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Annual European Union greenhouse gas inventory 1990–2022 and inventory document 2024

First submission under the Enhanced Transparency Framework of the Paris Agreement

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Annex I: Key category analysis

Annex II: Assessment of uncertainty (the assessment is included in NID, section 1.6)

Annex III: Summary description of the methodologies used by each Member State for the EU Key Categories

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

This report is the official inventory submission of the European Union (EU) for 2024 under the Paris Agreement and the United Nations Framework Convention on Climate Change (UNFCCC) and follows the modalities, procedures and guidelines (MPGs) under the Enhanced Transparency Framework (ETF) of the Paris Agreement (Decisions 18/CMA.1 and 5/CMA.3).

The European Union (EU), as a party to the Paris Agreement and to the UNFCCC, reports annually on greenhouse gas (GHG) inventories for the years between 1990 and 2022, which is 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 the EU territory).

The legal basis for the compilation of the EU inventory is the Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action (Governance Regulation)[1], the Commission Implementing Regulation (EU) 2020/1208 of 7 August 2020 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) 2018/1999 of the European Parliament and of the Council and repealing Commission Implementing Regulation (EU) No 749/2014[2], and the Commission Delegated Regulation (EU) 2020/1044 of 8 May 2020 supplementing Regulation (EU) 2018/1999 of the European Parliament and of the Council with regard to values for global warming potentials and the inventory guidelines and with regard to the Union inventory system and repealing Commission Delegated Regulation (EU) No 666/2014.

These Regulations establish inter alia 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 and the Paris Agreement 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 under the Effort Sharing Regulation[3].

The EU GHG inventory comprises the direct sum of emissions and removals from the national inventories compiled by the EU Member States. 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).

[1] OJ L 328, 21.12.2018, p. 1–77 .

[2] OJ L 278, 26.8.2020, pp. 1–132

[3] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013 (OJ L 156, 19.6.2018, p. 26–42.

The main institutions involved in the compilation of the EU GHG inventory are the Member States, 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), and Eurostat.

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

1. Member States 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 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 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, that may lead to improved emissions and removals by Member States, 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[4].

ES-2 SUMMARY OF TRENDS RELATED TO EMISSIONS AND REMOVALS IN THE EU

Total GHG emissions - including Land Use, Land Use Change and Forestry (LULUCF) and indirect CO_2 emissions - in the EU amounted to 3 133 million tonnes CO_2 equivalent in 2022. All GHG emission totals provided in this report include indirect CO_2 emissions[5]. The EU's national total emissions[6] also include LULUCF.

[4] The EU, as Party to the Paris Agreement and the UNFCCC, reports its GHG inventory according to the modalities, procedures and guidelines (MPGs) under the Enhanced Transparency Framework (ETF) of the Paris Agreement (Decisions 18/CMA.1 and 5/CMA.3).

The EU Greenhouse gas inventory data in this report was compiled using the September 2024 release of the 'CRT reporting tool' developed by the UNFCCC Secretariat. However, due to remaining technical shortcomings in the UNFCCC ETF tools, there have been substantial difficulties in preparing and finalizing the EU GHG inventory tables, which are based on the aggregation of emissions and removals from Member States' GHG inventories. At the time of the submission of the EU NID, 13 December, the CRTs are still under preparation, with regular discussions between the EEA and the UNFCCC secretariat's technical support aiming to resolve the issues with the EU aggregation as quickly as possible. The CRT tables will be submitted as soon as the EU aggregation checks out and is fully consistent with the sum of emissions and removals from Member States' inventories.

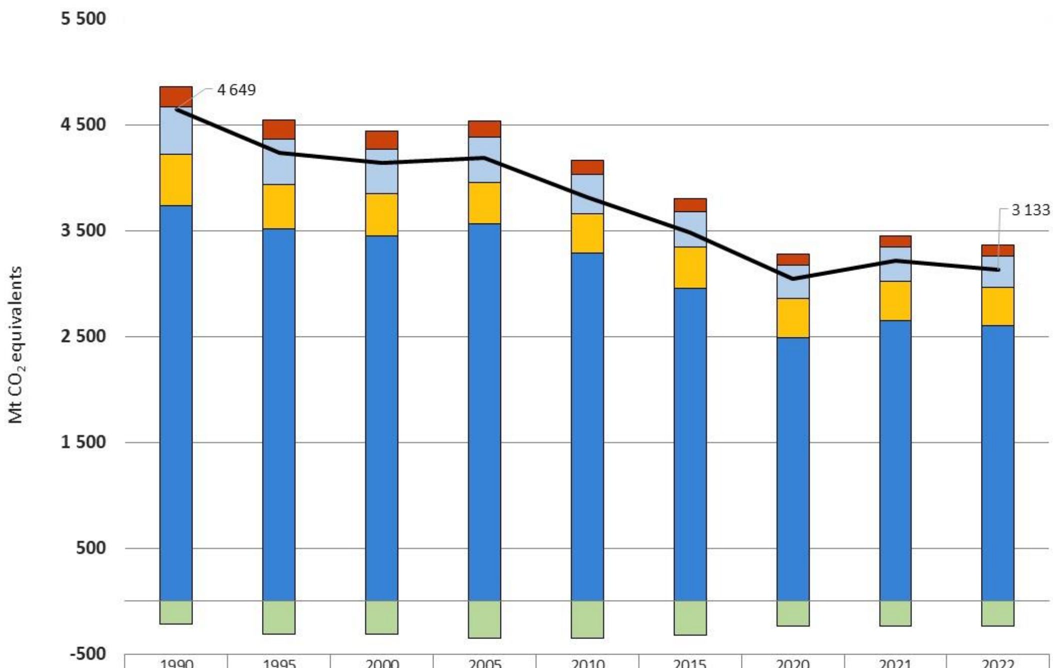
In addition, because of the ongoing improvements and additional releases of the ETF tools by the UNFCCC secretariat after the compilation of the EU GHG inventory, reported data may differ from actual inventory data in some cases. When known, outstanding issues affecting the aggregation of emissions and removals and errors linked to the use of confidential data, will be mentioned in the different sectoral chapters. Thus, the EU should not be held responsible for technical issues and errors caused by the CRT electronic tool affecting the quality of the GHG inventory during the technical expert review. The EU expects that further development of the ETF tools should eliminate the number of existing errors by the time the EU submits its next inventory under the Convention by 15 April 2025.

[5] According to the MPGs, 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 CRT tables include national totals, including and excluding indirect CO_2 emissions.

[6] Unless otherwise specified, the national GHG totals in this report always include LULUCF and indirect CO_2 emissions. They may also be referred to as 'net' total GHG emissions. Besides LULUCF, the other UNFCCC sectors that are included in the national totals are energy, industrial processes and product use (IPPU), agriculture and waste.

In 2022, total GHG emissions were 33 % (1 516 million tonnes CO_2 equivalents) below 1990 levels. Emissions decreased by 2.6 % or 83 million tonnes CO_2 equivalents between 2021 and 2022 (Figure ES. 1).

Figure ES. 1 EU GHG emissions and removals (MT CO_2 eq)



	1990	1995	2000	2005	2010	2015	2020	2021	2022
LULUCF	-217	-317	-311	-348	-351	-325	-241	-241	-236
Waste	184	187	174	155	136	117	111	110	109
IPPU	450	430	414	429	364	342	306	318	289
Agriculture	483	417	408	387	375	383	380	376	366
Energy	3 741	3 516	3 449	3 566	3 290	2 961	2 486	2 650	2 602
Total net GHG emissions (including indirect CO2)	4 649	4 240	4 141	4 194	3 819	3 482	3 045	3 216	3 133

Notes: 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 Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

1.1 Main trends by source category, 1990-2022

Total GHG emissions (including LULUCF and indirect CO_2 emissions) decreased by 1 516 Mt CO_2 eq. since 1990 reaching 3 133 Mt CO_2 equivalent in 2022. There has been a progressive decoupling of gross domestic product (GDP) and GHG emission compared to 1990, with an increase in GDP of 67 % alongside a decrease in emissions of about 33 % over the period.

The trend in GHG emissions over the 32-year period was driven by 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, and more recently, the economic recession from the COVID-19 pandemic in 2020, the recovery of 2021 and high energy prices in 2022.

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 2022 compared to 1990. Demand for energy to heat households has also been lower, as, besides better insulation standards in buildings, 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 2022, with the notable exception of transport, refrigeration and air conditioning, where emissions increased, and forest land, where net removals decreased. For the latter, the main reasons for the decrease in net removals include the aging of the forests from the late 2000s and a lower annual increment, as well as increased harvesting. At the aggregate level, emission reductions were largest for public electricity and heat production, manufacturing industries and construction, residential combustion, and iron and steel production (including energy-related emissions).

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 have decreased strongly since 1990. In addition to improved energy efficiency there has been a move towards less carbon intense fuels. Between 1990 and 2022, the use of solid and liquid fuels in thermal power stations decreased strongly (by 50% and 83%, respectively) whereas natural gas consumption developed in the opposite direction (increasing by 71%). Coal consumption in 1990 was two times higher than in 2022. The use of renewable energy sources in electricity and heat generation has increased substantially in the EU since 1990. According to Eurostat, more electricity was produced from renewables in the EU than for all fossil fuels together in the years between 2020 and 2022. 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 32 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 also been substantial, reflecting, inter alia, 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 Member State specific, have contributed to the overall GHG emission reduction, such as key agricultural and environmental policies in the 1990s and climate and energy policies in the past two decades since 2005. The latter include the implementation of the EU Emissions Trading System as well as national policies for the sectos not covered by the EU ETS. More information on policies and measures can be found in the EU's first Biennial Transparency Report under the Enhanced Transparency Framework of the Paris Agreement.

Almost all EU Member States reduced emissions compared to 1990 and thus contributed to the overall positive EU performance. Germany, Romania, Italy and France accounted for almost two thirds of the total net reduction in EU emissions during the past 32 years.

Table ES. 1 shows those categories that made the largest contribution to the change in total GHG emissions and removals in the EU between 1990 and 2022.

Table ES. 1 Overview of EU categories whose emissions and/or removals increased or decreased by more than 20 million tonnes CO_2 equivalent in the period 1990–2022

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO_2 from 1.A.3.b)	147
Refrigeration and Air conditioning (HFCs from 2.F.1)	54
Forest land remaining forest land (CO_2 from 4.A.1)	40
Unmanaged Waste Disposal Sites (CH_4 from 5.A.2)	-21
Fuels used in Agriculture/Forestry/Fishing (CO_2 from 1.A.4.c)	-21
Grassland (CO_2 from 4.C)	-23
Cropland remaining cropland (CO_2 from 4.B.1)	-25
Agricultural soils: Direct N2O emissions (N_2O from 3.D.1)	-28
Cement Production (CO_2 from 2.A.1)	-28
Adipic Acid Production (N_2O from 2.B.3)	-33
Managed Waste Disposal Sites (CH_4 from 5.A.1)	-37
Nitric Acid Production (N_2O from 2.B.2)	-39
Fugitive Emissions from Oil and Natural Gas (CH_4 from 1.B.2)	-44
Cropland (CO_2 from 4.B)	-44
Enteric Fermentation: Cattle (CH_4 from 3.A.1)	-46
Fugitive Emissions from Solid Fuels (CH_4 from 1.B.1)	-60
Manufacture of Solid Fuels and Other Energy Industries (CO_2 from 1.A.1.c)	-70
Fuels used Commercial/Institutional Sector (CO_2 from 1.A.4.a)	-71
Iron and Steel Production (CO_2 from 1.A.2.a + 2.C.1)	-122
Fuels used Residential Sector (CO_2 from 1.A.4.b)	-151
Manufacturing industries (excl. Iron and steel) (Energy-related CO_2 from 1.A.2 excl. 1.A.2.a)	-248
Public Electricity and Heat Production (CO_2 from 1.A.1.a)	-498
Total	**-1516**

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 and the indirect CO_2 emissions are reflected in this table.

1.2 Main trends by source category, 2021–2022

Total GHG emissions (including LULUCF) decreased in 2022 by 83 million tonnes, or 2.6 % compared to 2021, to reach 3 133 Mt CO_2 equivalent in 2022.

The largest decrease in emissions in 2022 was in ‘buildings', which includes fuels used in the residential and commercial/institutional sectors. The reduction in CO_2 was 50 Mt in the last year alone, mostly attributed to lower natural gas consumption compared to 2021. According to the Copernicus climate change service, 2022 was the second warmest year on record in Europe. A strong reduction in Eurostat’s heating degree days also confirms reduced demand for heating in 2022 leading to signficantly lower emissions.

The other large decrease in EU emissions occurred in manufacturing industries and construction, including combustion and process-related emissions from iron and steel, with a reduction of 40 Mt in 2022 triggered by lower industrial demand for energy.

Higher emissions from electricity and heat production and from road transportation did not offset stronger emission reductions in other inventory sectors, resulting in the reported net emission reduction of 83 Mt CO_{2e} in the EU in 2022.

Table ES. 2 shows the categories making the largest contribution to the change in GHG emissions and removals in the EU between 2021 and 2022.

Table ES. 2 Overview of EU categories whose emissions and/or removals increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2021–2022

Source category	Million tonnes (CO_2 equivalents)
Public Electricity and Heat Production (CO_2 from 1.A.1.a)	21
Road Transportation (CO_2 from 1.A.3.b)	19
Harvested wood products (CO_2 from 4.G)	7
Domestic Aviation (CO_2 from 1.A.3.a)	3
Fuels used in Agriculture/Forestry/Fishing (CO_2 from 1.A.4.c)	-4
Ammonia Production (CO_2 from 2.B.1)	-5
Cement Production (CO_2 from 2.A.1)	-5
Agricultural soils: Direct N_2O emissions (N2O from 3.D.1)	-6
Forest land (CO_2 from 4.A)	-6
Forest land remaining forest land (CO_2 from 4.A.1)	-6
Fuels used Commercial/Institutional Sector (CO_2 from 1.A.4.a)	-14
Iron and Steel Production (CO_2 from 1.A.2.a + 2.C.1)	-14
Manufacturing industries (excl. Iron and steel) (Energy-related CO_2 from 1.A.2 excl. 1.A.2.a)	-26
Fuels used Residential Sector (CO_2 from 1.A.4.b)	-36
Total	**-83**

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 and the indirect CO_2 emissions are reflected 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

	1990 (million tonnes)	2022 (million tonnes)	2021 - 2022 (million tonnes)	Change 2021 - 2022 (%)	Change 1990-2022 (%)	Share MS/EU 2022
Austria	67.4	68.4	2.1	3.1%	1.4%	2.2%
Belgium	142.9	103.1	-6.8	-6.1%	-27.8%	3.3%
Bulgaria	81.0	48.9	4.4	10.0%	-39.7%	1.6%
Croatia	25.2	19.7	1.0	5.4%	-21.9%	0.6%
Cyprus	5.4	8.5	0.0	-0.1%	56.3%	0.3%
Czechia	192.5	121.1	-4.9	-3.9%	-37.1%	3.9%
Denmark	78.3	41.7	-2.1	-4.8%	-46.8%	1.3%
Estonia	35.0	14.3	0.9	6.7%	-59.2%	0.5%
Finland	48.2	50.1	-0.9	-1.8%	4.1%	1.6%
France	521.2	377.2	-15.4	-3.9%	-27.6%	12.0%
Germany	1283.4	754.3	-7.9	-1.0%	-41.2%	24.1%
Greece	101.7	72.9	-0.1	-0.1%	-28.3%	2.3%
Hungary	91.8	52.7	-3.8	-6.7%	-42.5%	1.7%
Ireland	60.2	64.6	-1.8	-2.7%	7.2%	2.1%
Italy	518.7	391.8	5.3	1.4%	-24.5%	12.5%
Latvia	13.7	15.1	2.1	16.4%	10.3%	0.5%
Lithuania	42.7	12.6	-2.1	-14.5%	-70.6%	0.4%
Luxembourg	12.7	7.5	-1.2	-14.0%	-40.8%	0.2%
Malta	2.6	2.3	0.2	7.8%	-13.5%	0.1%
Netherlands	228.1	158.4	-13.0	-7.6%	-30.5%	5.1%
Poland	447.4	344.9	-30.6	-8.1%	-22.9%	11.0%
Portugal	66.1	50.5	0.2	0.3%	-23.7%	1.6%
Romania	230.4	63.5	-3.9	-5.7%	-72.4%	2.0%
Slovakia	64.6	29.8	-4.2	-12.3%	-53.8%	1.0%
Slovenia	14.4	15.4	-0.3	-1.9%	7.1%	0.5%
Spain	253.4	246.8	5.8	2.4%	-2.6%	7.9%
Sweden	19.9	-3.4	-6.4	-215.7%	-117.2%	-0.1%
EU-27	**4649.0**	**3132.7**	**-83.3**	**-2.6%**	**-32.6%**	

1.4 Summary of emissions and removals by main greenhouse gas

Table ES. 4 gives an overview of the main trends in EU GHG emissions and removals for 1990–2022. In the EU the most important GHG is CO_2, accounting for 74 % of total EU emissions in 2022 including LULUCF. In 2022, CO_2 emissions including LULUCF were 2 481 Mt, which was 32 % below 1990 levels. Emissions of CH_4 and N_2O also decreased substantially in the past 32 years since 1990. Emissions of HFCs increased compared to 1990 but have reported significant reductions in past years.

Table ES. 4 Overview of EU GHG emissions and removals from 1990 to 2022 in million tonnes CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2010	2015	2020	2021	2022
Net CO_2 emissions/removals	3 635	3 301	3 275	3 374	3 061	2 757	2 368	2 545	2 481
CO_2 emissions (without LULUCF)	3 881	3 647	3 613	3 748	3 438	3 106	2 634	2 812	2 744
CH_4	666	610	559	512	472	445	419	416	409
N_2O	298	274	243	231	191	188	184	183	175
HFCs	13	21	42	63	84	83	66	63	60
PFCs	22	15	10	6	3	3	2	2	1
Unspecified mix of HFCs and PFCs	5	5	2	1	1	1	2	2	1
SF_6	10	14	9	7	6	6	5	5	4
NF_3	0	0	0	0	0	0	0	0	0
Total (with net CO_2 emissions/removals)	**4 649**	**4 240**	**4 141**	**4 194**	**3 819**	**3 482**	**3 045**	**3 216**	**3 133**
Total (without LULUCF)	**4 866**	**4 558**	**4 452**	**4 542**	**4 170**	**3 807**	**3 286**	**3 457**	**3 369**

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.

1.5 Summary of emissions and removals by main source and sink category

Figure ES. 1 and Table ES. 5 show EU GHG emissions for the main sectors for the period 1990–2022. The most important sector in terms of GHG emissions is energy (i.e. combustion and fugitive emissions), which accounted for 77 % of total EU net emissions in 2022. The second largest sector is agriculture (11 %), followed by industrial processes (9 %). The LULUCF sector accounted for 7.0 % of the EU's gross national total emissions (excluding LULUCF and including indirect CO_2 emissions) in 2022. More detailed trend descriptions are included in the individual sector chapters (chapters 3-7).

Table ES. 5 Overview of EU GHG emissions (in million tonnes CO_2-equivalent) in the main source and sink categories for the period 1990 to 2022

GHG SOURCE AND SINK	1990	1995	2000	2005	2010	2015	2020	2021	2022
1. Energy	3 741	3 516	3 449	3 566	3 290	2 961	2 486	2 650	2 602
2. Industrial Processes	450	430	414	429	364	342	306	318	289
3. Agriculture	483	417	408	387	375	383	380	376	366
4. Land-Use, Land-Use Change and Forestry	-217	-317	-311	-348	-351	-325	-241	-241	-236
5. Waste	184	187	174	155	136	117	111	110	109
6. Other	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	8	7	6	6	5	4	4	4	4
Total (with net CO_2 emissions/removals)	**4 649**	**4 240**	**4 141**	**4 194**	**3 819**	**3 482**	**3 045**	**3 216**	**3 133**
Total (without LULUCF)	**4 866**	**4 558**	**4 452**	**4 542**	**4 170**	**3 807**	**3 286**	**3 457**	**3 369**

1.6 SUMMARY OF EU MEMBER STATE EMISSION TRENDS

Table ES. 6 gives an overview of Member States' contributions to EU GHG emissions for the period 1990–2022. Countries show large variations in GHG emissions trends.

Table ES. 6 Overview of countries' contributions to total EU GHG emissions, including LULUCF, international aviation and including indirect CO_2, from 1990 to 2022 in million tonnes CO_2-equivalent

Member State	1990	1995	2000	2005	2010	2015	2020	2021	2022
Austria	67.4	60.6	66.7	74.5	65.4	72.7	68.2	66.3	68.4
Belgium	142.9	151.3	147.2	143.6	133.2	118.4	107.0	109.9	103.1
Bulgaria	81.0	54.8	40.2	46.0	47.4	52.4	38.3	44.4	48.9
Croatia	25.2	14.3	19.1	22.0	21.4	19.1	18.3	18.7	19.7
Cyprus	5.4	6.8	8.2	9.0	9.2	8.1	8.2	8.5	8.5
Czechia	192.5	149.6	143.0	141.7	133.8	122.2	123.7	126.0	121.1
Denmark	78.3	85.2	77.4	72.9	67.1	49.6	43.9	43.8	41.7
Estonia	35.0	15.1	14.0	16.2	16.4	18.8	12.6	13.4	14.3
Finland	48.2	49.9	49.0	44.9	53.1	41.8	42.3	51.1	50.1
France	521.2	508.5	522.0	496.9	469.5	417.3	368.1	392.6	377.2
Germany	1283.4	1101.5	1036.2	995.9	926.5	891.3	737.6	762.2	754.3
Greece	101.7	106.5	124.1	133.2	115.8	91.8	70.7	73.0	72.9
Hungary	91.8	71.4	74.4	71.3	61.7	56.4	55.6	56.6	52.7
Ireland	60.2	65.9	75.2	77.4	68.0	65.5	63.9	66.4	64.6
Italy	518.7	513.1	541.1	561.9	482.7	400.6	351.6	386.5	391.8
Latvia	13.7	-2.2	-1.7	5.1	10.0	11.1	11.3	12.9	15.1
Lithuania	42.7	17.8	9.9	18.2	10.2	12.1	14.0	14.7	12.6
Luxembourg	12.7	9.5	9.0	12.4	11.9	9.9	8.6	8.8	7.5
Malta	2.6	2.7	2.7	3.0	3.0	2.1	2.1	2.1	2.3
Netherlands	228.1	237.1	225.2	220.6	219.9	200.4	168.8	171.5	158.4
Poland	447.4	428.4	358.7	351.4	370.9	349.4	348.1	375.5	344.9
Portugal	66.1	58.6	80.2	89.6	62.4	63.9	52.9	50.3	50.5
Romania	230.4	160.2	112.0	119.2	89.8	68.5	62.5	67.4	63.5
Slovakia	64.6	44.1	40.0	46.4	41.2	35.6	30.0	34.0	29.8
Slovenia	14.4	13.7	12.5	13.4	12.6	17.4	15.5	15.7	15.4
Spain	253.4	290.2	339.7	391.7	308.6	286.8	224.2	241.0	246.8
Sweden	19.9	25.3	14.8	15.6	7.3	-1.1	-2.8	3.0	-3.4
EU-27	**4649.0**	**4240.1**	**4140.7**	**4194.1**	**3818.9**	**3482.2**	**3045.1**	**3216.0**	**3132.7**

The largest emitters in the EU inventory in 2022 were Germany (24 % of EU net emissions), followed by Italy, France and Poland. The majority of EU Member States contributed to the strong decrease in GHG emissions in the EU between 1990 and 2022, with Germany, Romania, France and Italy together accounting for 64 % of the total net reduction.

Common drivers to lower GHG emissions in most EU countries over the past 32 years 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 Member State can be found in the relevant national inventory reports to UNFCCC https://unfccc.int/ghg-inventories-annex-i-parties/2024

ES-3 OTHER INFORMATION

INTERNATIONAL AVIATION AND MARITIME TRANSPORTATION

After a sharp drop due to the COVID-19 pandemic, emissions from international aviation were almost at 1990 levels in 2020. However, in 2021 and 2022 emissions increased rapidly and were 101 % above the 1990 level in 2022. GHG emissions from international shipping also increased in 2021 and 2022 due to the economic recovery and were 28 % above 1990 levels in 2022. In 2022, international aviation accounted for 110 million tonnes CO_2 equivalent (compared to 56 million tonnes in 2020) and international shipping for 131 million tonnes CO_2 equivalent (compared to 121 million tonnes in 2020).

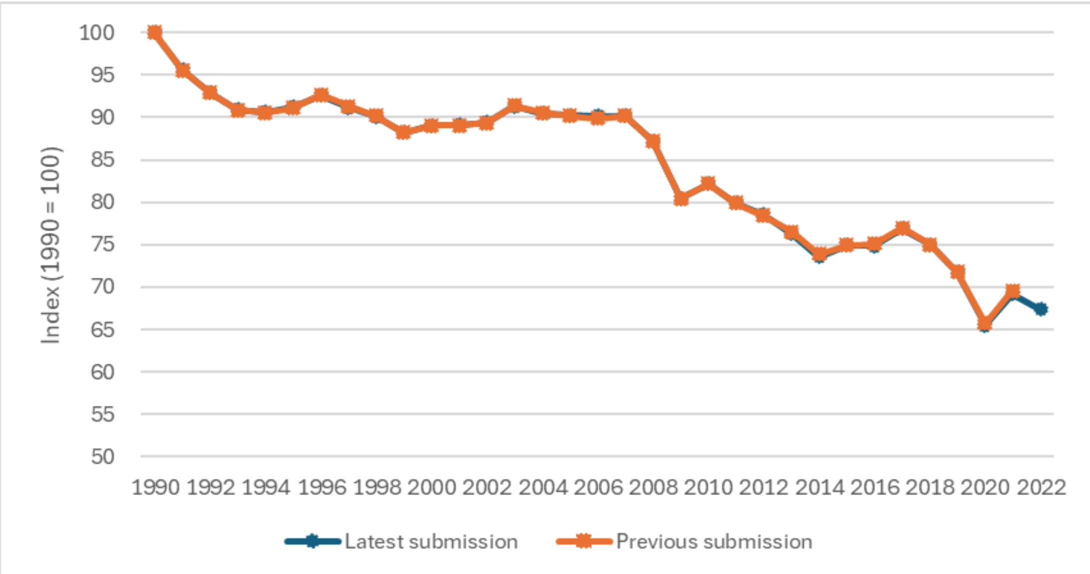
For detailed information on emissions from international bunkers, see Chapter 3.7 of this report.

INFORMATION ON RECALCULATIONS

According to the MPGs, 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, which should ensure the consistency of the time series and be carried out to improve the accuracy and/or completeness of the inventory.

Figure ES.3 shows that the overall emission trend has only marginally changed due to recalculations caused by methodoligcal changes. The indexes are therefore largely overlapping. In the previous submission total GHG emissions (with indirect CO_2 and including LULUCF) of the EU decreased by 30.4%, and in the latest submission it decreased by 30.8% between 1990 and 2021.

Figure ES. 2 EU GHG emissions (incl. LULUCF, indirect CO_2 emissions and international aviation)



For more information on recalculations see Chapter 10.

ES-4 KEY CATEGORY ANALYSIS

A level and a trend assessment was carried out for the years 1990 and 2022 for emissions excluding LULUCF and including LULUCF.

The key category analysis including LULUCF identified 93 key categories for the EU covering 95.3 % of total EU GHG emissions in 2022 while The key category analysis excluding LULUCF resulted in 82 key categories. For more information see chapter 1.4.

ES-5 IMPROVEMENTS INTRODUCED

In 2024, the EU adapted its reporting to the first inventory under the Paris Agreement. The CRT tables as well as the NID outline have been amended to be in line with the new reporting. Descriptions of categories have been aligned accordingly. Information across sectors has been streamlined to provide a harmonised approach across the whole NID. Any recommendations related to improvements from earlier UNFCCC reviews have been continuously followed up and implemented.

Improvements planned for the next inventory reporting will focus on futher improving the transparency of the information in the EU NID as well as the automatization and consistency between CRTs/JSON files and the NID.

1 NATIONAL CIRCUMSTANCES, INSTITUTIONAL ARRANGEMENTS AND CROSS-CUTTING INFORMATION

This report is the official inventory submission of the European Union (EU) for 2024 under the Paris Agreement and the United Nations Framework Convention on Climate Change (UNFCCC) and follows the modalities, procedures and guidelines (MPGs) under the Enhanced Transparency Framework (ETF) of the Paris Agreement (Decisions 18/CMA.1 and 5/CMA.3)[7].

The European Union (EU), as a party to the Paris Agreement and 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 27 Member States (i.e. emissions taking place within the EU territory). The EU Member States are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden. . 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. For reasons of clarity, please note that in some cases the terms 'Member States' and 'EU' and 'Union' may be used.

This chapter 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. The EU GHG inventory is based on the GHG inventories of its Member States[8]. They are responsible for the methods, emissions, emission factors, and other activity and background data reported in their GHG inventories, and will consider national inventory priorities and any resource constraints when estimating and reporting emissions and removals according to the MPGs and the IPCC Guidelines based on the data available in the country.

As the data used in the EU inventory are the aggregation of emissions and removals of the 27 Member States inventories, the detailed sectoral methodologies used in the EU inventory are fully consistent with the methodologies reported by the Member States to both the EU and 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

[7] The EU, as Party to the Paris Agreement and the UNFCCC, reports its GHG inventory according to the modalities, procedures and guidelines (MPGs) under the Enhanced Transparency Framework (ETF) of the Paris Agreement (Decisions 18/CMA.1 and 5/CMA.3).

The EU Greenhouse gas inventory data in this report was compiled using the September 2024 release of the 'CRT reporting tool' developed by the UNFCCC Secretariat. However, due to remaining technical shortcomings in the UNFCCC ETF tools, there have been substantial difficulties in preparing and finalizing the EU GHG inventory tables, which are based on the aggregation of emissions and removals from Member States' GHG inventories. At the time of the submission of the EU NID, 13 December, the CRTs are still under preparation, with regular discussions between the EEA and the UNFCCC secretariat's technical support aiming to resolve the issues with the EU aggregation as quickly as possible. The CRT tables will be submitted as soon as the EU aggregation checks out and is fully consistent with the sum of emissions and removals from Member States' inventories.

In addition, because of the ongoing improvements and additional releases of the ETF tools by the UNFCCC secretariat after the compilation of the EU GHG inventory, reported data may differ from actual inventory data in some cases. When known, outstanding issues affecting the aggregation of emissions and removals and errors linked to the use of confidential data, will be mentioned in the different sectoral chapters. Thus, the EU should not be held responsible for technical issues and errors caused by the CRT electronic tool affecting the quality of the GHG inventory during the technical expert review. The EU expects that further development of the ETF tools should eliminate the number of existing errors by the time the EU submits its next inventory under the Convention by 15 April 2025.

[8] The EU Greenhouse gas inventory data in this report was compiled using the September 2024 release of the 'CRT reporting tool' developed by the UNFCCC Secretariat. Because of the ongoing improvements in the ETF tool by the UNFCCC secretariat after the compilation of the EU GHG inventory, reported data may differ from actual inventory data in some cases. The EU should not be held responsible for any remaining technical issues and errors caused by the CRT electronic tool affecting the quality of the GHG inventory during the technical expert review

up to previous review recommendations, the EU submission in 2024 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 (CRT) 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) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action [9] (hereafter referred to as the Governance Regulation). 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, where energy statistics from Eurostat are used.

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 Paris Agreeement and the UNFCCC as a Party, has to report annually on GHG inventories within the area covered by its Member States.

Secondly, under the EU Governance 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 with respect to EU legislation for reduction of GHG emissions (Effort Sharing Regulation)[10]. For this purpose, the Commission has to prepare a progress evaluation report (State of the Energy Union 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.

Conclusions of the 16th meeting of GHG lead reviewers[11]:

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 NID, 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[12]:

[9] OJ L 328, 21.12.2018, p. 1–77 .

[10] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013 (OJ L 156, 19.6.2018, p. 26–42.

[11] https://unfccc.int/sites/default/files/resource/04_GHG-LRs-2019-conclusions_0.pdf

[12] https://unfccc.int/sites/default/files/resource/Nineteenth%20meeting%20of%20Inventory%20Lead%20Reviewers.pdf

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:

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.

(i) 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.

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 among entities involved

In accordance with the Governance Regulation Article 37(3), 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[13]) 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 DG Eurostat[14].

The legal basis of the compilation of the EU inventory is the Governance Regulation and Commission Implementing Regulation (EU) 2020/1208 of 7 August 2020 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) 2018/1999 of the European Parliament and of the Council and repealing Commission Implementing Regulation (EU) No 749/2014[15]. The Governance Regulation and the implementing regulation establish 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 and the Paris Agreement 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

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

[14] The Statistical Office of the European Communities (Eurostat) is a DG of the European Commission. For simplicity reasons, this institution is referred to as 'Eurostat' in this report.

[15] OJ L 278, 26.8.2020, pp. 1–132

substances that deplete the ozone layer in the Member States; (4) evaluating progress by the Member States towards meeting their obligations under the Effort Sharing Regulation.

Under the provisions of Article 26(3) of the Governance Regulation and Articles 8-18 of the Commission Implementing Regulation 2020/1208, 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 (SO_2), nitrogen oxides (NO_X) 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);
- 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, information on methods and emission factors used, 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 Governance Regulation are detailed in the Commission Implementing Regulation 2020/1208. According to the Governance Regulation and its implementing decision, the reporting 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. 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 (16^{th} and 19^{th} meetings, respectively).

Figure 1.1 Inventory system of the European Union

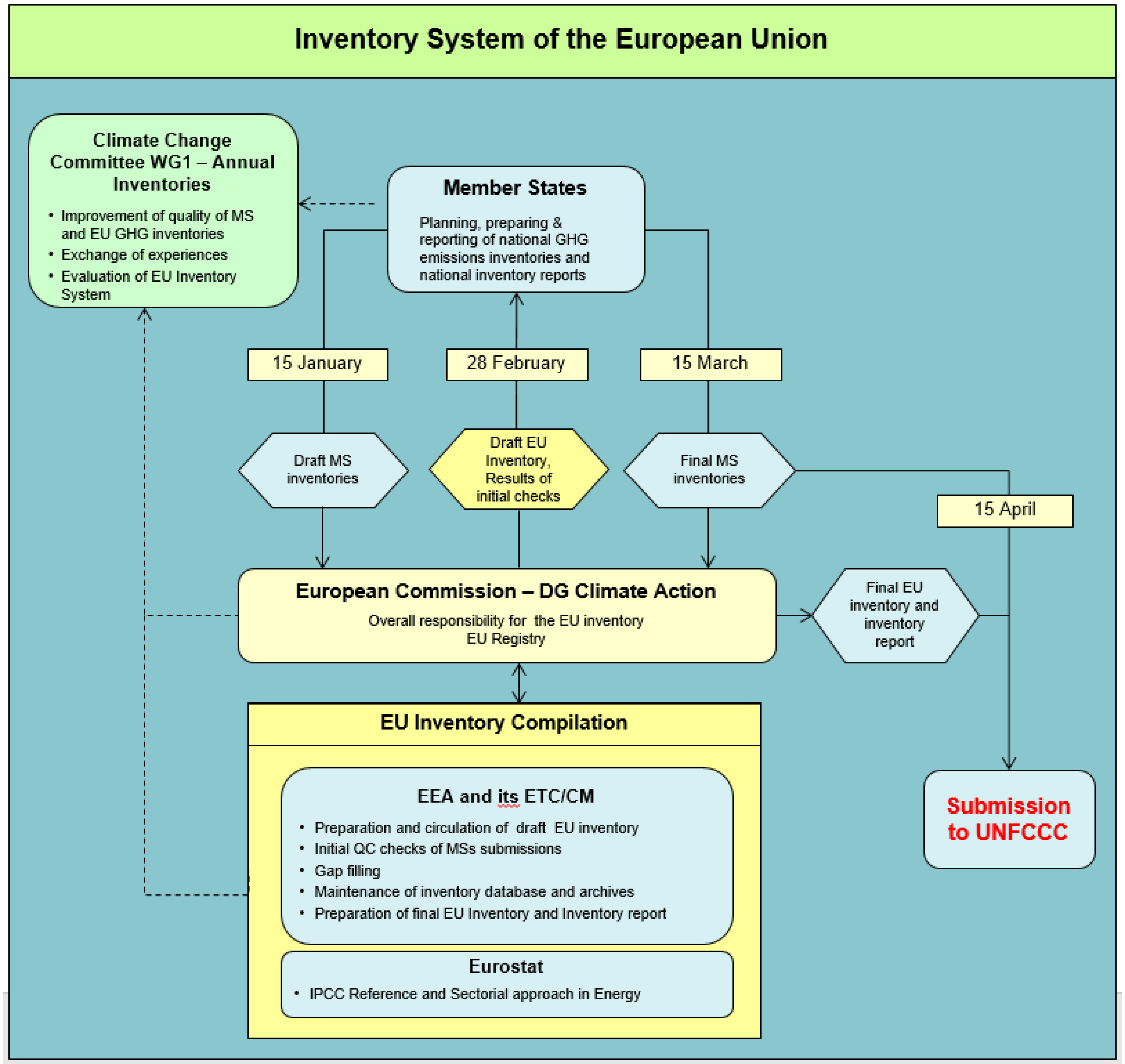


Table 1.1 shows the main institutions and persons involved in the compilation and submission of the EU inventory.

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	Michael Anderl Umweltbundesamt Michael.anderl@umweltbundesamt.at
Belgium	Peter Wittoeck Federal Department of the Environment
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

Member State/EU institution	Contact address
	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 Cris-Tiina Pärn Adviser, Estonian Environmental Research Centre cris-tiina.parn @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
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 Climate and Energy agita.gancone@kem.gov.lv
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

Member State/EU institution	Contact address
	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	Ana Paula Rodrigues Agência Portuguesa do Ambiente, Departamento de Alterações Climáticas (DCLIMA) apaula.rodrigues@apambiente.pt
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
European Commission	Xavier Seront European Commission, DG Climate Action Xavier.SERONT@ec.europa.eu
European Environment Agency (EEA)	Ricardo Fernandez, Claire Qoul European Environment Agency Ricardo.Fernandez@eea.europa.eu, Claire.Qoul@eea.europa.eu
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

1.2.1.1 The Member States

All EU Member States are Parties to UNFCCC and the Paris Agreement and have to prepare national GHG inventories in accordance with the MPGs and 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 37(1) of the Governance Regulation. 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 reported to the EU 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 the MPGs 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 15^{th} 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 Governance Regulation. The purpose of the Climate Change Committee is to assist the European Commission in its tasks under the Governance Regulation. 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 Governance 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/CM and by Eurostat.

The consultation between the DG Climate Action and the Member States takes place in the Climate Change Committee established under Article 44(1)(a) of the Governance Regulation. The Committee is composed of the representatives of the Member States and chaired by the representative of the DG Climate Action. 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 Governance Regulation;

- 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 Article 42 of the Governance Regulation 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[16] (see http://eionet.eea.europa.eu). Member States report the information reported pursuant to Article 26(3) of the Governance Regulation 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. Since 2023 EEA is also responsible for initial checks and compilation of NID chapters for the sectors agriculture and LULUCF (supported by ETC/CM – see below); in previous years these tasks were carried out by the Directorate General Joint Research Centre of the European Commission.

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 (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 (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 on part of the work of the previous ETC/CME on Climate change Mitigation and Energy, which ended in 2021.

The EEA's ETC/CM involves 15 organisations and institutions in ten 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

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

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 documented in the EEA review tool;
- Performing the first step of the annual Effort Sharing Regulation (ESR) review and identifying significant issues according to Art. 30 and Annex XXII of the Commission Implementing Regulation 2020/1208;
- 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 European Environment Agency provides database systems and queries on EEA CWS environment developed to ensure the EU submission is fully consistent with member state's (MS) submissions. From CWS the aggregated EU inventory is transferred into the CRT reporter software for preparing the official EU GHG 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 CRT submissions. These comparisons are normally 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 CRT 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.

1.2.2 Inventory preparation process

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 performs initial checks of the submitted data up to 28 February. The ETC/CM transfers the nationally submitted data from the JSON-files into the EEA database. The data are aggregated and transferred into the CRT 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 CRT Reporter manually.

Table 1.2 Annual process of submission and review of Member States inventories and compilation of the EU inventory[17]

Element	Who	When	What
1. Submission of annual inventories (complete CRT and elements of the national inventory report) by Member States	Member States	15 January	Elements listed in Article 26(3) of the Governance Regulation
2. 'Initial checks' of Member States submissions	Commission (incl. Eurostat), assisted by the EEA	For the Member State submission from 15 January at the latest until 28 February	Checks to verify the transparency, accuracy, consistency, completeness and comparability of Member States' inventories (by EEA). Comparison of energy data provided by Member States in the CRT with Eurostat energy data (sectoral and reference approach) by Eurostat and EEA. Check of Member States' agriculture inventories by EEA (in consultation with Member States). Check of Member States' land use, land-use change and forestry (LULUCF) inventories by EEA (in consultation with EEA and Member States).The findings of the initial checks will be documented.
3. Compilation of draft Union inventory and inventory report (elements of the Union inventory report)	Commission (incl. Eurostat), 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)	15 April	Submission to UNFCCC of the final annual Union inventory.

[17] At COP27 in Sharm COP decision (4/CP.27 Revision of the modalities and procedures for international assessment and review) clarifying that the date was moved to not later than 31 December 2024.

Element	Who	When	What
	assisted by EEA		
15. 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 (CRT or national inventory report) which they provide to the UNFCCC secretariat after

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. After the submission to UNFCCC 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.)

The EU inventory is compiled in accordance with Decision 18/CMA.1 Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement, Annex Chapter II '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),and Decision 18/CMA.1 and 5/CMA.3. The *2006 IPCC guidelines for national greenhouse gas inventories* have been applied. The 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories has been used on a voluntary basis by Member States, where appropriate and feasible. Finally, for the compilation of the EU GHG inventory, the Governance Regulation and its implementing legislation is applicable.

The EU GHG inventory is compiled on the basis of the inventories of the 27 Member States. The emissions of each source category are the sum of the emissions of the respective source and sink categories of the Member States.

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[18].

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, and several ERTs have confirmed, that it is consistent with the UNFCCC reporting guidelines 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. Annex III includes 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.

[1818] 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.

1.2.2.1 Internal consistency of the EU CRT 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 CRT 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 CRT submission. In order to make this more transparent, the CRF tables 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 CRT 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 CRT reporter manually.

Table 1.7 lists the procedures applied for the EU.

Table 1.3 Manual changes in the CRT Reporter

Year	Sector	Source category	Parameter	Manual changes / inclusion in the CRF Reporter
1990-2022	Energy	1 AB, 1AC, 1AD	All	Enter Reference Approach data from Eurostat
2013-2022	Energy, IPPU	1.A.1, 1.A.2, 1.B.2, 2.C, 2D, 2G	CO_2, CH_4, N_2O, NO_X, 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.
1990-2022	IPPU	2.B, 2.C, 2.E, 2.F, 2.G, 2.H	f gases	Enter country-specific f gases
1990-2022	IPPU	2.C.7, 2.G.4, 2.H	CO_2, CH_4, N_2O, NO_X, NMVOC, SO_2	Enter country-specific emissions and recovery data.
1990, 2022	IPPU	2.A.2, 2.B.1	AD	Replace aggregated activity (‘AD’) data with gap-filled AD provided by sector experts
1990-2022	IPPU	2.A, 2.B, 2.C, 2.D, 2.G, 2.H	AD	Replace aggregated AD with notation key ‘NE’ if an aggregation does not make sense due to inhomogeneous AD
1990-2022	Agriculture	3	CH_4, N_2O, NMVOC	Enter aggregated data from EEA
1990-2022	Agriculture	3	AD	Correct additional information with aggregated data from EEA
1990-2022	LULUCF	4.G	All	Enter aggregated data (approach B)

1.2.2.2 Overview of Member States submissions

Table 1.3 summarises timeliness and completeness of the EU Member States submissions in 2024 that were taken into account for the compilation EU GHG inventory.

Table 1.4 Date, mode and content of submission of EU Member States in 2024 that were taken into account for the compilation of EU GHG inventory

MS	Date	Submission mode	JSON	CRT	NID
AUT	13.09.2024	CDR	AUT-CRT-2024-V0-1-DataEntry-20240911-152909.json	1990-2022	
BEL	14.09.2024	CDR	Result_without_RA_BEL-CRT-2024-V0-1-DataEntry-20240912-185757.json	1990-2022	
BGR	15.09.2024	CDR	BGR-CRT-2024-V0-1-DataEntry-20240915-200103.json	1988, 1990-2022	
CYP	23.09.2024	CDR	CYP-CRT-2024-V0-1-DataEntry-20240923-103733.json	1990-2022	x
CZE	12.09.2024	CDR	CZE-CRT-2024-V0-1-DataEntry-20240912-084955.json	1990-2022	
DEU	13.09.2024	CDR	DEU-CRT-2024-V0-1-DataEntry-20240913-144952.json	1990-2022	
DNK	29.10.2024	CDR	DNK-CRT-2024-V0-7-DataEntry-20241028-154610.json	1990-2022	
ESP	16.09.2024	CDR	ESP-CRT-2024-V0-1-DataEntry-20240911-120348.json	1990-2022	
EST	16.09.2024	CDR	EST-CRT-2024-V0-1-DataEntry-20240916-161534.json	1990-2022	
FIN	12.09.2024	CDR	FIN-CRT-2024-V0-4-DataEntry-20240905-153326.json	1990-2022	
FRA	01.10.2024	CDR	FRA-CRT-2024-V0-2-DataEntry-20241001-162753.json	1990-2022	
GRC	11.09.2024	CDR	GRC-CRT-2024-V0-1-DataEntry-20240906-143025.json	1990-2022	
HRV	19.09.2024	CDR	HRV-CRT-2024-V0-1-DataEntry-20240919-121547.json	1990-2022	x
HUN	28.10.2024	CDR	HUN-CRT-2024-V0-1-DataEntry-20241025-205304.json	1985-1987, 1990-2022	
IRL	16.09.2024	CDR	IRL-CRT-2024-V0-1-DataEntry-20240916-170054.json	1990-2022	
ITA	08.10.2024	CDR	ITA-CRT-2024-V0-2-DataEntry-20241007-181055.json	1990-2022	
LTU	30.09.2024	CDR	LTU-CRT-2024-V0-4-DataEntry-20240930-162501.json	1990-2022	
LUX	18.09.2024	CDR	LUX-CRT-2024-V0-1-DataEntry-20240918-091002.json	1990-2022	
LVA	13.09.2024	CDR	LVA-CRT-2024-V0-1-DataEntry-20240911-085616.json	1990-2022	x
MLT	20.09.2024	CDR	MLT-CRT-2024-V0-1-DataEntry-20240919-083054.json	1990-2022	x
NLD	29.10.2024	CDR	NLD-CRT-2024-V0-1-DataEntry-20241029-173551_Validated.json	1990-2022	
POL	13.09.2024	CDR	POL-CRT-2024-V0-1-DataEntry-20240913-141028.json	1988-2022	x
PRT	01.10.2024	CDR	PRT-CRT-2024-V0-1-DataEntry-20240930-195807.json	1990-2022	
ROU	13.09.2024	CDR	ROU-CRT-2024-V0-3-DataEntry-20240830-120014, ROU-CRT-2024-V0-3-DataEntry-20240830-120014_Validated.json	1989-2022	
SVK	12.09.2024	CDR	SVK-CRT-2024-V0-1-DataEntry-20240910-135733.json	1990-2022	
SVN	08.10.2024	CDR	SVN-CRT-2024-V0-9-DataEntry-20241008-122416_Validated.json	1986, 1990-2022	
SWE	29.10.2024	CDR	Datafile_exported_from_the_ETF_database__SWE-CRT-2024-V0-4-DataEntry_.json	1990-2022	

1.2.2.3 Overview of personnel involved

Table 1.4 gives an overview on people involved in the compilation of the EU GHG inventory submission in 2024 and their individual responsibilities in this process.

Table 1.5 Responsibility list for the compilation of the EU GHG inventory submission in 2024

	Name	**EU GHG inventory/inventory document compilation**				**Initial Checks**			
		Overall responsibility	Project manager	Sector experts, experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts, experts	Quality expert
Commission	Roxanne Lake (DG Clima) Roxanne.LAKE@ec.europa.eu	X			executive summary, chapter 1				
	GENET Julien (CLIMA) julien.genet@ec.europa.eu	X			executive summary, chapter 1				
	JUVYNS Olivier olivier.juvyns@ec.europa.eu	X			executive summary, chapter 1				
	Michael Goll (Eurostat) Michael.Goll@ec.europa.eu			1A Reference approach				1A Reference approach	
EEA	Ricardo Fernandez (EEA) ricardo.fernandez@eea.europa.eu	X			executive summary, chapter 1, trend chapter, chapter 10	X			
	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			sector 4				sector 4	
	Raul Abad-Vinas (EEA) raul.abad@eea.europe.eu			sector 4				sector 4	
	Simon Kay (EEA) simon.kay@eea.europe.eu			sector 4				sector 4	
	Lucia Perugini (EEA) Lucia.Perugini@eea.europa.eu;				sector 4				sector 4
	Herdis Gudbrandsdottir (EEA) herdis.gudbrandsdottir@eea.europa.eu			data checks					
	Gorka Mendiguren (EEA) Gorka.Mendiguren@eea.europa.eu			plots all sectors				plots sector 3, plots all sectors	
	Katarzyna Kowalczewska (EEA) Katarzyna.Kowalczewska@eea.europa.eu				sector 3				sector 3
ETC/CM	Michaela Gager (ETC/CM; UBA-V) michaela.gager@umweltbundesamt.at		data manager	support				support	
	Günther Schmidt (ETC/CM; UBA-V) guether.schmidt@umweltbundesamt.at		data manager						

	Name	EU GHG inventory/inventory document compilation				Initial Checks			
		Overall responsibility	Project manager	Sector experts, experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts, experts	Quality expert
	Nicole Mandl (ETC/CM; UBA-V) nicole-mandl@umweltbundesmat.at		X	executive summary, chapter1, chapter 2			X	cross-cutting issues	cross-cutting issues
	Bernd Gugele (ETC/CM; UBA-V) bernd.gugele@umweltbundesamt.at			1A reference approach, support				1A reference approach	
	Bradley Matthews (ETC/CM; UBA-V) bradley.matthews@umweltbundesamt.at			uncertainties				uncertainties	
	Manuela Wieser (ETC/CM; UBA-V) manuela.wieser@umweltbundesamt.at				sector 2 - F-gases only				sector 2 - F-gases only
	Maria Purzner (ETC/CM; UBA-V) maria.purzner@umweltbundesamt.at				sector 2 - F-gases only				sector 2 - F-gases only
	Oscar Redeyoff (ETC/CM; UBA-V) oscar.redeyoff@umweltbundesamt.at			support					
	Michaela Stiefmann (ETC/C; UBA-V) michaela.stiefmann@umweltbundesamt.at			uncertainties, support				support	
	Marion Pinterits (ETC/CM; Klarfakt) m.pinterits@klarfakt.com		support	1B, 1C	reference approach		support	1B, 1C	reference approach
	Elisabeth Kampel (ETC/CM, Klarfakt) e.kampel@klarfakt.com		support	chapter 1, chapter 10					
	Barbora Koci (ETC/CM; CHMI) barbora.koci@chmi.cz			1A2, 1A4, 1A5				1A2, 1A4, 1A5	
	Jitka Slamova (ETC/CM; CHMI) jitka.slamova@chmi.cz				1A1				1A1
	SAARIKIVI RISTO JUHANA (ETC/CM; CHMI) ristojuhana.saarikivi@chmi.cz				sector 5				sector 5
	Céline GUEGUEN (ETC/CM; T4L) celine.gueguen2@gmail.com			sector 5				sector 5	
	Coralie JEANNOT (ETC/CM; CITEPA) coralie.jeannot@citepa.org			EU ETS, 2C				EU ETS, 2C	
	Grégoire Bongrand (ETC/CM; CITEPA) gregoire.bongrand@citepa.org			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
	Etienne MATHIAS (ETC/CM; CITEPA) etienne.mathias@citepa.org				sector 3				sector 3

	Name	EU GHG inventory/inventory document compilation				Initial Checks			
		Overall responsibility	Project manager	Sector experts, experts	Quality expert	Overall responsibility	QA/QC coordinator	Sector experts, experts	Quality expert
	Anais Durand (ETC/CM; CITEPA) anais.durand@citepa.org			sector 3				sector 3	
	Athina Grigoriadou (ETC/CM; Emisia) athina.g@emisia.com			1A3 + bunkers, comparison with Eurocontrol				1A3 + bunkers	
	Giannis Papadimitriou (ETC/CM; Emisia) giannis.p@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	
	David Behringer (ETC/CM; Oeko Recherche) d.behringer@oekorecherche.de			F-gases, 2B9 2E, 2F, 2G1-2				F-gases, 2B9 2E, 2F, 2G1-2	
	Lorenz Moosmann (ETC/CM; Oeko) l.moosmann@oeko.de			sectors 2A, 2B				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 (excl. F-gases)				sector 2 (excl. F-gases)

1.2.3 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 a separate folder at the Environment Agency Austria , which is not publicly accessible:

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 (CRT, JSON, NID, etc.) or for mails. Each submission is numbered consecutively.

1.2.4 Processes for official consideration and approval of inventory

The report is prepared and approved by EEA. The official submission is done by DG CLIMA of the European Commission on behalf of the EU using the final EEA report.

1.3 Brief general description of methodologies and data sources used

According to the MPGs, each Party should make every effort to use a recommended method (tier level) for key categories in accordance with the 2006 IPCC guidelines, or with the 2019 refinement when used on a voluntary basis Table 1.8 gives an overview on the share of emissions for which higher tiers are used in the EU 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. They are responsible for the methods, emission factors and emissions used, and for the implementation of the reporting guidelines (MPGs) and the 2006 IPCC Guidelines, taking into account inventory priorities and resource constraints.

Table 1.6 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)	99.0 %
1.A.1.a. Public electricity and heat production: Liquid Fuels (CO_2)	95.3 %
1.A.1.a. Public electricity and heat production: Other Fuels (CO_2)	95.6 %
1.A.1.a. Public electricity and heat production: Peat (CO_2)	99.2 %
1.A.1.a. Public electricity and heat production: Solid Fuels (CO_2)	96.4 %
1.A.1.b. Petroleum refining: Gaseous Fuels (CO_2)	98.5%

Source category gas	**Share of higher tier**
1.A.1.b. Petroleum refining: Liquid Fuels (CO_2)	97.4 %
1.A.1.c. Manufacture of solid fuels and other energy industries: Gaseous Fuels (CO_2)	95.6 %
1.A.1.c. Manufacture of solid fuels and other energy industries: Solid Fuels (CO_2)	96.4 %
1.A.2.a. Iron and steel: Gaseous Fuels (CO_2)	99.79 %
1.A.2.a. Iron and steel: Liquid Fuels (CO_2)	99.8% %
1.A.2.a. Iron and steel: Solid Fuels (CO_2)	99.0 %
1.A.2.b. Non-ferrous metals: Gaseous Fuels (CO_2)	100.0 %
1.A.2.c. Chemicals: Gaseous Fuels (CO_2)	95.8 %
1.A.2.c. Chemicals: Liquid Fuels (CO_2)	99.4 %
1.A.2.c. Chemicals: Solid Fuels (CO_2)	92.6 %
1.A.2.d. Pulp, paper and print: Gaseous Fuels (CO_2)	100.0 %
1.A.2.d. Pulp, paper and print: Liquid Fuels (CO_2)	92.8 %
1.A.2.d. Pulp, paper and print: Solid Fuels (CO_2)	92.1 %
1.A.2.e. Food processing, beverages and tobacco: Gaseous Fuels (CO_2)	96.1 %
1.A.2.e. Food processing, beverages and tobacco: Liquid Fuels (CO_2)	97.5 5
1.A.2.e. Food processing, beverages and tobacco: Solid Fuels (CO_2)	68.8 %
1.A.2.f. Non-metallic minerals: Gaseous Fuels (CO_2)	95.5 %
1.A.2.f. Non-metallic minerals: Liquid Fuels (CO_2)	99.1 %
1.A.2.f. Non-metallic minerals: Other Fuels (CO_2)	96.3 %
1.A.2.f. Non-metallic minerals: Solid Fuels (CO_2)	69.4 %
1.A.2.g. Other: Gaseous Fuels (CO_2)	96.0 %
1.A.2.g. Other: Liquid Fuels (CO_2)	98.3 %
1.A.2.g. Other: Other Fuels (CO_2)	98.3 %
1.A.2.g. Other: Solid Fuels (CO_2)	98.3 %
1.A.3.a. Domestic aviation: Jet Kerosene (CO_2)	94.1 %
1.A.3.b. Road transportation: Diesel Oil (CO_2)	83 %
1.A.3.b. Road transportation: Diesel Oil (N_2O)	95.6 %
1.A.3.b. Road transportation: Gaseous Fuels (CO_2)	91.4 %
1.A.3.b. Road transportation: Gasoline (CH_4)	97.4 %
1.A.3.b. Road transportation: Gasoline (CO_2)	90 %
1.A.3.b. Road transportation: Liquefied Petroleum Gases (LPG) (CO_2)	99.8 %
1.A.3.c. Railways: Liquid Fuels (CO_2)	95 %
1.A.3.d. Domestic navigation: Gas/Diesel Oil (CO_2)	73.7 %
1.A.3.d. Domestic navigation: Residual Fuel Oil (CO_2)	74.3 %
1.A.4.a. Commercial/institutional: Gaseous Fuels (CO_2)	94 %
1.A.4.a. Commercial/institutional: Liquid Fuels (CO_2)	80 %
1.A.4.a. Commercial/institutional: Other Fuels (CO_2)	97 %
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)	94 %
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 %

Source category gas	**Share of higher tier**
1.A.4.c. Agriculture/forestry/fishing: Gaseous Fuels (CO_2)	87 %
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 Stationary: Liquid Fuels (CO_2)	96 %
1.A.5.a Stationary: Solid Fuels (CO_2)	99.5 %
1.A.5.b Mobile: Liquid Fuels (CO_2)	83 %
1.B.1.a. Coal mining and handling: no classification (CH_4)	69 %
1.B.2.a. Oil: no classification (CH_4)	31%
1.B.2.a. Oil: no classification (CO_2)	72 %
1.B.2.b. Natural gas: no classification (CH_4)	63 %
2.A.1. Cement production: no classification (CO_2)	100 %
2.A.2. Lime production: no classification (CO_2)	97.6 %
2.A.4. Other process uses of carbonates: no classification (CO_2)	81.7 %
2.B.1. Ammonia production: no classification (CO_2)	100 %
2.B.10. Other: no classification (CO_2)	100 %
2.B.2. Nitric acid production: no classification (N_2O)	100 %
2.B.3. Adipic acid production: no classification (N_2O)	85.1 %
2.B.8. Petrochemical and carbon black production: no classification (CO_2)	100 %
2.B.9. Fluorochemical production: no classification (Unspecified mix of HFCs and PFCs)	95.4 %
2.C.1. Iron and steel production: no classification (CO_2)	100%
2.F.1. Refrigeration and air-conditioning: no classification (HFCs)	100%
3.A. Enteric fermentation: no classification (CH_4)	96 %
3.B. Manure management: no classification (CH_4)	80 %
3.B. Manure management: no classification (N_2O)	56 %
3.D.1. Direct N_2O emissions from managed soils: Direct N_2O Emissions From Managed Soils (N_2O)	65 %
3.D.2. Indirect N_2O emissions from managed soils: no classification (N_2O)	28.5 %
3.G.1. Limestone $CaCO_3$: no classification (CO_2)	96 %
5.A.1. Managed waste disposal sites: no classification (CH_4)	100%
5.A.2. Unmanaged waste disposal sites: no classification (CH_4)	100%
5.D.1. Domestic wastewater: no classification (CH_4)	44.4%
5.D.1. Domestic wastewater: no classification (N_2O)	32.0%
5.D.2. Industrial wastewater: no classification (CH_4)	45.0%

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

1.3.1.1 Overview

As in Annex V under the MMR, Annex XII under Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action (GOV REG) requires Member States to report EU ETS emissions per CRT categories and to comment the share of EU ETS emissions in CRT categories.

The EU ETS generates an EU-27 data set on verified installation-specific emissions for the sectors covered by the scheme. For 2022, the main activities, the number of entities and the verified emissions reported under the EU ETS are presented in Table 1.9.

Table 1.7 Activities and emissions covered by the EU ETS in 2022 (Member States)

Main activity	Activity code	Number of entities	Verified emissions ($Mt\ CO_2$-eq.)
Combustion of fuels	**20**	**5 427**	**813**
Refining of mineral oil	21	110	108
Production of coke	22	15	5
Metal ore roasting or sintering	23	10	2
Production of pig iron or steel	24	188	102
Production or processing of ferrous metals	25	195	7
Production of primary aluminium	26	20	3
Production of secondary aluminium	27	25	1
Production or processing of non-ferrous metals	28	74	6
Production of cement clinker	29	211	105
Production of lime, or calcination of dolomite/magnesite	30	214	24
Manufacture of glass	31	297	17
Manufacture of ceramics	32	660	12
Manufacture of mineral wool	33	46	2
Production or processing of gypsum or plasterboard	34	35	1
Production of pulp	35	144	4
Production of paper or cardboard	36	475	17
Production of carbon black	37	17	2
Production of nitric acid	38	29	2
Production of adipic acid	39	3	0.1
Production of glyoxal and glyoxylic acid	40	0	0
Production of ammonia	41	19	13
Production of bulk chemicals	42	274	28
Production of hydrogen and synthesis gas	43	37	7
Production of soda ash and sodium bicarbonate	44	12	4
Capture of greenhouse gases under Directive 2009/31/EC	45	0	0
Transport of greenhouse gases under Directive 2009/31/EC	46	0	0
Other activity opted-in under Art. 24	99	185	1
All stationary installations		8 722	1 286

Source: EEA, 2024 (EU ETS data viewer, EU 27)

1.3.1.2 Mapping table between EU ETS activities and CRT categories

The table below indicates the mapping between the EU ETS activities and the IPCC/CRT categories, with supporting comments. Such table is based on the scope of the EU ETS in the fourth phase and the CRT 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 1.8 Mapping table outlining the correspondence of CRT categories related to the EU ETS activities

EU ETS activity	CRT 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 2.B.10 Other	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 CRT 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 • 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.1 Iron and Steel	• Scopes of EU ETS and 2006 IPCC Guidelines are generally consistent, however EU ETS emissions may be allocated to several CRT 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.2.a 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.2.a 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.2.a 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

EU ETS activity	CRT category	Comment
		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 CRT 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 metals from: o conventional and alternative fuels, o reducing agents including coke, o graphite electrodes, o raw materials including limestone and dolomite, o carbon containing metal ores and concentrates, o secondary feed materials. • Combustion related emissions from EU ETS activity code 25 are included in in CRT 1.A.2.a. Iron and Steel. • Process related emissions can be included in CRT 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 Al_2O_3 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 CRT category 2.C.3 are consistent. PFC emissions are allocated to 2.C.3 Aluminium production. • CRT 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 CRT 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 CRT 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 CRT 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

EU ETS activity	CRT category	Comment
		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 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 CRT 2.A.1 Cement Production • Combustion related emissions from ETS activity code 29 are included in CRT 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 CRT 2.A.2 Lime Production • Combustion related emissions from EU ETS activity code 30 are included in CRT 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 CRT 2.A.3 Glass Production • Combustion related emissions from EU ETS activity code 31 are included in CRT 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 CRT 2.A.4 Other process uses of carbonates. • Combustion related emissions from EU ETS activity code 32 are included in CRT 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 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. • 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 2.A.5.
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.

EU ETS activity	CRT category	Comment
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 CRT 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 CRT 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 CRT 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 .
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 CRT 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 CRT 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

EU ETS activity	CRT category	Comment
		of the EU ETS system cannot be deducted from ammonia production for EU ETS reporting.
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 CRT code 1.A.2.c Chemicals. • Some of the emissions reported under this EU ETS activity could be allocated to CRT 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 CRT 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 CRT, 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 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 CRT 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 CRT 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 CRT categories (Annex V under the MMR (phase III of EU ETS); Annex XII under the GOV REG for phase IV). 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

The EU ETS cover installations with activities overpassing certain capacity thresholds (which can sometimes be null). Hence, the inventory scopes for the same activities are often larger (or equal).

Determination of tiers

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 EU ETS, tiers apply at installation level for each source stream activity data and calculation factors 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) and source stream contributions. 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.

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

An analysis of data consistency between EU ETS and inventory data ideally 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 CRT categories; (2) a detailed comparison of the methodological parameters (methods, activity data, calculation parameters).

1.3.1.3 Use of EU ETS data reported in 2024

Under the GOV REG article 37 (EU 2018a), 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 CRT 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 1.A.2 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 (NIDs) in 2024 to the European Commission, all Member States indicated that they used EU ETS data at least for QA/QC purposes

(Table 1.11). 24 Member States indicated to directly use the verified emissions reported by installations under the EU ETS (depending on 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 1.9 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	✓	✓	✓	✓

Source: NID 2024 submissions of Member States

1.3.2 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/CM assist DG CLIMA regarding the technical requirements.

To support the inventory process for the submission in 2024, in August/September 2023 Member States received fuel and emissions data for the years 2005 to 2022 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 2022 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 2024 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/CM 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 2022, related CO_2 emissions and implied emission factors of CH_4 and N_2O. For more information on the results of the collaboration with EUROCONTROL and the comparison, see chapter 3.4.

1.4 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 the following procedure was applied:

- Starting point for the key category identification for this report was the EEA database. All 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 NID. Although the more detailed EU approach differs from the KCA generated in the CRT overall the results are very similar.
- The confidential data of Sweden were not included when the key category analysis was conducted owing to timing constraints. The list of (sub-) categories for which confidential data

reported by member States are excluded when conducting the key category analysis is included in chapter 1.7.3. The exclusion of confidential Swedish does not significantly affect the EU key category analysis as these emissions account for roughly 1000 kt CO_2 equivalents whereas the smallest EU key category is 4843 kt CO_2 equivalents.

- A level and a trend assessment was carried out for the years 1990 and 2022. The assessment was carried out for emissions excluding LULUCF and including LULUCF.
  The key category analysis including LULUCF identified 93 key categories for the EU covering 95.3 % of total EU GHG emissions in 2022 (Table 1.13). The key category analysis excluding LULUCF resulted in 82 key categories (Annex I).

