.776,9	11.874,4	11.971,9	12.069,5	12.167,0
DEU	-621,7	-684,7	-747,9	-379,3	-467,0	-531,6	-622,8	-725,1	623,2	669,1	716,2	1.171,6	1.217,1	1.256,1	1.262,6	1.274,1
GRC	-135,9	-146,9	-124,4	-138,4	-80,1	-126,5	-120,6	-82,2	47,3	47,3	44,9	56,2	52,4	53,2	45,5	49,2
HUN**	1.481,9	1.585,5	1.411,5	1.312,3	1.104,3	1.012,0	957,7	750,0	176,4	272,9	273,8	345,1	399,3	442,8	453,6	310,0
IRL	-3.699,0	-3.282,2	-3.505,5	-3.527,7	-3.254,4	-3.063,0	-2.936,8	-3.233,3	1.065,1	261,0	1.346,1	362,0	283,0	275,9	266,5	293,8
ITA	-6.257,0	-8.165,7	-8.569,9	-9.035,8	-8.299,9	-5.485,3	-7.986,9	-9.141,6	1.942,4	1.953,1	1.963,6	1.973,5	1.975,4	1.983,5	1.993,3	2.000,0
LVA	-179,8	-194,1	-208,6	-222,7	-240,7	-254,6	-273,2	-293,3	1.066,4	820,2	850,6	880,9	911,2	941,3	1.118,6	1.150,7
LTU	-167,4	-222,9	-213,7	-311,4	-264,8	-401,0	-394,7	-424,6	204,9	270,8	27,4	164,5	85,3	1.287,2	556,6	224,5
LUX	-31,7	-31,3	-31,0	-30,8	-30,1	-29,5	-28,8	-28,7	40,8	41,0	41,2	18,5	18,3	18,2	18,0	17,8

Country	Net emissions (+) and removals (-), kt CO_2eq.															
	Art 3.3 activities															
	A.1 Afforestation/reforestation								**A.2 Deforestation**							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
MLT	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	NO	NO	NO	NO	NO	NO	NO	NO
NLD	-841,4	-834,1	-826,3	-818,1	-832,7	-842,5	-852,4	-842,4	1.101,6	1.143,6	1.187,0	1.231,5	651,3	664,0	676,8	689,8
POL	-2.205,6	-2.182,4	-2.250,0	-2.509,1	-1.511,0	-2.267,7	-2.359,3	-2.403,1	946,9	936,7	1.027,8	5.571,9	1.876,5	1.892,6	1.911,6	1.834,4
PRT	-3.346,0	-3.585,8	-3.446,9	-2.866,5	-581,4	-3.177,7	-3.318,6	-3.150,5	2.123,7	2.100,5	2.079,2	2.064,4	2.074,6	1.988,4	1.959,4	1.934,0
ROU	-645,9	-675,7	-701,5	-724,9	-753,0	-780,6	-796,2	-803,0	1.005,4	1.004,0	1.140,2	1.141,6	1.184,3	1.182,8	1.182,4	1.165,0
SVK	-454,3	-474,5	-509,7	-536,5	-557,7	-579,6	-591,1	-600,4	42,9	62,6	60,5	28,3	56,2	111,6	39,2	45,2
SVN	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	250,9	251,4	252,3	253,8	255,7	256,8	259,7	262,5
ESP	-8.205,0	-7.898,6	-7.273,1	-6.801,0	-6.118,0	-5.677,5	-5.309,5	-4.792,6	639,1	636,3	632,6	631,3	630,5	629,6	629,4	629,5
SWE	-1.156,0	-1.100,0	-978,0	-1.037,5	-1.029,5	-1.044,0	-1.087,0	-1.111,4	2.941,1	3.159,6	4.286,5	2.953,5	2.711,1	2.850,9	2.996,4	2.393,2
EU	**-45.214,8**	**-47.045,2**	**-46.578,2**	**-46.801,8**	**-41.910,3**	**-42.927,3**	**-45.182,5**	**-46.934,3**	**32.259,0**	**31.603,5**	**34.483,6**	**37.378,1**	**32.340,8**	**33.967,2**	**33.426,9**	**32.411,8**
UK	-1.245,8	-1.626,2	-1.941,9	-2.317,0	-2.650,7	-2.919,6	-3.210,5	-3.526,6	1.562,0	1.581,8	2.172,3	2.017,3	1.847,0	2.359,8	2.769,6	2.250,3
ISL	-183,7	-204,3	-225,0	-244,6	-281,4	-309,2	-310,1	-337,4	0,2	0,1	0,7	0,3	0,5	0,5	0,5	0,6
EU+UK+ISL	**-46.644,3**	**-48.875,7**	**-48.745,2**	**-49.363,4**	**-44.842,3**	**-46.156,2**	**-48.703,0**	**-50.798,3**	**33.821,1**	**33.185,4**	**36.656,6**	**39.395,7**	**34.188,2**	**36.327,4**	**36.197,0**	**34.662,6**

Country	Net emissions (+) and removals (-), kt CO_2eq. Art. 3.4 activities B.1 Forest Management							
	2013	2014	2015	2016	2017	2018	2019	2020
AUT	-1.633,9	-1.825,8	-1.671,8	-1.520,2	-2.049,7	-2.255,5	-1.723,5	-431,4
BEL	-1.864,5	-1.837,2	-1.780,2	-1.978,7	-1.863,7	-1.834,8	-1.709,1	-1.578,4
BGR	-7.671,0	-7.712,6	-7.848,8	-9.342,5	-9.533,8	-9.494,1	-9.469,2	-9.173,9
HRV	-8.132,0	-7.767,5	-7.319,4	-7.030,9	-6.201,0	-6.665,7	-4.163,7	-6.730,4
CYP	-142,3	-143,6	-142,7	94,9	-148,4	-140,5	-137,5	-137,6
CZE	-6.242,7	-6.073,5	-5.846,0	-4.970,4	-3.299,3	2.402,2	9.281,0	13.826,0
DNM	-3.377,0	-3.863,9	-3.868,1	-3.018,9	-2.390,9	-1.707,3	-1.988,6	-945,4
EST	-3.484,0	-3.000,7	-3.659,4	-3.505,1	-2.973,2	-3.430,9	-2.135,1	-365,4
FIN	-47.335,0	-46.089,7	-41.400,7	-38.782,8	-35.735,0	-26.169,4	-31.938,3	-34.799,6
FRA	-53.704,0	-47.145,6	-43.292,5	-33.076,8	-23.950,3	-20.601,8	-18.837,8	-19.728,3
DEU	-65.412,6	-65.023,5	-62.907,8	-65.764,1	-65.519,9	-63.972,2	-58.022,8	-54.098,4
GRC	-1.964,7	-1.964,7	-1.953,6	-1.922,4	-1.972,7	-2.071,6	-1.999,2	-2.016,7
HUN	-1.517,6	-2.923,8	-3.766,9	-2.987,6	-3.548,9	-3.140,6	-3.937,0	-5.309,0
IRL	-3,9	-235,2	-276,2	-40,4	479,8	218,2	117,6	302,3
ITA	-30.100,1	-31.097,4	-32.248,2	-29.064,1	-13.117,3	-24.274,6	-30.218,3	-23.179,1
LVA	-6.625,0	-938,5	-2.723,1	-1.826,0	-3.064,0	-2.295,2	-3.069,9	-1.558,8
LTU	-9.111,2	-8.078,1	-7.009,2	-5.989,9	-5.852,2	-5.705,2	-5.376,0	-5.653,3
LUX	-508,1	-430,0	-376,9	-452,4	-346,3	-167,3	-291,0	-353,9
MLT	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
NLD	-1.393,7	-1.360,8	-1.287,6	-1.298,8	-1.251,4	-1.203,4	-1.187,1	-1.183,1
POL	-43.414,0	-36.819,3	-32.917,4	-43.888,9	-42.511,2	-40.720,1	-23.091,0	-25.050,9
PRT	-6.979,6	-8.879,9	-8.137,0	-4.505,1	7.632,8	-6.104,2	-7.075,6	-6.169,0
ROU	-28.453,0	-29.389,6	-29.000,5	-29.957,3	-28.335,4	-26.138,9	-26.690,1	-26.010,4
SVK	-7.307,7	-5.342,8	-5.887,2	-5.715,6	-5.650,3	-4.832,6	-5.431,3	-7.384,4
SVN	-4.440,5	1.494,9	1.506,5	1.577,9	1.611,6	1.578,4	-4.463,6	-4.411,5
ESP	-27.310,3	-28.150,8	-28.938,4	-28.943,7	-29.547,3	-30.056,1	-29.455,2	-28.680,1
SWE	-47.739,5	-46.918,7	-45.493,9	-44.640,4	-41.097,1	-41.181,6	-42.101,2	-44.160,5
EU	**-415.868,0**	**-391.518,3**	**-378.247,1**	**-368.550,4**	**-320.235,2**	**-319.964,6**	**-305.113,7**	**-294.981,0**
UK	-18.868,9	-18.583,1	-17.972,2	-17.593,7	-17.119,5	-16.380,1	-15.800,6	-15.496,0
ISL	-168,1	-171,4	-175,1	-178,8	-180,6	-180,8	-180,5	-173,3
EU+UK+ISL	**-434.905,0**	**-410.272,7**	**-396.394,4**	**-386.323,0**	**-337.535,3**	**-336.525,5**	**-321.094,8**	**-310.650,3**

Country	Net emissions (+) and removals (-), kt CO_2eq. Art. 3.4 activities **B.2 Cropland Management**								
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
DNM	5.544,77	2.422,07	3.560,94	2.450,75	2.610,04	2.208,34	3.302,01	2.994,15	2.756,71
DEU	14.141,85	18.165,94	18.168,11	18.521,90	17.785,30	17.454,87	17.320,19	16.906,17	16.551,80
IRL	-96,99	-30,38	-84,14	-89,90	-109,70	-88,74	-194,86	-134,24	-105,24

Country	Net emissions (+) and removals (-), kt CO_2eq.								
	Art. 3.4 activities								
	B.2 Cropland Management								
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
ITA	1.381,46	-2.283,25	-2.578,34	-3.503,61	-5.673,70	-5.581,17	-5.318,02	-5.417,10	-4.011,22
PRT	3.352,83	349,36	357,85	356,54	357,55	401,23	357,45	373,35	404,39
ESP	-144,04	1.610,60	83,55	-2.292,31	-2.754,18	-3.175,59	-3.265,81	-3.296,90	-3.145,92
EU	**24.179,89**	**20.234,35**	**19.507,98**	**15.443,37**	**12.215,31**	**11.218,96**	**12.200,95**	**11.425,44**	**12.450,52**
UK	16.693,62	15.948,35	15.920,39	15.836,57	15.889,88	15.952,62	15.890,87	15.896,22	15.949,41
EU+UK	**40.873,52**	**36.182,70**	**35.428,37**	**31.279,95**	**28.105,20**	**27.171,57**	**28.091,82**	**27.321,66**	**28.399,92**

Country	Net emissions (+) and removals (-), kt CO_2eq								
	Art. 3.4 activities								
	B.3 Grazing land management								
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
DNM	2.371,07	1.810,94	1.953,75	1.992,16	2.117,88	2.058,79	2.186,44	2.152,20	2.254,65
DEU	27.118,39	23.154,96	22.930,67	21.968,59	22.231,26	21.973,40	21.277,58	20.958,23	20.465,60
IRL	6.988,58	6.561,83	6.577,12	6.524,49	6.517,52	6.709,03	6.641,58	6.637,95	6.491,15
ITA	125,62	-769,26	-1.183,49	-845,01	-933,11	-542,41	-573,89	-639,91	-612,90
PRT	1.442,75	42,07	22,47	-40,04	-100,13	-148,56	-132,21	-149,53	-157,13
EU	**38.046,41**	**30.800,54**	**30.300,51**	**29.600,18**	**29.833,42**	**30.050,25**	**29.399,50**	**28.958,95**	**28.441,37**
UK	3.988,78	2.916,70	2.865,19	2.687,24	2.784,06	2.663,77	2.597,01	2.438,93	2.474,67
EU+UK	**42.035,18**	**33.717,24**	**33.165,70**	**32.287,42**	**32.617,48**	**32.714,02**	**31.996,51**	**31.397,88**	**30.916,04**

Country	Net emissions (+) and removals (-), kt CO_2eq.								
	Art. 3.4 activities								
	B.4 Revegetation								
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
ROU	-1.574,45	-612,84	-613,40	-612,71	-607,59	-606,18	-605,82	-603,73	-602,67
ISL	-385,76	-607,60	-614,04	-621,37	-594,87	-597,64	-614,50	-602,13	-600,39
EU+ISL	**-1.960,21**	**-1.220,44**	**-1.227,44**	**-1.234,08**	**-1.202,46**	**-1.203,82**	**-1.220,32**	**-1.205,85**	**-1.203,06**

Country	Net emissions (+) and removals (-), kt CO_2eq.								
	Art. 3.4 activities								
	B.5 Wetland drainage and rewetting								
	1990	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
UK	286,44	225,58	225,38	224,69	223,38	223,03	210,71	210,36	204,59

NE – removals/emissions are not estimated; IE – removals/emissions are included elsewhere; NO – removals/emissions are not occurring; NA – not applicable. i.e., MS does not account for the activity.

Table 11.6 *Cumulated accounting quantities for 2013-2020 of KP-LULUCF activities as reported by EU MS, UK and Iceland (Kt CO_2eq*), based on information reported in CRF accounting table.*

Country	Accounting quantity							
	Article 3.3		Article 3.4					Accounting amount on KP activities (RMUs)
	AR	D	FM	CM	GM	RV	WDR	
Austria	-16.961,81	4.074,61	-7.175,39					-20.062,58
Belgium	-2.194,62	4.971,52	-2.536,10					240,80
Bulgaria	-8.836,86	1.264,40	16.887,47					9.315,01
Croatia	-1.574,20	236,81	3.036,03					1.698,64
Cyprus*	-46,98	1,98	358,30					313,30
Czechia	-4.979,89	1.880,70	38.365,28					35.266,09
Denmark	-2.610,01	2.670,97	-23.771,31	-22.053,14	-2.441,75			-48.205,23
Estonia	-1.941,68	4.792,69	-15.176,90					-12.325,88
Finland	-4.404,69	30.268,12	-64.938,69					-39.075,26
France	-110.315,34	95.222,19	92.398,95					77.305,80
Germany	-4.780,25	8.189,90	-372.022,61	27.739,50	-41.986,82			-382.860,28
Greece	-955,04	395,93	-2.908,64					-3.467,76
Hungary**	9.615,22	2.673,93	-16.461,70					-4.172,55
Ireland	-26.501,85	4.153,30	795,73	-61,27	-3.247,94			-24.862,02
Italy	-62.942,15	15.784,65	-22.530,59	-45.418,10	-7.104,99			-122.211,17
Latvia	-1.866,87	7.739,90	-10.317,30					-4.444,26
Lithuania	-2.400,42	2.821,18	-8.983,06					-8.562,30
Luxembourg	-241,97	213,87	-28,51					-56,60
Malta	-0,11	NO	-0,05					-0,16
Netherlands	-6.689,98	7.345,62	-1.465,31					-809,67
Poland	-17.688,07	15.998,33	-14.693,00					-16.382,74
Portugal	-23.473,43	16.324,20	-12.530,83	-23.864,94	-12.205,03			-55.750,03
Romania***	-5.880,74	9.005,83	-48.290,97			7.730,66		-37.435,23
Slovakia	-4.303,71	446,48	-9.095,96					-12.953,18
Slovenia	NO,NA	2.043,09	21.112,60					23.155,69
Spain	-52.075,47	5.058,26	-12.193,99	-15.084,25				-74.295,45
Sweden	-8.543,38	24.292,42	-94.185,35					-78.436,31
EU	**-362.594,28**	**267.870,88**	**-566.351,88**	**-78.742,20**	**-66.986,53**	**7.730,66**		**-799.073,36**
United Kingdom	-19.438,33	16.559,99	2.993,91	-6.264,75	-10.482,65		-543,78	-17.175,60
Iceland	-2.095,76	3,22	-9,68			-1.766,44		-3.868,67
EU +UK+ Iceland	**-384.128,37**	**284.434,09**	**-563.367,65**	**-85.006,96**	**-77.469,18**	**5.964,21**	**-543,78**	**-820.117,63**

Information on EU KP-LULUCF activities presented here is shown for information purposes. It is important to note that each country will account for net emissions/removals for each activity under Article 3(3), and 3(4) if elected, by issuing removals units (RMUs) or cancelling KP units based on their own accounting quantities. ***The EU will neither issue, nor cancel units based on the reported emissions and removals from KP activities.***

**During the QAQC checks implemented under the Reg (EU)525/2013 the EU has informed the Party on the need to provide information on the TC of the FMRL, however Cyprus did not include information on the TC of the FMRL in its 2022 submission. The lack of this information distorts the final accounting quantities of the FM activity for Cyprus and subsequently for the EU. Cyprus confirmed that the issue will* *be addressed in a resubmission of the inventory planned by before the closure of the KP-CP2. Until this information is provided any assessment on accounting quantities for FM added in the EU GHG inventory should bear in mind this issue*

***During the QAQC checks implemented under the Reg (EU)525/2013, the EU identified a potential error in the reporting of AR by Hungary. Hungary reported by mistake N_2O emissions under AR in table 4(KP-II)1 that should be reported under Agriculture, and which lead to the AR activity to be reported as a source of emissions. The EU communicated this issue with the Party, who confirmed that the issue will be addressed in a resubmission of the inventory planned by before the closure of the KP-CP2.*

It should be noted that because the EU CRF tables must be compiled by direct aggregation of the CRF tables provided by the countries, the CRF tables of the EU included in its submission unavoidably the impact of these issues. (See above information on (*) and (**)

**** The accounting for the activity RV needs to consider 1989 as the base year for Romania. However, the CRF Reporter Software does not allow the EU to work with two different base years as it would be needed to be the sum of the two Parties that elected to account RV. (i.e., Iceland 1990 and Romania 1989). As a result, the CRF tables above show the real sum of the accounting quantity of these two countries for RV as reported in their tables, but due to technical constrains of the software, the CRF table accounting of the EU does not display correct information on the accounting quantity for RV because only information on RV from a single base year is COnsidered. N.B.: the different in the accounting quantity that is reported in the EU CRF table accounting for RV and the one that result from the sum of the parties is 65 Kt CO_2 eq. A quantity considered insignificant according to paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines (i.e., below 0.05 per cent of the national total GHG emissions and does not exceed 500 kt CO_2 eq).*

11.1.6 Definition of forest and any other criteria

The threshold values applied to define a land as forest under the KP by EU MS, UK and Iceland are summarized in Table 11.7.

With an exception, threshold values and definitions applied for reporting forest areas under the KP are identical to those used to report forest area under the Convention. However, Finland applies 0.5 ha. as minimum forest area under KP, whereas according to the national forest land definition, a minimum area for forest is not exactly set, but a guideline of 0.25 ha for a forest stand in Southern Finland and 0.5 ha in Northern Finland is given. Finland informs that this is to include all nationally defined forest lands in the GHG inventory under Forest Land category, included in the Convention reporting. And stated that the proportion of sample plots falling on patches under 0.5 ha was 0.1%.

Table 11.7 Threshold values applied to define "forest" under the Kyoto Protocol.

Country	Minimum crown cover (%)	Minimum height (m)	Minimum area (ha)	Minimum width (m)
Austria	30	2	0.05	10
Belgium	20	5	0.5	--
Bulgaria	10	5	0.1	10
Croatia	10	2	0.1	20
Cyprus	10	5	0.3	--
Czechia	30	2	0.05	20

Country	Minimum crown cover (%)	Minimum height (m)	Minimum area (ha)	Minimum width (m)
Denmark	10	5	0.5	20
Estonia	30	2	0.5	--
Finland	10	5	0.5	20
France	10	5	0.5	20
Germany	10	5	0.1	--
Greece	25	2	0.3	--
Hungary	30	5	0.5	10
Ireland	20	5	0.1	20
Italy	10	5	0.5	--
Latvia	20	5	0.1	--
Lithuania	30	5	0.1	--
Luxembourg	10	5	0.5	--
Malta	30	5	1.0	--
Netherlands	20	5	0.5	30
Poland	10	2	0.1	10
Portugal	10	5	1.0	20
Romania	10	5	0.25	20
Slovakia	20	5	0.3	20
Slovenia	30	2	0.25	--
Spain	20	3	1.0	25
Sweden	10	5	0.5	10
UK	20	2	0.1	20
Iceland	10	2	0.5	20

Only few countries provided explicit definitions on what is considered a natural forest. The vast majority of countries reported that conversions of natural to planted forests do not take place in their territories, based on the fact that (i) any natural forest is under strict protection (e.g., Czechia), or mainly because (ii) there are no natural forests within the national territories.

When definitions are provided, natural forests are considered as those matching the definition of primary forests used by FAO (e.g., Finland), or forest lands with specific silvicultural features related to age, stand structure, species compositions, etc., (e.g., Estonia). In some case, natural forests are defined by exclusion from what is defined as planted forest (e.g., Hungary).

11.1.7 Information on how definitions of each activity under Article 3(3), and each mandatory and elected activity under Article 3(4) have been implemented and applied consistently over time.

Lands subject to KP activities have been generally identified considering that since the entire national territory is subject to anthropogenic influence, all lands under a specific land use category have to be reported in the corresponding direct human-induced activities. For instance, some countries considered “human-induced” AR any expansion of forest areas since 1990 (see following chapters for more details). Most of the countries considered all national pre-1990 forest area to be subject to management and, therefore, associated to FM activity. Only in few cases, countries do not include the entire forest area under KP LULUCF activities, e.g., Greece reports under FM and AR only one third of its forest land area.

Consistency of the land representation systems (i.e., identification and tracking of lands) is ensured with the use of the same activity definitions along the time series and data sources. Some countries have also performed comparison and internal verification exercises of activity data with other national datasets, to ensure the consistency (e.g., Finland compared AR and D data generated from NFI with statistics from the forest authority).

In addition, identification and tracking of lands also contribute to ensure the consistency of the KP reporting with the reporting of the land use categories under the Convention, and with the KP reporting under the first commitment period (CP1). Both, countries that elected and non-elected to account for voluntary activities under the CP1 and or CP2, started the reporting of the current CP looking into land use matrix underlying the reporting of lands under the Convention and under the CP1.

In terms of reporting, the CP2 did not mean a “start from scratch”, countries faced the new reporting requirements of the CP2, but for that they continued looking backward to the areas reported during the CP1 and implementing the same approaches to assign the unit of lands to the activities, and their changes to ensure the consistency. And fulfilling the mandate of that a unit of land that was accounted for during the CP1 continues being accounted for during the CP2.

The implementation of QAQC checks during the first years of the CP2 to detect discontinuities, along with the checks implemented currently to ensure the consistency of the time series, also contributed to address the requirement of ensuring that a unit of land that is accounted for during the CP1 is also accounted during the CP2. Emphasis was also given to ensure that a land that enters into the accounting meets the rule of “once Kyoto, always Kyoto”.

11.1.8 Description of precedence conditions and/or hierarchy among elected Article 3(4) activities, and how they have been consistently applied in determining how each land has been classified.

According with the IPCC good practices, countries that have elected voluntary activities under Article 3(4) (see Table 11.1) have established a hierarchy among KP activities. The hierarchy is in some cases driven by the intensity of the human intervention on lands, but in any case, the objective was to ensure that there is not double accounting of lands. In general, the highest hierarchy is assigned to CM followed by GM and RV and WDR.

All national systems ensure that once a unit of land has been accounted for under any KP activity, it has consistently tracked and accounted for in subsequent years. To this purpose, countries implement methods to avoid double counting (or omission) of lands under different activities (i.e., based on repeated field assessments and remote sensing products). In addition, also the implementation of a hierarchy among mandatory and elected activities ensures a consistent classification of lands.

The CRF table NIR-2 implicitly fulfills the obligation to demonstrate that emissions by sources and removals by sinks resulting from activities elected under Article 3(4) are not accounted for under Article 3(3) activities. To this regard, the consistency in the time series is checked every year during the QA/QC procedures, to ensure that: (i) the total area reported in NIR-2 table is constant over time and matches the official country area; and (ii) the total area for each activity “at the end of the current inventory year”, as reported for the year X-1, is the same to “total area at the end of the previous inventory year” reported for the year X.

11.2 Land-related information

11.2.1 Spatial assessment unit used for the determining the area of the units of land under Article 3(3)

For each national submission, the spatial assessment unit applied for identifying and tracking lands under Afforestation/Reforestation and Deforestation, as well as for Forest management, is in line with the thresholds value of minimum area, and minimum width (if applicable), used to define forest land. This ensures that no land, defined as forest, and subject to direct human-induced activities, is left aside from the accounting.

11.2.2 Methodology used to develop the land transition matrix.

Areas of KP-LULUCF activities must be consistent with areas of correspondent land categories reported under the Convention. This is an issue subject to annual QA/QC checks implemented by the JRC before the final version of the EU inventory is compiled.

The land transition matrix reported under the Convention (CRF table 4.1) and the one reported under KP (CRF table NIR-2) allow checking the consistency of the reported areas for land categories and KP activities across the time series, although the transition period used under the Convention needs to be considered.

Annual areas for KP activities are estimated by EU MS, UK and Iceland either based on extrapolation or interpolation of available datasets at different times (e.g., remote sensing products), or based on annual estimates provided by specific land surveys (i.e., sampling grids, subsidies records, land registries/cadaster). Sometimes, inventory compilers also combine several data sources involving expert judgment (e.g., Italy's assumption that conversions to forest can only occur from grasslands).