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

Table 1.10 Key categories for the EU (Gg CO_2 equivalents)

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2022		1990	2022
1.A.1.a. Public electricity and heat production: Gaseous Fuels (CO_2)	107683	187917	T	L	L
1.A.1.a. Public electricity and heat production: Liquid Fuels (CO_2)	156347	26264	T	L	L
1.A.1.a. Public electricity and heat production: Other Fuels (CO_2)	10453	36978	T	L	L
1.A.1.a. Public electricity and heat production: Peat (CO_2)	9164	3733	T	L	0
1.A.1.a. Public electricity and heat production: Solid Fuels (CO_2)	943403	474092	T	L	L
1.A.1.b. Petroleum refining: Gaseous Fuels (CO_2)	5345	15019	T	0	L
1.A.1.b. Petroleum refining: Liquid Fuels (CO_2)	97131	79606	T	L	L
1.A.1.c. Manufacture of solid fuels and other energy industries: Gaseous Fuels (CO_2)	8199	7309	0	L	L
1.A.1.c. Manufacture of solid fuels and other energy industries: Solid Fuels (CO_2)	88816	22081	T	L	L
1.A.2.a. Iron and steel: Gaseous Fuels (CO_2)	29392	15708	T	L	L
1.A.2.a. Iron and steel: Liquid Fuels (CO_2)	9044	973	T	L	0
1.A.2.a. Iron and steel: Solid Fuels (CO_2)	112384	52646	T	L	L
1.A.2.b. Non-ferrous metals: Gaseous Fuels (CO_2)	3013	6469	T	0	L
1.A.2.c. Chemicals: Gaseous Fuels (CO_2)	49423	29792	T	L	L
1.A.2.c. Chemicals: Liquid Fuels (CO_2)	29756	13168	T	L	L
1.A.2.c. Chemicals: Solid Fuels (CO_2)	12004	8133	0	L	L
1.A.2.d. Pulp, paper and print: Gaseous Fuels (CO_2)	11336	15831	T	L	L
1.A.2.d. Pulp, paper and print: Liquid Fuels (CO_2)	10835	1782	T	L	0
1.A.2.d. Pulp, paper and print: Solid Fuels (CO_2)	6774	1746	T	0	0
1.A.2.e. Food processing, beverages and tobacco: Gaseous Fuels (CO_2)	15813	26637	T	L	L
1.A.2.e. Food processing, beverages and tobacco: Liquid Fuels (CO_2)	18064	3008	T	L	0
1.A.2.e. Food processing, beverages and tobacco: Solid Fuels (CO_2)	11581	3386	T	L	0
1.A.2.f. Non-metallic minerals: Gaseous Fuels (CO_2)	27265	31631	T	L	L
1.A.2.f. Non-metallic minerals: Liquid Fuels (CO_2)	46178	20924	T	L	L
1.A.2.f. Non-metallic minerals: Other Fuels (CO_2)	1438	14298	T	0	L
1.A.2.f. Non-metallic minerals: Solid Fuels (CO_2)	52408	13664	T	L	L
1.A.2.g. Other: Gaseous Fuels (CO_2)	79964	72348	T	L	L
1.A.2.g. Other: Liquid Fuels (CO_2)	81823	38150	T	L	L
1.A.2.g. Other: Other Fuels (CO_2)	2451	4440	T	0	0
1.A.2.g. Other: Solid Fuels (CO_2)	90611	10197	T	L	L
1.A.3.a. Domestic aviation: Jet Kerosene (CO_2)	10813	12867	T	L	L

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2022		1990	2022
1.A.3.b. Road transportation: Diesel Oil (CO_2)	270372	533937	T	L	L
1.A.3.b. Road transportation: Diesel Oil (N_2O)	1320	6009	T	0	L
1.A.3.b. Road transportation: Gaseous Fuels (CO_2)	508	3673	T	0	0
1.A.3.b. Road transportation: Gasoline (CH_4)	5556	767	T	0	0
1.A.3.b. Road transportation: Gasoline (CO_2)	330645	201449	T	L	L
1.A.3.b. Road transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7266	15085	T	L	L
1.A.3.c. Railways: Liquid Fuels (CO_2)	11549	3281	T	L	0
1.A.3.d. Domestic navigation: Gas/Diesel Oil (CO_2)	12831	9964	0	L	L
1.A.3.d. Domestic navigation: Residual Fuel Oil (CO_2)	7006	6149	0	0	L
1.A.4.a. Commercial/institutional: Gaseous Fuels (CO_2)	50344	74915	T	L	L
1.A.4.a. Commercial/institutional: Liquid Fuels (CO_2)	73102	20751	T	L	L
1.A.4.a. Commercial/institutional: Other Fuels (CO_2)	748	5822	T	0	L
1.A.4.a. Commercial/institutional: Solid Fuels (CO_2)	44975	2108	T	L	0
1.A.4.b. Residential: Biomass (CH_4)	10438	11625	T	L	L
1.A.4.b. Residential: Gaseous Fuels (CO_2)	129940	176067	T	L	L
1.A.4.b. Residential: Liquid Fuels (CO_2)	174026	78065	T	L	L
1.A.4.b. Residential: Solid Fuels (CH_4)	8905	1956	T	L	0
1.A.4.b. Residential: Solid Fuels (CO_2)	118831	22233	T	L	L
1.A.4.c. Agriculture/forestry/fishing: Gaseous Fuels (CO_2)	12291	9802	0	L	L
1.A.4.c. Agriculture/forestry/fishing: Liquid Fuels (CO_2)	65657	57365	T	L	L
1.A.4.c. Agriculture/forestry/fishing: Solid Fuels (CO_2)	9740	2136	T	L	0
1.A.5.a Stationary: Liquid Fuels (CO_2)	7011	3968	0	L	0
1.A.5.a Stationary: Solid Fuels (CO_2)	6065	4	T	0	0
1.A.5.b Mobile: Liquid Fuels (CO_2)	8088	2490	T	L	0
1.B.1.a. Coal mining and handling (CH_4)	84974	24874	T	L	L
1.B.2.a. Oil (CH_4)	6897	727	T	0	0
1.B.2.a. Oil (CO_2)	8633	9709	T	L	L
1.B.2.b. Natural gas (CH_4)	46594	11994	T	L	L
2.A.1. Cement production (CO_2)	95237	67428	T	L	L
2.A.2. Lime production (CO_2)	23935	15894	0	L	L
2.A.4. Other process uses of carbonates (CO_2)	11061	10305	T	L	L
2.B.1. Ammonia production (CO_2)	31628	14900	T	L	L
2.B.10. Other (CO_2)	9157	13836	T	L	L
2.B.2. Nitric acid production (N_2O)	40776	1865	T	L	0
2.B.3. Adipic acid production (N_2O)	33558	79	T	L	0
2.B.8. Petrochemical and carbon black production (CO_2)	13613	14088	T	L	L
2.B.9. Fluorochemical production (Unspecified mix of HFCs and PFCs)	4670	23	T	0	0
2.C.1. Iron and steel production (CO_2)	103488	60475	T	L	L
2.F.1. Refrigeration and air-conditioning (HFCs)	5	54307	T	0	L
3.A. Enteric fermentation (CH_4)	237259	180808	T	L	L
3.B. Manure management (CH_4)	54611	44849	T	L	L
3.B. Manure management (N_2O)	25645	17362	0	L	L
3.D.1. Direct N_2O Emissions From Managed Soils (N_2O)	115139	87488	T	L	L
3.D.2. Indirect N_2O emissions from managed soils (N_2O)	31339	20739	0	L	L

Source category gas	kt CO_2 equ.		Trend	Level	
	1990	2022		1990	2022
3.G.1. Limestone $CaCO_3$ (CO_2)	6701	4843	0	0	L
4(II).D. Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CH_4)	7855	8583	T	L	L
4.A.1. Forest land remaining forest land (CO_2)	-297676	-257603	T	L	L
4.A.2. Land converted to forest land (CO_2)	-57731	-42104	T	L	L
4.B.1. Cropland remaining cropland (CO_2)	29739	4755	T	L	L
4.B.2. Land converted to cropland (CO_2)	34591	15083	T	L	L
4.C.1. Grassland remaining grassland (CO_2)	45129	27212	T	L	L
4.C.2. Land converted to grassland (CO_2)	-6738	-11595	T	0	L
4.D.1. Wetlands remaining wetlands (CH_4)	7917	8289	T	L	L
4.D.1. Wetlands remaining wetlands (CO_2)	9465	10822	T	L	L
4.D.2. Land converted to wetlands (CO_2)	1199	3562	T	0	0
4.E.2. Land converted to settlements (CO_2)	22357	24064	T	L	L
4.G. Harvested wood products: Wood product (CO_2)	-28404	-39341	0	L	L
5.A.1. Managed waste disposal sites (CH_4)	102013	65244	T	L	L
5.A.2. Unmanaged waste disposal sites (CH_4)	30130	9007	T	L	L
5.D.1. Domestic wastewater (CH_4)	26502	10200	T	L	L
5.D.1. Domestic wastewater (N_2O)	6508	7455	T	0	L
5.D.2. Industrial wastewater (CH_4)	9469	5900	0	L	L

Note: EU totals for 2022 in sector Energy and IPPU do not include data for Sweden due to confidential reporting. For more details on confidential reporting from Sweden refer to section 1.7.2.

1.5 Quality assurance, quality control of the European Union inventory

1.5.1 QA/QC programme

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)[19]. 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, as well as for adherence to the IPCC methodologies. Member States are also responsible for establishing national QA/QC programmes for their inventories as part of their national inventory systems.
- The European Commission (DG CLIMA) ensures that the objectives of the QA/QC programme are fulfilled. The EEA is responsible for the annual implementation of QA/QC procedures for the Union inventory. The EEA performs the tasks relating to the objectives of the QA/QC programme while the EEA's ETC/CM coordinates QA/QC activities for the Union inventory and develops the QA/QC plan.

[19] https://climate.ec.europa.eu/document/download/0e61356d-64f2-4c36-b5e0-51d3ede269e1_en?filename=swd_2013_308_en.pdf

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

The overall objectives of the EU QA/QC programme are stated in the SWD(2013) 308, §29 (a)-(g).

A number of specific objectives (SWD(2013) 308, §31 to 36) 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 (SWD(2013) 308, §38 to 50) 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 ((SWD(2013) 308, §51 to 56) are defined, such as the Working Group1, an internal review mechanism, sector specific workshops, UNFCCC review results.

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 1.11 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		

Chapter		Chapter description
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:

1.5.2 Quality control procedures at MS inventory level

The QC activities of MS submissions include:

Completeness Check	- all gases for all years
	- correct use of notation keys
	- check of blank cells
Time series consistency	- consistency in emissions, IEF - detect identical values in different reporting years
IEF comparison	- identify IEF outliers
Recalculations	- identify recalculations > +/- 0.05% and/or 500 kt CO_2 eq - check explanations provided - check recalculations of resubmissions within year
EU ETS	- check consistency/transparency of EU ETS data with CRT data
Review recommendations	- check status of implementation of review recommendations
Potential over- and underestimates	- identify potential over- and underestimates and MS level
Methods and EF used	- collect and check information on methods and EF used

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 Climate Action 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 CRT 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 Governance Regulation, 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 inventory team that are not resolved at the end of the QA/QC process in one submission year will be followed-up in the consecutive year.

1.5.3 Quality control at EU inventory level

After the initial checks of the emission data, the EEA transfers the national data from the JSON-files into their CRT CWS database. The CRT CWS database is maintained and managed by European Environment Agency..

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'.

1.5.4 Quality assurance procedures

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 NID.

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

Between 2012 and 2022, nine 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 (Effort Sharing Decision[20])

The ESD reviews were coordinated by the EEA, and were carried out in two steps: Step 1 was implemented by the EU team and made 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 EU legislation and the separate inventory review process occurring under the UNFCCC. Step 2 was implemented by independent review teams comprising of lead reviewers and sector experts. The ESD reviews were carried out either as comprehensive review or as annual review. History of ESD reviews:

Year	Review Type	Purpose of the Review
2012	1st comprehensive Review	Determine the emission allocations 2013-2020 for the EU internal GHG emission reduction targets 2020 and respective trajectories

[20] 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, p. 136–148

2015, 2017, 2018, 2019, 2021, 2022	Annual Review	Compliance with their annual ESD targets, enable the use of flexibilities and the application of corrective action, where necessary, at the end of each relevant year.
2016	2nd comprehensive Review	Review of reference years 2005, 2008-2010, 2013-2014
2020	3rd Comprehensive Review	Fix the base year and the greenhouse gas emissions targets for 2030, and the trajectory years for 2021-2029

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.

From 2017 to 2022 onwards, every year capacity building webinars have been organised for the Sectors Energy, IPPU, Agriculture, and Waste based on the most common issues detected during the EU internal reviews. Almost all Member States participated in the training sessions.

In 2021, 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.

As a result of the capacity building webinars guidance documents have been developed to support the Member States in improving their inventories. By April 2023 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, which also allowed for in-country visits.

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 2022 the European Union was last reviewed by the UNFCCC inventory review, the review report can be found here: https://unfccc.int/sites/default/files/resource/arr2022_EU.pdf.

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 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.

1.5.5 Further improvement of the quality of inventories

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 EU legislation. 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. The follow-up activities are subsequently addressed in meetings of WG 1 under the Climate Change Committee.

Table 1.12 Overview of recent GHG inventory related workshops and expert meetings organised by the EU

Workshop/expert meeting	Date and venue
JRC LULUCF workshop 2024	22-23 May, 2024. Ispra (VA). Italy.
JRC LULUCF workshop 2023: LULUCF inventories for enhancing climate action.	11-12 May, 2023. JRC, Ispra (VA). Italy.
JRC technical workshop: Towards 'fit for 55': updates in LULUCF reporting and accounting"	20-21 June 2022, Varese, Italy
JRC virtual technical workshop: LULUCF in transition: present and future challenges for reporting and accounting	7-8 June 2021, JRC, Ispra (VA). Italy.
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

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

There were no changes since previous annual GHG inventory submission.

1.6 General uncertainty evaluation

The uncertainty analysis was made on the basis of the Tier 1 uncertainty estimates, which were submitted by EU Member States as part of their EU GHG inventory reporting requirements under Article 26(3) and Annex V(Part 1)(m) of the Governance Regulation (EU) 2018/1999.

As documented in previous NID submissions, some of the Member State Tier 1 uncertainty estimates that are reported for the purpose of compiling the Union inventory are 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 are provided varies between the countries. Since the UNFCCC submission in 2022, the methodology for compiling the EU inventory uncertainties harmonises and gap-fills the MS uncertainty estimates so that the tables containing the EU uncertainties are consistent with the final aggregate-, sector- and subsector emission values reported in the EU CRT tables and elsewhere in the NID 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 CRT tables of the countries. These final CRT data are accessed via an SQL query of the EEA database containing the Member State CRT 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 uncertainty 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 CRT tables.

With complete data on uncertainties as well as emissions and removals for all 27 EU Member States, 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 the CRT 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 1.16) 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 1.16) 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, the 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 calculated by aggregating 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 NID 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 were used in all the cases to ensure comparability with analytical estimates. Table 1.14 gives an example of such a 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 a MC procedure without any further detailed assumptions on distributions would simply lead to comparable estimates as the first order approximation (Table 1.15).

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 1.16 shows the main results of the Tier 1 uncertainty analysis for the EU. The lowest level uncertainty estimates are for Fuel combustion activities (2.7 %) and the highest estimates are for LULUCF (52.7 %). Overall level uncertainty estimates on total GHG emissions and removals including LULUCF is calculated at 5.5%. If LULUCF is excluded, the total level uncertainty is lower at 3.5 %. With regard to trend uncertainty estimates (expressed as a percentage of base year emissions), the lowest uncertainty estimates are for Fuel combustion activities (+/-2.3 percentage points) and the highest estimates are for LULUCF (+/- 29.4 percentage points). Overall trend uncertainty (including LULUCF) of total emissions and removals is estimated to be 2.3 percentage points. Excluding LULUCF, the trend uncertainty is slightly lower at 1.8 percentage points. More detailed uncertainty estimates for the source categories are provided in Chapters 3-7.

It is perhaps important to clarify that uncertainties are inherent to all kinds of estimates (statistics, measurements, model simulations etc) thus underlining the fundamental importance of uncertainty assessment. Furthermore, the estimated uncertainties here (and elsewhere in the NID) indicate the likely range around which the EU GHG emission levels and trends vary according to error assumptions on the underlying activity data and emission factors used by the Member States. They are thus estimates of confidence (95% confidence intervals) in the results of the EU GHG emission inventory and are not indications of biases in given directions.

Overall, the uncertainty in the total EU emission and removal (including LULUCF) levels and trends are low at 5.5% and 2.3%, respectively. In percentage points, trend uncertainty is lower than level uncertainty given that inventory methods are applied consistently over time, meaning that uncertainties are likely correlated over time. For example, a thermometer with a given error (offset) may provide an uncertain estimate of daily air temperature on a given day, but will provide a much less uncertain estimate of temperature change between days, assuming that the error remains stable over time.

While level and trend uncertainties in total EU GHG emissions and removals are low, uncertainties do vary considerably between and within sectors, reflecting the varying difficulty in estimating emissions and removals from different sources and sinks. Level uncertainties in 1.A Fuel combustion, the largest absolute sectoral contributor to the inventory level and trend, are low at 2.7%, while for LULUCF they are much higher at 52.7%. Assessments of (sub-) sectoral uncertainty help guide targeted inventory methodological improvements that ultimately should lead to uncertainty reductions and accuracy improvements. While this is principally the responsibility of the individual Member States, it is worth noting relevant EU legislation targeting methodological improvements in some of the more uncertain sources/sinks of GHGs. For example, the amended EU LULUCF Regulation (2023/839) will require MS to move to higher Tier methodologies for all pools and categories of the LULUCF sector over the coming decade.

Table 1.15 Tier 1 uncertainty estimates of EU GHG emissions and removals (in CO_2 equivalents) for the main sectors

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2021	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A Fuel combustion activities	all	3 572 043	2 542 748	-28,8%	2,7%	2,3%
1.B Fugitive emissions	all	169 011	59 322	-64,9%	36,1%	9,6%
2. Industrial processes	all	450 353	289 158	-35,8%	7,7%	2,3%
3. Agriculture	all	483 222	365 719	-24,3%	21,9%	3,0%
4. LULUCF	all	-217 454	-236 454	8,7%	52,7%	29,4%
5. Waste	all	184 092	108 570	-41,0%	38,5%	7,9%
Indirect CO2 emissions	all	7 748	3 624	-53,2%	17,5%	4,5%
Total (excl LULUCF)	**all**	**4 866 469**	**3 369 140**	**-30,8%**	**3,5%**	**1,8%**
Total (incl LULUCF)	**all**	**4 649 015**	**3 132 686**	**-32,6%**	**5,5%**	**2,3%**

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 was in particular evident with regards to the KP LULUCF, where a carbon pool could be not reported ('NR' should be used) provided that transparent and verifiable information was provided indicating that the pool was 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 Governance 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 XXI 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 Article 5 of the Commission Delegated Regulation (EU) 2020/1044[21]. Article 5(3) 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.

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 was also relevant for the ESD reviews.

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

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.

[21] Commission Delegated Regulation (EU) 2020/1044 of 8 May 2020 supplementing Regulation (EU) 2018/1999 of the European Parliament and of the Council with regard to values for global warming potentials and the inventory guidelines and with regard to the Union inventory system and repealing Commission Delegated Regulation (EU) No 666/2014; OJ L 230, 17.7.2020, p. 1–6

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 CRTs 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 CRTs in a category where all EU MS report notation keys. Table 1.18 shows the mandatory categories where "NE" are visible in the CRTs for 2022.

Table 1.16 Overview of the number of NE visible in the EU CRTs for 2022

Sector	**Number of NE visible in the EU CRTs for the year 2022 for mandatory categories (MS reporting NE)**
Energy	*
IPPU	*
Agriculture	*
Waste	*

Note: The table will be updated during the technical expert review of the GHG inventory scheduled in 2025, following the submission of the final CRTs by the EU. See also footnote 4 of the executive summary for more information.

1.7.3 Reporting of confidential data

According to the MPGs Parties may report specific categories with the notation key C in case of confidentiality. Manual changes are regularly performed by the EU in order to protect confidential data reported by its EU Member States. 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 2023.

Table 1.17 Confidential data reported by MS in key categories for the EU

Source category gas	**Confidential data**	
	1990	**2022**

Note: The EU will provide further information during the technical expert review of the GHG inventory scheduled in 2025, following the submission of the final CRTs by the EU. See also footnote 4 of the executive summary for more information.

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 CRT tables only.

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 based on the following methodologies and data:

where a Member State has submitted in the previous reporting year a consistent time series of estimates for the relevant source category and:

- that Member State has submitted an approximated greenhouse gas inventory for the year X – 1 pursuant to Article 26(2) of Regulation (EU) 2018/1999 that includes the missing estimate, on the data from that approximated greenhouse gas inventory;
- that Member State has not submitted an approximated greenhouse gas inventory for the year X – 1 under Article 26(2) of Regulation (EU) 2018/1999, but the Union has estimated approximated greenhouse gas emissions for the year X – 1 for that Member State in accordance with Article 26(2) of Regulation (EU) 2018/1999[22], on the data from that Union approximated greenhouse gas inventory;
- the use of the data from the approximated greenhouse gas inventory of the Member State is not possible or may lead to a highly inaccurate estimation, for missing estimates in the energy sector, on the energy statistics data obtained in accordance with Regulation (EC) No 1099/2008 of the European Parliament and of the Council;
- the use of the data from the approximated greenhouse gas inventory is not possible or may lead to a highly inaccurate estimation, for missing estimates in non-energy sectors, on estimation methodologies consistent with the technical advice on gap filling in Section 2.2.3 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Vol. 1) using, where appropriate, European statistics;

where an estimate of an emission by source or removal by sink for the relevant category was subject to technical corrections in accordance with Article 38(2)(d) of Regulation (EU) 2018/1999 in the latest review prior to the submission and the Member State concerned has not submitted a revised estimate, on the method used by the technical expert review team to calculate the technical correction;

where a consistent time series of reported estimates for the relevant source category is not available, on estimation methodologies consistent with the technical advice on gap filling in Section 2.2.3 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Vol. 1).

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.

[22] Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics; OJ L 304, 14.11.2008, p. 1

The methods used for gap filling include interpolation, extrapolation and clustering. These methods are consistent with the 2006 IPCC guidelines[23].

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

1.7.4.2 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.

Applying the rules mentioned above activity data of the following categories have been gap-filled in this inventory submission for the year 2021:

- Lime Production 2A2
- Ammonia Production 2B1

1.7.5 Geographical coverage of the European Union inventory

Table 1.20 shows the geographical coverage of the EU Member States' national inventories. Note that the EU territory of a Member State is not always equivalent to the territory of the Party to the UNFCCC. For two Member States there are differences in geographical coverage as UNFCCC Party and/or EU Member State (Denmark and France). If there are differences in geographical coverage the respective country needs to prepare more than one inventory.

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 for their respective EU territory. Note that Denmark and France submit GHG inventories to the UNFCCC that may differ from the GHG inventories used for the EU inventory because these countries submit an inventory to the UNFCCC, which is consistent with the Party coverage of these countries. However, the EU's submission under the Convention is fully consistent with MS GHG emissions by sources and sinks according to the EU territory (see Table 1.20).

Table 1.18 Geographical coverage of the Union's GHG inventory

Member State	Geographical coverage	EU-territory coverage	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

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

Member State	Geographical coverage	EU-territory coverage	Country code
Czechia	Czech Republic	✓	CZE
Denmark	Denmark (excluding Greenland and the Faeroe Islands)	✓	DNK
Estonia	Estonia	✓	EST
Finland	Finland including Åland Islands	✓	FIN
France	Metropolitan France, the overseas departments (Guadeloupe, Martinique, French Guiana, Réunion and Mayotte) and the overseas community Saint-Martin; excluding the overseas communities French Polynesia, Wallis and Futuna, Saint-Pierre and Miquelon, and Saint-Barthélemy; and excluding the 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
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 the Dutch Caribbean territories 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 realised 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	✓	EUU

1.7.6 Completeness of the European Union submission

1.7.6.1 National inventory document

The EU NID follows – as far as possible - the annotated outline of the national inventory document following Annex V of Decision 5/CMA.3, 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 1.21 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 1.19 Annexes as outlined in the UNFCCC reporting guidelines and annexes included in the EU submission

Annex required in Annex V of Decision 5/CMA3	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 NID, section 1.6
Annex III: Any additional information, as applicable, including detailed methodological descriptions of source or sink categories and the national emission balance	Included: A summary description of the methodologies used by each Member State for the EU key categories

1.7.6.2 Activity data in the EU CRT/JSON

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.

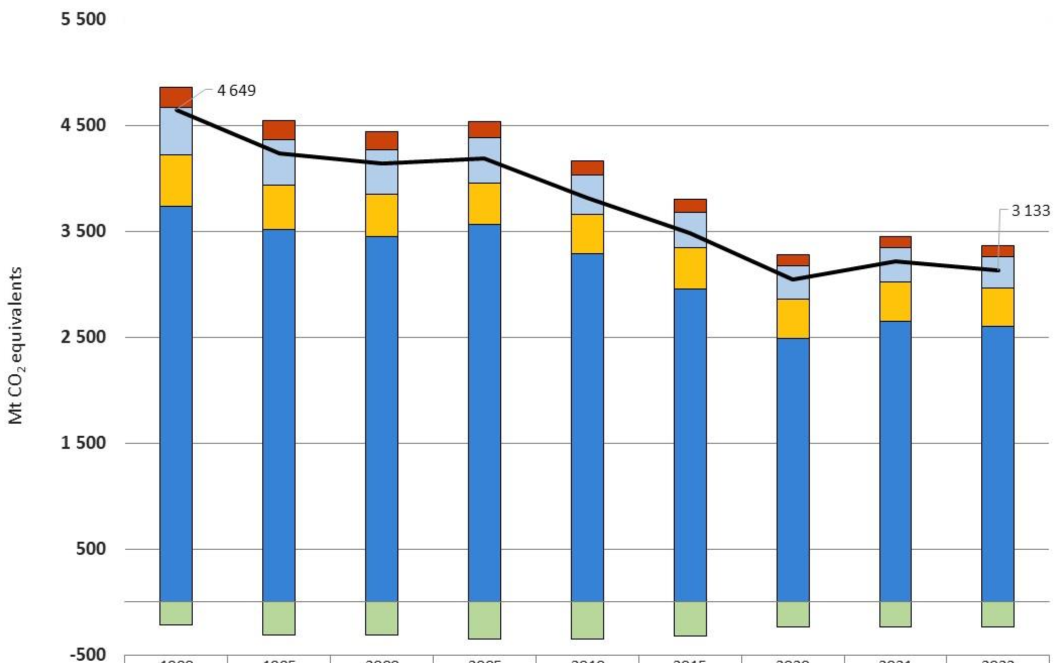
2 TRENDS IN EU GREENHOUSE GAS EMISSION AND REMOVALS

This chapter presents the main GHG emission trends in the EU. 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 GHG trends is given. Finally, the trends of indirect GHGs and SO_2 emissions are presented.

2.1 Aggregated greenhouse gas emissions and removals

In 2022, total GHG emissions in the EU, including LULUCF and indirect CO_2, were 33 % (-1 516 million tonnes CO_2 equivalents) below 1990 levels. Emissions decreased by 2.6 % (-83 million tonnes CO_2 equivalents) between 2021 and 2022 (Figure 2.1). The EU's national total emissions[24] also include LULUCF.

Figure 2.1 EU GHG emissions and removals 1990–2022



	1990	1995	2000	2005	2010	2015	2020	2021	2022
LULUCF	-217	-317	-311	-348	-351	-325	-241	-241	-236
Waste	184	187	174	155	136	117	111	110	109
IPPU	450	430	414	429	364	342	306	318	289
Agriculture	483	417	408	387	375	383	380	376	366
Energy	3 741	3 516	3 449	3 566	3 290	2 961	2 486	2 650	2 602
Total net GHG emissions (including indirect CO2)	4 649	4 240	4 141	4 194	3 819	3 482	3 045	3 216	3 133

Notes: 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 Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

[24] Unless otherwise specified, the national GHG totals in this report always include LULUCF. They may also be referred to as 'net' total GHG emissions. The other UNFCCC sectors that are included in the national totals are energy, industrial processes and product use, agriculture, waste, international aviation, and indirect CO_2 emissions.

2.1.1 Main trends by source category, 1990-2022

Total GHG emissions (including LULUCF and indirect CO_2 emissions) decreased by 1 516 Mt CO_2 eq. since 1990 reaching 3 133 Mt CO_2 equivalent in 2022. There has been a progressive decoupling of gross domestic product (GDP) and GHG emission compared to 1990, with an increase in GDP of 67 % alongside a decrease in emissions of about 33 % over the period.

The trend in GHG emissions over the 32-year period was driven by 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, and more recently, the economic recession from the COVID-19 pandemic in 2020, the recovery of 2021 and high energy prices in 2022.

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 2022 compared to 1990. Demand for energy to heat households has also been lower, as, besides better insulation standards in buildings, 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 2022, with the notable exception of transport, refrigeration and air conditioning, where emissions increased, and forest land, where net removals decreased. For the latter, the main reasons for the decrease in net removals include the aging of the forests from the late 2000s and a lower annual increment, as well as increased harvesting. At the aggregate level, emission reductions were largest for public electricity and heat production, manufacturing industries and construction, residential combustion, and iron and steel production (including energy-related emissions).

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 have decreased strongly since 1990. In addition to improved energy efficiency there has been a move towards less carbon intense fuels. Between 1990 and 2022, the use of solid and liquid fuels in thermal power stations decreased strongly (by 50% and 83%, respectively) whereas natural gas consumption developed in the opposite direction (increasing by 71%). Coal consumption in 1990 was two times higher than in 2022. The use of renewable energy sources in electricity and heat generation has increased substantially in the EU since 1990. According to Eurostat, more electricity was produced from renewables in the EU than for all fossil fuels together in the years between 2020 and 2022. 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 32 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 also been substantial, reflecting, inter alia, 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 Member State specific, have contributed to the overall GHG emission reduction, such as key agricultural and environmental policies in the 1990s and climate and energy policies in the past two decades since 2005. The latter include the implementation of the EU Emissions Trading System as well as national policies for the sectos not covered by the EU ETS. More information on policies and measures can be found in the EU's first Biennial Transparency Report under the Enhanced Transparency Framework of the Paris Agreement.

Almost all EU Member States reduced emissions compared to 1990 and thus contributed to the overall positive EU performance. Germany, Romania, Italy and France accounted for almost two thirds of the total net reduction in EU emissions during the past 32 years.

Table 2.1 shows those sources that made the largest contribution to the change in total GHG emissions in the EU between 1990 and 2022.

Table 2.1 Overview of EU categories whose emissions and/or removals increased or decreased by more than 20 Million tonnes CO_2 equivalent in the period 1990-2022; including LULUCF categories

Source category	Million tonnes (CO_2 equivalents)
Road Transportation (CO_2 from 1.A.3.b)	147
Refrigeration and Air conditioning (HFCs from 2.F.1)	54
Forest land remaining forest land (CO_2 from 4.A.1)	40
Unmanaged Waste Disposal Sites (CH_4 from 5.A.2)	-21
Fuels used in Agriculture/Forestry/Fishing (CO_2 from 1.A.4.c)	-21
Grassland (CO_2 from 4.C)	-23
Cropland remaining cropland (CO_2 from 4.B.1)	-25
Agricultural soils: Direct N2O emissions (N_2O from 3.D.1)	-28
Cement Production (CO_2 from 2.A.1)	-28
Adipic Acid Production (N_2O from 2.B.3)	-33
Managed Waste Disposal Sites (CH_4 from 5.A.1)	-37
Nitric Acid Production (N_2O from 2.B.2)	-39
Fugitive Emissions from Oil and Natural Gas (CH_4 from 1.B.2)	-44
Cropland (CO_2 from 4.B)	-44
Enteric Fermentation: Cattle (CH_4 from 3.A.1)	-46
Fugitive Emissions from Solid Fuels (CH_4 from 1.B.1)	-60
Manufacture of Solid Fuels and Other Energy Industries (CO_2 from 1.A.1.c)	-70
Fuels used Commercial/Institutional Sector (CO_2 from 1.A.4.a)	-71
Iron and Steel Production (CO_2 from 1.A.2.a + 2.C.1)	-122
Fuels used Residential Sector (CO_2 from 1.A.4.b)	-151
Manufacturing industries (excl. Iron and steel) (Energy-related CO_2 from 1.A.2 excl. 1.A.2.a)	-248
Public Electricity and Heat Production (CO_2 from 1.A.1.a)	-498
Total	**-1516**

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 and the Memorandum item international aviation are reflected in this table.

2.1.2 Main trends by source category, 2021-2022

Total GHG emissions (including LULUCF) decreased in 2022 by 83 million tonnes, or 2.6 % compared to 2021, to reach 3 133 Mt CO_2 equivalent in 2022.

The largest decrease in emissions in 2022 was in 'buildings', which includes fuels used in the residential and commercial/institutional sectors. The reduction in CO_2 was 50 Mt in the last year alone, mostly attributed to lower natural gas consumption compared to 2021. According to the Copernicus climate change service, 2022 was the second warmest year on record in Europe. A strong reduction in

Eurostat's heating degree days also confirms reduced demand for heating in 2022 leading to signficantly lower emissions.

The other large decrease in EU emissions occurred in manufacturing industries and construction, including combustion and process-related emissions from iron and steel, with a reduction of 40 Mt in 2022 triggered by lower industrial demand for energy.

Higher emissions from electricity and heat production and from road transportation did not offset stronger emission reductions in other inventory sectors, resulting in the reported net emission reduction of 83 Mt CO_{2e} in the EU in 2022.

Table 2.2 shows the categories making the largest contribution to the change in GHG emissions and removals in the EU between 2021 and 2022.

Table 2.2 Overview of EU categories whose emissions and/or removals increased or decreased by more than 3 million tonnes CO_2 equivalent in the period 2021–2022

Source category	Million tonnes (CO_2 equivalents)
Public Electricity and Heat Production (CO_2 from 1.A.1.a)	21
Road Transportation (CO_2 from 1.A.3.b)	19
Harvested wood products (CO_2 from 4.G)	7
Domestic Aviation (CO_2 from 1.A.3.a)	3
Fuels used in Agriculture/Forestry/Fishing (CO_2 from 1.A.4.c)	-4
Ammonia Production (CO_2 from 2.B.1)	-5
Cement Production (CO_2 from 2.A.1)	-5
Agricultural soils: Direct N_2O emissions (N2O from 3.D.1)	-6
Forest land (CO_2 from 4.A)	-6
Forest land remaining forest land (CO_2 from 4.A.1)	-6
Fuels used Commercial/Institutional Sector (CO_2 from 1.A.4.a)	-14
Iron and Steel Production (CO_2 from 1.A.2.a + 2.C.1)	-14
Manufacturing industries (excl. Iron and steel) (Energy-related CO_2 from 1.A.2 excl. 1.A.2.a)	-26
Fuels used Residential Sector (CO_2 from 1.A.4.b)	-36
Total	**-83**

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 and the Memorandum item international aviation are reflected in this table.

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

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

	1990 (million tonnes)	2022 (million tonnes)	2021 - 2022 (million tonnes)	Change 2021 - 2022 (%)	Change 1990-2022 (%)	Share MS/EU 2022
Austria	67.4	68.4	2.1	3.1%	1.4%	2.2%
Belgium	142.9	103.1	-6.8	-6.1%	-27.8%	3.3%
Bulgaria	81.0	48.9	4.4	10.0%	-39.7%	1.6%
Croatia	25.2	19.7	1.0	5.4%	-21.9%	0.6%
Cyprus	5.4	8.5	0.0	-0.1%	56.3%	0.3%
Czechia	192.5	121.1	-4.9	-3.9%	-37.1%	3.9%
Denmark	78.3	41.7	-2.1	-4.8%	-46.8%	1.3%
Estonia	35.0	14.3	0.9	6.7%	-59.2%	0.5%
Finland	48.2	50.1	-0.9	-1.8%	4.1%	1.6%
France	521.2	377.2	-15.4	-3.9%	-27.6%	12.0%
Germany	1283.4	754.3	-7.9	-1.0%	-41.2%	24.1%
Greece	101.7	72.9	-0.1	-0.1%	-28.3%	2.3%
Hungary	91.8	52.7	-3.8	-6.7%	-42.5%	1.7%
Ireland	60.2	64.6	-1.8	-2.7%	7.2%	2.1%
Italy	518.7	391.8	5.3	1.4%	-24.5%	12.5%
Latvia	13.7	15.1	2.1	16.4%	10.3%	0.5%
Lithuania	42.7	12.6	-2.1	-14.5%	-70.6%	0.4%
Luxembourg	12.7	7.5	-1.2	-14.0%	-40.8%	0.2%
Malta	2.6	2.3	0.2	7.8%	-13.5%	0.1%
Netherlands	228.1	158.4	-13.0	-7.6%	-30.5%	5.1%
Poland	447.4	344.9	-30.6	-8.1%	-22.9%	11.0%
Portugal	66.1	50.5	0.2	0.3%	-23.7%	1.6%
Romania	230.4	63.5	-3.9	-5.7%	-72.4%	2.0%
Slovakia	64.6	29.8	-4.2	-12.3%	-53.8%	1.0%
Slovenia	14.4	15.4	-0.3	-1.9%	7.1%	0.5%
Spain	253.4	246.8	5.8	2.4%	-2.6%	7.9%
Sweden	19.9	-3.4	-6.4	-215.7%	-117.2%	-0.1%
EU-27	**4649.0**	**3132.7**	**-83.3**	**-2.6%**	**-32.6%**	

2.2 Emission and removal trends by gas

Table 2.4 and Figure 2.3 give an overview of the main trends in EU GHG emissions and removals for 1990–2022. In the EU the most important GHG is CO_2, accounting for 74 % of total EU emissions in 2022 including LULUCF. In 2022, CO_2 emissions including LULUCF were 2 481 Mt, which was 32 % below 1990 levels. Compared to 2021, CO_2 emissions decreased by 3 %. During that period CH_4 and N_2O emissions decreased slightly more by 4%.

Table 2.4 Overview of EU GHG emissions and removals from 1990 to 2022 in CO_2 equivalent

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2010	2015	2020	2021	2022
Net CO_2 emissions/removals	3 635	3 301	3 275	3 374	3 061	2 757	2 368	2 545	2 481
CO_2 emissions (without LULUCF)	3 881	3 647	3 613	3 748	3 438	3 106	2 634	2 812	2 744
CH_4	666	610	559	512	472	445	419	416	409
N_2O	298	274	243	231	191	188	184	183	175
HFCs	13	21	42	63	84	83	66	63	60
PFCs	22	15	10	6	3	3	2	2	1
Unspecified mix of HFCs and PFCs	5	5	2	1	1	1	2	2	1
SF_6	10	14	9	7	6	6	5	5	4
NF_3	0	0	0	0	0	0	0	0	0
Total (with net CO_2 emissions/removals)	**4 649**	**4 240**	**4 141**	**4 194**	**3 819**	**3 482**	**3 045**	**3 216**	**3 133**
Total (without LULUCF)	**4 866**	**4 558**	**4 452**	**4 542**	**4 170**	**3 807**	**3 286**	**3 457**	**3 369**

Notes: CO_2 emissions include indirect CO_2

The largest key categories for CO_2 emissions and removals (Table 2.5) have been reduced between 1990 and 2022 with the exception of 1.A.3.b Road transportation.

Table 2.5 CO_2 emissions by large key categories: absolute and relative change 1990 to 2022 in CO_2 equivalents (Mt) and their share in 2022 EU Total CO_2 emissions

GREENHOUSE GAS SOURCE CATEGORIES	1990 (kt)	2022 (kt)	absolute change (Mt)	% change (in Mt)	share 2022
1.A.3.b - Road Transportation	609231	755844	147	24%	28%
1.A.1.b - Petroleum Refining	107030	94956	-12	-11%	3%
2.A.1 - Cement Production	95237	67428	-28	-29%	2%
2.C.1.a - Steel Production	77597	48934	-29	-37%	2%
1.A.4.a - Commercial/Institutional	165593	94655	-71	-43%	3%
1.A.4.b - Residential	413579	262733	-151	-36%	10%
1.A.2 - Manufacturing Industries and Construction	715764	389302	-326	-46%	14%
1.A.1.a - Public Electricity and Heat Production	1227049	728984	-498	-41%	27%
All other CO2 emissions	469692	301376	-168	-36%	11%
Total CO2	**3880771**	**2744214**	**-1137**	**-29.29%**	**100.00%**

Note: Other is calculated by subtracting the presented categories from the sector total including LULUCF and international aviation

CH_4 emissions account for 12 % of total EU GHG emissions in 2022 and decreased by 39 % since 1990 to 409 Mt CO_2 equivalents in 2022 (Table 2.6). The two largest key categories are enteric fermentation from cattle and anaerobic waste (Table 2.6). They account for 54 % of CH_4 emissions in 2022.

Table 2.6 shows that the main reasons for declining CH_4 emissions were reductions in coal mining, cattle population and natural gas operations.

Table 2.1 CH_4 emissions by large key categories: absolute and relative change 1990 to 2022 in CO_2 equivalents (Mt) and their share in 2022 EU Total CH_4 emissions

GREENHOUSE GAS SOURCE CATEGORIES	1990 (kt)	2022 (kt)	absolute change (Mt)	% change (in Mt)	share 2022
1.A.4 - Other Sectors	22869	16221	-7	-29%	4%
3.A.2 - Enteric Fermentation - Sheep	23577	15895	-8	-33%	4%
3.B.1 - CH4 Emissions - Farming	54611	44849	-10	-18%	11%
5.D - Wastewater Treatment and Discharge - Wastewater	36220	16172	-20	-55%	4%
5.A.1.a - Anaerobic - Waste	95625	64383	-31	-33%	16%
1.B.2.b - Natural Gas - Operation	46594	11994	-35	-74%	3%
3.A.1 - Enteric Fermentation - Cattle	201206	154727	-46	-23%	38%
1.B.1.a - Coal Mining and Handling - Operation	84974	24874	-60	-71%	6%
All other CH4 emissions	100353	59595	-41	-41%	15%
Total CH4	**666029**	**408710**	**-257**	**-39%**	**100%**

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

N_2O emissions are responsible for 5 % of total EU GHG emissions and decreased by 41 % to 175Mt CO_2 equivalents in 2022 (Table 2.7). N_2O emissions derive mainly from the agriculture sector. The two largest key categories account for about 64 % of N_2O emissions in 2021 (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.

Table 2.7 N_2O emissions by large key categories: absolute and relative change 1990 to 2022 in CO_2 equivalents (Mt) and their share in 2022 EU Total N_2O emissions

GREENHOUSE GAS SOURCE CATEGORIES	1990 (kt)	2022 (kt)	absolute change (Mt)	% change (in Mt)	share 2022
3.D.1 - Agricultural Soils - Direct N2O Emissions From Managed Soils	115139	87488	-28	-24%	50%
3.D.2 - Agricultural Soils - Farming	31339	20739	-11	-34%	12%
3.B.2 - N2O and NMVOC Emissions - Farming	25645	17362	-8	-32%	10%
5.D - Wastewater Treatment and Discharge - Wastewater	7109	7683	1	8%	4%
1.A.3.b - Road Transportation	4734	7080	2	50%	4%
2.B - Chemical Industry	78749	3149	-76	-96%	2%
1.A.1.a - Public Electricity and Heat Production	5283	4842	0	-8%	3%
All other N2O emissions	30221	26814	-3	-11%	15%
Total N2O	**298218**	**175159**	**-123**	**-41%**	**100%**

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

Fluorinated gas emissions account for 2% of total EU GHG emissions. In 2022, emissions amounted to 67 Mt CO_2 equivalents, which was 36 % above 1990 levels (Table 2.8). Refrigeration and air conditioning, the largest key category, accounts for 81 % of fluorinated gas emissions in 2022. 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 Table 2.8 decreased substantially.

Table 2.8 F-Gases emissions by large key categories: absolute and relative change 1990 to 2022 in CO_2 equivalents (Mt) and their share in 2022 EU Total F-Gases emissions

GREENHOUSE GAS SOURCE CATEGORIES	1990 (kt)	2022 (kt)	absolute change (Mt)	% change (in Mt)	share 2022
2.F.1 - Refrigeration and Air conditioning - HFCs	5	54307	54	1164580%	81%
2.F.3 - Fire Protection - HFCs	0	2351	2	NA	3%
2.F.4 - Aerosols - HFCs	1	1724	2	117600%	3%
2.F.2 - Foam Blowing Agents - HFCs	0	1561	2	NA	2%
2.G.2 - SF6 and PFCs from Other Product Use - SF6	4275	2367	-2	-45%	4%
All other F-gas emissions	45272	5014	-40	-89%	7%
Total F-gases	**49554**	**67323**	**18**	**36%**	**100%**

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

2.3 Emission and removal trends by sector

Table 2.9 gives an overview of EU emissions in the main source and sink categories for 1990–2022. The most important sector in terms of GHG emissions is energy (i.e. combustion and fugitive emissions), which accounted for 77 % of total emissions including LULUCF in 2022. The second largest sector is agriculture (11 %), followed by industrial processes (9 %). The LULUCF sector accounted for -7 % of the EU's gross national total emissions (excluding LULUCF) in 2022. More detailed trend descriptions are included in the individual sector chapters (chapters 3-7) and chapter 9 on indirect CO_2 emissions.

Table 2.9 Overview of EU GHG emissions (in million tonnes CO_2 equivalent) in the main source and sink categories for the period 1990 to 2022

GHG SOURCE AND SINK	1990	1995	2000	2005	2010	2015	2020	2021	2022
1. Energy	3 741	3 516	3 449	3 566	3 290	2 961	2 486	2 650	2 602
2. Industrial Processes	450	430	414	429	364	342	306	318	289
3. Agriculture	483	417	408	387	375	383	380	376	366
4. Land-Use, Land-Use Change and Forestry	-217	-317	-311	-348	-351	-325	-241	-241	-236
5. Waste	184	187	174	155	136	117	111	110	109
6. Other	0	0	0	0	0	0	0	0	0
indirect CO_2 emissions	8	7	6	6	5	4	4	4	4
Total (with net CO_2 emissions/removals)	**4 649**	**4 240**	**4 141**	**4 194**	**3 819**	**3 482**	**3 045**	**3 216**	**3 133**
Total (without LULUCF)	**4 866**	**4 558**	**4 452**	**4 542**	**4 170**	**3 807**	**3 286**	**3 457**	**3 369**

2.4 Emission trends by Member State

Table 2.6 gives an overview of EU Member States' contributions to the EU emissions including LULUCF and international aviation for 1990–2022. Countries show large variations in GHG emission trends.

Table 2.4 Overview of countries contributions to total EU GHG emissions, including LULUCF and including indirect CO_2 emissions from 1990 to 2022 in million tonnes CO_2-equivalent

Member State	1990	1995	2000	2005	2010	2015	2020	2021	2022
Austria	67.4	60.6	66.7	74.5	65.4	72.7	68.2	66.3	68.4
Belgium	142.9	151.3	147.2	143.6	133.2	118.4	107.0	109.9	103.1
Bulgaria	81.0	54.8	40.2	46.0	47.4	52.4	38.3	44.4	48.9
Croatia	25.2	14.3	19.1	22.0	21.4	19.1	18.3	18.7	19.7
Cyprus	5.4	6.8	8.2	9.0	9.2	8.1	8.2	8.5	8.5
Czechia	192.5	149.6	143.0	141.7	133.8	122.2	123.7	126.0	121.1
Denmark	78.3	85.2	77.4	72.9	67.1	49.6	43.9	43.8	41.7
Estonia	35.0	15.1	14.0	16.2	16.4	18.8	12.6	13.4	14.3
Finland	48.2	49.9	49.0	44.9	53.1	41.8	42.3	51.1	50.1
France	521.2	508.5	522.0	496.9	469.5	417.3	368.1	392.6	377.2
Germany	1283.4	1101.5	1036.2	995.9	926.5	891.3	737.6	762.2	754.3
Greece	101.7	106.5	124.1	133.2	115.8	91.8	70.7	73.0	72.9
Hungary	91.8	71.4	74.4	71.3	61.7	56.4	55.6	56.6	52.7
Ireland	60.2	65.9	75.2	77.4	68.0	65.5	63.9	66.4	64.6
Italy	518.7	513.1	541.1	561.9	482.7	400.6	351.6	386.5	391.8
Latvia	13.7	-2.2	-1.7	5.1	10.0	11.1	11.3	12.9	15.1
Lithuania	42.7	17.8	9.9	18.2	10.2	12.1	14.0	14.7	12.6
Luxembourg	12.7	9.5	9.0	12.4	11.9	9.9	8.6	8.8	7.5
Malta	2.6	2.7	2.7	3.0	3.0	2.1	2.1	2.1	2.3
Netherlands	228.1	237.1	225.2	220.6	219.9	200.4	168.8	171.5	158.4
Poland	447.4	428.4	358.7	351.4	370.9	349.4	348.1	375.5	344.9
Portugal	66.1	58.6	80.2	89.6	62.4	63.9	52.9	50.3	50.5
Romania	230.4	160.2	112.0	119.2	89.8	68.5	62.5	67.4	63.5
Slovakia	64.6	44.1	40.0	46.4	41.2	35.6	30.0	34.0	29.8
Slovenia	14.4	13.7	12.5	13.4	12.6	17.4	15.5	15.7	15.4
Spain	253.4	290.2	339.7	391.7	308.6	286.8	224.2	241.0	246.8
Sweden	19.9	25.3	14.8	15.6	7.3	-1.1	-2.8	3.0	-3.4
EU-27	**4649.0**	**4240.1**	**4140.7**	**4194.1**	**3818.9**	**3482.2**	**3045.1**	**3216.0**	**3132.7**

The overall EU GHG emission trend is dominated by the largest emitters Germany (24 %), France, Italy (12 % each) and Poland (11 %), accounting for over half of total EU GHG emissions in 2022. Germany, France, Italy and Romania accounted for 64 % of EU emission reductions between 1990 and 2022.

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.

France's emissions were 26 % below 1990 levels in 2022. 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 2022. However, HFC emissions from electronics industry and product uses as substitutes of ODS increased considerably between 1990 and 2022.

Italy's GHG emissions were 21 % below 1990 levels in 2022. 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 20% below 1990 levels in 2022. 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.

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 between 1990 and 2022. All emissions were reduced significantly from 1990 levels.

Table 2.5 Overview of EU indirect GHG and SO_2 emissions for 1990–2022 (kt)

	1990	1995	2000	2005	2010	2015	2020	2021	2022
NO_X	13 605	11 678	10 292	9 692	7 820	6 626	5 015	5 080	4 982
CO	55 353	42 469	33 537	27 428	23 683	19 419	16 276	17 093	16 626
NMVOC	15 804	12 779	10 755	9 536	8 288	7 461	7 035	6 896	7 158
SO_2	20 595	13 024	8 161	6 492	3 739	2 745	1 609	1 702	1 748

3 ENERGY (CRT SECTOR 1)

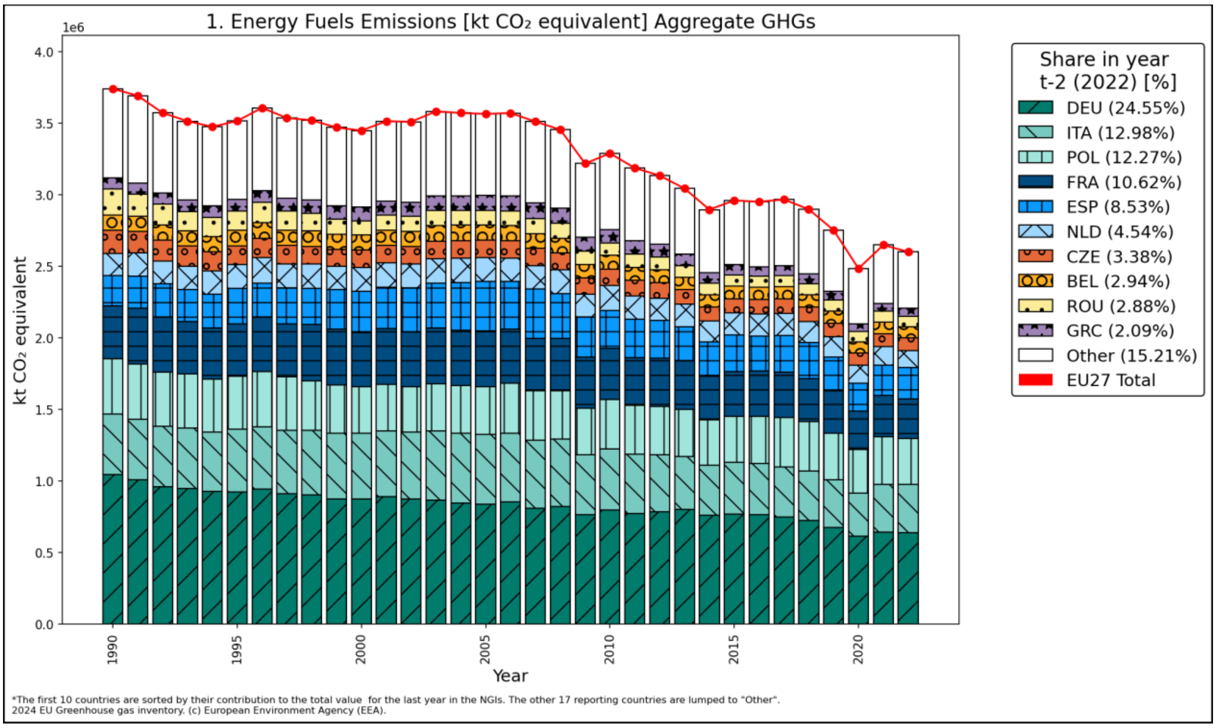
This chapter starts with an overview on emission trends in CRT Sector 1 Energy. For each EU key category as well as other important subsector specific categories, overview tables are presented including the countries' contributions to the category in terms of level and trend. This chapter includes also, the reference approach, and international bunkers[25].

3.1 Overview of sector

CRT 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 77% to total GHG emissions and is the largest emitting sector in the EU. Total GHG emissions from this sector decreased by 30 % from 3741 Mt in 1990 to 2602 Mt in 2022 (Figure 3.1). In 2022, emissions increased by 2 % compared to 2021.

The most important energy-related gas is CO_2 that makes up 80 % of the total EU greenhouse gas emissions in 2022. CH_4 of the energy sector is responsible for 2 % and N_2O for 1 % of the total GHG emissions.

Figure 3.1 CRT Sector 1 Energy: EU GHG emissions in CO_2 equivalents (kt) for 1990–2022



[25] The EU Greenhouse gas inventory data in this report was compiled using the September 2024 release of the 'CRT reporting tool' developed by the UNFCCC Secretariat. However, due to remaining technical shortcomings in the UNFCCC ETF tools, there have been substantial difficulties in preparing and finalizing the EU GHG inventory tables, which are based on the aggregation of emissions and removals from Member States' GHG inventories. In addition, because of the ongoing improvements and additional releases of the ETF tools by the UNFCCC secretariat after the compilation of the EU GHG inventory, reported data may differ from actual inventory data in some cases. The EU will provide additional information on sector-specific issues affected by the ETF tool during the technical expert review. For more information, see also footnote 4 of the executive summary.

Table 1-1shows that CO_2 emissions from source categories 1.A.1.a – Public Electricity and Heat Production and 1.A.3.b – Road Transportation account for 57% from the whole Sector 1. Substantial decreases in absolute terms between 1990 and 2022 were reported in CO_2 emissions from sectors 1.A.1.a – Public Electricity and Heat Production and 1.A.2 – Manufacturing Industries and Construction, while CO_2 emissions from sector 1.A.3.b – Road Transportation increased by 24% in the same period.

Table 3.1 Sector 1 Energy: Share and change of key source categories and all remaining categories in 1990 and 2022 in the EU

GREENHOUSE GAS SOURCE CATEGORIES	1990 (kt)	2022 (kt)	absolute change (Mt)	% change (in Mt)	share 2022
1.A.3.b - Road Transportation - CO2	609231	755844	147	24%	29%
1.A.1.b - Petroleum Refining - CO2	107030	94956	-12	-11%	4%
1.A.4.a - Commercial/Institutional - CO2	165593	94655	-71	-43%	4%
1.A.4.b - Residential - CO2	413579	262733	-151	-36%	10%
1.A.2 - Manufacturing Industries and Construction - CO2	715764	389302	-326	-46%	15%
1.A.1.a - Public Electricity and Heat Production - CO2	1227049	728984	-498	-41%	28%
All other Energy categories	502809	275595	-227	-45%	11%
Total Energy	**3741054**	**2602070**	**-1139**	**-30%**	**100%**

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.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: Gaseous Fuels (CO_2)
- 1.A.2.g. Other: Liquid Fuels (CO_2)

- 1.A.2.g. Other: Other Fuels (CO_2)
- 1.A.2.g. Other: 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 Stationary: Liquid Fuels (CO_2)
- 1.A.5.a Stationary: Solid Fuels (CO_2)
- 1.A.5.b Mobile: Liquid Fuels (CO_2)
- 1.B.1.a. Coal mining and handling: no classification (CH_4)
- 1.B.2.a. Oil: no classification (CH_4)
- 1.B.2.a. Oil: no classification (CO_2)
- 1.B.2.b. Natural gas: no classification (CH_4)

3.2 Comparison between the sectoral approach and the reference approach

The IPCC reference approach for CO_2 from fossil fuels for the EU is based on Eurostat energy data (Eurostat database, February 2023) 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 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 as a whole.

The Eurostat data for the EU 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 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 2023 inventory submission, and reported in table 1.A(b), corresponds to the sum of the EU Member States.
- 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 2023.
- 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 CO_2 emissions calculated with the IPCC reference approach and the sectoral approach (Table 3.108). The percentage differences for both energy consumption and CO_2 emissions are very similar to previous submissions.

Table 3.2 Comparison of reference approach and sectoral approach for EU

[1. Energy][1.AC Comparison of CO2 Emissions from Fuel Combustion]	Unit	1990	2000	2010	2015	2020	2021	2022
Fuel consumption								
Sectoral approach	PJ	44 444	43 283	42 418	37 888	33 241	35 322	34 498
Apparent energy consumption (excluding non-energy use, reductants and feedstocks)	PJ	44 005	42 407	41 833	36 643	32 900	34 964	33 646
Energy consumption difference	%	-1,0	-2,0	-1,4	-3,3	-1,0	-1,0	-2,5
CO2 emissions								
Reference approach	kt	3 446 001	3 186 408	3 080 726	2 734 951	2 344 407	2 512 880	2 440 396
Sectoral approach	kt	3 516 207	3 279 302	3 147 837	2 830 212	2 379 555	2 541 659	2 497 417
Difference	%	-2,0	-2,8	-2,1	-3,4	-1,5	-1,1	-2,3

Table 3.118 provides an overview for EU-27 on differences between the Eurostat and national reference approach for apparent consumption in TJ for 2022. The main reasons for minor diverging energy data

are the use of different calorific values and 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).

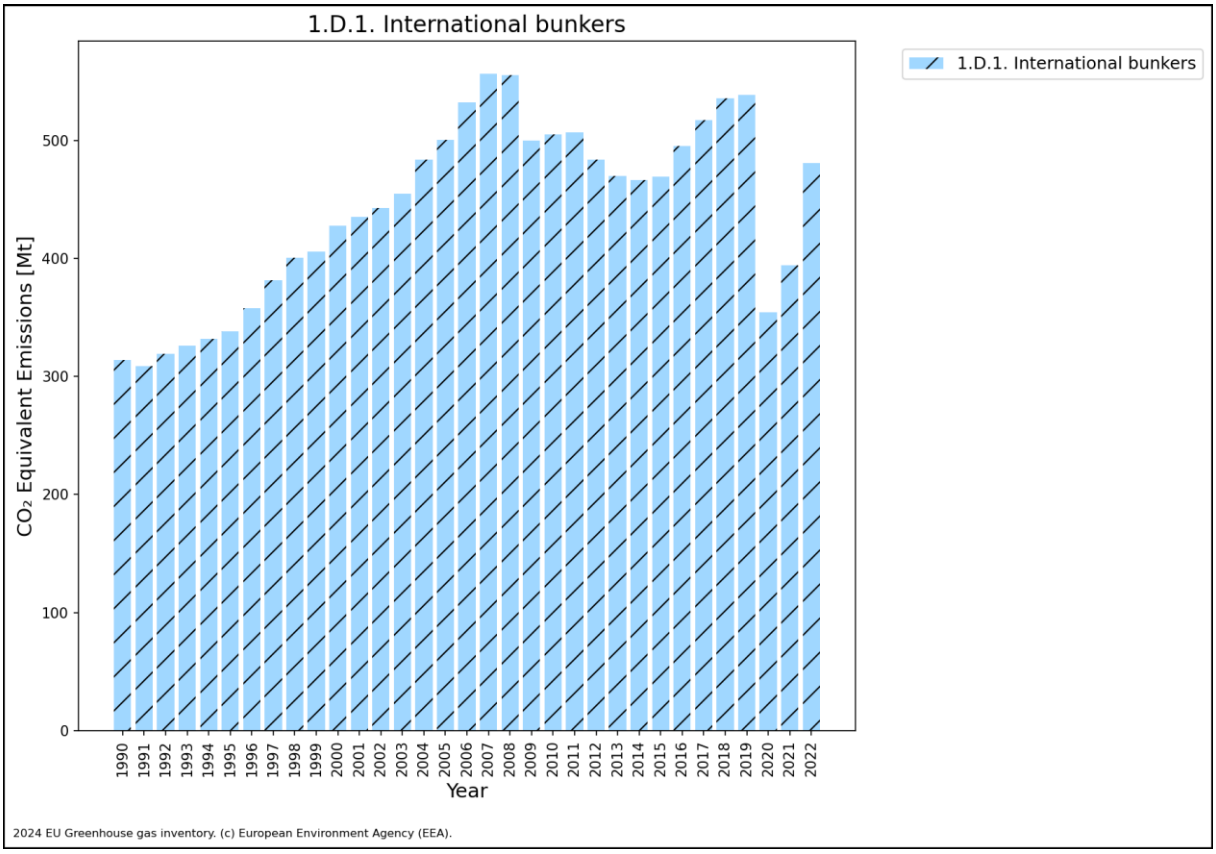
Table 3.3 Comparison between Eurostat and national reference approach for apparent consumption for EU for 2022 (CRF 1.A) [26]

	Total gaseous			Total liquid			Total solid		
	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %	Eurostat TJ	Crf TJ	Difference %
EU-27	12 504 574	12 503 859	0,0%	18 542 207	18 486 797	-0,3%	7 028 967	6 986 244	-0,6%

3.3 International aviation (aviation bunkers) and international navigation (marine bunkers) (EU)

International bunker emissions include emissions from aviation and marine bunkers reported under CRT category 1.D.1. The EU emissions are derived as the sum of the international bunker emissions of the countries[27]. Between 1990 and 2022, total greenhouse gas emissions from international bunkers increased by 53 % in the EU. CO_2 emissions from marine bunkers accounted for 54 % of total greenhouse gas emissions from international bunkers in 2022, while from aviation bunkers 45 % (Figure 3.200).

Figure 3.2 1D1 International bunkers: Greenhouse gas emissions (in Mt of CO_2 equ.)



[26] Minus means that Member State-based estimates are lower than the Eurostat-based estimates.

[27] Specifically, what is considered as 'international bunker emissions' from the MS perspective, it is also considered from the perspective of the EU. Hence, the EU emissions are derived as the exact sum of emissions reported by the MS.

3.3.1 International Aviation (1D1a) (EU)

This mobile source category includes emissions from civil international aviation, i.e. passenger and freight activity of flights having their origin and destination (O-D) in different countries. The main fuel used is jet kerosene, while the use of aviation gasoline is almost negligible.

CO_2 emissions from 1D1a International Aviation

CO_2 emissions from international aviation accounted for 3 % of total GHG emissions in EU, 2022 (including indirect CO_2, with LULUCF and international aviation). Considering only international aviation, CO_2 accounted for 99.2 % of total GHG emissions from international aviation in EU, 2022.

The time series of CO_2 emissions and activity data from 1D1a International aviation, years 1990-2022, are shown in Figure 3.201

Figure 3.3 1D1a International Aviation: CO_2 emissions (in kt) and activity data (in TJ)

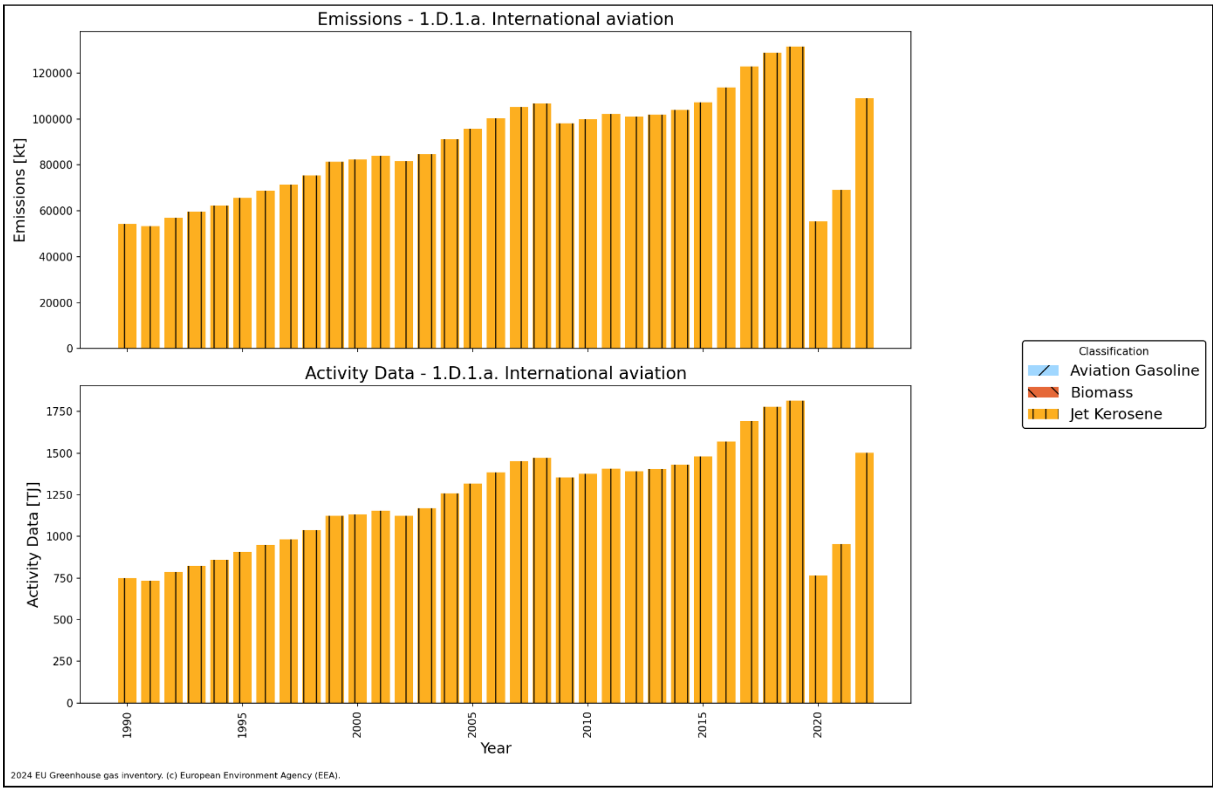


Table 3.119 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), and change between years for international aviation. Between 1990 and 2022, CO_2 emissions from international aviation increased by 101 % in the EU, while between 2021 and 2022 the corresponding change was 57 % increase.

Table 3.4 1D1a International Aviation bunkers: CO_2 emissions per country (in kt), share in EU (%), and change between years

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	880	1 228	1 967	1.8%	1 087	123%	739	60%
Belgium	3 125	4 535	5 257	4.8%	2 132	68%	722	16%
Bulgaria	713	489	594	0.5%	-119	-17%	105	21%
Croatia	497	298	564	0.5%	68	14%	266	89%
Cyprus	718	555	788	0.7%	70	10%	233	42%
Czechia	670	466	806	0.7%	137	20%	340	73%
Denmark	1 763	1 261	2 169	2.0%	405	23%	908	72%
Estonia	107	129	172	0.2%	65	61%	43	33%
Finland	1 008	824	1 630	1.5%	622	62%	805	98%
France	9 378	8 973	13 957	12.8%	4 579	49%	4 984	56%
Germany	12 026	18 167	27 184	25.0%	15 158	126%	9 017	50%
Greece	2 475	2 512	3 942	3.6%	1 467	59%	1 430	57%
Hungary	504	375	791	0.7%	286	57%	416	111%
Ireland	1 073	1 315	3 023	2.8%	1 950	182%	1 708	130%
Italy	4 285	4 961	9 107	8.4%	4 823	113%	4 146	84%
Latvia	221	239	434	0.4%	213	96%	195	82%
Lithuania	399	185	305	0.3%	-94	-24%	119	64%
Luxembourg	394	1 867	1 938	1.8%	1 543	391%	71	4%
Malta	197	247	382	0.4%	185	94%	135	55%
Netherlands	4 604	7 292	9 543	8.8%	4 939	107%	2 250	31%
Poland	640	1 724	2 903	2.7%	2 263	354%	1 179	68%
Portugal	1 533	1 996	4 166	3.8%	2 633	172%	2 170	109%
Romania	790	246	274	0.3%	-516	-65%	28	11%
Slovakia	67	65	131	0.1%	64	95%	65	100%
Slovenia	49	27	61	0.1%	12	25%	34	128%
Spain	4 741	8 256	14 974	13.8%	10 233	216%	6 718	81%
Sweden	1 335	986	1 803	1.7%	468	35%	817	83%
EU-27	**54 191**	**69 219**	**108 864**	**100%**	**54 673**	**101%**	**39 646**	**57%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period

1D1a International Aviation – Jet Kerosene (CO_2)

CO_2 emissions from jet kerosene accounted for 99.2 % of total GHG emissions from international aviation in 2022.