A synthesis of the methodologies for land identification and tracking of lands is provided in Table 11.8. For more detailed information on data sources and methods applied by the countries, their individual national GHG inventories should be consulted.

Table 11.8 Methodologies for land identification and tracking of lands subject to KP- LULUCF activities by the EU MS, UK and Iceland

Country	Methods			Land identification and tracking features for the "lands" or "units of lands"
	National forest inventory	Mapping by Earth Observations methods	Land registry systems, including surveys	
Austria	X			Statistical methods
Belgium	X	X		Statistical methods
Bulgaria	X			Maps and forest management plans
Croatia	X	X		Statistical methods
Cyprus		X		CORINE Land Cover Maps
Czechia			X	Wall-to-wall mapping approach
Denmark	X	X		Statistical methods

Country	Methods			Land identification and tracking features for the "lands" or "units of lands"
	National forest inventory	Mapping by Earth Observations methods	Land registry systems, including surveys	
Estonia	X			Statistical methods
Finland	X	X		Statistical methods
France			X	Statistical methods
Germany	X	X		Wall-to-wall mapping approach
Greece			X	Afforestation registry and Land Use Change Database
Hungary			X	Statistical methods
Ireland	X			Statistical methods, Land Parcel Information System and Central Statistics Office analysis of Utilized Agricultural Area (CL and GM)
Italy	X		X	Statistical methods
Latvia	X			Statistical methods
Lithuania	X	X		Wall-to-wall mapping approach (ARD) and statistical methods (FM)
Luxembourg		X		Geoprocessing based on successive land use maps
Malta		X		Malta use mainly CLC product to assess areas subject to KP
Netherlands	X			Wall-to-wall approach
Poland	X		X	Statistical methods
Portugal	X	X		Wall-to-wall maps
Romania	X		X	Statistical methods
Slovakia			X	Statistical methods
Slovenia	X			Statistical methods
Spain		X	X	Wall-to-wall approach
Sweden	X			Statistical methods
UK			X	National planting statistics (AR) multiple sources (D), agricultural census data and countryside survey data (CM,GM), and research program (WDR)
Iceland	X	X		Statistical methods

11.2.3 Maps and/or databases to identify the geographical locations, and the system of identification codes for the geographical locations.

The majority of inventories report a single geographical boundary at country level (Table 11.9), although in some cases, underlying data might provide information at higher spatial disaggregation. On the other hand, some inventories report two (e.g., Finland) or more geographical boundaries (e.g., Italy, and UK) that often correspond to administrative regions and that are summed up in CRF tables to provide a total national value.

According to the availability of data and resources (Table 11.8), the individual inventories rely on various methods and approaches to identify and track lands under Article 3(3) and Article 3(4) of the KP. Generally, the data sources used for the identification of KP-LULUCF activities are the same, or in line with those, used under the Convention; nevertheless, because of specific requirements existing under the KP, in some instances, countries have implemented dedicated projects aimed to collect additional information that allow to comply with KP reporting requirements.

Reporting method 1 is based on the use of grid-based assessments, usually with Approach 3 or sometimes Approach 2 with supplementary information. Most of the national systems rely on the grid of their National Forest Inventories to identify and track lands under AR, D and FM, very often complemented by remote sensing datasets, so most of the countries apply reporting Method 1 and Approach 3 (being this approach the only one that allow tracking lands across time) or approach 2 plus additional information to allow tracking lands.

National systems using Approach 3 may rely also on land parcel identification system (e.g., as used for subsidy payments or licensing), which allow recording and tracking individual parcels in time and space since the onset of the subsidized activity and for which the information is, in some cases, in digital format (e.g., in Ireland). Such systems are supported by adequate verification procedures at the country level as they are under public funding. Additional information when Approach 2 is used is taken from license database, payment scheme database, forest management planning related databases, or expert judgment.

Reporting Method 2 is used in only few cases, when, each single area subject to a KP activity is identified and tracked, usually, based on a geographical information system with wall-to-wall datasets derived from remotely sensed data.

Table 11.9 Information on reporting methods and approaches used for reporting KP activities (based on the information available in NIRs)

Country	Reporting Method
Austria	1
Belgium	1
Bulgaria	1
Croatia	1
Cyprus	1
Czechia	1
Denmark	1
Estonia	1
Finland	1
France	1
Germany	2
Greece	1
Hungary	1
Ireland	2
Italy	1
Latvia	1
Lithuania	2
Luxembourg	1
Malta	1
Netherlands	2
Poland	1
Portugal	1
Romania	1
Slovakia	1
Slovenia	1
Spain	1
Sweden	1
UK	1
Iceland	1

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emissions and CO_2 removal estimates

Methods used for estimating emissions and removals related to Article 3(3) and Article 3(4) activities are consistent with those used for reporting carbon stock changes and non- CO_2 emissions in the corresponding land use categories under the Convention. In Chapter 6, methods and datasets are described for each of the relevant land use category. In addition, more detailed information on such methodologies can be found as an annex to this report (Annex III) and in the individual GHG inventories.

11.3.2 Description of the methodologies and the underlying assumptions used.

Information used to estimate carbon stock changes under ARD & FM.

The main data source used for reporting carbon stock changes in ARD and FM activities are the national forest inventories carried out by the countries. In few cases, annual net CO_2 emissions and removals are modeled based on non-NFI data (i.e., modeling based on yield tables and age-classes distribution from plantation plans and other available national statistics). Carbon stock changes from mineral soils associated with any conversion to and from forest lands are estimated by modeling or by using the IPCC default methodology together with country-specific reference carbon stocks values. When these activities occur in organic soils, the resulting GHG emissions are estimated using country-specific factors or in very few cases with IPCC default factors.

The reporting of carbon stock changes in litter, dead wood, and mineral soils carbon pools was improved considerably in the last years, as proven by the reduced number of countries using notation keys for these carbon pools in the current inventory.

The range of the implied carbon stock change factors reported for AR (Table 11.10) is similar to the one reported in the Convention tables for land converted to forest land. Among inventories, there are notable differences on the net biomass increment that are due to the type of species, climatic conditions, and other specific silvicultural characteristics (e.g., non-uniform rate of harvesting, different management practices). One additional reason for large differences is the use of either time averaged or actual annual growth data, depending on the methodology applied by the inventory compilers.

Slovenia reports that there is not AR in its territory, and Malta neither D. Some other countries reported the notation key (NE, NO or NA) for carbon pools for which it was demonstrated the absence of net emissions under the “not a source” provision (Table 11.17), or when AR (or any other activity) does not occur under organic soils.

The EU has devoted, and is still devoting, efforts to enhance the harmonization of the use of notation keys among countries, however some differences on which notation key have to be used when the “not a source” provision is implemented, still remain across submission. Partly due to different recommendations on the correct notation key to be used that have been received by the EU MS from the UN ERTs.

Table 11.10 Implied carbon stock change factors (tC ha^{-1}yr^{-1}) by pool reported under AR activity by EU MS, UK and Iceland (for the year 2020), based on KP CRF tables.

Afforestation/reforestation						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	0,98	0,27	0,72	0,02	0,42	NO,NA
Belgium	1,27	0,26	NO,NA	NO,NA	0,77	NO,NA
Bulgaria	3,24	NO,IE	0,32	NO,NA	-0,45	NO
Croatia	0,84	0,36	0,22	0,02	-0,24	NO,NA
Cyprus	0,97	0,27	3,37	NO	0,20	NO
Czechia	1,95	0,47	0,14	0,04	0,20	NO
Denmark	0,53	0,10	0,01	0,02	0,18	-1,30
Estonia	0,40	0,16	0,30	0,00	0,17	-0,34
Finland	0,95	0,23	IE,NA	IE,NA	0,08	-1,01
France	0,97	0,46	0,15	0,02	0,04	NO,IE
Germany	0,30	-0,19	0,47	0,00	0,29	-2,66
Greece	0,54	0,10	NE,NA	NE,NA	NE,NA	NA
Hungary	1,37	0,36	NE,NA	0,07	NE,NA	NO,NA
Ireland	2,13	0,44	0,37	0,36	0,09	-1,60
Italy	0,87	0,17	0,01	0,01	0,11	NO,NA
Latvia	0,43	0,10	0,08	0,09	NO,NA	-0,52
Lithuania	1,61	0,08	0,10	NO,NA	0,44	-0,93
Luxembourg	3,65	0,73	0,45	0,16	0,47	NO
Malta	0,18	NO	NO	NO	NO	NO
Netherlands	3,14	0,58	0,99	0,14	0,02	-0,94
Poland	0,76	0,22	NO,NA	NO,NA	-0,11	-0,68
Portugal	1,07	0,09	0,04	NO,IE	0,15	NO
Romania	3,05	NO,IE	0,06	NO,IE	1,64	NO
Slovakia	1,25	0,28	0,42	0,08	1,19	NO,NA
Slovenia	NA	NA	NA	NA	NA	NA
Spain	0,81	IE,NA	0,05	0,02	0,17	NO,NA
Sweden	0,62	0,21	0,22	0,05	-0,06	-2,23
United Kingdom	1,47	0,50	0,08	0,18	-0,56	-1,27
Iceland	1,08	0,28	0,14	NO,NA	0,41	-0,37

Notation keys for tables below 11.10- 11.16: IE – included elsewhere i.e., included in other pools. NO – not occurring e. NA- not applicable, NE-not estimated (the MS using NE, NA, NO justify these pools as being "not a net source" or negligible; or that the activity does not take place in organic soils).

The use of several notation keys under a single carbon pool is due to the aggregation system of the CRF tables. See CRF table of the concerned country for more clarification.

Under Deforestation, there is a rather full reporting of carbon pools (Table 11.11) where estimations are based on country-specific data. A particular case is Malta that did not report areas of Deforestation.

Moreover, some countries also used notation keys under Deforestation. For instance, when carbon stock changes for a certain pool have been already included in the estimation of other carbon pool due to the methodology used to derive carbon stock changes (e.g., below-ground biomass include as part of above-ground biomass, or litter estimated along with SOC), as it is the case for the use of "IE" by Finland, Spain, UK, and Romania.

Furthermore, also notation keys are also used when Deforestation does not take place in organic soils.

Finally, the notation key NA, as a second notation key in the cell, is a matter of the aggregation implemented by the CRF Reporter that adds to the summed-up value also the notation key "NA" when this refers to "*Deforested land previously reported under afforestation/reforestation and forest management and subject to natural disturbances".* This applies to other similar tables.

Table 11.11 Implied carbon stock change factors (tC ha-1yr-1) by pool reported under D activity in EU MS, UK and Iceland (for the year 2020), based on KP CRF tables.

Deforestation						
Country	**Above ground Biomass**	**Below ground Biomass**	**Litter**	**Dead wood**	**Min Soils**	**Org Soils**
Austria	-0,60	-0,15	-0,47	0,00	-0,35	NO,NA
Belgium	-3,68	-0,75	-0,13	-0,20	-1,13	NO,NA
Bulgaria	-2,30	NO,IE	-0,36	-0,16	-2,07	NO
Croatia	0,52	-0,05	-0,02	-0,02	-1,47	NO,NA
Cyprus	-4,41	-1,24	-0,19	NO	0,98	NO
Czechia	-2,89	-0,64	0,08	0,13	-0,13	NO,NA
Denmark	-1,46	-0,23	-1,18	-0,11	-0,40	-8,40
Estonia	-1,60	-0,38	-0,58	-0,08	-1,04	-1,51
Finland	-0,42	-0,12	IE,NA	-0,01	-0,26	-4,77
France	-1,44	-0,40	-0,20	-0,03	-0,71	NO,IE
Germany	-0,91	0,00	-0,79	-0,08	-0,15	-5,17
Greece	-0,26	-0,11	-0,12	-0,01	-1,65	NO,NA
Hungary	-0,63	-0,16	-0,23	-0,09	-0,65	NO
Ireland	-0,67	-0,13	-0,01	-0,01	-0,23	-0,96
Italy	-2,55	-0,54	-0,15	-0,08	-4,39	NO,NA
Latvia	-0,21	-0,33	-0,44	-0,63	-0,21	-4,19
Lithuania	-3,71	-0,87	-0,41	-0,19	-4,57	-9,19
Luxembourg	-1,41	-0,34	-0,29	-0,10	-1,16	NO,NA
Malta	NO	NO	NO	NO	NO	NO
Netherlands	-1,34	-0,22	-0,62	-0,05	0,09	-2,38
Poland	-0,75	-0,17	-0,29	-0,03	-1,82	-1,00
Portugal	-0,27	-0,04	-0,04	IE	-0,91	NO
Romania	-2,57	NO,IE	-0,14	NO,IE	-1,27	NO
Slovakia	-0,94	-0,21	-0,09	-0,09	-0,02	NO,NA
Slovenia	-0,82	-0,12	-0,11	-0,07	-1,29	NA

Deforestation						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Spain	-1,00	IE,NA	-0,07	-0,03	-0,19	NO,NA
Sweden	-0,66	-0,22	-0,37	0,00	-0,55	-1,36
United Kingdom	-2,07	IE,NA	-0,66	IE,NA	-2,67	-0,93
Iceland	-0,45	-0,11	NO,IE,NA	NO,IE,NA	-0,60	-7,90

With regard to FM (Table 11.12), notation keys are more widely used for reporting carbon pools, than under AR and D. Mineral soils, litter and dead wood carbon pools when reported are mainly estimated to be a net sink of carbon under FM. Organic soils are always reported as a net source whenever drainage took place in such areas. UK report this pool as a carbon sink estimated using a model.

Malta has devoted effort during the last years to collect information in order to report and update Forest Management activity that is now for first time used to report estimates in this category.

Concerning the reporting of carbon pools for agricultural activities (Table 11.13, Table 11.14), biomass is reported mainly as a net source of emissions under GM and as a net sink under CM. By contrary, mineral soils are mainly reported as a net sink under GM and as a net source under CM.

Italy uses the not a source provision for reporting DOM under CM and GM explaining that the pools are not estimated on the basis that either DOM stocks are insignificant (annual crops) and consequently any change is insignificant too, or that DOM stocks are at equilibrium (perennial crops) and therefore that carbon stock changes are insignificant. Furthermore, considering that agricultural practices following European Union policies are increasingly more sustainable and climate change oriented, and that the area of annual and perennial crops is decreasing across time any comparison among GHG fluxes in the base year and in the CP´s years results in a net sink so that the DOM pools cannot be a net source.

With regards to WDR, the UK has reported for first time information on carbon stock change in this activity.

Table 11.12. Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under FM activity in EU MS, UK and Iceland (for the year 2020), based on MS CRF tables.

Forest Management						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Austria	0,185	0,013	NO,NE,IE,NA	0,006	-0,184	NO,NA
Belgium	0,622	0,068	NO,NA	NO,NA	NA	NO,NA
Bulgaria	0,501	NO,IE	NO,NA	0,079	NO,NA	NO
Croatia	0,562	0,134	NA	NA	NA	NO,NA
Cyprus	0,219	0,061	NO	0,003	NO	NO
Czech Republic	-1,810	-0,393	0,407	0,154	0,027	NO
Denmark	0,474	0,023	0,002	0,005	NA	-1,305
Estonia	-0,095	-0,022	NA	0,015	0,155	-0,165

Forest Management						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Finland	0,296	0,055	IE,NA	IE,NA	0,089	-0,161
France	0,117	0,132	0,001	-0,019	0,001	IE
Germany	0,636	0,113	-0,013	0,095	0,410	-2,654
Greece	0,332	0,118	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Hungary	0,587	0,147	NO,NE,NA	NO,NE,NA	NE,NA	-2,600
Ireland	0,618	0,084	0,104	-0,136	-0,052	-1,595
Italy	0,687	0,140	0,002	0,001	NO,NE,NA	NO,NA
Latvia	0,268	0,066	0,002	-0,030	NA	-0,520
Lithuania	0,548	0,130	0,003	0,177	NO,NE,NA	-1,476
Luxembourg	0,784	0,164	0,000	0,106	0,000	NO
Malta	0,017	NO	NO	NO	NO	NO
Netherlands	0,907	0,191	NO,NE	0,112	NO,NA	-0,912
Poland	0,382	0,065	NO,NA	0,142	0,094	-0,680
Portugal	0,366	0,159	-0,002	NO,IE	-0,006	NO
Romania	0,904	NO,IE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	-2,600
Slovakia	0,746	0,177	NA	0,080	NA	NO,NA
Slovenia	0,665	0,153	NO,NA	0,184	NO,NA	NO,NA
Spain	0,519	NO,IE,NA	NO,NE,NA	NO,NE,NA	NO,NE,NA	NO,NA
Sweden	0,220	0,072	-0,035	0,060	0,124	-0,424
United Kingdom	0,421	0,129	0,029	0,302	0,475	0,132
Iceland	0,369	0,120	0,005	NO,IE,NA	0,012	-0,370

Table 11.13 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under CM activity in EU MS and UK (for the year 2020), based on MS CRF tables.

Cropland Management						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Denmark	-0,009	-0,009	NA	NA	0,013	-6,243
Germany	0,015	-0,006	IE	NO	-0,099	-9,041
Ireland	0,001	IE	NO	NO	0,037	NO
Italy	-0,024	-0,015	NA	NA	0,186	-10,000
Portugal	0,016	-0,003	-0,001	IE	-0,050	NO
Spain	0,023	IE	0,000	NO	0,021	NO
United Kingdom	0,015	IE,NA	NA	NA	-0,562	-7,954

Table 11.14 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under GM activity in EU MS and UK (for the year 2020), based on MS CRF tables.

Grazing land Management						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Denmark	-0,1447	-0,0926	NA	NA	0,1289	-6,6348
Germany	-0,0101	-0,0063	IE	NO	0,3572	-7,2193
Ireland	-0,0005	NO,IE	NO	NO	0,1559	-6,7835
Italy	NO	NO	NE	NE	0,0423	NO
Portugal	-0,0039	-0,0046	0,0010	IE	0,1009	NO
United Kingdom	-0,0087	IE,NA	NA	NA	0,1666	-0,7267

Table 11.15 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under RV activity in EU MS and Iceland (for the year 2020), based on MS CRF tables.

Revegetation						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
Romania	1,71	NO,IE	0,00	NO	0,03	NO
Iceland	0,06	IE	IE	NO	0,51	NA

Table 11.16 Implied carbon stock change factors (tC $ha^{-1}yr^{-1}$) by pool reported under WDR activity in UK (for the year 2020), based on its CRF tables.

Wetlands Drainage and Rewetting						
Country	Above ground Biomass	Below ground Biomass	Litter	Dead wood	Min Soils	Org Soils
United Kingdom	NO,NA	NO,NA	NO,NA	NO,NA	-3,36	-1,13

Information used to estimate direct and indirect N_2O emissions from N fertilization (4(KP-II)1)

Only few countries report fertilization of mature forests (e.g., Sweden) or young plantations (e.g. UK). For the majority of them, fertilization of forests is not a common practice, or if any, N_2O emissions are expected to be extremely low, and are in any case captured and reported under the Agriculture sector. For instance, the last occurs in cases when a country is not able to separate fertilizers applied to forest lands from those applied in agriculture (e.g., a unique total national value is available from national statistics).

Information used to estimate CH_4 and N_2O emissions from drained and rewetted organic soils (4(KP-II)2)

Total EU area of drained organic soils on forest related activities for which emissions are reported is about 7.000 kha, which occurs mainly in Finland and Germany. Emissions are estimated based on IPCC default factors or country-specific factors, but in any case, estimation methods are consistent with those used to report under Convention.

In general, most of the drainage area is associated with agricultural activities. Therefore, in the CRF table 4(KP-II) 2, most of the reported values refer to countries that elected to account for CM or GM and that report estimates of CH_4 emissions. Moreover, their associated CO_2 emissions are reported in the background activity table together with carbon stock changes in other carbon pools, and N_2O emissions are reported under agriculture sector.

N_2O emissions from N mineralization/immobilization due to carbon loss/gain associated with land-use conversions and management change in mineral soils (4(KP-II)3)

N_2O emissions, from N mineralization, are expected to be, at least, reported for those counties for which a loss of soil carbon stock is reported under the KP activities. These emissions are mainly reported for Deforestation and Cropland Management and Grassland Management when the productive activities in these lands lead to the oxidation of the soil organic carbon.

Information used to estimate GHG emissions from biomass burning (4(KP-II)4)

Estimation methods are consistent with those used to report emissions from biomass burning under the Convention. In general, monitoring systems on burned areas are not able to discriminate whether the fire occurred on AR lands or on lands subject to FM so that burnt areas are apportioned on the basis of their share on total forest areas.

In Europe, usually burned areas are protected by law, so that there is not the possibility of a land use change after a fire event. Accordingly, just in few cases GHG emissions from biomass burning are reported under Deforestation. Besides that, there are some emissions from biomass burning reported under this activity that relate to “controlled burning” as a management practice of forest residues.

A small share of total emissions from biomass burning under non-forest related activities is also reported in the CRF table 4(KP-II) 4.

11.3.3 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article (3.3) and elected and mandatory activities under Article (3.4)

In order to ensure that no underestimation of emissions occur, a decision tree guiding the use of the “not a source” provision was elaborated by the JRC, and countries were encouraged to follow it whenever such provision is applied. (http://forest.jrc.ec.europa.eu/activities/lulucf/workshops/).

Accordingly, during the EU QA/QC process, countries have been encouraged to use the notation key “NR” in CRF table NIR-1 for pools reported under the “not a source”. And, following the UN ERT recommendation, the EU has requested countries to use the notation key “NA” in the KP activity tables 4(KP-I)A.1- 4(KP-I)B.5 whenever the carbon pool is considered to be a “not a source” or being in “equilibrium”.

Further, it was requested to provide information, on the reasons for omitting carbon pools, in the CRF documentation box and in the NIR of the countries concerned. Table 11.17 summarized the demonstrations provided by the individual inventories for omitted carbon pools.

Table 11.17   Overview of information provided by EU MS, UK and Iceland to demonstrate that omitted carbon pools are not a net source of emissions.

Country	Activity / C pool	Reasoning
Belgium	AR (LT, DW) FM (LT, DW, SOCmin)	Consistent with tier 1 presented in IPCC 2006 Guidelines, section 2.3.2.2, it is assumed that afforestation results in buildup of litter and dead wood carbon pools, starting from zero carbon in those pools. DOM carbon gains on land converted to forest occur linearly, starting from zero, over a default transition period of 20 years. The litter and deadwood C stock is assumed stable in the case of forest management, with respectively 1,9 t /ha and 7,56 t C/ha. Consequently, no variation of the C stock for the DOM category is calculated for forest management. The UNFCCC review drew the attention to the fact that the carbon stock change applied for SOC appeared to be an outlier compared to other Parties. The SOC stock change reported by Belgium in the former submissions was the highest of all member states: 18 member States report no change in carbon stocks and the other present an extremely limited sink (or source for 2 MS). Only one Member State currently reports an annual change of the same order of magnitude. As a consequence and considering that no recent information confirms that the drivers of the SOC change between 1960 and 2000 are applicable to the present forest, Belgium is revising its estimates for Soil carbon in this submission. In the absence of complete updated values from the regional forest inventories, it is deemed that the currently available data and studies do not allow the application of the average carbon stock change factor from 1960-2000 to the recent years, as it appears likely to overestimate the actual carbon stock change.
Bulgaria	AR (DW) FM (LT, SOCmin)	Deadwood is assumed not to occur on AR areas. Due to the young age of the forests at AR areas (since 1990) and the assumed lack of dead wood at areas of all other land uses it is assumed that a stock change of dead wood does not occur at AR areas. If there was any in the young forests of AR areas, it would represent a C stock increase due to the lack of dead wood in the previous land uses. So, the assumption is conservative. Bulgaria reports CSC in litter and SOC under Tier 1 (2006 IPCC Guidelines), where litter inputs and outputs are assumed to balance, and the pools therefore taken to be stable.
Croatia	FM (LT, DW, SOCmin)	Data on wood removal from FRA reports (for 1990 FRA 2005 and for 2000 and 2005 FRA 2010) were compared to NIR data on fellings. The comparison indicated that not all wood was removed from the forest and that certain percentage (about 10-15%) was left in the forest; thus, contributing to a C input in other carbon pools. Reporting on wood removals under the FRA fits adequately to the wood removals practices conducted in Croatia that is performed in a way that harvest residues and wood less than 7 cm in diameter are left in the forest. Within the KP Forest management reporting, total gross fellings (i.e., including branches and bark) are reported. Considering latter, there are no underestimations in regard to dead wood. Furthermore, based on the available data on growing stocks and harvest which prove steadily increase in the standing stocks in Croatia (Table 11.3-5) while the forest management methods remain the same. Under such circumstances and due to the fact that mortality is correlated with stand density, also an increase in dead wood stocks is very likely, as indicated by the FRA results. Within the reporting period, there was no change in the forest management. At this moment in Croatia there is no expert and scientific literature or investigation the hypothesis soil pool under the Forest management is not a source of emissions. However, based on the data and information provided above that prove carbon stock increases in biomass, dead wood and litter pool, an increase in these pools is correlated with an increase of the C input to the mineral soil and consequently with an increase of carbon stock in soil. Consequently, it can be also assumed this pool is not a source of emission.
Denmark	FM (SOCmin) CM (LT, DW) GM (LT, DW)	Aboveground and belowground living biomass, litter and dead organic are only reported for perennial woody crops, in accordance with IPCC Supplementary GPG 2014. No litter and dead organic matter are reported under CM, as this is seen as not occurring, or as very insignificant because it only related to a small area with fruit plantations and hedges. Therefore, only above- and belowground living biomasses for perennial fruit plantations, edgerows and willow plantations for bioenergy purposes on agricultural land, are reported under CM. CL converted to other land uses, such as WE and SE, is assumed not to store litter and other dead organic matter. Christmas trees are reported under Forest Management
Estonia	FM (LT)	For FM Estonia does not have sufficient data regarding litter stocks, thus the Tier 1 method was implemented, assuming that carbon stocks are in equilibrium, therefore the changes in the litter pool are assumed to be zero. In ARR 2016 ERT recommended to obtain necessary data for litter pool. Estonia has an ongoing project to obtain litter stock data and more thorough explanation is added in Chapter 6.2.2.

Country	Activity / C pool	Reasoning
Greece	AR (LT, DW, SOCmin) FM (LT, DW, SOCmin)	Based on several studies SOC and DOM increase in AR. For FM, selvicultural practices promotes the carbon accumulation in both those carbon pools, which is even more justified by the fact that the living biomass pool in forest under management acts as a net sink. Consequently, the dead organic matter pool and mineral soils in soil organic matter pools in Greece cannot be a net source of carbon. Quantitative demonstration is also provided in the NIR.
Hungary	AR (LT, SOCmin) FM (LT, DW, SOCmin)	For FM and AR, Hungary does not explicitly quantify emissions and removals for three forest carbon pools, i.e. soil, deadwood and litter, but demonstrates that these pools are not a source. To demonstrate that soils are not a source, a conservative approach is taken based on the IPCC 2006GL methodology using country-specific and other data. The demonstration for DW and LI is based on expert judgment which is a practicable method in our situation. Further demonstration is included separately for FM and R in the NIR
Ireland	CM (DW, LT) GM (DW, LT)	Based on the decision tree in Section 2.9.4.1 of the 2013 KP Supplement to the 2006 IPCC Guidelines, and Section 5.2.2.4, Vol 4 of the 2006 Guidelines, changes in Litter and Dead Matter carbon pools are assumed to be stable. Changes in biomass associated with transitions between grassland and croplands within the CM cohort are estimated. Changes in the biomass of hedgerows, and other non-forest wood features, have not been estimated. Biomass changes due to changes in the area of perennial woody crops are based on the analysis of the dominant crops, apple orchards and Christmas trees. It the case of Christmas trees, there is evidence that the market for trees is stable or increasing over time, and as such the biomass associated with this crop is stable or increasing, See section 6.4.7. The area of apple orchard decreased in the early 1990s but has been in near equilibrium in recent years as shown in Figure 6.21. Hedgerows are an integral part of the CM landscape. However, there is very limited long-term monitoring data as to conditions and extent of these features. The EPA has funded a research project to pilot an analysis of historic and contemporary remote sensing data to establish a robust time series of changes in these landscapes.
Italy	FM (SOCmin) CM (DW, LT) GM (DW, LT)	In relation to CM and GM, Tier1 is applied for litter and deadwood pools: those pools are not estimated on the basis that either DOM stocks are insignificant (annual crops) and consequently any change is insignificant too or that DOM stocks are at equilibrium (perennial crops) and therefore that C stock changes are insignificant. Furthermore, considering that agricultural practices within the European Union policies are increasingly sustainable and climate-friendly (see figure 9.2) and that the area of annual and perennial crops is decreasing across time any comparison among GHG fluxes in the base year and in the CP-year's results in a net sink so that the DOM pools cannot be under any circumstances a net source. Following the main finding of 2011 review process, Italy has decided not to account for the SOC changes in mineral soils from activities under forest management, providing transparent and verifiable information to demonstrate that SOM in mineral soils is not a source, as required by par. 21 of the annex to decision 16/CMP.1.
Latvia	AR (SOCmin) FM (SOCmin)	According to the NFI conversions to forestland that can be classified as afforestation/reforestation take place only on grasslands. The soil monitoring study initiated in 2012 by the Joint stock company "Latvia state forests" and Ministry of Agriculture demonstrates no statistically significant difference in carbon stock in mineral soil in grassland, forest land remaining forest in fertile stand types and in afforested lands, i.e. no changes appear in soil organic matter (SOM) due to afforestation.
Lithuania	AR (DW) FM (SOCmin)	Based on NFI 1998-2011 data changes of dead wood are not significant in the afforested and reforested lands, as any dead wood in young forest stands usually are fine (trees from natural losses or thinning residues) and decay in one year. For estimation of carbon stock change of dead wood, it was assumed to be zero and reported as 'NO'. Not having proof of significant increase in mineral soils in forest land and having information that this pool is not a source, Lithuania has decided to be conservative and consequently not to account for this pool under FM
Malta	AR (DW, LT, SOC) FM (DW, LT, SOCmin)	For Dead Organic Matter estimations, specifically litter pool in Forest and conversions to Forest Land, the calculations are estimated according to Chapter 2 of the 2006 IPCC Guidelines, as conversion to Forest Land results in build-up of litter and dead wood carbon pools starting from zero carbon in those pools
Netherlands	FM (LT, SOCmin)	The NIF provides an estimate for the average amount of litter (in plots on sandy soils only) and the amount of dead wood (all plots) for plots in permanent forests. The data provide the age of the trees and assume that the plots are no older than the trees. However, it is possible that several cycles of forest have been grown and harvested on the same spot. The age of the plot does not consider this history or any effect it may have on litter accumulation from previous forests in the same location. Therefore, the age of the trees does not necessarily represent the time since AR. This is reflected in a very weak relation between tree age and carbon in litter and a large variation in dead wood, even for plots with young trees.

Country	Activity / C pool	Reasoning
Poland	AR (LT DW) FM (LT)	When an area is afforested, first it is cleared of all above-ground biomass in case there was any, however, no DW and LI are usually present on these lands prior to afforestation. After afforestation, dead woody debris, litter as well as dead trees start to accumulate. In lack of representative measurements, the rate and timing of accumulation is not known, however, standard forestry experience suggests that they depend on species, site and silvicultural regime, and quickly accumulate over time. Fast growing species are usually planted so that no large amount of deadwood is produced, or thinned so that self-thinning does not ensue, but litter is continuously produced even in these stands. On the other hand, slow-growing species tend to produce dead wood and litter even at an early stage. Overall for all AR land, also considering that AR activity has been continuous since 1990 and stands on AR land are usually younger for deadwood and litter accumulation to saturate, it can safely be concluded that the carbon in the deadwood and litter pools in AR lands was increasing between 2008-2010, i.e. these pools are not a source. The above demonstration is based upon well-established principles of forest science, the every-day experiences of forestry practice, the experience and data of forest surveys, as well as sound reasoning.
Romania	FM (DW, LT, SOCmin) RV (DW)	DW in Afforestation/Reforestation and Revegetation is reported as NR (as not occurring or it is considered as a very small sink since initial mass is null, then it could only increase in time, or in any case it cannot decrease). Litter becomes a measurable pool in AR lands in some 4 years since planting (sampled data is available from Romanian JI and national FORLUC project mentioned under AFOLU sector chapter), thus C stock change is estimated and reported. Instead, DW cannot be defined as a standing alone pool, also recalling that dead wood is considered under same definition and dimensional thresholds as in NFI. Nevertheless, by the age of 20 years old of stands, the dead trees barely occur caused by natural mortality and especially by competition. This should lead to a continually increasing number of dead trees, thus expected that inputs are larger than decomposition. With such argumentation, we can safely and conservatively assume that DW is not a net source of emissions on AR lands. Under FM, Romania is not reporting carbon stock change occurring in the litter, deadwood, and mineral soils pools. Justification of the Tier 1 approach under the UNFCCC is described in sections 6.2.2.1.2 and 6.2.2.1.3. Apart from these reasons also, qualitative and quantitative arguments are presented below. Carbon stock in mineral soils. Assessments of several existing datasets, focusing on two approaches: the arguments are based on their source and methodological approach, independent of each other. These show that the mineral soil carbon pool most likely behaves like a small sink or rather as a neutral, in which case, "not a source" applies (key category NR is reported in NIR-2 and NE in sectoral table 4.A.1 Cropland remaining Cropland).
Slovakia	FM (LT, DW, SOCmin)	It can be demonstrating that DW carbon pool is not a source of CO_2 emissions. The evidence is based on increasing growing stock in Slovak forests published in the latest Slovak Green Report 2017 http://www.mpsr.sk/en/index.php?navID=17&id=67. The growing stock in forests is gradually increasing as indicated by trends and actual age structure of forests. On large temporal and spatial scales, the amount of deadwood is roughly proportional to the growing stock. The statistically representative empirical data from the second Slovak NFI, which will confirm this assumption, are under the evaluation. Slovakia has assumed that, under the conditions of current forestry practices at the country level, forest soils and litter do not represent a net source of CO_2 emissions. This assumption was confirmed by soil data analysis (Slovak ICP forests data) in 1993 and 2006 (Table 11.11). The results of statistical analysis have not confirmed the changes of soil C stocks in FM areas. A similar conclusion was obtained from comparison of carbon stocks in litter. The litter C stock in 2006 were even found slightly higher compared the first evaluation (1993).
Slovenia	FM (LT, SOCmin)	For calculations of carbon stock changes in litter and soils “a pool is not a source” approach was used. According to this approach the net emissions/removals from litter and soils is balanced and therefore equal to zero. Results of our preliminary expertise for period 1996 – 2006 (Kobal and Simoncic 2011), show relative stable carbon stocks in litter in forest land remaining forest land. Estimates under FM for carbon stock changes in litter and soils were therefore not reported.
Spain	FM (LT, DW, SOCmin) CM (DW)	Regarding the forest's DW and LT deposits, at least in the inventoried period (1990-2018), the set of both deposits it has not been a source, but rather a sink. However, accurate quantification of the net fixation of C by the set of these two arrangements is not presented in this edition of the National Inventory, since the process of modifications is still in progress development.
United Kingdom	CM (DW,LT) GM (DW, LT)	Carbon stock changes on CM and GM are calculated using Tier 1 methodologies, therefore carbon stock changes in litter and dead wood are not reported and the notation key NA is used in the tables due to the lack of guidance on reporting these pools in the IPCC guidance and the consideration of carbon stocks in equilibrium in these lands under the IPCC Tier 1 method.

Country	Activity / C pool	Reasoning
Iceland	AR (DW) RV (DW)	Change in the carbon stock of other vegetation than trees are omitted in this year's submission. A research project where carbon stock in other vegetation than trees was measured on afforestation sites of different ages of larch plantations did show very low increase C-stock 50 years after afforestation although the variation inside this period where considerable (Sigurðsson, et al., 2005). Losses in Revegetation are not specifically detected. The losses are assumed to be reflected as changes in the C-pool estimates of NIRA. Potential losses include losses in revegetated area, due to changes in land use. Losses in C-pools through grazing, biomass burning, and erosion are also recognized as potential. These losses are expected to be detected in the current NIRA upgrade and will be reported in future submissions.

For a consistent demonstration of 'not a source', EU MS, UK and Iceland have been encouraged to avoid simple assumption of "equilibrium" following IPCC Tier 1 methods, but to demonstrate, based on qualitative information, reasoning and, to the extent possible, quantitative estimates from any available documentation (i.e., scientific papers, reports, etc.) that the omitted pool does not result in a net source of emissions.

11.3.4 Information on whether or not indirect and natural CO_2 removals have been factored out.

Because of the use of the "managed land" approach, which so far is the stipulated approach used for estimating emissions and removals from anthropogenic activities, individual inventories have not factored out from the reporting the estimates of indirect and natural CO_2 removals. In most cases, they argued the lack of methods to do so, or that, due to the length of the reporting period, the magnitude of these removals is insignificant.

For FM, it is recognized that the issue of factoring out indirect removals from elevated carbon dioxide concentrations above pre-industrial levels, indirect nitrogen deposition, and the dynamic effects of age structure resulting from KP activities prior to 1 January 1990 is addressed in the accounting through the FMRL. Indeed, it is expected that the effects of such processes on the emissions and removals occurring during the commitment period approximately cancel out in the accounting when the projected FMRL is compared to the reported FM estimates.

11.3.5 Changes in data and methods since the previous submission (recalculations)

An overview of the reasons for recalculation of inventory estimates is provided in table 11.18.

Table 11.18 Summary of information on changes and methods since the previous submissions (recalculations)

Country	Overview of reasons for recalculations
Austria	The intermediate increment, drain and dead wood results of the NFI 2016/21 for the measurement period 2016 to 2018 were taken to update the time series for the Forest land category for the years since 2009.
Belgium	Wallonia: Update of the forest inventory data and use of a model to complete the measures for the recent years. Update of the soil organic carbon in cropland and grassland, including new trends. Update of the LU matrix. Brussels region: Matrix update: 2020 was added. National Level :The emissions of wildfires have been recalculated.
Bulgaria	Improved estimates of the area of LUC to FL: The changes came as a result of reassement of the afforestation and reforestation areas in relation with the accounting of the KP activities. The recalculations affected mostly the area

Country	Overview of reasons for recalculations
	representation of forest land category and the sub-category of Shrubs and grassland. However, small changes in area representation and land-use changes are present in almost all land categories, which affected also the emissions estimates in all categories. There are also updated information on the carbon stock changes in living biomass and dead wood for the years 2016-2020 due to newly available data on growing stock.
Croatia	In this year submission, some recalculations have been done. Corrections in the emissions from biomass was done. On that basis new calculation was performed. Estimation in LULUCF sector for NIR 2022 has been performed by using the nationally determined value for CS in biomass pool of perennial Cropland instead of using the value prescribed by 2006 GL. This influenced emissions/removals in all land categories where LUC from or to CL occurs
Cyprus	Change of BCEFI (biomass conversion and expansion factor for increment) from 0.645 tC/m3 to the default value 0.450 tC/m3 (Table 6.4.5, p. 4.51, value for Mediterranean, dry tropical and subtropical coniferous forest). Use of interpolated and extrapolated data provided in Table 6.6 to cover the entire period from 1990 to the reported year instead of using an average (0.844 m3/ha/yr) for the entire period (coniferous forest). Use of corrected data for area of land remaining in Forest Land category and converted to Forest Land category.
Czechia	Significant methodological improvements were made for the current submission by implementing Tier 3 estimation approaches facilitated by CBM (CBM-CFS3; Kurz et al. 2009, Kull et al. 2016). These changes concern all carbon pools and activities except mineral soil under AR and D activities
Denmark	To account for the grasses and herbs in the first 25 years of afforestation (cor-responding to the situation in grasslands), an estimate of this is included. In practice it is assumed that afforestation initially will hold the same pools of AGB and BGB as unmanaged grassland (Table 6.12). These pools will linearly decrease over a period of 25 years, reflecting the reduced light to ground vegetation from the increasing crown cover of the trees established in the afforestation. This is supported by a number of observations of afforestation, with data for both trees and grass vegetation. For Deforestation an error was corrected in the emission for living biomass for Christmas trees. In the 2021 submission there were a multiplication with 640 about 1000 for living biomass giving a far too high loss when land with Christ-mas trees were converted to Cropland/Grassland. A minor reallocation of raised hedges between 2018 and 2019 and a major re-calculation was made for Cropland mineral soils for the whole time series. This because an error was identified in the C-TOOL calculation on the incorporated amount of wheat straw which was overestimated
Estonia	The entire time series of activity data is annually recalculated for all areas of land categories and land-use conversions, since new data about land-use transitions is collected every year and new estimates will be integrated into overall activity data. Changes in living biomass C pool compared to the previous submission have resulted from the recalculation of average growing stocks and changes in methodology for Land converted to forest land areas. After the transition to Forest land, average growing stock was assumed to increase at rate of 3.04 m3 ha-1 yr-1. Soil emission factors were updated for Land remaining forest land and Land converted to forest land. Emissions from mineral and organic soils under Forest land remaining forest land have significantly decreased because of updated emission factors.
Finland	The areas of Article 3.3 activities and Forest Management were recalculated. The areas were recalculated because new NFI data were available, also new remote sensing data for updating. The new AD estimates induced the recalculations of time series for gains and losses in living tree biomass as well as carbon stock changes in DOM and SOM pools. For the tree growth under the forest management, a recalculation was applied due to the new NFI data. New BCEFs were applied to estimate the losses in living biomass. Due to the recalculation of activity data and biomass stocks to calculate litter input, also the time series in carbon stock changes of mineral and organic soils were recalculated. For losses in living biomass, a minor recalculation was done for the year 2019 due to updates in the official drain statistics. Losses in living biomass (due to harvesting) on afforestation areas were recalculated due to the new NFI data. For harvested wood products, small recalculations were conducted for the year 2019 due to updates in the FAOSTAT and national data. For harvested wood products from AR areas, an error was corrected which affected the whole time series
France	In the 2021 edition of the NIR, the latest National Forest Inventory (IFN) campaign was not available and the values concerning growth and mortality in the forest could not be updated for recent years. For the 2022 edition, the last two IFN campaigns (2014-2018 relative to 2016; 2015-2019 relative to 2017) were taken into account to estimate the years 2016 and 2017. This update has very strong impacts on the forest balance sheet. • Wood energy consumption has been updated to be in line with the energy report the proportion of damage caused. The harvests have been updated by integrating the actual annual harvests.
Germany	Update of whole time series due to improved data basis, these concerns: adjustment of the sampling for land use and land use change, changed emission factors for biomass, data correction for dead wood, amendment of

Country	Overview of reasons for recalculations
	emission factors for land use changes (grassland to forest)
Greece	In the current submission no specific changes have been made with regard to methodologies applied in comparison to the previous submission. The only recalculations performed in comparison to the previous submission refer to the 3.3 Afforestation/reforestation activity in 2016 as a result of the update (latest available EF) of the IEF used, and to 3.4 Forest Management activity for all years in the commitment period as a result to the update of the activity data in the FAO statistics database.
Hungary	Due to the revision of the area data in the 4.A.1 and 4.A.2 category, all the related emissions in the biomass losses ,deadwood, litter and soil pools were recalculated.(2) Due to the revision of the ratio of the succsessfull initial planting the emission of the biomass gain pool in 4.A.2 was also recalculated.
Ireland	Ireland has performed recalculations for the historic time series and has applied a technical correction for accounting at the end of the second commitment period. The requirement to apply a recalculation is based on conditions as outlined in the IPCC 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.
Italy	A comprehensive comparison of 2022 and 2021 submissions has been carried out; in table 9.9 a summary related to the ARD and FM activities is reported, while in table 9.10 the recalculation are shown for each carbon pool, with reference to the 2019 reporting year. The 2022 submission results, for AR and FM activities, in a deviation for the reporting years 2013-2019; the recalculation is due to the update of the activity data as resulting from the NFI outcomes (NFI2015): 2015 area data of “Forest” and of “other wooded land” (reported under grassland category), have been therefore modified, resulting in a consequent recalculation of the 2005-2015 period (annual areas have been interpolated) and 2015-2020 period (annual areas have been extrapolated). The comparison of the 2022 and 2021 submissions resulted, for cropland management activities, in a recalculation, shown in table 9.11, due to the revision of woody crops activity data and related carbon stock changes from living biomass, for 2016-2019.
Latvia	Methodological consistency between the reference level and reporting for forest management during the 2nd CP, including the area accounted for the treatment of HWP is ensured by implementation of the same methodological approaches for the whole reporting period and recalculation of the whole time series according to a new methodology. A technical correction to FMRL is recalculated because of above-mentioned reasons. Country specific method for estimation of FMRL and recalculation of historical data affecting the FMRL is implemented.
Lithuania	Difference in total GHG removals from forest land resulted in adjustment of living biomass carbon stock change in forest land remaining forest land due to the newest growing stock volume data applied - extrapolated values for year 2017 were replaced with actual values. In addition to this, calculation errors in carbon stock changes in living biomass of forest land remaining forest land were corrected as a resulted of additional internal QA/QC procedure.
Luxembourg	The LULUCF sector has had some major changes which have led to important changes in emissions and removals for the whole timeseries. The changes were essentially driven by a revised estimation of land use changes. Previous estimation of land use changes was based on spatially explicit data existing for the country, namely the OBS (Occupation Bio physique du Sol) maps for the reference years of 1989, 1999, and 2007, as well as a land use map of 2012, specifically updated for the National Inventory Report. Since then, new, and more recent land use and land cover data sets have been produced for the whole Luxembourg for the years 2015 and 2018. In order to integrate those new datasets a new study was commissioned which has led to the recalculations.
Malta	Recalculations for the Forest Land category are found to be unnecessary for this year’s submission, since in the previous submission there were no estimates calculated from this category
Netherlands	In this NIR two methodological changes have been implemented and additionally two new data sources were introduced resulting in modifications to the carbon stock changes and associated emissions and removals along (part of) the time series. Additionally, a number of errors were corrected. These have also resulted in recalculations for AR, D and FM. Because the separate changes may interact with each other, the effects of the separate changes cannot be quantified
Poland	All changes are caused by the change in activity data, for forest and forest management activity. In this submission, we have implemented a number of recalculations. The main reason for the recalculations is that we identified some minor calculation updates in the area of some categories. A few other recalculations were made due to some minor category-specific issues that are reported in the relevant sections.
Portugal	All spreadsheets for estimating emissions and removals from KP LULUCF have been adapted so that they recalculate automatically the FMRL if and when the base information changes. Following the specifications of Decision 2/CMP.7, the assumptions used in FMRL construction are kept constant. All changes to the FMRL value are therefore due to changes in

Country	Overview of reasons for recalculations
	the base information (historical time series) or changes in methodologies in use, which then apply both to the historic time series and to reporting in the commitment period. Since the communication of the FMRL by Portugal in 2011, several changes have been introduced in the reporting by Portugal. Table 11.3 summarizes the main differences between the original FMRL submission and the current estimates, following the methodological and time series changes introduced since 2011.
Romania	New L-FL and FL-L conversions areas have been estimated for the all-time series. Much smaller sizes reported for both L-FL and FL-L categories for 2022 submission have driven a decrease in CO_2 stock in the FLFL (i.e., from 3672 kt CO_2 to 2660 kt CO_2 in L-FL and a "transfer" of C loss from deforestation to the FLFL).
Slovakia	In the category 4.A, both subcategories 4.A.1 Forest Land remaining Forest Land and 4.A.2 Land converted to Forest Land was recalculated for the whole time period since 1990. The main reason for recalculation in 4.A.1 and 4.A.2 included the calculation of CSC in DW carbon pools following the ERT recommendation. Another reasons of recalculation in 4.A.1 was change and correction of root-to-shoot ratios (using only 0.2 for coniferous and 0.24 for broadleaved; no specific value for oaks following the ERT recommendation.
Slovenia	The total forest area was carefully stratified into forest land remainig forest land and land converted to forest land. Sampling plots of the national forest inventory were assigned to each subcategory, and carbon stocks in the living biomass were recalculated accordingly. Based on the carbon stock changes for the 2007-2012 and 2012-2018 inventory cycles, new emission factors were calculated for each subcategory. Second, following the recommendation of the ERT, the new BCEF factors were used to convert volume to biomass. The BCEF factors were calculated as the product of basic wood density (D) of each tree species and the biomass expansions factors (BEF) dependent on the growing stock using the equations proposed by Teobaldelli et al. (2009). Recalculations in this category were also made due to the inclusion of two carbon pools, litter and dead wood, in the mass of available fuel in relative to emissions from wildfires (biomass burning), as recommended by the ERT.
Spain	New estimate of the C content of living biomass in category 4A1, due to the incorporation of provincial living biomass data from the fourth National Forest Inventory (IFN4) of Salamanca, Burgos, Segovia and Soria, which involves a recalculation of the period 2003-2019. New data available on subsidized afforestation for the years 2018 and 2019 and non-subsidized afforestation for the years 2016-2019. New fire data available for the year 2019, which replace the average of the last available decade (2009-2018) used in the 2021 edition of the National Inventory (1990-2019 series)
Sweden	Recalculations due to updated NFI data which affects the estimates for the previous four years as described in section 6.3.1.1. Small corrections of historical land-use changes may affect estimates for earlier years, especially for categories using area as activity data. recalculations related to extended datasets for litter and soil from the SFSI. Since the whole dataset is included using extrapolation and interpolation techniques this may generate updated data for the entire time series, but quantitatively important recalculations are expected because of phasing in new data on carbon stock changes.
UK	Details of recalculations are given in Table 11.5. Justifications for the recalculations are given in Chapter 6, Sections 6.2.7, 6.3.7, 6.4.7 and 6.5.7 for the UK, and in Section 6.9.4 for the Overseas Territories and Crown Dependencies.
Iceland	Area dependent sources as removal to litter and soil and emission from drained organic soil have been changed in relation to changes in the area estimate for each category and each year. The C-stock changes in biomass in CF are based on direct stock measurements (Tier 3) as in last year's submission. They are recalculated for 2019 due to new data from NFI measurements in 2021. Estimates of the net gain of biomass of the natural birch forest are totally revised in this year submission built on new data from the newly conducted NFI (2015-2021) of the natural birch woodland.