Figure 3.3 shows the time series of CO_2 emissions in EU from international aviation – jet kerosene and the highest shares of countries. Figure 3.4 shows the CO_2 implied emission factor (IEF) in EU and per country (in t/TJ). From the latter it is observed that the CO_2 IEF at EU level is almost constant over the years at 72.5 t/TJ.

Figure 3.3 1D1a International Aviation – Jet Kerosene: Time series of CO_2 emissions in EU and highest shares of countries

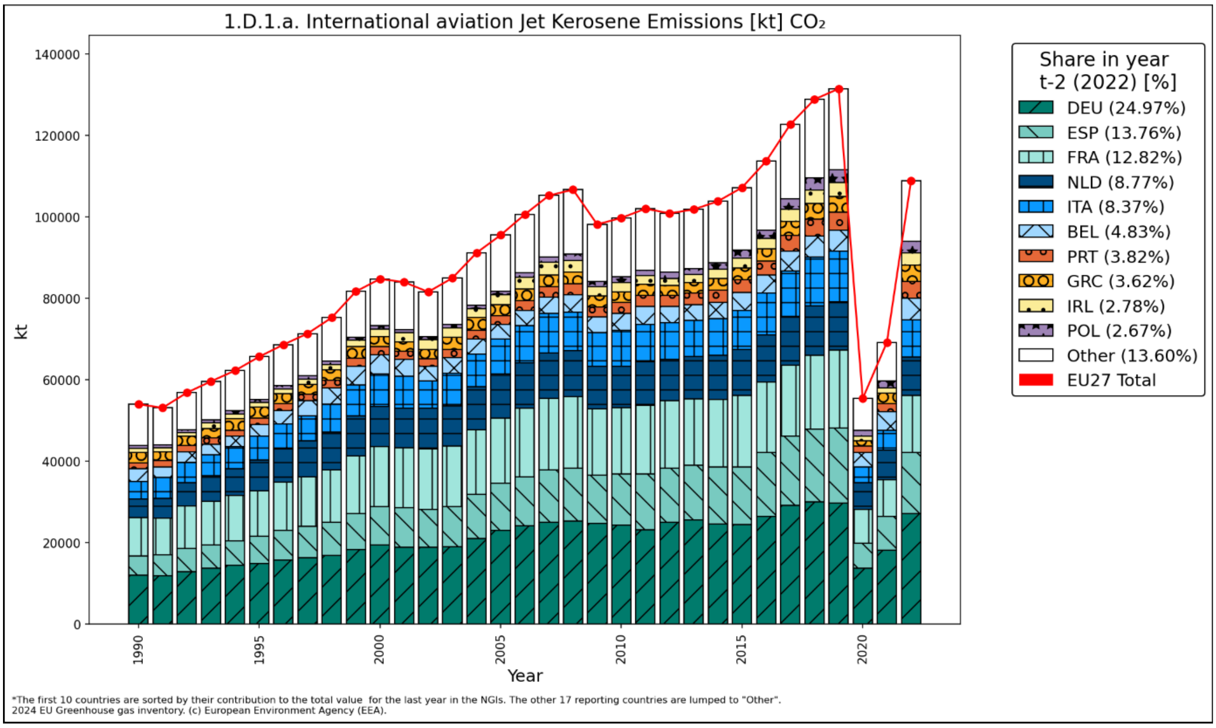
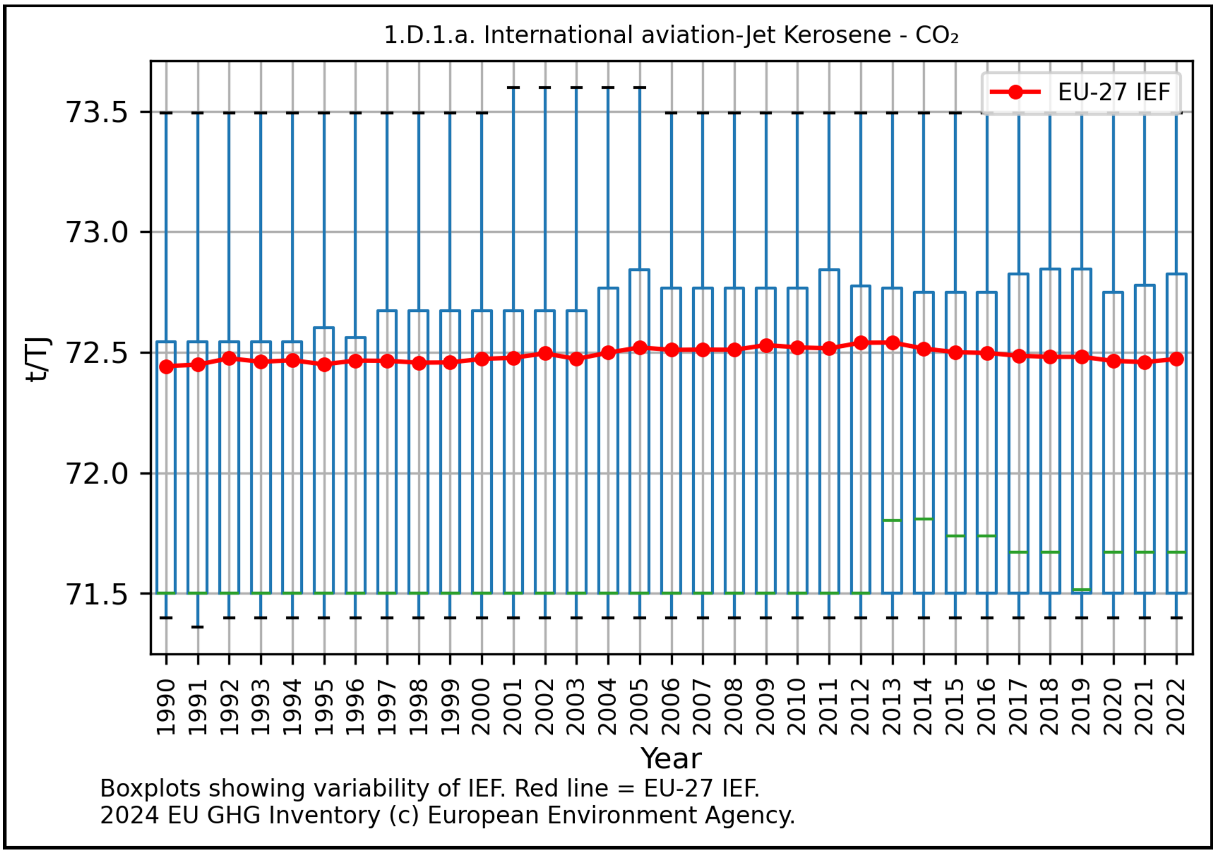


Figure 3.4: 1D1a International Aviation - Jet Kerosene: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



3.3.2 International Navigation (1D1b) (EU)

This mobile source category includes emissions from international waterborne transport, i.e. passenger and freight activity of trips having their origin and destination (O-D) in different countries. The main fuel used is residual fuel oil, followed by gas/diesel oil. Fishing vessels are excluded and they are reported separately under category 1A4ciii (Other sectors – Fishing).

CO_2 emissions from 1D1b International Navigation

CO_2 emissions from international navigation accounted for 4 % of total GHG emissions in EU, 2022 (including indirect CO_2, with LULUCF and international aviation). Considering only international navigation, CO_2 accounted for 98.9 % of total GHG emissions from international navigation in EU, 2022.

The time series of CO_2 emissions and activity data from 1D1b International navigation, years 1990-2022, are shown in Figure 3.202.

Figure 3.4 1D1b International Navigation: CO_2 emissions (in kt) and activity data (in TJ)

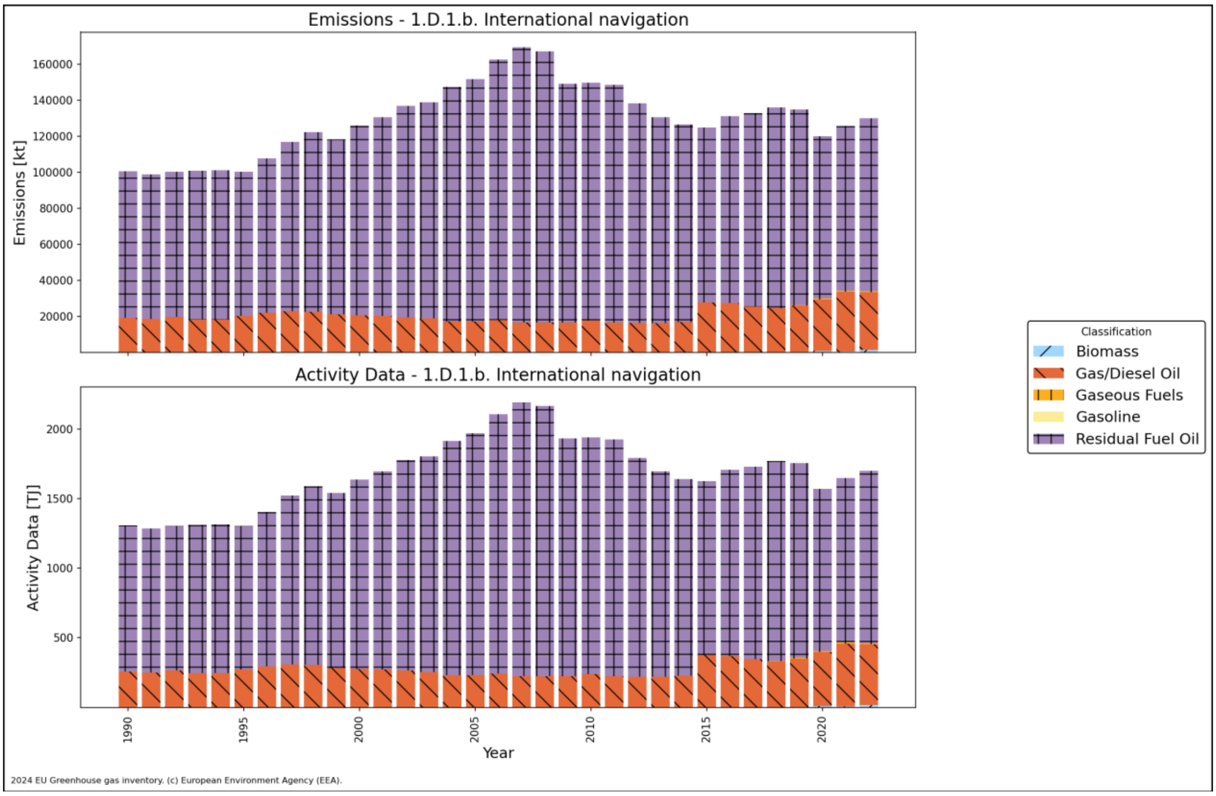


Table 3.120 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), and change between years for international navigation. Between 1990 and 2022, CO_2 emissions from international navigation increased by 28 % in the EU, while between 2021 and 2022 the corresponding change was 3 % increase.

Table 3.5 1D1b International Navigation: CO_2 emissions per country (in kt), share in EU (%), and change between years

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	46	39	32	0.0%	-14	-30%	-7	-17%
Belgium	13 313	24 041	24 572	19.0%	11 260	85%	531	2%
Bulgaria	183	265	211	0.2%	29	16%	-53	-20%
Croatia	147	74	59	0.0%	-88	-60%	-15	-20%
Cyprus	183	800	910	0.7%	727	398%	109	14%
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	3 014	1 368	1 554	1.2%	-1 460	-48%	185	14%
Estonia	573	941	937	0.7%	364	64%	-4	0%
Finland	1 832	877	1 058	0.8%	-774	-42%	181	21%
France	8 018	3 565	3 809	2.9%	-4 209	-52%	243	7%
Germany	6 917	3 713	3 988	3.1%	-2 930	-42%	275	7%
Greece	8 106	5 925	6 376	4.9%	-1 730	-21%	451	8%
Hungary	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Ireland	57	533	403	0.3%	346	609%	-130	-24%
Italy	4 280	5 633	4 230	3.3%	-50	-1%	-1 404	-25%
Latvia	1 515	650	347	0.3%	-1 168	-77%	-303	-47%
Lithuania	302	593	485	0.4%	183	61%	-108	-18%
Luxembourg	0	0	0	0.0%	0	-73%	0	54%
Malta	895	6 231	6 826	5.3%	5 931	663%	595	10%
Netherlands	34 944	35 984	35 640	27.6%	696	2%	-344	-1%
Poland	1 265	1 092	854	0.7%	-412	-33%	-238	-22%
Portugal	1 400	2 148	2 224	1.7%	824	59%	77	4%
Romania	NO	104	52	0.0%	52	∞	-52	-50%
Slovakia	65	17	17	0.0%	-47	-73%	0	2%
Slovenia	NA,NO	242	NO	-	-	-	-242	-100%
Spain	11 587	23 500	27 671	21.4%	16 084	139%	4 171	18%
Sweden	2 333	7 358	6 932	5.4%	4 598	197%	-427	-6%
EU-27	**100 974**	**125 695**	**129 188**	**100%**	**28 214**	**28%**	**3 493**	**3%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period

1D1b International Navigation – Residual Fuel Oil (CO_2)

CO_2 emissions from residual fuel oil accounted for 74 % of total GHG emissions from international navigation in 2022.

Figure 3.203 shows the time series of CO_2 emissions in EU from international navigation – residual fuel oil and the highest shares of countries. Figure 3.204 shows the CO_2 implied emission factor (IEF) in EU and per country (in t/TJ). From the latter it is observed that the CO_2 IEF at EU level is almost constant over the years at 77.6 t/TJ.

Figure 3.5 1D1b International Navigation – Residual Fuel Oil: Time series of CO_2 emissions in EU and highest shares of countries

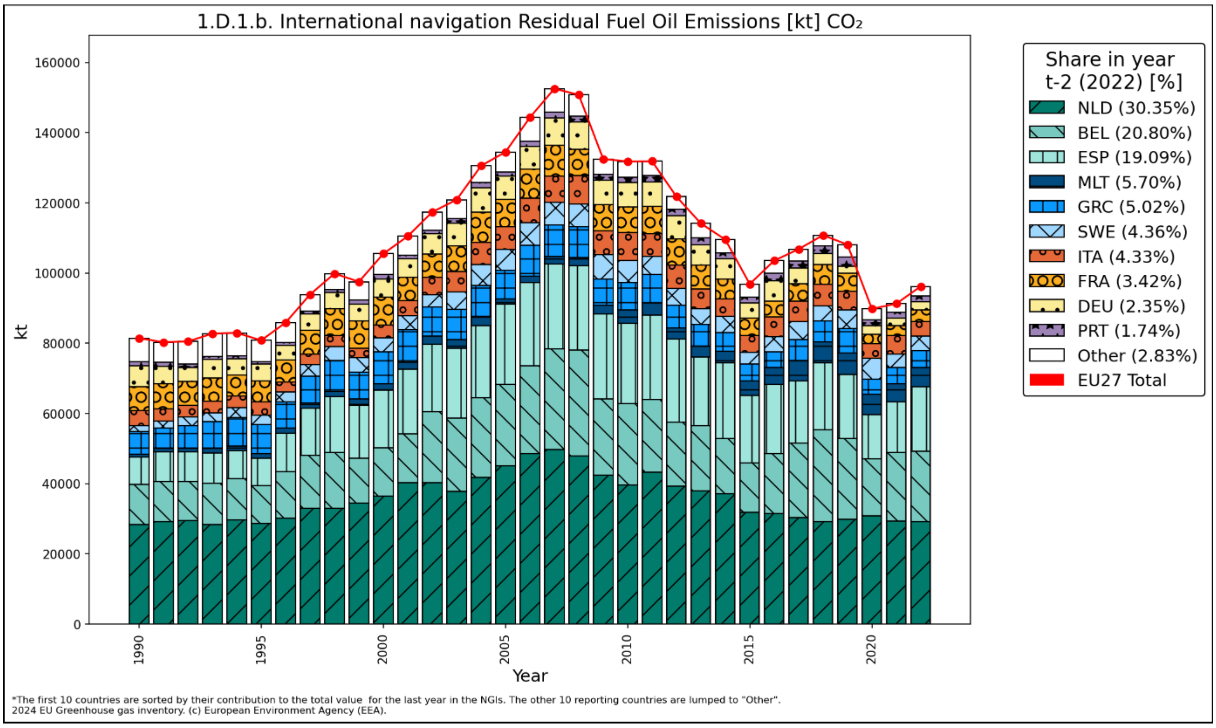
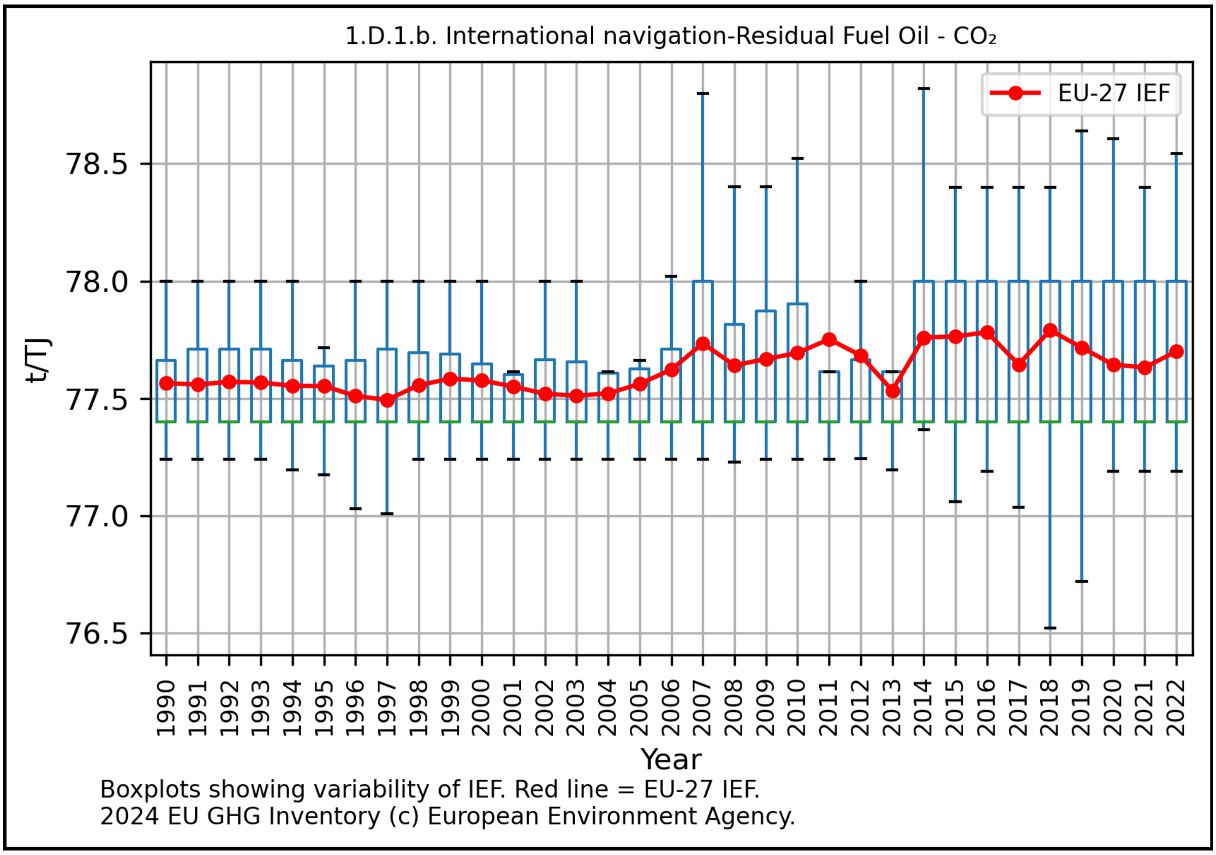


Figure 3.6 1D1b International Navigation – Residual Fuel Oil: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



1D1b International Navigation – Gas/Diesel Oil (CO_2)

CO_2 emissions from gas/diesel oil accounted for 25 % of total GHG emissions from international navigation in 2022.

Figure 3.205 shows the time series of CO_2 emissions in EU from international navigation – gas/diesel oil and the highest shares of countries. Figure 3.9 shows the CO_2 implied emission factor (IEF) in EU and per country (in t/TJ). From the latter it is observed that the CO_2 IEF at EU level is almost constant over the years at 74 t/TJ, with a slight decrease approximately at 73.8 t/TJ.

Figure 3.7 1D1b International Navigation – Gas/Diesel Oil: Time series of CO_2 emissions in EU and highest shares of countries

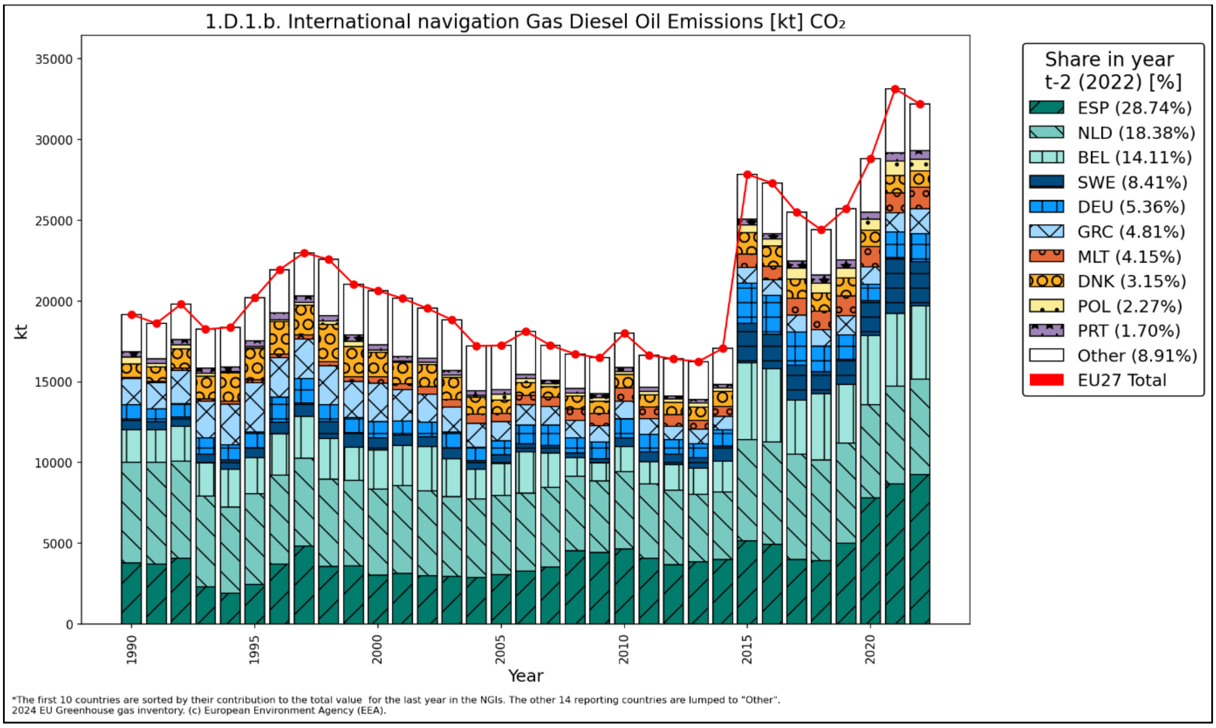
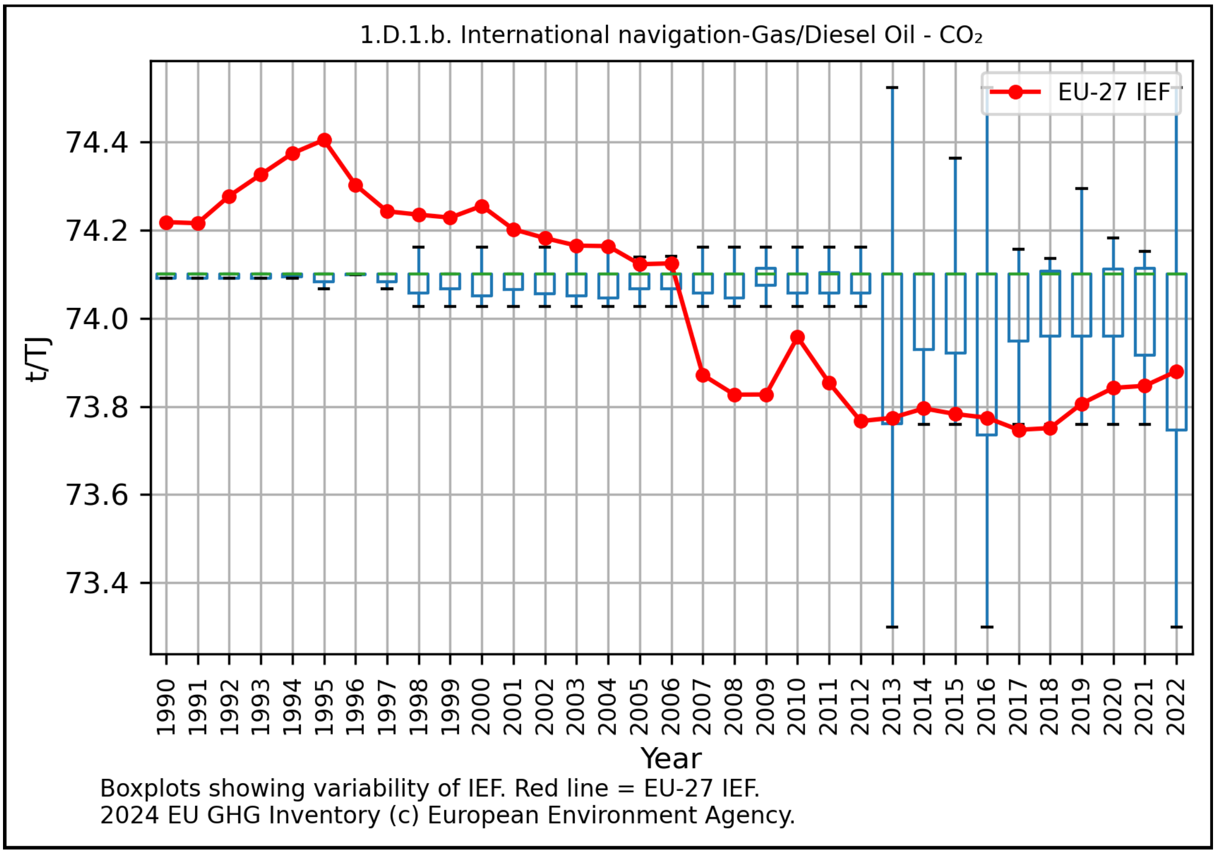


Figure 3.9: 1D1b International Navigation – Gas/Diesel Oil: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



3.4 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 3.6 shows the fuels that were used for the purpose of non-energy use in the EU in 2022. All data in CRF table 1A(d) is calculated as the sum of respective MS data. It shows that 73 % 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 11 % of non-energy use of fuels and is mainly used for feedstock in ammonia production. Coke oven / gas coke accounts for 11 % of NEU of fuels and is mainly used as reductant in the metal industry.

Table 3.6 Fuel quantity for non-energy use in TJ and % for the EU for 2022

Fuel			TJ	%
Liquid fossil	Primary fuels	Crude oil	526	0,01%
		Natural gas liquids	62 697	1,4%
		Gasoline	116 320	2,628%
		Jet kerosene	NO	0,0%
		Other kerosene	1 106	0,03%
		Gas/diesel oil	97 987	2,2%
		Residual fuel oil	53 843	1,2%
		Liquefied petroleum gases (LPG)	428 644	9,7%
		Ethane	31 725	0,7%
		Naphtha	1 457 229	32,9%
		Bitumen	519 812	11,7%
		Lubricants	154 966	3,5%
		Petroleum coke	35 891	0,8%
		Refinery feedstocks	12 523	0,3%
		Other oil	243 243	5,5%
Other liquid fossil			7 157	0,2%
Liquid fossil totals			**3 223 670**	**72,8%**
Solid fossil	Primary fuels	Anthracite	19 041	0,4%
		Coking coal	49 099	1,1%
		Other bituminous coal	108 974	2,5%
		Sub-bituminous coal	5 189	0,1%
		Lignite	315	0,01%
		Oil shale and tar sand	7 748	0,2%
		Coke oven/gas coke	490 891	11,1%
		Coal tar	23 480	0,5%
Solid fossil totals			**704 738**	**15,9%**
Gaseous fossil		Natural gas (dry)	496 978	11,2%
Gaseous fossil totals			**496 978**	**11,2%**
Waste (non-biomass fraction)			512	0,01%
Total			**4 425 386**	**100,0%**

Table 3.7 shows the associated CO_2 emissions from the NEU reported in the inventory for the year 2022. It shows that 50 % of the CO_2 emissions stem from solid fuels, 26 % from liquid fuels and 25 % 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 3.7 CO_2 emissions from the NEU reported in the inventory kt CO_2 and % for the EU for 2022

Fuel			kt	%
Liquid fossil	Primary fuels	Crude oil	12	0,01%
		Other kerosene	0,0	0,0000%
		Gas/diesel oil	7	0,01%
		Residual fuel oil	1	0,0%
		Liquefied petroleum gases (LPG)	2 695	3,0%
		Ethane	317	0,4%
		Naphtha	11 144	12,5%
		Bitumen	1 877	2,1%
		Lubricants	2 130	2,4%
		Petroleum coke	1 783	2,0%
		Other oil	2 690	3,0%
Other liquid fossil			266	0,3%
Liquid fossil totals			22 922	**25,7%**
Solid fossil	Primary fuels	Anthracite	10 222	11,5%
		Coking coal	3 436	3,9%
		Other bituminous coal	6 310	7,1%
		Sub-bituminous Coal	482	0,5%
		Coke oven/gas coke	23 779	26,7%
		Coal tar	15	0,0%
Solid fossil totals			**44 248**	**49,6%**
Gaseous fossil		Natural gas (dry)	22 031	24,7%
Gaseous fossil totals			**22 031**	**24,7%**
Waste (non-biomass fraction)			111	0,1%
Total			**89 202**	**100,0%**

Table 3.8 shows the recalculations of non-energy use of fuels for the year 2021. The main reason for recalculations is a recalculation for non-energy use of gasoline by Germany. Other reasons for recalculations are revisions in the energy balance. Across all fuels recalculations were at +3 %.

Table 3.8 Recalculations of fuel quantity for non-energy use of fuels for the inventory year 2021 submitted in 2023 and 2024

FUEL TYPE			ACTIVITY DATA AND RELATED INFORMATION			
			Fuel quantity for NEU (TJ)		Difference in TJ	Difference in %
			2023	2024		
Liquid fossil fossil	Primary fuels	Crude oil	382	382	0	0%
		Orimulsion	IE,NO	IE,NO	0	-
		Natural gas liquids	60 000	60 023	23	0%
	Secondary fuels	Gasoline	1 900	125 373	123 473	6499%
		Jet kerosene	NO	0	0	-
		Other kerosene	1 335	1 319	-16	-1%
		Shale oil	NO	NO	0	-
		Gas/diesel oil	123 657	123 348	-309	0%
		Residual fuel oil	51 964	51 748	-216	0%
		Liquefied petroleum gases (LPG)	448 490	455 631	7 141	2%
		Ethane	36 276	36 276	0	0%
		Naphtha	1 686 532	1 686 551	19	0%
		Bitumen	567 401	575 633	8 232	1%
		Lubricants	169 632	173 109	3 477	2%
		Petroleum coke	49 264	48 073	-1 191	-2%
		Refinery feedstocks	6 735	6 735	0	0%
		Other oil	247 866	257 056	9 190	4%
Other liquid fossil			7 684	7 689	4	0%
Liquid fossil totals			**3 459 117**	**3 608 944**	**149 827**	**4%**
Solid fossil	Primary fuels	Anthracite	18 910	18 877	-33	0%
		Coking coal	58 942	58 951	9	0%
		Other bituminous coal	131 053	131 014	-38	0%
		Sub-bituminous Coal	8 689	8 689	0	-
		Lignite	256	256	0	0%
		Oil shale and tar sand	7 687	7 687	0	0%
	Secondary fuels	BKB and patent fuel	NA,NO	NA,NO	0	-
		Coke oven/gas coke	527 896	532 083	4 188	1%
		Coal tar[7]	24 913	25 141	227	1%
Other solid fossil					0	-
		Other			0	-
Solid fossil totals			**778 346**	**782 699**	**4 352**	**1%**
Gaseous fossil		Natural gas (dry)	691 769	688 975	-2 793	0%
Other gaseous fossil			NA,NO	NA,NO	0	-
Gaseous fossil totals			**691 769**	**688 975**	**-2 793**	**0%**
Waste (non-biomass fraction)			517	517	0	0%
Other fossil fuels			NA,NO	NA,NO	0	-
Other fossil fuels totals			NA,NO	NA,NO	0	-
Total fossil fuels			**4 929 232**	**5 080 618**	**151 386**	**3%**

3.5 Source categories

3.5.1 Energy Industries (CRT Source Category 1.A.1)

Energy Industries (CRT 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 (CRT 1.A.1.a), Petroleum-refining (CRT 1.A.1.b), and Manufacture of solid fuels and other energy industries (CRT 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 and Italy have mainly been influencing this share of higher tier methods because of their weight of emissions. The same applies for Italy, Germany and Spain in sector 1.A.1.b and Germany, Italy and Czechia in sector 1.A.1.c.

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 and use default emission factors for fuels of minor importance. 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.

Table 3.9: 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	**2022**		**1990**	**2022**	
1.A.1.a. Public electricity and heat production: Gaseous Fuels (CO_2)	107683	187917	T	L	L	99.0 %
1.A.1.a. Public electricity and heat production: Liquid Fuels (CO_2)	156347	26264	T	L	L	95.3 %
1.A.1.a. Public electricity and heat production: Other Fuels (CO_2)	10453	36978	T	L	L	95.6 %
1.A.1.a. Public electricity and heat production: Peat (CO_2)	9164	3733	T	L	0	99.2 %
1.A.1.a. Public electricity and heat production: Solid Fuels (CO_2)	943403	474092	T	L	L	96.4 %
1.A.1.b. Petroleum refining: Gaseous Fuels (CO_2)	5345	15019	T	0	L	98.5%
1.A.1.b. Petroleum refining: Liquid Fuels (CO_2)	97131	79606	T	L	L	97.4 %
1.A.1.c. Manufacture of solid fuels and other energy industries: Gaseous Fuels (CO_2)	8199	7309	0	L	L	95.6 %
1.A.1.c. Manufacture of solid fuels and other energy industries: Solid Fuels (CO_2)	88816	22081	T	L	L	96.4 %

Figure 3.4 shows the trends in emissions in Energy Industries for the EU between 1990 and 2022, 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) and around 84 % in 2022.

Total greenhouse gas emissions from 1.A.1 decreased by 40%, between 1990 and 2022. This was mainly due to a decrease of CO_2eq emission from Public Electricity and Heat Production (- 495 Mt CO_2eq) followed by -69.8 Mt CO_2eq of the manufacturing of solid fuels and -8.8 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. Consumptions and emissions have increased again since 2021 but remain lower than the 2019 levels.

Figure 3.8 1.A.1 Energy Industries: Total GHG, emission trends and Activity Data

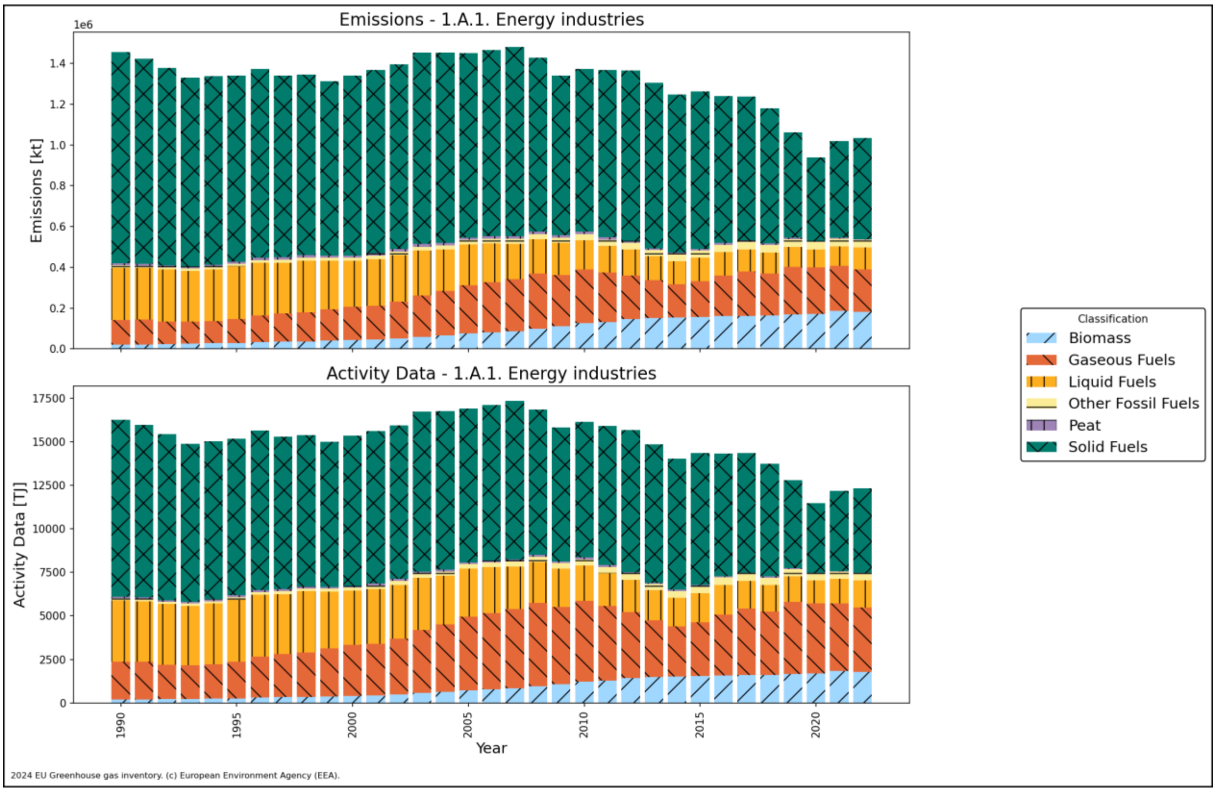


Table 3.2 breaks down the information by country. Between 1990 and 2022, greenhouse gas emissions from energy industries increased in two countries and fell in 25. The change in the EU was a net decrease of about 578.8 Mt CO_2eq or 40.1% in 32 years. The table shows the emissions of GHG, N_2O and CH_4 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.

Table 3.10 1.A.1 Energy industries: Countries' contributions to CO_2, N_2O and CH_4 emissions

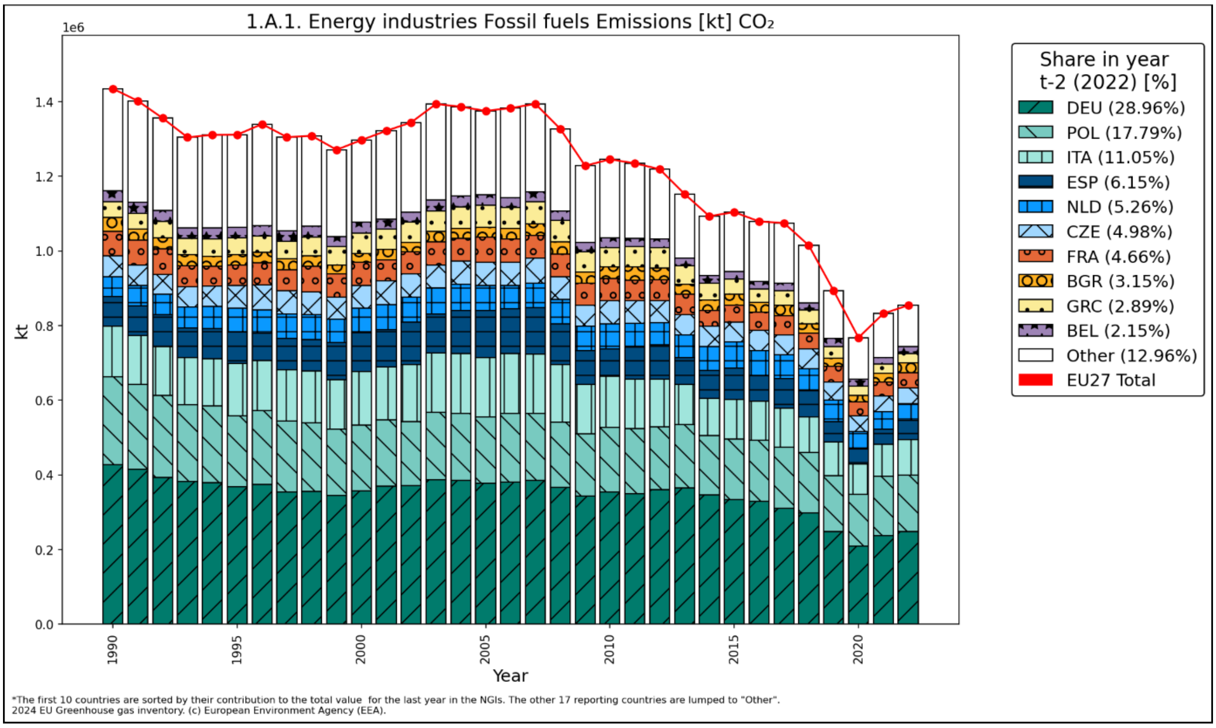
Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt		N2O emissions in kt CO2 equivalents		CH4 emissions in kt CO2 equivalents	
	1990	2022	1990	2022	1990	2022	1990	2022
Austria	14 008	8 476	13 961	8 364	37	85	9	28
Belgium	29 728	18 501	29 547	18 368	159	98	22	36
Bulgaria	36 526	27 021	36 401	26 872	111	120	15	28
Croatia	7 087	4 106	7 066	4 063	15	29	6	15
Cyprus	1 767	3 115	1 761	3 105	4	7	2	4
Czechia	56 830	42 770	56 594	42 537	218	192	19	41
Denmark	26 249	8 197	26 156	8 020	76	68	17	109
Estonia	28 285	8 426	28 269	8 380	13	29	3	18
Finland	18 958	12 911	18 843	12 645	104	230	11	36
France	66 302	40 043	65 821	39 778	399	201	83	64
Germany	431 083	252 073	427 953	247 455	2 816	1 817	314	2 800
Greece	43 238	24 735	43 094	24 682	129	40	16	13
Hungary	20 866	10 744	20 796	10 671	60	45	11	27
Ireland	11 216	9 989	11 145	9 874	64	103	7	12
Italy	137 620	94 871	136 941	94 410	425	332	254	130
Latvia	6 317	999	6 302	955	10	25	5	20
Lithuania	13 552	2 530	13 522	2 461	18	38	11	30
Luxembourg	35	232	32	225	1	4	1	3
Malta	1 765	797	1 759	796	5	0	1	0
Netherlands	53 356	45 328	53 147	44 953	132	250	77	125
Poland	235 229	152 691	234 294	152 029	905	631	30	31
Portugal	16 415	8 372	16 366	8 252	43	108	7	13
Romania	71 655	18 072	71 448	17 997	164	61	43	14
Slovakia	19 077	6 407	19 010	6 366	57	26	9	16
Slovenia	6 374	3 416	6 349	3 397	23	15	2	4
Spain	78 851	53 163	78 541	52 553	257	539	53	71
Sweden	9 858	5 416	9 746	5 190	99	173	12	52
EU-27	**1 442 247**	**863 402**	**1 434 862**	**854 395**	**6 343**	**5 268**	**1 042**	**3 739**

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 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 level, 39.1 % of the fuel used in energy industries come from solid fuels. Its contribution has been declining in favour of the relatively cleaner natural gas, with about 30.0 % in 2022. However, solid fuels represent the first source of energy in 2022. Biomass has been constantly increasing with a share of 14.4 % in 2022, constant since 2021.

The contribution of the MS can be seen in Figure 3.5.

Figure 3.9 1.A.1 Energy Industries, all fuels: Emission trend and share for CO_2



3.5.1.1 Public Electricity and Heat Production (1.A.1.a) (EU)

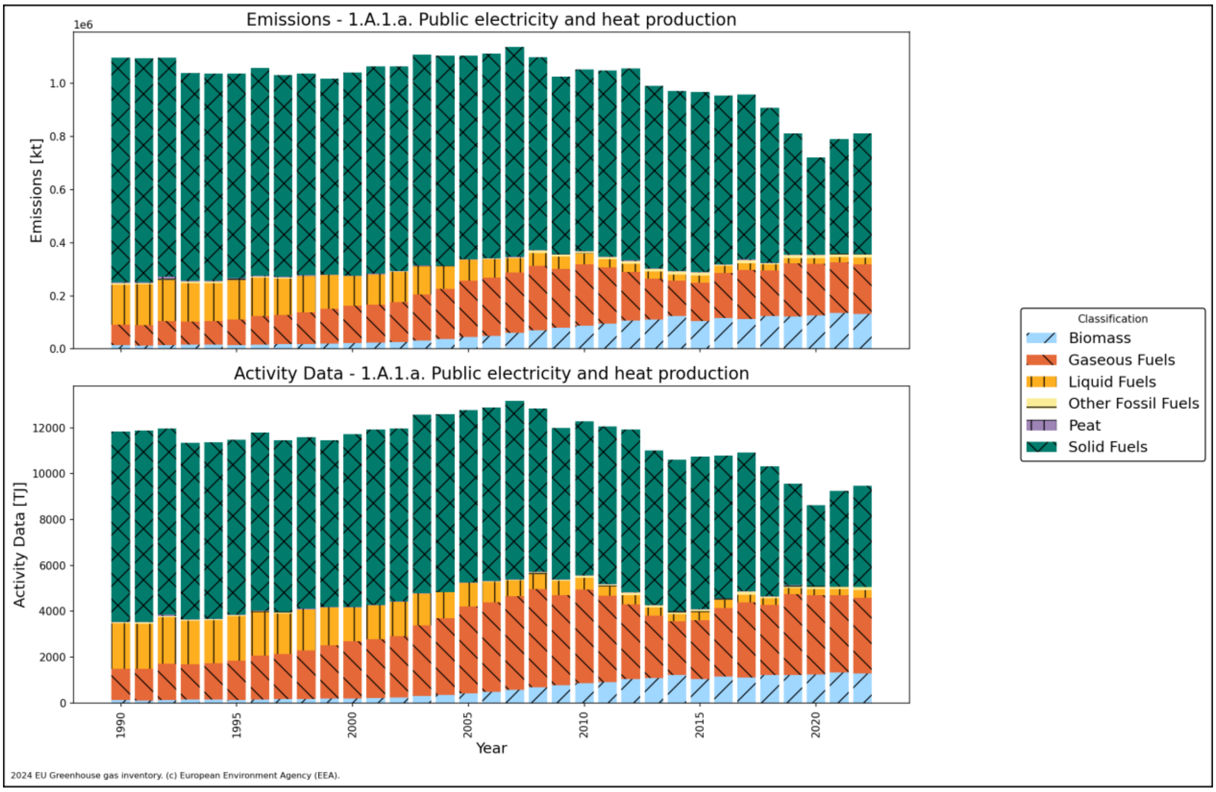
According to the 2006 IPCC guidelines, emissions from public electricity and heat production (CRT 1.A.1.a) should include emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants. Main activity producers (i.e. public utilities) are defined 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 accounting for 23.3 % of total greenhouse gas emissions in 2022 and for about 84 % of greenhouse gas emissions of the Energy Industries Sector. Between 1990 and 2022, CO_2 emissions from electricity and heat production decreased by 40.5 % in the EU.

Figure 3.6 shows the trends in emissions originating from the production of public electricity and heat by fuel in the EU between 1990 and 2022 as well as the underlying activity data[28].

[28] 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.

Figure 3.10 1.A.1.a Public Electricity and Heat Production: Total emission and activity data trends



Fuel used for public electricity and heat production decreased by 23 % in the EU between 1990 and 2022. Solid fuels represent 44 % of the fuel used in public conventional thermal power plants; its combustion has been declining by 50 % between 1990 and 2022. 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. In 2020, natural gas consumptions were higher than solid fuel consumptions for the 1st time. However, the situation is different in 2022 with a share of 32% % of all the fuels used for the production of heat and electricity in the EU. Liquid fuels still account for some 3.0 %, but its use has declined gradually since 1990. The use of biomass has increased even more rapidly than the use of gas: its share in the fuel mix is now around 17 %. Finally, other fossil fuels consumptions have been multiplied by almost 4 between 1990 and 2022 and represent 4.0 % of total consumptions. Peat remains marginal with a share of 0.3 % in 2022.

Table 3.3 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. The change in the EU between 1990 and 2022 was a net decrease of 497.5 Mt CO_2 respectively of 40.5 %.

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

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	11 056	5 668	5 764	0.8%	-5 292	-48%	97	2%	NA,T2	CS,NA
Belgium	23 224	12 814	13 480	1.8%	-9 744	-42%	665	5%	NA,T1,T3	D,NA,PS
Bulgaria	35 179	21 240	25 836	3.5%	-9 343	-27%	4 596	22%	NA,T1,T2	CS,D,NA
Croatia	3 729	2 749	3 061	0.4%	-668	-18%	312	11%	NA,T1,T2	CS,D,NA
Cyprus	1 676	3 078	3 099	0.4%	1 423	85%	21	1%	CS,NA	CS,NA
Czechia	54 585	39 044	40 431	5.5%	-14 154	-26%	1 386	4%	NA,T1,T2	CS,D,NA
Denmark	24 717	6 285	6 229	0.9%	-18 489	-75%	-56	-1%	T1,T2,T3	D,PS
Estonia	28 191	5 405	6 819	0.9%	-21 372	-76%	1 414	26%	T1,T2,T3	CS,D,PS
Finland	16 453	11 640	10 912	1.5%	-5 541	-34%	-728	-6%	NA,T3	CS,D,NA,PS
France	49 147	31 676	32 377	4.4%	-16 770	-34%	701	2%	NA	NA
Germany	338 451	206 804	215 835	29.6%	-122 616	-36%	9 031	4%	CS	CS
Greece	40 617	20 118	18 837	2.6%	-21 780	-54%	-1 281	-6%	NA,T2	NA,PS
Hungary	17 850	9 642	8 968	1.2%	-8 882	-50%	-674	-7%	NA,T1,T2,T3	CS,D,NA,PS
Ireland	10 876	9 689	9 500	1.3%	-1 377	-13%	-190	-2%	T1,T3	CS,D,PS
Italy	108 670	64 807	71 388	9.8%	-37 282	-34%	6 581	10%	T3	CS
Latvia	6 097	1 339	908	0.1%	-5 189	-85%	-431	-32%	NA,T2	CS,NA
Lithuania	12 003	1 454	1 168	0.2%	-10 835	-90%	-286	-20%	NA,T1,T2,T3	CS,D,NA,PS
Luxembourg	32	256	225	0.0%	192	592%	-31	-12%	NA,T2	CS,NA
Malta	1 759	772	796	0.1%	-962	-55%	25	3%	NA,T2	CS,NA
Netherlands	40 026	35 043	33 151	4.5%	-6 875	-17%	-1 892	-5%	CS,NA,T2	CS,NA
Poland	227 279	151 555	144 788	19.9%	-82 492	-36%	-6 767	-4%	NA,T1,T2	CS,D,NA
Portugal	14 355	6 443	6 728	0.9%	-7 627	-53%	285	4%	T1,T3	D,PS
Romania	67 020	15 646	15 057	2.1%	-51 963	-78%	-589	-4%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	14 700	4 342	3 286	0.5%	-11 414	-78%	-1 055	-24%	NA,T2	CS,NA
Slovenia	6 096	4 176	3 397	0.5%	-2 700	-44%	-780	-19%	NA,T1,T2,T3	CS,D,NA,PS
Spain	65 593	30 834	42 128	5.8%	-23 465	-36%	11 295	37%	NA,T1,T2	CS,NA,PS
Sweden	7 668	5 736	4 818	0.7%	-2 850	-37%	-918	-16%	T2	CS

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations are explained in the Chapter 'Units and abbreviations'.

N_2O emissions currently represent 0.6 % of greenhouse gas emissions from public electricity and heat production. Between 1990 and 2022, emissions decreased by 8 % (Table 3.4).

Table 3.12 1.A.1.a Public Electricity and Heat Production: Countries' contributions to N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	35	84	82	1.7%	47	134%	-1	-2%	NA,T1	D,NA
Belgium	45	66	64	1.3%	19	42%	-2	-3%	NA,T1,T3	D,NA
Bulgaria	109	106	120	2.5%	11	10%	14	14%	NA,T1	D,NA
Croatia	12	24	28	0.6%	16	142%	4	15%	NA,T1	D,NA
Cyprus	3	6	6	0.1%	3	88%	0	2%	NA,T1	D,NA
Czechia	215	179	186	3.8%	-29	-13%	7	4%	NA,T1	D,NA
Denmark	70	70	63	1.3%	-7	-10%	-7	-10%	NA	CS,D
Estonia	13	27	27	0.6%	15	116%	0	1%	T1,T2	CS,D
Finland	89	218	215	4.4%	126	141%	-3	-1%	NA,T3	CS,NA
France	373	192	198	4.1%	-175	-47%	6	3%	NA	NA
Germany	2 141	1 599	1 645	34.0%	-496	-23%	46	3%	T2	CS
Greece	126	36	35	0.7%	-90	-72%	-1	-2%	NA,T1	D,NA
Hungary	56	45	44	0.9%	-12	-22%	-1	-3%	NA,T1	D,NA
Ireland	63	95	102	2.1%	39	62%	7	7%	T1,T2	D
Italy	273	174	198	4.1%	-76	-28%	24	14%	T3	CR,D
Latvia	10	24	24	0.5%	15	152%	0	-1%	NA,T1	D,NA
Lithuania	17	42	37	0.8%	21	125%	-5	-11%	NA,T1	D,NA
Luxembourg	1	4	4	0.1%	3	223%	0	-3%	NA,T1	D,NA
Malta	5	0	0	0.0%	-5	-91%	0	6%	NA,T1	D,NA
Netherlands	118	242	228	4.7%	110	94%	-13	-6%	D,NA,T1	D,NA
Poland	891	652	624	12.9%	-268	-30%	-29	-4%	NA,T1	D,NA
Portugal	41	98	108	2.2%	67	165%	10	10%	T1	D
Romania	160	59	58	1.2%	-103	-64%	-1	-2%	NA,T1	D,NA
Slovakia	52	26	23	0.5%	-29	-56%	-2	-10%	NA,T1	D,NA
Slovenia	22	18	15	0.3%	-7	-31%	-3	-16%	NA,T1	D,NA
Spain	244	380	533	11.0%	290	119%	153	40%	NA,T2	D,NA,OTH
Sweden	98	180	173	3.6%	75	77%	-6	-4%	T2	CS
EU-27	**5 283**	**4 646**	**4 842**	**100%**	**-441**	**-8%**	**196**	**4%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period 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 2022, emissions increased by 488 %.

Table 3.13 1.A.1.a Public Electricity and Heat Production: Countries' contributions to CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	7	25	25	0.7%	18	271%	0	-1%	NA,T1,T2	CS,D,NA
Belgium	13	33	34	1.0%	21	167%	0	1%	NA,T1,T3	D,NA
Bulgaria	14	31	28	0.8%	14	101%	-3	-11%	NA,T1	D,NA
Croatia	4	13	14	0.4%	10	265%	1	11%	NA,T1	D,NA
Cyprus	2	3	3	0.1%	2	85%	0	2%	NA,T1	D,NA
Czechia	17	40	40	1.1%	23	132%	0	1%	NA,T1	D,NA
Denmark	16	129	108	3.1%	92	559%	-21	-16%	NA	CS,D
Estonia	3	17	16	0.5%	14	471%	0	-3%	T1,T2	CS,D
Finland	10	37	35	1.0%	26	256%	-1	-3%	NA,T3	CS,NA
France	15	52	59	1.7%	44	291%	8	15%	NA	NA
Germany	193	2 646	2 660	75.8%	2 467	1279%	13	1%	T2	CS
Greece	14	10	9	0.3%	-5	-34%	-1	-6%	NA,T1	D,NA
Hungary	8	27	26	0.7%	18	218%	-1	-4%	NA,T1	D,NA
Ireland	7	11	12	0.3%	4	61%	0	2%	T1,T2	D
Italy	106	113	111	3.1%	4	4%	-3	-2%	T3	CR,D
Latvia	5	19	19	0.5%	14	269%	0	-1%	NA,T1	D,NA
Lithuania	10	33	29	0.8%	19	194%	-4	-11%	NA,T1	D,NA
Luxembourg	1	4	3	0.1%	2	225%	0	-3%	NA,T1	D,NA
Malta	1	0	0	0.0%	-1	-68%	0	2%	NA,T1	D,NA
Netherlands	44	123	108	3.1%	64	145%	-16	-13%	NA,T1,T2	CS,D,NA
Poland	22	26	26	0.7%	4	17%	0	-1%	NA,T1,T2	CS,D,NA
Portugal	5	15	12	0.3%	7	161%	-4	-23%	T1	D
Romania	40	12	12	0.3%	-28	-70%	0	-3%	NA,T1	D,NA
Slovakia	7	15	14	0.4%	7	111%	-2	-11%	NA,T1	D,NA
Slovenia	2	4	4	0.1%	2	79%	0	-4%	NA,T1	D,NA
Spain	19	42	52	1.5%	32	168%	10	23%	NA,T2	CR,CS,D,NA
Sweden	12	54	52	1.5%	40	347%	-2	-4%	T2	CS
EU-27	**597**	**3 536**	**3 510**	**100%**	**2 913**	**488%**	**-26**	**-1%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period 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 3.6 % of all greenhouse gas emissions from 1.A.1.a. Within the EU, emissions fell by 83 % respectively by 130.083 Mt CO_2 between 1990 and 2022 (Table 3.6).

Table 3.14 1.A.1.a Public Electricity and Heat Production, Liquid Fuels: Countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	1 229	120	236	0.9%	-992	-81%	117	98%
Belgium	663	24	43	0.2%	-620	-94%	18	76%
Bulgaria	3 245	68	109	0.4%	-3 136	-97%	41	60%
Croatia	2 142	14	64	0.2%	-2 078	-97%	50	360%
Cyprus	1 676	3 078	3 099	11.8%	1 423	85%	21	1%
Czechia	1 174	109	127	0.5%	-1 046	-89%	18	17%
Denmark	953	161	322	1.2%	-632	-66%	160	99%
Estonia	3 519	62	128	0.5%	-3 391	-96%	65	104%
Finland	1 234	697	1 190	4.5%	-43	-4%	493	71%
France	8 209	3 811	4 022	15.3%	-4 188	-51%	211	6%
Germany	8 637	1 188	1 630	6.2%	-7 007	-81%	442	37%
Greece	5 416	3 151	3 248	12.4%	-2 168	-40%	96	3%
Hungary	1 443	47	42	0.2%	-1 401	-97%	-5	-11%
Ireland	1 087	1 180	833	3.2%	-253	-23%	-347	-29%
Italy	64 597	1 517	1 982	7.5%	-62 615	-97%	466	31%
Latvia	3 079	7	64	0.2%	-3 015	-98%	57	784%
Lithuania	6 021	84	273	1.0%	-5 749	-95%	188	224%
Luxembourg	NO	0	2	0.0%	2	∞	2	465%
Malta	1 049	33	49	0.2%	-1 000	-95%	16	48%
Netherlands	233	321	462	1.8%	229	98%	141	44%
Poland	5 198	1 455	1 622	6.2%	-3 575	-69%	168	12%
Portugal	6 434	638	702	2.7%	-5 732	-89%	65	10%
Romania	20 441	326	379	1.4%	-20 062	-98%	53	16%
Slovakia	1 033	6	9	0.0%	-1 024	-99%	3	61%
Slovenia	272	56	79	0.3%	-193	-71%	23	41%
Spain	6 087	5 192	5 548	21.1%	-539	-9%	355	7%
Sweden	1 277	416	C	-	-1 277	-100%	-416	-100%
EU-27	**156 347**	**23 762**	**26 264**	**100%**	**-130 083**	**-83%**	**2 501**	**11%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations are explained in the Chapter 'Units and abbreviations'.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 and 2021 EU sums do include emission from Sweden.

Figure 3.7 shows the contribution to the emission trend for liquid fuels by the main countries.

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

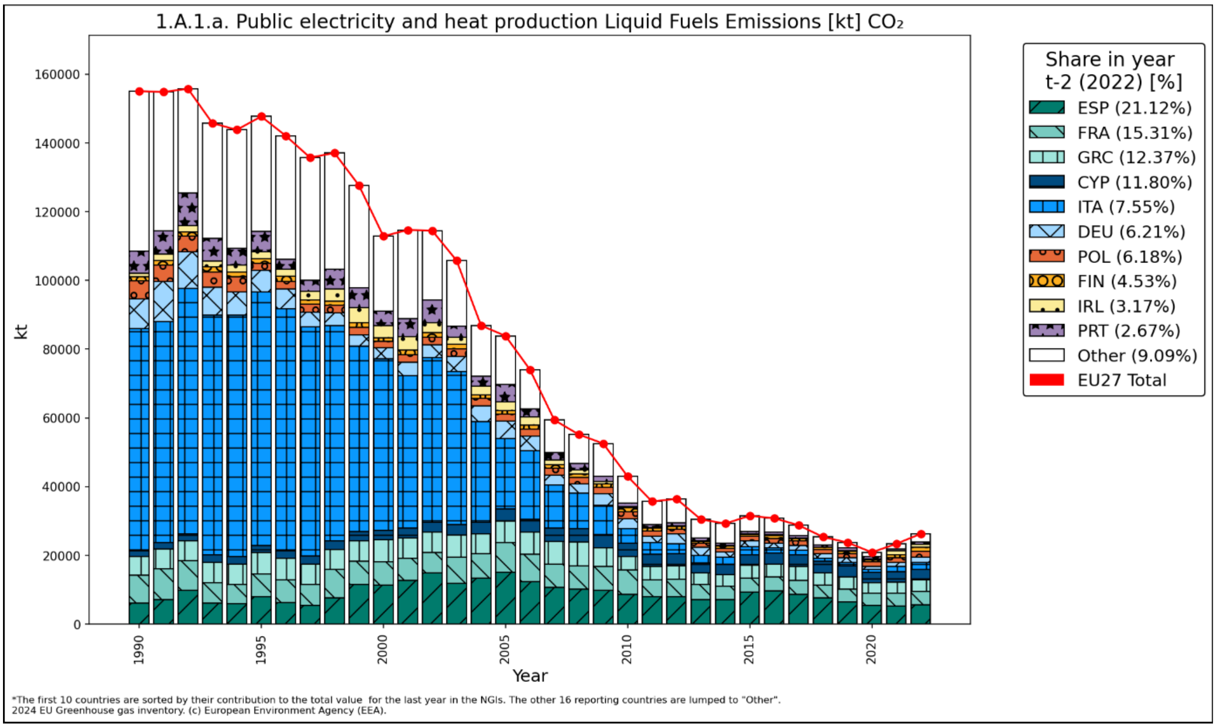
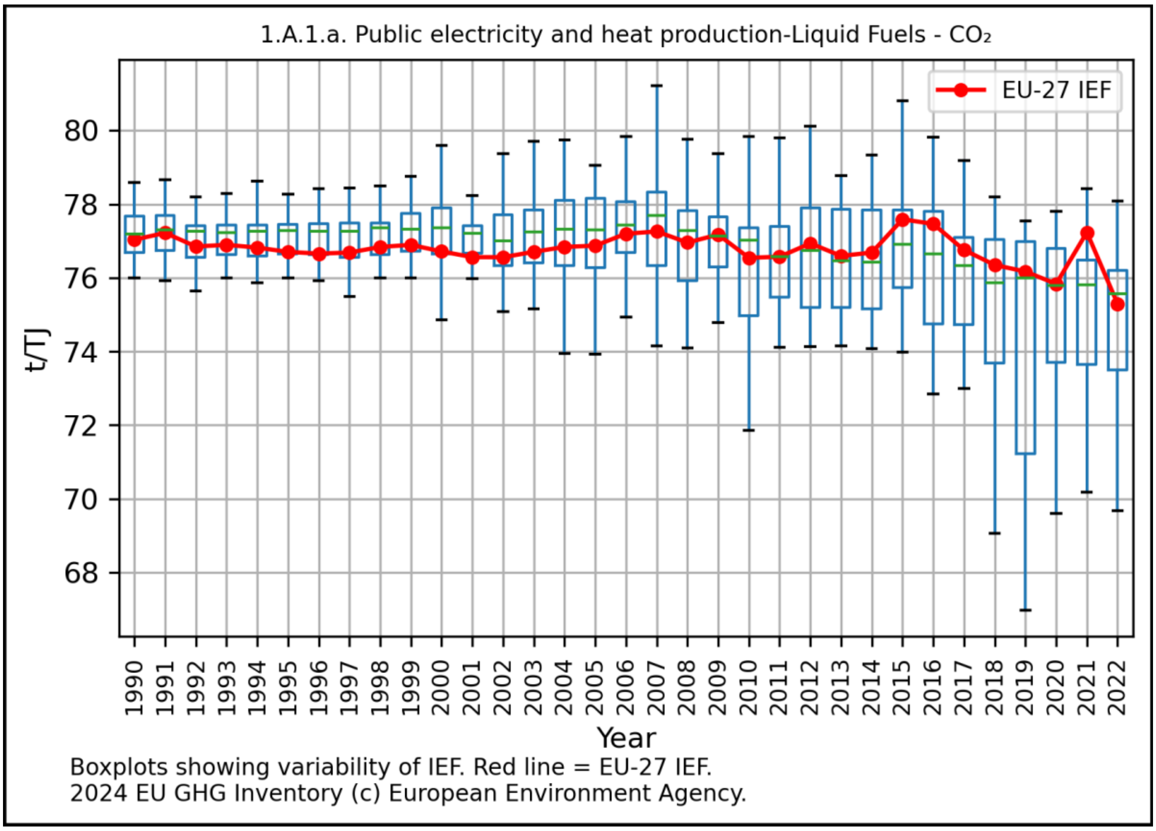


Figure 3.8 shows the implied emission factors for CO_2 emissions from liquid fuels used in public electricity and heat production. The IEFs in most countries range between 76 and 79 t/TJ on the entire time-series. The average IEF within the EU is 75.3 t/TJ in 2022.

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



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

CO_2 emissions from the combustion of solid fuels represented about 64.2 % of all greenhouse gas emissions from public electricity and heat production. Within the EU, emissions fell by 50 % between 1990 and 2022 (Table 3.7). A reason for the recent decline is that coal is being phased out of the fuel mix.

Table 3.15 1.A.1.a Public Electricity and Heat Production, Solid Fuels: Countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	6 247	NO	NO	-	-6 247	-100%	-	-
Belgium	19 148	4 323	5 057	1.1%	-14 091	-74%	734	17%
Bulgaria	25 638	18 820	23 892	5.0%	-1 746	-7%	5 072	27%
Croatia	595	1 195	1 267	0.3%	672	113%	73	6%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	52 368	35 376	37 261	7.9%	-15 107	-29%	1 885	5%
Denmark	22 225	3 687	3 766	0.8%	-18 460	-83%	78	2%
Estonia	22 017	4 881	6 272	1.3%	-15 745	-72%	1 392	29%
Finland	9 281	4 958	5 214	1.1%	-4 067	-44%	255	5%
France	37 410	9 260	7 563	1.6%	-29 847	-80%	-1 696	-18%
Germany	307 246	157 601	170 756	36.0%	-136 490	-44%	13 155	8%
Greece	35 201	8 299	8 251	1.7%	-26 950	-77%	-48	-1%
Hungary	12 266	4 029	3 895	0.8%	-8 371	-68%	-134	-3%
Ireland	4 845	2 618	2 196	0.5%	-2 648	-55%	-422	-16%
Italy	27 756	13 020	20 456	4.3%	-7 300	-26%	7 436	57%
Latvia	211	7	3	0.0%	-208	-99%	-4	-58%
Lithuania	174	6	5	0.0%	-169	-97%	-1	-11%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	710	NO	NO	-	-710	-100%	-	-
Netherlands	25 862	16 718	16 480	3.5%	-9 382	-36%	-238	-1%
Poland	220 132	141 996	136 551	28.8%	-83 580	-38%	-5 445	-4%
Portugal	7 921	691	NO	-	-7 921	-100%	-691	-100%
Romania	25 734	9 789	9 471	2.0%	-16 263	-63%	-317	-3%
Slovakia	11 542	1 747	1 592	0.3%	-9 950	-86%	-155	-9%
Slovenia	5 712	3 790	3 025	0.6%	-2 686	-47%	-765	-20%
Spain	58 931	7 246	9 507	2.0%	-49 424	-84%	2 261	31%
Sweden	4 231	1 922	1 610	0.3%	-2 621	-62%	-313	-16%
EU-27	**943 403**	**451 978**	**474 092**	**100%**	**-469 310**	**-50%**	**22 114**	**5%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 3.9 shows the trend of emissions for solid fuels for main contributing countries.