11.3.6 Improvement status and plan

The following improvements have been introduced in the GHG inventory submission 2022 to address recommendations received from the UNFCCC's expert review team (ERT), to correct issues identified during our internal quality control process, and/or to introduce developments identified during our internal peer review:

- The information on tables 11.2 and 11.23 was updated to reflect improvements introduced in the reporting of individual inventories. But also, other sections were modified whenever was needed to capture the new information reported by the countries.
- Specifically, attention was given to update the text in sections 11.4.5 and 11.5.1 line with current reporting by individual inventories in order to provide more information on how the EU has addressed the recommendations of the UN ERT.
- As every year the EU KP-LULUCF inventory has increased its completeness and improved the accuracy as a result of the efforts implemented by MS to improve the information, as well as the support provided to the countries by the EU. Notable examples in this submission are: (I) Czechia implemented this year a new tier 3 method for estimating carbon stock changes in forest land, (ii) Malta reports for first time emissions/removals from Forest Management (iii) Romania reports carbon stock changes from mineral soils under AR, (iv) UK repots carbon stock changes in WDR However, these are just some examples for this year submission, and many others were introduced during the KP-CP2.
- Following the recommendation of the ERT the EU requested to the countries the use of the notation key NA for carbon pools considered in balance or equilibrium. MS agreed with the use of this NK, with the exception of those countries that have received different recommendation from their own ERT and have changed accordingly their inventories in this submission. ***(EU ARR 2020/KL.1).***
- Correction of inconsistencies identified across the areas reported in CRF tables NIR-2 and specific KP-activity tables. The EU has been working during the last years with its MSs in order to address this issue. As a result, in this submission differences on areas between these tables is for each of the KP activity reduced to less than 10 kha, which has an insignificant impact in the EU GHG inventory in terms of emissions and removals. Also, because for some KP activities the inconsistency in areas between tables have been corrected in this submission. ***(EU ARR 2020/KL.2 and KL.3).***
- Table 11.6 includes enhanced information to explain the technical limitation that prevents the EU GHG inventory to provide in its CRF table accounting the accounting quantity for revegetation that matches the sum of the quantities reported by Romania and Iceland.
- The EU has included information on table 11.17 as provided by UK in its inventory to demonstrate that DW and LT are not a net source of emissions. In addition, UK has provided information for the KP activity WDR, and accordingly the EU has included information on the relevant sections of this chapter. ***(EU ARR 2020/KL.4).***
- The FMRL value of the EU inserted in the CRF table 4(KP-I)B.1.1 has been changed to match the value inscribed in the annex to the decision 2.Cmp/7. And accordingly, the text in section 11.5.2.2 has been enhanced to describe the new approach implemented by the EU to calculate the technical correction of the FMRL in line with the recommendation of the UN ERT. ***(EU ARR 2020/KL.6).***
- The EU has included in the section 11.5.2.2 and 11.5.2.3 more transparent information on the background level of emissions associated with natural disturbances included in the FMRL values. And on the work carried out in collaboration with the member States, in particular those that apply the JRC approach, in order to improve consistency between the FMRL and the reporting and accounting of FM activity. ***(EU ARR 2020/KL.7).***

As this is the last year for reporting LULUCF information under the KP-CP2, the EU plans to resubmit its inventory after the countries have submitted their inventories to address the recommendations raised during their own reviews under the UN review process of the 2022 submissions. In the meantime, the EU will continue providing support to the MS to ensure the quality submitted in this sector.

11.3.7 Uncertainty estimates

For information on uncertainties please refer to chapter 1.6

11.3.8 Information on other methodological issues

During the EU QA/QC process an important number of checks are implemented every year to ensure the transparency, accuracy completeness, and consistency of the KP information included in the individual inventories. Focus is also placed on increasing the comparability, and on improving the overall quality of the EU GHG inventory.

For instance, among many others, the consistency among the information submitted under the KP and the Convention is assessed every year in terms of methods, emission factors and activity data to ensure consistency and discard potential issues. Also, many other checks are implemented to ensure that estimates are prepared by applying methodologies that are consistent with IPCC methods and adequate to the significance of the category or carbon pool that is being estimated. Detailed information on these QAQC procedures can be found in chapter 6.

11.3.9 The year of the onset of an activity, if after 2013

This information is implicitly achieved by each individual inventory, and consequently by the EU GHG inventory, through the provision of the activity data information in the CRF table NIR-2. The onset of any activity on any land is reported according to the year when the land is reported as subject to the activity for the first time.

Checks are also devoted to ensuring that once a unit of land is reported in such table, it continues to be reported in subsequent submissions. Also, among others, a check is implemented to ensure that the hierarchy of the KP activities is properly applied and that areas of deforestation do not decrease across time, instead that they are consistently updated with annual areas of “forest converted to” that the country considers direct human induced deforestation, as reported in CRF table 4.1.

11.4 Article 3(3)

11.4.1 Information that demonstrates that activities under Article 3(3) began on or after 1 January 1990 and before 31 December of the last year of the commitment period and are direct human induced.

Land representation systems implemented at national level are able to determine the onset for any KP activity along time series and starting from 1990 onwards.

For example, planting year is mentioned as the information used to assess the onset of Afforestation/reforestation activity (e.g., DNK, UK, GRC, IRL), or, the year when the encroaching woody vegetation meets the definition of forest, for instance in the case of natural-assisted afforestation, as detected by national forest inventories or remotely sensed products, that because are not often annually available are supported by interpolation/extrapolation techniques.

For Deforestation, information comes from annual direct assessments, for instance, when national statistics based on license for clear-felling are available; or datasets on land cover and land use compiled by sampling or wall-to-wall techniques with ground data and, or remotely sensed data. In the latter cases, as mentioned above, because data are not often annually available, interpolation/extrapolation techniques have to be involved.

According to the IPCC, it is good practice to provide documentation to prove that all lands reported under afforestation and reforestation are subject to direct human-induced activities. In this sense, relevant documentation provided in the individual inventories often includes forest management records or other documentation that demonstrates that a decision was taken to replant or to allow forest regeneration by other means, including the decision allow the natural expansion of forests.

Table 11.19 shows a synthesis of information reported by EU MS, UK and Iceland on the direct-human induced origin of reported AR lands.

Table 11.19 Summary of current information reported by EU MS, UK and Iceland aimed at demonstrating that Afforestation/Reforestation activities are direct human induced.

Country	Categorization of the demonstration for direct human induced.				
	Areas converted, either subject to subsidies or not, have been reported in registries either for authorization or compilation of land use changes	Whole national territory covered by legal instruments for Land planning and/or management, therefore any change in land use is directly human induced	Where a conversion results in a land use subject to management practice, the conversion is considered directly human-induced	As all land area is under management (i.e. subject to some kind of human interactions), all changes are considered as directly human-induced	A decision to change the use of a land or a decision not to continue the previous management practices has been made, which allow for conversion
Austria		X			
Belgium				X	
Bulgaria		X		X	
Croatia	X	X			
Cyprus				X	
Czechia	X	X			
Denmark				X	
Estonia				X	X
Finland	X			X	X
France			X		
Germany		X			
Greece	X				
Hungary	X				
Ireland	X	X		X	
Italy			X		
Latvia	X				
Lithuania		X			
Luxembourg			X	X	
Malta	X				
Netherlands					X
Poland	X				
Portugal				X	
Romania	X				
Slovakia	X				
Slovenia		X		X	
Spain	X				
Sweden			X	X	
United Kingdom	X			X	
Iceland			X		

In general, a rather "broad" interpretation of "direct human-induced" AR is applied by most countries, so that around 90% of the total area reported under conversion to forest land is assumed as directly human-induced. However, some countries adopt some more stringent criteria. For instance, UK does not report under AR the areas of planting that are not state-owned or grant aided. If not included under AR, natural forest expansion has been reported by individual inventories under FM.

11.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation.

Although the loss of forest cover is often readily identified by the land monitoring systems, the classification of an area as deforested once the tree coverage has been removed, is more challenging. Individual inventories provided information on the criteria by which temporary un-stocked forest lands can be distinguished from deforestation, and how these criteria are consistently applied, see Table 11.20.

The simple combination of NFI data with remotely sensed data may not be fully adequate to assess the areas which can be classified as deforested, and thus these data are often complemented by other type of information. For instance, information on license that is typically required when a land use change occurs. Or in the absence of detailed information on the future use of the land, some countries defined an expected time period in years within which the removal of tree cover has to be followed by natural regeneration or planting, once such time period is passed and trees are not yet growing again on the land, the land is considered deforested.

On the other hand, most of the countries reported that there are legal obligations to restore the forest on harvested areas, or following wildfires, so that such kind of forest cover loss are never identified as deforestation.

Table 11.20 Information on differentiation between temporary forest cover loss and deforestation as provide by EU MS, UK and Iceland in the GHG inventories.

Country	Information
Austria	In Austria temporarily unstocked areas (e.g., harvested area, disturbances) remain forests and are not accounted as deforestation. NFI teams are trained to distinguish between the results of forest management operations and Land Use Changes.
Belgium	It is assumed that forest has been planted and can be recognized on all areas that have been harvested or have been subject to other human disturbance but for which it was expected that a forest would be replanted. In this view no plantation is expected on areas identified as deforested. About one third of the deforested areas were replaced by settlements, for which no re-establishment of forest will occur. Each point identified by the geoprocessing tool as being subject to LUC is verified through photointerpretation to confirm the interpretation.
Bulgaria	Deforestation areas that followed all administrative steps needed to get the permission for deforestation. Only such areas are accounted as D areas in Bulgaria.
Croatia	The main criteria for distinguishing the harvesting or forest disturbance followed by the re-establishment of forest from deforestation is whether or not the land use has changed, which is strictly regulated by the legal framework.
Cyprus	This information is not yet available. The Forest Department is conducting a full inventory of forested areas which should be complete by 2020. This should give us the additional information needed to distinguish between forest disturbance and deforestation. Harvesting is not taking place extensively in Cyprus and no areas are clear-cut of forest as the common practice is the thinning of trees.
Czechia	The main criteria for distinguishing the harvesting or forest disturbance followed by the re-establishment of forest from deforestation is whether or not the land use has changed, which is strictly regulated by the legal framework.
Denmark	Deforestation is detected by analysis of satellite images. Furthermore, deforestation of larger areas is confirmed by e.g., projects on nature restoration. Temporarily unstocked areas are typically located within larger forest areas and will in most cases be reforested within a period of 10 years as according to the Forest Act of Denmark, which applies to all Legal Forest Reserves (Fredsskov) and equals approximately 70 % of the total forest area. Clear-cuts outside

Country	Information
	forests - e.g., small plantations of conifers on former cropland - is considered deforestation.
Estonia	According to Estonian legislation, the land category change by humans is allowed only with orders from local authorities and/or the Minister of the Environment. This must be preceded by the reassignment of the land (e.g. commercial, residential or transport land), which is reflected both in the Land Cadaster and Land Registry. When an NFI sample plot is located in a clear-cut area, the surveyor assesses whether the cutting has been done for regeneration purpose or for land-use change. Clear signs of a land-use change can be seen in the surrounding and location of the area; also, the data from Land Cadaster and Land Registry is checked. According to the Forest Act, the forest owner is obliged to implement reforestation techniques to the extent that within five years after logging or forest death a renewed forest is ensured. Re-establishment of a forest usually starts within 2 years after harvesting.
Finland	When a clear-cut area is located in an NFI sample plot, the surveyor assesses whether the cutting has been done for regeneration purpose or for land-use change. The distinction between these two cases can generally be made on a reliable basis. The distinction between these two cases can generally be made on a reliable basis. Clear signs of a land-use change can be seen in the surroundings and location of the area: construction projects, stacked cutting residuals or if the area is under a regional or town plan. The re-establishment of a forest usually starts within two years after the harvesting. The Forest Act lays down provisions that a new forest must be established within three years after the regeneration cutting. In the case the land-use change occurs after a clear-cut, this can be considered by classifying the sample plot as non-forest.
France	The method used to monitor lands, works over two features, land use and land cover, therefore it is able to differentiate forest cover loss from deforestation.
Germany	Länder laws are to be enacted that set forth obligations for all forest owners whereby clear-cut or degraded forest areas are to be reforested, or replenished, in cases in which natural regrowth remains incomplete, within a reasonable period of time, unless conversion to another type of use has been approved or is otherwise permitted. In general, reforestation is called for on all forest areas that are to remain in use as forest land. That is a legal requirement, and it is the customary practice in the German forestry sector. Forest land that is temporarily unstocked thus continues to fall within the scope of required reporting on forest management pursuant to Art. 3.4 KP. The situation is different in cases in which forest land becomes unstocked and planning calls for subsequent use of the land to fall within the category "non-forest land". Such land is to be considered deforested land, with the relevant deforestation directly human-induced, regardless of whether the deforestation was caused by harvesting or by natural disturbances.
Greece	According to the national legislative framework the forest land use after any disturbance cannot be changed. More specifically in the cases of wildfire events, the areas affected, are instantly declared to be reforested by the responsible authority, which is the Forest Service, with this decision being published in the Official Government Gazette. Harvesting, either in public or private forests, is regulated through national laws (Presidential Degree No 126/1986) and regulations, according to which, specific, and discrete procedures have to be followed only after the authorization of the Forest Service.
Hungary	In Hungary, all forests must be regenerated after clearing mature stands by law. All AR and D areas, as well as those under regeneration are identified by categorizing forest compartments. These compartments have been surveyed since 1 Jan 2008 for all information that is relevant for assigning them to the respective Kyoto forest categories (AR or D and, in case of regenerations, FM), as well as their location within each geographical area. It is also possible to identify each compartment in both the underlying database of this report (which is part of the documentation) and on the forest management maps since 2008.
Ireland	NFI identifies if the lands are unstocked or deforested (5 years periodicity)
Italy	Extensive forest disturbances have been rare in Italy, except for wildfires. Land-use changes after damage do not occur; concerning wildfires, national legislation does not allow any land use change after a fire event for 15 years. Harvesting is regulated through regional rules, which establish procedures to follow in case of harvesting. Although different rules exist at regional level, a common denominator is the requirement of an explicit written communication with the localization and the extent of area to be harvested, existing forest typologies and forestry treatment. Deforestation is allowed only in very limited circumstances (i.e., in construction of railways the last years) and has to follow several administrative steps before being legally permitted. In addition, clear-cutting is a not allowed practice.
Latvia	In Latvia temporarily unstocked areas (e.g., harvested area) remain forests and are not accounted as deforestation if no other activities prohibiting forest regeneration are implemented. The NFI teams are trained to distinguish between forest management and land use changes.
Lithuania	According to Lithuanian Forest Law the clear-cut areas should be reforested for 3 years and

Country	Information
	are under strict control of forest management and State inspection. Temporarily unstocked areas after harvesting remain forests and are not accounted as deforestation. Every deforestation case must be reported to LSFC and is very rare. Any deforested area must follow the afforestation of three-time larger area than the one was deforested.
Luxembourg	Art 13 of the National Nature Conservation Act states that 3 years after a clear cut on forestland, the owner is pledged to reconstruct the forestland. This means that areas of forestland, where a clear-cut has occurred, has to be considered as forestland, as no other use of forestland after a clear-cut is permitted. In addition, after a period of three years, the owner is forced to take measures to restore forestland if it hasn't occurred already. So, no deforestation can occur by law, except if permitted by a ministerial act. If this is the case, this is documented by the Ministry.
Malta	No Deforestation is reported.
Netherlands	Following the Forest definition and the mapping practice applied in the Netherlands, areas subject to harvesting or forest disturbance are still classified as Forest and as such will not result in a change in land use in the overlay of the land-use maps (Kramer et al., 2009; Arets et al., 2016).
Poland	Since no remote sensing technology is directly involved in the KP LULUCF emission inventory, there is no issue related to distinguishing harvesting or forest disturbance from deforestation. Harvesting and forest disturbance always occur on forest land, while deforestation is a cadastral change of land use from forest land to other land use categories
Portugal	Some losses of forest cover are obvious deforestation events and are classified as deforestation as soon as they are detected (e.g. conversions to settlements, flooding by a recently constructed water reservoir, conversion to irrigated farmland). In other situations, the land use following forest cover loss is less obvious. In those situations, and consistent with the KP forest definition, land is considered as "temporarily unstocked" for a period of up to 5 years. After such period the land should be confirmed as forest land (i.e., no deforestation has occurred) or non-forest land. In the latter case the land is considered deforested and the time series for area of FM is recalculated since the year when the event was first detected.
Romania	The forest disturbance alone cannot trigger land conversions from forestland. Thus distinction between harvested and disturbance affected areas, on the one hand, and deforestation, on the other, is made as follows: for the former, there is legal obligation for the forest owner/administrator to maintain the land under forests category and forestry regime (including tree harvest based on permit), to apply the forest management plans

Country	Information
	specifications and regenerate it within a given timeframe (maximum 2 years); for the latter, following legal procedure with the issuance of the approval, a new land use category is assigned to that land, and the forestry regime is no longer applicable.
Slovakia	The temporarily (no more than 2 years) unstocked areas (e.g., harvested area, disturbances) are still considered as forest area and are not accounted as deforestation. According to the cadastral law deforestation means that the category of forest land was definitely and permanently changed to another land use category.
Slovenia	Extensive forest disturbances have been rare in Slovenia. If a large forest area is mainly or totally damaged, the legislation on prevention of insect and fungus disturbances binds owners to remove the rest of the damaged trees. After that, the reestablishment work should be started immediately if possible. That areas remain registry as forest land in forestry spatial information system database.
Spain	After a disturbance, the land does not change its use. By other hand all deforested land is assessed on the basis of cartography where unless a change of the land use is detected, the land would continue to be considered as forest land.
Sweden	Final felling is a natural step in the rotation cycle of forestry. Also, storms may result in large areas of felled trees (wind-throws). If final felling or disturbances as storms have been identified between two consecutive inventories this is not enough to classify the plot as D. However, if for instance a new road, a power line or other land use preceding the definition of forest is located on the former Forest land, then the plot is considered D. The emission from "loss of biomass" is matched to the conversion year. If final felling has occurred on a plot between two consecutive inventories with no sign of D, but D is confirmed at the next re-inventory, then the year of D is "re-calculated" to match the "loss of biomass" to the conversion year.
UK	The data sources used for estimating Deforestation do not confuse between harvesting or forest disturbance and deforestation. This is because the unconditional felling licenses used for the estimation of rural deforestation are only given when no restocking will occur, and the survey of land converted to developed use describes the conversion of forest land to the settlement category, which precludes re-establishment. The Countryside Survey data (used for gap filling) are adjusted in order that deforestation is not over-estimated. New data sources (post-2000) have been used that clearly identify the post-deforestation land use.
Iceland	Deforestation is estimated by special inventory where the change in the area of forest where deforestation has been reported is estimated

Country	Information
	by GPS delineation of a new border between forest and the new land use which is dominantly settlements (new power lines, roads, or buildings). Major forest disturbances will be detected in the NFI but local forest disturbances (wildfires etc.) will be handled with special inventory as done for deforestation

11.4.3 Information on the size and geographical location of forest areas that have lost forest cover, but which are not yet classified as deforested.

The methodologies adopted by individual inventories ensure consistent reporting in time and space of KP lands declared as temporary un-stocked areas. Such post-disturbed areas correspond to all lands reported as harvested under clear-felling, and all those areas where natural disturbances caused a complete loss of forest cover, e.g., windfall, devastating wildfires, and that are thus kept under AR or FM reporting because they do not undergo any land use change.

In general, the distinction between deforested areas and temporarily un-stocked areas is achieved by national methodologies through the implementation of multiple assessment criteria and hierarchical phases, but also field checks or identified disturbed plot data is use for processing the information. Supplementary arguments for a correct classification of the lands are given by enforcement of law requirements.

11.4.4 Information related to the natural disturbances provision under Article 3(3)

In accordance with decision 2/CMP.7; 13 MS, UK and Iceland stated in their “Initial Reports” the intention of excluding emissions resulting from natural disturbances that affect AR lands during the CP2. However, during the UN revision of that reports, Malta indicated that it would not exclude emissions from natural disturbances for any KP-LULUCF activity irrespective of the information in its Initial Report. (Table 11.21).

In general, countries argued that the effects of natural disturbances are always understood as “beyond the control” since the areas affected are broadly considered direct human-induced and subject to management plans that implement management prevention plans to avoid such damages. In addition, it is also argued that according to current national laws it is not allowed to change the use of a disturbed land, but just to implement measures to rehabilitate such forest areas.

The types of disturbance for which countries intended to exclude emissions from the accounting of AR activities vary among individual submissions of their “initial reports” This also explains why a value on background level and margin for the EU does not make full sense and can instead be misleading. Among other factors, the heterogeneity on the type of disturbances considered by countries makes the information on background level and margin meaningless at EU level, either under AR or FM.

In general, wildfires seem to be the most important disturbance affecting AR areas. However, several countries decided to intend to exclude emissions only from areas affected by windstorms, while some others considered all disturbance types as a safeguard measured in case some non-expected disturbance events could occur in the future.

Overall, countries have developed a consistent time series of emissions from natural disturbances that cover different time spans depending on data availability. Annual emissions included in the time series were based on country-specific activity data collected by national authorities, and emissions that are calculated in line with the methods used for reporting the forest land category under the Convention.

Regarding the estimation of the background level and the margin of emissions from natural disturbance, the vast majority of countries have used the default method as described in the 2013 KP Supplement. In the case of Luxembourg and Sweden, the background levels have been set as zero due to the low incidence of natural disturbances that emerged from the analysis of the past disturbances records.

Countries have also provided information to demonstrate the no expectation of net credits by implementing the default method (i.e., ensuring that annual emissions in the background group used to calculate the background level are always lower or equal to the background level plus the margin). In some instance, countries have also stated that:

- No trend was observed in natural disturbance emissions during the calibration period or is expected during the commitment period.
- The background level of emissions for FM included in the FMRL after technical correction is equal to the average of annual emissions from natural disturbances during the calibration period which are in the background group.

Besides that, in line with requirements for the exclusion of emissions from natural disturbances, in some cases, it has been also argued that salvage logging does not occur in lands subjected to forest fires, as all biomass and dead organic matter is immediately oxidized when affected by wildfires. In contrast, some other countries that intend to exclude emissions from windstorms or insect attacks applied a percentage value of the wood stock that is not subject to salvage logging (e.g., Netherlands and Romania) and for which emissions can be excluded.

Table 11.21 Synthesis of Information from EU MS, UK and Iceland that intend to apply the natural disturbance provision under AR activity during CP2, as reported in individual NIRs

Country	Approach used for developing the BL and the Margin	BL	Margin	Type of disturbance
		Kt CO_2 eq		
Bulgaria	Default method	4.000	2.190	wildfires, extreme weather events – windstorms, wet snowfall, ice, others
Croatia	Default method	0.000	0.000	Wildfires
France	Default method	5790.000	1581.000	Wildfires, storms, droughts
Greece	Default method	1.351	2.385	Wildfires
Ireland	Default method	23.950	46.666	Wildfires
Italy	Default method	0.451	0.708	Wildfires
Luxembourg	Minimum level of historical time series	0.000	0.000	Extreme weather events (storms)
Netherlands	Default method	0.007	0.006	Wildfires
Portugal	Default method	29.870	9.540	---
Romania	Default method	0.200	0.220	Wildfires
Spain	Default method	[0.287t CO_2eq/ha.]	[0.209t CO_2eq/ha.]	All considered in the 2013 KP supplement
Sweden	Default method	0.000	300.000	Wildfires, insect attacks and disease infestations, extreme weather events and geological disturbances
United Kingdom	Default method	34.900	18.800	Wildfires, insect attacks and disease infestations, extreme weather events and geological disturbances
Iceland	---	---	---	Only ND of catastrophic size that heavily will affect the normal emission/removal account

So far, emissions from natural disturbances have not been excluded from the accounting of AR activities. Some countries have stated that although emissions from natural disturbances, in some of the reporting years, have exceeded the calculated background level plus the margin, the method used to track the disturbance events does not allow to know the georeferenced location of the affected areas as it is required under the decision 2/CMP.8., (e.g., Ireland). Some other countries informed that irrespective to their intention to implement the natural disturbances provision, those emissions will not be excluded pursuant this provision due to the low incidence of disturbances or because most emissions are associated to salvage logging that follows disturbance (e.g., Luxembourg).

11.4.5 Information on Harvested Wood Products under Article 3(3)

All countries used the "Production approach" to estimate net carbon stock changes from this carbon pool. The methodology corresponds to the IPCC Tier 2 method, where first-order decay functions with default half-life values are used. In addition, information on activity data is often collected from international data sources (i.e., FAO, UNECE, etc.). More details can be found in section 6.2.6 of this document and in individual GHG inventories.

Some countries have stated that it is not possible to unequivocally separate HWP originated from AR lands from those originated from FM lands. Therefore, when this is the case, in line with the IPCC guidelines, following a conservative approach, all the emissions and removals from this carbon pool have been assigned to FM lands. Additionally, some other countries have also stated that HWP are never originated from AR lands as the age of the trees does not allow harvesting practices (e.g., Croatia, Latvia). Finally, when carbon stock changes from HWP are separated between AR and FM, the default IPCC method (equation 2.8.3 of the 2013 KP Supplement) has been used for this purpose.

Concerning HWP originated from deforestation events, following reporting rules, these have been reported on the basis of instantaneous oxidation. And following an issue discussed during the 2016 UN annual review, The EU requested countries to include information, when it is relevant, on *"harvest originating from deforestation events*" in table 4(KP-I)C for information purposes. This aims to provide transparent information on the HWP quantities from deforestation that are considered as instantaneous oxidation.

Moreover, countries have also progressively enhanced the transparency of the information included in the NIR by providing more detailed descriptions on the origin of HWP reported under deforested lands. In some instances, the share of HWP originating from D within the total budget of the country is estimated on an area-basis share of lands under D and FM for individual reporting years (e.g., Czechia).

Beside this, one country reports HWP from deforestation that originated from trees growing in lands that underwent deforestation. While some countries justified that by law HWP cannot be linked to Deforestation (e.g., Greece). In line with the IPCC guidelines, instantaneous oxidation approach has been also used to estimate carbon stock changes from wood products in solid waste disposal sites and harvested wood used for energy purposes as stated in individual GHG inventories.

Emissions and removals that are reported from HWP originating from Deforestation lands are in overall insignificant, for this year submission, only Denmark reports -3.30 kt $CO_{2.}$ Denmark explained that despite of that small quantity, in general there are no HWP resulting from trees growing in previously deforested lands because Deforestation in the period since 1990 have been reported for land use changes from forestry to other land uses, mainly cropland, grassland and settlement. And that there are very few areas having truly changed from forestry – another land use – forestry within the reporting period, will in no circumstances have reached a size (height/diameter) that can provide HWP products. This deforestation will have been in effect for at least 1-2 years before any reforestation could occur.

11.5 Article 3(4)

11.5.1 Information that demonstrates that activities under Article 3(4) have occurred since 1 January 1990 and are human induced.

Land representation systems that are used at national level to track the lands are able to determine the onset of the activities along the time series. Information in CRF table NIR-2 allows to check when a unit of land enters in the accounting and to track that such unit of land continues to be accounted for during the subsequent years of the KP.

Since FM, CM, GM, WDR, and RV are all activities that involve land management, they always qualify as direct human induced. In most of the cases, countries implemented the broad approach, described in the 2013 IPCC KP Supplement, to define what management refers to.

11.5.2 Information relating to Forest Management

Forest management is understood as the set of forest practices and operations, which occur at the stand-level. This includes harvesting, natural and human-induced regeneration, site, and soil preparation (including drainage, burning of slash), seeding, thinning, pruning, fertilization and liming, conservation of habitats, and fire prevention plans.

Sustainable forestry has long tradition in Europe, where some management plans are dated from hundreds of years ago. Currently, each country has in force its own legislation on forest lands, as well as other laws supporting a sustainable management and protection of forest areas. At the EU level, there are strong requirements for sustainable management of forests and environmental obligations on nature and biodiversity protection, but also for sustainable rural development, and renewable energy policies.

Moreover, there is an EU forest strategy for 2030[64] that sets a vision and concrete actions to improve the quantity and quality of EU forests and strengthen their protection, restoration, and resilience. It aims to adapt Europe's forests to the new conditions, weather extremes and high uncertainty brought about by climate change.

In addition, some countries report forest certification frameworks as an additional tool to highlight the sustainability of the whole chain of forestry and associated products.

Forest related information reported under different international processes (e.g., FAO, MCFPE, CBD) may be slightly different from LULUCF data due to different reference time and definitions underlying each of the reporting obligations. Thus, any comparison among data sources has to be done cautiously. As an example, there is a particular case that concerns to the reporting of France that was subject to a question from the UN ERT years ago. Specifically, in the past, new forest areas that are considered managed but that are not considered direct human-induced, and therefore not qualify as AR, were not

[64] https://ec.europa.eu/environment/strategy/forest-strategy_es

included in the accounting under FM. France has now clarify that this issue is now solved and that all the managed areas of forest are covered by the KP reporting and accounting.

11.5.2.1 Conversion of natural forest to planted forest.

Countries have reported that these conversions do not take place in their territories. The main reasons are, either that natural forests do not exist, as all forests are under more or less intensive management plans, or because natural forests are under strict conservation and protection regimes (e.g., Czechia) that prevent such conversions.

11.5.2.2 Forest Management Reference Level (FMRL)

For the construction of the FMRL, EU MS, UK and Iceland implemented different approaches, although all of them were based on projections under a “business-as-usual” scenario (Table 11.22).

This section provides a synthesis of information on those values and approaches, but for more detailed information it is suggested to refer to individual submissions of information on FMRL, as submitted by individual countries and the EU before the beginning of the CP2; or to the national GHG inventories.

As regards with approaches used in the construction of the FMRL; 10 MS, UK and Iceland prepared model-based projections using country-specific methodologies. In these cases, national forest inventory data, remotely sensed information, and other available national statistics were the main data sources used. Moreover, 14 MS prepared model-based projections using a common approach coordinated by the JRC in collaboration with the International Institute for Applied System Analysis (IIASA) and the European Forest Institute (EFI). To this purpose, two models were used, G4M and EFISCEN which are run on the basis of information on country-specific forest parameters shared by countries. In addition, information on wood production and prices of land and timber, was derived from the GLOBIOM model.

The remaining three MS used historical data projections based on the elaboration of historical data, assumed as proxy for a “business-as-usual” scenario. Specifically, Greece used the historical average of net removals from forests for the period 1990-2009, while Cyprus and Malta based their FMRL on the linear extrapolation of historical net emissions from forest for the period 1990-2008.

Table 11.22 Synthesis of information related to the construction of the FMRL values as reported by EU MS, UK and Iceland in this inventory year.

Country	Value inscribed in the Appendix to the annex to decision 2/CMP.7 (kt CO_2 eq/yr.)	Technical correction	FMRL based on projections under a "Business-as-usual" scenario		
			Model-based projections using country-specific methodology	Model-based projections using "JRC approach"	Projections based on historical data assumed as proxy for a "business-as-usual"
Austria	-6516	5774	X		
Belgium	-2499	1010		X	
Bulgaria	-7950	-2942		X	
Croatia	-6289	-842	X		
Cyprus*	-157	NA			X
Czechia	-4686	-225		X	
Denmark	409	-83	X		
Estonia	-2741	1819		X	
Finland	-20466	-9198	X		
France	-67410	23318		X	
Germany	-22418	6331	X		
Greece	-1830	210			X
Hungary	-1000	-334		X	
Ireland	-142	113	X		
Italy	-22166	-1680		X	
Latvia	-16302	14829		X	
Lithuania	-4552	-922		X	
Luxembourg	-418	56		X	
Malta	-49	49			X
Netherlands	-1425	337		X	
Poland	-27133	-7082	X		
Portugal	-6830	3369	X		
Romania	-15793	-6168		X	
Slovakia	-1084	-3723		X	
Slovenia	-3171	-161	X		
Spain	-23100	-4261		X	
Sweden	-41336	8943	X		
UK	-8268	-9333	X		
Iceland	-154	-21	X		
EU KP-LULUCF	**-306736**	**10444.32**	**----**	**----**	**----**

**During the QAQC checks implemented under the Reg (EU)525/2013 the EU has informed the Party on the need to provide information on the TC of the FMRL, however Cyprus did not include information on the TC of the FMRL in its 2022 submission. The lack of this information distorts the final accounting quantities of the FM activity for Cyprus and subsequently for the EU. Cyprus confirmed that the issue will be addressed in a resubmission of the inventory planned by before the closure of the KP-CP2. Until this information is provided any assessment on accounting quantities for FM added in the EU GHG inventory should bear in mind this issue It should be noted that because the EU CRF tables must be compiled by direct aggregation of the CRF tables provided by the countries, the CRF tables of the EU included in its submission unavoidably the impact of this issue.*

It is important to keep in mind that the FMRL value inscribed in the decision 2/CMP.7 for the EU considers the coverage of the Union at the time of setting the values. At the present, the Union differs from that coverage as the EU MS have changed. Such values as inscribed in the appendix to the annex to Decision 2/CMP.7 are:

I. EU FMRL applying instantaneous oxidation: -253336 kt CO_2 eq/yr
II. EU FMRL applying first-order decay function for HWP: -306736 kt CO_2 eq/yr,

Nevertheless, the current EU GHG inventory refers to a different EU coverage that the one represented by the value in Decision 2/CMP.7. Because the FM accounting quantity of the EU GHG inventory depends on the accounting quantities, FMRL values, and their technical corrections reported by countries in their CRF table "accounting". In order to ensure the consistency among the EU GHG inventory (i.e., as a direct sum of individual GHG inventories) and the individual inventories, and to fulfill the mandate of use as a FMRL value the value in the decision 2/CMP.7, the EU FMRL is technically corrected to overcome the different coverage if the Union at the present.

Following a reiterated recommendation from the UN ERT, the current inventory addresses the issue represented by the different EU coverages by applying a TC that is the sum of the TC applied by the countries (19184.49 kt CO_2 eq) plus the difference between the FMRL value inscribed in the decision and the one that would result from the current coverage of the EU inventory[65] (-315 476.17 kt CO_2 eq/yr). Doing it so, the sum of accounting quantities for FM submitted by individual inventories matches the accounting quantity that is reflected in the EU CRF table 'Accounting", while at the same time the FMRL used for the EU is the one included in the appendix to the annex to Decision 2/CMP.7 as requested by the UN ERT.

In addition, as requested by the UN ERT, the EU has also included in this submission more transparent information on the background level of emissions associated with natural disturbances that is included in the FMRL values.

In this regard, as acknowledged by the UN ERT of the EU FMRL submission, it should be noted that, as part of the approaches used to calculate the FMRL values, the emissions from natural disturbances (if any) were automatically included in the historical records used to derive the FMRLs. These emissions were in some cases considered insignificant, but more importantly is that in any case, no matter whether the country used or not the JRC approach, the reasoning applies to all individual submissions and was accepted by the UN review experts.

More details on how the background level of emissions associated with natural disturbances is included in the FMRL values can be found on the individual UN technical assessment reports of the FMRL reports submitted by the Parties[66].

For MS that used the JRC approach to calculate their FMRL values (see table 11.22), the calibration procedure used by the modelers to estimate the FMRL automatically incorporated into the projections the average rate (for the period 2000-2008) of the impact of past natural disturbances in the reporting of GHG in forest. This was acknowledged by the UN ERT of the EU FMRL submission in 2011[67].

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[65] The FMRL for EU+UK+ISL calculated as the value inscribed in the Appendix to the annex to decision 2/CMP/7 for EU-27 (this includes UK), plus the values applying instantaneous oxidation inscribed for Croatia and Iceland.

[66] https://unfccc.int/topics/land-use/workstreams/land-use--land-use-change-and-forestry-lulucf/forest-management-reference-levels

[67] https://unfccc.int/sites/default/files/resource/docs/2011/tar/eu01.pdf

Explicit information on the background level of emissions associated with natural disturbances included in the EU FMRL for those MS that used the JRC approach is reported in the table A.5 of the EU FMRL submission[68].

In any individual submission, the consistency in the accounting of the FM activity at the end of the KP-CP2 is ensured with the implementation of the technical corrections of the FMRLs reported by the countries. The TC values incorporate, among others revised parameters, any relevant update of the information on the background level of emissions associated with natural disturbances that was intrinsically included at the time of estimating the FMRL values".

This approach is in line with the guidelines of the IPCC KP 2013 supplement (page 2.50) *" The remaining emissions due to natural disturbances during the commitment period are included in accounting during the commitment period. These natural disturbance emissions are effectively balanced by the background level emissions from the natural disturbances that are included in the FMRL. The expected outcome is that the background level emissions will be equal to the average natural disturbance emissions over the commitment period that are not excluded from accounting individually"*

Additional information on the background level of emissions from natural disturbances that occur in FM areas (and AR) from those MS that intended to apply the natural disturbance provision is included in the table 11.24 (and 11.21) of this chapter. Although it should be noted that none of the individual inventories have applied the natural disturbance provision to the accounting of the KP-CP2

11.5.2.3 Technical Corrections of FMRL

In line with requirements of the Decision 2/CMP.7, countries have already assessed the consistency between the FMRL and the reporting of FM activity in terms of methodological elements (e.g., pools and gases included, area considered, natural disturbances, etc.). As a result, 26 EU MS, UK and Iceland implemented technical corrections to the FMRL (Table 11.22) in order to ensure such consistency.

During these last years of the KP-CP2, the EU offered support to the MS for the calculation of the TC of the FMRL in order to ensure the correct accounting of the FM activity. Some MS accepted the offering and in collaboration with these countries the JRC has provided guidance to these MS in the calculation process of the TC value that has been provided in this submission.

Reasons for these inconsistencies and the associated technical corrections vary among inventories (Table 11.23). Overall, they mostly relate to the inclusion of emissions and removals from previously unaccounted carbon pools, the use of the new methodological guidance, especially on HWP and BGL of natural disturbances, and the availability of updated data for FM reporting as compared with the data used for the construction of the FMRL.

However, noting the selection of accounting frequency for KP activities at the end of CP2, regardless of some inconsistencies that were found among the methodological elements, some countries postponed the TC until this last year udder the KP accounting, due to constrains on time and resources available.

[68] https://unfccc.int/files/meetings/ad_hoc_working_groups/kp/application/pdf/awgkp_eu_2011_rev.pdf

Bearing in mind the importance of this year submissions being the last ones under the KP-CP2. And the need to ensure that the FMRL are technically corrected as needed so that they allow a proper accounting quantity of the FM activity, the JRC offered support to the countries, and in particular those that used the JRC approach in the construction of their FMRL. In the table below it is included a compilation of the reasons provided by countries for a TC of the FMRL values.

Table 11.23 Information on inconsistencies among the FMRL and the reporting of FM activity that have triggered the need of TC.

Country	Information on the need for applying Technical Correction to the FMRL
Austria	Improvements and updates in the forest land remaining forest land category have impacts on accounting for Forest Management in the second commitment period which require the following adjustments: 1) Inclusion of the litter and soil pools. 2) Updated expansion ratios: 3) Updated data on 'drain': 4) Updated dead wood pool: 5) Corrections in the calculations of the 'increment' 6) Update of harvested wood products:
Belgium	Updated historical data became available since the submission of the FMRL in 2011 and recent improvements were performed in the inventory. The most important recalculation in 2019 is Soil organic carbon, with a difference around 1350 kt CO_2-eq. The second one are the revisions in Wallonia (forest inventory data and BEF), which reduces the sink by 350 kt CO_2 from 2002 to present. Considering the magnitude of the changes, a technical correction of the reference level is proposed, in order to ensure methodological consistency between the FMRL and the current reporting for forest management.
Bulgaria	Changes in GHG Inventory since 2011 which trigger a technical correction are: 1. Changes in the historical data regarding the area of forest land remaining forest land as a proxy for the FM 2. Changes in the growing stock per ha data due to inclusion of updated information as well as correction of technical error from previous submissions (e.g in 2011) 3. Changes in EFs 4. Inclusion of DW pool
Croatia	Since the submission of FMRL Croatia implemented several methodological improvement steps in estimating its emissions/removals of FM. Due to these methodological improvements, changes in the FM input data, FM estimates and FM figures of historic years occur. As a consequence of all these methodological changes the FMRL changes from -6,289 kt CO_2 net removals to FMRLcorr. – 4,906.20178 kt CO_2 net removals without HWP instantaneous oxidation) and to FMRLcorr. – 5,384.16933 kt CO_2 net removals with the HWP
Czechia	The technical correction (TC) is calculated to FMRL for the Czech Republic pursuant to Paragraphs 14 and 15 of Annex to Decision 2/CMP.7 (Land-use, land-use change and forestry) contained in document FCCC/KP/CMP/2011/10/Add.1, p.15. TC was necessary for FMRL due to 1) change of the methods used for GHG reporting as compared to the methods used for the development of the original FMRL and its assessment; 2) inclusion of additional carbon pools in the reporting; 3) changes in input activity data for the estimates of some components of the total FM emissions.
Denmark	For the accounting of emissions, a FMRL is constructed specifying the expected average annual net emissions from the HWP pool for the second commitment period. Due to the data corrections it was decided to correct the original FMRL reported in 2011 (Johansen et al. 2011). This correction also entailed a change in the reference period used to project the inflow to the HWP pool – from 2005-2009 to 2008-2012 – in order to provide a more accurate reference level using the most recently collected data. Had the reference period not been changed, the FMRL would have significantly underestimated the inflow for 2013 and thus caused a significant gap between the report-ed net emissions and the projected net emissions by the FMRL. This means that the HWP pool would actually have been projected to decrease as op-posed to the expected increase in the pool during the second commitment period.
Estonia	Technical correction of FMRL was calculated due to the following reasons: • Estimates of carbon stock change in living biomass have been updated due to revised data from the NFI. Country specific BCEFS were calculated based on NFI and research studies. • CO_2 emissions from drained organic forest soils were recalculated using updated activity data and emission factors. • Non- CO_2 GHG emissions from forest fires were recalculated and estimated according to 2006 IPCC Guidelines. • The following additional carbon pools were included in reporting the FM for the second commitment period: CO_2 emissions from mineral soils and dead organic matter. • Additional non- CO_2 source was included in reporting the FM for the second commitment period: CH_4 and N_2O emissions from drained organic soils.
Finland	The adopted FMRL was constructed as a projection for development of forest-related greenhouse gas removals and emissions from FM (FMRL Submission 2011). Three different kinds of methods were used to prepare the FMRL. Development of forest resources (volume of growing stock, increment, harvest, total drain) was modelled with MELA software, and carbon stock changes in mineral soils with Yasso soil model. For organic drained soils CO_2 emissions were estimated by multiplying drained area with emission factors. For emissions from nitrogen fertilization and biomass burning a five-year average of historical emissions was used. 2009 FM area was decreased by the historical five-year average deforestation area. Several technical corrections, as listed in Table 11.5-2, are made to the FMRL during the second commitment period due to methodological changes and increase of the coverage of emission sources in the GHG inventory. The final TC is calculated to correctly reflect the data and methods used in the 2022 submission for FM.
France	Here are no plans to completely recalculate the FMRL based on new modeling. The modification of the calculation parameters is therefore not intended to improve the consistency between the FM activity and the FMRL, in particular with regard to the age class structure and the areas. However, the FMRL modeling is brought back into overall coherence with the inventory using a technical correction.

Country	Information on the need for applying Technical Correction to the FMRL
Germany	With regard to carbon stocks in living biomass, the previous FMRL, which was reported to the UNFCCC Secretariat and the EU in 2011, is based on data of the 2008 Inventory Study and, for the projection, on the forest management scenario of the WEHAM forest development and wood-production model. For the pools dead biomass (litter, dead wood) and soils, and for emissions from fertilization, drainage and combustion of biomass (forest fires), country-specific emission factors either were not available or were not recorded. Carbon in harvested wood products (HWP) was not accounted for in a manner consistent with decision 2/CMP.7 and the KP Supplement adopted following the submission of the FMRL. The reference level used to date does not contain all categories and other emissions that are reported relative to KP 3.4, pursuant to the current rules for GHG reporting, and thus are part of the pertinent accounting (cf. Table 510). Additional recommendations relative to corrections are provided in the "Report of the technical assessment of the FMRL submission of Germany submitted in 2011" (FCCC/TAR/2011/DEU). For this reason, Germany has carried out a technical correction of the FMRL.
Greece	The changes that have occurred in relation to methodological elements, which are triggering a technical correction are: 1 The update of the Forest Management Plans database. The new data incorporated in the database have resulted in the recalculation of the whole time series for the 4.A.1 “Forest land remaining Forest land/managed” category which is equivalent to the Forest Management activity. 2 The area of forest land remaining forest land/managed that equals to Forest Management area has changed. 3 In the current submission, CO_2 and non- CO_2 emissions from dead wood and litter subject to wildfires in lands under 3.4 have been reported for the first time. 4 There has been a recalculation of the whole time series of emissions from wildfires. 5 The period 1990-2014 has been considered for the technical correction of the FMRL, while the FMRL value inscribed in the appendix of 2/CMP.7 is based on the average of emissions/removals of the period 1990-2009. 6 In the estimation of emissions/removals from Forest land remaining forest land, the updated emission and conversion factors from 2006 GL AFOLU and KP Supplement have been used. In addition, the new global warming potential values for CH_4 and N_2O from the 4th AR IPCC have been used. 7 In the current submission, both a FMRL assuming instantaneous oxidation and applying the FOD function for HWP is submitted. It should be noted that a forest management reference level applying first-order decay function for HWP was not included in the appendix of 2/CMP.7,
Hungary	A technical correction was necessary for the FMRL because there are several methodological changes that have been implemented in the estimation of emissions and removals from FM, including the HWP pool.
Ireland	Ireland has performed recalculations for the historic time series and 2013 and will apply a technical correction when accounting for the second commitment period. The requirement to apply a recalculation is based on conditions as outlined in the IPCC 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (IPCC 2013 GPG KP-LULUCF): 1 Use of new models to derive the reported carbon stock (CSC) changes in the inventory 2013. 2 There have been a range of methodological changes for estimation CO_2, N_2O and CH_4 emissions from organic and mineral soils. 3 Ireland has obtained new historical data for several elements included in the construction of the FMRL
Italy	The following changes have been done since the submission of the MFRL which trigger the need for TC: The FMRL has been calculated with the EU models G4M (IIASA) and EFISCEN (EFI). Estimates of emissions and removals under FM activities have been carried out with the growth model For-est, used to estimate the net change of carbon in the five reporting pools. Availability of new data resulting from the ongoing NFI and consequent recalculations of the reported data under FM and Forest Land Remaining Forest Land used to establish the reference level. The estimates have been carried out on the basis of the 2013 KP Supplement (IPCC 2014) methodology
Latvia	The need for Technical Correction is determined by following reasons: 1.- The method used for GHG reporting changed after the adoption of FMRL as part of improving inventory quality and due to conversion of calculations from the IPCC GPG LULUCF 2003 to 2006 IPCC Guidelines and IPCC Wetlands Supplement. 2.- New non- CO_2 GHG sources are included in reporting for FM in the second commitment period. 3.- Recalculated historical data was done for the most important parameters. 4.- The accounting of HWP has been also improved since estimation of the FMRL which was submitted before Decision 2/CMP.7. Technical Correction was calculated based on a model re-calibration. A full re-run of the model will be carried in the future to allow Latvia to implement a complete Technical Correction.
Lithuania	Lithuania has already applied technical correction to the forest management reference level which is equal to -922.0 kt CO_2 eq. G4M and EFISCEN models, used for FMRL estimation, were updated with more recent NFI data to calculate technical correction. The main changes were larger forest area for both models and a larger increment rate and growing stock and a higher share of wood coming from thinning in total wood removals for EFISCEN as compared to data used originally for the FMRL calculations. With the updated input data G4M and EFISCEN project a CO_2 sink in the range of 5.4-9.0 Mt CO_2/year in 2020. Both models agree on the declining trend of the biomass forest management emissions. For the FMRL projection in 2011 EFISCEN model was initialized with the National Forest Inventory (NFI) data referring to the year 2000 and respective age structure while G4M was initialized with age structure projected by EFISCEN for 2010. For the technical correction projection EFISCEN model was initialized with data from the 2010-2012 (2010 midpoint) NFI measurements while G4M used the same initial age structure as for the FMRL.
Luxembourg	The IPCC KP Supplements require a technical correction of the FMRL if methodological changes result in calculation of the time series, if new historical data become available or if pools are included in current reporting that have not been taken into account in the FMRL. Those conditions are fulfilled as the current FMRL does not use the methodological approach employed in Luxembourg and hence a technical correction of the FMRL was carried out.
Malta	Since the national greenhouse gas inventory submission of 2011, Malta has changed the methodology for estimating emissions and removals for the sector LULUCF. During those previous submissions the category ‘Forestland remaining forestland’ was taken to include coniferous forest, mixed forest and shrubland (maquis). Malta has now a national definition which states that a forest is defined as an area of minimum 1 hectare with a tree crown cover of more than 30% and

Country	Information on the need for applying Technical Correction to the FMRL
	minimum tree height of 5 meters. This has resulted in shrubland no longer being considered as part of the category 'Forestland', now being classified as part of the category 'Grassland'. In view of this, Malta is seeking a correction of the FMRL currently inscribed under the Kyoto Protocol. This methodological change leads to the sink value of -49Gg CO_2 equivalent as reported when using the previous methodology being reduced to a net removal for the category 'Forestland remaining forestland' of 0Gg CO_2 equivalent.
Netherlands	A number of changes in the Netherlands' inventory caused methodological inconsistencies between the inventory and the FMRLs. This was partly because the accounting of HWP as agreed in decision 2/CMP.7 was not yet available at the time the FMRLs were submitted: natural disturbances were not yet included at the time of submission of the FMRLs. Additionally, new NFI statistics became available covering the period 2003–2012, and in the NIR 2021 a land-use map for 1970 was introduced, all resulting in recalculated historical data. Moreover, also new methodologies on calculating the carbon stock changes in forest land have been introduced since the adoption of the FMRL and new information on land-use change from using additional maps for the years 2013 and 2017 is used resulting in inconsistencies between the reported emissions and removals in FM and those included in the FMRL.
Poland	Pursuant to paragraphs 14 and 15 of Annex to Decision 2/CMP.7 (Land use, land-use change and forestry), a technical correction for FMRL will became necessary. Relevant corrections are needed to reflect several methodological changes that have been implemented in the estimation of emissions and removals from FM, including the HWP pool. A technical correction is implemented in the light of new data available from NFI at the later stage. This approach allows to consume final information that have been produced and verified internally by using CBM CFS 3 software to assess carbon stock changes in forest ecosystems and by using calculation methods and a model to assess the effect of carbon substitution of harvested wood products considered as part of the national greenhouse gas inventory.
Portugal	All spreadsheets for estimating emissions and removals from KP LULUCF have been adapted so that they recalculate automatically the FMRL if and when the base information changes. Following the specifications of Decision 2/CMP.7, the assumptions used in FMRL construction are kept constant. All changes to the FMRL value are therefore due to changes in the base information (historical time series) or changes in methodologies in use, which then apply both to the historic time series and to reporting in the commitment period. Since the communication of the FMRL by Portugal in 2011, several changes have been introduced in the reporting by Portugal.
Romania	According to requirements in Decision 2/CM.7, para 14 and 15, to ensure methodological consistency between the FMRL and reporting for Forest Management during CP2, Romania calculated a technical correction (TC). In this submission, Romania calculates TC in GHG Inventory for the first time. The TC was triggered by methodological inconsistencies between the FMRL and the revision of GHG estimates reported for the managed forest. To calculate the FRML corrections, Romania implemented the following methodological elements: 1.Romania used the same historical time period, 2000-2008, to source information.2. As in the initial FRML submission, no additional policies with effect to GHG emissions from the FM activity were considered. 3.The GHG emissions from the FM activity were recalculated and submitted for all years succeeding the 2011 submission (based which the FRML was estimated) using an age class structure based on the linear interpolation of the NFFI 1985, NFI 2012, and NFI 2018, that is thus similar to the age class structure used by the models (G4M, EFISCEN). 4. The same pools and gasses were used to report E/R from the FM activity as in the initial FMRL. 5. The same approach was used for emissions from salvage logging, i.e., it is included in the annual harvest in the initial FRML and also used in the carbon stock change in the current FM estimates.
Slovakia	Technical corrections were (TC) calculated for the first time in submission 2018. The actual value of technical correction is - 1 164.0 kt CO_2 eq. the TC values recalculated for 2019 submission. Methodology for reporting of Forest Management evolved significantly during CP2, leading to relatively high value of TC.
Slovenia	The following list of identified elements was considered key to make a technical correction of the FMRL: Methodological inconsistency: the Gain-Loss method was used to produce the FMRL, while the Stock-Difference method was used to estimate GHG emissions and removals for FM in the second commitment period Modification of some methodological elements: addition of new pools or gasses, namely dead wood and emissions from biomass burning, which were not included in the FMRL, o recalculated historical data on (forest) area due to change in data source, o recalculated historical data for FM in the GHG inventory (i.e. recalculated growing stock based on the NFI data for the years 2007 and 2012 and change in parameters used to convert volume to biomass).
Spain	The TC performed this year is due to updating the historical data (2000-2008) of the parameters listed below: (1) Forest land areas; (2) estimation of the living biomass pool (LB) in FL; (3) emissions caused by biomass burning in FL; 4) HWP estimates.
Sweden	Sweden has performed a technical correction for the forest management reference level due to the following reasons: - The historical dataset for Living biomass representing the period 2005-2009 has been updated using new inventory data from the NFI. - The historical dataset for Litter representing the period 2000-2009 has been updated using new inventory data from the soil inventory. - The historical dataset for Soil organic carbon representing the period 2000-2009 has been updated using new inventory data from the soil inventory. The method to calculate emissions/removals from the harvested products pool was slightly revised in Submission 2015. T - New sources of greenhouse gases was amended in the reporting in Submission 2015. - The emission factor for drained organic forest soils and nitrogen fertilization was changed in Submission 2015. - Biomass burning now includes only emissions of N_2O and CH_4. - The GWPs for CH_4 and N_2O have been changed according to decision 4/CMP.7 and affects all estimates of emissions of CH_4 and N_2O.