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

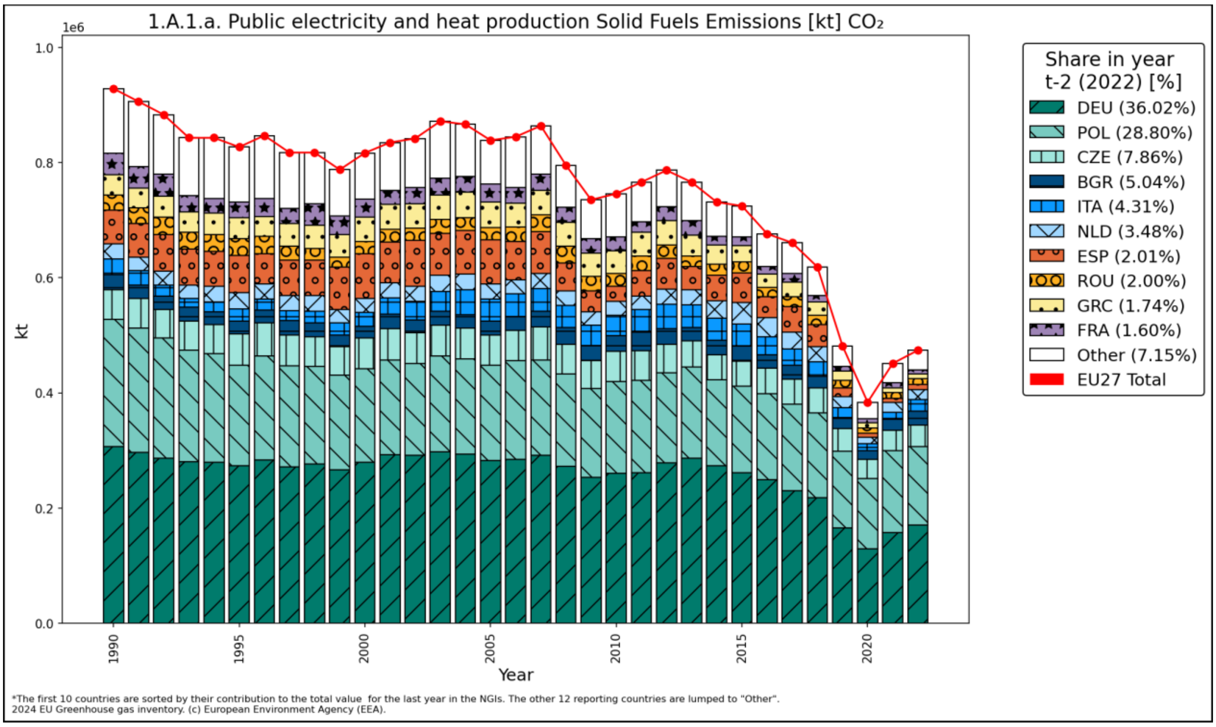
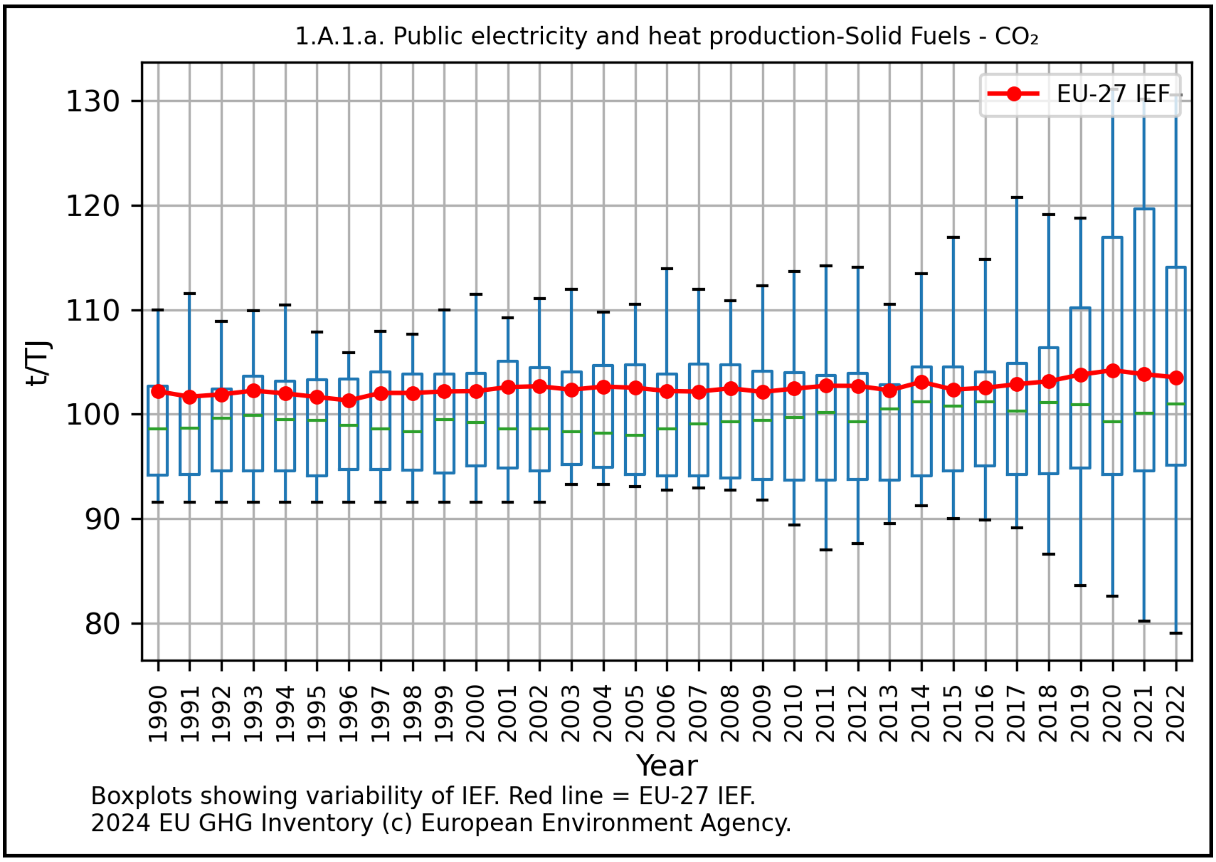


Figure 3.10 (on the next page) shows the relevant implied emission factors for solid fuels. The EU implied emission factor has remained fairly stable between 100 t/TJ and 103 t/TJ on the entire time-series (around 103.5 t/TJ in 2022).

Figure 3.14 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 25.5 % of all greenhouse gas emissions from public electricity and heat generation in 2022. Emissions increased by 75 % in the EU between 1990 and 2022 (Table 3.8).

Table 3.16 1.A.1.a Electricity and heat production, Gaseous Fuels: Countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	3 294	4 499	4 500	2.4%	1 206	37%	0	0%
Belgium	2 739	6 330	6 372	3.4%	3 633	133%	42	1%
Bulgaria	6 295	2 352	1 835	1.0%	-4 460	-71%	-516	-22%
Croatia	991	1 540	1 730	0.9%	738	74%	190	12%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	1 019	3 298	2 781	1.5%	1 762	173%	-517	-16%
Denmark	1 000	888	494	0.3%	-506	-51%	-393	-44%
Estonia	1 812	317	281	0.1%	-1 531	-85%	-36	-11%
Finland	1 989	2 059	585	0.3%	-1 404	-71%	-1 475	-72%
France	970	11 531	13 713	7.3%	12 743	1314%	2 182	19%
Germany	18 447	34 490	29 866	15.9%	11 419	62%	-4 624	-13%
Greece	NO	8 668	7 339	3.9%	7 339	∞	-1 329	-15%
Hungary	4 111	5 346	4 826	2.6%	715	17%	-519	-10%
Ireland	1 881	4 972	5 599	3.0%	3 718	198%	627	13%
Italy	16 173	50 124	48 832	26.0%	32 659	202%	-1 292	-3%
Latvia	2 658	1 325	840	0.4%	-1 817	-68%	-484	-37%
Lithuania	5 797	897	440	0.2%	-5 356	-92%	-457	-51%
Luxembourg	NO	156	119	0.1%	119	∞	-37	-23%
Malta	NO	739	747	0.4%	747	∞	9	1%
Netherlands	13 329	15 332	13 541	7.2%	212	2%	-1 791	-12%
Poland	1 197	7 150	5 588	3.0%	4 391	367%	-1 562	-22%
Portugal	NO	4 593	5 593	3.0%	5 593	∞	999	22%
Romania	20 845	5 532	5 207	2.8%	-15 638	-75%	-325	-6%
Slovakia	2 089	2 409	1 509	0.8%	-580	-28%	-899	-37%
Slovenia	113	311	273	0.1%	160	141%	-38	-12%
Spain	447	16 759	25 306	13.5%	24 858	5555%	8 547	51%
Sweden	486	192	C	-	-486	-100%	-192	-100%
EU-27	**107 683**	**191 808**	**187 917**	**100%**	**80 234**	**75%**	**-3 891**	**-2%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Abbreviations are explained in the Chapter 'Units and abbreviations'.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 and 2021 EU sums do include emission from Sweden.

Figure 3.11 shows the trend of emissions from gaseous fuels by the main contributing countries. 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 (2021 and 2022 are exceptions in the recent years).

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

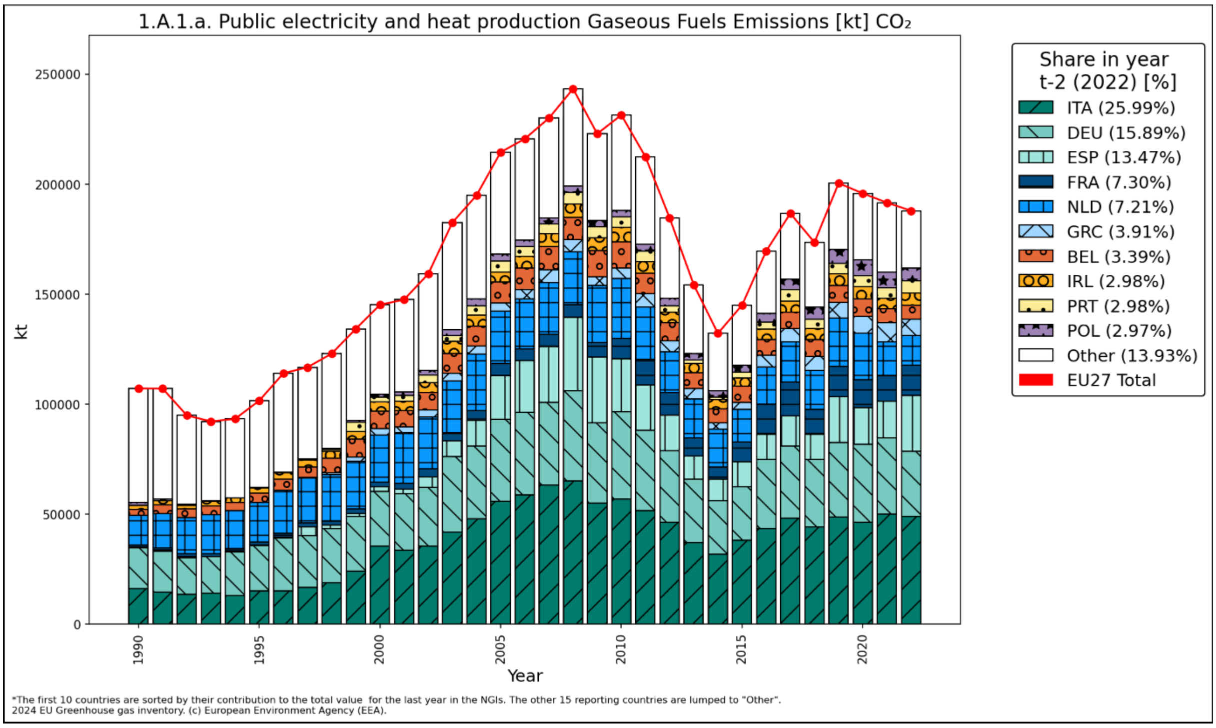
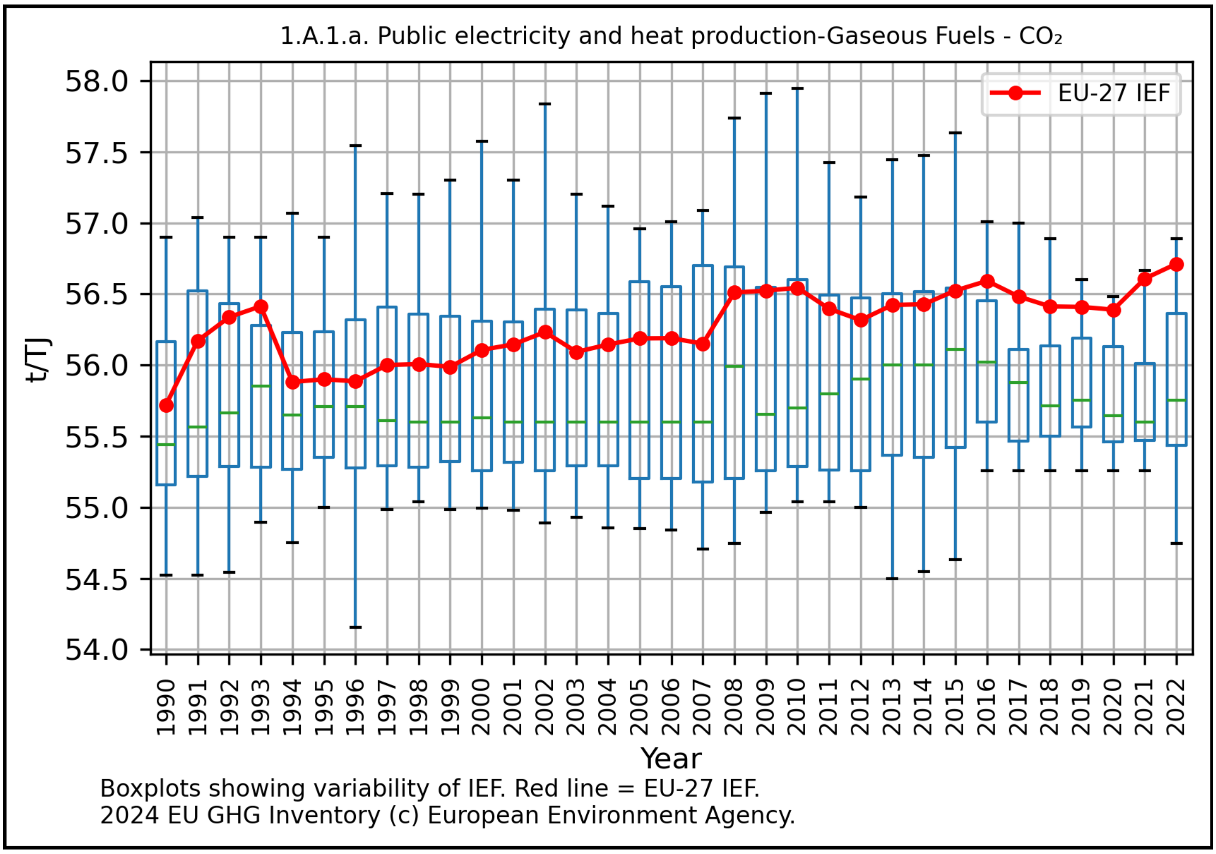


Figure 3.12 (on the next page) shows the implied emission factors from gaseous fuels for CO_2. The EU implied emission factor has remained fairly stable (56.7 t/TJ in 2022) which is very close to the default emission factor of natural gas (56.1 t/TJ). The IEF is driven by the source of importation of natural gas and its composition.

Figure 3.16 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 2022, the share of CO_2 emissions from other fuels amounts to 5.0 % 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 3.9).

Table 3.17 1.A.1.a Public Electricity and Heat Production, Other Fuels: Countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	286	1 049	1 028	2.8%	742	259%	-21	-2%
Belgium	674	2 137	2 007	5.4%	1 333	198%	-130	-6%
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	24	261	261	0.7%	237	987%	0	0%
Denmark	539	1 548	1 647	4.5%	1 108	206%	99	6%
Estonia	NO	124	112	0.3%	112	∞	-12	-10%
Finland	1	661	614	1.7%	613	61222%	-47	-7%
France	2 557	7 075	7 079	19.1%	4 522	177%	4	0%
Germany	4 121	13 525	13 582	36.7%	9 462	230%	57	0%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	30	220	205	0.6%	175	583%	-15	-7%
Ireland	NO	586	594	1.6%	594	∞	8	1%
Italy	143	146	117	0.3%	-26	-18%	-29	-20%
Latvia	3	NO	NO	-	-3	-100%	-	-
Lithuania	NO	448	438	1.2%	438	∞	-11	-2%
Luxembourg	32	99	103	0.3%	71	218%	4	4%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	601	2 671	2 667	7.2%	2 066	343%	-4	0%
Poland	753	954	1 026	2.8%	273	36%	72	8%
Portugal	NO	521	433	1.2%	433	∞	-88	-17%
Romania	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Slovakia	36	180	175	0.5%	140	392%	-5	-3%
Slovenia	NO	19	20	0.1%	20	∞	0	2%
Spain	128	1 637	1 768	4.8%	1 640	1286%	131	8%
Sweden	524	2 996	3 101	8.4%	2 577	491%	105	4%
EU-27	**10 453**	**36 859**	**36 978**	**100%**	**26 525**	**254%**	**120**	**0%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 3.13 illustrates clearly the strong increase of emissions caused by other fuels over the past 32 years.

Figure 3.17 1.A.1.a Public Electricity and Heat Production, Other Fuels: Emission trend and share for CO_2

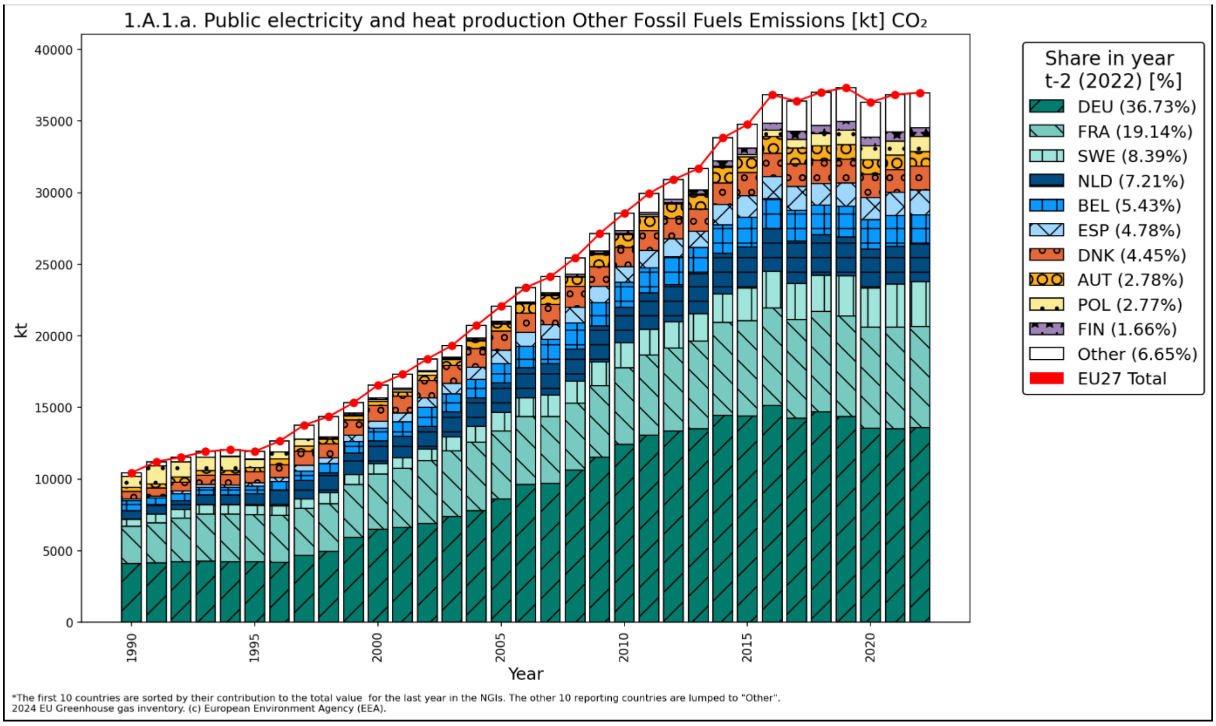
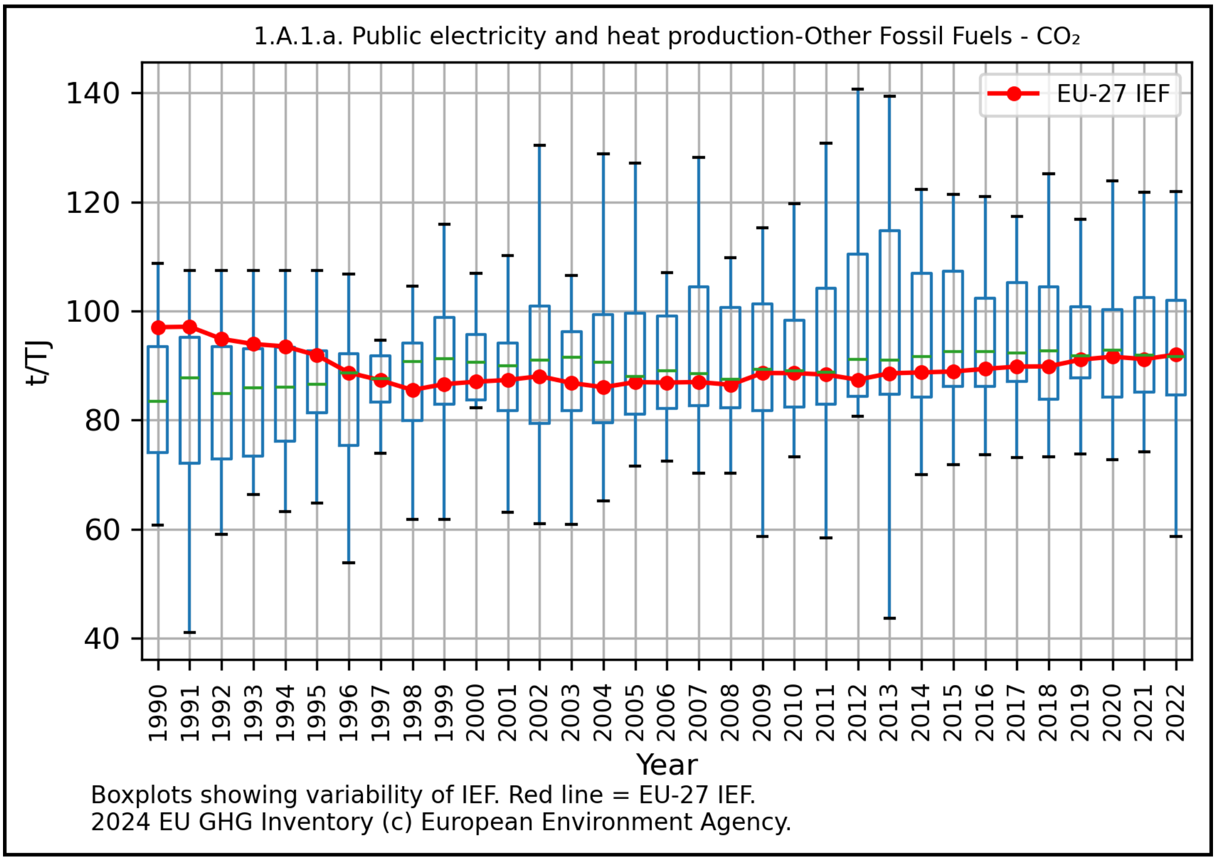


Figure 3.14 (on the next page) shows the implied emission factors from other fuels for CO_2. The EU implied emission factor has gradually fallen until 1998, then levelled out between 85 and 92 t/TJ on the entire time-series. This is because the combustion of industrial waste has been greatly reduced 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 3.18 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 0.5 % 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. Within the EU, emissions declined by 59 % respectively 5.4 Mt CO_2 between 1990 and 2022 and by 3 % between 2021 and 2022 (Table 3.10).

Table 3.18 1.A.1.a Public Electricity and Heat Production, Peat: Countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
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	843	21	26	0.7%	-817	-97%	5	23%
Finland	3 950	3 264	3 310	88.7%	-640	-16%	46	1%
France	NO	NO	NO	-	-	-	-	-
Germany	NO	NO	NO	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	3 065	333	277	7.4%	-2 788	-91%	-56	-17%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	146	0	0	0.0%	-145	-100%	0	300%
Lithuania	11	19	13	0.3%	2	14%	-6	-33%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	NO	NO	NO	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	1 150	210	107	2.9%	-1 043	-91%	-103	-49%
EU-27	**9 164**	**3 847**	**3 733**	**100%**	**-5 431**	**-59%**	**-114**	**-3%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Abbreviations are explained in the Chapter 'Units and abbreviations'.
Peat is not used as a fuel in the Netherlands. Nevertheless, the Netherlands did not report Peat as notation key

Figure 3.15 illustrates the trend of peat emissions throughout the last 32 years,

Figure 3.19 1.A.1.a Public Electricity and Heat Production, Peat: Emission trend and share for CO_2

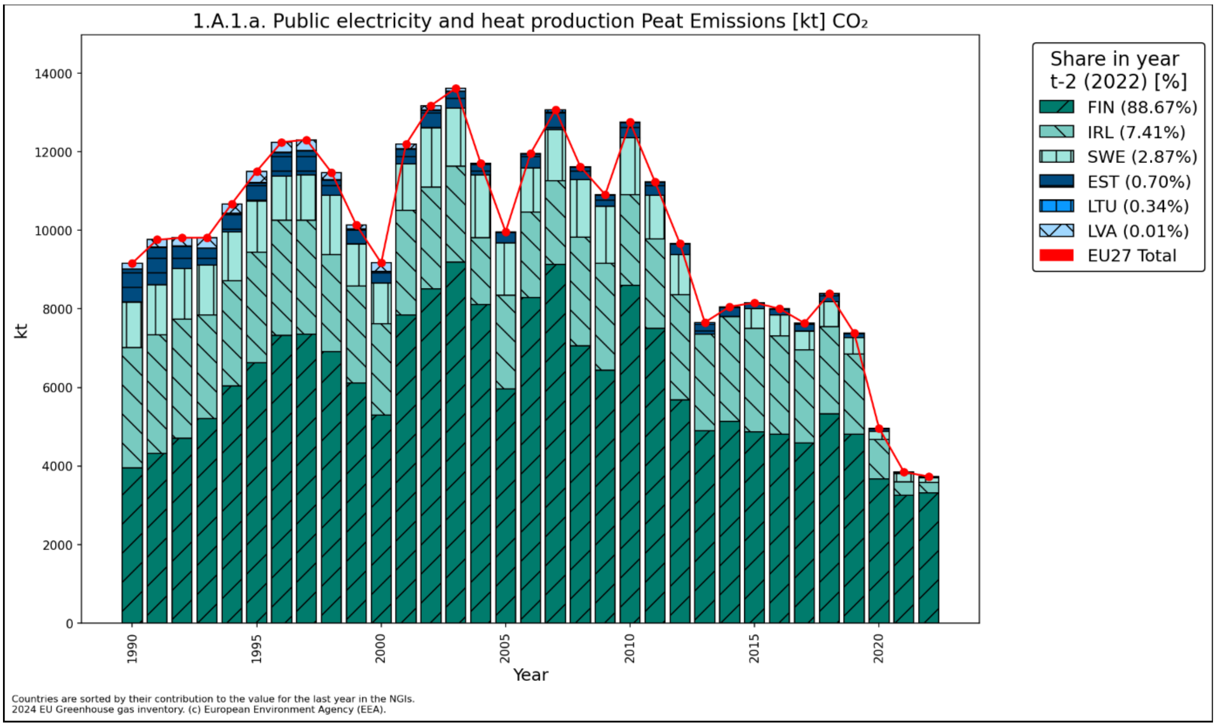
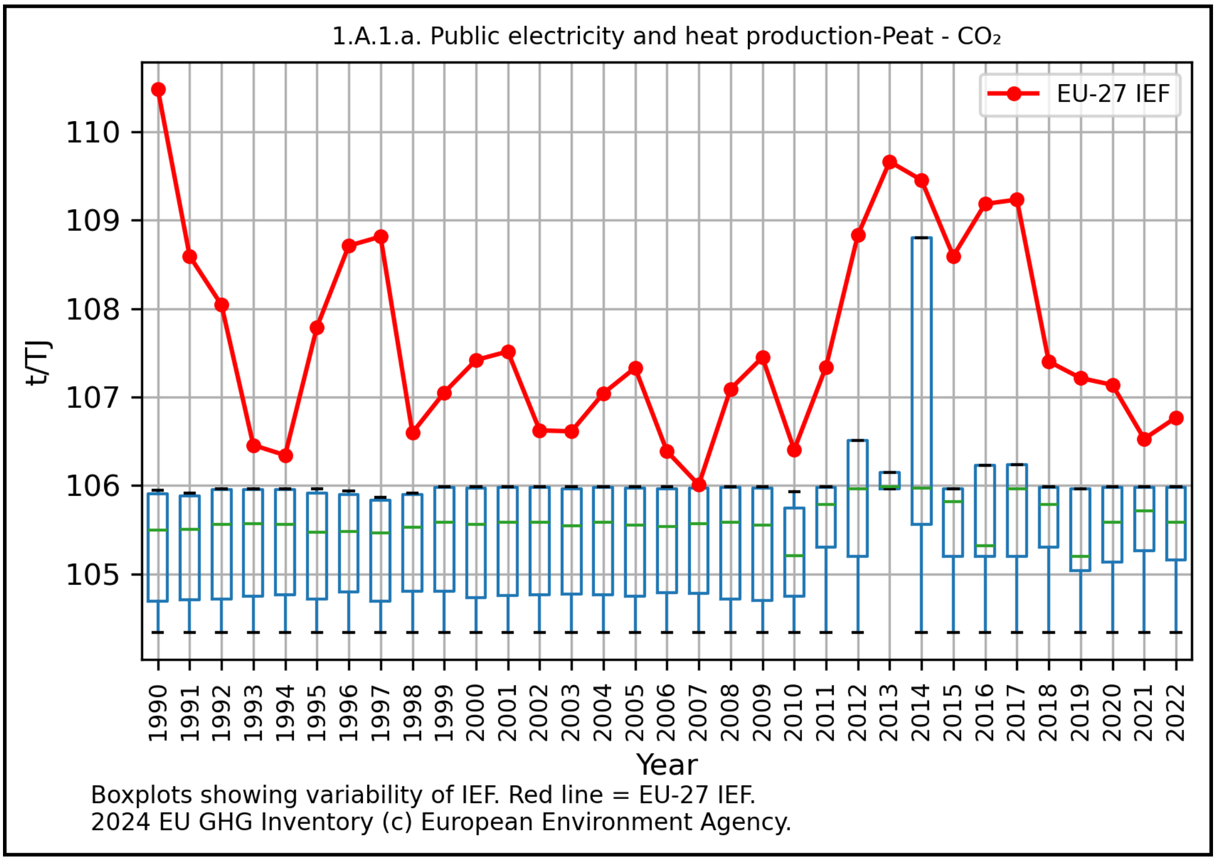


Figure 3.16 shows the implied emission factors of peat for CO_2. The EU implied emission factor amounts to 106.7 t/TJ in 2022 and has been quite stable over the last 32 years. It is mainly influenced by the IEF of the two largest emitters. The default emission factor for peat is 106 t/TJ according to the 2006 IPCC guidelines.

Figure 3.20 1.A.1.a Public Electricity and Heat Production, Peat: Implied Emission Factors for CO_2



3.5.1.2 Petroleum Refining (1.A.1.b) (EU)

According to the 2006 IPCC guidelines, Petroleum Refining (CRT 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 3.0 % of total greenhouse gas emissions in year 2022. Between 1990 and 2022, EU CO_2 emissions decreased by 11 % (Table 3.11). The decrease at European level can be explained by the reduction of Liquid fuels consumptions (-17 % for sector 1.A.1.b Liquid fuels between 1990 and 2022).

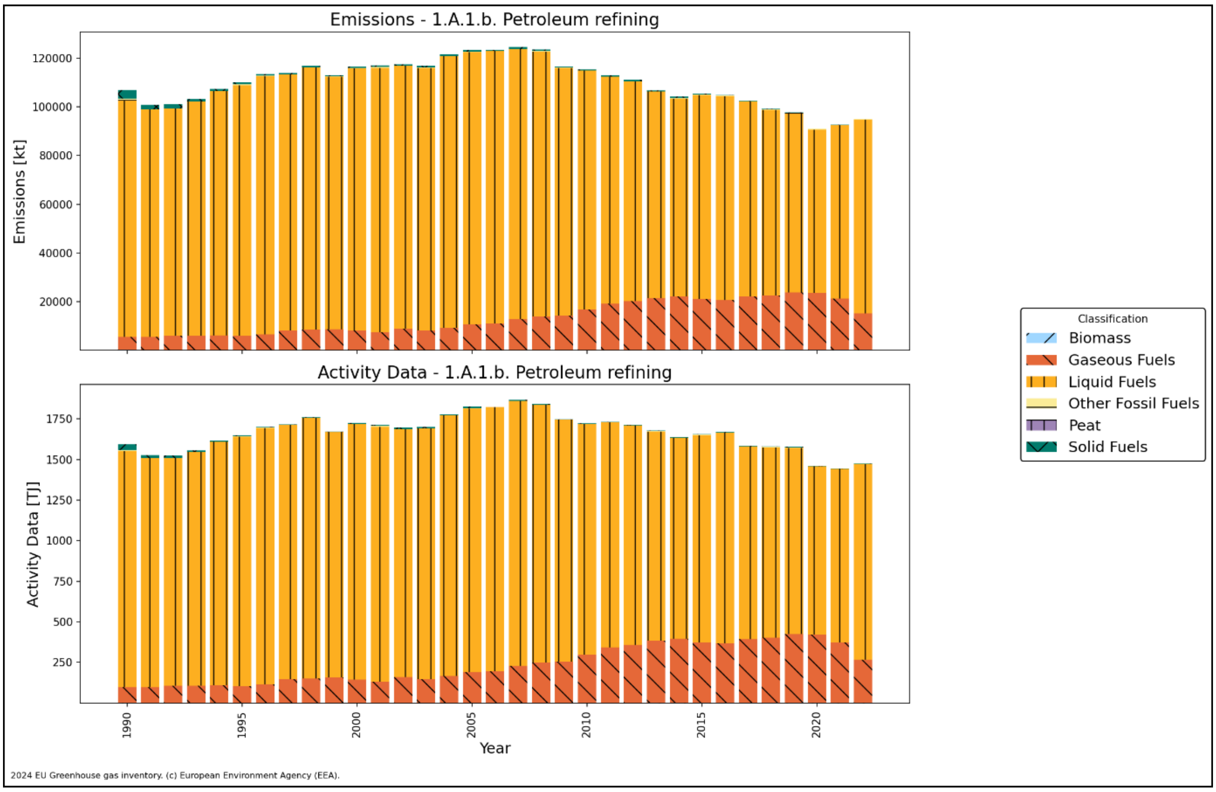
Table 3.19 1.A.1.b Petroleum Refining: Countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	2 394	2 750	2 255	2.4%	-139	-6%	-495	-18%	NA,T2	CS,NA
Belgium	4 299	5 081	4 727	5.0%	428	10%	-354	-7%	CS,NA,T3	NA,PS
Bulgaria	860	729	1 031	1.1%	172	20%	303	42%	NA,T1,T2	CS,D,NA
Croatia	2 425	745	695	0.7%	-1 729	-71%	-50	-7%	NA,T1	D,NA
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czechia	493	479	506	0.5%	13	3%	27	6%	NA,T1,T2	CS,D,NA
Denmark	908	938	912	1.0%	4	0%	-26	-3%	NA,T2,T3	NA,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2 042	1 171	1 415	1.5%	-627	-31%	245	21%	NA,T3	CS,NA,PS
France	11 935	4 893	5 208	5.5%	-6 728	-56%	315	6%	NA	NA
Germany	24 212	19 984	21 979	23.1%	-2 234	-9%	1 995	10%	CS,NA	CS,NA
Greece	2 375	5 277	5 841	6.2%	3 466	146%	565	11%	NA,T2	NA,PS
Hungary	2 376	1 515	1 493	1.6%	-882	-37%	-22	-1%	NA,T2,T3	CS,NA,PS
Ireland	168	294	308	0.3%	140	83%	14	5%	NA,T3	CS,NA,PS
Italy	15 817	16 548	19 035	20.0%	3 218	20%	2 487	15%	NA,T3	CS,NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 210	1 241	1.3%	-269	-18%	31	3%	NA,T2,T3	CS,NA,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	11 010	9 471	9 432	9.9%	-1 578	-14%	-39	0%	NA,T2	CS,D,NA
Poland	2 169	4 403	3 918	4.1%	1 749	81%	-486	-11%	NA,T1,T2	CS,D,NA
Portugal	1 870	1 761	1 523	1.6%	-347	-19%	-237	-13%	NO,T2	CR,D,NO,PS
Romania	4 282	1 606	1 936	2.0%	-2 345	-55%	330	21%	NA,T3	NA,PS
Slovakia	2 990	1 838	1 893	2.0%	-1 097	-37%	55	3%	NA,T3	NA,PS
Slovenia	171	NO	NO	-	-171	-100%	-	-	NA	NA
Spain	10 858	9 044	9 606	10.1%	-1 252	-12%	562	6%	NA,T2,T3	NA,PS
Sweden	1 778	2 767	C,NO	-	-1 778	-100%	-2 767	-100%	T2	CS
EU-27	**107 030**	**92 504**	**94 956**	**100%**	**-12 073**	**-11%**	**2 452**	**3%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations are explained in the Chapter 'Units and abbreviations'. This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 and 2021 EU sums do include emission from Sweden.

Figure 3.17 shows the trends in activity data and the associated emissions originating from the refining of petroleum by fuel in the EU between the years 1990 and 2022. Fuel used for petroleum refining decreased by 5 % in the EU between 1990 and 2022. In the year 2022, liquid fuels represent about 80 % of all fuel used in the refining of petroleum. Gaseous fuels almost fully account for the remaining part (around 18%) of the activity data. Gaseous fuels use is almost three times higher in 2022 compared to 1990. There remains a small amount of biomass and solid fuels used each accounting for 0.15 % in petroleum refining;.

Figure 3.21 1.A.1.b Petroleum Refining: Total emission and activity trends



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 81 % of all greenhouse gas emissions from petroleum refining in 2022. Emissions decreased by 18 % between 1990 and 2022 (Table 3.12).

Table 3.20 1.A.1.b Petroleum Refining, Liquid Fuels: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 958	2 217	1 955	2.5%	-3	0%	-262	-12%	T2	CS
Belgium	4 285	3 267	3 632	4.6%	-653	-15%	365	11%	CS,T3	PS
Bulgaria	791	617	991	1.2%	200	25%	374	61%	T1	D
Croatia	2 411	396	464	0.6%	-1 947	-81%	68	17%	T1	D
Cyprus	86	NO	NO	-	-86	-100%	-	-	NA	NA
Czechia	176	294	291	0.4%	116	66%	-3	-1%	T1	CS,D
Denmark	908	902	901	1.1%	-7	-1%	-1	0%	T2,T3	PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 383	983	1 369	1.7%	-14	-1%	386	39%	T3	CS,PS
France	11 413	3 459	3 919	4.9%	-7 494	-66%	460	13%	-	-
Germany	19 464	17 021	18 915	23.8%	-549	-3%	1 894	11%	CS	CS
Greece	2 375	5 277	5 841	7.3%	3 466	146%	565	11%	T2	PS
Hungary	1 683	878	914	1.1%	-769	-46%	36	4%	T3	PS
Ireland	168	280	295	0.4%	126	75%	15	5%	T3	CS,PS
Italy	15 656	13 028	16 317	20.5%	660	4%	3 289	25%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 510	1 123	1 221	1.5%	-289	-19%	98	9%	T2,T3	CS,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 968	6 946	8 276	10.4%	-1 692	-17%	1 330	19%	T2	CS,D
Poland	1 326	2 472	2 681	3.4%	1 355	102%	209	8%	T1,T2	CS,D
Portugal	1 870	925	991	1.2%	-879	-47%	67	7%	T2	CR,D,PS
Romania	4 282	1 362	1 791	2.2%	-2 491	-58%	429	31%	T3	PS
Slovakia	2 786	1 301	1 418	1.8%	-1 368	-49%	117	9%	T3	PS
Slovenia	43	NO	NO	-	-43	-100%	-	-	NA	NA
Spain	10 812	5 982	7 424	9.3%	-3 388	-31%	1 442	24%	T2,T3	PS
Sweden	1 778	2 504	C	-	-1 778	-100%	-2 504	-100%	T2	CS
EU-27	**97 131**	**71 233**	**79 606**	**100%**	**-17 525**	**-18%**	**8 372**	**12%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period

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

This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 and 2021 EU sums do include emission from Sweden.

Figure 3.18 illustrates that the trend for liquid fuels was continuously decreasing since the year 2008 with a stabilization between 2014 and 2016. A slight increase can be observed between 2020 and 2021 following the COVID crisis and even much larger between 2021 and 2022.

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

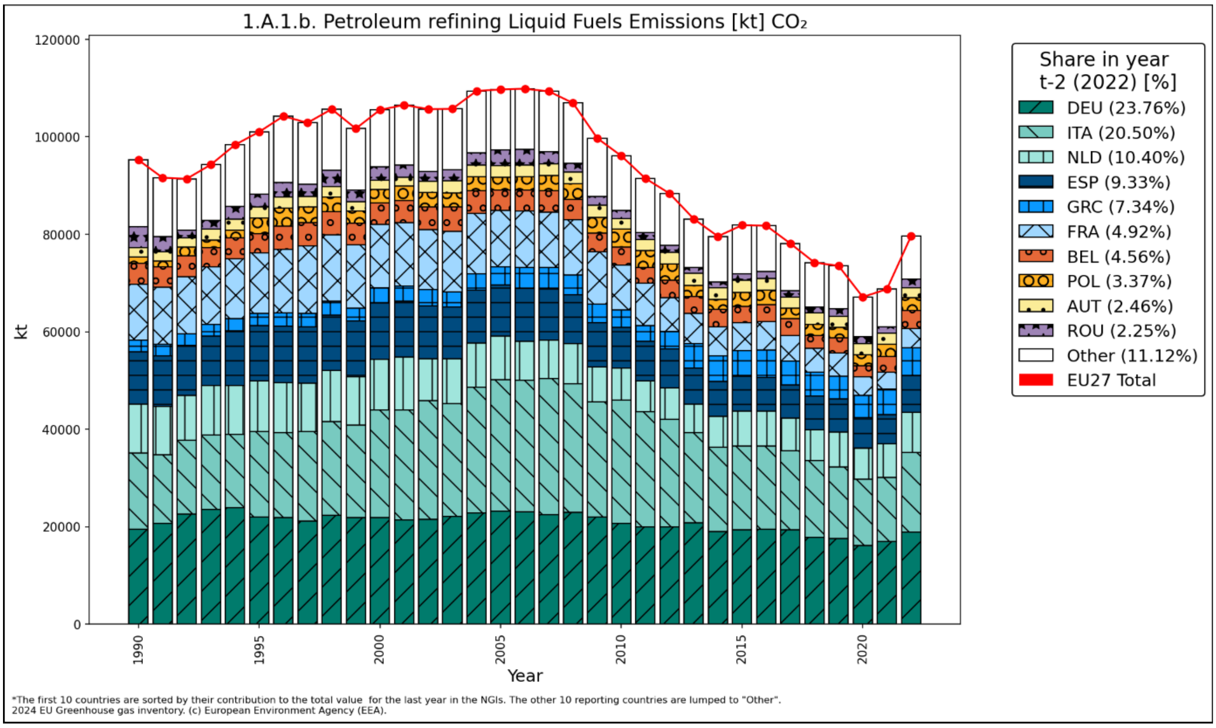
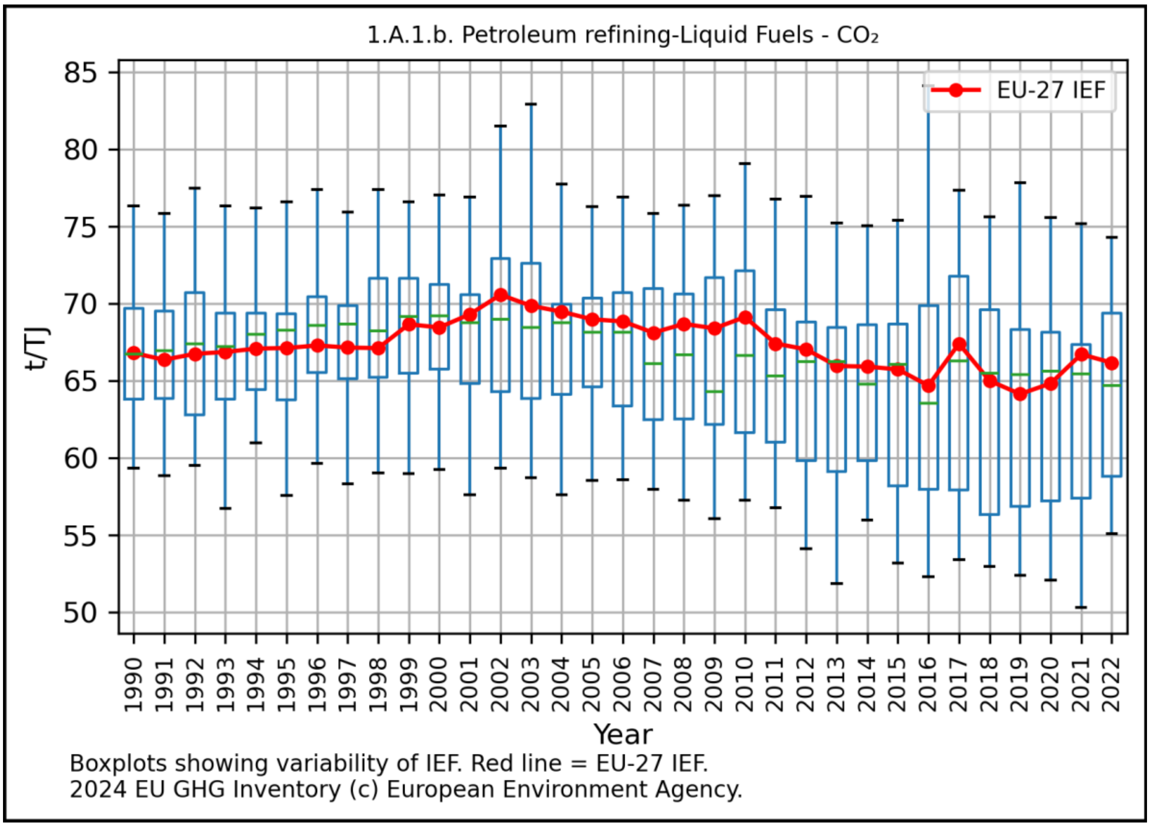


Figure 3.19 (on the next page) shows the emission factors for CO_2 emissions from liquid fuels. The EU implied emission factor shows variations around 68 t/TJ over the time series and amounts 66.3 t/TJ in 2022. In general, the fluctuating IEF is due to the annual variations of fuel consumption with different carbon content. The IEF declining trend observed since 2002 is due to the higher share of refinery gas in the energy mix.

Figure 3.23 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 2022. Over the whole times series emissions fell by 96 % on average (Table 3.13).

Table 3.21 1.A.1.b Petroleum Refining, Solid Fuels: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
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	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	39	68	53.0%	-3 063	-98%	29	76%	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	57	55	43.3%	51	1203%	-1	-2%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	NO	NO
Romania	NO	4	5	3.7%	5	∞	1	28%	T3	PS
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	-	-
EU-27	**3 633**	**99**	**128**	**100%**	**-3 505**	**-96%**	**29**	**29%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 3.20 illustrates the trend of emissions in 1.A.1.b for solid fuels for the past 32 years. The use of solid fuels in petroleum refining has declined drastically since 1990. Emissions are down by 96 %.

Figure 3.24 1.A.1.b Petroleum Refining, Solid Fuels: Emission trend and share for CO_2

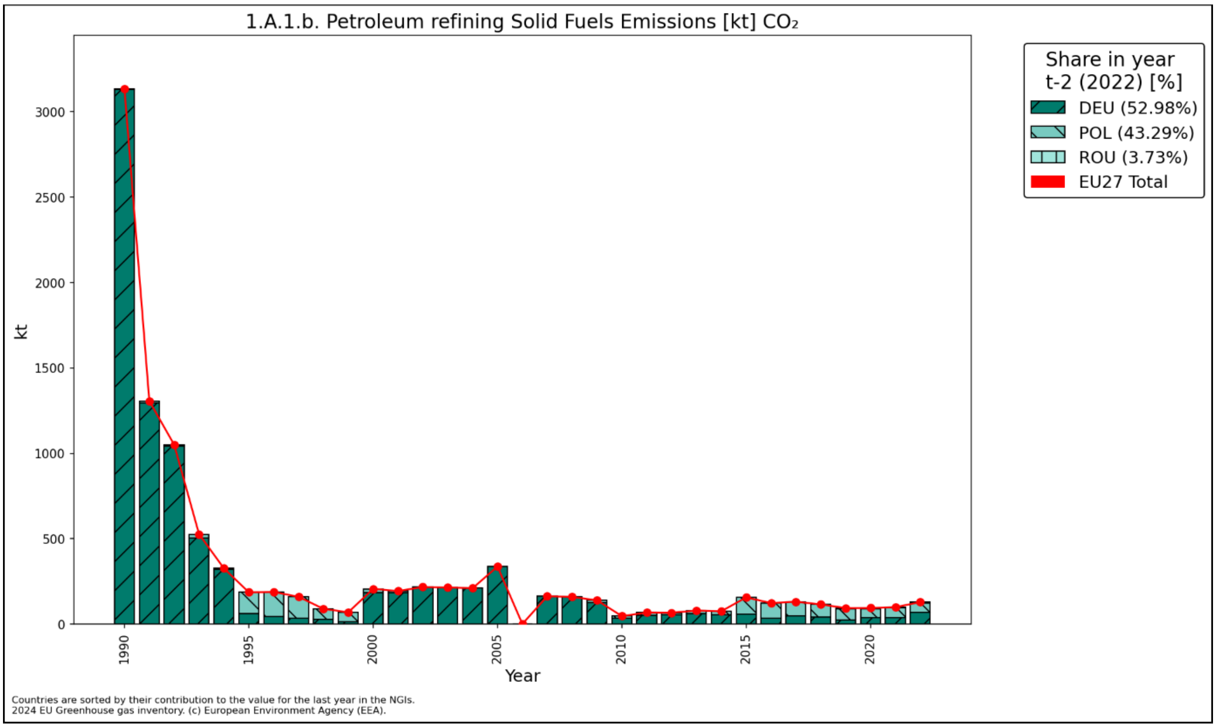
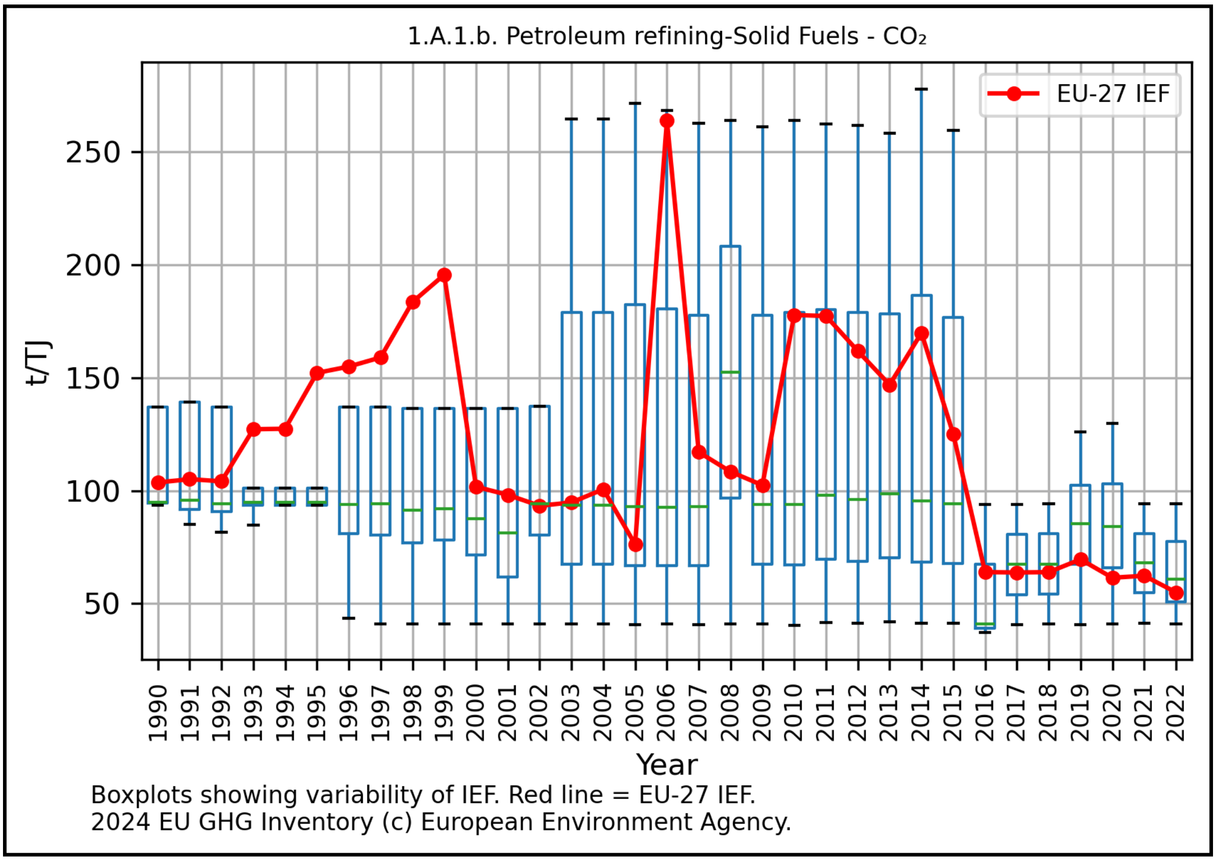


Figure 3.21 (on the next page) shows the relevant implied emission factors. The EU implied emission factor showed strong fluctuations and amounts 55 t/TJ in 2022. One explanation for this is the low number of countries reporting this category. Apart from that, the variation in the EU factor can be partly explained by the declining use of solid fuels in petroleum refining. The evolution of the IEF on the time-series can be explained by the fuel mix (including the use of blast furnace gas; lignite, etc. for example).

Figure 3.25 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 2022, CO_2 emissions from the combustion of gaseous fuels used for petroleum refining accounted for about 15 % of total greenhouse gas emissions from 1.A.1.b. Emissions in the EU increased by 181 % between 1990 and 2022 (Table 3.14).

Table 3.22 1.A.1.b Petroleum Refining, Gaseous Fuels: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	437	533	300	2.0%	-136	-31%	-232	-44%	T2	CS
Belgium	14	1 810	1 084	7.2%	1 070	7704%	-726	-40%	CS,T3	PS
Bulgaria	69	112	40	0.3%	-28	-41%	-71	-64%	T2	CS
Croatia	14	350	231	1.5%	217	1557%	-119	-34%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	317	185	215	1.4%	-102	-32%	29	16%	T2	CS
Denmark	NO	36	10	0.1%	10	∞	-26	-71%	-	-
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	648	188	46	0.3%	-601	-93%	-141	-75%	T3	CS
France	36	1 433	1 131	7.5%	1 095	3024%	-302	-21%	-	-
Germany	1 444	2 924	2 996	20.0%	1 552	107%	72	2%	CS	CS
Greece	NO	IE	IE	-	-	-	-	-	NA	NA
Hungary	693	620	567	3.8%	-126	-18%	-54	-9%	T3	PS
Ireland	NO	14	13	0.1%	13	∞	-1	-5%	T3	CS,PS
Italy	161	3 520	2 719	18.1%	2 558	1592%	-801	-23%	T3	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	87	20	0.1%	20	∞	-67	-77%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 042	2 524	1 156	7.7%	113	11%	-1 369	-54%	T2	CS
Poland	92	1 875	1 182	7.9%	1 089	1178%	-693	-37%	T2	CS
Portugal	NO	836	532	3.5%	532	∞	-304	-36%	T2	CR,D,PS
Romania	NO	241	141	0.9%	141	∞	-100	-41%	T3	PS
Slovakia	205	537	475	3.2%	271	132%	-62	-11%	T3	PS
Slovenia	128	NO	NO	-	-128	-100%	-	-	NA	NA
Spain	46	3 050	2 159	14.4%	2 113	4596%	-891	-29%	T2,T3	PS
Sweden	NO	263	C	-	-	-	-263	-100%	T2	CS
EU-27	**5 345**	**21 138**	**15 019**	**100%**	**9 674**	**181%**	**-6 118**	**-29%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Abbreviations are explained in the Chapter 'Units and abbreviations'.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 and 2021 EU sums do include emission from Sweden.

Figure 3.22 illustrates the trend of increasing emissions from gaseous fuels in category 1.A.1.b in the last 32 years. A big drop is observed since 2020 with a reduction of 29% of CO_2 emissions between 2021 and 2022.

Figure 3.26 1.A.1.b Petroleum Refining, Gaseous Fuels: Emission trend and share for CO_2

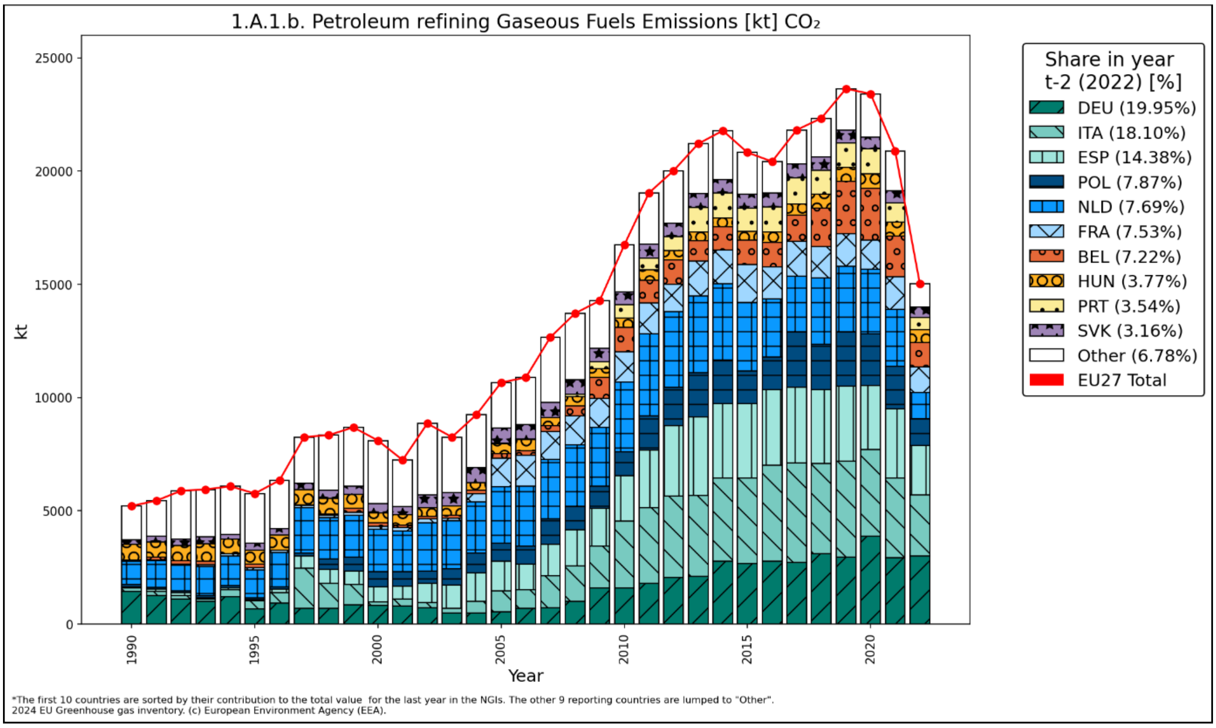
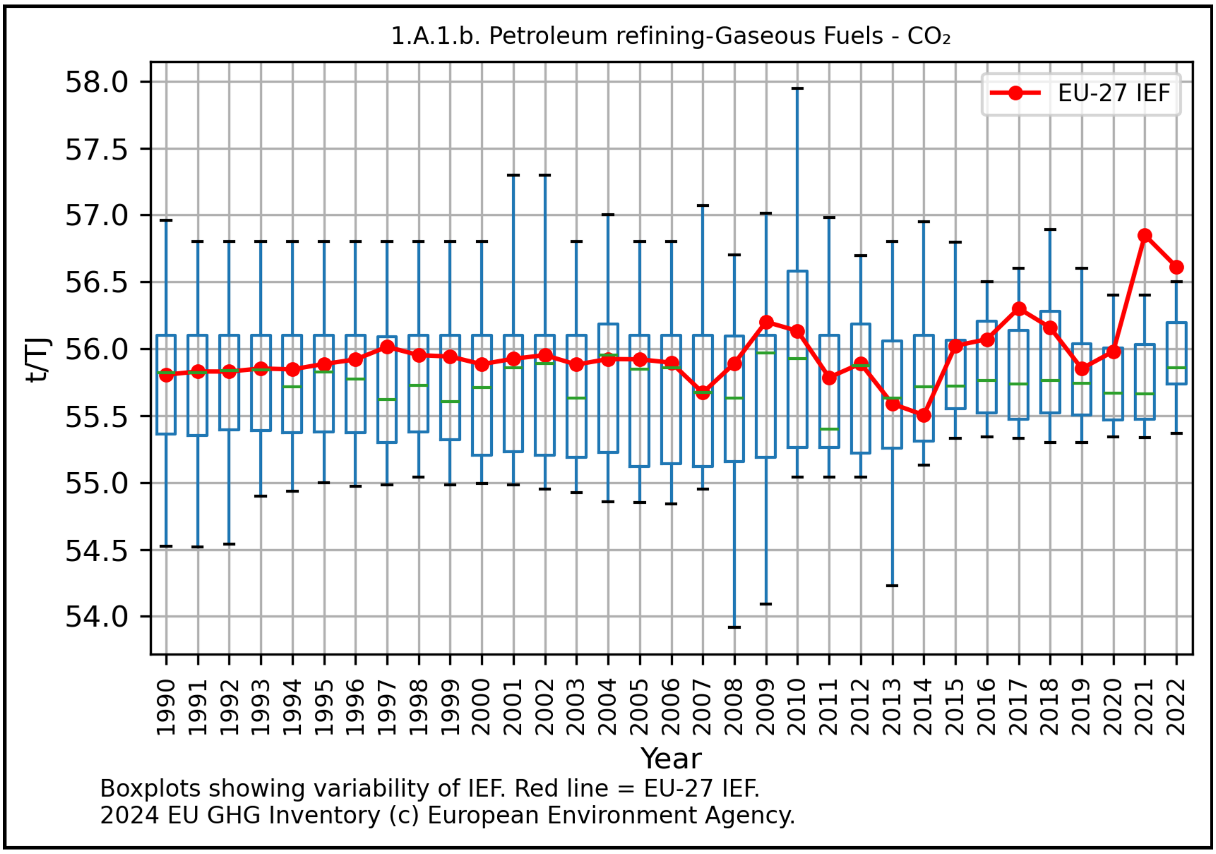


Figure 3.23 (on the next page) shows the implied emission factors for CO_2 emissions from gaseous fuels. The EU implied emission factor has remained broadly stable around 56 t/TJ on the entire time-series with a high value of 56.6 t/TJ in 2022 which remains in the IPCC range.

Figure 3.27 1.A.1.b Petroleum Refining, Gaseous Fuels: Implied Emission Factors for CO_2



3.5.1.3 Manufacture of Solid Fuels and Other Energy Industries (1.A.1.c) (EU)

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 % of total EU greenhouse gas emissions in 2022. Between 1990 and 2022, CO_2 emissions fell by 70 % in the EU (Table 3.15).