Country	Information on the need for applying Technical Correction to the FMRL
UK	The UK has calculated a technical correction (TC) to the FMRL for the 2016 inventory. The FMRL submitted by the UK in 2011 was based on the 1990-2008 UK greenhouse gas inventory, since which, the following data and assumptions have changed that necessitate a technical correction: 1.- A switch in the model used from CFlow to CARBINE; 2.- Inclusion of pre-1921 forest area; 3.- Change in tree growth assumptions; 4.- Change in the assumptions about harvesting rates; 5.- Updated information on the rate of deforestation; 6.- Updated approach to estimating the incidence of emissions from wildfires;
ISL	Iceland did estimate Forest Management Reverence level (FMRL) for current commitment period in February 2011 (Snorrason, 2011). It was clear in the beginning that the estimates were uncertain. Especially was the estimate for the natural birch forest (NBF) critical as the ERT did point out (see page 19 paragraph h) in Synthesis report of the technical assessments of the forest management reference level submissions. Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol Sixteenth session, part four Durban, 29 November 2011. FCCC/KP/AWG/2011/INF.2) New approach to estimate the change in the carbon stock of natural birch forest was conducted soon after the reference level was accepted.

11.5.2.4 Carbon equivalent Forest Conversion

This provision is not relevant for EU MS, or for UK, or Iceland.

11.5.3 Information related to the natural disturbances provision under article 3(4)

In accordance with decision 2/CMP.7; 18 MS, UK and Iceland stated their intention of excluding emissions resulting from natural disturbances that affect areas subject to FM during CP2 in the “Initial Reports” (Table 11.24). However, during the UN review of those reports, Malta indicated that it would not exclude emissions from natural disturbances for any KP-LULUCF activity irrespective of the information in its Initial Report.

Most detailed information on the approaches used by the countries to calculate the background level and the margin, as well as, on other requirements for Parties that intend to apply this provision can be found in section 11.4.4 of this report. And a comprehensive information in this regard is available in the inventories submitted by the EU MS, UK and Iceland.

As with the KP activity AR, emissions from natural disturbances have not been excluded from the accounting of FM activity.

Table 11.24 Synthesis of Information from EU MS, UK and Iceland that intends to apply the natural disturbance provision under FM activities during CP2.

Country	Approach used for developing the BL and the Margin	BL	Margin	Type of disturbance
		Kt CO_2 eq		
Austria	Default method	[0.147t CO_2eq/ha.]	[0.171 t CO_2eq/ha.]	All considered in the 2013 KP supplement
Belgium	Default method	3.540	7.800	Wildfires
Bulgaria	Default method	848.012	531.646	Wildfires, extreme weather events – windstorms, wet snowfall, ice, others
Cyprus	Default method	14.910	23.030	Wildfires, extreme weather events – windbreaks, snow breaks and ice breaks
Croatia	Default method	59.480	114.070	Wildfires
Estonia	Default method	181.731	112.544	Biotic or abiotic damages being the most critical Extreme weather events (storms)
Finland	Default method	532.000	314.000	Windstorms, insect attacks and wildfires
France	Default method	13588.000	1744.000	Wildfires, storm, droughts
Greece	Default method	82.078	144.937	Wildfires
Ireland	Default method	69.363	66.782	Wildfires
Italy	Default method	1689.239	1374.197	Wildfires
Luxembourg	Minimum level of historical time series	0.000	0.000	Extreme weather events
Netherlands	Default method	2.380	2.000	Wildfires and wind storms
Portugal	Default method	1080.880	1197.120	Wildfires
Romania	Default method	66.000	61.000	Wildfires and windfalls
Spain	Default method	4166.460	3033.170	All considered in the 2013 KP supplement
Sweden	Default method	14.120	3000.000	Wildfires, insect attacks and disease infestations, windstorms and geological disturbances
United Kingdom	Default method	270.000	112.000	Wildfires, insect attacks and disease infestations, windstorms and geological disturbances
Iceland	---	---	---	Only ND of catastrophic size that heavily will affect the normal emission/removal account

11.5.4 Information on Harvested Wood Products under Article 3(4)

All counties used the "Production approach" to estimate carbon stock changes in the HWP pool in line with the IPCC 2013 KP Supplement. The default IPCC method (equation 2.8.3 of the 2013 KP Supplement) was mainly used to allocate the carbon stock changes to specific forest related activities under Article 3(3), and Article 3(4).

As regards with the information item in the CRF table 4(KP-I) C on information for harvest from lands not included under forest management or under Article 3(3) activities, five countries have reported quantitative information on CRF table 4(KP-I) C. All the others have explained that HWP are not originating from lands subject to any other activity than ARD, or FM.

Further information on the reporting of HWP for Art. 3(4) activities of the KP-LULUCF is provided in section 11.4.5 of this chapter.

11.5.5 Information relating to Cropland Management, Grazing Land Management and Revegetation, Wetland Drainage and Rewetting if elected, for the base year.

For the KP-CP2, emissions and removals from CM are reported and accounted for by Denmark, Germany, Ireland, Italy, Portugal, Spain and UK. With the exception of Spain, these countries also elected to account for emissions and removals from the activity GM. Moreover, RV activity has been elected only by Romania and Iceland, whereas only United Kingdom account for emissions and removals from the activity WDR.

Definitions implemented by the countries are consistent with those contained in decision 16/CMP.1. Cropland and Grazing land management activities consist in the implementation of specific practices and operations, which differ substantially from country to country. CM is dedicated to agricultural crops, perennial, and annual, woody and non-woody crops, including lands temporary under reserve or out of the productive cycle (fallow lands). GM is the system of practices consisting in manipulating site features and the amount of vegetation on lands for livestock production (include e.g. drainage of organic soils or productivity and quality of grass vegetation improvement).

As regard of the activity RV, as stated in individual GHG inventories, Iceland includes the activity of increasing carbon stocks on eroding or eroded/desertified sites through the establishment of vegetation or the restoration of existing vegetation that covers a minimum area of 0.5 hectares and does not meet the definitions of afforestation or reforestation. It includes also, activities related to emissions of GHG and/or decreases in carbon stocks on sites which have been categorized as revegetation areas and do not meet the definition of deforestation. For Romania this activity corresponds with plantation of trees on non-forest lands and can be associated with forest belts.

The area under CM corresponds, in overall, to the area reported under Cropland minus the cropland area originated from forest conversion since 1990, while GM areas may likely not correspond to Grassland since usually not the entire area of grassland within a country is managed for grazing.

Activity data for CM and GM in the base year, and all the years of the CP, are compiled from remote sensed products, or NFIs grids, coupled with any available ancillary data. Agriculture census, national statistics, cadaster data, result-based payments information, and some European initiatives (e.g. LPIS) have also a significant role on data acquisition.

Concerning RV, Iceland uses national registry to collect the area subject to this activity, while in Romania activity data is available either as number of planted trees or km of tree lines or ha as recorded in statistical reports.

Wetland drainage and rewetting is covered in this inventory as it is reported by UK. The area of this activity in the UK refers to the area of active peat extraction, areas of rewetted former peat extraction and areas that were known to have been rewetted by 1990. Areas of drained WDR land may transition to rewetted WDR land but there is no change in the total area of WDR land across the time series. Areas of drained and rewetted soils are also reported under the other KP-LULUCF activities, following the hierarchy that is requested by the IPCC guidelines for reporting the KP activities.

11.6 Other information

11.6.1 Key category analysis for Article 3(3) activities and any elected Article 3(4) activity

Countries apply mainly quantitative criteria for the assessment of key categories among KP-LULUCF activities (see Table 11.4), based on the correspondence between KP activities and land categories in the Convention. When elected CM,GM, RV and WDR, as well as FM, AR, and D are key categories in most of the cases. Further information regarding KC analysis can be found in section 11.1.4.

11.6.2 Information related to Article 6

With the exception of Romania, all other countries do not report information on JI projects.

In the case of Romania, the Party informs in its NIR that is implementing an AR activity project as a Joint Implementation project within the framework of the flexible mechanism under Article 3.3 of the Kyoto Protocol. The project lasted from 2002 to 2017. The emission reduction transaction is subject to a commercial contract between RNP Romsilva (Romania) and Carbon Prototype Fund (managed by the World Bank). Calculation of the emissions reduction is based on the partner's agreed monitoring plan, while emission reduction/removals amount is subject to independent verification. The first verification was performed in 2007 and the second in 2014 (overlapping on pre-CP1 and CP1 (under JI Track II scheme. Following internationally agreed procedures, CO_2 removals from the JI project activities will be further allocated to third parties (project partners). Project methodology provides net removals and associated non- CO_2 emissions pre-2008, 2008-2012, and 2014-2017 time period.

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 Background information

The standard electronic format (SEF) for providing information on ERUs, CERs, tCERs, lCERs, AAUs and RMUs for the year 2021 for the EU[69] registry is submitted together with this report (Annex 1.13). The data in the EU registry reflect only the transactions to and from the EU registry, but not the sum of all Member States' transactions. Member States separately submit information on Kyoto units in SEF tables to the UNFCCC.

12.2 Summary of information reported in the SEF tables for the EU registry

The standard electronic format tables for the EU are included in the submission. The SEF reporting software has been used for this purpose. The tables include information on the AAU, ERU, CER, t-CER, l-CER and RMU in the Union registry at 31.12.2021 as well as information on transfers of the units in 2021 to and from other Parties of the Kyoto Protocol.

The United Kingdom has left the EU on 1 February 2020, but continues to implement the Kyoto Protocol and relevant EU law in accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community[70].

The joint assigned amount of the EU, its Member States, United Kingdom, and Iceland for the second commitment period of the Kyoto Protocol is equal to the percentage inscribed for the Union, its Member States, United Kingdom and Iceland in the third column of Annex B to the Kyoto Protocol as replaced by the Doha Amendment (80 %) of its base year emissions multiplied by eight. Council Decision (EU) 2015/1339 sets out the terms of the joint fulfilment agreement as well as the respective emission levels of each Party to that agreement. The Agreement between the EU, its Member States and Iceland, concerning Iceland's participation in the joint fulfilment of commitments by the EU, its Member States and Iceland for the second commitment period of the Kyoto Protocol sets out the terms governing Iceland's participation.[71] The emission levels define the Member States', the United Kingdom's and Iceland's assigned amounts for the second commitment period. These emission levels have been determined on the basis of the existing Union legislation for the period 2013-2020 under the 'Climate and Energy package'[72]. This assigned amount of the EU is determined in line with the terms of the joint fulfilment agreement, as described in the EU's initial report[73] and was established

[69] The Community registry was replaced by the Union registry in 2012

[70] Adopted by Council Decision (2019/C 384 I/01) (OJ C 384, 12.11.2019, p. 1), Art 96 (5): "Article 5 of Commission Regulation (EU) No 389/2013 shall apply to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol."

[71] OJ L 207, 4.8.2015, p. 17

[72] Directive 2009/29/EC of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community and Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, OJ L 140, 5.6. 2009.

[73] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016SC0316&from=en

upon the completion of the initial review[74]. The joint assigned amount as established upon completion of the initial review is 37 604 433 280 t CO_2 eq; the EU assigned amount is 15 813 089 338 t CO_2 eq.

12.3 Summary of information reported in the CP2 SEF tables of the EU registry.

SEF tables for the EU registry are provided in Annex 1.13. Table 12.1 provides an overview of transactions included in Table 2(b) in the EU registry.

Table 12.1 Transactions included in Table 2(b) in the EU registry.

		Additions						Subtractions					
		Unit type						Unit type					
		AAUs	ERUs	RMUs	CERs	tCERs	ICERs	AAUs	ERUs	RMUs	CERs	tCERs	ICERs
	Total transfers and acquisitions												
1	CH	NO	NO	NO	663.306	NO	NO	NO	NO	NO	4.508.214	NO	NO
2	IE	NO	NO	NO	NO	NO	NO	NO	NO	NO	780.716	NO	NO
3	AU	NO	NO	NO	2.483.802	NO	NO	NO	NO	NO	676.962	NO	NO
4	CZ	NO	NO	NO	46.210	NO	NO	NO	NO	NO	2.638	NO	NO
5	SE	NO	NO	NO	68.871	NO	NO	NO	NO	NO	16.550	NO	NO
6	GB	NO	NO	NO	NO	NO	NO	NO	NO	NO	500.381	NO	NO
7	AT	NO	NO	NO	3.099.190	NO	NO	NO	NO	NO	7.075	NO	NO
8	LV	NO	NO	NO	7.167	NO	NO	NO	NO	NO	7.167	NO	NO
9	DE	NO	NO	NO	1.546.023	NO	NO	NO	NO	NO	3.473.439	NO	NO
10	MC	NO	NO	NO	NO	NO	NO	NO	NO	NO	7.382	NO	NO
11	NO	NO	NO	NO	180.013	NO	NO	NO	NO	NO	71.037	NO	NO
12	IT	NO	NO	NO	39.029	NO	NO	NO	NO	NO	NO	NO	NO
13	ES	NO	NO	NO	22.780	NO	NO	NO	NO	NO	78.876	NO	NO
14	DK	NO	NO	NO	102.367	NO	NO	NO	NO	NO	42.367	NO	NO
15	NL	NO	NO	NO	4.919.584	NO	NO	NO	NO	NO	590.890	NO	NO
16	SI	NO	NO	NO	NO	NO	NO	NO	NO	NO	2.725.348	NO	NO
17	CDM	NO	NO	NO	12.281	NO	NO	NO	NO	NO	NO	NO	NO
18	FI	NO	NO	NO	86.456	NO	NO	NO	NO	NO	NO	NO	NO
19	FR	NO	NO	NO	9.136	NO	NO	NO	NO	NO	193.984	NO	NO
20	RO	NO	NO	NO	NO	NO	NO	NO	NO	NO	297	NO	NO
21	LU	NO	NO	NO	NO	NO	NO	NO	NO	NO	11.620	NO	NO
	Sub-total	NO	NO	NO	13.286.215	NO	NO	NO	NO	NO	13.694.943	NO	NO

12.4 Discrepancies and notifications

With respect to the respective paragraphs of decision 15/CMP.1 the following information is provided for the EU registry:

- **Paragraph 12:** No discrepancies identified by the transaction log.
- **Paragraph 13**: No notifications directed to the Party to replace ICERs in accordance with Paragraph 49 of the annex to decision 5/CMP.1.
- **Paragraph 14:** No notifications directed to the Party to replace ICERs in accordance with para 50 of the annex to decision 5/CMP.1.
- **Paragraph 15:** No issue of non-replacement.
- **Paragraph 16**: No KP Units that are not valid.
- **Paragraph 17:** No actions were necessary to correct any problem causing a discrepancy.

[74] Report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of the European Union - FCCC/IRR/2016/EU - GE.18-07661(E)

12.5 Publicly accessible information

The information based on the requirements in the annex to decision 13/CMP is publicly available on the European Commission website:

https://ets-registry.webgate.ec.europa.eu/euregistry/EU/public/reports/publicReports.xhtml

Article 6 project information

No ERUs have been issued in the EU Registry in 2013

No ERUs have been issued in the EU Registry in 2014

No ERUs have been issued in the EU Registry in 2015

No ERUs have been issued in the EU Registry in 2016

No ERUs have been issued in the EU Registry in 2017

No ERUs have been issued in the EU Registry in 2018

No ERUs have been issued in the EU Registry in 2019

No ERUs have been issued in the EU Registry in 2020

No ERUs have been issued in the EU Registry in 2021

The total quantity of ERUs, CERs, AAUs and RMUs in each account at the beginning of the year

This information is confidential.

The total quantity of AAUs issued on the basis of the assigned amount pursuant to Article 3, paragraphs 7 and 8

No AAUs have been issued in the EU Registry in 2013

No AAUs have been issued in the EU Registry in 2014

No AAUs have been issued in the EU Registry in 2015

No AAUs have been issued in the EU Registry in 2016

No AAUs have been issued in the EU Registry in 2017

No AAUs have been issued in the EU Registry in 2018

No AAUs have been issued in the EU Registry in 2019

No AAUs have been issued in the EU Registry in 2020

15.813.089.338 AAUs have been issued in the EU Registry in 2021

The total quantity of ERUs issued on the basis of Article 6 projects

No ERUs have been issued in the EU Registry in 2013

No ERUs have been issued in the EU Registry in 2014

No ERUs have been issued in the EU Registry in 2015

No ERUs have been issued in the EU Registry in 2016

No ERUs have been issued in the EU Registry in 2017

No ERUs have been issued in the EU Registry in 2018

No ERUs have been issued in the EU Registry in 2019

No ERUs have been issued in the EU Registry in 2020

No ERUs have been issued in the EU Registry in 2021

The total quantity of ERUs, CERs, AAUs and RMUs acquired from other registries.

YEAR	Registry	AAU	ERU	RMU	CER
2013	GB	0	0	0	29.448
2013	CH	0	0	0	172.337
2014	AT	0	0	0	1
2014	FR	0	0	0	165.465
2014	DK	0	0	0	3.142
2014	DE	0	0	0	39.320
2014	SE	0	0	0	122.180
2014	GB	0	0	0	2.256.786
2014	AU	0	0	0	120.870
2014	NO	0	0	0	167.074
2014	CH	0	0	0	1.790.323
2014	NL	0	0	0	575.673
2014	IT	0	0	0	168.671
2014	ES	0	0	0	60.966
2014	CDM	0	0	0	14.921
2015	CDM	0	0	0	136.554
2015	FR	0	0	0	1.071.564
2015	SE	0	0	0	2.091.044
2015	DK	0	0	0	45.156

YEAR	Registry	AAU	ERU	RMU	CER
2015	NO	0	0	0	753.110
2015	DE	0	0	0	5.336.978
2015	GB	0	0	0	12.377.526
2015	NL	0	0	0	9.557.045
2015	AU	0	0	0	1.799.631
2015	ES	0	0	0	997.749
2015	BE	0	0	0	130.368
2015	CH	0	0	0	9.203.722
2015	PT	0	0	0	935.000
2015	IT	0	0	0	1.836.849
2015	FI	0	0	0	52.378
2016	AT	0	0	0	75.396
2016	AU	0	0	0	386.987
2016	BE	0	0	0	239.290
2016	CDM	0	0	0	6.620
2016	CH	0	0	0	6.066.604
2016	DE	0	0	0	1.402.960
2016	DK	0	0	0	634.856
2016	ES	0	0	0	229.375
2016	FI	0	0	0	294.692
2016	FR	0	0	0	1.314.645
2016	GB	0	0	0	13.163.692
2016	IT	0	0	0	154.464
2016	NL	0	0	0	9.551.267
2016	NO	0	0	0	11.392
2016	PT	0	0	0	3.403.623
2016	SE	0	0	0	5.101.906
2017	AT	0	0	0	458.832
2017	SE	0	0	0	1.638.914
2017	DK	0	0	0	16.155
2017	DE	0	0	0	953.892
2017	GB	0	0	0	4.014.277
2017	NO	0	0	0	12.166
2017	ES	0	0	0	241.452
2017	AU	0	0	0	943.312
2017	HU	0	0	0	9.647
2017	PT	0	0	0	167
2017	CH	0	0	0	10.435.307
2017	BE	0	0	0	217.165
2017	IE	0	0	0	115.965
2017	LU	0	0	0	314.417
2017	NL	0	0	0	17.607.672

YEAR	Registry	AAU	ERU	RMU	CER
2017	CDM	0	0	0	4.991
2017	IT	0	0	0	323.106
2017	FI	0	0	0	346.506
2018	ES	0	0	0	22.316
2018	GB	0	0	0	5.775.293
2018	DE	0	0	0	3.805.830
2018	CH	0	0	0	8.469.849
2018	SE	0	0	0	2.465.927
2018	NL	0	0	0	8.531.061
2018	NO	0	0	0	121.637
2018	FI	0	0	0	58.031
2018	IT	0	0	0	4.789
2018	AU	0	0	0	975.901
2018	DK	0	0	0	2.559
2018	BE	0	0	0	107.616
2019	AT	0	0	0	531
2019	AU	0	0	0	722.419
2019	BE	0	0	0	1.523
2019	CDM	0	0	0	515
2019	CH	0	0	0	3.768.871
2019	DE	0	0	0	4.899.665
2019	DK	0	0	0	1.199
2019	ES	0	0	0	365.442
2019	FI	0	0	0	334.701
2019	GB	0	0	0	437.845
2019	IT	0	0	0	12.401
2019	NL	0	0	0	12.730.228
2019	NO	0	0	0	277.593
2019	SE	0	0	0	1.420.654
2020	AU	0	0	0	3.415.163
2020	BE	0	0	0	4.987
2020	CDM	0	0	0	1.202.550
2020	CH	0	0	0	9.397.725
2020	CZ	0	0	0	2.902
2020	DE	0	0	0	12.337.359
2020	DK	0	0	0	3.575.000
2020	ES	0	0	0	24.795
2020	FI	0	0	0	814.579
2020	FR	0	0	0	292
2020	GB	0	0	0	2.380.163
2020	HU	0	0	0	14.000
2020	IT	0	0	0	223.431

YEAR	Registry	AAU	ERU	RMU	CER
2020	NL	0	0	0	17.187.347
2020	NO	0	0	0	99.233
2020	SE	0	0	0	292.369
2021	CH	0	0	0	663.306
2021	AU	0	0	0	2.483.802
2021	CZ	0	0	0	46.210
2021	SE	0	0	0	68.871
2021	AT	0	0	0	3.099.190
2021	LV	0	0	0	7.167
2021	DE	0	0	0	1.546.023
2021	NO	0	0	0	180.013
2021	IT	0	0	0	39.029
2021	ES	0	0	0	22.780
2021	DK	0	0	0	102.367
2021	NL	0	0	0	4.919.584
2021	CDM	0	0	0	12.281
2021	FI	0	0	0	86.456
2021	FR	0	0	0	9.136
TOTAL		**0**	**0**	**0**	**251.276.069**

The total quantity of RMUs issued on the basis of each activity under Article 3, paragraphs 3 and 4

No RMUs have been issued in the Union registry in 2013

No RMUs have been issued in the Union registry in 2014

No RMUs have been issued in the Union registry in 2015

No RMUs have been issued in the Union registry in 2016

No RMUs have been issued in the Union registry in 2017

No RMUs have been issued in the Union registry in 2018

No RMUs have been issued in the Union registry in 2019

No RMUs have been issued in the Union registry in 2020

No RMUs have been issued in the Union registry in 2021

The total quantity of ERUs, CERs, AAUs and RMUs transferred to other registries.