Table 3.23 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Countries' contributions to CO_2 emissions

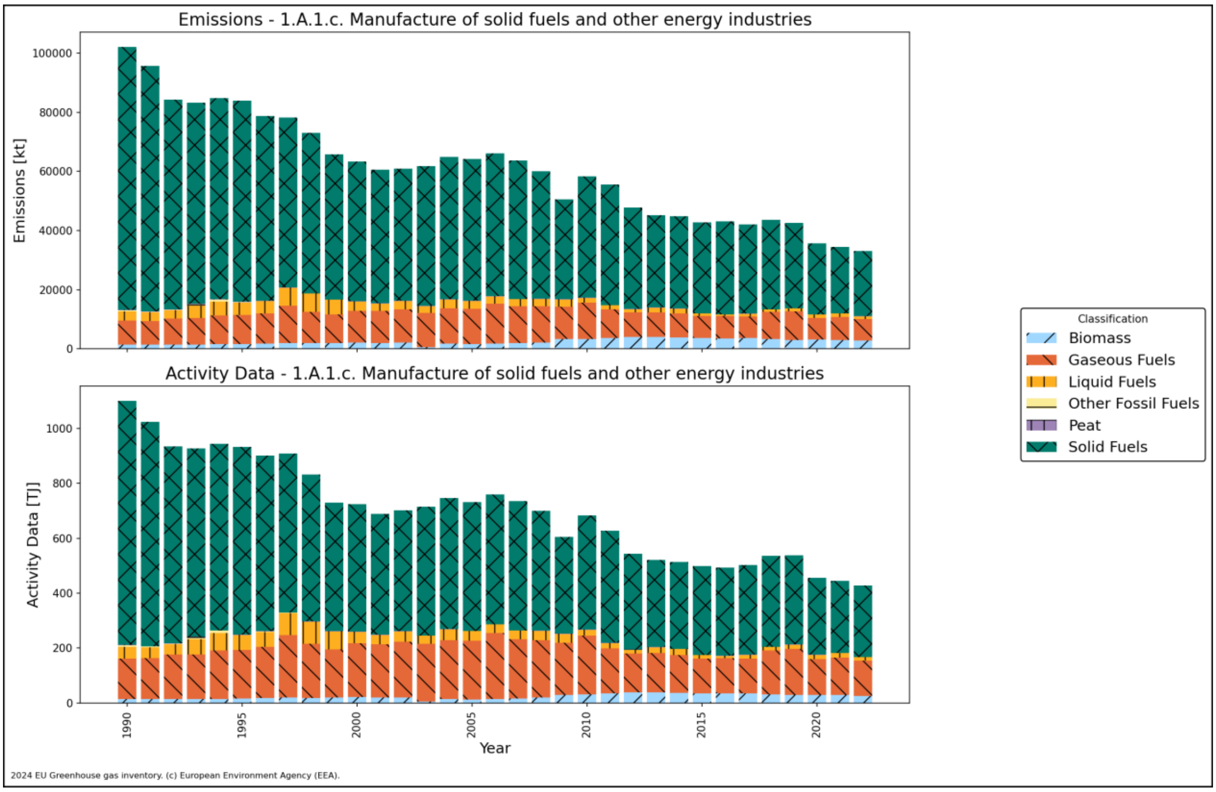
Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	510	375	344	1.1%	-166	-32%	-30	-8%	NA,T2	CS,NA
Belgium	2 024	160	161	0.5%	-1 863	-92%	1	1%	NA,T3	NA,PS
Bulgaria	362	2	5	0.0%	-358	-99%	2	89%	NA,T1,T2	CS,D,NA
Croatia	912	237	307	1.0%	-606	-66%	70	29%	NA,T1	D,NA
Cyprus	NO	NO	6	0.0%	6	∞	6	∞	NA,T1	D,NA
Czechia	1 516	1 258	1 600	5.3%	84	6%	342	27%	NA,T1,T2	CS,D,NA
Denmark	530	894	879	2.9%	349	66%	-14	-2%	NA,T2,T3	CS,NA
Estonia	78	1 545	1 561	5.1%	1 483	1892%	15	1%	T3	PS
Finland	347	329	318	1.0%	-30	-9%	-11	-3%	NA,T3	CS,NA
France	4 738	2 160	2 193	7.2%	-2 545	-54%	33	2%	NA	NA
Germany	65 289	9 812	9 641	31.7%	-55 648	-85%	-171	-2%	CS	CS
Greece	102	26	4	0.0%	-98	-96%	-22	-84%	NA,T2	NA,PS
Hungary	570	265	210	0.7%	-360	-63%	-55	-21%	NA,T1,T2,T3	CS,D,NA,PS
Ireland	100	80	67	0.2%	-33	-33%	-14	-17%	T3	CS
Italy	12 454	4 654	3 986	13.1%	-8 468	-68%	-668	-14%	T3	CS
Latvia	205	53	47	0.2%	-158	-77%	-6	-10%	NA,T2	CS,NA
Lithuania	9	43	52	0.2%	43	456%	9	20%	NA,T2	CS,NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	-	-
Netherlands	2 110	2 484	2 370	7.8%	260	12%	-114	-5%	NA,T2	CS,NA
Poland	4 846	3 574	3 324	10.9%	-1 522	-31%	-250	-7%	NA,T1,T2	CS,D,NA
Portugal	141	NO	NO	-	-141	-100%	-	-	NA,NO,T1	D,NA,NO
Romania	146	1 236	1 003	3.3%	857	587%	-232	-19%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	1 319	1 084	1 186	3.9%	-133	-10%	103	9%	NA,T2	CS,NA
Slovenia	82	0	0	0.0%	-82	-100%	0	-56%	NA,T2	CS,NA
Spain	2 089	890	818	2.7%	-1 271	-61%	-72	-8%	NA,T1,T2	CS,D,NA,PS
Sweden	300	327	372	1.2%	72	24%	45	14%	T2	CS
EU-27	**100 783**	**31 488**	**30 455**	**100%**	**-70 328**	**-70%**	**-1 033**	**-3%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period 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 between 1990 and 2022. The largest share of greenhouse gas emissions from the manufacture of solid fuels can be accounted to CO_2 emissions from solid (about 72 % of emission) and gaseous fuels (the remaining share). 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 61 % in the EU between 1990 and 2022. The strongest decline was reported for solid fuels (-70 %), followed by liquid fuels (-67 %). Only biomass consumptions increased in the period from 1990 to 2022.

Figure 3.28 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Total emission and activity trends



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 72 % of total greenhouse gas emissions from 1.A.1.c in 2022. Emissions in the EU declined by 75% since 1990.

Table 3.24 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Belgium	2 017	160	161	0.7%	-1 856	-92%	1	1%
Bulgaria	274	0	0	0.0%	-274	-100%	0	-33%
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	1 352	1 243	1 585	7.2%	233	17%	342	27%
Denmark	NO	NO	NO	-	-	-	-	-
Estonia	78	1 545	1 561	7.1%	1 483	1892%	15	1%
Finland	347	329	318	1.4%	-30	-9%	-11	-3%
France	4 054	2 160	2 193	9.9%	-1 861	-46%	33	2%
Germany	61 101	8 253	8 021	36.3%	-53 080	-87%	-232	-3%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	220	142	66	0.3%	-154	-70%	-76	-54%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	10 891	3 646	2 971	13.5%	-7 920	-73%	-675	-19%
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	916	1 193	1 282	5.8%	366	40%	89	7%
Poland	4 009	2 139	1 942	8.8%	-2 067	-52%	-196	-9%
Portugal	91	NO	NO	-	-91	-100%	-	-
Romania	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Slovakia	1 319	1 046	1 138	5.2%	-181	-14%	91	9%
Slovenia	37	NO	NO	-	-37	-100%	-	-
Spain	1 809	294	471	2.1%	-1 338	-74%	178	61%
Sweden	300	327	372	1.7%	72	24%	45	14%
EU-27	**88 816**	**22 477**	**22 081**	**100%**	**-66 735**	**-75%**	**-396**	**-2%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period

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

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

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. 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.

Figure 3.29 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Solid Fuels: Emission trend and share for CO_2

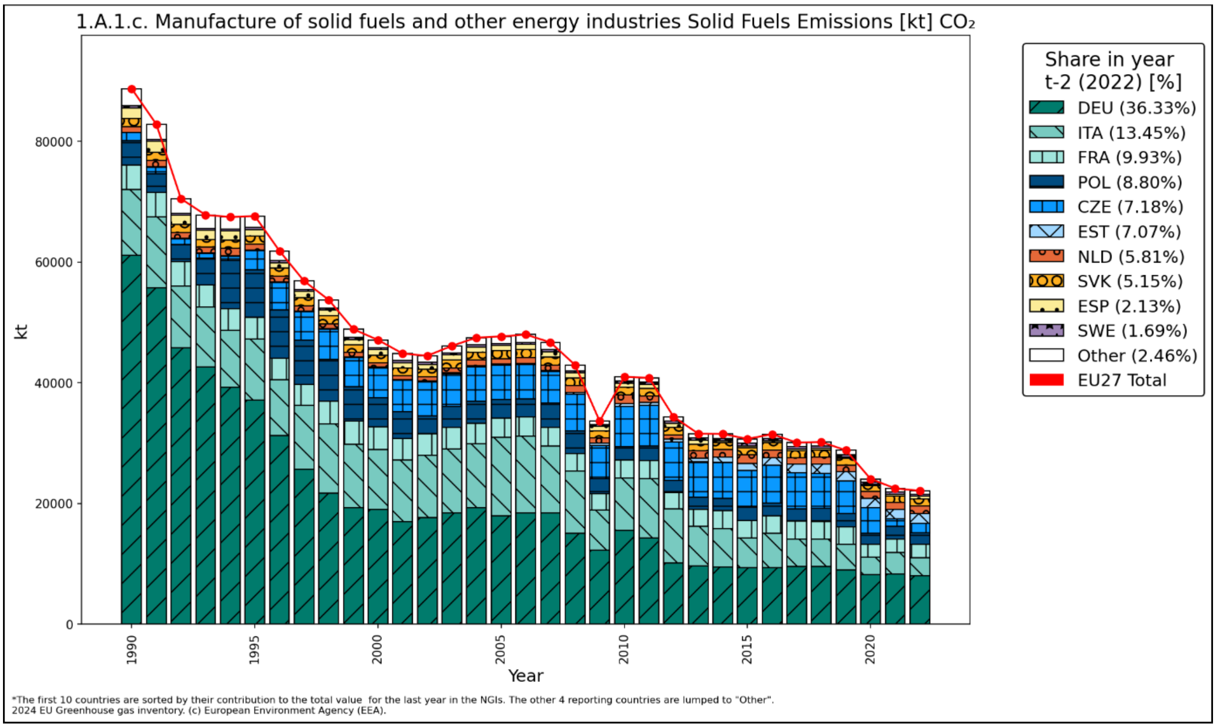
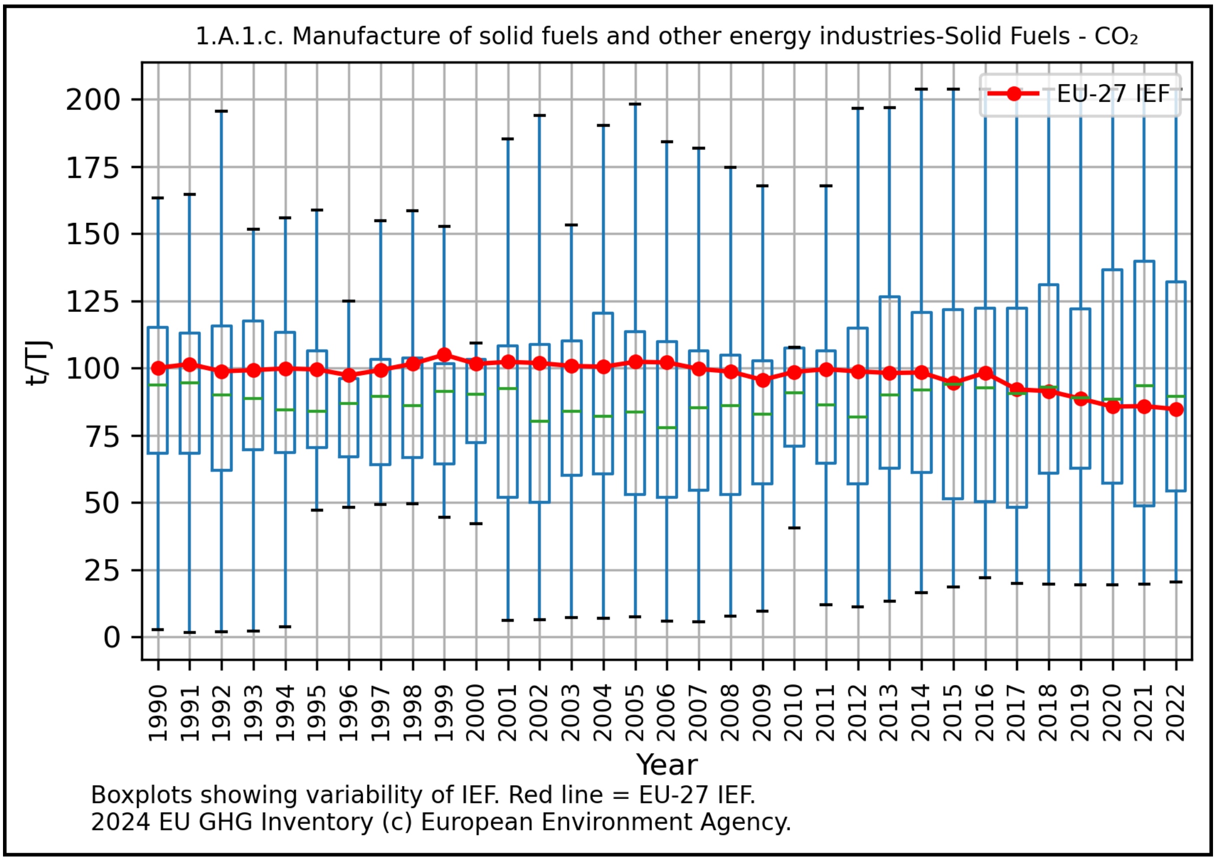


Figure 3.26 shows the relevant implied emission factors for solid fuels. The EU implied emission factor amounted to 84.7 t/TJ in 2022: it is the lowest of the entire time-series.

In general, the variation can be explained by the mix of different fuels and the shifts of their energy consumptions between years.

Figure 3.30 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 about 24 % of total greenhouse gas emissions from this category in 2022. Emissions in the EU decreased by 11 % (Table 3.17 below) between the years 1990 and 2022. After a strong increase in the 1990s and stabilisation in the 2000s there has been a significant reduction in the last few years.

Table 3.25 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	506	375	344	4.7%	-162	-32%	-30	-8%
Belgium	3	NO	NO	-	-3	-100%	-	-
Bulgaria	NO	2	1	0.0%	1	∞	-1	-28%
Croatia	875	237	307	4.2%	-568	-65%	70	29%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	6	6	0.1%	6	∞	1	11%
Denmark	525	878	867	11.9%	342	65%	-11	-1%
Estonia	IE	IE	IE	-	-	-	-	-
Finland	NO	NO	NO	-	-	-	-	-
France	531	NO	NO	-	-531	-100%	-	-
Germany	2 622	1 540	1 594	21.8%	-1 028	-39%	54	3%
Greece	102	26	4	0.1%	-98	-96%	-22	-84%
Hungary	311	123	144	2.0%	-167	-54%	21	17%
Ireland	IE	5	4	0.1%	4	∞	0	-6%
Italy	621	1 008	1 015	13.9%	395	64%	7	1%
Latvia	105	29	21	0.3%	-84	-80%	-8	-29%
Lithuania	NO	32	45	0.6%	45	∞	13	39%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	1 184	1 291	1 088	14.9%	-96	-8%	-203	-16%
Poland	684	1 348	1 297	17.7%	613	90%	-51	-4%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	IE,NO	172	177	2.4%	177	∞	5	3%
Slovakia	NO	37	49	0.7%	49	∞	11	30%
Slovenia	42	0	0	0.0%	-42	-100%	0	-56%
Spain	89	587	345	4.7%	256	286%	-242	-41%
Sweden	IE,NO	-	-	-	-	-	-	-
EU-27	**8 199**	**7 696**	**7 309**	**100%**	**-890**	**-11%**	**-387**	**-5%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period

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

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

Figure 3.27 illustrates the emission trend for gaseous fuels split by countries over the last 32 years. Although the emissions in the year 2022 compared to 1990 decreased by 11 % over the whole time series, there was a strong increase in the 1990s and a decline after 2009.

Figure 3.31 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Emission trend and share for CO_2

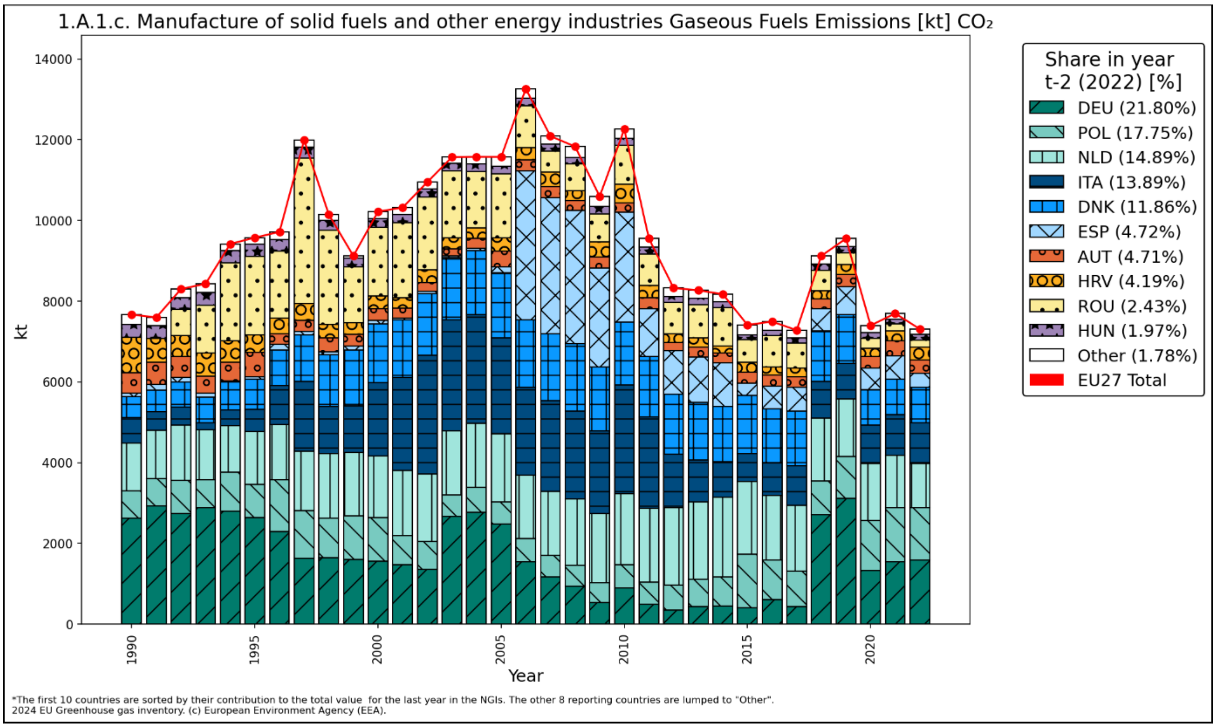
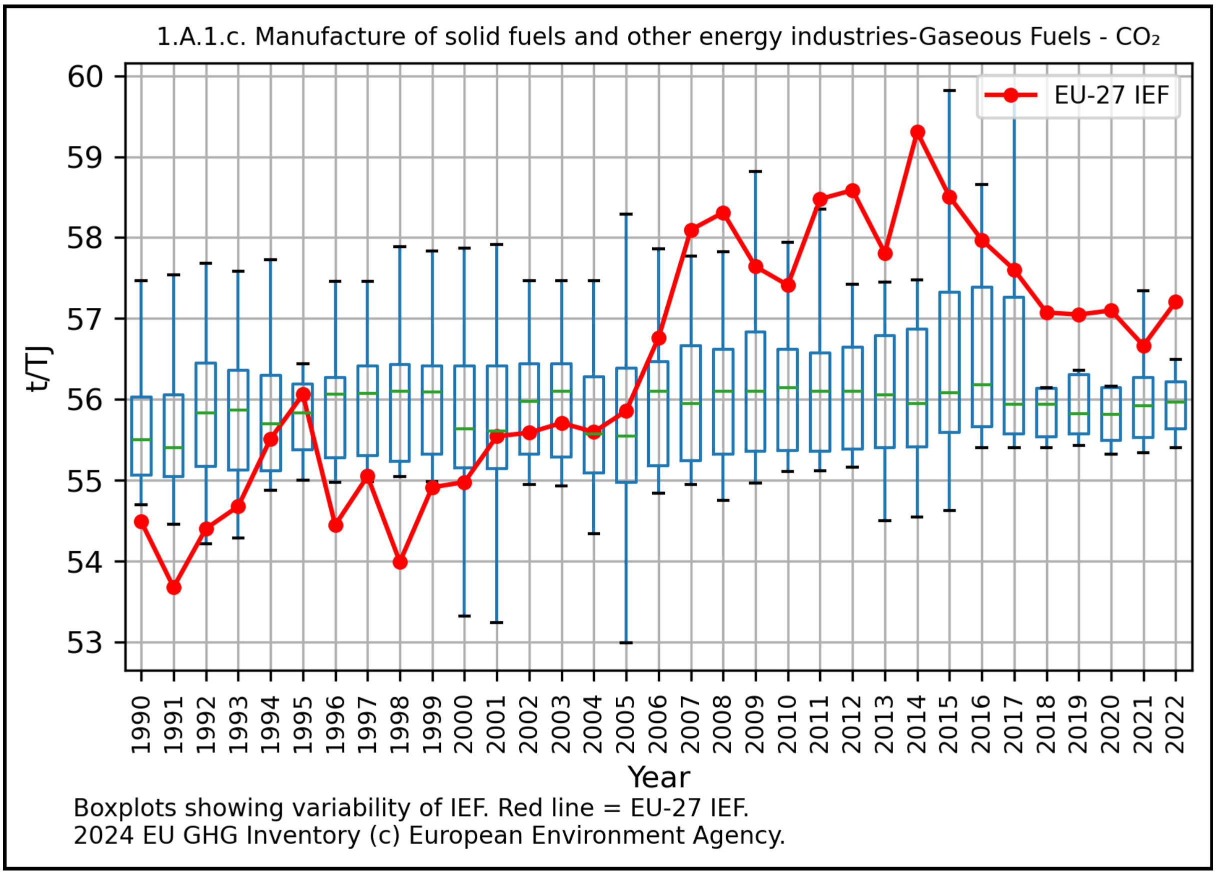


Figure 3.28 (on the next page) shows the implied emission factors for gaseous fuels. The EU implied emission factor amounts 57.2 t/TJ in 2022 and varies between 55 and 59 t/TJ over the last 32 years. The IPCC default values range between 54.3 t/TJ (lower) and 58.3 t/TJ (upper).

Figure 3.32 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries, Gaseous Fuels: Implied Emission Factors for CO_2



3.5.2 Manufacturing industries and construction (CRT Source Category 1.A.2.)

Category 1.A.2 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 3.26**:** 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	12.7%
T1	5.9%
T1,T2	14.0%
T1,T3	4.0%
T2	35.2%
T,T3	7.9%
T3	4.0%
T1,T2,T3	6.0%
CS,T1	8.9%
Other combination	0.0%

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 3.27: Key categories for sector 1.A.2. (Table excerpt)

Source category gas	kt CO_2 equivalent		Trend	Level		Share of higher Tiers [%]
	1990	2022		1990	2022	
1.A.2.a. Iron and steel: Gaseous Fuels (CO_2)	29392	15708	T	L	L	99.79
1.A.2.a. Iron and steel: Liquid Fuels (CO_2)	9044	973	T	L	0	99.00
1.A.2.a. Iron and steel: Solid Fuels (CO_2)	112384	52646	T	L	L	99.95
1.A.2.b. Non-ferrous metals: Gaseous Fuels (CO_2)	3013	6469	T	0	L	95.78
1.A.2.c. Chemicals: Gaseous Fuels (CO_2)	49423	29792	T	L	L	99.42
1.A.2.c. Chemicals: Liquid Fuels (CO_2)	29756	13168	T	L	L	92.63
1.A.2.c. Chemicals: Solid Fuels (CO_2)	12004	8133	0	L	L	99.97
1.A.2.d. Pulp, paper and print: Gaseous Fuels (CO_2)	11336	15831	T	L	L	92.81
1.A.2.d. Pulp, paper and print: Liquid Fuels (CO_2)	10835	1782	T	L	0	92.06
1.A.2.d. Pulp, paper and print: Solid Fuels (CO_2)	6774	1746	T	0	0	96.13
1.A.2.e. Food processing, beverages and tobacco: Gaseous Fuels (CO_2)	15813	26637	T	L	L	97.49
1.A.2.e. Food processing, beverages and tobacco: Liquid Fuels (CO_2)	18064	3008	T	L	0	68.80
1.A.2.e. Food processing, beverages and tobacco: Solid Fuels (CO_2)	11581	3386	T	L	0	95.46
1.A.2.f. Non-metallic minerals: Gaseous Fuels (CO_2)	27265	31631	T	L	L	99.05
1.A.2.f. Non-metallic minerals: Liquid Fuels (CO_2)	46178	20924	T	L	L	96.29
1.A.2.f. Non-metallic minerals: Other Fuels (CO_2)	1438	14298	T	0	L	69.43
1.A.2.f. Non-metallic minerals: Solid Fuels (CO_2)	52408	13664	T	L	L	95.98
1.A.2.g. Other: Gaseous Fuels (CO_2)	79964	72348	T	L	L	98.34
1.A.2.g. Other: Liquid Fuels (CO_2)	81823	38150	T	L	L	98.34
1.A.2.g. Other: Other Fuels (CO_2)	2451	4440	T	0	0	98.34
1.A.2.g. Other: Solid Fuels (CO_2)	90611	10197	T	L	L	98.34

In 2022, category 1.A.2 contributed to 394 766 kt CO_2 equivalents of which 98.6 % share belongs to CO_2 emissions, 0.8 % to N_2O emissions and 0.6 % 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 31.2 % followed by 1.A.2.f Non-metallic Minerals contributing by 20.5 %, 1.A.2.a Iron and steel contributing by 17.7 %, 1.A.2.c Chemicals by 13.4 %, 1.A.2.e Food processing, beverages and tobacco by 8.6 %, 1.A.2.d Pulp, paper and print by 5.2 % and 1.A.2.b Non-ferrous metals by 2.1 %. 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.

For the years 2013 to 2022 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 3.33: 1.A.2. Manufacturing Industries and Construction: Total emission trends

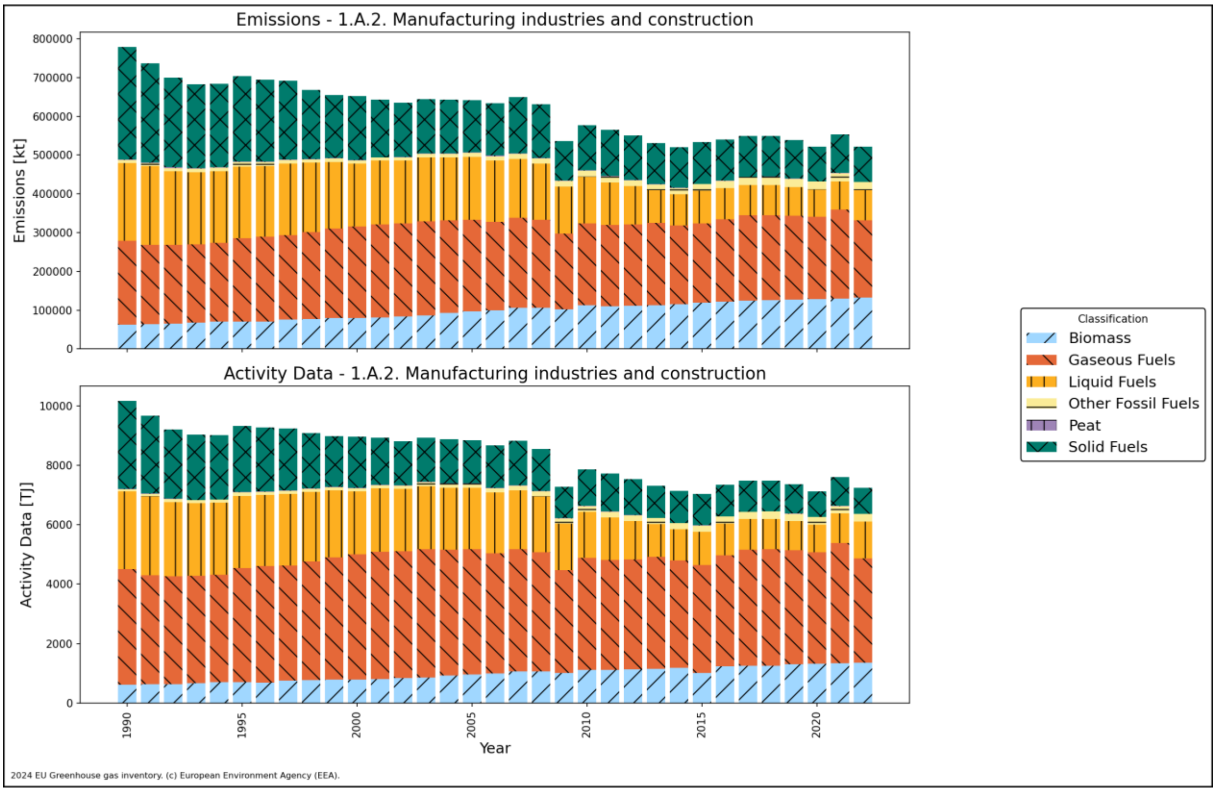


Table 3.19 summarizes information by countries on GHG emissions and CO_2 emissions from 1.A.2 Manufacturing Industries and Construction in 1990 and 2022.

Table 3.28: 1.A.2. Manufacturing Industries and Construction: Member States contributions to total GHG and CO_2 emissions

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt	
	1990	2022	1990	2022
Austria	9 609	10 619	9 533	10 477
Belgium	23 527	12 565	23 388	12 408
Bulgaria	17 757	4 360	17 664	4 309
Croatia	5 128	2 325	5 103	2 313
Cyprus	503	583	501	575
Czechia	47 105	11 318	46 824	11 200
Denmark	5 732	3 484	5 668	3 421
Estonia	3 454	267	3 446	264
Finland	13 358	5 868	13 192	5 723
France	64 496	40 129	63 961	39 530
Germany	184 480	115 803	183 008	114 780
Greece	9 400	4 474	9 338	4 396
Hungary	13 509	4 637	13 475	4 591
Ireland	4 074	4 302	4 055	4 284
Italy	92 151	54 728	90 773	53 701
Latvia	3 965	602	3 910	545
Lithuania	6 158	1 206	6 106	1 188
Luxembourg	6 244	1 013	6 229	990
Malta	53	94	53	94
Netherlands	29 861	18 364	29 763	18 260
Poland	42 831	27 835	42 621	27 563
Portugal	8 994	6 793	8 853	6 619
Romania	54 097	13 201	53 959	13 089
Slovakia	16 095	5 923	16 027	5 874
Slovenia	3 095	1 605	3 066	1 581
Spain	44 880	37 864	44 537	36 818
Sweden	10 851	4 805	10 711	4 709
EU-27	**721 408**	**394 766**	**715 764**	**389 302**

Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.2 Manufacturing Industries and Construction is the fourth largest sector in the EU accounting for 15 % of total GHG emissions from Energy sector in 2022. Between 1990 and 2022, CO_2 emissions from 1.A.2. Manufacturing Industries and Construction declined by 46 %. 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 111 %.

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 (37 %) was the restructuring of the industry and efficiency improvements after German reunification. The decline in recent years is caused by restrictions during the COVID.

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

This chapter provides information about European emission trend, Member States 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 3.21. CO_2 emissions have almost 100 % share on total emissions from 1.A.2.a.

Total CO_2 emissions from 1.A.2.a amounted to 64 590 kt CO_2 eq. in 2022. The trend of total CO_2 emissions for 1990 to 2022 from category 1.A.2.a is depicted in *Figure 3.30*. Total CO_2 emissions decreased by 55 % 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 2021 and 2022. CO_2 emissions from 1.A.2.a Iron and Steel accounted for 18% 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 1.4 % in 2022. The share of solid fuels on CO_2 emissions from 1.A.2.a was 76% in 2022 and 73% in 1990. The share of gaseous fuels on CO_2 emissions from 1.A.2.a increased from 21% in 1990 to 23% in 2022.

Figure 3.34: 1.A.2.a Iron and Steel: total emissions and activity data trends

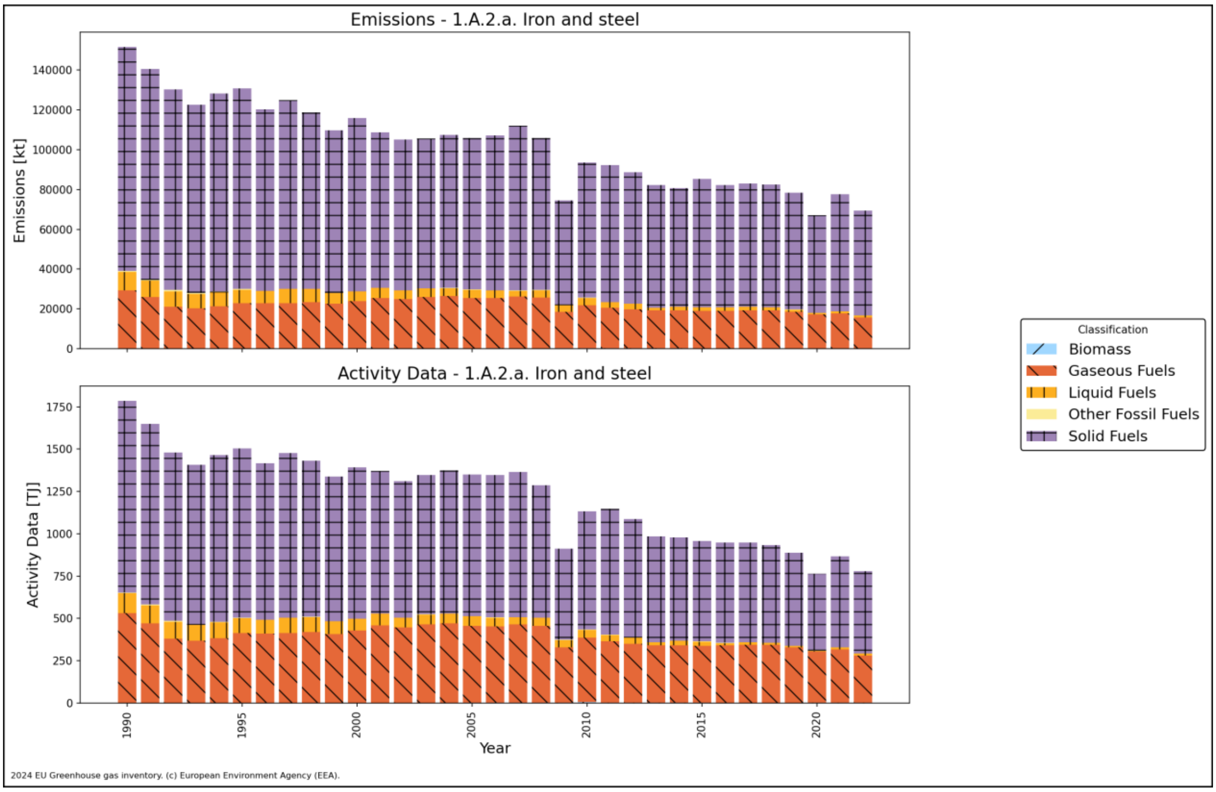


Table 3.29: 1.A.2.a Iron and Steel: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 833	1 783	1 936	3.0%	103	6%	152	9%	NA,T2	CS,NA
Belgium	5 662	1 246	978	1.5%	-4 683	-83%	-268	-21%	NA,T1,T3	D,NA,PS
Bulgaria	2 705	123	111	0.2%	-2 594	-96%	-13	-10%	NA,T1,T2	CS,D,NA
Croatia	1 062	56	64	0.1%	-999	-94%	7	13%	NA,T1	D,NA
Cyprus	0	NO	0	0.0%	0	45%	0	∞	NA	NA
Czechia	14 861	2 116	1 622	2.5%	-13 238	-89%	-494	-23%	NA,T2	CS,D,NA
Denmark	136	86	81	0.1%	-55	-41%	-5	-6%	NA,T2,T3	CS,NA
Estonia	NO	1	1	0.0%	1	∞	0	-5%	NA,T2	CS,NA
Finland	2 499	890	799	1.2%	-1 699	-68%	-90	-10%	NA,T3	CS,NA,PS
France	8 777	4 320	3 798	5.9%	-4 979	-57%	-522	-12%	NA	NA
Germany	35 269	37 276	33 691	52.2%	-1 579	-4%	-3 585	-10%	CS,NA	CS,NA
Greece	447	116	123	0.2%	-324	-72%	7	6%	NA,T2	CS,NA,PS
Hungary	2 524	139	104	0.2%	-2 420	-96%	-35	-25%	NA,T1,T2	CS,D,NA
Ireland	175	2	2	0.0%	-173	-99%	0	0%	NA,T2	CS,NA
Italy	25 255	9 429	8 758	13.6%	-16 497	-65%	-671	-7%	NA,T2	CS,NA
Latvia	389	0	1	0.0%	-389	-100%	0	37%	NA,T2	CS,NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	5 393	276	231	0.4%	-5 161	-96%	-44	-16%	NA,T2	CS,NA
Malta	NO	0	0	0.0%	0	∞	0	36%	NA,T1	D,NA
Netherlands	5 599	4 423	4 114	6.4%	-1 484	-27%	-309	-7%	NA,T2	CS,NA
Poland	16 247	4 103	3 067	4.7%	-13 181	-81%	-1 036	-25%	NA,T1,T2	CS,D,NA
Portugal	373	85	96	0.1%	-278	-74%	11	12%	NO,T2	CR,D,NO,PS
Romania	9 154	854	1 024	1.6%	-8 130	-89%	170	20%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	2 682	3 164	2 474	3.8%	-208	-8%	-690	-22%	NA,T2	CS,NA
Slovenia	423	212	191	0.3%	-232	-55%	-21	-10%	NA,T1,T2	CS,D,NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	1 706	1 341	1 323	2.0%	-382	-22%	-18	-1%	T2	CS
EU-27	**143 172**	**72 043**	**64 590**	**100%**	**-78 582**	**-55%**	**-7 453**	**-10%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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 973 kt in 2022 for EU. CO_2 emissions decreased compared to the year 1990 by 89 % and increased by 9 % compared to 2022. This category corresponds to 0.3% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 88% compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.22.

Table 3.30: 1.A.2.a Iron and Steel, liquid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	76	20	45	4.6%	-32	-42%	25	128%	T2	CS
Belgium	885	16	17	1.8%	-867	-98%	2	11%	T1,T3	D,PS
Bulgaria	37	1	1	0.1%	-37	-99%	0	-20%	T1	D
Croatia	208	7	10	1.0%	-198	-95%	3	49%	T1	D
Cyprus	0	-	0	0.0%	0	45%	0	∞	-	-
Czechia	427	NO	NO	-	-427	-100%	-	-	NA	NA
Denmark	25	6	10	1.0%	-15	-61%	4	76%	T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	305	20	24	2.4%	-281	-92%	4	19%	T3	CS
France	1 725	128	128	13.1%	-1 598	-93%	-1	0%	-	-
Germany	916	11	15	1.6%	-900	-98%	4	37%	CS	CS
Greece	447	30	55	5.6%	-393	-88%	25	83%	T2	PS
Hungary	583	NO	NO	-	-583	-100%	-	-	NA	NA
Ireland	16	NO	NO	-	-16	-100%	-	-	NA	NA
Italy	156	5	49	5.0%	-107	-69%	44	859%	T2	CS
Latvia	92	NO	NO	-	-92	-100%	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	37	NO	NO	-	-37	-100%	-	-	NA	NA
Malta	NO	0	0	0.0%	0	∞	0	36%	T1	D
Netherlands	19	10	7	0.8%	-11	-61%	-2	-24%	-	-
Poland	870	15	14	1.5%	-856	-98%	-1	-7%	T1,T2	CS,D
Portugal	109	0	0	0.0%	-109	-100%	0	141%	T2	CR,D,PS
Romania	NO	2	1	0.1%	1	∞	-1	-64%	T1,T2,T3	CS,D,PS
Slovakia	164	3	2	0.3%	-162	-98%	0	-10%	T2	CS
Slovenia	54	2	2	0.2%	-52	-96%	0	1%	T1	D
Spain	1 059	91	39	4.0%	-1 020	-96%	-52	-57%	T1,T2,T3	CS,D,PS
Sweden	831	529	555	57.0%	-276	-33%	26	5%	T2	CS
EU-27	**9 044**	**894**	**973**	**100%**	**-8 070**	**-89%**	**79**	**9%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.

Figure 3.35: 1.A.2.a Iron and Steel, Liquid fuels: Emission trend and share for CO_2

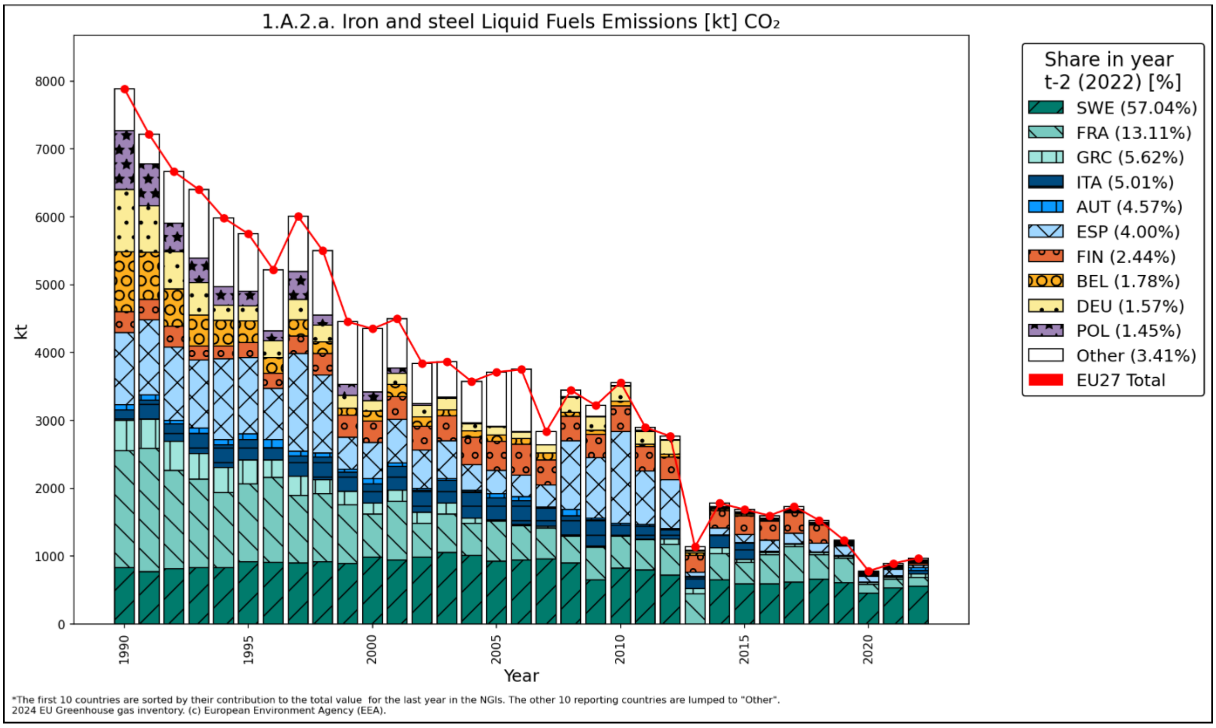
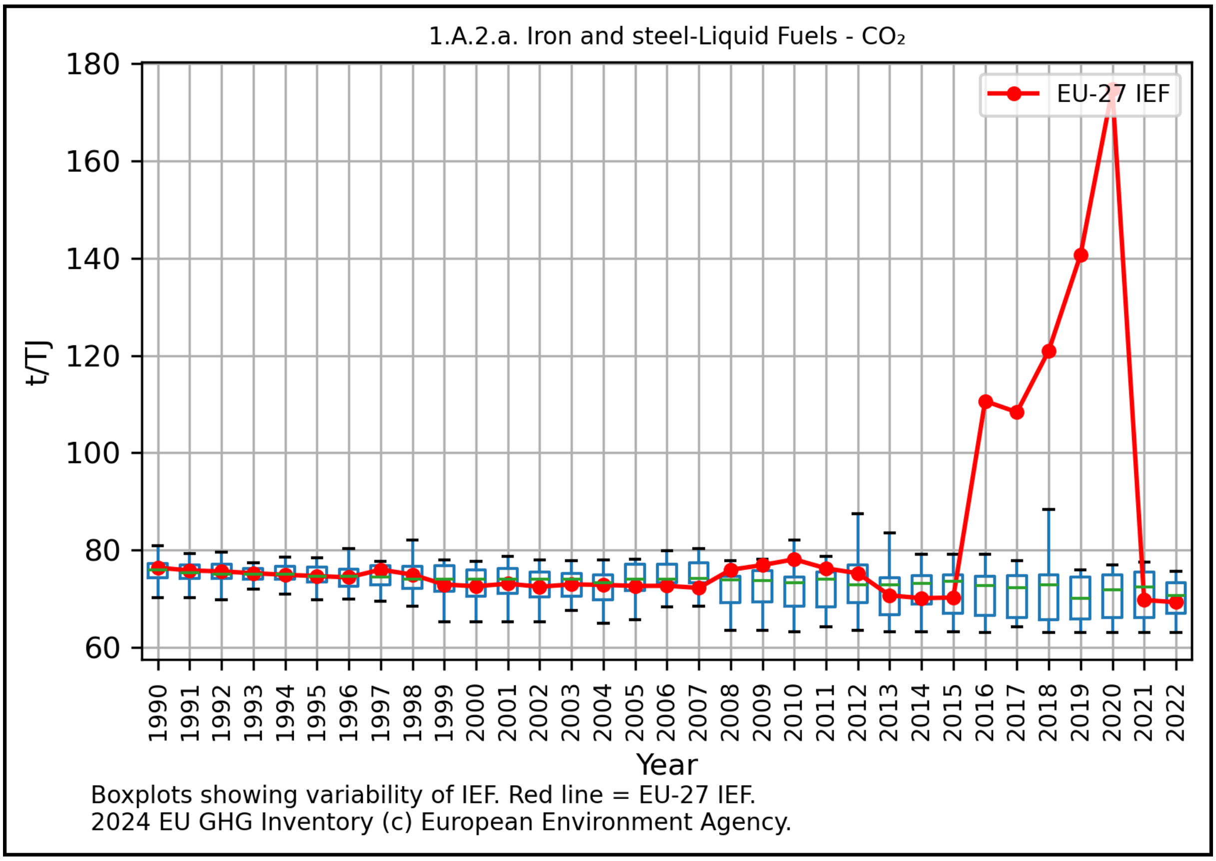


Figure 3.32 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. In the graph, data from Sweden are not included due to reported confidential data. The EU CO_2 IEF equalled 69.43 t/TJ in 2022 excluding Sweden.

Figure 3.36: 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.

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 52 646 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 53 % and decreased compared to 2021 by 10 %. This category represents 14 % of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 58 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.23.

Table 3.31: 1.A.2.a Iron and Steel, solid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 107	760	843	1.6%	-264	-24%	82	11%	T2	CS
Belgium	3 284	14	16	0.0%	-3 268	-100%	2	14%	T3	PS
Bulgaria	1 631	0	0	0.0%	-1 631	-100%	0	0%	T1,T2	CS,D
Croatia	625	11	13	0.0%	-612	-98%	2	15%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	13 709	1 495	1 249	2.4%	-12 460	-91%	-246	-16%	T2	CS,D
Denmark	5	NO	NO	-	-5	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	2 084	506	443	0.8%	-1 641	-79%	-64	-13%	T3	CS,PS
France	4 265	2 276	1 874	3.6%	-2 391	-56%	-402	-18%	-	-
Germany	29 912	34 313	31 213	59.3%	1 301	4%	-3 100	-9%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	629	53	26	0.0%	-603	-96%	-27	-51%	T1,T2	CS,D
Ireland	115	NO	NO	-	-115	-100%	-	-	NA	NA
Italy	20 762	5 458	5 001	9.5%	-15 760	-76%	-457	-8%	T2	CS
Latvia	NO	NO	0	0.0%	0	∞	0	∞	T2	CS
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	3 743	3 587	6.8%	-1 325	-27%	-156	-4%	T2	CS
Poland	11 870	2 805	2 148	4.1%	-9 722	-82%	-657	-23%	T1,T2	CS,D
Portugal	264	NO	NO	-	-264	-100%	-	-	T2	CR,D,PS
Romania	2 599	179	115	0.2%	-2 484	-96%	-65	-36%	T1,T2	CS,D
Slovakia	2 296	3 020	2 346	4.5%	50	2%	-674	-22%	T2	CS
Slovenia	57	19	18	0.0%	-39	-68%	-1	-5%	T1	D
Spain	6 449	3 556	3 136	6.0%	-3 313	-51%	-419	-12%	T1,T2,T3	CS,PS
Sweden	850	590	617	1.2%	-233	-27%	26	4%	T2	CS
EU-27	**112 384**	**58 801**	**52 646**	**100%**	**-59 738**	**-53%**	**-6 155**	**-10%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period 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.

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

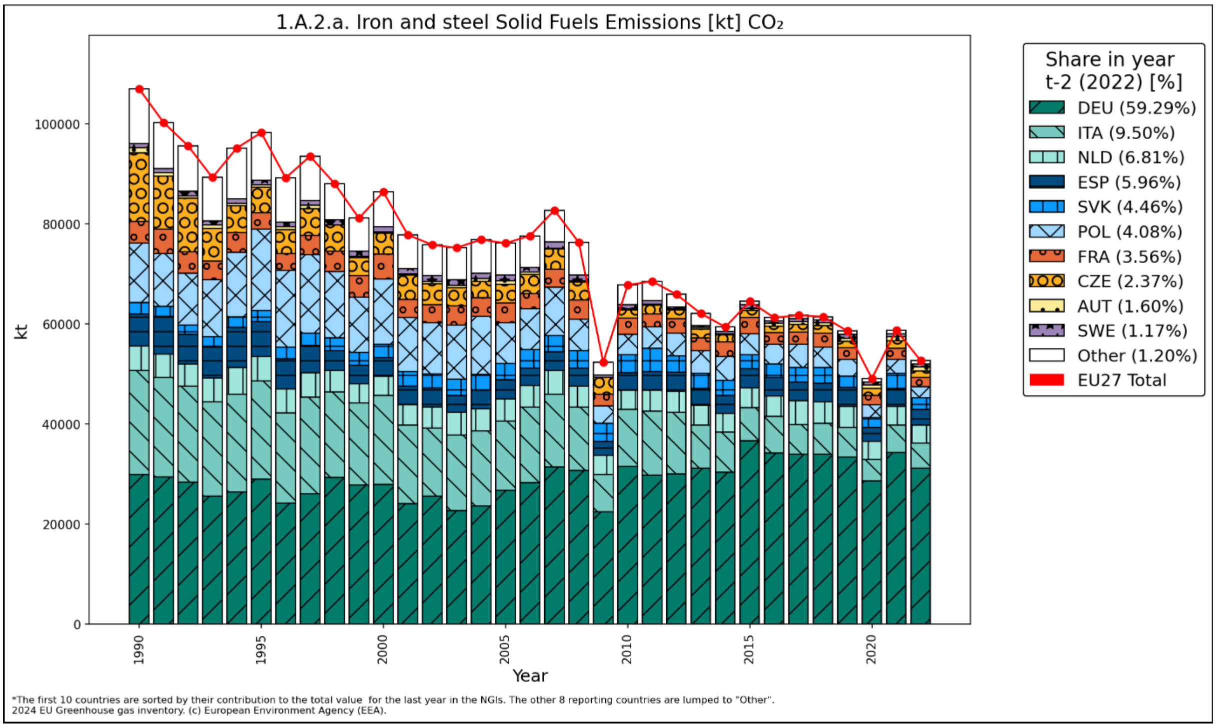
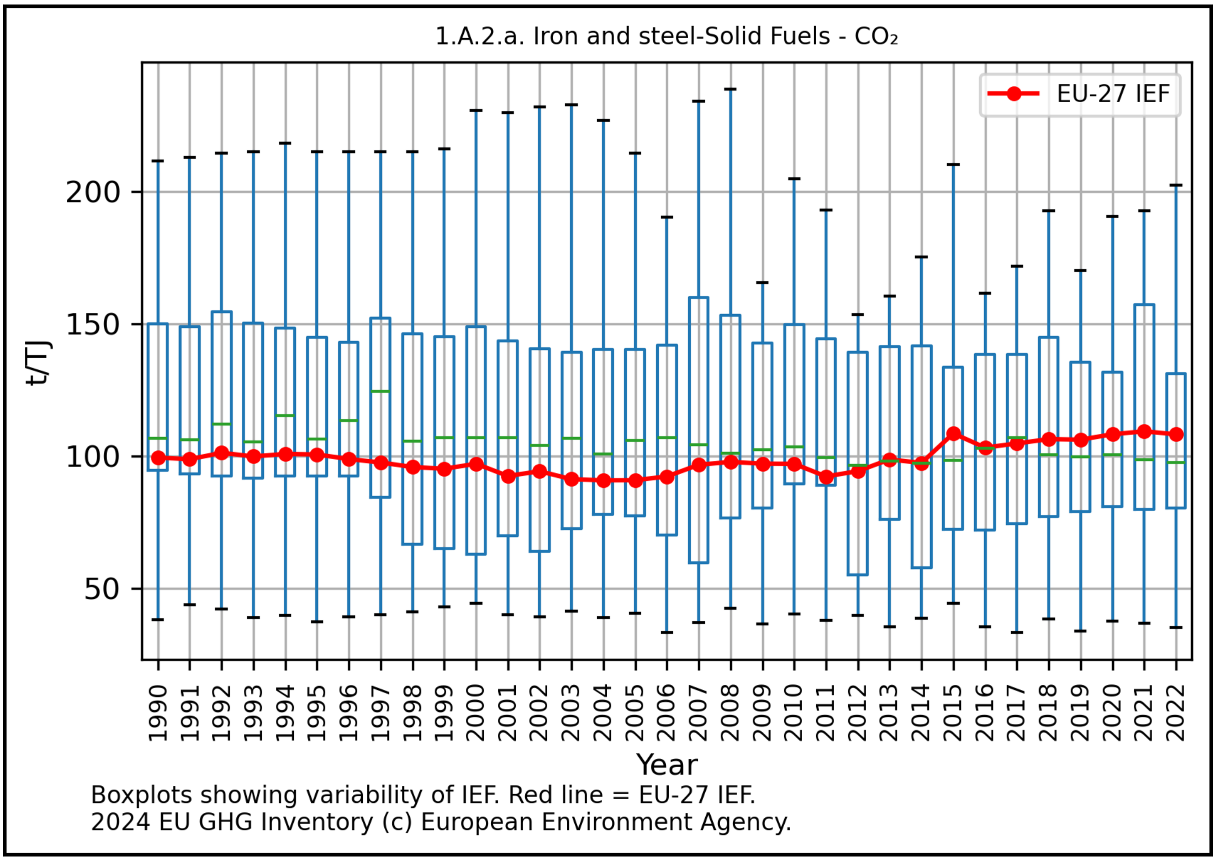


Figure 3.35 shows implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. It can be seen that CO_2 IEF fluctuate during the whole time series. CO_2 IEF equalled to 118.31 t/TJ in 2022.

Figure 3.38: 1.A.2.a Iron and Steel, Solid fuels: Implied Emission Factors for CO_2 (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 15 708 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 47 % and decreased compared to 2021 by 12 %. This category represents 4 % of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 48 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.24.

Table 3.32: 1.A.2.a Iron and Steel, gaseous fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	650	1 004	1 049	6.7%	399	61%	45	4%	T2	CS
Belgium	1 493	1 211	940	6.0%	-553	-37%	-270	-22%	T1,T3	D,PS
Bulgaria	1 037	123	110	0.7%	-927	-89%	-12	-10%	T2	CS
Croatia	229	38	40	0.3%	-189	-83%	2	4%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	724	621	373	2.4%	-351	-48%	-247	-40%	T2	CS
Denmark	106	80	71	0.5%	-36	-33%	-10	-12%	T3	CS
Estonia	NO	1	1	0.0%	1	∞	0	-5%	T2	CS
Finland	110	363	333	2.1%	223	203%	-30	-8%	T3	CS
France	2 777	1 912	1 795	11.4%	-981	-35%	-116	-6%	-	-
Germany	4 442	2 951	2 462	15.7%	-1 980	-45%	-489	-17%	CS	CS
Greece	NO	86	68	0.4%	68	∞	-18	-21%	T2	CS
Hungary	1 312	86	78	0.5%	-1 234	-94%	-8	-9%	T2	CS
Ireland	44	2	2	0.0%	-41	-95%	0	0%	T2	CS
Italy	4 338	3 966	3 708	23.6%	-630	-15%	-258	-7%	T2	CS
Latvia	236	0	0	0.0%	-235	-100%	0	-50%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	397	276	231	1.5%	-165	-42%	-44	-16%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	667	670	520	3.3%	-147	-22%	-150	-22%	T2	CS
Poland	2 924	1 283	904	5.8%	-2 019	-69%	-378	-29%	T2	CS
Portugal	NO	85	96	0.6%	96	∞	11	12%	T2	CR,D,PS
Romania	6 556	672	908	5.8%	-5 647	-86%	236	35%	T2,T3	CS,PS
Slovakia	221	141	125	0.8%	-96	-43%	-16	-11%	T2	CS
Slovenia	312	191	171	1.1%	-141	-45%	-20	-11%	T2	CS
Spain	795	1 778	1 571	10.0%	776	98%	-207	-12%	T2,T3	CS,PS
Sweden	25	222	150	1.0%	125	496%	-71	-32%	T2	CS
EU-27	**29 392**	**17 761**	**15 708**	**100%**	**-13 684**	**-47%**	**-2 053**	**-12%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period 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.

Figure 3.39: 1.A.2.a Iron and Steel, Gaseous fuels: Emission trend and share for CO_2

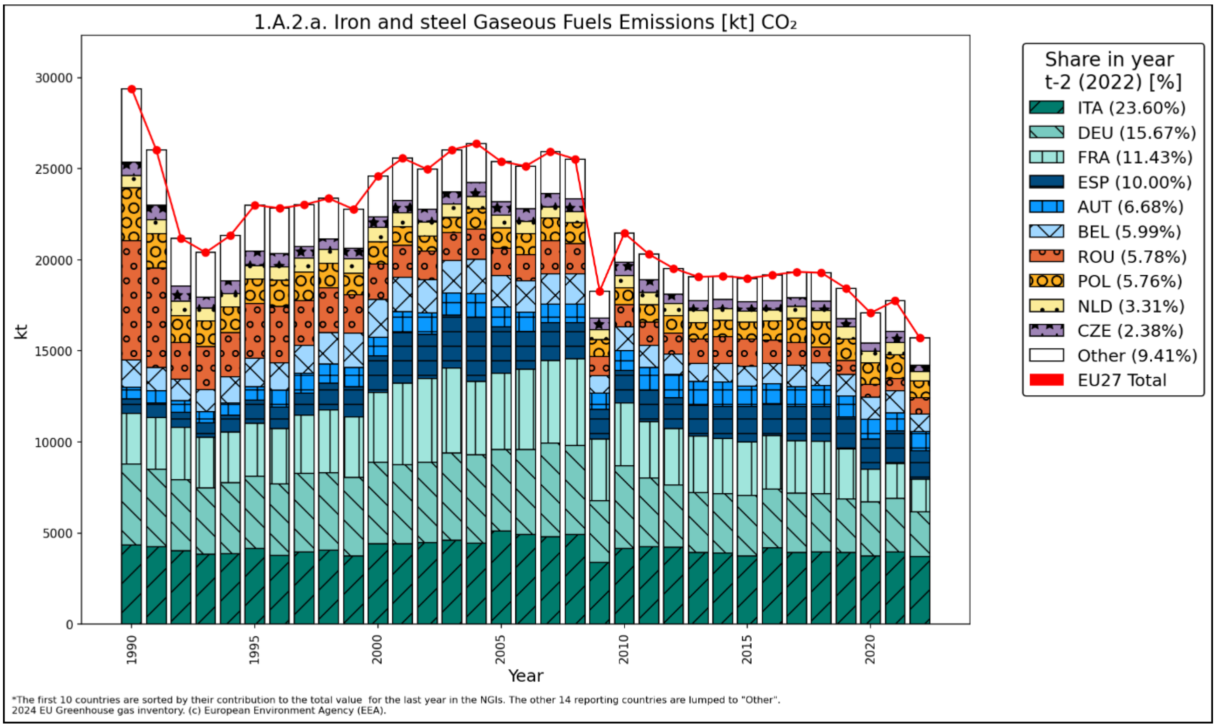
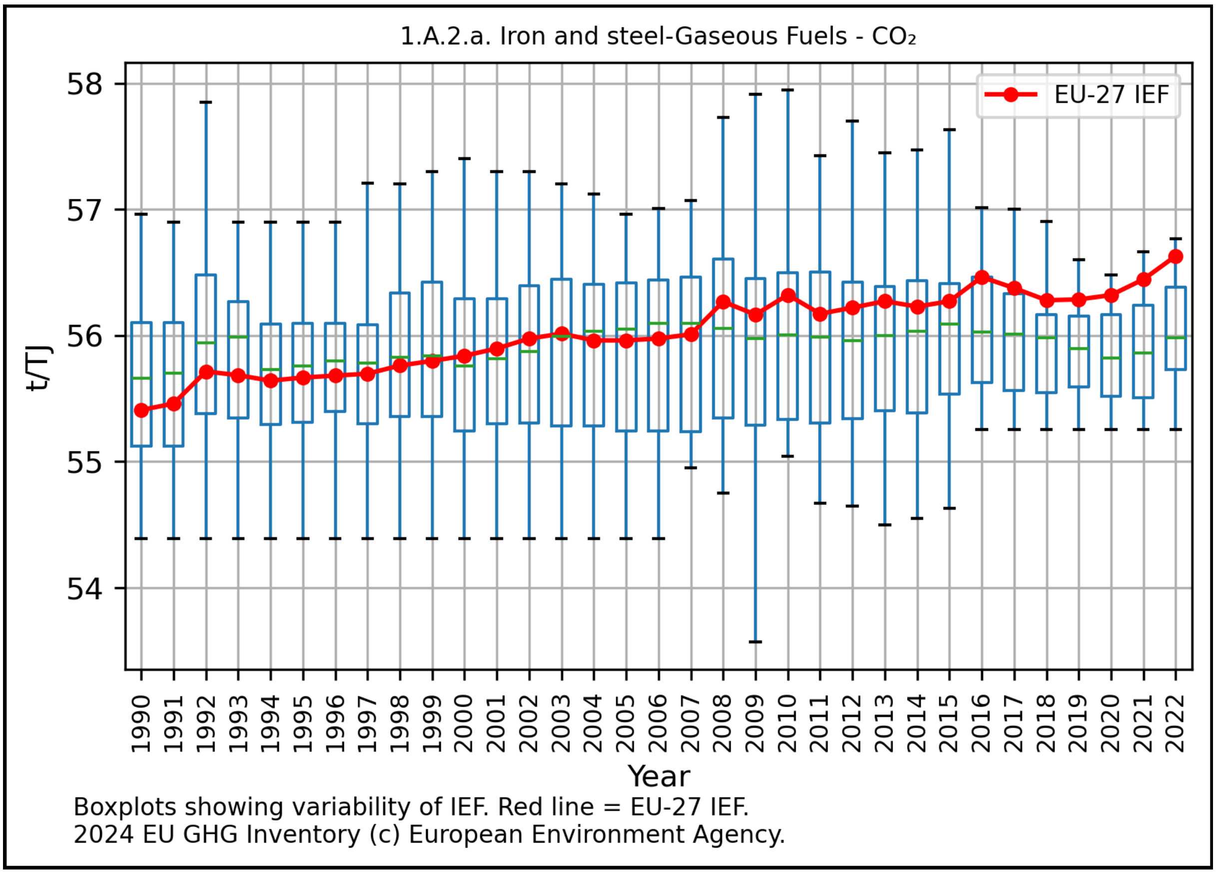


Figure 3.38 shows implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. It can be seen that the CO_2 IEF is fluctuating. CO_2 IEF equaled to 56.62 t/TJ in 2022.

Figure 3.40: 1.A.2.a Iron and Steel, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



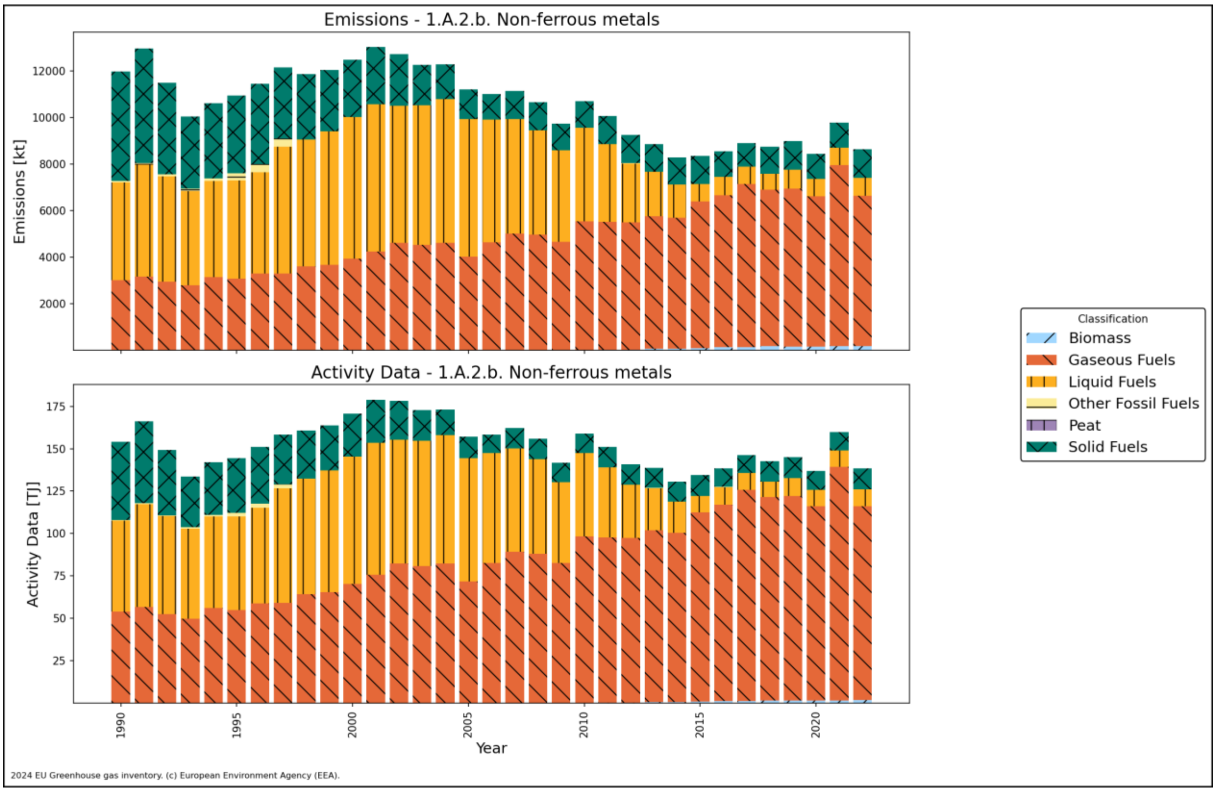
3.5.2.2 Non-Ferrous Metals (1.A.2.b)

This chapter provides information about European emission trend, Member States 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 7 116 kt CO_2 eq. in 2022. The trend of total emissions for 1990 to 2022 from category 1.A.2.b is depicted in Figure 3.40. Total CO_2 emissions decreased by 34 % since 1990 and decreased by 8 % between 2021 and 2022. 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 2022. The share of liquid fuels on CO_2 emissions from 1.A.2.b decreased from 36% in 1990 to 9 % in 2022. The share of solid fuels on CO_2 emissions from 1.A.2.b decreased from 39% in 1990 to 15 % in 2022. The share of gaseous fuels on CO_2 emissions from 1.A.2.b increased from 25% in 1990 to 76 % in 2022.

Figure 3.41: 1.A.2.b Non-ferrous Metals: total emissions and activity data trends



Data displayed as dashed line refers to the secondary axis.

Detailed data related to the EU submissions are depicted in Table.3.25.

Table.3.33: 1.A.2.b Non-ferrous Metals: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	132	297	302	4.2%	170	129%	6	2%	NA,T2	CS,NA
Belgium	629	425	395	5.6%	-233	-37%	-29	-7%	NA,T1	D,NA
Bulgaria	299	246	254	3.6%	-45	-15%	9	4%	NA,T1,T2	CS,D,NA
Croatia	17	30	31	0.4%	14	80%	1	2%	NA,T1	D,NA
Cyprus	3	3	2	0.0%	-1	-33%	-1	-20%	NA,T1	D,NA
Czechia	102	186	148	2.1%	46	45%	-38	-20%	NA,T2	CS,D,NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	0	NO	-	-	-	0	-100%	NA	NA
Finland	338	81	87	1.2%	-251	-74%	6	8%	NA,T3	CS,NA
France	2 276	737	784	11.0%	-1 491	-66%	47	6%	NA	NA
Germany	1 377	143	146	2.0%	-1 231	-89%	3	2%	CS,NA	CS,NA
Greece	582	674	558	7.8%	-24	-4%	-116	-17%	NA,T2	CS,NA,PS
Hungary	301	161	161	2.3%	-140	-46%	0	0%	NA,T2	CS,NA
Ireland	809	1 370	1 214	17.1%	405	50%	-156	-11%	NA,T1,T2,T3	CS,D,NA
Italy	735	1 326	1 133	15.9%	398	54%	-193	-15%	NA,T2	CS,NA
Latvia	NO	1	0	0.0%	0	∞	-1	-59%	NA,T2	CS,NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	28	49	48	0.7%	19	67%	-1	-2%	NA,T2	CS,NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	214	151	135	1.9%	-79	-37%	-16	-11%	NA,T2	CS,NA
Poland	1 053	1 095	1 212	17.0%	160	15%	117	11%	NA,T1,T2	CS,D,NA
Portugal	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NO	NO
Romania	81	413	196	2.8%	115	141%	-217	-52%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	1 256	114	79	1.1%	-1 177	-94%	-35	-31%	NA,T2	CS,NA
Slovenia	440	138	131	1.8%	-309	-70%	-7	-5%	NA,T1,T2	CS,D,NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	129	117	99	1.4%	-30	-23%	-18	-15%	T2	CS
EU-27	**10 801**	**7 757**	**7 116**	**100%**	**-3 684**	**-34%**	**-641**	**-8%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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 758 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 82 % and compared to 2021 increased by 3 %. Category has 0.2 % share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 82 % 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 submissions are depicted in *Table 3.26*.

Table 3.34: 1.A.2.b Non-ferrous Metals, liquid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	35	9	9	1.2%	-26	-75%	-1	-6%	T2	CS
Belgium	220	39	43	5.7%	-177	-80%	4	9%	T1	D
Bulgaria	199	48	41	5.4%	-158	-79%	-7	-15%	T1	D
Croatia	17	3	4	0.5%	-13	-77%	1	31%	T1	D
Cyprus	3	3	2	0.3%	-1	-33%	-1	-20%	T1	D
Czechia	3	NO	NO	-	-3	-100%	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	174	60	71	9.3%	-103	-59%	11	19%	T3	CS
France	570	89	181	23.9%	-388	-68%	93	104%	-	-
Germany	144	114	120	15.8%	-24	-17%	6	5%	CS	CS
Greece	582	19	16	2.1%	-566	-97%	-3	-15%	T2	PS
Hungary	202	NO	NO	-	-202	-100%	-	-	NA	NA
Ireland	766	12	16	2.1%	-751	-98%	4	34%	T1,T3	CS,D
Italy	18	30	19	2.5%	1	6%	-11	-36%	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	26	25	3.3%	-38	-60%	-1	-5%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NO	NO
Romania	IE	4	2	0.3%	2	∞	-2	-48%	T1,T2	CS,D
Slovakia	23	3	3	0.4%	-20	-87%	0	9%	T2	CS
Slovenia	120	3	8	1.1%	-112	-93%	5	175%	T1	D
Spain	923	171	115	15.2%	-808	-88%	-56	-33%	T1,T2,T3	CS,D,PS
Sweden	110	100	83	11.0%	-27	-24%	-17	-17%	T2	CS
EU-27	**4 188**	**733**	**758**	**100%**	**-3 430**	**-82%**	**25**	**3%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.

Figure 3.42: 1.A.2.b Non-ferrous Metals, liquid fuels: Emission trend and share for CO_2

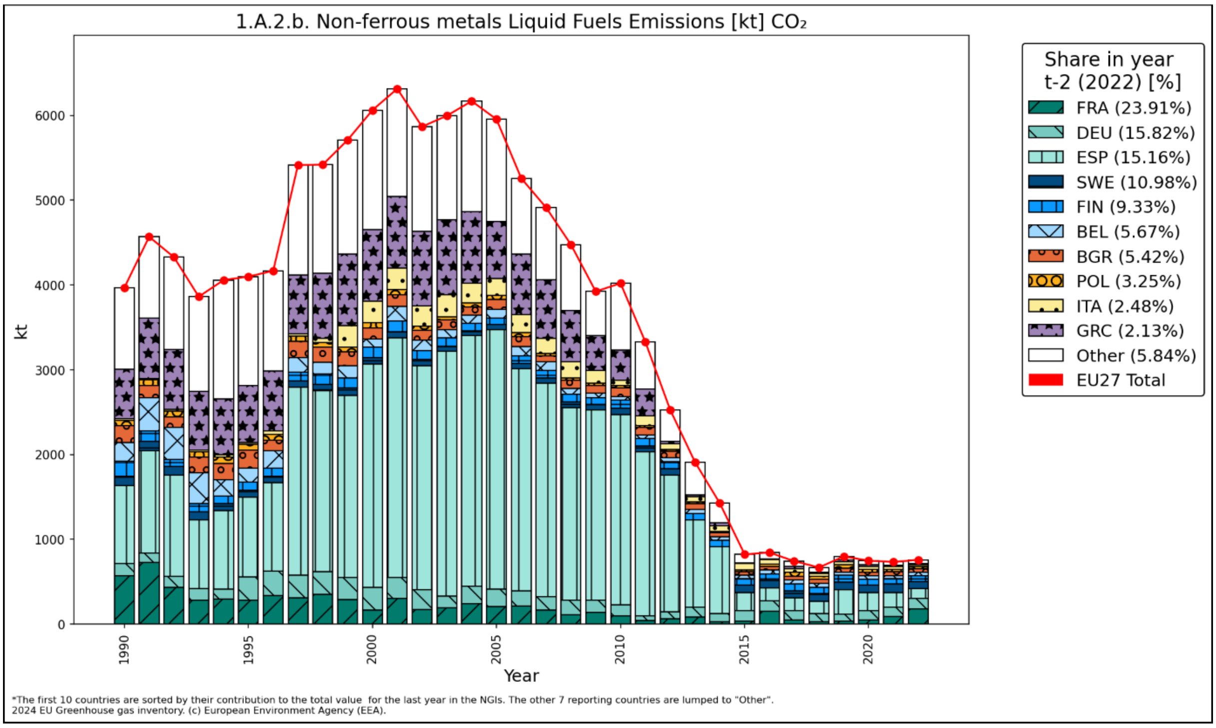
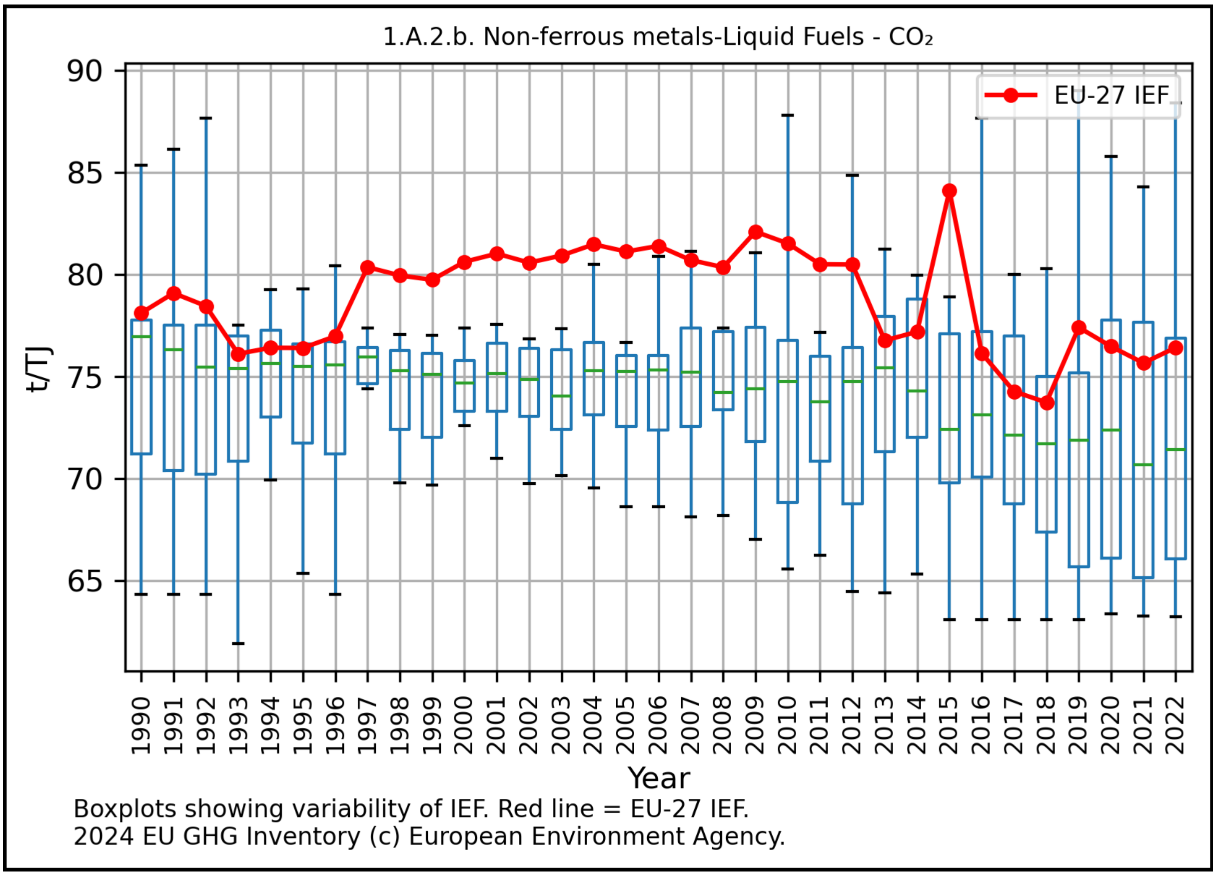


Figure 3.42 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. It can be seen that CO_2 IEF fluctuated at the beginning of the time series and since 2013 shows major fluctuations. The peak in the 2015 implied emission factor, as presented in the figure below, occurs because Sweden reported activity data as confidential. Huge drop of IEF in 2018 was caused by massive decrease of fuel consumption in France from 1 896 to 419 TJ. CO_2 IEF equalled to 76.54 t/TJ in 2022.

Figure 3.43: 1.A.2.b Non-ferrous Metals, liquid fuels: Implied Emission Factors for CO_2 (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 1 226 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 74 % and compared to 2020 increased by 13 %. Category has 0.3 % share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 73 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.27.

Table 3.35: 1.A.2.b Non-ferrous Metals, solid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	22	10	14	1.2%	-8	-35%	4	46%	T2	CS
Belgium	147	96	78	6.4%	-69	-47%	-18	-18%	T1	D
Bulgaria	76	77	103	8.4%	27	35%	26	33%	T1,T2	CS,D
Croatia	0	NO	NO	-	0	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	46	17	15	1.3%	-30	-66%	-2	-9%	T2	CS,D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	155	18	14	1.1%	-142	-91%	-4	-25%	T3	CS
France	961	2	2	0.2%	-958	-100%	0	-2%	-	-
Germany	1 233	28	26	2.1%	-1 207	-98%	-3	-9%	CS	CS
Greece	IE	IE	IE	-	-	-	-	-	NA	NA
Hungary	12	NO	NO	-	-12	-100%	-	-	NA	NA
Ireland	4	NO	NO	-	-4	-100%	-	-	NA	NA
Italy	152	47	47	3.8%	-105	-69%	0	1%	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	626	780	63.6%	107	16%	153	24%	T1,T2	CS,D
Portugal	IE	IE	IE	-	-	-	-	-	NO	NO
Romania	81	IE	IE	-	-81	-100%	-	-	NA	NA
Slovakia	798	25	22	1.8%	-777	-97%	-3	-12%	T2	CS
Slovenia	154	5	3	0.2%	-152	-98%	-2	-41%	T1,T2	CS,D
Spain	182	132	122	9.9%	-60	-33%	-10	-7%	T1,T2	CS,D
Sweden	8	NO	NO	-	-8	-100%	-	-	-	-
EU-27	**4 706**	**1 083**	**1 226**	**100%**	**-3 481**	**-74%**	**143**	**13%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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

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

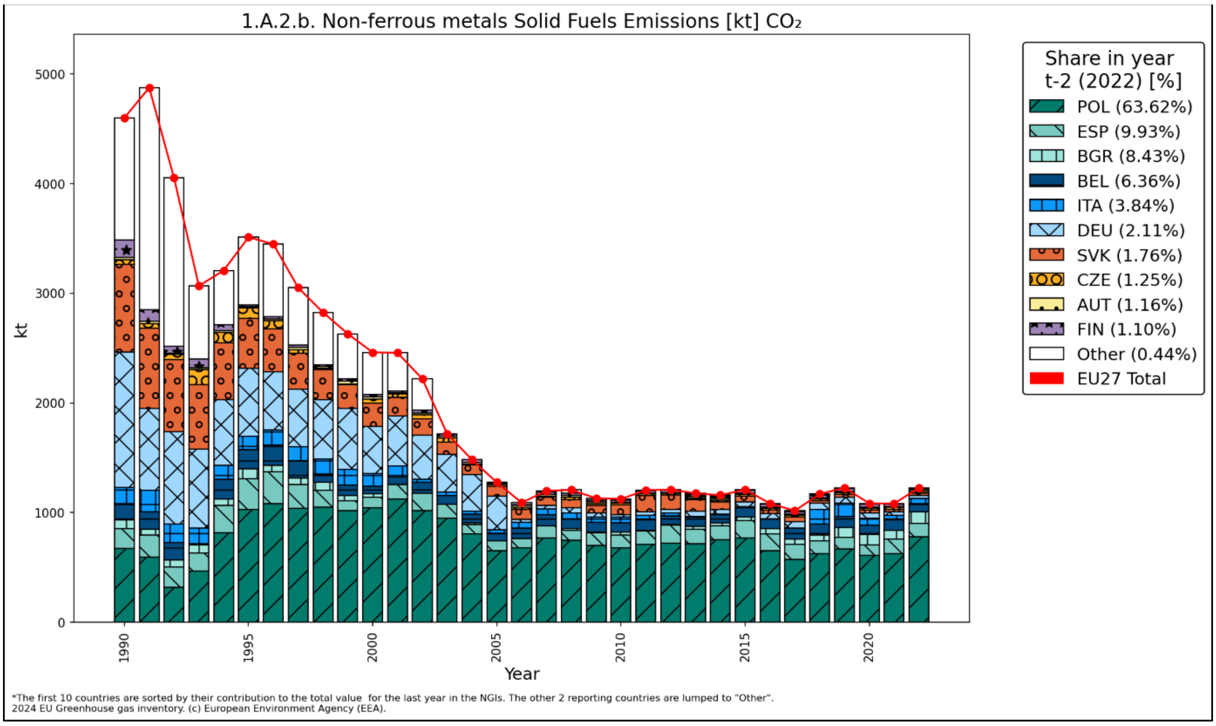
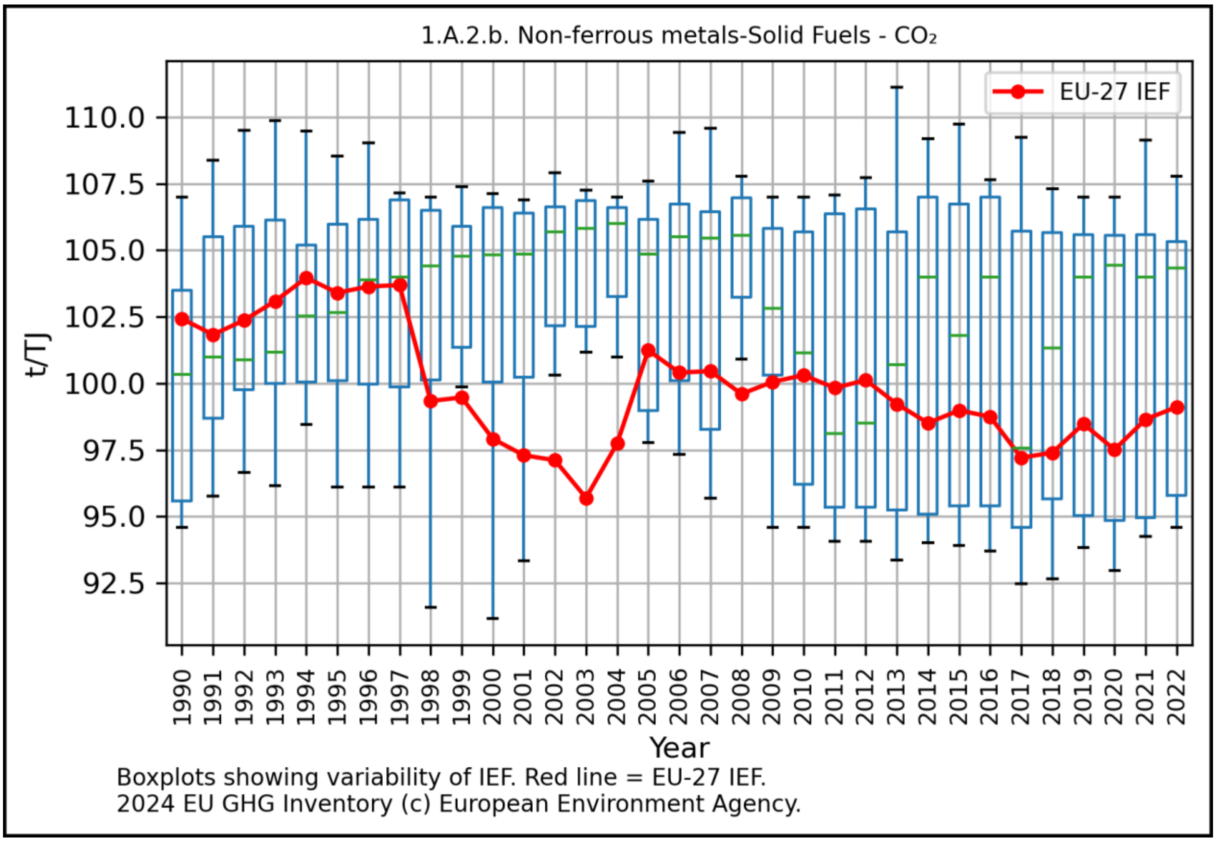


Figure 3.45 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. CO_2 IEF equalled to 99.11 t/TJ in 2022.

Figure 3.45: 1.A.2.b Non-ferrous Metals, solid fuels: Implied Emission Factors for CO_2 (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 6 469 kt in 2022 for EU. CO_2 emissions increased compared to year 1990 by 115 % and compared to year 2021 decreased by 17 %. This category represents 1.6 % share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 110 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.28.Table 3.36: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	75	277	279	4.3%	204	272%	1	1%	T2	CS
Belgium	261	290	274	4.2%	13	5%	-15	-5%	T1	D
Bulgaria	23	120	110	1.7%	87	371%	-10	-8%	T2	CS
Croatia	NO	27	27	0.4%	27	∞	0	-1%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	53	169	133	2.1%	80	150%	-37	-22%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	0	NO	-	-	-	0	-100%	NA	NA
Finland	NO	3	3	0.0%	3	∞	-1	-21%	T3	CS
France	745	646	601	9.3%	-145	-19%	-46	-7%	-	-
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	655	542	8.4%	542	∞	-113	-17%	T2	CS
Hungary	86	161	161	2.5%	75	87%	0	0%	T2	CS
Ireland	39	1 358	1 198	18.5%	1 159	3006%	-160	-12%	T2	CS
Italy	566	1 249	1 067	16.5%	501	89%	-182	-15%	T2	CS
Latvia	NO	1	0	0.0%	0	∞	-1	-55%	T2	CS
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	13	49	48	0.7%	34	255%	-1	-2%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	213	151	135	2.1%	-79	-37%	-16	-11%	T2	CS
Poland	254	443	408	6.3%	154	60%	-35	-8%	T2	CS
Portugal	IE	IE	IE	-	-	-	-	-	NO	NO
Romania	IE	409	194	3.0%	194	∞	-215	-53%	T2,T3	CS,PS
Slovakia	435	86	54	0.8%	-380	-87%	-32	-37%	T2	CS
Slovenia	165	130	120	1.8%	-45	-27%	-11	-8%	T2	CS
Spain	73	1 546	1 101	17.0%	1 028	1403%	-445	-29%	T2,T3	CS,PS
Sweden	10	17	16	0.2%	5	52%	-1	-7%	T2	CS
EU-27	**3 013**	**7 789**	**6 469**	**100%**	**3 457**	**115%**	**-1 320**	**-17%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.

Figure 3.46: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Emission trend and share for CO_2

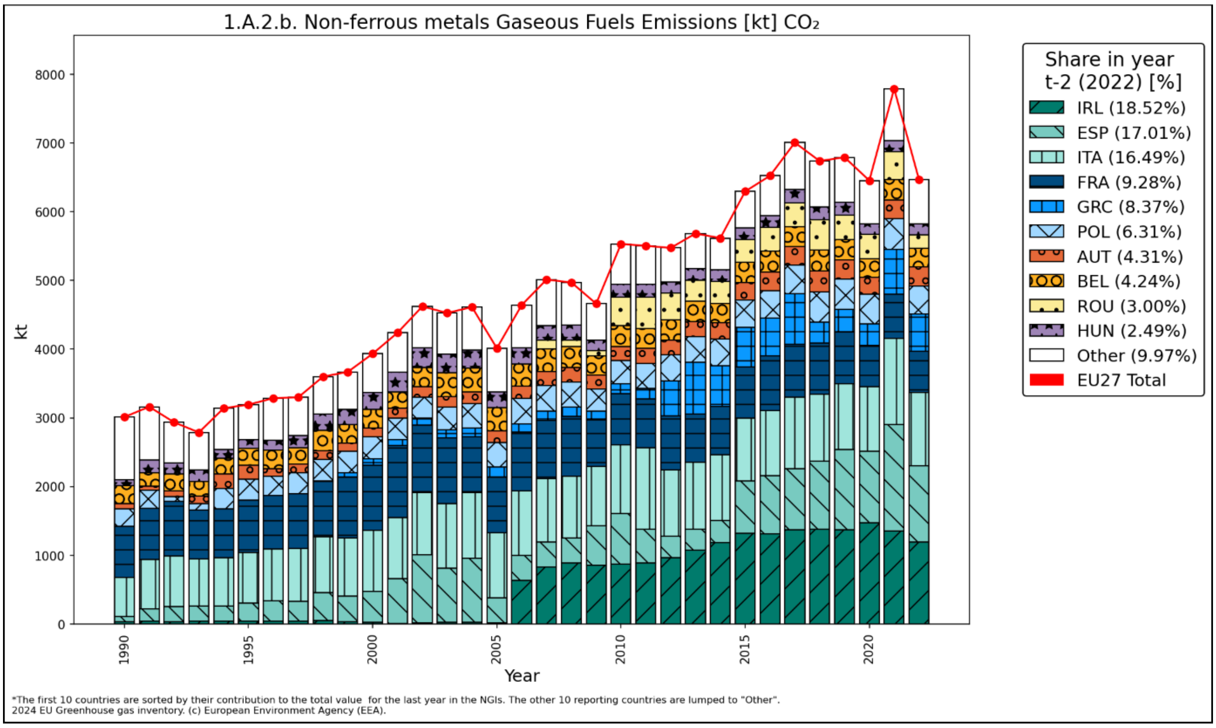
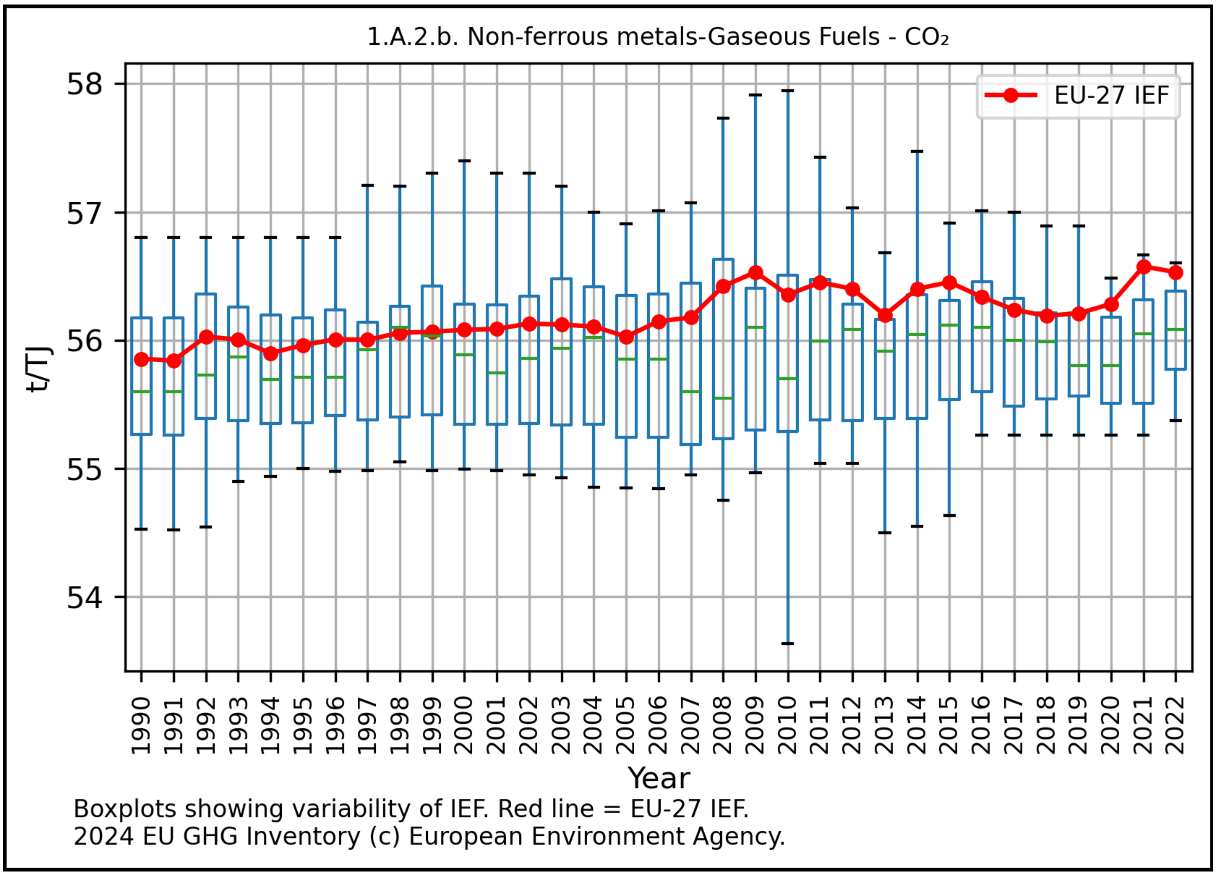


Figure 3.48 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. CO_2 IEF equalled to 56.50 t/TJ in 2022.

Figure 3.47: 1.A.2.b Non-ferrous Metals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



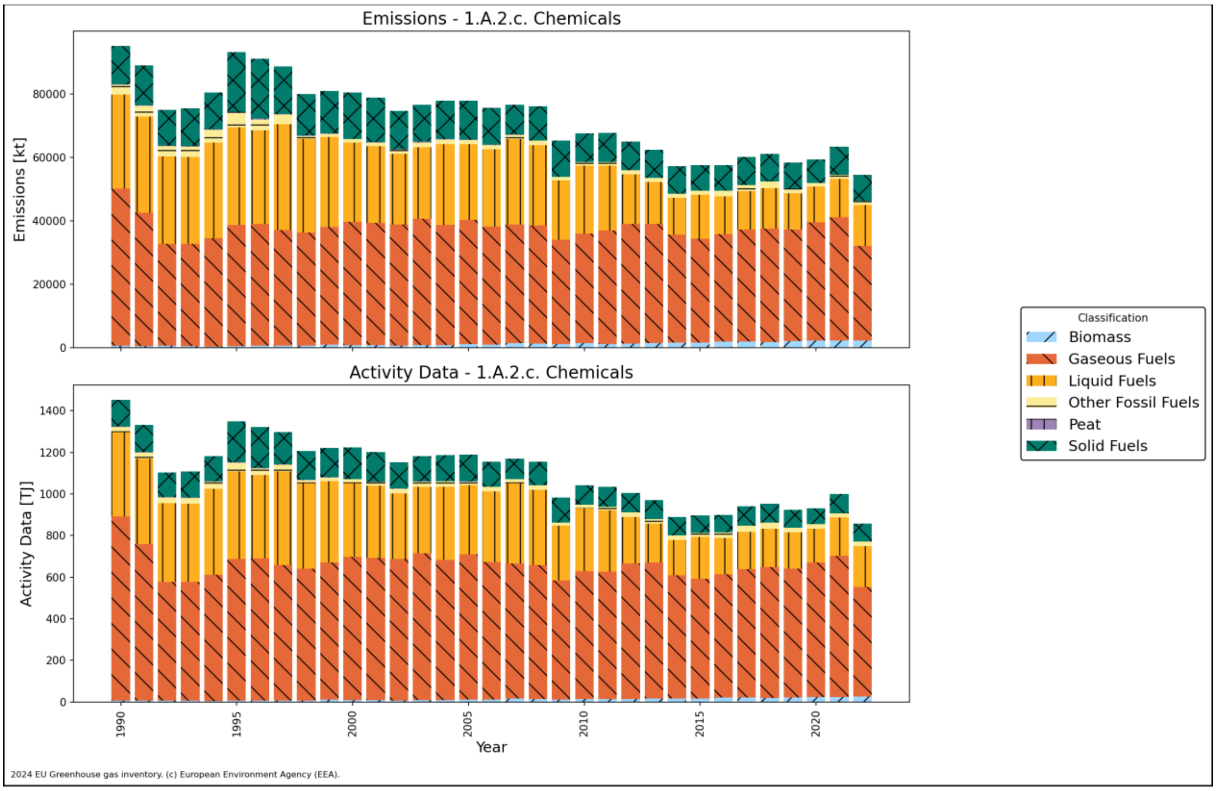
3.5.2.3 Chemicals (1.A.2.c)

This chapter provides information about European emission trend 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 46 068 kt CO_2 eq. in 2022. The trend of total CO_2 emissions for 1990 to 2022 from category 1.A.2.c is depicted in Figure 3.50. CO_2 emissions decreased by 48 % since 1990 and decreased by 12 % between 2021 and 2022. CO_2 emissions from 1.A.2.c Chemicals accounted for 13 % 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 2022. The share of liquid fuels on CO_2 emissions from 1.A.2.c decreased from 35 % in 1990 to 25 % in 2022. The share of solid fuels on CO_2 emissions from 1.A.2.c slightly increased from 12 % in 1990 to 16 % in 2022. The share of gaseous fuels on CO_2 emissions from 1.A.2.c increased from 50 % in 1990 to 57 % in 2022.

Figure 3.48: 1.A.2.c Chemicals: Total emission and activity trends



Detailed data related to the EU submissions are depicted in Table 3.29.

Table 3.37: 1.A.2.c Chemicals: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	847	1 531	1 398	3.0%	551	65%	-133	-9%	NA,T2	CS,NA
Belgium	5 098	4 122	3 584	7.8%	-1 514	-30%	-538	-13%	NA,T1,T3	D,NA,PS
Bulgaria	966	1 556	1 426	3.1%	461	48%	-130	-8%	NA,T1,T2	CS,D,NA
Croatia	738	234	72	0.2%	-665	-90%	-162	-69%	NA,T1	D,NA
Cyprus	2	7	10	0.0%	8	356%	3	49%	NA,T1	D,NA
Czechia	2 996	3 247	3 256	7.1%	260	9%	9	0%	NA,T1,T2	CS,D,NA
Denmark	337	275	186	0.4%	-150	-45%	-89	-32%	NA,T2,T3	CS,NA
Estonia	390	15	13	0.0%	-377	-97%	-2	-12%	NA,T1,T2	CS,D,NA
Finland	1 191	729	703	1.5%	-488	-41%	-25	-3%	NA,T3	CS,NA
France	13 092	9 208	8 544	18.5%	-4 548	-35%	-665	-7%	NA	NA
Germany	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Greece	808	645	217	0.5%	-590	-73%	-428	-66%	NA,T2	CS,NA
Hungary	1 626	398	339	0.7%	-1 287	-79%	-59	-15%	NA,T1,T2,T3	CS,D,NA,PS
Ireland	410	404	369	0.8%	-42	-10%	-35	-9%	NA,T2	CS,NA
Italy	21 429	9 813	10 080	21.9%	-11 349	-53%	267	3%	NA,T2	CS,NA
Latvia	294	30	24	0.1%	-270	-92%	-6	-21%	NA,T2	CS,NA
Lithuania	397	280	241	0.5%	-156	-39%	-40	-14%	NA,T2	CS,NA
Luxembourg	170	122	110	0.2%	-60	-35%	-12	-10%	NA,T1,T3	CS,D,NA
Malta	NO	7	6	0.0%	6	∞	-1	-16%	NA,T1	D,NA
Netherlands	11 574	7 145	6 022	13.1%	-5 552	-48%	-1 123	-16%	NA,T2	CS,D,NA
Poland	4 003	6 845	5 781	12.5%	1 778	44%	-1 064	-16%	NA,T1,T2	CS,D,NA
Portugal	1 412	1 326	1 109	2.4%	-303	-21%	-217	-16%	NA,T1,T3	D,NA,PS
Romania	17 850	3 458	1 744	3.8%	-16 106	-90%	-1 714	-50%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	2 652	476	450	1.0%	-2 202	-83%	-26	-6%	NA,T2	CS,NA
Slovenia	211	73	73	0.2%	-138	-65%	0	0%	NA,T1,T2	CS,D,NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	683	323	311	0.7%	-372	-54%	-12	-4%	T2	CS
EU-27	**89 174**	**52 271**	**46 068**	**100%**	**-43 106**	**-48%**	**-6 202**	**-12%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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 13 168 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 56 % and compared to 2021 increased by 9 %. Category has 3 % 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 submissions are depicted in Table 3.30.

Table 3.38: 1.A.2.c Chemicals, Liquid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	97	35	48	0.4%	-49	-51%	13	36%	T2	CS
Belgium	1 852	303	418	3.2%	-1 434	-77%	115	38%	T1	D
Bulgaria	855	965	1 037	7.9%	182	21%	72	7%	T1	D
Croatia	291	7	6	0.0%	-285	-98%	-1	-17%	T1	D
Cyprus	2	7	10	0.1%	8	356%	3	49%	T1	D
Czechia	175	324	379	2.9%	204	116%	55	17%	T1	D
Denmark	220	16	31	0.2%	-189	-86%	15	97%	T2	CS
Estonia	229	3	6	0.0%	-223	-98%	3	111%	T1,T2	CS,D
Finland	677	616	603	4.6%	-74	-11%	-13	-2%	T3	CS
France	4 871	1 821	1 753	13.3%	-3 117	-64%	-68	-4%	-	-
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	639	79	87	0.7%	-552	-86%	8	10%	T2	CS
Hungary	431	3	6	0.0%	-426	-99%	3	100%	T1	D
Ireland	131	49	23	0.2%	-108	-82%	-26	-53%	T2	CS
Italy	13 126	4 438	5 645	42.9%	-7 482	-57%	1 207	27%	T2	CS
Latvia	270	11	11	0.1%	-259	-96%	0	-3%	T2	CS
Lithuania	69	5	8	0.1%	-61	-89%	3	67%	T2	CS
Luxembourg	112	0	3	0.0%	-109	-97%	3	24634%	T1,T3	CS,D
Malta	NO	7	6	0.0%	6	∞	-1	-16%	T1	D
Netherlands	791	129	207	1.6%	-585	-74%	77	60%	T2	CS,D
Poland	308	1 198	901	6.8%	593	192%	-297	-25%	T1,T2	CS,D
Portugal	1 373	726	587	4.5%	-786	-57%	-139	-19%	T1,T3	D,PS
Romania	NO	933	977	7.4%	977	∞	44	5%	T1,T2,T3	CS,D,PS
Slovakia	51	1	2	0.0%	-50	-97%	0	8%	T2	CS
Slovenia	32	9	12	0.1%	-20	-64%	2	27%	T1	D
Spain	2 729	118	94	0.7%	-2 635	-97%	-24	-20%	T1,T2	CS,D
Sweden	424	323	311	2.4%	-114	-27%	-12	-4%	T2	CS
EU-27	**29 756**	**12 127**	**13 168**	**100%**	**-16 588**	**-56%**	**1 041**	**9%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.

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.

Figure 3.49: 1.A.2.c Chemicals, Liquid fuels: Emission trend and share for CO_2

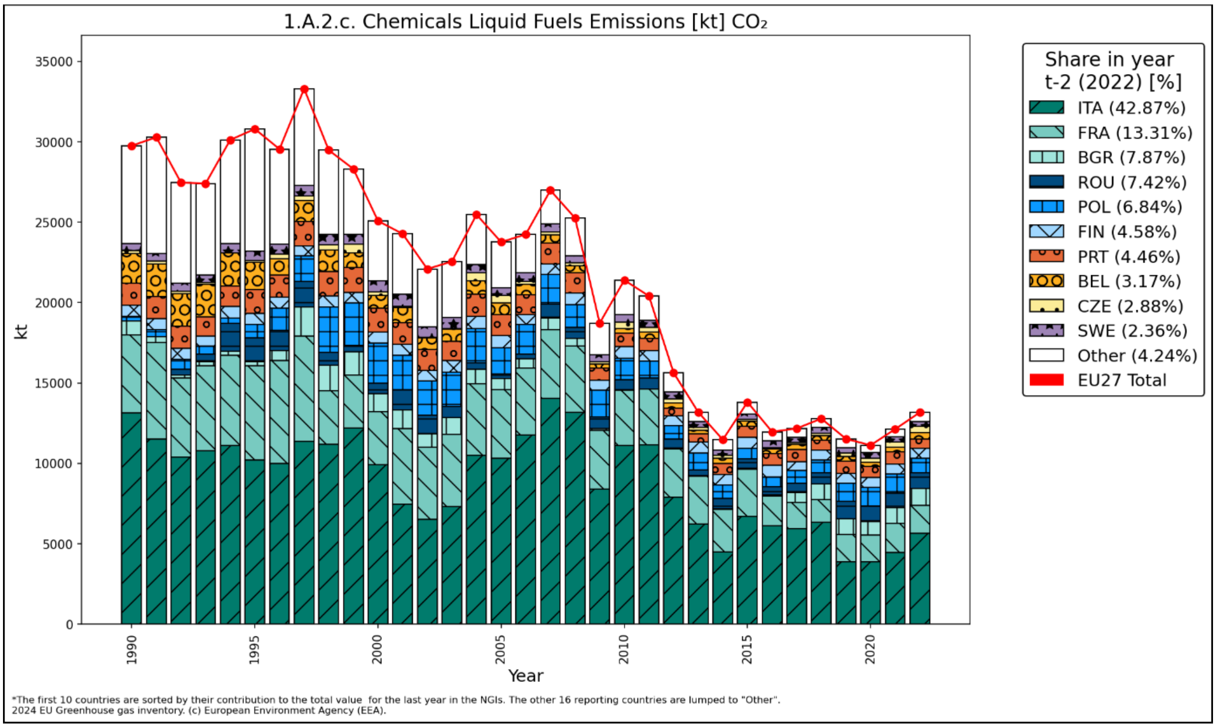
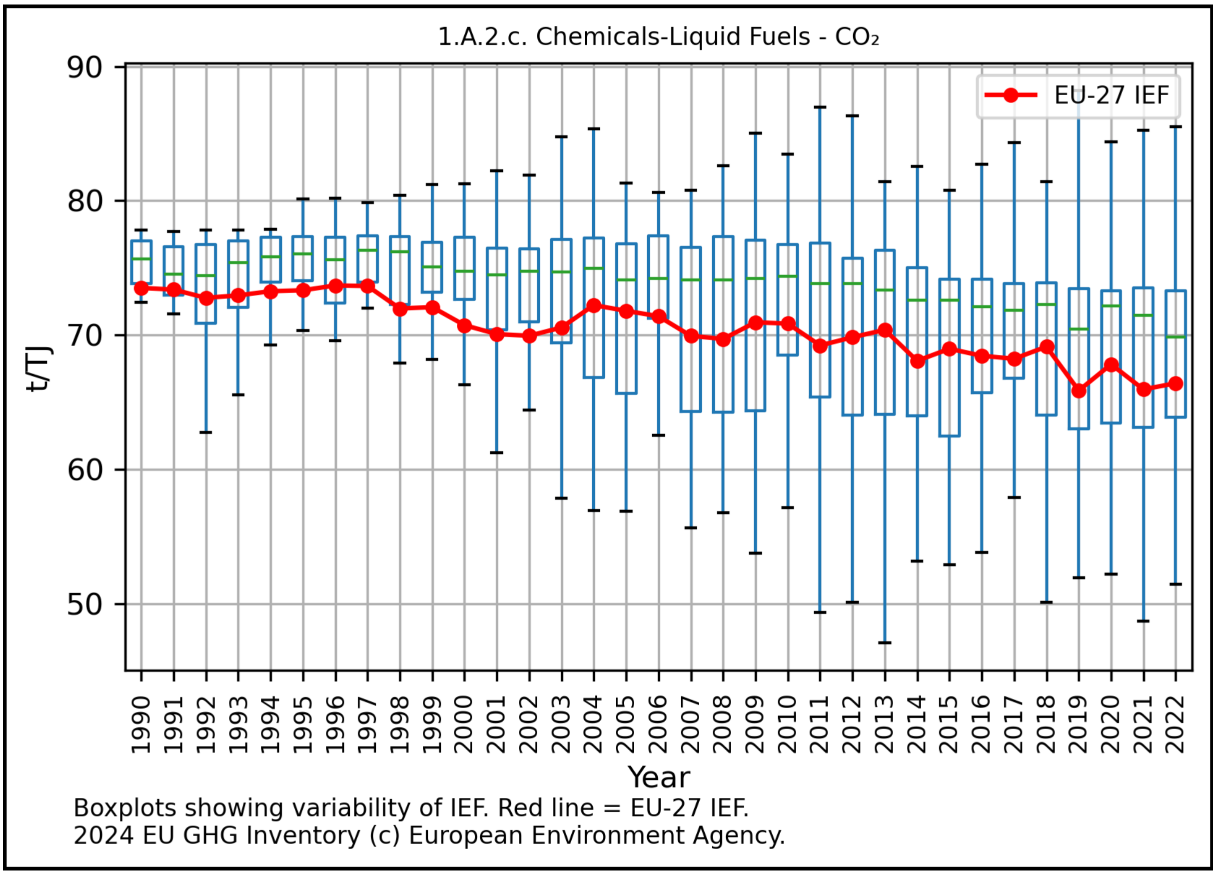


Figure 3.52 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. It can be seen that CO_2 IEF fluctuates over the time period with decreasing trend. CO_2 IEF equaled to 66.17 t/TJ in 2022.

Figure 3.50: 1.A.2.c Chemicals, Liquid fuels: Implied Emission Factors for CO_2 (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 8 133 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 32 % and compared to 2021 decreased by 9 %. Category has 2% share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 40 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.31.

Table 3.39: 1.A.2.c Chemicals, Solid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	106	34	52	0.6%	-55	-51%	18	53%	T2	CS
Belgium	688	3	3	0.0%	-685	-100%	0	-10%	T1	D
Bulgaria	80	301	246	3.0%	165	206%	-56	-18%	T1,T2	CS,D
Croatia	101	NO	1	0.0%	-100	-99%	1	∞	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	2 487	2 104	2 157	26.5%	-330	-13%	54	3%	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	1 257	957	11.8%	-1 192	-55%	-301	-24%	-	-
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	169	NO	NO	-	-169	-100%	-	-	NA	NA
Hungary	140	NO	NO	-	-140	-100%	-	-	NA	NA
Ireland	72	NO	NO	-	-72	-100%	-	-	NA	NA
Italy	640	NO	NO	-	-640	-100%	-	-	NA	NA
Latvia	NO	1	0	0.0%	0	∞	-1	-75%	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	4 595	4 126	50.7%	3 113	308%	-470	-10%	T1,T2	CS,D
Portugal	39	NO	NO	-	-39	-100%	-	-	T1,T3	D,PS
Romania	644	NO	NO	-	-644	-100%	-	-	NA	NA
Slovakia	1 584	9	9	0.1%	-1 574	-99%	0	-1%	T2	CS
Slovenia	1	NO	NO	-	-1	-100%	-	-	NA	NA
Spain	678	592	583	7.2%	-95	-14%	-8	-1%	T1,T2	CS,D,PS
Sweden	101	C	C	-	-101	-100%	-	-	T2	CS
EU-27	**12 004**	**8 896**	**8 133**	**100%**	**-3 871**	**-32%**	**-763**	**-9%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2021 and 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 EU sums do include emission from Sweden.

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.

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

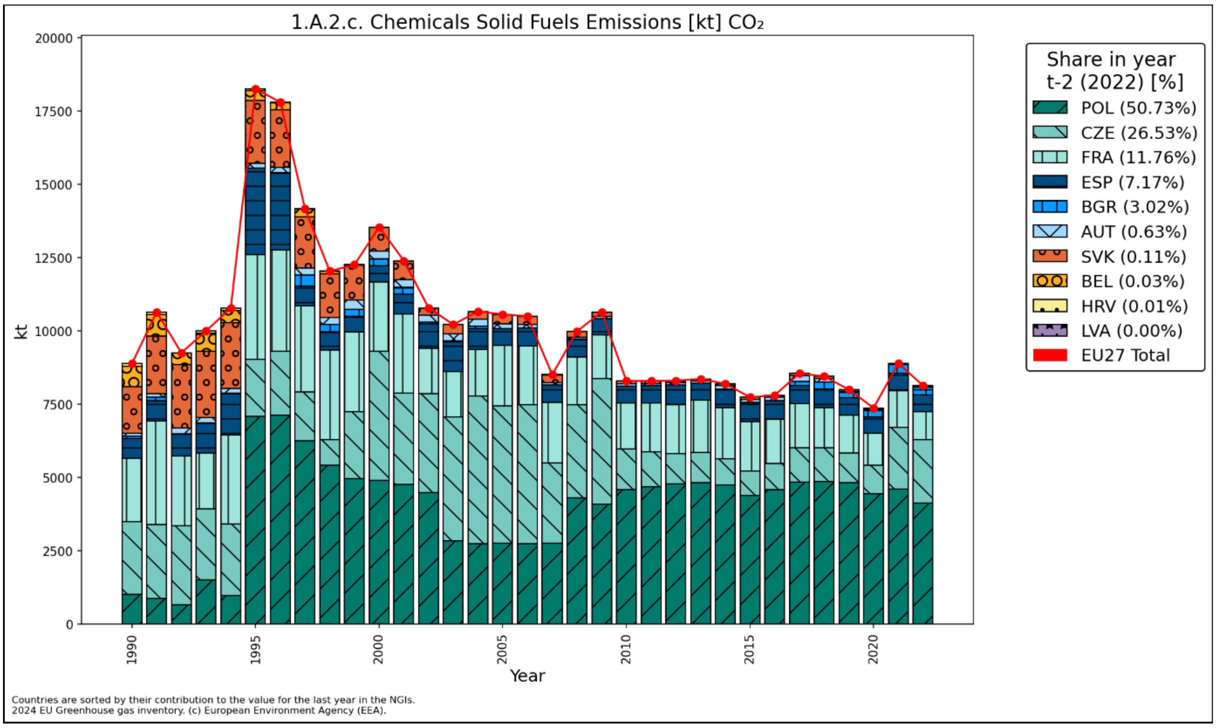
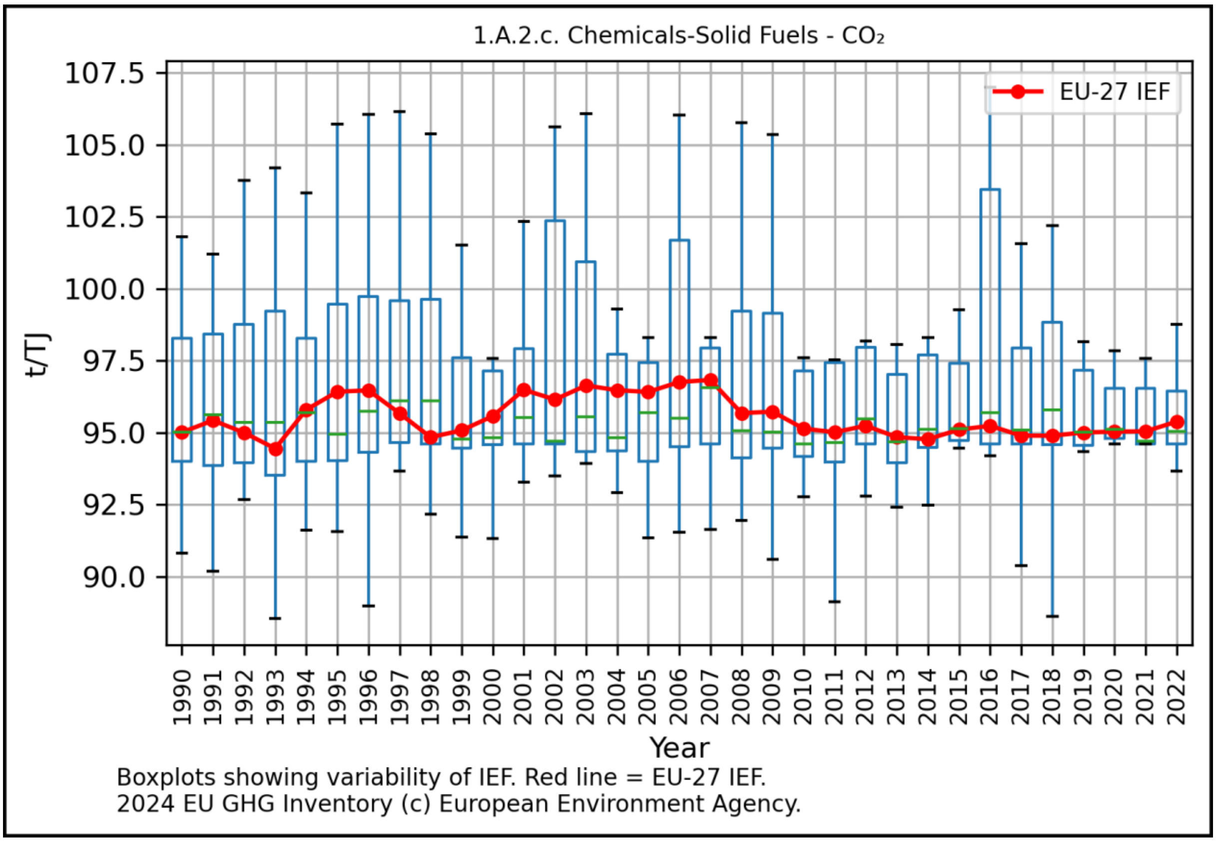


Figure 3.55 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. It can be seen that since 2010, the CO_2 IEF fluctuates only slightly. CO_2 IEF equalled to 95.38 t/TJ in 2022.

Figure 3.52: 1.A.2.c Chemicals, Solid fuels: Implied Emission Factors for CO_2 (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 29 792 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 40 % and compared to 2021 CO_2 emissions decreased by 23 %. This category represents 8 % of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 40 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.32.

Table 3.40: 1.A.2.c Chemicals, gaseous fuels: Member States contributions to CO_2

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	519	1 231	991	3.3%	472	91%	-240	-20%	T2	CS
Belgium	2 559	3 810	3 156	10.6%	598	23%	-653	-17%	T1,T3	D,PS
Bulgaria	30	290	144	0.5%	113	375%	-146	-50%	T2	CS
Croatia	346	227	66	0.2%	-280	-81%	-161	-71%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	334	819	720	2.4%	386	116%	-99	-12%	T2	CS
Denmark	110	259	155	0.5%	45	41%	-104	-40%	T3	CS
Estonia	156	12	7	0.0%	-149	-95%	-5	-39%	T2	CS
Finland	99	91	80	0.3%	-18	-19%	-10	-12%	T3	CS
France	5 602	5 125	4 912	16.5%	-690	-12%	-213	-4%	-	-
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	566	130	0.4%	130	∞	-436	-77%	T2	CS
Hungary	1 055	388	323	1.1%	-732	-69%	-65	-17%	T2	CS
Ireland	207	354	345	1.2%	138	67%	-9	-3%	T2	CS
Italy	7 663	5 375	4 436	14.9%	-3 227	-42%	-940	-17%	T2	CS
Latvia	24	18	13	0.0%	-11	-45%	-5	-29%	T2	CS
Lithuania	328	276	233	0.8%	-95	-29%	-43	-15%	T2	CS
Luxembourg	57	122	106	0.4%	49	85%	-16	-13%	T3	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	9 695	7 016	5 816	19.5%	-3 880	-40%	-1 200	-17%	T2	CS
Poland	293	1 048	720	2.4%	428	146%	-327	-31%	T2	CS
Portugal	NO	600	521	1.8%	521	∞	-78	-13%	T1,T3	D,PS
Romania	17 206	2 520	761	2.6%	-16 445	-96%	-1 759	-70%	T2,T3	CS,PS
Slovakia	989	456	429	1.4%	-560	-57%	-26	-6%	T2	CS
Slovenia	177	64	61	0.2%	-116	-65%	-3	-4%	T2	CS
Spain	1 819	8 097	5 664	19.0%	3 845	211%	-2 433	-30%	T2	CS
Sweden	155	C	C	-	-155	-100%	-	-	T2	CS
EU-27	**49 423**	**38 764**	**29 792**	**100%**	**-19 632**	**-40%**	**-8 972**	**-23%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year. This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2021 and 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 EU sums do include emission from Sweden.

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.

Figure 3.53: 1.A.2.c Chemicals, Gaseous fuels: Emission trend and share for CO_2

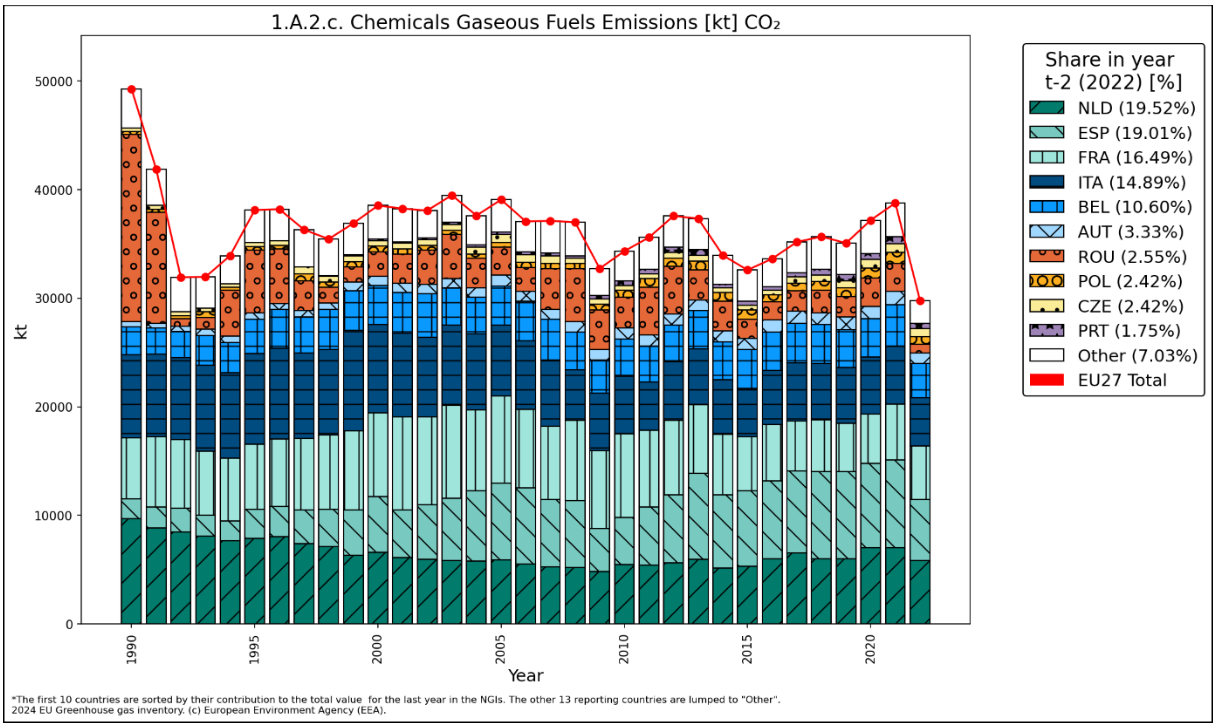
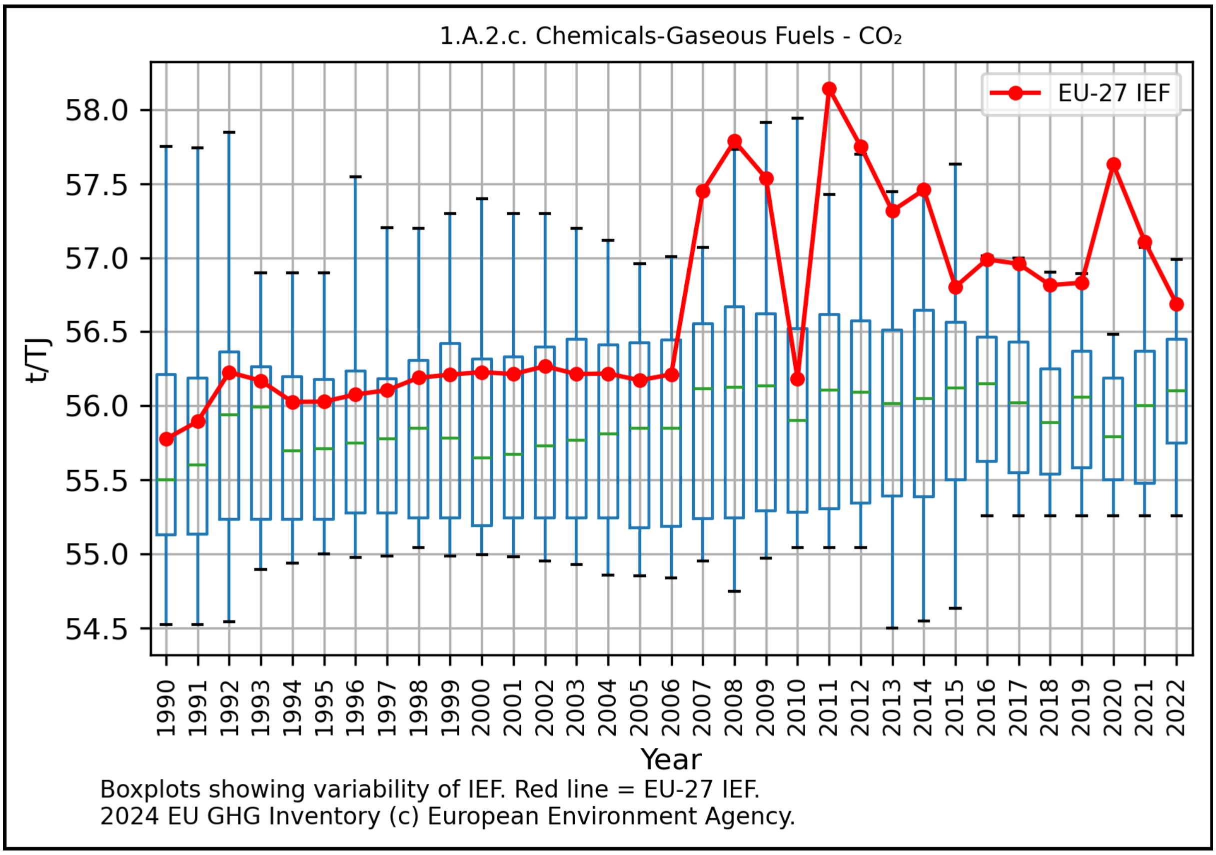


Figure 3.58 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. CO_2 IEF equaled to 56.57 t/TJ in 2022.

Figure 3.54: 1.A.2.c Chemicals, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



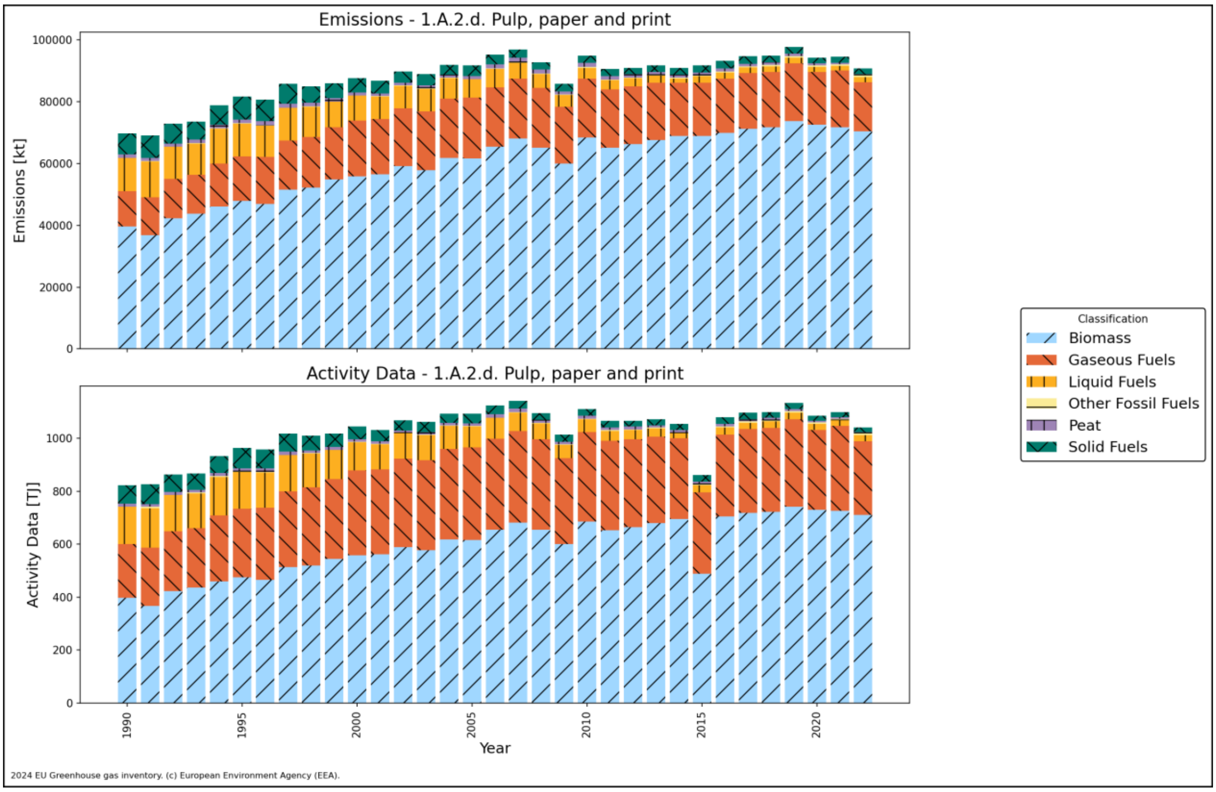
3.5.2.4 Pulp, Paper and Print (1.A.2.d)

This chapter provides information about European emission trend and Member States 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 20 301 kt CO_2 eq. in 2022. The trend of total emissions for 1990 to 2022 from category 1.A.2.d is depicted in Figure 3.60. Total CO_2 emissions decreased by 26 % since 1990 and increased by 9 % between 2021 and 2022. 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 2022. The share of liquid fuels on CO_2 emissions from 1.A.2.d decreased from 36 % in 1990 to 9% in 2022. The share of solid fuels on CO_2 emissions from 1.A.2.d decreased from 23 % in 1990 to 9% in 2022. The share of gaseous fuels on CO_2 emissions from 1.A.2.d increased from 37 % in 1990 to 78 % in 2022. 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 3.55: 1.A.2.d Pulp, Paper and Print: Total emission and activity trends



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 submissions are depicted in Table 3.33.

Table 3.41: 1.A.2.d Pulp, Paper and Print: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	2 208	1 820	1 528	7.5%	-680	-31%	-291	-16%	NA,T2	CS,NA
Belgium	644	559	547	2.7%	-96	-15%	-12	-2%	NA,T1,T3	D,NA,PS
Bulgaria	16	110	88	0.4%	73	466%	-22	-20%	NA,T1,T2	CS,D,NA
Croatia	303	121	118	0.6%	-185	-61%	-3	-3%	NA,T1	D,NA
Cyprus	5	3	2	0.0%	-3	-66%	-2	-53%	NA,T1	D,NA
Czechia	2 285	778	665	3.3%	-1 620	-71%	-113	-15%	NA,T1,T2	CS,D,NA
Denmark	343	39	26	0.1%	-317	-92%	-13	-34%	NA,T2,T3	CS,NA
Estonia	145	56	42	0.2%	-103	-71%	-14	-25%	NA,T1,T2	CS,D,NA
Finland	5 330	2 206	1 874	9.2%	-3 456	-65%	-332	-15%	T3	CS
France	4 483	2 278	2 110	10.4%	-2 373	-53%	-168	-7%	NA	NA
Germany	4	11	9	0.0%	5	143%	-2	-18%	CS,NA	CS,NA
Greece	306	86	84	0.4%	-222	-73%	-3	-3%	NA,T2	CS,NA
Hungary	349	372	388	1.9%	39	11%	16	4%	NA,T1,T2,T3	CS,D,NA,PS
Ireland	28	19	19	0.1%	-10	-34%	0	-1%	NA,T2	CS,NA
Italy	3 108	5 011	4 535	22.3%	1 428	46%	-475	-9%	NA,T2	CS,NA
Latvia	168	6	4	0.0%	-164	-98%	-2	-30%	NA,T2	CS,NA
Lithuania	255	30	28	0.1%	-227	-89%	-2	-6%	NA,T2	CS,NA
Luxembourg	IE,NO	14	8	0.0%	8	∞	-5	-40%	NA,T2	CS,NA
Malta	NO	1	1	0.0%	1	∞	0	53%	NA,T1	D,NA
Netherlands	1 668	944	855	4.2%	-813	-49%	-89	-9%	NA,T2	CS,NA
Poland	284	1 436	1 358	6.7%	1 074	378%	-77	-5%	NA,T1,T2	CS,D,NA
Portugal	754	1 102	936	4.6%	182	24%	-166	-15%	T1	D
Romania	NO	347	309	1.5%	309	∞	-38	-11%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	2 329	296	244	1.2%	-2 086	-90%	-53	-18%	NA,T2	CS,NA
Slovenia	381	244	240	1.2%	-140	-37%	-3	-1%	NA,T1,T2,T3	CS,D,NA,PS
Spain	NO	NO	3 639	17.9%	3 639	∞	3 639	∞	NA,T1,T2,T3	CS,D,NA,PS
Sweden	2 156	660	641	3.2%	-1 515	-70%	-19	-3%	T2	CS
EU-27	**27 553**	**18 550**	**20 301**	**100%**	**-7 252**	**-26%**	**1 751**	**9%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period 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 1 782 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 84 % and compared to 2021 increased by 13 %. Category has 0.5 % share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 83% compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.34.

Table 3.42: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	853	14	24	1.3%	-829	-97%	9	64%	T2	CS
Belgium	235	16	5	0.3%	-230	-98%	-12	-70%	T1,T3	D,PS
Bulgaria	16	1	1	0.1%	-14	-92%	0	-16%	T1	D
Croatia	58	3	3	0.2%	-55	-95%	0	11%	T1	D
Cyprus	5	3	2	0.1%	-3	-66%	-2	-53%	T1	D
Czechia	461	10	16	0.9%	-445	-97%	6	53%	T1	CS,D
Denmark	94	7	12	0.7%	-82	-87%	5	72%	T2	CS
Estonia	145	1	2	0.1%	-143	-99%	1	192%	T1,T2	CS,D
Finland	1 138	369	456	25.6%	-682	-60%	87	23%	T3	CS
France	1 386	104	110	6.2%	-1 276	-92%	7	6%	-	-
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	302	50	35	1.9%	-268	-89%	-15	-31%	T2	CS
Hungary	69	3	3	0.2%	-66	-96%	0	0%	T1	D
Ireland	28	3	3	0.2%	-26	-90%	0	5%	T2	CS
Italy	1 017	7	15	0.8%	-1 002	-99%	8	129%	T2	CS
Latvia	16	0	0	0.0%	-15	-98%	0	20%	T2	CS
Lithuania	69	1	1	0.1%	-68	-99%	0	-6%	T2	CS
Luxembourg	IE	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	1	1	0.1%	1	∞	0	53%	T1	D
Netherlands	2	NO	NO	-	-2	-100%	-	-	NA	NA
Poland	106	150	158	8.9%	52	49%	8	5%	T1,T2	CS,D
Portugal	754	106	167	9.4%	-587	-78%	61	57%	T1	D
Romania	NO	2	4	0.2%	4	∞	2	124%	T1,T2	CS,D
Slovakia	985	3	3	0.2%	-981	-100%	1	37%	T2	CS
Slovenia	98	3	9	0.5%	-89	-91%	6	185%	T1	D
Spain	1 214	170	207	11.6%	-1 007	-83%	37	22%	T1,T2,T3	CS,D,PS
Sweden	1 786	555	545	30.6%	-1 240	-69%	-10	-2%	T2	CS
EU-27	**10 835**	**1 583**	**1 782**	**100%**	**-9 052**	**-84%**	**200**	**13%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.