YEAR	Registry	AAU	ERU	RMU	CER
2014	GB	0	0	0	135.000
2014	CH	0	0	0	1.397.541
2015	FR	0	0	0	106.092

YEAR	Registry	AAU	ERU	RMU	CER
2015	SE	0	0	0	12.246
2015	DK	0	0	0	548.202
2015	NO	0	0	0	40.385
2015	DE	0	0	0	514.092
2015	GB	0	0	0	675.749
2015	NL	0	0	0	261.062
2015	AU	0	0	0	1.394.059
2015	ES	0	0	0	1.350
2015	BE	0	0	0	5.465
2015	CH	0	0	0	5.696.488
2015	IT	0	0	0	1
2015	FI	0	0	0	31.924
2016	AT	0	0	0	37.698
2016	AU	0	0	0	3.573.312
2016	BE	0	0	0	7.554
2016	CH	0	0	0	9.703.077
2016	DE	0	0	0	218.209
2016	ES	0	0	0	20.000
2016	FR	0	0	0	300
2016	GB	0	0	0	2.061.256
2016	NL	0	0	0	648.580
2016	NO	0	0	0	49.879
2016	PT	0	0	0	510
2016	SE	0	0	0	3.992
2017	AT	0	0	0	11.139
2017	SE	0	0	0	113.284
2017	DK	0	0	0	1.092
2017	LI	0	0	0	14.775
2017	DE	0	0	0	554.336
2017	GB	0	0	0	683.071
2017	NO	0	0	0	94.570
2017	ES	0	0	0	104.878
2017	AU	0	0	0	5.070.826
2017	HU	0	0	0	9.647
2017	CH	0	0	0	7.382.252
2017	IE	0	0	0	115.965
2017	LU	0	0	0	314.417
2017	NL	0	0	0	408.076
2017	FR	0	0	0	127.000
2017	FI	0	0	0	81.549
2018	ES	0	0	0	174.349
2018	GB	0	0	0	405.983

YEAR	Registry	AAU	ERU	RMU	CER
2018	DE	0	0	0	283.839
2018	LI	0	0	0	28.938
2018	CH	0	0	0	4.113.163
2018	SE	0	0	0	162.030
2018	NL	0	0	0	256.230
2018	NO	0	0	0	109.909
2018	FI	0	0	0	90.271
2018	IT	0	0	0	105.000
2018	AU	0	0	0	1.458.014
2018	DK	0	0	0	952
2018	FR	0	0	0	336.000
2019	AU	0	0	0	1.092.080
2019	CH	0	0	0	3.696.943
2019	DE	0	0	0	386.230
2019	DK	0	0	0	299
2019	ES	0	0	0	136.345
2019	FI	0	0	0	111.721
2019	GB	0	0	0	700.153
2019	IT	0	0	0	95.000
2019	NL	0	0	0	296.710
2019	NO	0	0	0	261.018
2019	SE	0	0	0	101.145
2019	FR	0	0	0	111.895
2019	IE	0	0	0	400.576
2019	LI	0	0	0	53.463
2020	AU	0	0	0	2.503.778
2020	BE	0	0	0	987.314
2020	CH	0	0	0	8.568.746
2020	DE	0	0	0	352.177
2020	DK	0	0	0	500.000
2020	ES	0	0	0	143.274
2020	FI	0	0	0	87.857
2020	FR	0	0	0	1.007.298
2020	GB	0	0	0	3.365.531
2020	HU	0	0	0	14.000
2020	IT	0	0	0	40.665
2020	NL	0	0	0	1.277.395
2020	NO	0	0	0	180.219
2020	SE	0	0	0	50.078
2020	IE	0	0	0	1.117.466
2021	CH	0	0	0	4.508.214
2021	IE	0	0	0	780.716

YEAR	Registry	AAU	ERU	RMU	CER
2021	AU	0	0	0	676.962
2021	CZ	0	0	0	2.638
2021	SE	0	0	0	16.550
2021	GB	0	0	0	500.381
2021	AT	0	0	0	7.075
2021	LV	0	0	0	7.167
2021	DE	0	0	0	3.473.439
2021	MC	0	0	0	7.382
2021	NO	0	0	0	71.037
2021	ES	0	0	0	78.876
2021	DK	0	0	0	42.367
2021	NL	0	0	0	590.890
2021	SI	0	0	0	2.725.348
2021	FR	0	0	0	193.984
2021	RO	0	0	0	297
2021	LU	0	0	0	11.620
TOTAL		**0**	**0**	**0**	**91.089.897**

The total quantity of ERUs, CERs, AAUs and RMUs cancelled on the basis of activities under Article 3, paragraphs 3 and 4

YEAR	AAU	ERU	RMU	CER
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**

The total quantity of ERUs, CERs, AAUs and RMUs cancelled following determination by the Compliance Committee that the Party is not in compliance with its commitment under Article 3, paragraph 1

YEAR	AAU	ERU	RMU	CER
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0

YEAR	AAU	ERU	RMU	CER
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**

The total quantity of other ERUs, CERs, AAUs and RMUs cancelled

YEAR	AAU	ERU	RMU	CER
2013	0	0	0	0
2014	0	0	0	1.892
2015	0	0	0	487.961
2016	0	0	0	877.355
2017	0	0	0	3.433.767
2018	0	0	0	4.115.756
2019	0	0	0	4.520.677
2020	0	0	0	5.409.430
2021	0	0	0	2.864.549
TOTAL	**0**	**0**	**0**	**21.711.387**

The total quantity of ERUs, CERs, AAUs and RMUs retired

YEAR	AAU	ERU	RMU	CER
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	0	0	0	0
2020	0	0	0	0
2021	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**

12.6 Calculation of commitment period reserve (CPR)

For the purposes of the joint fulfilment, the commitment period reserve applies to the EU, its Member States and Iceland individually. The EU commitment period reserve, established upon the completion of the initial review[75], is 14 231 780 406 t CO_2 eq.

12.7 KP-LULUCF accounting

Each EU Member State and Iceland apply Article 3(3) and (4) of the Kyoto Protocol and decisions agreed thereunder individually. Member States account individually for emissions by sources and removals by sinks from Kyoto LULUCF activities and individually decide on accounting modalities and elections where foreseen under the Kyoto Protocol. Any issuance of removal units (RMUs) or cancellation of units resulting from the accounting under Articles 3(3) and (4) would be made to the Member States' and Iceland's Kyoto registries. The EU will report the sum of Member States' cumulative accounting quantities for these activities at the end of the commitment period, representing the Member States' cumulative additions to or subtractions from their assigned amount at the end of the commitment period.

The United Kingdom has left the EU on 1 February 2020, but continues to implement the Kyoto Protocol and relevant EU law in accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community[76].

[75] Report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of the European Union - FCCC/IRR/2016/EU - GE.18-07661(E)

[76] Adopted by Council Decision (2019/C 384 I/01) (OJ C 384, 12.11.2019, p. 1), Art 96 (5): "Article 5 of Commission Regulation (EU) No 389/2013 shall apply to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol."

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

The European Union (EU) already had a quantified emission limitation and reduction target in the first commitment period and provided a description of its national system in the report to calculate the assigned amount of the first commitment period. Subsequently, any changes that occurred to the EU national system were reported as part of the annual supplementary information under Article 7 of the Kyoto Protocol and included in the national inventory report.

There are no changes compared to the 2021 inventory submission related to the national system, as the United Kingdom, which left the EU on 1 February 2020, continues to implement the Kyoto Protocol and relevant EU law in accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community[77].

As mentioned in the 2018 inventory submission of the EU under the Kyoto Protocol, the Kyoto greenhouse inventory for the second commitment period follows the terms of the joint fulfilment agreement for the second commitment period. This included, until 31 January 2020, 28 Member States[78] and Iceland, and includes 27 Member States and United Kingdom and Iceland thereafter.

The institutions, which were part of the EU inventory system and responsible for the EU inventory preparation during the first commitment period, remain the same in the second commitment period. The Directorate-General (DG) for Climate Action of the European Commission has overall responsibility for the inventory of the EU while each Member State is responsible for the preparation of its own inventory which is the basic input for the inventory of the EU. DG Climate Action is supported in the establishment of the inventory by the following main institutions: the European Environment Agency (EEA) and its European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/CME) as well as other DGs of the European Commission: Eurostat, and the Joint Research Centre (JRC).

[77] Adopted by Council Decision (2019/C 384 I/01) (OJ C 384, 12.11.2019, p. 1), Art 96 (5): "Article 5 of Commission Regulation (EU) No 389/2013 shall apply to the United Kingdom until the closure of the second commitment period of the Kyoto Protocol."

[78] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of EU have occurred in 2021. Note that the 2021 SIAR confirms that previous recommendations have been implemented and included in the annual report.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	There was a change in the cooperation arrangement during the reported period as the United Kingdom of Great Britain and Northern Ireland no longer operate their registry in a consolidated manner within the Consolidated System of EU registries, CS EUR.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There has been 6 new EUCR releases (versions 12.4, 13.0.2, 13.2.1, 13.3.3 , 13.5.1 and 13.5.2) after version 11.5 (the production version at the time of the last Chapter 14 submission). No changes were applied to the database, whose model is provided in Annex A. No change was required to the application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The changes that have been introduced with versions 12.4, 13.0.2, 13.2.1, 13.3.3, 13.5.1 and 13.5.2 compared with version 11.5 of the national registry are presented in Annex B. It is to be noted that each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and are carried out prior to the relevant major release of the version to Production (see Annex B). No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No changes regarding security were introduced.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change to the registry internet address during the reported period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	No change during the reported period.

15 INFORMATION ON MINIMIZING ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

15.1 Information on how the EU is striving, under Article 3, paragraph 14, of the Kyoto Protocol, to implement the commitments mentioned in Article 3, paragraph 1, of the Kyoto Protocol in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention

Editorial comment: The EU is only required to report changes related to the information on minimizing adverse impacts in accordance with Article 3, paragraph 14. However, for an improved understanding, most of the text from the last year's inventory report was included and additional or new information is marked in bold.

In this section the EU provides information on how it is implementing its commitment under Article 3, paragraph 14 of the Kyoto Protocol, i.e. how it is striving to implement its emission reduction commitment under Article 3, paragraph 1 of the Kyoto Protocol in such a way as to minimize potential adverse social, environmental and economic impacts on developing countries. In order to strive for such a minimization, an assessment of potential positive and negative impacts – both of direct and indirect nature – is necessary with a double objective to maximize positive impacts and to minimize adverse impacts. The EU is well aware of the need to assess impacts and has built up thorough procedures in line with our obligations. This includes bilateral dialogues and different platforms in which we interact with third countries, explain new policy initiatives and receive comments from third countries.

Impacts on third countries are mostly indirect and can frequently neither be directly attributed to a specific EU policy, nor directly measured by the EU in developing countries. Therefore, the reported information covers potential adverse social, environmental and economic impacts that result from complex assessments of effects and that are based on accessible data sources in developing countries.

Impact assessment of EU policies

In the EU a wide-ranging impact assessment system accompanying all new policy initiatives has been established. This regulatory impact assessment is a key element in the development of the European Commission's legislative proposals. The Commission is required to take the impact assessment reports into account when taking its decisions, while the impact assessments are also presented and discussed during the scrutiny of legislative proposals by the Council and the Parliament. This approach ensures that potential adverse social, environmental and economic impacts are identified and minimized within the legislative process. In general, impact assessments are required for all legislative proposals, but also for other important Commission initiatives which are likely to have far-reaching impacts. Below the impact assessment process implemented in the EU policy making is explained in more detail in order to better demonstrate how the EU is striving for all strategies and policies to minimize their adverse impacts. This process is governed by the so-called "Better Regulation Guidelines"[79].

Assessing systematically the likely effects of different policy initiatives on developing countries is a requirement based on Article 208(1) TFEU (Treaty on the Functioning of the European Union), which stipulates that the EU "shall take account of the objectives of development co-operation in the policies that it implements which are likely to affect developing countries". This constitutes the legal basis of a concept generally known as "Policy Coherence for Development" (PCD). Practically, the application of the PCD principle means recognizing that some EU policy measures can have a significant impact outside of the EU which may contribute to or undermine the Union's policy objectives concerning development. Through PCD, the EU seeks to take account of development objectives in all of its policies that are likely to affect developing countries, by minimising contradictions and building synergies between different EU policies to benefit developing countries and by increasing the effectiveness of development cooperation. Measures regarding climate change mitigation and affecting adaptation needs in developing countries have been identified as "measures known to have impacts on developing countries". The assessment of impacts on developing countries includes economic, social and environmental impacts.

Related to economic impacts the following guiding questions have to be assessed[80]:

- Who are the developing countries producing (and exporting to the EU) the goods/services affected? Are these least developed countries?
- What is the impact on proportion (especially in value) of the trade between these developing countries and the EU, in particular regarding the trade balance of developing countries?
- What is the likely impact on price volatility?
- What are the impacts on proportion between the purchase of raw materials and finished products from developing countries?
- What is the impact on the competitiveness of exporters in developing countries in terms of intended or unintended trade barriers?
- What are the impacts of the initiative on intellectual property rights, standards, and technology and business skills in developing countries and on their capacity to trade their goods (towards the EU or between themselves)?
- What is the impact on food security for local population (e.g. by impacting on price of commodities or food on world and regional/local markets or by limiting access to land, water or other assets)?
- What is the impact on different population groups (urban vs. rural, small vs. large scale farmers)?
- What are the impacts on international and domestic investment flows (outflows and inflows including foreign direct investment) in the developing countries?
- What are the impacts on the private sector in developing countries (including competitiveness, access to finance, access to market)?

Related to social impacts the following guiding questions have to be assessed:

- What are the impacts on labour market (e.g. creation of job or decrease in employment level, impacts on different groups of the workforce – low-skilled vs. high skilled workforce, wages level, working conditions)?
- What are the impacts on main stakeholders and institutions affected by the proposal?

[79] http://ec.europa.eu/smart-regulation/guidelines/toc_guide_en.htm

[80] Better regulation toolbox (page 266), http://ec.europa.eu/smart-regulation/guidelines/docs/br_toolbox_en.pdf

- What is the impact on poverty levels and inequality in developing countries?
- What are the impacts on gender equality and on the most vulnerable groups of society?
- What is the impact on human rights in the development countries?
- What is the impact on migration in developing countries (rural-urban or international)?
- What is the impact on food security for the local population (e.g. by impacting on price of commodities or food on world and regional/local markets or by limiting access to land, water or other assets)?
- What is the impact on different population groups (urban vs. rural, small vs. large scale farmers)?

Related to environmental impacts the following guiding questions have to be assessed:

- How does it impact ecosystems?
- What is the impact on emission targets in developing countries?
- What is the impact on chemicals authorisation as well as on use and waste management?
- What is the impact on green economy development, both globally and in partner countries?
- What is the impact on low carbon technology transfer and its availability in developing countries?
- What is the impact on biodiversity (mono-cropping, deforestation) and global or local food security?
- What is the impact on the management and use of natural resources, e.g. minerals, timber, water, land, etc.?
- Are these options consistent with our support (under development cooperation policy) to responsible approaches to natural resources management such as the Action plan on Forest Law enforcement, Governance and Trade (FLEGT)[81], the Extractive Industries Transparency Initiative (EITI)[82] or the Kimberley agreement[83]?

Depending on the case, a comprehensive literature review is conducted, while in some cases a detailed, substantial and quantified analysis including detailed quantitative data to establish the causal link between the policy option and its impacts is carried out. A range of analytical approaches can be used for this purpose, such as econometric analysis or computable general equilibrium (CGE) models.

Consulting interested parties is an obligation for every impact assessment and all affected stakeholders should be engaged. Each consultation includes a 12-week internet-based public consultation and can be complemented by other approaches and tools. Existing international policy dialogues are also used to keep third countries fully informed of forthcoming initiatives, and as a means of exchanging information, data and results of preparatory studies with partner countries and other external stakeholders.

The EU's Fourth Biennial Report[84] provides a detailed overview of the European policies and measures to mitigate GHG emissions in all sectors. All key strategies and climate policies have been subject to impact assessments as described above. All impact assessments and all opinions of the Impact Assessment Board are published online[85]. In addition to the general approach described above to

[81] The Action Plan on Forest Law Enforcement, Governance and Trade (FLEGT) is the European Union response to illegal logging that was adopted in 2003. http://ec.europa.eu/environment/forests/illegal_logging.htm

[82] The Extractive Industries Transparency Initiative (EITI) provides a global standard to promote the open and accountable management of oil, gas and mineral resources. https://eiti.org/who-we-are

[83] The Kimberley Process (KP) is a joint government, industry and civil society initiative to stem the flow of conflict diamonds – rough diamonds used by rebel movements to finance wars against legitimate governments. http://www.kimberleyprocess.com/

[84] https://unfccc.int/documents/228427

[85] http://ec.europa.eu/transparency/regdoc/?language=en

address adverse social, environmental and economic impacts, more specific ways to minimize impacts depend on the respective policies and measures implemented. As the reporting obligation related to Article 3, paragraph 14 in the UNFCCC reporting guidelines for GHG inventories does not include an obligation to report on each specific mitigation policy, the EU chooses the approach to provide some specific examples to illustrate how the EU is striving to minimize adverse impacts.

Major EU policies such as the directives on the promotion of the use of energy from renewable sources are presented in more detail as examples in this chapter, because the related impact assessments identified potential impacts on third countries.

Directives on the promotion of the use of renewable energy

The Directive 2009/28/EC on the promotion of the use of energy from renewable sources (the "Renewable Energy Directive") set ambitious targets for all Member States, such that the EU will reach a 20% share of energy from renewable sources in the overall energy consumption by 2020 (with individual targets for each Member State) and a 10% share of renewable energy specifically in the transport sector, which includes liquid biofuels, biogas, hydrogen and electricity from renewables. The impact assessments related to enhanced biofuel and biomass use in the EU showed that the cultivation of energy crops have both potential positive and negative impacts. To address the risk of potentially negative impacts, Article 17 of the Renewable Energy Directive created pioneering "sustainability criteria", applicable to all biofuels (biomass used in the transport sector) and bioliquids. These sustainability criteria included:

- Establishment of a threshold for GHG emission reductions that have to be achieved from the use of biofuels;
- exclusion of the use of biofuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly biodiverse grasslands),
- exclusion of the use of biofuels from land with high carbon stocks, such as wetlands, peatlands or continuously forested areas.

Developing country representatives as well as other stakeholder were extensively consulted during the development of the sustainability criteria and preparation of the directive and the extensive consultation process has been documented.

A directive amending the legislation on biofuels through the Renewable Energy and the Fuel Quality Directives was adopted in 2015 (Directive (EU) 2015/1513) with the objectives:

- To increase the minimum greenhouse gas saving threshold for new installations to 60% in order to improve the efficiency of biofuel production processes as well as discouraging further investments in installations with low greenhouse gas performance.
- To include indirect land use change (ILUC) factors in the reporting by fuel suppliers and Member States of greenhouse gas savings of biofuels and bioliquids;
- To limit the amount of food crop-based biofuels and bioliquids that can be counted towards the EU's 10% target for renewable energy in the transport sector by 2020, to the current consumption level, 5% up to 2020, while keeping the overall renewable energy and carbon intensity reduction targets;
- To provide additional market incentives to the existing ones for biofuels with no or low indirect land use change emissions, and in particular the 2nd and 3rd generation biofuels produced from feedstock that do not create an additional demand for land, including algae, straw, and various types of waste, as they will contribute more towards the 10% renewable energy in transport target of the Renewable Energy Directive.

With these measures, the EU wants to promote biofuels that help achieving substantial emission cuts, do not directly compete with food and are more sustainable at the same time. While the directive does not affect the possibility for Member States to provide financial incentives for biofuels, the Commission considers that in the period after 2020 biofuels should only receive financial support if they lead to substantial greenhouse gas savings and are not produced from crops used for food and feed. The impact assessment of the directive analysed social, economic and environmental impacts on third countries in detail[86]. The directive also ensures that the Commission reports every two years, in respect to both third countries and Member States which constitute a significant source of biofuels or of raw material for biofuels consumed within the Union, on national measures taken to respect the sustainability criteria for soil, water and air protection.

In December 2018, the revised Renewable Energy Directive (EU) 2018/2001 was adopted, which set a new target, namely to achieve a share of at least 32% of energy from renewable energy sources in the EU's gross final energy consumption by 2030. In addition to biofuels and bioliquids, the directive now also covers solid biomass and biogas for heat and power. More specifically, it includes the following requirements that have to be applied to all biofuels, to biogas used in installations with a total rated thermal input equal to or exceeding 2 MW and to solid biomass with a total rated thermal input equal to or exceeding 20 MW:

- Requirements for minimum greenhouse gas emissions savings have been strengthened.
- Agriculture production within the EU is no longer interlinked with sustainability requirements under the Common Agriculture Policy, but globally applicable criteria to mitigate risks for soil quality and carbon have been added for agricultural biomass.
- A new sustainability criterion on forest biomass has been introduced, focusing on legality of harvest, forest regeneration, maintaining or improving long term productivity, protected areas, minimizing negative impacts on soil quality and biodiversity during harvest as well as LULUCF requirements

Furthermore, high indirect land use change risks biofuels like biofuels from palm oil shall not exceed the level of consumption in 2019 and shall gradually decrease to 0% (31 December 2023 until 31 December 2030).

In October 2020, the European Commission published its biennial Renewable Energy Progress Report[87] under the framework of the 2009 Renewable Energy Directive. The report includes information on the assessment of sustainability of EU biofuels. Biodiesel is the most common biofuel in the EU, and approx. 59% of the feedstock used for biodiesel consumed in the EU in 2018 was imported or produced from imported feedstock. It is estimated that 7.4 Mha of land was required for the production of crops for EU biofuel consumption in 2018. Of that amount, 3.4 Mha are located within the EU and 3.8 Mha are located in third countries. For most of the non-EU countries, it is estimated that less than 1% of their total cropland was used for the extraction of feedstock to be used in the production of biofuels produced or consumed in the EU.

The report found that in recent years, no correlation has been observed between food prices and biofuel demand. It must be noted, however, that between 2008 and 2016, growing global demand for food and feed crops was requiring the agricultural sector to constantly increase production, which was achieved by both increasing yields and by an expanding agricultural area. The report also

[86] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0296&from=EN

[87] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0952

addresses environmental impacts, including eutrophication of water bodies, water scarcity, soil erosion, soil compaction, air pollution, habitat loss and biodiversity loss. The sustainability criteria for biofuels used in the EU prevent impacts such as the conversion of land with high carbon stock and land of high biodiversity value.

The Communication from the Commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme[88] sets up a system for certifying sustainable biofuels, including those imported into the EU. It lays down rules that such schemes must adhere to if they are to be recognized by the Commission. This will ensure that the EU's requirements that biofuels deliver substantial reductions in greenhouse gas emissions and that biofuels do not result from forests, wetlands and nature protection areas are implemented.

The European Commission has so far (April 2021) recognised 14 voluntary schemes: International Sustainability and Carbon Certification (ISCC), Bonsucro EU, Round Table on Responsible Soy (RTRS EU RED), Roundtable of Sustainable Biofuels (RSB EU RED), Biomass Biofuels voluntary scheme (2BSvs), Red Tractor Farm Assurance Combinable Crops & Sugar Beet Scheme, SQC (Scottish Quality Farm Assured Combinable Crops (SQC) scheme), Red Cert, Better Biomass NTA 8080, RSPO RED (Roundtable on Sustainable Palm Oil RED), , KZR INIG System, Trade Assurance Scheme for Combinable Crops**, Universal Feed Assurance Scheme and U.S. Soybean Sustainability Assurance Protocol (SSAP)**[89].

Regulation for energy efficiency labelling

In 2017, Regulation (EU) 2017/1369 setting a framework for energy efficiency labelling was adopted. It aims at further exploiting the potential of energy efficiency especially with regard to the EU target of substantially improving energy efficiency by 2030 compared to 2005. Its implementation will contribute to a moderation of energy demand and a reduction of the energy dependency of the European Union. Based on common energy labelling within the EU customers can obtain accurate, relevant and comparable information on the energy efficiency and consumption of energy-related products wherever they are in the Union.

The Commission carried out an ex-post evaluation of the previous Energy Labelling Directive and of specific aspects of the Ecodesign Directive. Furthermore, it carried out an impact assessment accompanying the proposal for the Regulation for energy efficiency labelling[90]. The final option chosen was to improve the existing regulatory framework on energy labelling, to require labelled products to be registered in a new database, improve the legal structure by changing the current Energy Labelling Directive to a Regulation, to align it with the market surveillance regulation, and to fund EU joint market surveillance actions.

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[88] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52010XC0619%2801%29

[89] https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels/voluntary-schemes

[90] http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2015/swd_2015_0139_en.pdf

Third countries are affected, because the use of energy efficiency classes from A to G has been followed as a model in many different countries around the world and some countries have also implemented EU Ecodesign regulations[91]. They are also affected through the Agreement on Technical Barriers to Trade which is to ensure that regulations, standards, testing and certification procedures do not create unnecessary obstacles, while also providing the right to implement measures to achieve legitimate policy objectives.

The EU's Nationally Determined Contribution and the assessment of its impacts

On 17 December 2020, the EU and its Member States communicated their updated NDC. The EU and its Member States, acting jointly, are committed to a binding target of a net domestic reduction of at least 55% in greenhouse gas emissions by 2030 compared to 1990. As part of the preparation of this NDC, an impact assessment[92] was carried out, which addresses the various impacts of increasing GHG ambition in the range of 50% to 55% reductions by 2030. It found that the reduction of GHG emissions in various decarbonisation scenarios has positive impacts on air pollution and human health. The impact assessment also addressed the synergies and trade-offs of bio-energy use and land management with biodiversity, social impacts and aspects of a just transition. The EU's 2030 climate and energy framework is currently under revision, and subsequent policies will be adopted to achieve the EU's updated NDC.

15.2 Information on how the EU gives priority, in implementing the commitments under Article 3, paragraph 14, to specific actions

The EU reports activities that are related to the actions specified in the subparagraphs (a) to (f) of paragraph 24 of the reporting requirements in the Annex to decision 15/CMP.1. However, no decision was agreed that these actions form part of the commitment under Article 3, paragraph 14. For some of the actions specified in the reporting requirements, it seems rather unclear how they relate to the minimization of adverse social, environmental and economic impacts resulting from policies and measures to mitigate GHG emissions. As an example, the cooperation activities specified in subparagraph (d) help both developing and developed countries in reducing emissions from fossil fuel technologies, but they do not directly address the minimization of potential adverse impacts in developing country Parties.

For the purposes of completeness in reporting, the EU addresses all subparagraphs specified in the reporting requirements, however the main ways how the EU is striving to minimize adverse impacts are described in the previous section.

a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities

[91] https://ec.europa.eu/energy/sites/ener/files/documents/201404_ieel_third_jurisdictions.pdf

[92] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020SC0176

The actions addressed in subparagraph a) also form part of the commitment to implement policies and measures requested under Article 2, paragraph 1(a) (v) of the Kyoto Protocol, however Article 2 specifies that Annex I Parties shall "implement and/or further elaborate policies and measures in accordance with national circumstances, such as progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse gas emitting sectors that run counter to the objective of the Convention and application of market instruments." Subparagraph a) in the reporting requirements lacks such objective and therefore seems somewhat inconsistent with the commitment under Article 2. The promotion of research, demonstration projects, fiscal incentives or carbon taxes is an important instrument to advance the objectives of the Convention, e.g. the use of renewable energies. A progressive reduction of all fiscal incentives or subsidies in all GHG emitting sectors would run counter the objective of the Convention and counter the ability of the EU to meet its commitment under Article 3, paragraph 1 of the Kyoto Protocol. Therefore the EU interprets this reporting requirement in a way consistent with Article 2 paragraph 1(a)(v) that the EU should focus on the progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies that run counter the objectives of the Convention and application of market instruments.

The 2009 Review of the EU Sustainable Development Strategy assesses that *"the Commission has been mainstreaming the progressive reform of environmentally harmful subsidies into its sectoral policies"*. For instance, environmental concerns have been gradually incorporated into the EU Common Agricultural Policy, including "decoupled" direct payments which have replaced price support; environmental cross compliance; a substantial increase in budget for rural development. As part of the 2008 Common Agriculture Policy Health Check, additional part of direct aid has been shifted to climate change, renewable energy, water management, biodiversity, innovation; transparency of agricultural subsidies has improved. It is important to note that in the other areas most subsidies are within the competence of the Member States and not of the EU, within the limits established by EU state aid rules.

EU policies aim to address market imperfections and to reflect externalities. For example, the EU has made significant efforts to liberalise the internal energy market and to create a genuine internal market for energy as one of its priority objectives. The existence of a competitive internal energy market is a strategic instrument both in terms of giving European consumers a choice between different companies supplying gas and electricity at reasonable prices, but also in terms of making the market accessible for all suppliers, especially the smallest and those investing in renewable forms of energy.

With the EU Emissions Trading System, the EU uses a market instrument to implement the objective of the Convention and its commitment under Article 3, paragraph 1 of the Kyoto Protocol which aims at creating the right incentives for forward looking low carbon investment decisions by reinforcing a clear, undistorted and long-term carbon price signal.

With respect to financial support provided by the Member States to undertakings, the EU Treaty pronounces a general prohibition of "State aid". This concept encompasses a broad range of financial support measures adopted at national or sub-national level (i.e. not at EU level), and which can take various forms (subsidies, tax relieves, soft loans…). The Treaty provides for exceptions to this general prohibition. When State aid measures can contribute in an appropriate manner to the furtherance of objectives of common interest for the EU, and provided that they comply with certain strict conditions, they may be authorised by the Commission. By complementing the fundamental rules through a series of legislative acts and guidelines, the EU has established a unique system of rules under which State aid is monitored and assessed in the European Union. This legal framework is regularly reviewed to improve its efficiency. EU State aid control is an essential component of competition policy and a necessary safeguard for effective competition and free trade.

State aid reform in the EU aims to redirect aid to objectives of common interest which are related to the EU Lisbon Treaty, such as research, development and innovation, risk capital measures, training, and environmental protection. Environmental protection, and in particular, the promotion of renewable energy and the fight against climate change, is considered one of the objectives of common interest for the EU which may, under certain circumstances, justify the granting of State aid.

Specific “Community Guidelines on State aid for Environmental Protection”[93] have been established. The Guidelines foresee in particular the possibility to authorise State aid for particular environmental purposes, such as for renewable energy sources or energy saving. The European Commission published in 2014 the “Guidelines on State aid for environmental protection and energy 2014-2020” The Guidelines set out the conditions under which state aid measures for environmental protection or energy objectives may be declared compatible with the internal market. This proposal includes a list of environmental and energy measures for which state aid under certain conditions may be compatible with the EU Treaty, covering the following areas:

- Aid to energy from renewable sources
- Energy efficiency measures, including cogeneration and district heating and district cooling
- Aid for resource efficiency and in particular aid to waste management
- Aid to Carbon Capture and Storage (CCS)
- Aid in the form of reductions in or exemptions from environmental taxes and in the form of reductions in funding support for electricity from renewable sources
- Aid to energy infrastructure
- Aid for generation adequacy
- Aid in the form of tradable permit schemes
- Aid for the relocation of undertakings

In 2012, the Commission adopted guidelines on certain state aid measures in the context of the EU Emissions Trading System (EU ETS). The guidelines provide a framework under which Member States may compensate some electro-intensive industries, such as steel and aluminium producers, for part of the higher electricity costs expected to result from the application of the harmonised allocation rules to be applied in the EU ETS as from 2013. The rules, subject to state aid scrutiny, ensure that national support measures are designed in a way that preserves the EU objective of decarbonising the European economy and maintains a level playing field among competitors in the internal market. The sectors deemed eligible for compensation include producers of aluminium, copper, fertilisers, steel, paper,

[93] Official Journal No C 82, 1.4.2008, p.1

cotton, chemicals and some plastics. The Guidelines give a right, not an obligation, to provide subsidies to energy intensive industries.

Carbon leakage means that global greenhouse gas emissions increase when companies in the EU shift production outside the EU because they cannot pass on the cost increases induced by the ETS to their customers without a significant loss of market share to third country competitors. The ETS Directive (2003/87/EC as amended) required the European Commission to compile a list of sectors and sub-sectors deemed exposed to significant risk of carbon leakage. Sectors on the list receive a higher share of free allowances. The criteria and thresholds to determine whether a sector is deemed exposed to carbon leakage or not are defined in Article 10a(13-18) of the ETS Directive and focus on additional costs incurred by the ETS Directive and trade intensity. The calculations are based on official Eurostat data and data collected from Member States. According to the ETS Directive, it is possible to add further sectors to the list if they comply with the criteria stated in the Directive, but it will not be possible to remove sectors from the list until its expiration.

The revised ETS Directive 2003/87/EC (as amended in 2018) builds on the positive experience with the harmonised rules implemented since 2013, by further developing predictable, robust and fair rules for free allocation of allowances to industry during the fourth trading period (2021-2030) to address the potential risk of carbon leakage in an adequate manner. This includes:

- Revising the system of free allocation to focus on sectors at highest risk of relocating their production outside the EU.
- A considerable number of free allowances set aside for new and growing installations.
- More flexible rules to better align the amount of free allowances with production figures.
- Update of benchmarks to reflect technological advances since 2008.

Under the revised ETS Directive, several support mechanisms are established to help the industry and the power sectors meet the innovation and investment challenges of the transition to a low-carbon economy. These include two new funds:

- Innovation Fund – extending existing support for the demonstration of innovative technologies to breakthrough innovation in industry.
- Modernisation Fund – facilitating investments in modernising the power sector and wider energy systems and boosting energy efficiency in 10 lower-income Member States.

The revised ETS Directive also contains a number of new provisions to protect industry against the risk of carbon leakage and the risk of application of a cross-sectoral correction factor:

- The share of allowances to be auctioned will be 57%, with a conditional lowering of the auction share by 3% if the cross-sectoral correction factor is applied. If triggered, it will be applied consistently across the sectors.
- Revised free allocation rules will enable better alignment with the actual production levels of companies, and the benchmark values used to determine free allocation will be updated.
- The sectors at highest risk of relocating their production outside the EU will receive full free allocation. The free allocation rate for sectors less exposed to carbon leakage will amount to 30%. A gradual phase-out of that free allocation for the less exposed sectors will start after 2026, with the exception of the district heating sector.
- The new entrants' reserve will initially contain unused allowances from the current 2013-2020 period and 200 million allowances from the market stability reserve. Up to 200 million allowances will be returned to the market stability reserve if not used during the period 2021-2030.

b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies

There is no clear definition of environmentally unsound and unsafe technologies. Therefore, the EU interprets this provision in the context of the Kyoto Protocol that unsound and unsafe technologies would be those increasing GHG emissions.

The phase-out of subsidies to fossil fuel production and consumption by 2010 was one of the objectives in the Communication from the Commission "A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development (European Commission 2001)".

Council Decision 2010/787/EU on State aid to facilitate the closure of uncompetitive coal mines adopted a new coal regulation enabling Member States to grant State aid to facilitate the closure of uncompetitive mines until 2018, following the expiry of the current Coal Regulation (Council Regulation (EC) N° 1407/2002). The decision includes the following main elements:

- the possibility of continuing to grant, under certain conditions, public aid to the coal industry with a view to facilitating the closure of uncompetitive hard coal mines until December 2018;
- the modalities for the phasing-out of the aid, under which the overall amount of aid granted by a Member State must follow a downward trend, in order to prevent undesirable effects of distortion of competition in the internal market. Subsidies will have to be lowered by at least 25% until 2013, by 40% until 2015, by 60% by 2016 and by 75% by 2017;
- the obligation for Member States granting aid to provide a plan on intended measures to mitigate the environmental impact of the production of coal; and
- the possibility of allowing subsidies, until December 2027, in order to cover exceptional expenditure in connection with the closure of mines that are not related to production, such as social welfare benefits and rehabilitation of sites.

In March 2015 the European Commission's Directorate-General for Economic and Financial Affairs published an article called "Measuring Fossil Fuel Subsidies"[94] in its Economic Brief which aims to shed some light on the true magnitude and allocation of fossil fuel subsidies so as to enable comparisons between countries and regions to provide background to policy discussions.

c) Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end;

The technological development of non-energy uses of fossil fuels is not a current research priority in the EU, nor a priority of cooperation with developing countries because the EU is not a major producer of oil and gas. Given the long-term depletion of fossil fuel resources and the decline in coal production, the EU's priority in general is the replacement of the use of fossil fuels by renewable resources and the more efficient use of resources.

[94] http://ec.europa.eu/economy_finance/publications/economic_briefs/2015/pdf/eb40_en.pdf

d) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort;

The EU is cooperating with other developing and developed country Parties (Australia, Brazil, Canada, China, Czech Republic, France, Germany, Greece, India, Italy, Japan, Republic of Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Romania, Russian Federation, Saudi Arabia, Serbia, South Africa, United Arab Emirates, United Kingdom and USA) in the Carbon Sequestration Leadership Forum (CSLF)[95]. The CSLF is a Ministerial-level international climate change initiative that is focused on the development of improved cost-effective technologies for the separation and capture of carbon dioxide (CO_2) for its transport and long-term safe storage. The mission of the CSLF is to facilitate the development and deployment of such technologies via collaborative efforts that address key technical, economic, and environmental obstacles. The CSLF also aims at promoting awareness and championing legal, regulatory, financial, and institutional environments conducive to such technologies. In 2017 a Technology Roadmap was released by the Carbon Sequestration Leadership Forum. This road map indicates that CCS has been proven to work and has been implemented in the power and industrial sectors, but that a number of important challenges remain that must be addressed to achieve widespread commercial deployment of CCS. A number of meetings and workshops are held each year. At the most recent physical meeting, the 2019 technical group annual meeting of the CSLF in Chatou, France, the focus was on carbon capture, utilization, and storage (CCUS). Workshops were held on hydrogen production with CCUS and on CCUS with energy intensive industries.

e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities

In the oil and gas industry the upstream sector is a term commonly used to refer to the exploration, drilling, recovery and production of crude oil and natural gas. The downstream sector includes the activities of refining, distillation, cracking, reforming, blending storage, mixing and shipping and distribution.

The EU contributes to strengthening of the capacities of fossil fuel exporting countries in the areas of energy efficiency via the work of the Energy Expert Group of the Gulf Cooperation Council (GCC)[96], in particular in the working sub-group on energy efficiency. As part of the EU's research programme, the "EUROGULF" project analysed EU-GCC relations with respect to oil and gas issues and proposing new policy initiatives and approaches to enhance cooperation between the two regional groupings.

[95] https://www.cslforum.org/cslf/

[96] The Gulf Cooperation Council covers Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

The European Commission has started a project with the specific objective to create and facilitate the operation of an EU-GCC Clean Energy Technology Network. The network is to be set up to act as a catalyst and element of coordination for development of cooperation on clean energy. On the network's website[97] further information on its recent activities can be found. The Masdar Institute of Science and Technology in Abu Dhabi has been selected as the lead research institution to represent the Gulf Cooperation Council (GCC) in the European Union-GCC Clean Energy Network. A number of discussion groups and training seminars have taken place each year from 2013 onwards. As an essential element of the project, five Working Groups focus on areas of common interest for the stakeholders of the two regions (EU, GCC):

- Renewable Energy Sources
- Energy Demand Side Management and Energy Efficiency
- Clean Natural Gas and Related Technologies
- Electricity Interconnections and Market Integration
- Carbon Capture and Storage

Energy efficiency activities in the upstream or downstream sector are also candidates for Clean Development Mechanism (CDM) projects. Thus, the development of the CDM under the Kyoto Protocol and the demand of CERs by Annex I Parties under the Kyoto Protocol as well as by operators under the EU ETS have fostered such activities performed by the private sector. Related CDM projects are for example:

- Rang Dong Oil Field Associated Gas Recovery and Utilization Project in Vietnam: The purpose of this project activity is the recovery and utilization of gases produced as a by-product of oil production activities at the Rang Dong oil field in Vietnam with the involvement of ConocoPhillips (UK).
- Recovery of associated gas that would otherwise be flared at Kwale oil-gas processing plant in Nigeria involves the capture and utilisation of the majority of associated gas previously sent to flaring at Kwale OGPP plant. The Kwale OGPP plant receives oil with associated gas from oil fields operated by Eni Nigeria Agip Oil Company.
- Recovery and utilization of associated gas produced as by-product of oil recovery activities at the Al-Shaheen oil field in Qatar.
- Flare gas recovery and utilisation project at Uran oil and gas processing plant in India which is handling the oil and gas produced in the Mumbai High offshore oil field.
- Flare gas recovery and utilisation project at Hazira gas and condensate processing plant in India.
- Flare gas recovery and utilisation project from Kumchai oil field in India.
- Flare gas recovery and utilisation project at the Ovade-Ogharefe oil field operated by Pan Ocean Oil Corporation in Nigeria.
- Flare gas recovery and utilisation project at Soroosh and Nowrooz offshore oil fields in Iran.
- Leak reduction in aboveground gas distribution equipment in the KazTransgaz-Tbilisi gas distribution system in Georgia where leakages at gate stations, pressure regulator stations, valves, fittings as well at connection points with consumers are reduced.
- There are currently 21 Coal Mine Methane Utilization Project in China which use coalmine methane previously released to the atmosphere.

[97] http://www.eugcc-cleanergy.net

Improved energy efficiency in the energy and the transport sector in a more general way is one of the priorities in the EU's development assistance as well as for the EIB (European Investment Bank) and the EBRD (European Bank for Reconstruction and Development). The EIB has also developed other means of financing, such as equity and carbon funds, to further support renewable energy and energy-efficiency projects.

f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.

The EU actively undertakes a large number of activities aiming at reducing dependence on the consumption of fossil fuels, in particular the EU supports activities for the promotion of renewable energies and energy efficiency in developing countries, which contribute to the reduction of dependence on fossil fuels, to meeting rural electricity needs, and to the improvement of air quality. The EU support programmes include:

Africa, Caribbean and the Pacific Energy Facility

The ACP-EU Energy Facility (EF) was established in 2005 to co-finance projects on increasing access to modern and sustainable energy services for the poor in African, Caribbean and Pacific (ACP) countries, especially in rural and peri-urban areas.

Following the successful implementation of the first Energy Facility, it was decided to create a second Energy Facility, which has later been extended to include more projects than originally foreseen.

Therefore, a total of four Calls for Proposals (CfP) have been made under the EF: under the first EF (9^{th} EDF) only one CfP was launched committing EUR 196 million to supporting projects; under the second EF (10^{th} EDF), EUR 100 million was allocated to the first CfP, EUR 132 million to the second (targeting rural electrification) and EUR 15 million to the third call (targeting fragile states).

- A total of 173 projects were selected to receive support to increase access to energy in Africa, the Caribbean and the Pacific, and a total project budget of approximately EUR 800 million has been provided by the EU and other donors. Most projects of the first EF have now ended or are about to be finalized. In addition, many of the projects from the first CfP under the second EF have ended or been extended. Subsequent projects are either about to start or are being implemented.

- *Latin America Investment Facility (LAIF)*

The European Commission also established the Latin America Investment Facility (LAIF) in 2010. The primary objective of LAIF is to finance key infrastructure projects in transport, energy, social and environmental sectors as well as to support private sector development in the Latin American region, in particular small- and medium-sized enterprises (SMEs). The main purpose of the LAIF is to mobilise additional financing to support investment in Latin America, encouraging beneficiary governments and public institutions to carry out essential investment in projects and programmes that could not be otherwise financed either by the market or by development Finance Institutions alone.

As part of its efforts to achieve this objective, LAIF pursues three strategic objectives:

- Improving interconnectivity between and within Latin American countries, in particular establishing better energy and transport infrastructure, including energy efficiency, renewable energy systems and the sustainability of transport and communication networks.
- Increasing the protection of the environment and supporting climate change adaptation and mitigation actions.
- Promoting equitable and sustainable socio-economic development through the improvement of social services infrastructure and support for small- and medium-sized enterprises (SMEs).

Since 2010, 43 projects (28 bilateral and 15 multi-country) have been launched, representing a total investment cost of approximately EUR 9 billion with an EU LAIF contribution of over EUR 377 million.

Caribbean Investment Facility

Like LAIF, CIF is one of the EU's regional blending facilities, which combine EU grants with other public and private sector resources to leverage additional non-grant financing to support investments in infrastructure and to support the private sector. The main purpose of CIF is to support investments in strategic economic infrastructure and private sector development, with a focus on small and medium-sized enterprises (SMEs), as well as to contribute to measures that help Caribbean countries to adapt to and mitigate the impacts of climate change.

The main strategic objectives of CIF are:

- Strengthening investments in strategic economic infrastructure, such as renewable energy, transport, information and communication technologies, and interconnectivity.
- Increasing investments in water and sanitation, climate adaptation and sustainable social infrastructure.
- Supporting investments in SME-development, including SMEs which contribute to the green economy.

CIF resources are made available under the European Development Fund (EDF), the EU's multiannual funding instrument to support countries in the African-Caribbean-Pacific (ACP) group.

Global Energy Efficiency and Renewable Energy Fund (GEEREF)

The Global Energy Efficiency and Renewable Energy Fund (GEEREF)[98], launched in 2008, aims to accelerate the transfer, development, use and enforcement of environmentally sound technologies for the world's poorer regions, helping to bring secure, clean and affordable energy to local people. GEEREF invests in regionally-oriented investment schemes and prioritises small investments below €10 million. It particularly focuses on serving the needs of the ACP, which is a group of 79 African, Caribbean and Pacific developing countries. It also invests in Latin America, Asia and neighbouring states of the

[98] https://geeref.com/

EU (except for Candidate Countries). Priority is given to investment in countries with policies and regulatory frameworks on energy efficiency and renewable energy.

Economic Partnership Agreements

The EU through the Directorate General Development and Cooperation – EuropeAid also supports African, Caribbean and Pacific countries in diversifying their economies. These activities are not limited to fossil fuel exporting countries, but are open to ACP countries based on Economic Partnership Agreements (EPAs) [99]. EPAs help ACP countries integrate into the global economy and improve the business environment, build up regional markets and promote good economic governance through reinforced regional cooperation in trade related issues. The majority of ACP countries are either implementing an EPA or have concluded EPA negotiations with the EU.

15.3 European Neighbourhood Policy

Through its European Neighbourhood Policy (ENP), the EU works with its southern and eastern neighbours to achieve the closest possible political association and the greatest possible degree of economic integration. Energy policy and diplomacy also plays an important role in ENP especially in relation to the newly established Energy Union.

The Energy Union Communication[100] and the related European Council Conclusions of March 2015 recognised the importance of the external dimension of the Energy Union and asked for greater engagement on energy and climate diplomacy. In particular, Action Point 15 of the Energy Union Communication states:

- The EU will use all external policy instruments to ensure that a strong, united EU engages constructively with its partners and speaks with one voice on energy and climate.
- The Commission and the Member States will revitalise the EU's energy and climate diplomacy.
- The Commission will develop an active agenda to strengthen EU energy cooperation with third countries, including on renewable energy and energy efficiency.
- The Commission will make full use of the EU's external trade policy to promote access to energy resources and to foreign markets for European energy technology and services.

In July 2015, the Foreign Affairs Council adopted Council Conclusions on EU Energy Diplomacy, which included an EU Energy Diplomacy Action Plan[101]. The Action Plan has four pillars:

1. Strengthen strategic guidance through high-level engagement.
2. Establish and further develop energy cooperation and dialogues, particularly in support of diversification of sources, suppliers and routes.
3. Support efforts to enhance the global energy architecture and multilateral initiatives.
4. Strengthen common messages and energy diplomacy capacities.

[99] https://ec.europa.eu/trade/policy/countries-and-regions/development/economic-partnerships/

[100] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0080

[101] http://data.consilium.europa.eu/doc/document/ST-10995-2015-INIT/en/pdf

The EEAS (European External Action Service) works closely with the Commission and the EU Member States to ensure the follow-up of the EU Energy Diplomacy Action Plan.

The 2015 review of the EU neighbourhood policy emphasised strong support to give energy cooperation a greater place in the ENP, both as a security measure (energy sovereignty) and as a means to sustainable economic development and to support greater energy independence through support to diversification of energy sources, better cooperation on energy efficiency, and transition to the low carbon economy[102].

The International Renewable Energy Agency IRENA) supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA, founded in 2009, promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. 145 countries of the world (including the EU) are members of IRENA, 31 more are states in accession. The permanent headquarter is located in Masdar City, Abu Dhabi.

[102] https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/neighbourhood/pdf/key-documents/151118_joint-communication_review-of-the-enp_en.pdf

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17 UNITS AND ABBREVIATIONS

t	1 tonne (metric) = 1 megagram (Mg) = 10^6 g
Mg	1 megagram = 10^6 g = 1 tonne (t)
Gg	1 gigagram = 10^9 g = 1 kilotonne (kt)
Tg	1 teragram = 10^{12} g = 1 megatonne (Mt)
TJ	1 terajoule

AWMS	animal waste management systems
AD	activity data
BEF	biomass expansion factor
BKB	lignite briquettes
C	confidential
CAPRI	Common Agricultural Policy Regional Impact Assessment model (http://www.capri-model.org/)
CCC	Climate Change Committee (established under Council Decision No 280/2004/EC)
CH_4	methane
CO_2	carbon dioxide
COP	conference of the parties
CRF	common reporting format
CV	calorific value
EC	European Community
EEA	European Environment Agency
EF	emission factor
Eionet	European environmental information and observation network
EMAS	Ecomanagement and Audit Scheme

ETC/CM	European Topic Centre on Climate Change Mitigation
ETS	European Emissions Trading System
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GHG	greenhouse gas
GPG	good practice guidance and uncertainty management in national greenhouse gas inventories (IPCC, 2000)
GWP	global warming potential
HFCs	hydrofluorocarbons
JRC	Joint Research Centre
F-gases	fluorinated gases (HFCs, PFCs, SF_6)
IE	included elsewhere
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LULUCF	land-use, land-use change and forestry
MNP	Milieu-en Natuurplanbureau
MS	Member State
MRG	monitoring and reporting guidelines
N	nitrogen
NH_3	ammonia
N_2O	nitrous oxide
NA	not applicable
NE	not estimated
NFI	national forest inventory
NIR	national inventory report
NO	not occurring
NUTS	Nomenclature of Territorial Units for Statistics

PFCs	perfluorocarbons
QA	quality assurance
QA/QC	quality assurance/quality control
QM	quality management
QMS	quality management system
RIVM	National Institute of Public Health and the Environment (The Netherlands)
SF_6	sulphur hexafluoride
SNE	Single National Entity
UNFCCC	United Nations Framework Convention on Climate Change
VOCs	Volatile Organic Compounds

Abbreviations in the source category tables in Chapters 3 to 9 and 18-24

Methods applied	**EF: methods applied for determining the emission factor**	**AD: methods applied for determining the activity data**	**Estimate: assessment of completeness**	**Quality: assessment of the uncertainty of the estimates**
CR — Corinair	CR — Corinair	AS — associations, business organizations	All — full	H — high
CS — country-specific	CS — country-specific	IS — international statistics	F — full	M — medium
COPERT X — Copert Model X = version	D — default	NS — national statistics	Full — full	L — low
D — default	M — model	PS — plant specific data	IE — included elsewhere	
M — model	MB — mass balance	Q — specific questionnaires, surveys	NE — not estimated	
NA — not applicable	PS — plant-specific	RS — regional statistics	NO — not occurring	
OTH - other				

Methods applied	**EF: methods applied for determining the emission factor**	**AD: methods applied for determining the activity data**	**Estimate: assessment of completeness**	**Quality: assessment of the uncertainty of the estimates**
RA — reference approach			P — partial	
T1 — IPCC Tier 1			Part — partial	
T1a — IPCC Tier 1a				
T1b — IPCC Tier 1b				
T1c — IPCC Tier 1c				
T2 — IPCC Tier 2				
T3 — IPCC Tier 3				