Figure 3.56: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Emission trend and share for CO_2

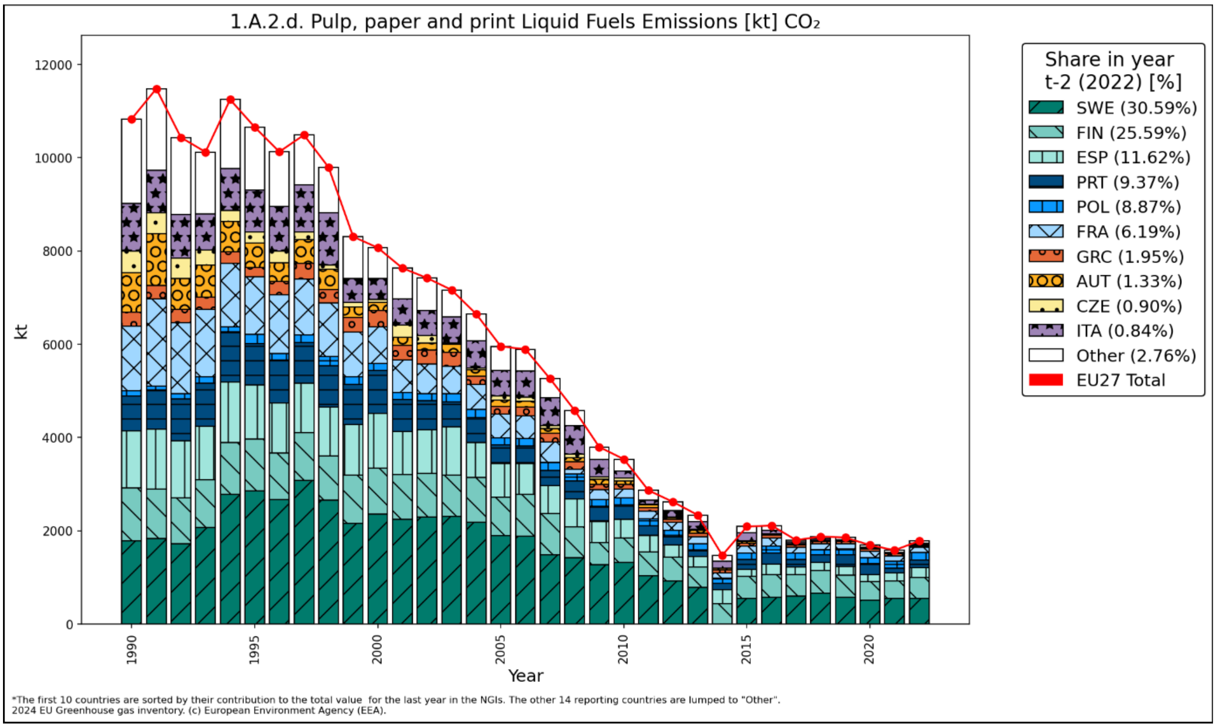
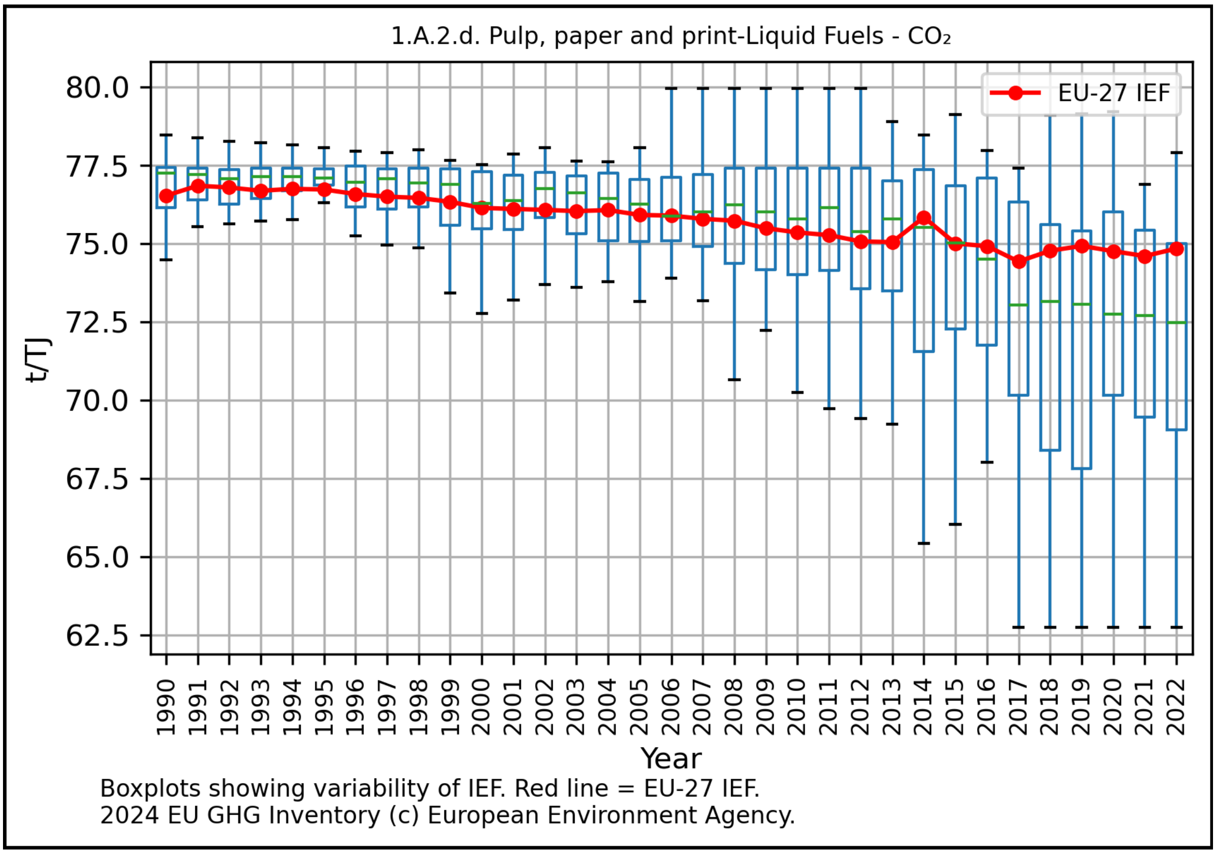


Figure.3.62 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. It can be seen that CO_2 IEF is decreasing during whole time period, which is caused by increasing consumption of Liquified Petroleum Gas with lower CO_2 IEF and decreasing consumption of Heavy Fuel Oil with higher CO_2 IEF. Peak in 2014 IEF was caused by SWE which reported data as C but it is reflected in EU IEF estimation for that year. CO_2 IEF equaled to 74.79 t/TJ in 2022.

Figure.3.57: 1.A.2.d Pulp, Paper and Print, Liquid fuels: Implied Emission Factors for CO_2 (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 1 746 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 74 % and decreased by 7 % to 2021. This category represents 0.4 % of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 74 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.35.

Table 3.43: 1.A.2.d Pulp, Paper and Print, solid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	398	210	130	7.5%	-268	-67%	-79	-38%	T2	CS
Belgium	128	73	80	4.6%	-48	-37%	7	9%	T1	D
Bulgaria	NO	11	12	0.7%	12	∞	0	3%	T1,T2	CS,D
Croatia	68	NO	NO	-	-68	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 646	360	367	21.0%	-1 279	-78%	7	2%	T2	CS,D
Denmark	125	NO	NO	-	-125	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 318	224	221	12.7%	-1 097	-83%	-3	-1%	T3	CS
France	1 034	53	38	2.2%	-996	-96%	-15	-28%	-	-
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	4	NO	NO	-	-4	-100%	-	-	NA	NA
Hungary	9	130	156	9.0%	148	1663%	26	20%	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	681	586	33.5%	413	239%	-95	-14%	T1,T2	CS,D
Portugal	NO	NO	NO	-	-	-	-	-	T1	D
Romania	NO	NO	0	0.0%	0	∞	0	∞	T1,T2	CS,D
Slovakia	1 142	102	87	5.0%	-1 055	-92%	-15	-15%	T2	CS
Slovenia	172	27	65	3.7%	-107	-62%	38	142%	T3	PS
Spain	277	NO	NO	-	-277	-100%	-	-	NA	NA
Sweden	265	7	4	0.2%	-260	-98%	-2	-36%	T2	CS
EU-27	**6 774**	**1 877**	**1 746**	**100%**	**-5 027**	**-74%**	**-131**	**-7%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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 3.64 shows CO_2 emissions trend as well as the share of the countries with the highest contribution to the total CO_2 emissions.

Figure 3.58: 1.A.2.d Pulp, Paper and Print, Solid fuels: Emission trend and share for CO_2

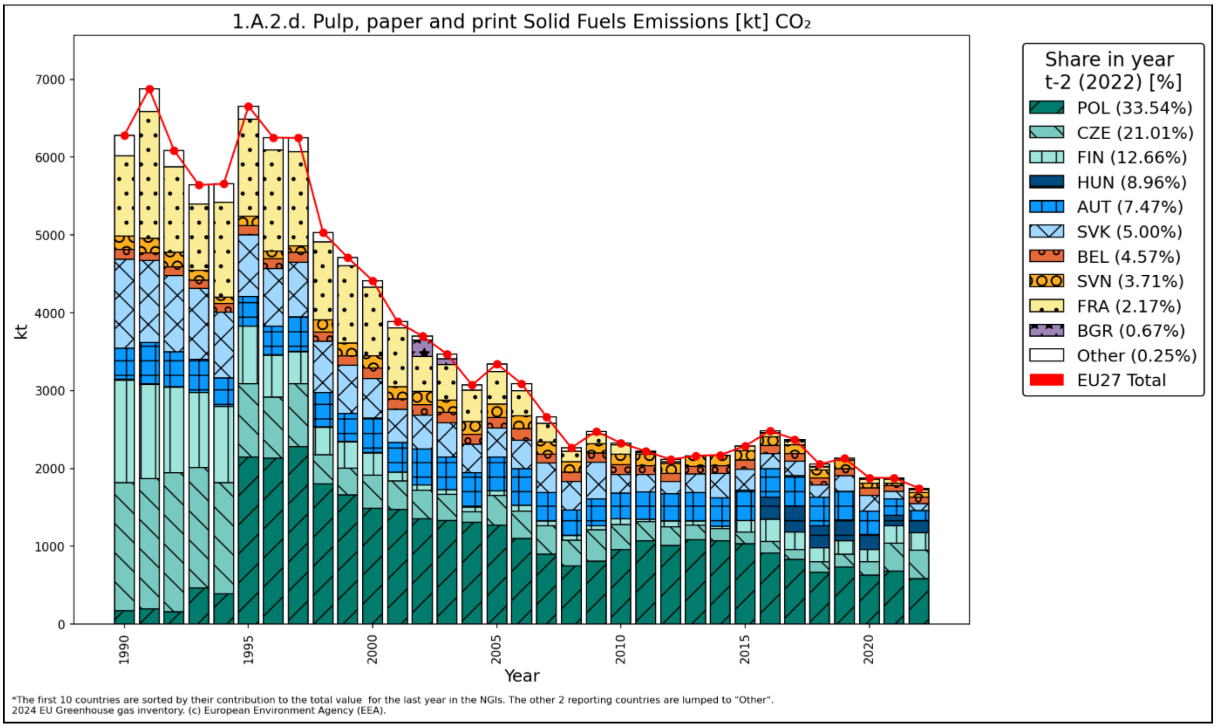
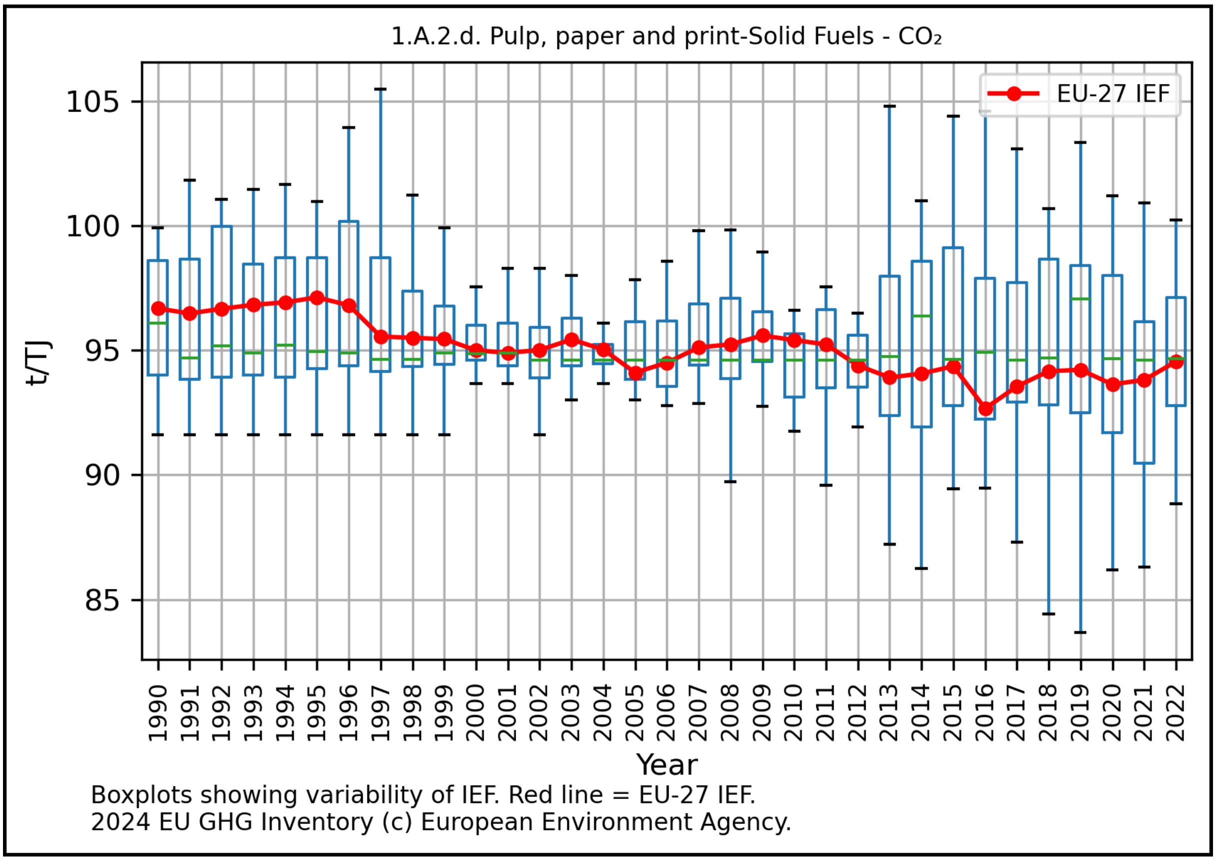


Figure 3.65 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. CO_2 IEF equalled to 94.55 t/TJ in 2022.

Figure 3.59: 1.A.2.d Pulp, Paper and Print, Solid fuels: Implied Emission Factors for CO_2 (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 15 831 kt in 2022 for EU. CO_2 emissions increased compared to year 1990 by 40 % and decreased compared to 2021 by 13 %. This category has 4 % share on total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 38 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.36.

Table 3.44: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	943	1 594	1 372	8.7%	429	46%	-222	-14%	T2	CS
Belgium	282	338	310	2.0%	28	10%	-28	-8%	T1	D
Bulgaria	NO	97	75	0.5%	75	∞	-22	-23%	T2	CS
Croatia	177	119	115	0.7%	-61	-35%	-4	-3%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	179	407	282	1.8%	103	58%	-125	-31%	T2	CS
Denmark	124	32	14	0.1%	-111	-89%	-18	-57%	T3	CS
Estonia	NO	56	40	0.3%	40	∞	-16	-28%	T2	CS
Finland	1 757	934	704	4.4%	-1 052	-60%	-229	-25%	T3	CS
France	2 063	2 095	1 945	12.3%	-118	-6%	-150	-7%	-	-
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	36	49	0.3%	49	∞	13	35%	T2	CS
Hungary	271	140	121	0.8%	-150	-55%	-19	-14%	T2	CS
Ireland	NO	16	16	0.1%	16	∞	0	-2%	T2	CS
Italy	2 085	5 004	4 520	28.6%	2 436	117%	-484	-10%	T2	CS
Latvia	150	5	4	0.0%	-147	-98%	-2	-33%	T2	CS
Lithuania	187	29	27	0.2%	-160	-85%	-2	-5%	T2	CS
Luxembourg	IE	14	8	0.1%	8	∞	-5	-40%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 659	944	855	5.4%	-803	-48%	-89	-9%	T2	CS
Poland	6	547	528	3.3%	522	9362%	-19	-3%	T2	CS
Portugal	NO	996	769	4.9%	769	∞	-227	-23%	T1	D
Romania	NO	330	291	1.8%	291	∞	-39	-12%	T2,T3	CS,PS
Slovakia	203	191	153	1.0%	-50	-25%	-38	-20%	T2	CS
Slovenia	110	213	167	1.1%	57	51%	-46	-22%	T2	CS
Spain	1 077	4 054	3 431	21.7%	2 354	219%	-623	-15%	T2,T3	CS,PS
Sweden	66	68	34	0.2%	-32	-49%	-35	-51%	T2	CS
EU-27	**11 336**	**18 261**	**15 831**	**100%**	**4 495**	**40%**	**-2 430**	**-13%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.

Figure 3.60: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Emission trend and share for CO_2

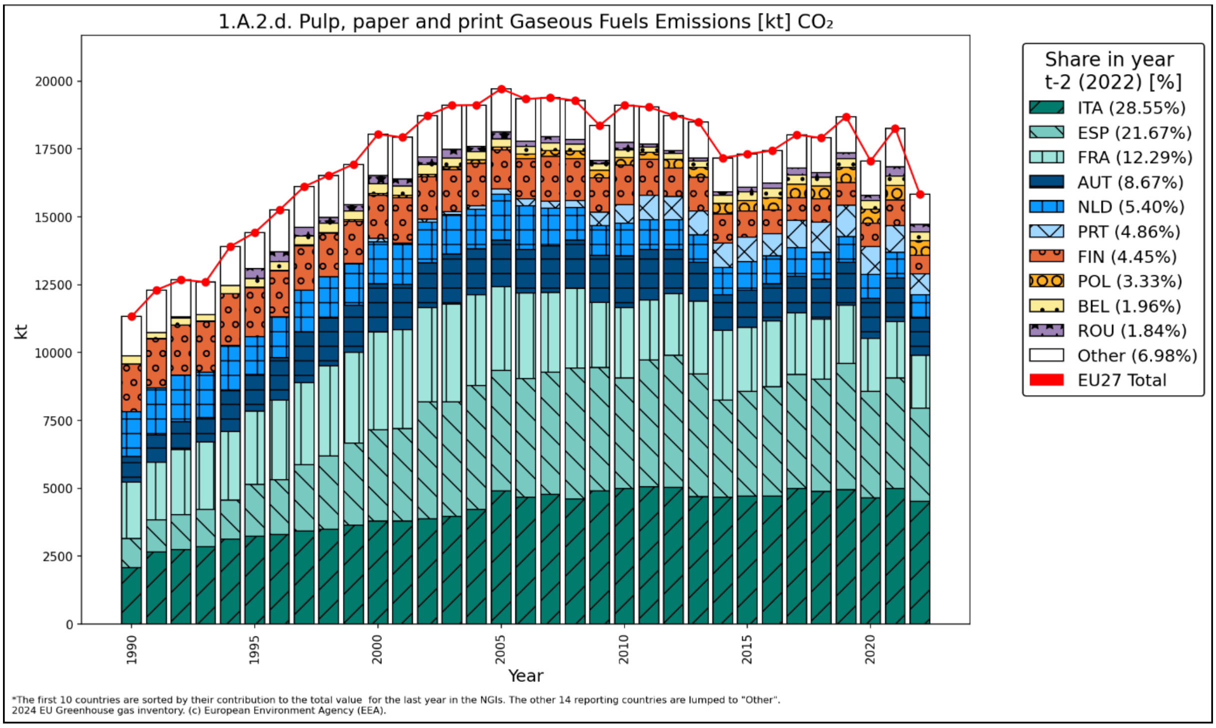
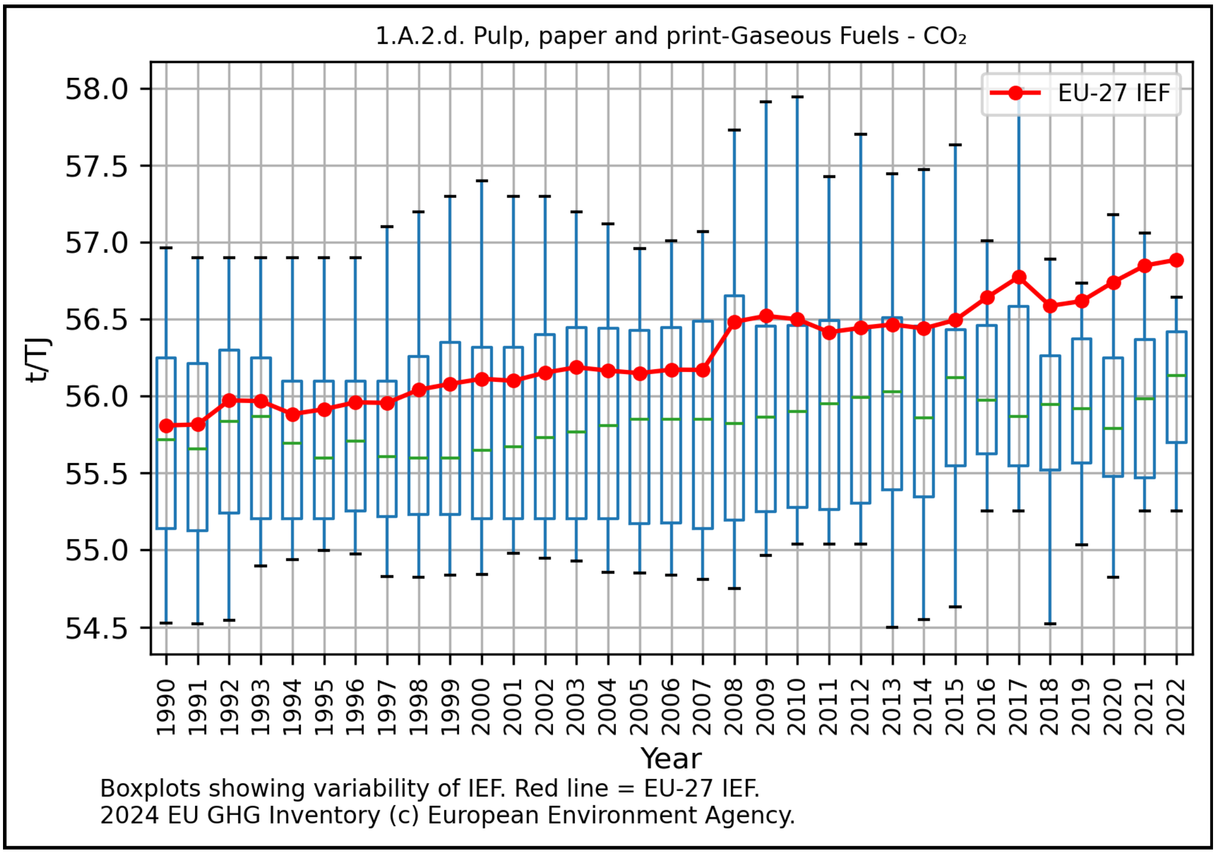


Figure 3.68 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. CO_2 IEF shows relatively stable slightly increasing trend without major fluctuations for whole time series. The main reason for increasing trend of the CO_2 IEF is the growing share of Italy and Spain on total EU emissions; their CO_2 IEFs have been slightly growing since 1990. CO_2 IEF equalled to 56.95 t/TJ in 2022.

Figure 3.61: 1.A.2.d Pulp, Paper and Print, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



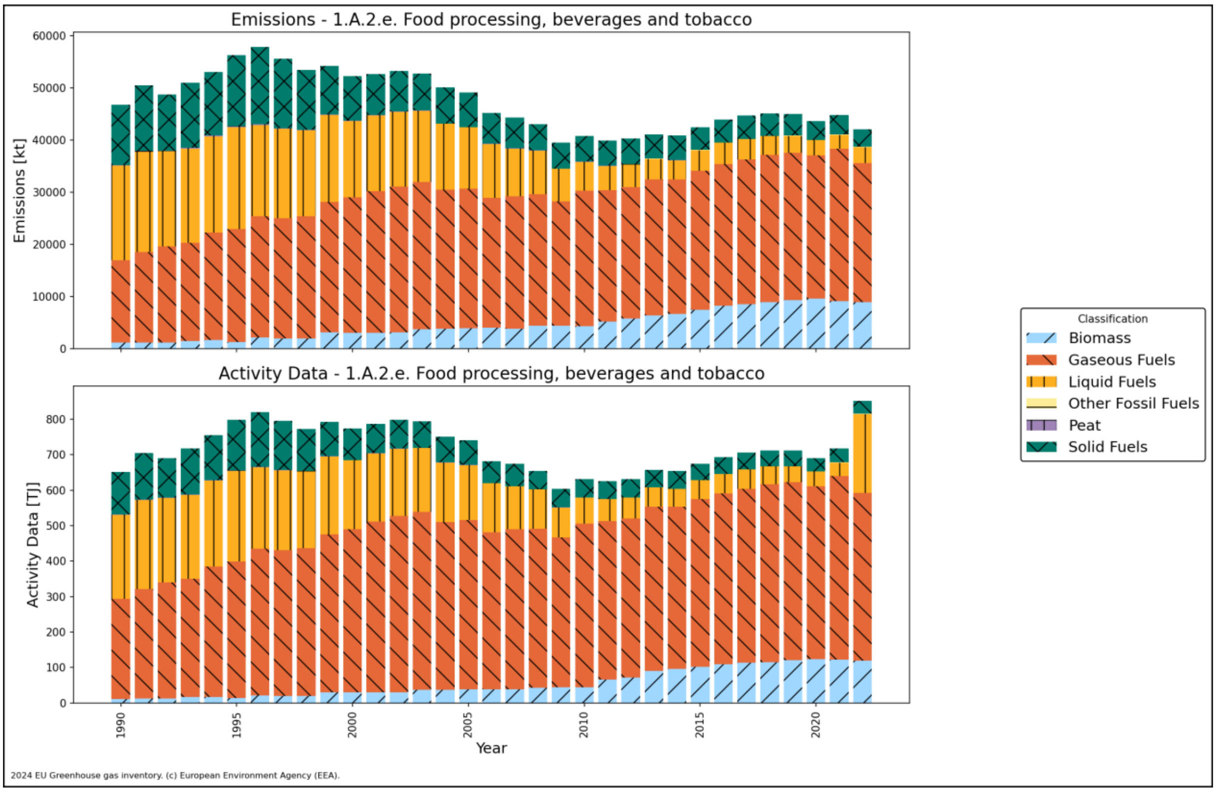
3.5.2.5 Food Processing, Beverages and Tobacco (1.A.2.e)

This chapter provides information about European emission trend, Member States 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 29 146 kt CO_2 eq. in 2022. The trend of total CO_2 emissions for 1990 to 2022 from category 1.A.2.e is depicted in Figure 3.70. Total CO_2 emissions decreased by 32 % since 1990 and decreased by 5 % between 2021 and 2022. 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 2022. The share of liquid fuels on CO_2 emissions from 1.A.2.e decreased from 39 % in 1990 to 9 % in 2022. The share of solid fuels on CO_2 emissions from 1.A.2.e decreased from 26 % in 1990 to 10 % in 2022. The share of gaseous fuels on CO_2 emissions from 1.A.2.e increased from 35 % in 1990 to 81 % in 2022.

Figure 3.62: 1.A.2.e Food Processing, Beverages and Tobacco: Total emission and activity trends



Detailed data related to the EU submissions are depicted in Table 3.37.

Table 3.45: 1.A.2.e Food Processing, Beverages and Tobacco: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	870	798	866	3.0%	-4	0%	68	9%	NA,T2	CS,NA
Belgium	3 023	2 399	2 202	7.6%	-822	-27%	-197	-8%	NA,T1,T3	D,NA,PS
Bulgaria	454	318	303	1.0%	-151	-33%	-15	-5%	NA,T1,T2	CS,D,NA
Croatia	729	242	315	1.1%	-415	-57%	73	30%	NA,T1	D,NA
Cyprus	73	64	67	0.2%	-6	-8%	3	4%	NA,T1	D,NA
Czechia	2 988	1 183	1 065	3.7%	-1 924	-64%	-118	-10%	NA,T1,T2	CS,D,NA
Denmark	1 651	890	709	2.4%	-942	-57%	-181	-20%	NA,T1,T2,T3	CS,D,NA,PS
Estonia	695	82	62	0.2%	-634	-91%	-21	-25%	NA,T1,T2	CS,D,NA
Finland	828	102	97	0.3%	-730	-88%	-5	-5%	NA,T3	CS,NA
France	8 678	8 014	7 182	24.6%	-1 496	-17%	-832	-10%	NA	NA
Germany	2 016	168	184	0.6%	-1 832	-91%	16	10%	CS,NA	CS,NA
Greece	917	611	625	2.1%	-292	-32%	13	2%	NA,T2	CS,NA
Hungary	2 279	877	806	2.8%	-1 473	-65%	-71	-8%	NA,T1,T2	CS,D,NA
Ireland	1 017	1 087	1 064	3.7%	47	5%	-23	-2%	NA,T1,T2	CS,D,NA
Italy	3 891	3 651	3 377	11.6%	-513	-13%	-273	-7%	NA,T2	CS,NA
Latvia	840	93	68	0.2%	-772	-92%	-25	-27%	NA,T2	CS,NA
Lithuania	676	236	210	0.7%	-467	-69%	-26	-11%	NA,T2	CS,NA
Luxembourg	5	15	13	0.0%	7	134%	-2	-12%	NA,T1,T2,T3	CS,D,NA
Malta	NO	12	11	0.0%	11	∞	-1	-8%	NA,T1	D,NA
Netherlands	4 009	3 528	3 300	11.3%	-709	-18%	-228	-6%	NA,T2	CS,NA
Poland	3 715	4 149	4 263	14.6%	548	15%	114	3%	NA,T1,T2	CS,D,NA
Portugal	830	702	638	2.2%	-192	-23%	-64	-9%	NA,T1	CR,D,NA
Romania	132	936	1 060	3.6%	928	705%	124	13%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	1 140	321	310	1.1%	-830	-73%	-11	-4%	NA,T2	CS,NA
Slovenia	221	95	105	0.4%	-116	-53%	10	10%	NA,T1,T2	CS,D,NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	945	264	245	0.8%	-700	-74%	-19	-7%	T2	CS
EU-27	**42 625**	**30 836**	**29 146**	**100%**	**-13 479**	**-32%**	**-1 690**	**-5%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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 3 008 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 83 % and compared to 2021 increased by 14 %. This category represents 0.8 % share of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 5 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.38.

Table 3.46: 1.A.2.e Food Processing, Beverages and Tobacco, liquid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	345	35	73	2.4%	-272	-79%	38	110%	T2	CS
Belgium	1 689	93	124	4.1%	-1 564	-93%	31	34%	T1	D
Bulgaria	409	23	29	1.0%	-380	-93%	6	28%	T1	D
Croatia	342	45	65	2.2%	-278	-81%	20	45%	T1	D
Cyprus	73	64	67	2.2%	-6	-8%	3	4%	T1	D
Czechia	472	28	29	1.0%	-443	-94%	0	2%	T1	CS,D
Denmark	786	194	226	7.5%	-560	-71%	32	16%	T2,T3	PS
Estonia	695	22	26	0.9%	-669	-96%	4	17%	T1,T2	CS,D
Finland	365	51	66	2.2%	-299	-82%	15	29%	T3	CS
France	3 156	354	356	11.8%	-2 800	-89%	2	1%	-	-
Germany	908	13	13	0.4%	-895	-99%	1	5%	CS	CS
Greece	863	457	464	15.4%	-399	-46%	7	1%	T2	CS
Hungary	810	26	29	1.0%	-781	-96%	3	11%	T1	D
Ireland	433	193	201	6.7%	-232	-54%	8	4%	T1,T2	CS,D
Italy	1 424	20	19	0.6%	-1 405	-99%	-2	-8%	T2	CS
Latvia	565	6	10	0.3%	-555	-98%	4	63%	T2	CS
Lithuania	174	32	29	0.9%	-146	-84%	-3	-11%	T2	CS
Luxembourg	2	3	3	0.1%	1	76%	0	-1%	T1,T3	CS,D
Malta	NO	12	11	0.4%	11	∞	-1	-8%	T1	D
Netherlands	165	0	0	0.0%	-165	-100%	0	-81%	-	-
Poland	232	171	372	12.4%	139	60%	201	117%	T1,T2	CS,D
Portugal	829	151	176	5.8%	-653	-79%	25	17%	T1	CR,D
Romania	NO	119	114	3.8%	114	∞	-5	-4%	T1,T2,T3	CS,D,PS
Slovakia	359	1	1	0.0%	-358	-100%	0	32%	T2	CS
Slovenia	146	17	22	0.7%	-123	-85%	6	34%	T1	D
Spain	2 227	413	383	12.7%	-1 844	-83%	-30	-7%	T1	D
Sweden	596	92	102	3.4%	-494	-83%	11	12%	T2	CS
EU-27	**18 064**	**2 634**	**3 008**	**100%**	**-15 056**	**-83%**	**375**	**14%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.

Figure 3.63: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Emission trend and share for CO_2

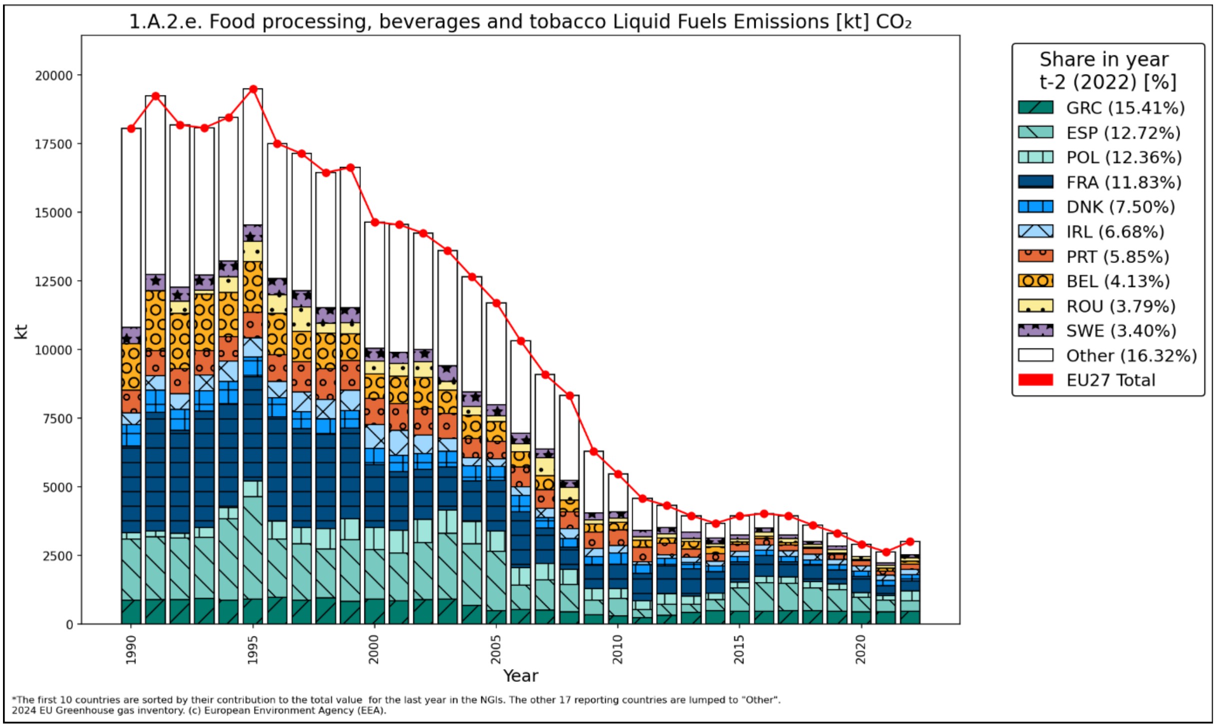
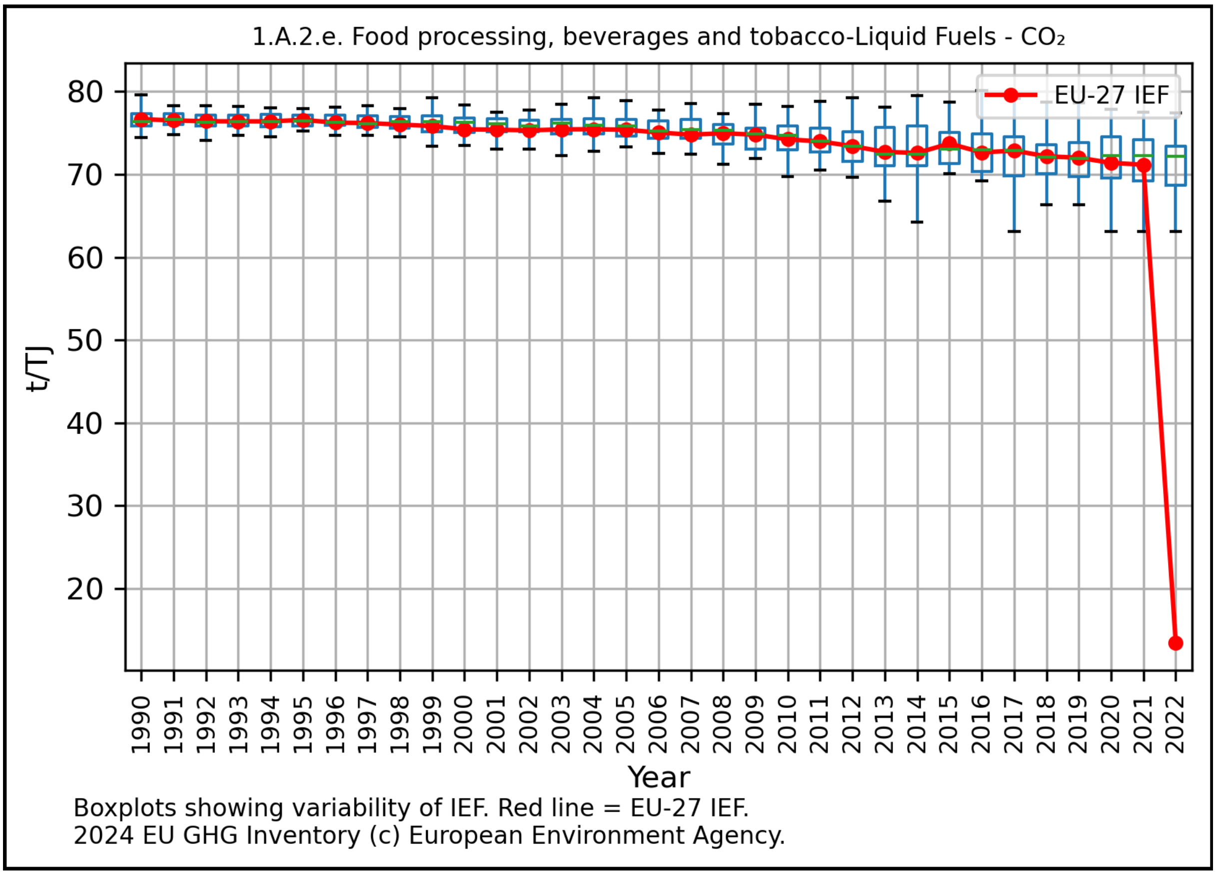


Figure 3.72 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. It can be seen that whole time series CO_2 IEF has decreasing trend with minor fluctuation between 2014 and 2018. CO_2 IEF equalled to 13.47 t/TJ in 2022 which is very low due to the mistake in Romania´s CRT.

Figure 3.64: 1.A.2.e Food Processing, Beverages and Tobacco, Liquid fuels: Implied Emission Factors for CO_2 (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 3 386 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 71 % and compared to 2021 decreased by 9 %. This category represents 0.9 % of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 71 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.39.

Table 3.47: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	18	13	17	0.5%	-1	-7%	3	25%	T2	CS
Belgium	651	42	42	1.2%	-609	-94%	0	-1%	T1	D
Bulgaria	33	4	5	0.2%	-27	-84%	1	32%	T1,T2	CS,D
Croatia	207	6	8	0.2%	-199	-96%	2	38%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 789	310	365	10.8%	-1 424	-80%	55	18%	T2	CS,D
Denmark	399	122	92	2.7%	-307	-77%	-30	-24%	T1,T2,T3	D,PS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	257	19	18	0.5%	-238	-93%	-1	-6%	T3	CS
France	2 077	918	578	17.1%	-1 499	-72%	-340	-37%	-	-
Germany	1 108	155	171	5.0%	-937	-85%	15	10%	CS	CS
Greece	54	NO	NO	-	-54	-100%	-	-	NA	NA
Hungary	241	6	3	0.1%	-238	-99%	-3	-51%	T1,T2	CS,D
Ireland	292	NO	NO	-	-292	-100%	-	-	NA	NA
Italy	87	5	NO	-	-87	-100%	-5	-100%	NA	NA
Latvia	100	1	1	0.0%	-99	-99%	0	-18%	T2	CS
Lithuania	33	8	6	0.2%	-28	-83%	-2	-27%	T2	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	227	80	40	1.2%	-187	-82%	-39	-49%	T2	CS
Poland	3 374	1 998	1 999	59.0%	-1 375	-41%	0	0%	T1,T2	CS,D
Portugal	1	NO	NO	-	-1	-100%	-	-	NA	D
Romania	132	5	4	0.1%	-128	-97%	-1	-22%	T2,T3	CS,PS
Slovakia	312	9	4	0.1%	-308	-99%	-4	-51%	T2	CS
Slovenia	9	NO	NO	-	-9	-100%	-	-	NA	NA
Spain	90	21	20	0.6%	-70	-78%	-1	-4%	T1,T2	CS,D
Sweden	91	13	12	0.4%	-78	-86%	0	-3%	T2	CS
EU-27	**11 581**	**3 735**	**3 386**	**100%**	**-8 195**	**-71%**	**-349**	**-9%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period 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.

Figure 3.65: 1.A.2.e Food Processing, Beverages and Tobacco, solid fuels: Emission trend and share for CO_2

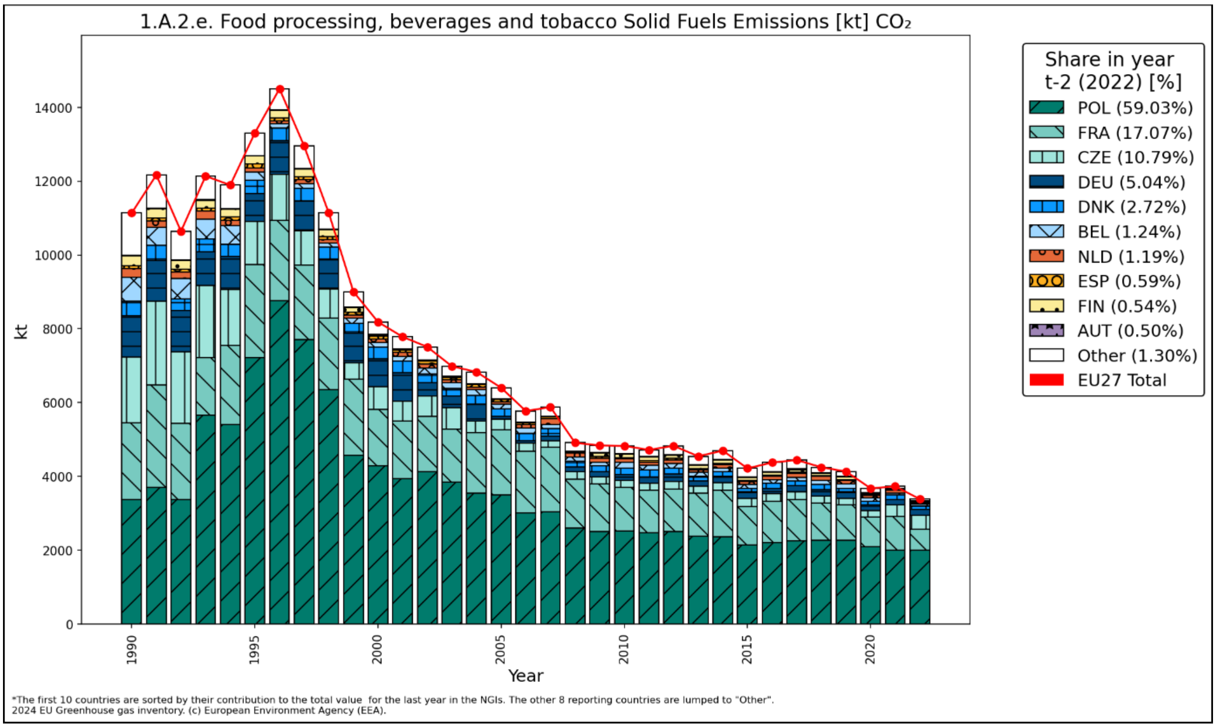
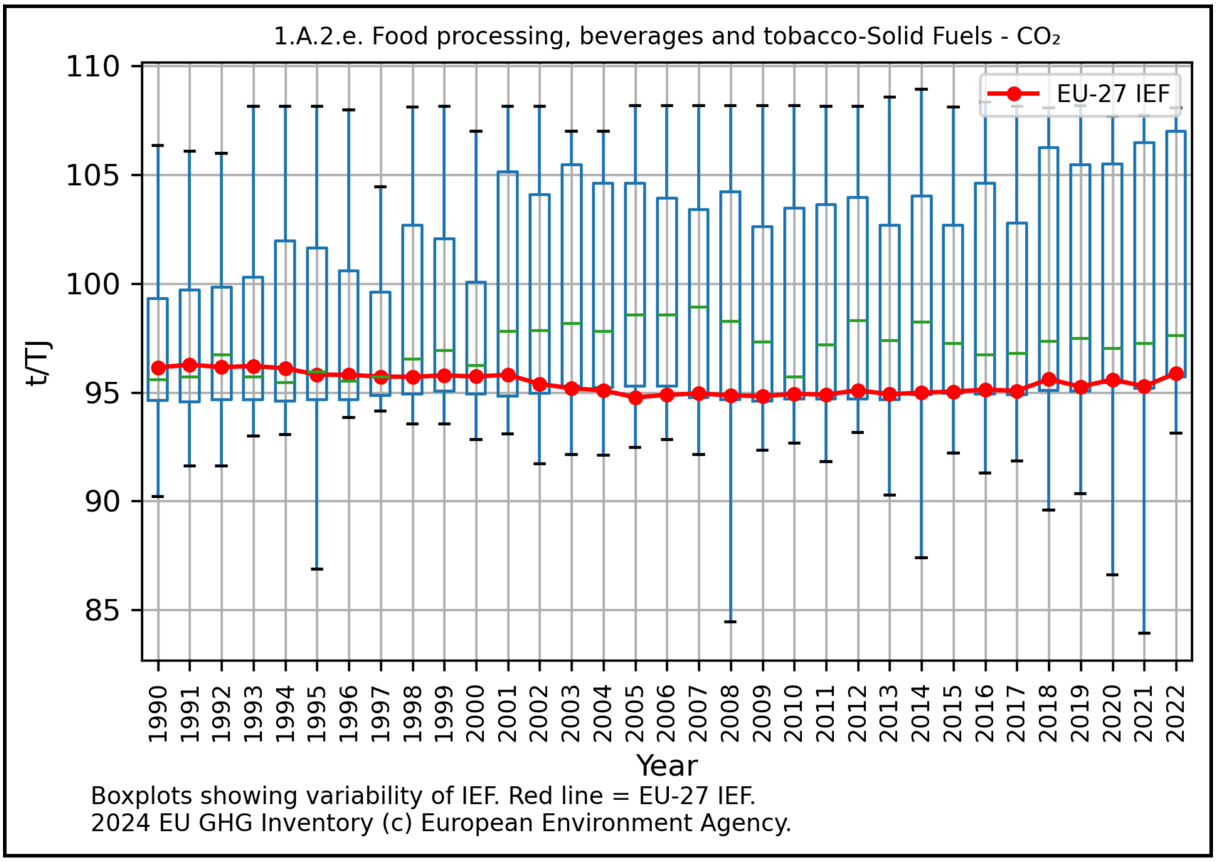


Figure 3.75 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. It can be seen that CO_2 IEF is relatively stable during whole period with slightly increasing trend since 2006. CO_2 IEF equalled to 95.88 t/TJ in 2022.

Figure 3.66: 1.A.2.e Food Processing, Beverages and Tobacco, Solid fuels: Implied Emission Factors for CO_2 (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 26 637 kt in 2022 for EU. CO_2 emissions increased compared to year 1990 by 68 % and decreased by 9 % compared to 2021. This category represents 7 % of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 71 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.40.

Table 3.48: 1.A.2.e Food Processing, Beverages and Tobacco, gaseous fuels: Member States contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	507	750	776	2.9%	269	53%	26	4%	T2	CS
Belgium	684	2 264	2 036	7.6%	1 351	198%	-228	-10%	T1,T3	D,PS
Bulgaria	11	291	268	1.0%	257	2247%	-23	-8%	T2	CS
Croatia	180	191	242	0.9%	61	34%	50	26%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	727	845	671	2.5%	-57	-8%	-174	-21%	T2	CS
Denmark	466	574	391	1.5%	-74	-16%	-183	-32%	T3	CS
Estonia	NO	60	36	0.1%	36	∞	-24	-41%	T2	CS
Finland	67	31	13	0.0%	-54	-80%	-18	-58%	T3	CS
France	3 446	6 684	6 208	23.3%	2 762	80%	-476	-7%	-	-
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	154	161	0.6%	161	∞	7	4%	T2	CS
Hungary	1 228	844	774	2.9%	-455	-37%	-71	-8%	T2	CS
Ireland	293	894	864	3.2%	570	195%	-31	-3%	T2	CS
Italy	2 380	3 626	3 359	12.6%	979	41%	-267	-7%	T2	CS
Latvia	175	86	57	0.2%	-118	-67%	-29	-34%	T2	CS
Lithuania	469	196	175	0.7%	-293	-63%	-20	-10%	T2	CS
Luxembourg	4	12	10	0.0%	6	159%	-2	-15%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	3 617	3 448	3 260	12.2%	-357	-10%	-188	-5%	T2	CS
Poland	109	1 980	1 893	7.1%	1 784	1637%	-87	-4%	T2	CS
Portugal	NO	551	462	1.7%	462	∞	-89	-16%	T1	D
Romania	NO	786	895	3.4%	895	∞	109	14%	T2,T3	CS,PS
Slovakia	470	312	305	1.1%	-165	-35%	-7	-2%	T2	CS
Slovenia	66	78	83	0.3%	17	25%	4	5%	T2	CS
Spain	660	4 387	3 570	13.4%	2 910	441%	-817	-19%	T2	CS
Sweden	254	159	130	0.5%	-124	-49%	-29	-18%	T2	CS
EU-27	**15 813**	**29 203**	**26 637**	**100%**	**10 824**	**68%**	**-2 566**	**-9%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.

Figure 3.67: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Emission trend and share for CO_2

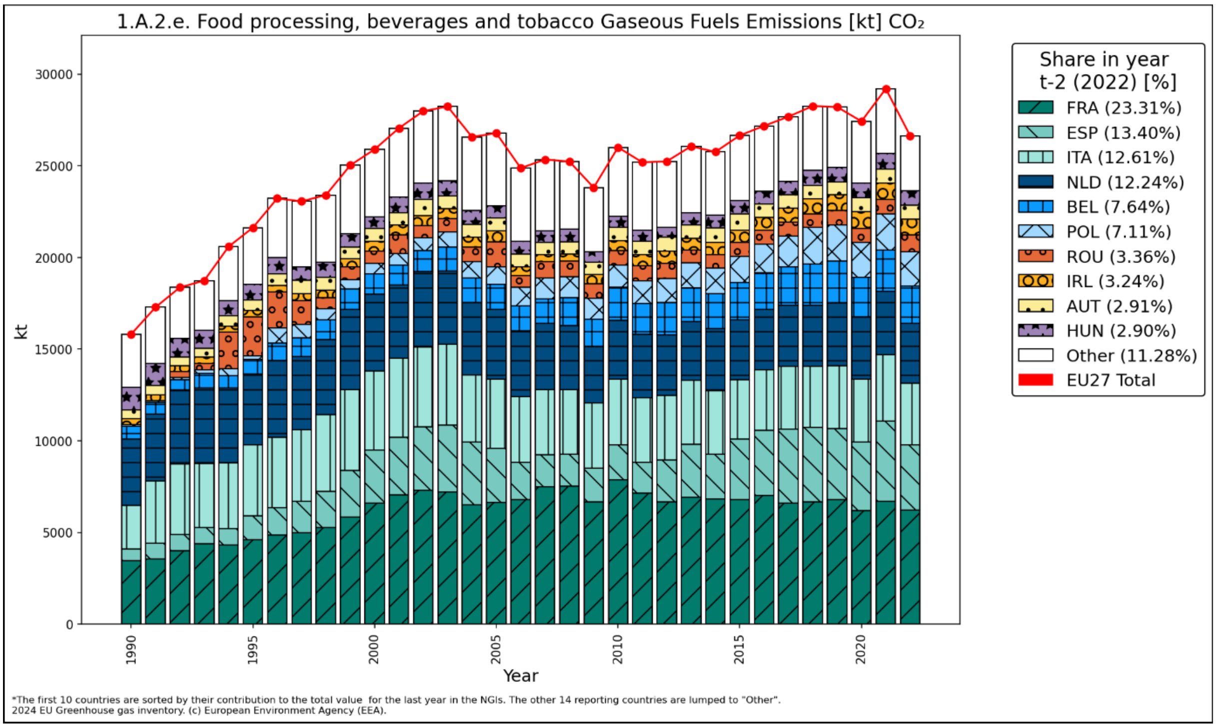
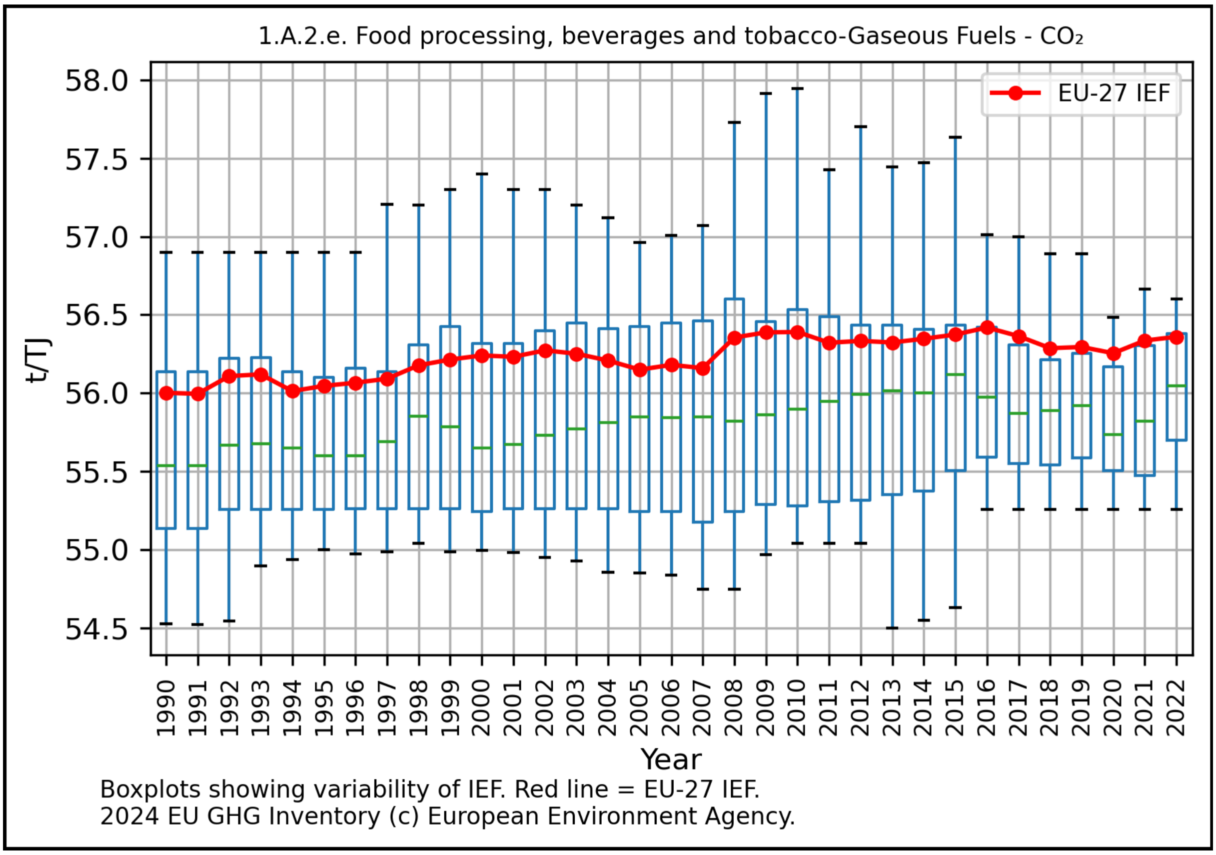


Figure 3.78 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022 which is stable with slightly increasing trend during whole time period. CO_2 IEF equalled to 56.41 t/TJ in 2022.

Figure 3.68: 1.A.2.e Food Processing, Beverages and Tobacco, Gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



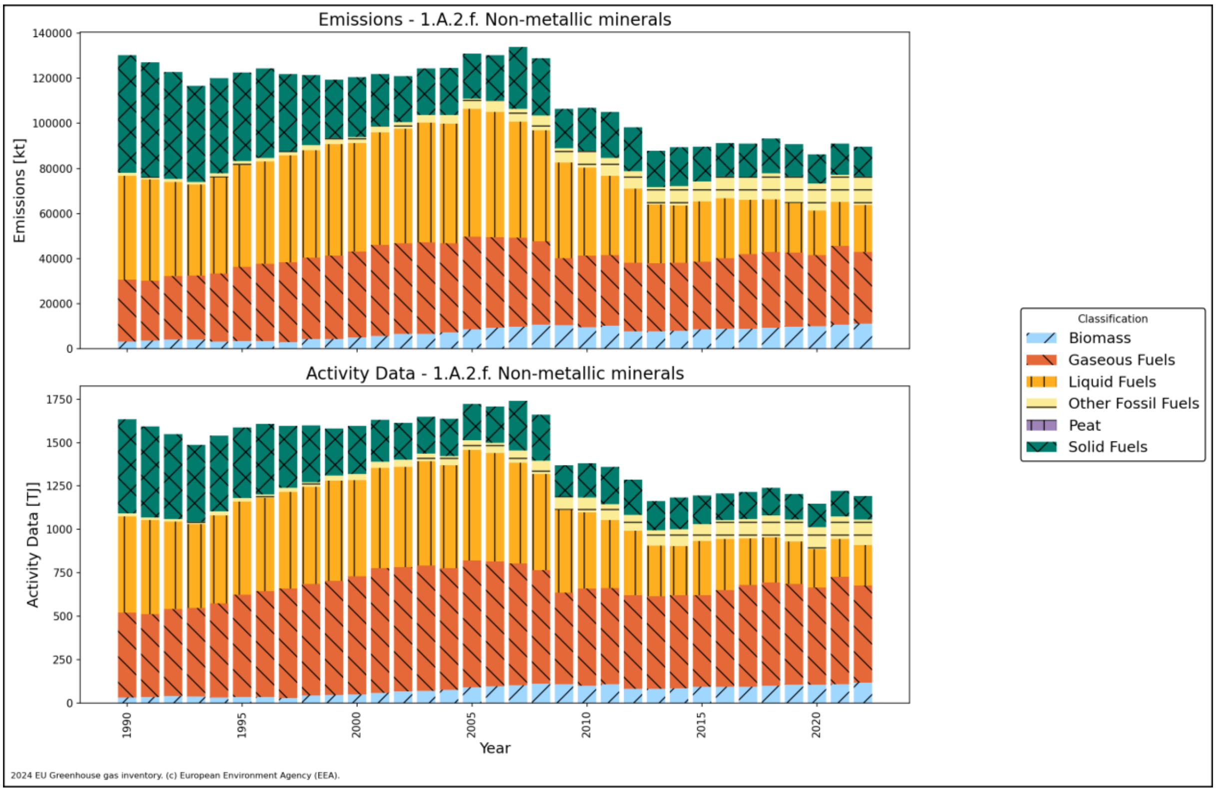
3.5.2.6 Non-metallic Minerals (1.A.2.f)

This chapter provides information about European emission trend, Member States 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 69 478 kt CO_2 eq. in 2022. The trend of total emissions for 1990 to 2022 from category 1.A.2.f is depicted in Figure 3.80. Total CO_2 emissions decreased by 37 % since 1990 and decreased by 3 % between 2021 and 2022. 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 21 % 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 2022. The share of liquid fuels on CO_2 emissions from 1.A.2.f decreased from 36 % in 1990 to 26 % in 2022. The share of solid fuels on CO_2 emissions from 1.A.2.f decreased from 41 % in 1990 to 17 % in 2022. The share of gaseous fuels on CO_2 emissions from 1.A.2.f increased from 22 % in 1990 to 40 % in 2022.

Figure 3.69: 1.A.2.f Non-metallic Minerals: Activity data and total emission trends



Detailed data related to the EU submissions are depicted in Table.3.41.

Table.3.49: 1.A.2.f Non-metallic Minerals: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 669	1 682	1 579	2.3%	-91	-5%	-103	-6%	NA,T2	CS,NA
Belgium	5 525	3 237	2 992	4.3%	-2 533	-46%	-245	-8%	NA,T1,T3	D,NA,PS
Bulgaria	2 646	1 069	1 050	1.5%	-1 596	-60%	-19	-2%	NA,T1,T2	CS,D,NA
Croatia	1 924	1 362	1 313	1.9%	-611	-32%	-49	-4%	NA,T1	D,NA
Cyprus	380	426	410	0.6%	31	8%	-15	-4%	CS,NA,T1	CS,D,NA
Czechia	4 527	2 760	2 433	3.5%	-2 094	-46%	-327	-12%	NA,T1,T2	CS,D,NA
Denmark	1 346	1 486	1 391	2.0%	45	3%	-95	-6%	NA,T2,T3	CS,NA,PS
Estonia	1 053	39	39	0.1%	-1 014	-96%	0	0%	NA,T1,T2,T3	CS,D,NA,PS
Finland	1 368	584	570	0.8%	-799	-58%	-15	-3%	NA,T3	CS,NA
France	15 106	9 936	9 429	13.6%	-5 677	-38%	-507	-5%	NA	NA
Germany	18 507	13 168	13 154	18.9%	-5 354	-29%	-14	0%	CS,NA	CS,NA
Greece	6 278	2 647	2 789	4.0%	-3 489	-56%	143	5%	NA,T2	CS,NA,PS
Hungary	2 471	1 054	916	1.3%	-1 555	-63%	-138	-13%	NA,T1,T2,T3	CS,D,NA,PS
Ireland	819	1 238	1 139	1.6%	320	39%	-99	-8%	NA,T1,T2,T3	CS,D,NA,PS
Italy	21 045	11 017	11 389	16.4%	-9 657	-46%	372	3%	NA,T2	CS,NA
Latvia	599	264	245	0.4%	-354	-59%	-19	-7%	NA,T2	CS,NA,PS
Lithuania	3 210	484	489	0.7%	-2 721	-85%	5	1%	NA,T2	CS,NA,OTH
Luxembourg	537	337	260	0.4%	-277	-52%	-77	-23%	NA,T1,T2,T3	CS,D,NA,PS
Malta	NO	18	20	0.0%	20	∞	2	13%	NA,T1	D,NA
Netherlands	2 298	1 203	1 151	1.7%	-1 146	-50%	-51	-4%	NA,T2	CS,NA
Poland	10 340	9 201	8 796	12.7%	-1 544	-15%	-405	-4%	NA,T1,T2	CS,D,NA
Portugal	3 289	2 490	2 468	3.6%	-822	-25%	-23	-1%	NO,T1,T3	D,NO,PS
Romania	285	3 937	3 336	4.8%	3 051	1071%	-601	-15%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	3 408	1 424	1 310	1.9%	-2 098	-62%	-114	-8%	NA,T2	CS,NA
Slovenia	297	456	438	0.6%	141	48%	-17	-4%	NA,T1,T2,T3	CS,D,NA,PS
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	1 832	256	372	0.5%	-1 460	-80%	116	45%	T1,T2	CS
EU-27	**110 759**	**71 774**	**69 478**	**100%**	**-41 281**	**-37%**	**-2 296**	**-3%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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 20 924 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 55 % and compared to 2020 increased by 6 %. Category has 5.3% 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 submissions are depicted in Table 3.42.

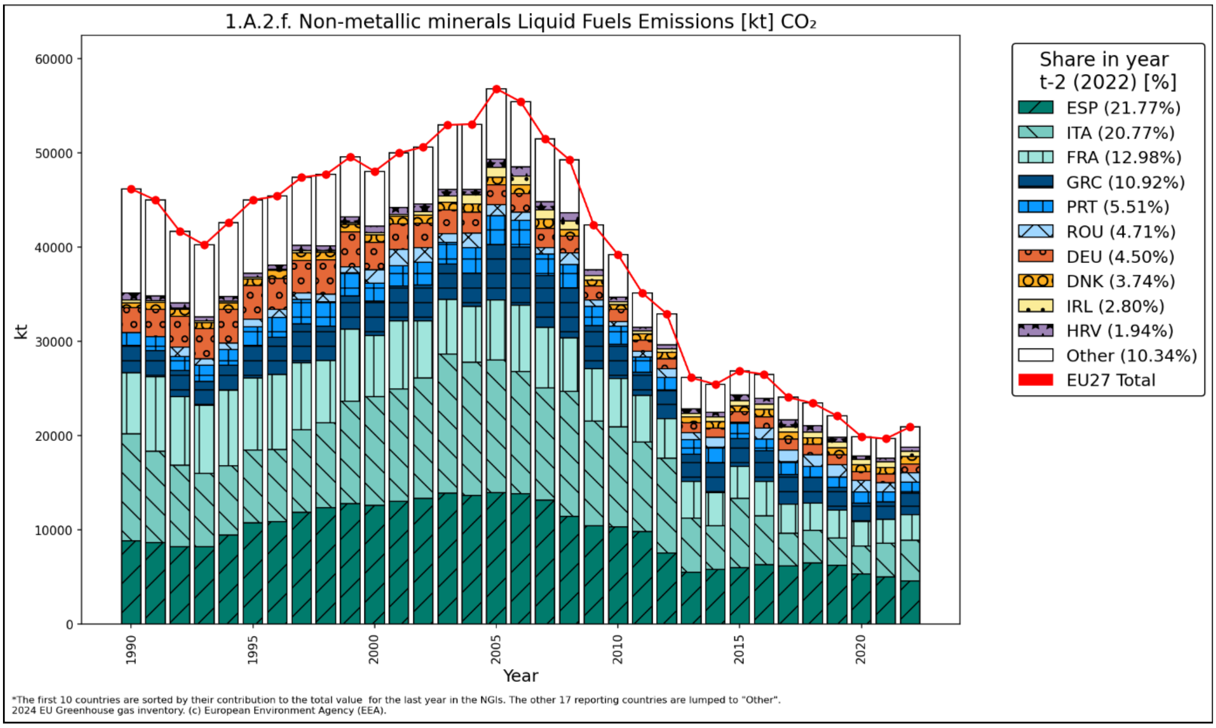
Table 3.50: 1.A.2.f Non-metallic Minerals , liquid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	508	147	160	0.8%	-348	-68%	13	9%	T2	CS
Belgium	1 509	295	278	1.3%	-1 231	-82%	-17	-6%	T1,T3	D,PS
Bulgaria	666	97	182	0.9%	-485	-73%	85	87%	T1	D
Croatia	745	352	407	1.9%	-338	-45%	55	15%	T1	D
Cyprus	148	98	98	0.5%	-50	-34%	0	0%	CS	CS
Czechia	1 029	40	25	0.1%	-1 004	-98%	-15	-37%	T1	CS,D
Denmark	535	712	784	3.7%	248	46%	71	10%	T2,T3	PS
Estonia	448	0	0	0.0%	-448	-100%	0	66%	T1,T2	CS,D
Finland	437	268	255	1.2%	-182	-42%	-13	-5%	T3	CS
France	6 508	2 503	2 716	13.0%	-3 792	-58%	213	9%	-	-
Germany	2 663	880	942	4.5%	-1 721	-65%	61	7%	CS	CS
Greece	2 914	1 859	2 286	10.9%	-628	-22%	427	23%	T2	PS
Hungary	463	164	142	0.7%	-321	-69%	-22	-14%	T1,T2	CS,D
Ireland	312	631	585	2.8%	273	88%	-46	-7%	T1,T2	CS,D
Italy	11 359	3 577	4 346	20.8%	-7 013	-62%	769	22%	T2	CS
Latvia	267	0	2	0.0%	-265	-99%	2	3100%	T2	CS
Lithuania	2 750	12	19	0.1%	-2 731	-99%	7	56%	T2	CS
Luxembourg	23	4	7	0.0%	-16	-69%	3	93%	T2	CS
Malta	NO	18	20	0.1%	20	∞	2	13%	T1	D
Netherlands	468	0	0	0.0%	-468	-100%	0	-20%	T2	CS
Poland	394	245	346	1.7%	-49	-12%	101	41%	T1,T2	CS,D
Portugal	1 319	1 040	1 154	5.5%	-165	-13%	114	11%	T1,T3	D,PS
Romania	NO	1 028	986	4.7%	986	∞	-43	-4%	T1,T2,T3	CS,D,PS
Slovakia	1 219	272	226	1.1%	-993	-81%	-45	-17%	T2	CS
Slovenia	63	142	140	0.7%	77	122%	-2	-1%	T1	D
Spain	8 805	5 027	4 555	21.8%	-4 250	-48%	-473	-9%	T1,T2	CS,D
Sweden	625	256	263	1.3%	-363	-58%	6	2%	T1	CS
EU-27	**46 178**	**19 669**	**20 924**	**100%**	**-25 255**	**-55%**	**1 255**	**6%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.

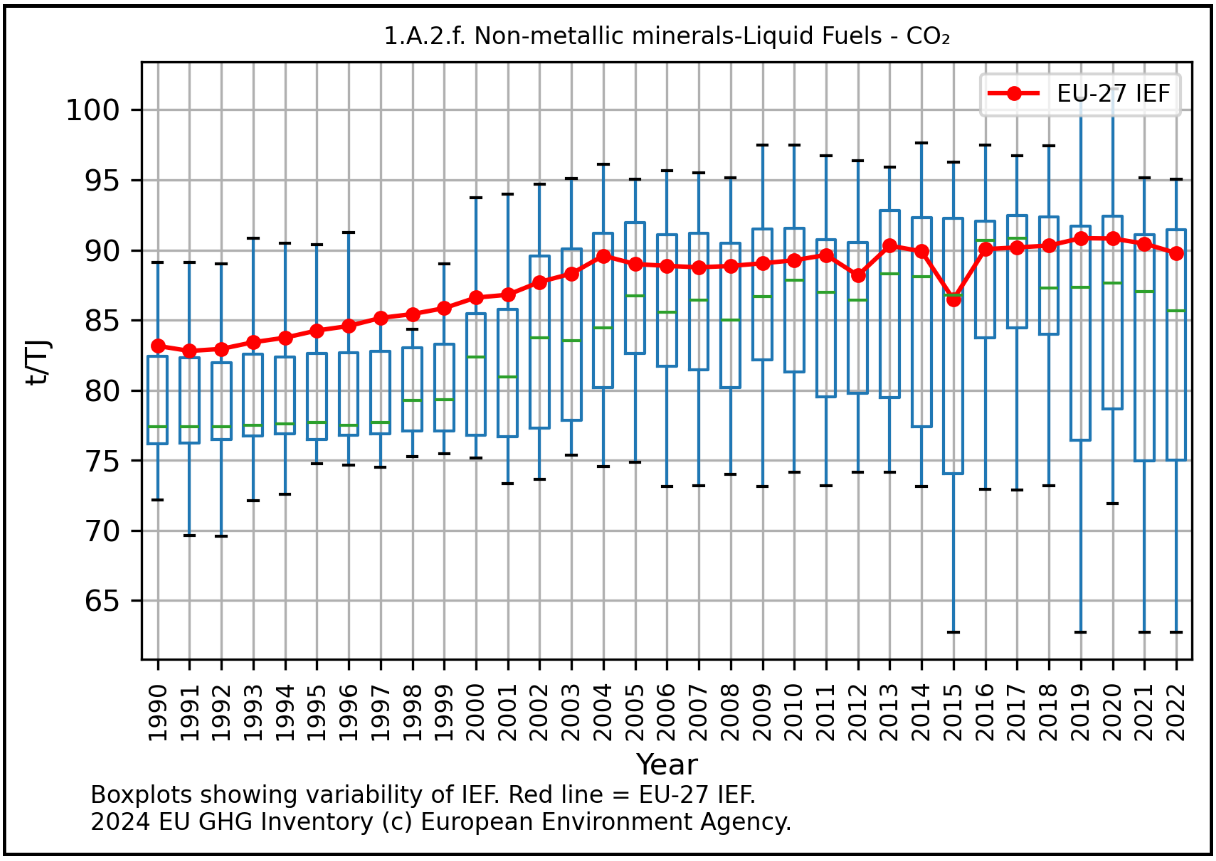
Figure.3.70: 1.A.2.f Non-metallic Minerals, liquid fuels: Emission trend and share for CO_2



Note: This figure does include Sweden.

Figure.3.82 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. CO_2 IEF equalled to 90.08 t/TJ in 2022.

Figure.3.71: 1.A.2.f Non-metallic Minerals, liquid fuels: Implied Emission Factors for CO_2 (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 13 664 kt in 2022 for EU. CO_2 emissions decreased compared to year 1990 by 74 % and compared to 2021 decreased by 8 %. This category represents 3.5 % of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption decreased by 74 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.43.

Table 3.51: 1.A.2.f Non-metallic Minerals, solid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	535	253	209	1.5%	-326	-61%	-44	-17%	T2	CS
Belgium	2 466	1 271	1 080	7.9%	-1 387	-56%	-191	-15%	T1,T3	D,PS
Bulgaria	295	244	239	1.7%	-56	-19%	-5	-2%	T1,T2	CS,D
Croatia	535	419	305	2.2%	-230	-43%	-114	-27%	T1	D
Cyprus	232	159	123	0.9%	-109	-47%	-36	-23%	CS	CS
Czechia	2 209	623	662	4.8%	-1 546	-70%	40	6%	T2	CS,D
Denmark	574	383	280	2.1%	-294	-51%	-102	-27%	T2,T3	PS
Estonia	595	NO	6	0.0%	-589	-99%	6	∞	NA	NA
Finland	806	204	196	1.4%	-610	-76%	-8	-4%	T3	CS
France	4 826	1 089	742	5.4%	-4 083	-85%	-347	-32%	-	-
Germany	12 053	4 490	5 129	37.5%	-6 924	-57%	639	14%	CS	CS
Greece	3 364	357	146	1.1%	-3 218	-96%	-211	-59%	T2	PS
Hungary	350	43	48	0.4%	-302	-86%	5	11%	T1,T2	D,PS
Ireland	375	354	281	2.1%	-94	-25%	-73	-21%	T2	CS
Italy	3 690	267	251	1.8%	-3 439	-93%	-16	-6%	T2	CS
Latvia	16	48	32	0.2%	16	101%	-16	-33%	T2	CS
Lithuania	60	413	425	3.1%	365	613%	12	3%	T2	CS
Luxembourg	312	139	146	1.1%	-167	-53%	6	4%	T1	D
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	346	116	110	0.8%	-236	-68%	-6	-5%	T2	CS
Poland	8 576	2 069	1 657	12.1%	-6 919	-81%	-412	-20%	T1,T2	CS,D
Portugal	1 958	33	2	0.0%	-1 956	-100%	-31	-95%	T1,T3	D,PS
Romania	285	1 065	810	5.9%	525	184%	-256	-24%	T2,T3	CS,PS
Slovakia	1 474	460	417	3.1%	-1 057	-72%	-43	-9%	T2	CS
Slovenia	113	51	48	0.4%	-65	-58%	-3	-5%	T1,T3	D,PS
Spain	5 221	292	319	2.3%	-4 902	-94%	27	9%	T1,T2	CS,D
Sweden	1 142	C	C	-	-1 142	-100%	-	-	T2	CS
EU-27	**52 408**	**14 843**	**13 664**	**100%**	**-38 744**	**-74%**	**-1 179**	**-8%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2021 and 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 EU sums do include emission from Sweden.
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.

Figure 3.72: 1.A.2.f Non-metallic Minerals, solid fuels: Emission trend and share for CO_2

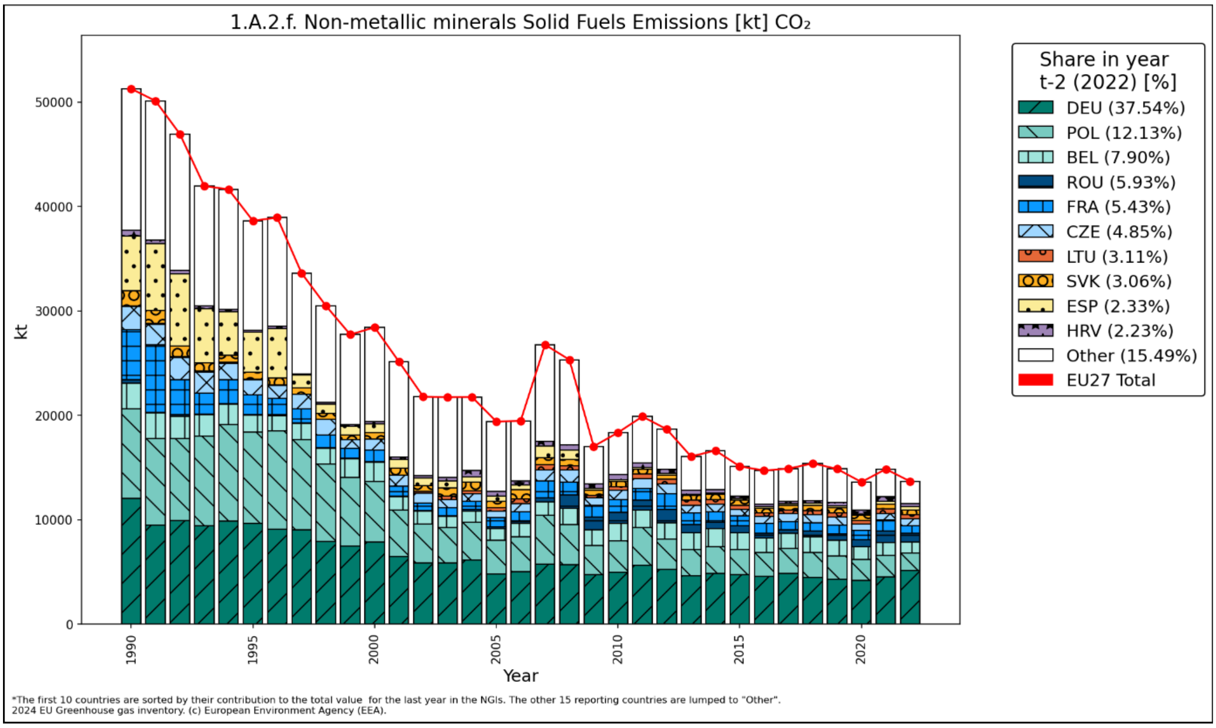
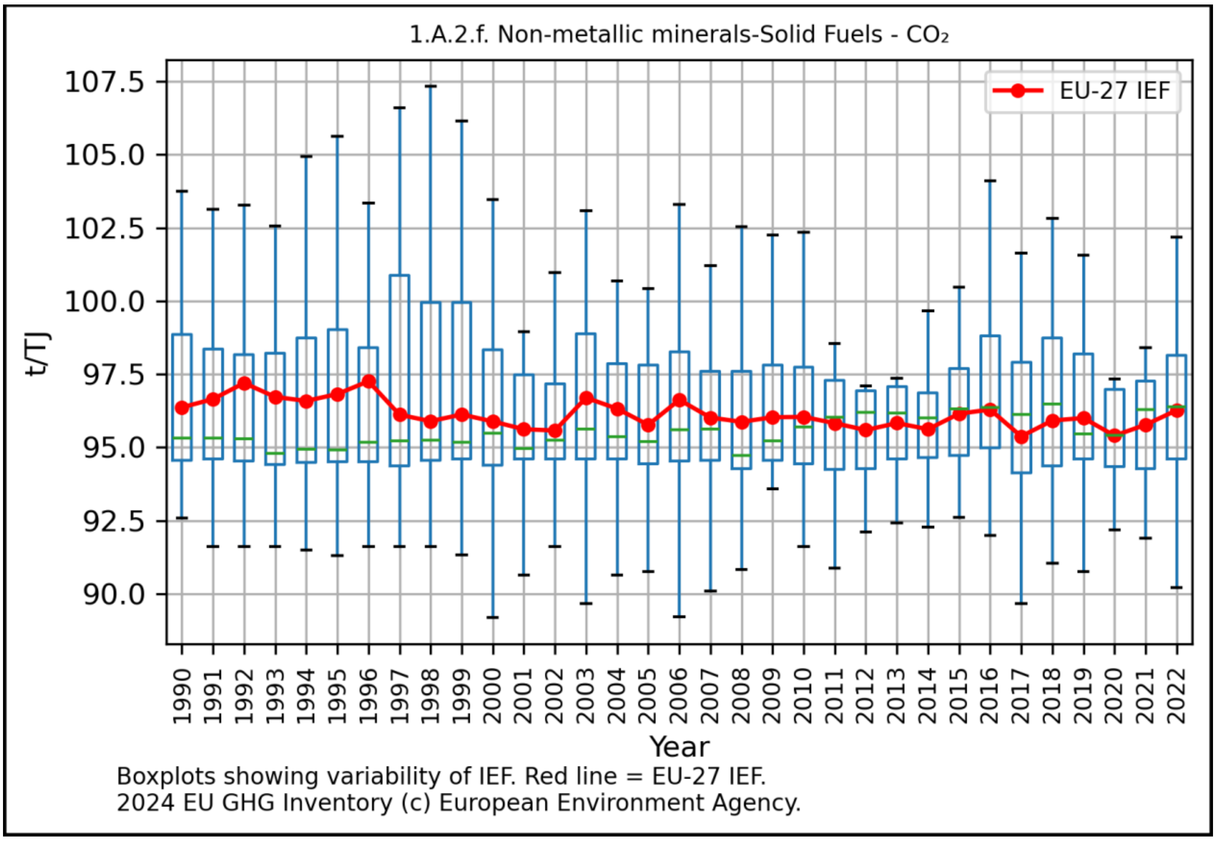


Figure 3.85 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. The IEF has slightly decreasing trend with minor fluctuations. CO_2 IEF equalled to 96.27 t/TJ in 2022.

Figure 3.73: 1.A.2.f Non-metallic Minerals, solid fuels: Implied Emission Factors for CO_2 (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 31 631 kt in 2022 for EU. CO_2 emissions increased compared to year 1990 by 16 % and compared to 2020 decreased by 9 %. This category represents 8.1 % of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 15 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.44.

Table 3.52: 1.A.2.f Non-metallic Minerals, gaseous fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	559	665	593	1.9%	34	6%	-72	-11%	T2	CS
Belgium	1 364	1 285	1 269	4.0%	-95	-7%	-16	-1%	T1,T3	D,PS
Bulgaria	1 684	728	629	2.0%	-1 055	-63%	-99	-14%	T2	CS
Croatia	645	323	326	1.0%	-319	-49%	3	1%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	1 289	1 518	1 202	3.8%	-87	-7%	-316	-21%	T2	CS
Denmark	237	234	196	0.6%	-41	-17%	-37	-16%	T3	CS
Estonia	NO	34	22	0.1%	22	∞	-11	-33%	T2	CS
Finland	126	62	60	0.2%	-66	-52%	-2	-3%	T3	CS
France	3 433	5 202	4 836	15.3%	1 403	41%	-366	-7%	-	-
Germany	3 265	4 642	4 087	12.9%	822	25%	-555	-12%	CS	CS
Greece	NO	180	152	0.5%	152	∞	-28	-16%	T2	CS
Hungary	1 658	471	426	1.3%	-1 232	-74%	-45	-10%	T2	CS
Ireland	132	57	56	0.2%	-77	-58%	-1	-2%	T2	CS
Italy	5 996	6 765	6 388	20.2%	392	7%	-377	-6%	T2	CS
Latvia	316	74	59	0.2%	-257	-81%	-15	-20%	T2	CS
Lithuania	382	52	38	0.1%	-345	-90%	-14	-27%	T2	CS
Luxembourg	201	94	13	0.0%	-188	-93%	-81	-86%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	1 484	1 086	1 041	3.3%	-442	-30%	-45	-4%	T2	CS
Poland	1 359	2 874	2 539	8.0%	1 179	87%	-335	-12%	T2	CS
Portugal	0	1 116	1 021	3.2%	1 021	8283107%	-95	-9%	T1,T3	D,PS
Romania	NO	804	548	1.7%	548	∞	-255	-32%	T2,T3	CS,PS
Slovakia	542	385	378	1.2%	-164	-30%	-8	-2%	T2	CS
Slovenia	116	166	153	0.5%	37	32%	-13	-8%	T2	CS
Spain	2 411	6 072	5 490	17.4%	3 079	128%	-582	-10%	T2	CS
Sweden	65	C	109	0.3%	44	68%	109	∞	T1	CS
EU-27	**27 265**	**34 888**	**31 631**	**100%**	**4 367**	**16%**	**-3 257**	**-9%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2021 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 and 2022 EU sums do include emission from Sweden.

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.

Figure 3.74: 1.A.2.f Non-metallic Minerals, gaseous fuels: Emission trend and share for CO_2

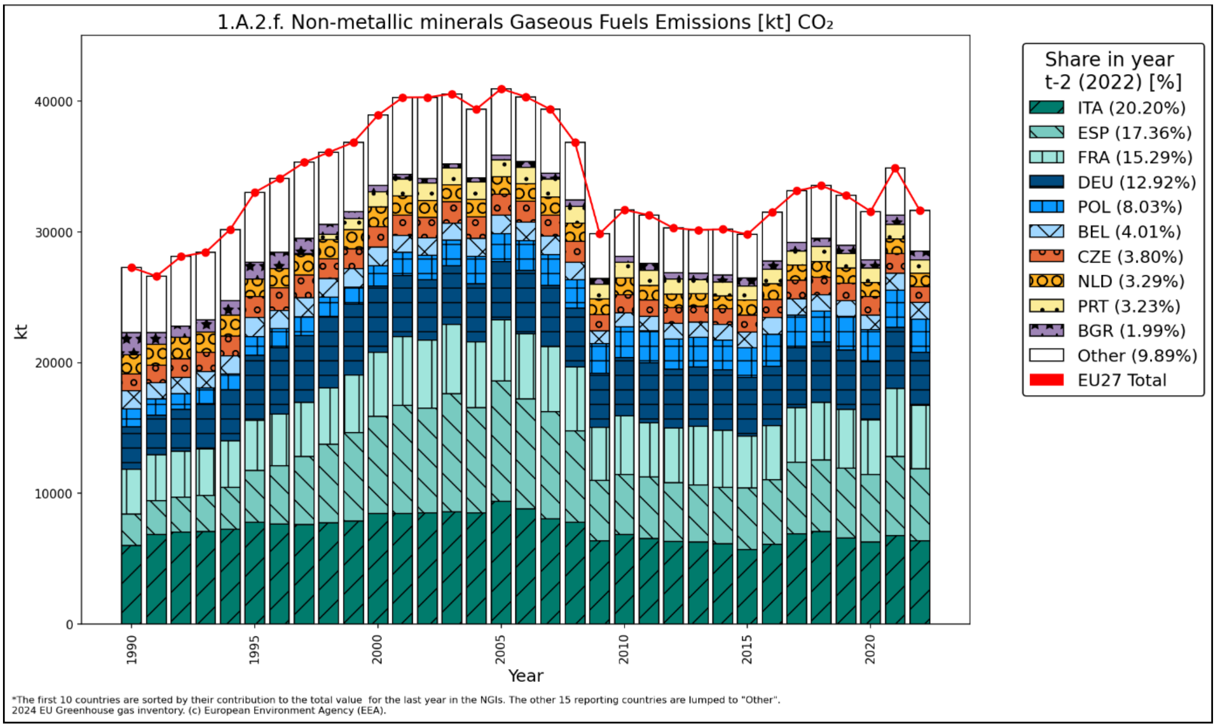
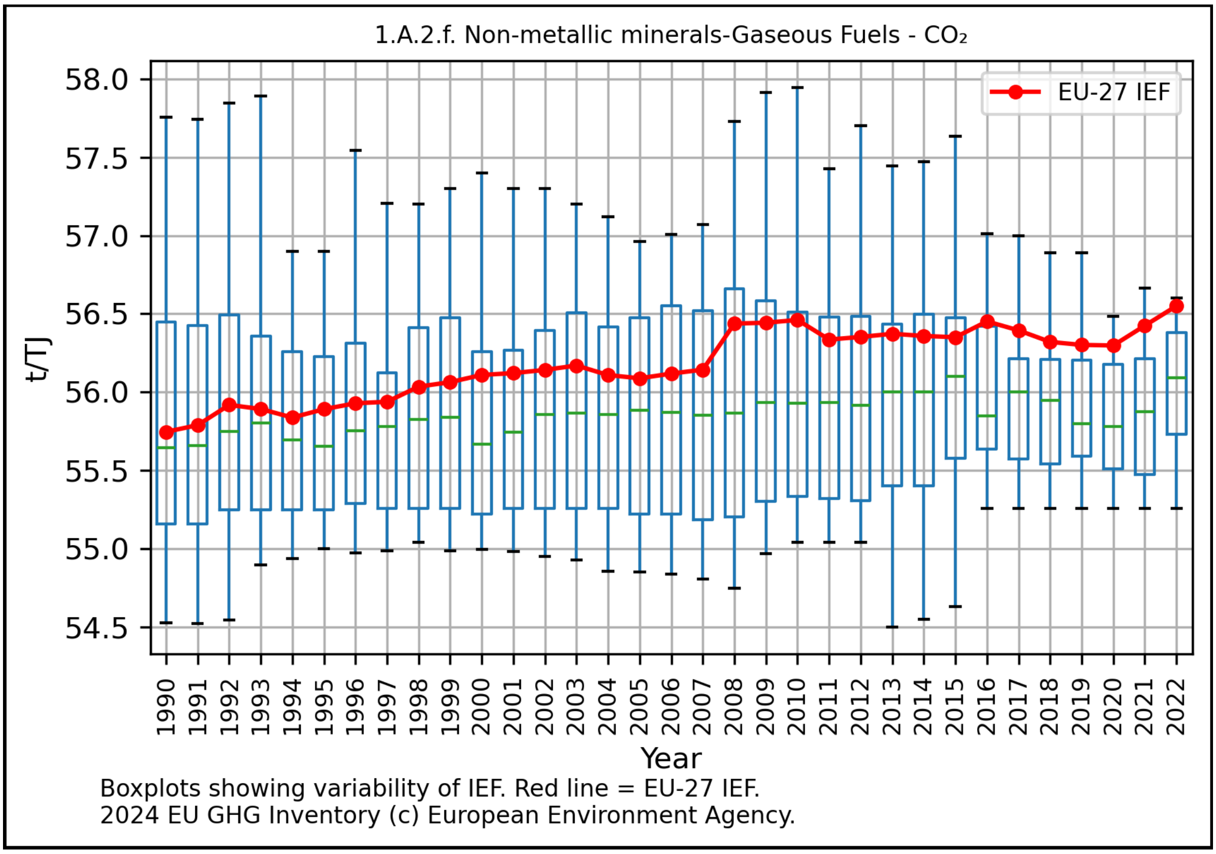


Figure 3.88 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. CO_2 IEF is stable during whole time period with slightly increasing trend. CO_2 IEF equalled to 56.56 t/TJ in 2022.

Figure 3.75: 1.A.2.f Non-metallic Minerals, gaseous fuels: Implied Emission Factors for CO_2 (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 14 298 kt in 2022 for EU. CO_2 emissions increased compared to year 1990 by 894 % and decreased by 1% compared to 2021. This category represents 3.6 % of total CO_2 equivalent emissions from category 1.A.2. Fuel consumption increased by 884 % compared to 1990.

Detailed data related to the EU submissions are depicted in Table 3.45.

Table 3.53: 1.A.2.f Non-metallic Minerals, other fossil fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	67	616	616	4.3%	549	816%	0	0%	T2	CS
Belgium	186	386	366	2.6%	179	96%	-20	-5%	T1,T3	D,PS
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	268	276	1.9%	276	∞	8	3%	T1	D
Cyprus	NO	169	190	1.3%	190	∞	21	12%	T1	D
Czechia	NO	580	543	3.8%	543	∞	-37	-6%	T2	CS
Denmark	NO	158	131	0.9%	131	∞	-27	-17%	T3	PS
Estonia	NO	5	6	0.0%	6	∞	1	13%	T3	PS
Finland	NO	50	59	0.4%	59	∞	8	16%	T3	CS
France	340	1 142	1 135	7.9%	795	234%	-7	-1%	-	-
Germany	526	3 156	2 996	21.0%	2 470	470%	-160	-5%	CS	CS
Greece	NO	251	205	1.4%	205	∞	-45	-18%	T2	PS
Hungary	NO	376	300	2.1%	300	∞	-76	-20%	T3	PS
Ireland	NO	196	218	1.5%	218	∞	21	11%	T3	PS
Italy	NO	408	403	2.8%	403	∞	-5	-1%	T2	CS
Latvia	NO	141	151	1.1%	151	∞	10	7%	T2	PS
Lithuania	NO	7	7	0.1%	7	∞	0	-1%	T2	OTH
Luxembourg	NO	100	94	0.7%	94	∞	-6	-6%	T1,T3	D,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	10	4 013	4 254	29.8%	4 244	43648%	241	6%	T1	D
Portugal	12	301	291	2.0%	279	2284%	-10	-3%	T1,T3	D,PS
Romania	NO	1 040	993	6.9%	993	∞	-47	-5%	T2	CS
Slovakia	173	307	289	2.0%	116	67%	-18	-6%	T2	CS
Slovenia	5	97	98	0.7%	93	1987%	1	1%	T1,T3	D,PS
Spain	120	689	679	4.7%	560	468%	-10	-2%	T2	CS,PS
Sweden	NO	C	C	-	-	-	-	-	T2	CS
EU-27	**1 438**	**14 455**	**14 298**	**100%**	**12 860**	**894%**	**-157**	**-1%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'. Presented methods and emission factor information refer to the last inventory year.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2021 and 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 EU sums do include emission from Sweden.

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.

Figure 3.76: 1.A.2.f Non-metallic Minerals, other fossil fuels: Emission trend and share for CO_2

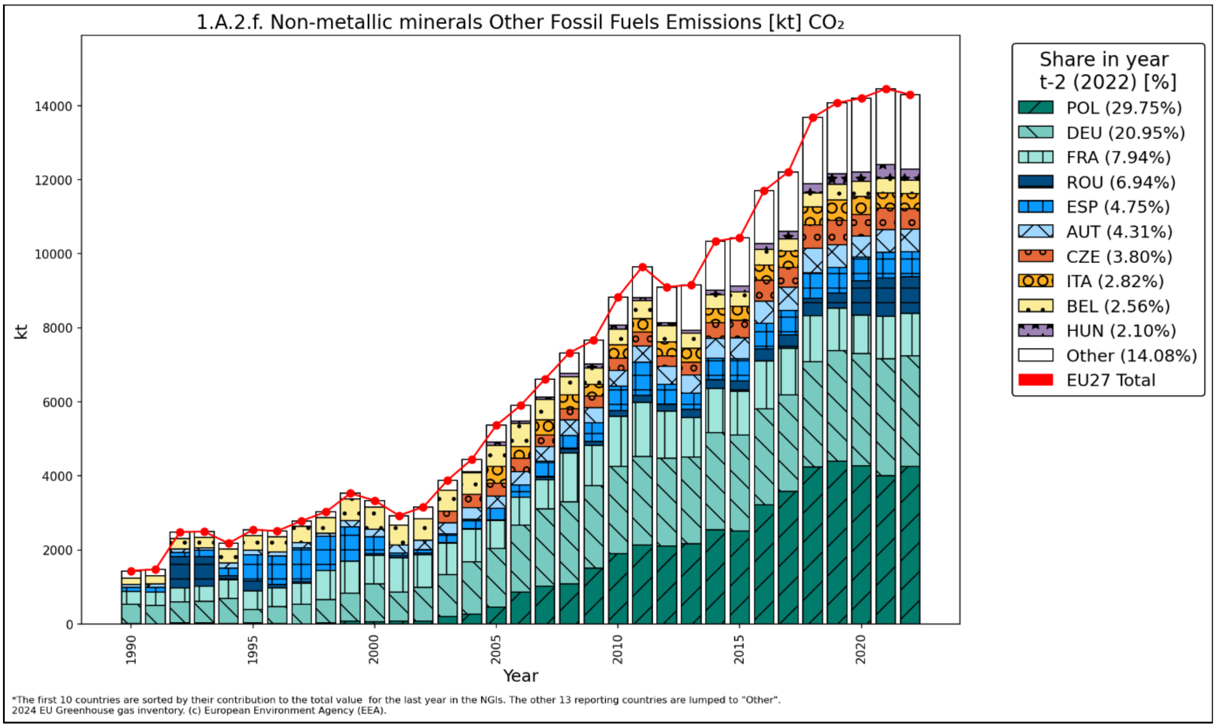
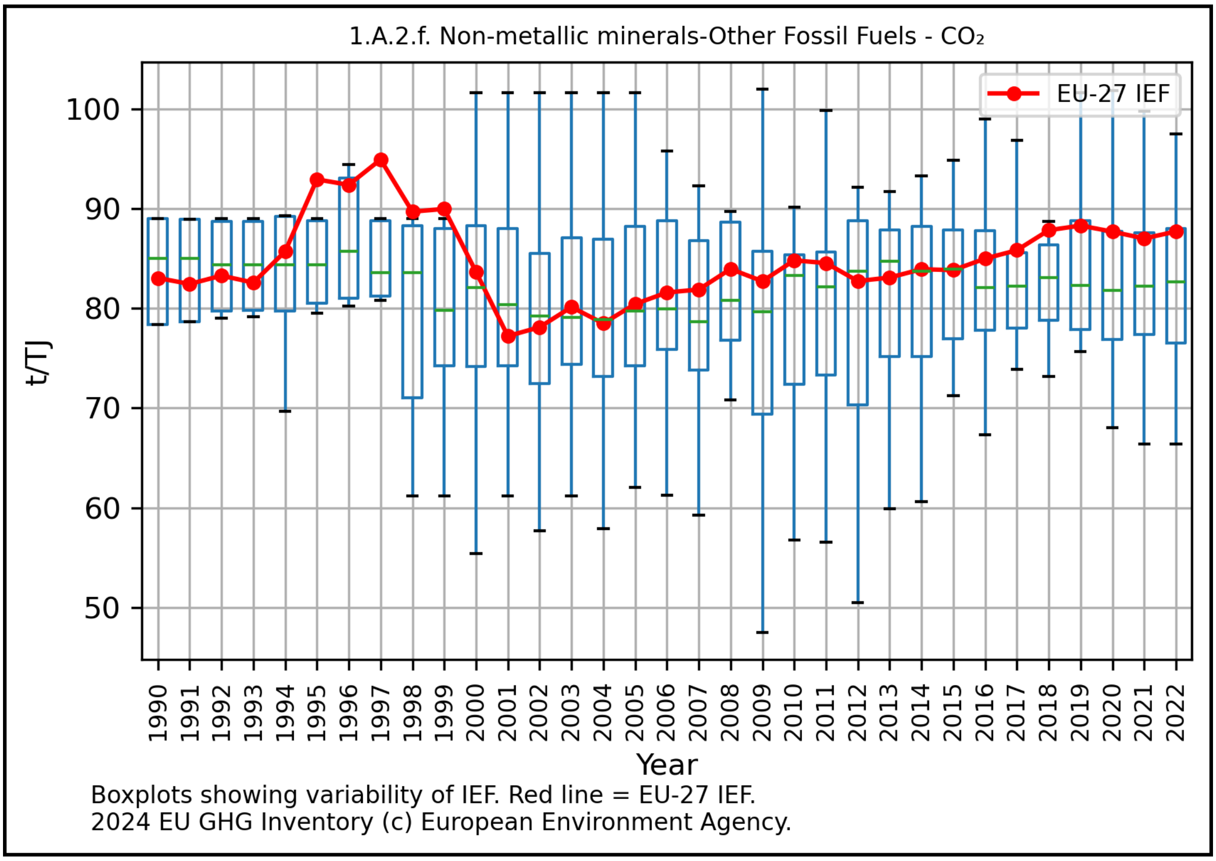


Figure 3.91 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. The CO_2 IEF for year 2022 equalled to 83.89 t/TJ.

Figure 3.77: 1.A.2.f Non-metallic Minerals, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)



3.5.2.7 Other (1.A.2.g)

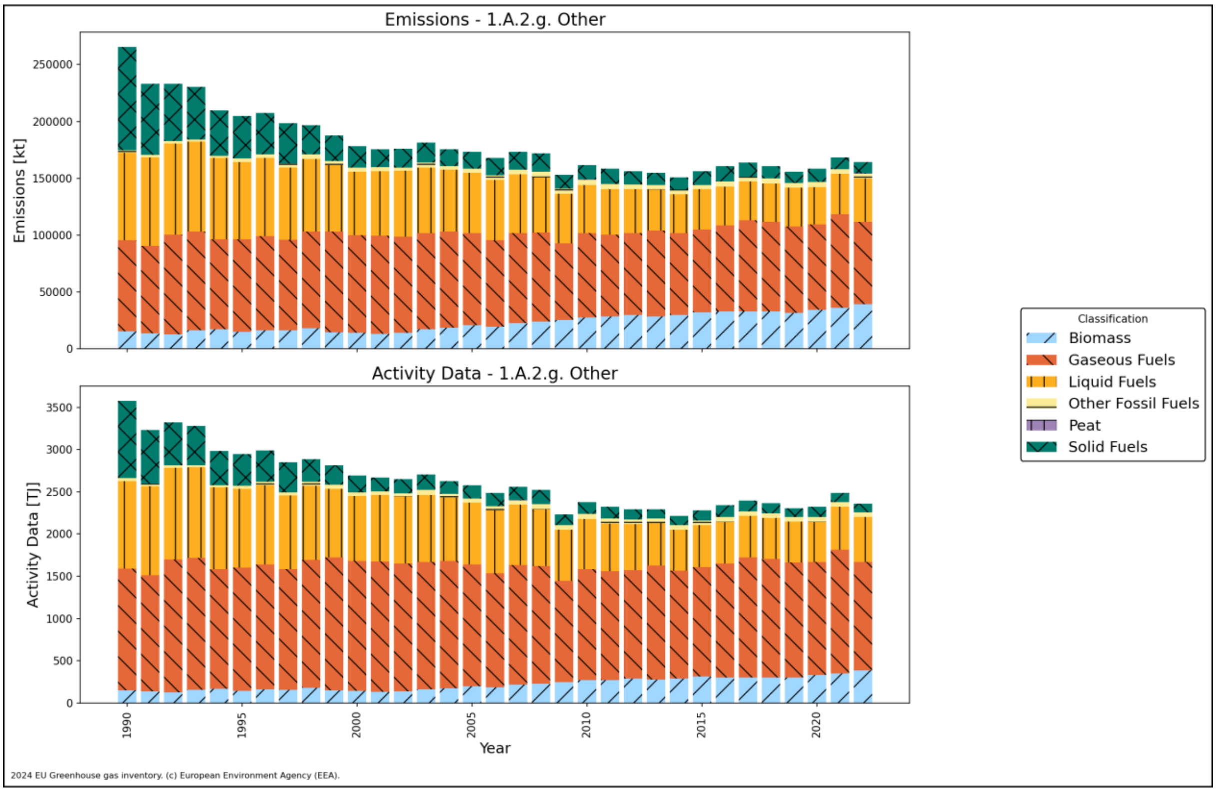
This chapter provides information about European emission trend, Member States contribution to the overall emission trend, activity data and emission factors used for emission estimates by countries for category 1.A.2.g Other.

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. Greece reports emissions of 1.A.2.g 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 1.A.4.c.ii while Italy and Poland report data under residential or commercial under categories 1.A.4 or 1.A.5.

Total CO_2 emissions from 1.A.2.g amounted to 125 162 kt CO_2 eq. in 2022. The trend of total CO_2 emissions for 1990 to 2022 from category 1.A.2.g is depicted in Figure 3.93. Total CO_2 emissions decreased by 51 % since 1990 and by 6 % between 2021 and 2022. CO_2 emissions from 1.A.2.g Other accounted for 31 % 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 3.78: 1.A.2.g Other: Activity data and total emission trends



Detailed data related to the EU submissions are depicted in Table 3.47.

Table 3.54: 1.A.2.g Other: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 974	2 852	2 869	2.3%	894	45%	17	1%	NA,T2	CS,NA
Belgium	2 807	1 987	1 709	1.4%	-1 097	-39%	-278	-14%	CS,M,NA,T1,T3	CS,D,NA,PS
Bulgaria	10 579	1 150	1 077	0.9%	-9 502	-90%	-73	-6%	NA,T1,T2	CS,D,NA
Croatia	329	371	400	0.3%	71	22%	28	8%	NA,NO,T1	D,NA,NO
Cyprus	38	67	83	0.1%	45	120%	16	24%	NA,T1	D,NA
Czechia	19 064	2 579	2 011	1.6%	-17 053	-89%	-568	-22%	NA,T1,T2	CS,D,NA
Denmark	1 856	943	1 028	0.8%	-828	-45%	85	9%	NA,T2,T3	CR,CS,D,NA
Estonia	1 163	112	108	0.1%	-1 055	-91%	-4	-4%	T1,T2	CS,D
Finland	1 639	1 657	1 592	1.3%	-47	-3%	-64	-4%	NA,T3	CS,NA
France	11 549	8 053	7 683	6.1%	-3 866	-33%	-370	-5%	NA	NA
Germany	125 835	72 722	67 597	54.0%	-58 237	-46%	-5 125	-7%	CS,NA	CS,NA
Greece	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Hungary	3 924	2 068	1 876	1.5%	-2 048	-52%	-192	-9%	NA,T1,T2	CS,D,NA
Ireland	796	474	477	0.4%	-320	-40%	3	1%	NA,T1,T2	CS,D,NA
Italy	15 310	13 245	14 428	11.5%	-882	-6%	1 183	9%	T2	CS
Latvia	1 620	210	203	0.2%	-1 417	-87%	-7	-3%	NA,T2	CS,NA
Lithuania	1 567	212	221	0.2%	-1 347	-86%	9	4%	NA,T2	CS,NA
Luxembourg	96	344	321	0.3%	224	233%	-23	-7%	NA,T1,T2	CS,D,NA
Malta	53	48	56	0.0%	3	6%	8	16%	NA,T1	D,NA
Netherlands	4 402	2 914	2 682	2.1%	-1 720	-39%	-232	-8%	NA,T2	CS,NA
Poland	6 979	3 001	3 085	2.5%	-3 893	-56%	85	3%	NA,T1,T2	CS,D,NA
Portugal	2 195	1 697	1 372	1.1%	-822	-37%	-325	-19%	NA,NO,T1	D,NA,NO
Romania	26 456	4 805	5 419	4.3%	-21 037	-80%	614	13%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	2 560	1 188	1 007	0.8%	-1 552	-61%	-181	-15%	NA,T2	CS,NA
Slovenia	1 094	491	403	0.3%	-692	-63%	-89	-18%	NA,T1,T2	CS,D,NA
Spain	7 728	7 060	5 738	4.6%	-1 990	-26%	-1 322	-19%	CR,NA,T1,T2	CR,CS,D,NA
Sweden	3 260	2 264	1 717	1.4%	-1 543	-47%	-547	-24%	T1,T2	CS
EU-27	**254 871**	**132 515**	**125 162**	**100%**	**-129 710**	**-51%**	**-7 353**	**-6%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period 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 38 150 kt in 2022 for EU. CO_2 emissions decreased compared to the year 1990 by 53 % and increased by 7 % compared to 2021. This category represents 5.3 % of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU submissions are depicted in Table.3.48.

Table.3.55: 1.A.2.g Other, liquid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	866	1 490	1 560	4.1%	694	80%	70	5%
Belgium	1 570	866	936	2.5%	-633	-40%	71	8%
Bulgaria	8 632	420	458	1.2%	-8 174	-95%	38	9%
Croatia	329	371	400	1.0%	71	22%	28	8%
Cyprus	38	67	83	0.2%	45	119%	16	24%
Czechia	2 935	149	97	0.3%	-2 838	-97%	-52	-35%
Denmark	1 242	771	884	2.3%	-357	-29%	114	15%
Estonia	683	46	66	0.2%	-616	-90%	20	45%
Finland	1 480	1 282	1 255	3.3%	-225	-15%	-27	-2%
France	6 322	4 320	4 254	11.1%	-2 069	-33%	-67	-2%
Germany	28 217	12 019	12 591	33.0%	-15 626	-55%	572	5%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	1 160	868	840	2.2%	-320	-28%	-29	-3%
Ireland	624	253	260	0.7%	-365	-58%	7	3%
Italy	5 707	3 440	5 426	14.2%	-281	-5%	1 986	58%
Latvia	1 066	127	149	0.4%	-917	-86%	23	18%
Lithuania	812	65	77	0.2%	-734	-90%	12	19%
Luxembourg	52	275	280	0.7%	227	434%	5	2%
Malta	53	48	56	0.1%	3	6%	8	16%
Netherlands	2 650	1 633	1 666	4.4%	-985	-37%	33	2%
Poland	1 028	679	778	2.0%	-251	-24%	99	15%
Portugal	2 145	606	561	1.5%	-1 584	-74%	-45	-7%
Romania	4 826	1 396	1 470	3.9%	-3 356	-70%	74	5%
Slovakia	66	12	19	0.0%	-48	-72%	6	54%
Slovenia	585	152	169	0.4%	-417	-71%	17	11%
Spain	5 685	2 470	2 108	5.5%	-3 577	-63%	-362	-15%
Sweden	3 049	1 845	1 709	4.5%	-1 340	-44%	-136	-7%
EU-27	**81 823**	**35 669**	**38 150**	**100%**	**-43 673**	**-53%**	**2 482**	**7%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Greece includes emissions of 1.A.2.g in category 1.A.2.f
The information on methodologies and emission factors is not available from the JSON on fuels level. Additional information is provided in Annex IX of the EU NID and in MS NIDs, 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.

Figure 3.79: 1.A.2.g Other, liquid fuels: Emission trend and share for CO_2

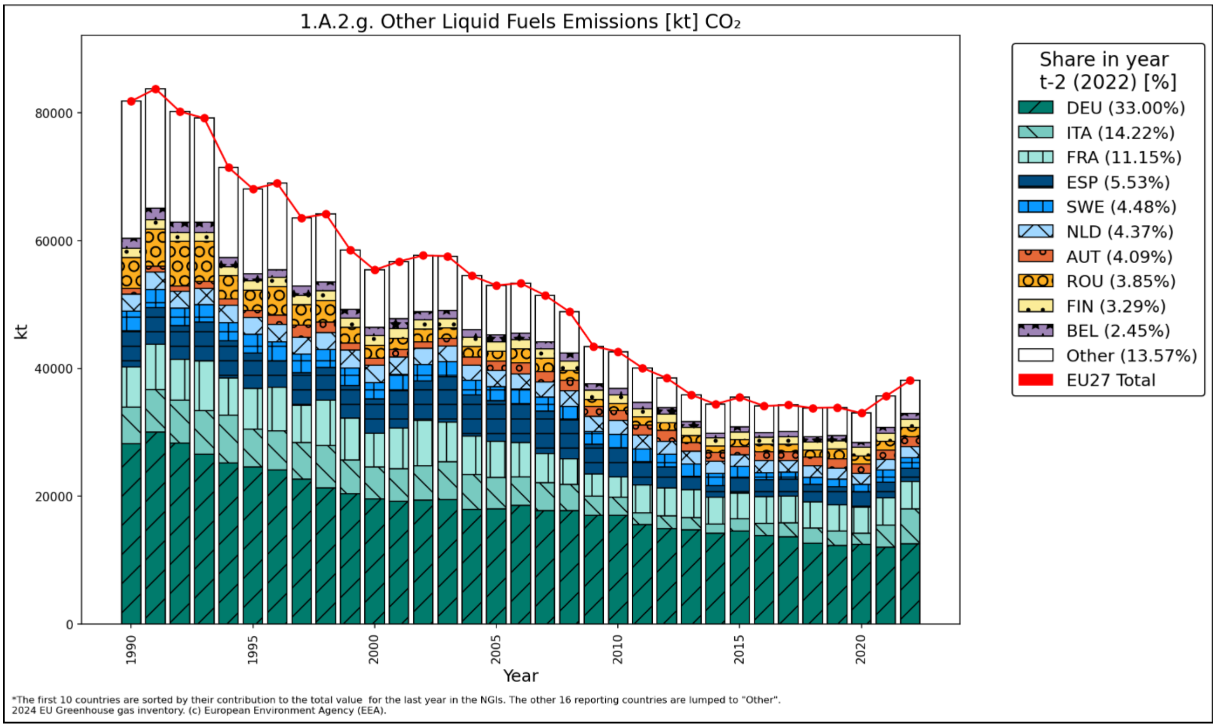
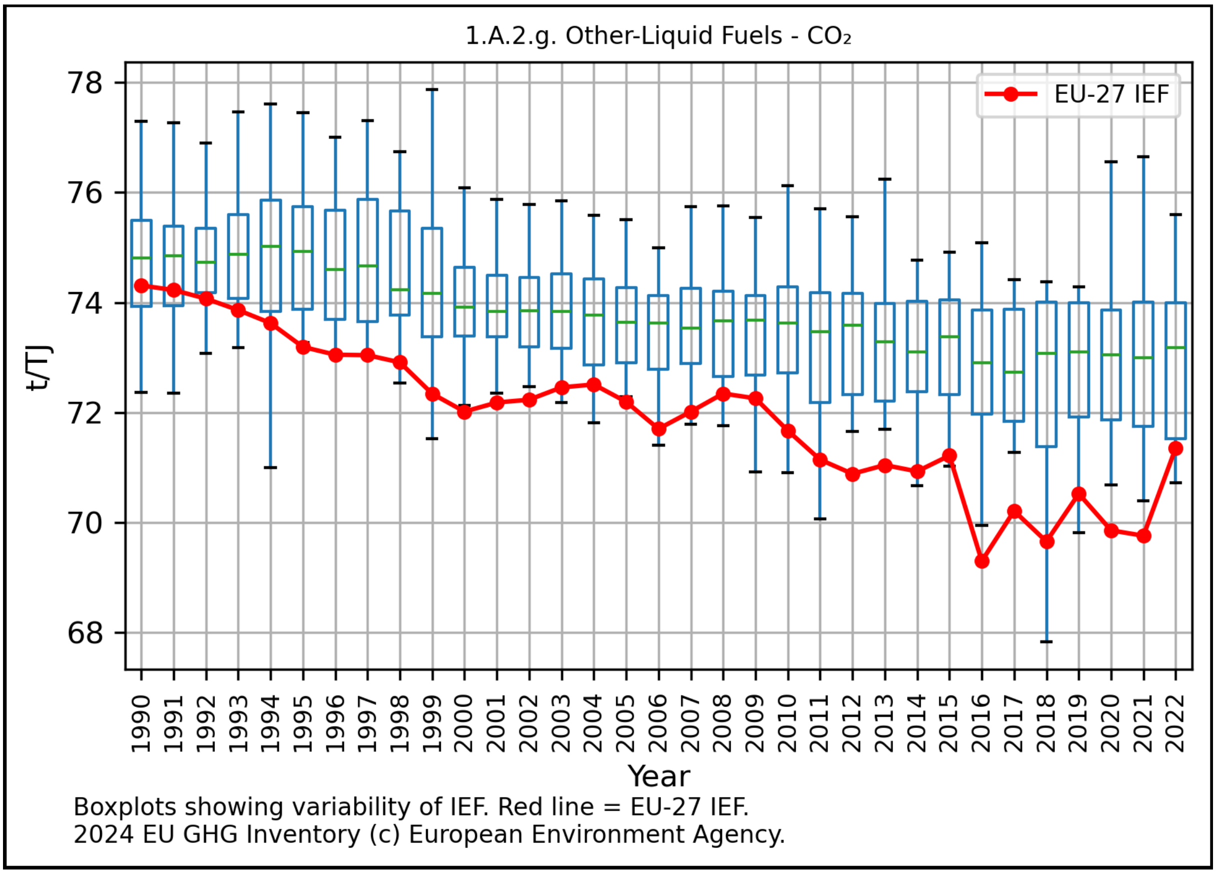


Figure 3.95 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. The CO_2 IEF shows a decreasing trend with minor fluctuations since 2015. This trend is driven mainly by Germany and is caused by changes in fuel mix. CO_2 IEF equaled to 71.54 t/TJ in 2022.

Figure 3.80: 1.A.2.g Other, liquid fuels: Implied Emission Factors for CO_2 (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 10 197 kt in 2022 for EU. CO_2 emissions decreased compared to the year 1990 by 89 % and compared to 2021 stayed on the same level. This category represents 3.5 % of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU submissions are depicted in Table 3.49.

Table 3.56: 1.A.2.g Other, solid fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	91	3	2	0.0%	-89	-98%	-1	-28%
Belgium	33	17	19	0.2%	-14	-43%	2	9%
Bulgaria	1 858	57	44	0.4%	-1 814	-98%	-14	-24%
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	13 750	130	122	1.2%	-13 629	-99%	-8	-6%
Denmark	324	4	13	0.1%	-311	-96%	9	254%
Estonia	194	1	NO	-	-194	-100%	-1	-100%
Finland	8	NO	NO	-	-8	-100%	-	-
France	816	41	9	0.1%	-807	-99%	-32	-78%
Germany	57 580	8 339	8 081	79.2%	-49 499	-86%	-258	-3%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	406	18	23	0.2%	-383	-94%	6	33%
Ireland	14	NO	NO	-	-14	-100%	-	-
Italy	396	114	734	7.2%	339	86%	620	544%
Latvia	27	1	1	0.0%	-26	-98%	0	-25%
Lithuania	79	2	1	0.0%	-78	-99%	-1	-44%
Luxembourg	20	16	8	0.1%	-13	-62%	-9	-54%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	42	39	34	0.3%	-8	-19%	-5	-13%
Poland	5 082	631	747	7.3%	-4 335	-85%	116	18%
Portugal	49	24	14	0.1%	-35	-71%	-10	-41%
Romania	8 006	4	4	0.0%	-8 003	-100%	0	5%
Slovakia	1 422	435	343	3.4%	-1 079	-76%	-92	-21%
Slovenia	89	NO	NO	-	-89	-100%	-	-
Spain	226	NO	NO	-	-226	-100%	-	-
Sweden	98	366	-	-	-98	-100%	-366	-100%
EU-27	**90 611**	**10 242**	**10 197**	**100%**	**-80 414**	**-89%**	**-44**	**0%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Greece includes emissions of 1.A.2.g in category 1.A.2.f
The information on methodologies and emission factors is not available from the JSON on fuels level. Additional information is provided in Annex IX of the EU NID and in MS NIDs, 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.

Figure.3.81: 1.A.2.g Other, solid fuels: Emission trend and share for CO_2

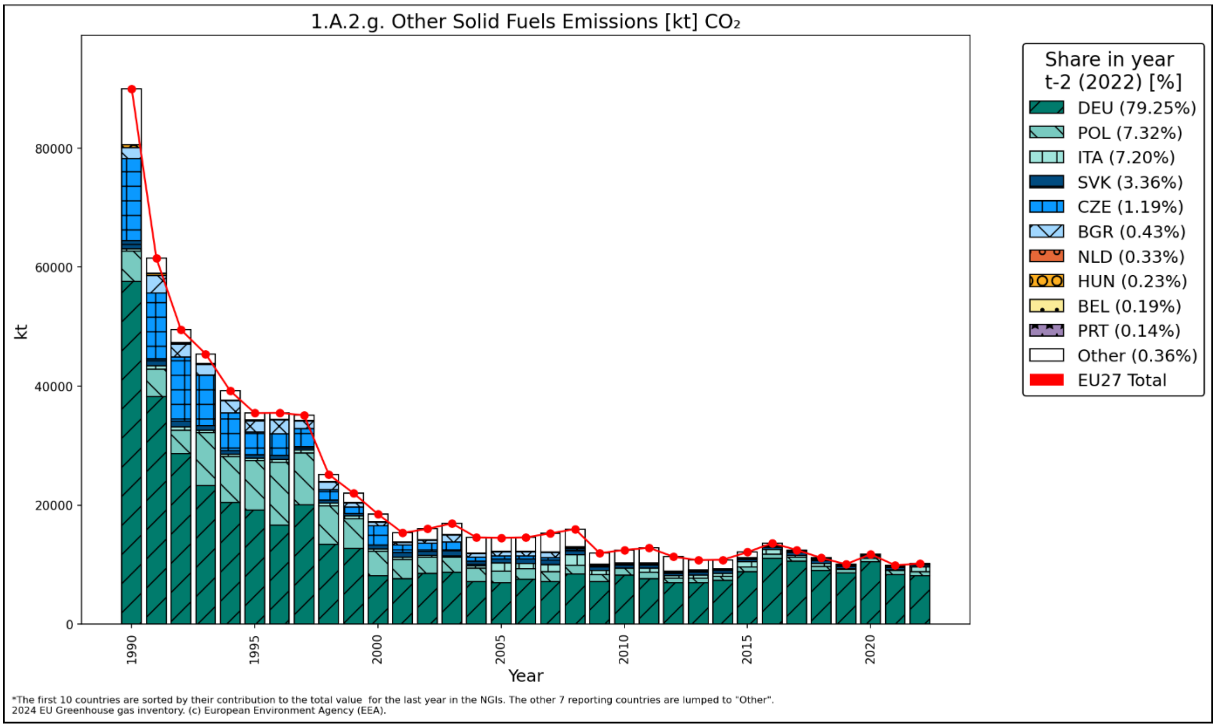
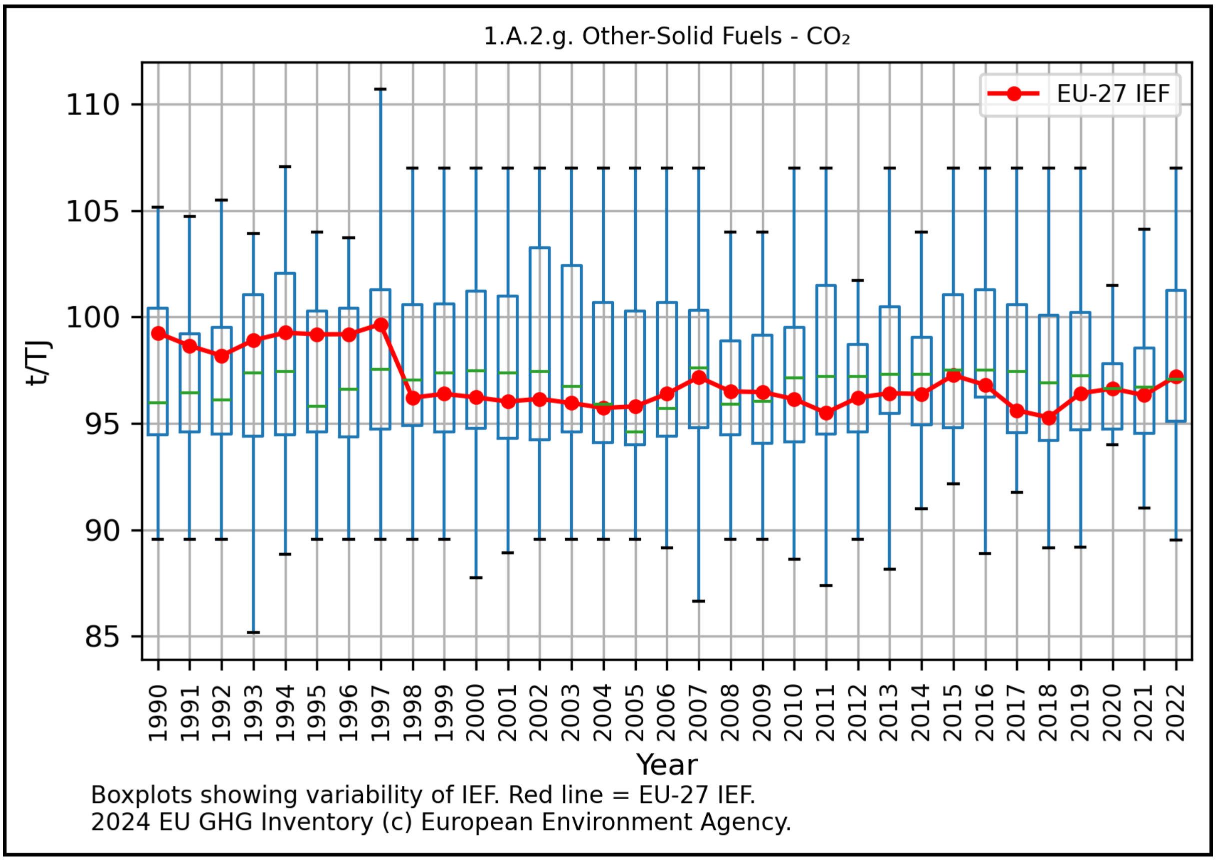


Figure 3.98 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022 which is fluctuating. CO_2 IEF equaled to 96.5 t/TJ in 2022.

Figure 3.82: 1.A.2.g Other, solid fuels: Implied Emission Factors for CO_2 (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 72 348 kt in 2022 for EU. The is a decrease of 10 % between 1990 and 2022 CO_2 emissions and 12 % decrease between 2021 and 2022. This category represents 21% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU submissions are depicted in Table 3.50.

Table 3.57: 1.A.2.g Other, gaseous fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	1 014	1 322	1 272	1.8%	258	25%	-50	-4%
Belgium	1 204	1 089	740	1.0%	-464	-39%	-349	-32%
Bulgaria	89	414	298	0.4%	209	235%	-117	-28%
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	2 379	2 300	1 793	2.5%	-586	-25%	-508	-22%
Denmark	289	165	129	0.2%	-160	-55%	-36	-22%
Estonia	286	66	42	0.1%	-244	-85%	-24	-36%
Finland	41	37	21	0.0%	-20	-48%	-15	-42%
France	4 400	3 686	3 412	4.7%	-988	-22%	-274	-7%
Germany	37 693	48 517	43 173	59.7%	5 480	15%	-5 344	-11%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	2 358	1 182	1 013	1.4%	-1 344	-57%	-169	-14%
Ireland	158	221	217	0.3%	59	38%	-4	-2%
Italy	9 207	9 691	8 268	11.4%	-939	-10%	-1 422	-15%
Latvia	527	80	50	0.1%	-477	-90%	-29	-37%
Lithuania	677	145	142	0.2%	-534	-79%	-3	-2%
Luxembourg	24	29	11	0.0%	-13	-55%	-19	-63%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	1 710	1 242	982	1.4%	-727	-43%	-260	-21%
Poland	865	1 674	1 543	2.1%	678	78%	-130	-8%
Portugal	NO	1 063	795	1.1%	795	∞	-268	-25%
Romania	13 624	3 406	3 941	5.4%	-9 682	-71%	536	16%
Slovakia	1 071	741	646	0.9%	-425	-40%	-95	-13%
Slovenia	420	331	228	0.3%	-192	-46%	-103	-31%
Spain	1 816	4 590	3 630	5.0%	1 814	100%	-960	-21%
Sweden	113	45	NO	-	-113	-100%	-45	-100%
EU-27	**79 964**	**82 037**	**72 348**	**100%**	**-7 617**	**-10%**	**-9 689**	**-12%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Greece includes emissions of 1.A.2.g in category 1.A.2.f
Abbreviations explained in the Chapter 'Units and abbreviations'.
The information on methodologies and emission factors is not available from the JSON 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 IX of the EU NID and in MS NIDs, 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.

Figure 3.83: 1.A.2.g Other, gaseous fuels: Emission trend and share for CO_2

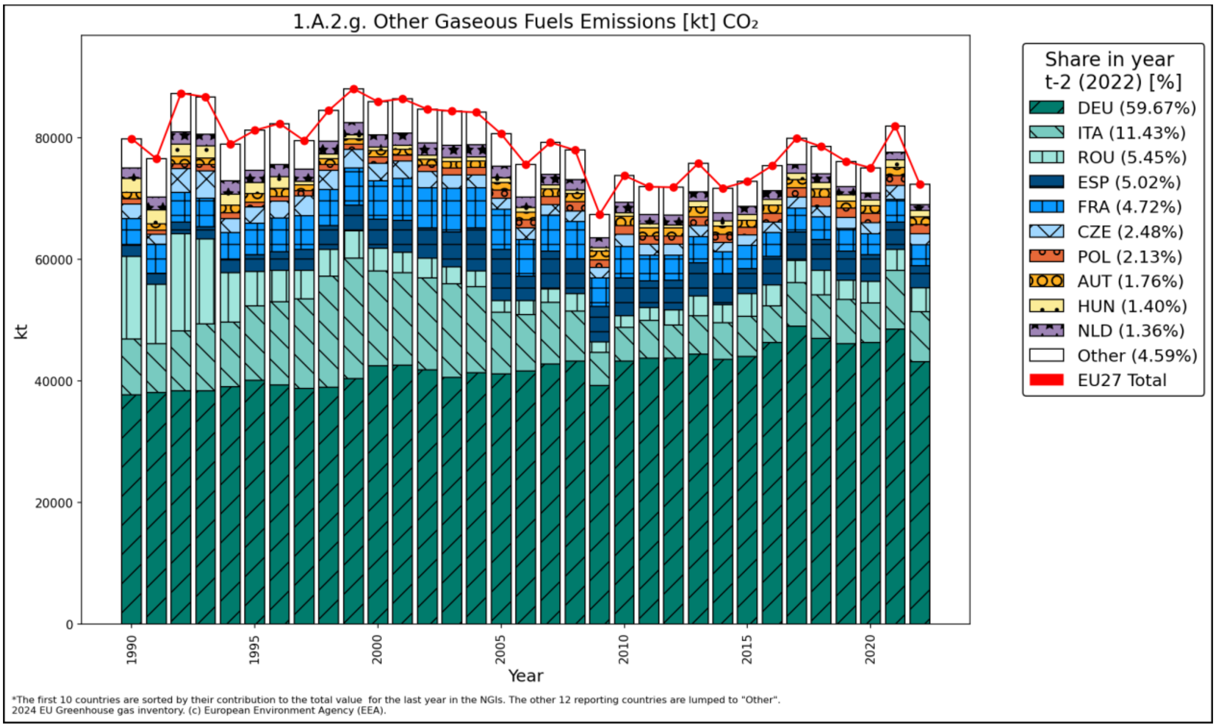
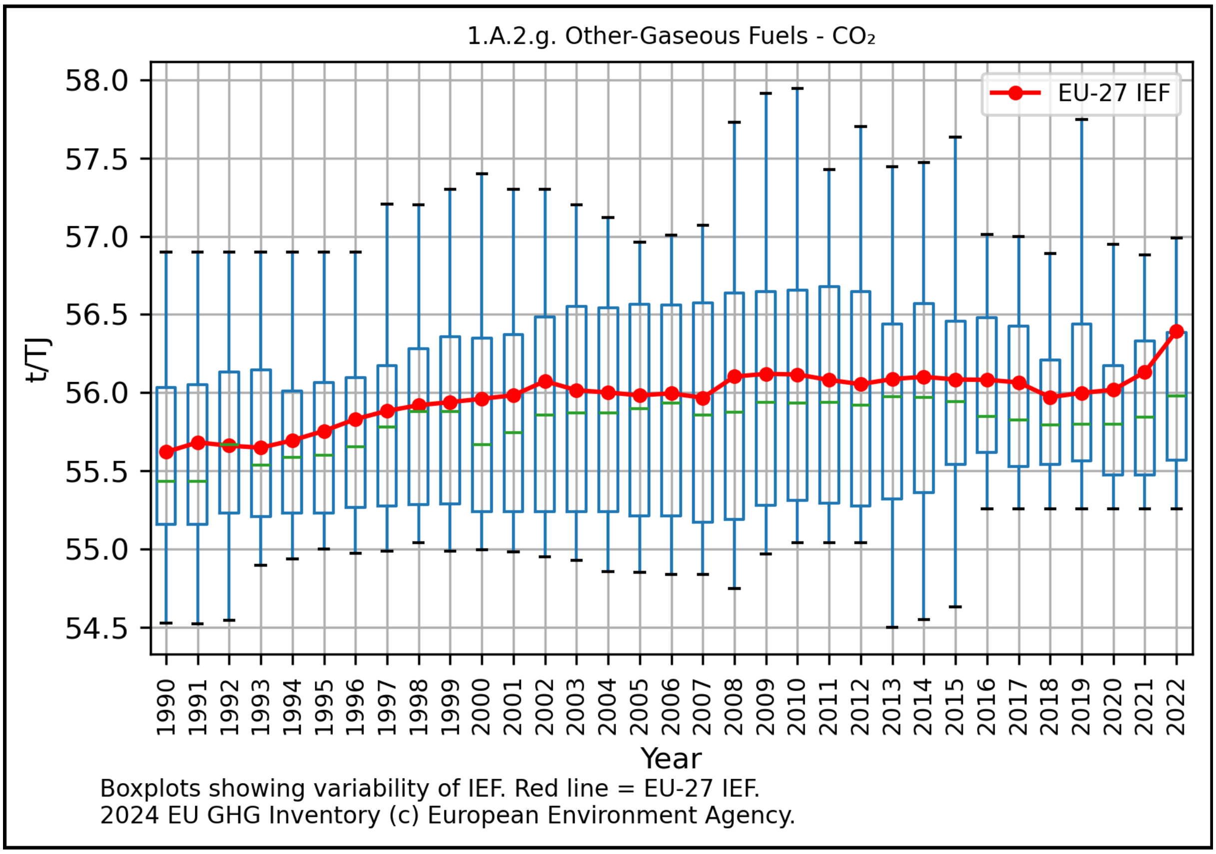


Figure 3.*101* shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. CO_2 IEF is relatively stable during reporting period. CO_2 IEF equaled to 56.42 t/TJ in 2022.

Figure 3.84: 1.A.2.g Other, gaseous fuels: Implied Emission Factors for CO_2 (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 4 440 kt in 2022 for EU. CO_2 emissions increased compared to year 1990 by 81 % and compared to 2021 decreased by 2 %. This category represents 1% of total CO_2 equivalent emissions from category 1.A.2.

Detailed data related to the EU submissions are depicted in Table 3.51.

Table 3.58: 1.A.2.g Other, other fossil fuels: Member States contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	3	37	34	0.8%	31	887%	-3	-7%
Belgium	NO	15	14	0.3%	14	∞	-1	-4%
Bulgaria	NO	259	278	6.3%	278	∞	19	7%
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	0	0	0.0%	0	∞	0	64%
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	1	3	1	0.0%	0	2%	-2	-65%
Estonia	NO	NO	NO	-	-	-	-	-
Finland	88	312	292	6.6%	204	232%	-20	-6%
France	11	6	9	0.2%	-2	-19%	3	55%
Germany	2 344	3 847	3 752	84.5%	1 408	60%	-95	-2%
Greece	IE	IE	IE	-	-	-	-	-
Hungary	NO	NO	NO	-	-	-	-	-
Ireland	NO	NO	NO	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	23	23	0.5%	23	∞	-1	-3%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	3	17	17	0.4%	14	455%	1	4%
Portugal	NO	4	2	0.0%	2	∞	-2	-57%
Romania	NO	0	4	0.1%	4	∞	4	872%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	9	6	0.1%	6	∞	-3	-34%
Spain	NO	NO	NO	-	-	-	-	-
Sweden	NO	7	8	0.2%	8	∞	1	9%
EU-27	**2 451**	**4 539**	**4 440**	**100%**	**1 989**	**81%**	**-99**	**-2%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Abbreviations explained in the Chapter 'Units and abbreviations'.
The information on methodologies and emission factors are only partially available from the JSON on fuels level.

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.

Figure 3.85: 1.A.2.g Other, other fossil fuels: Emission trend and share for CO_2

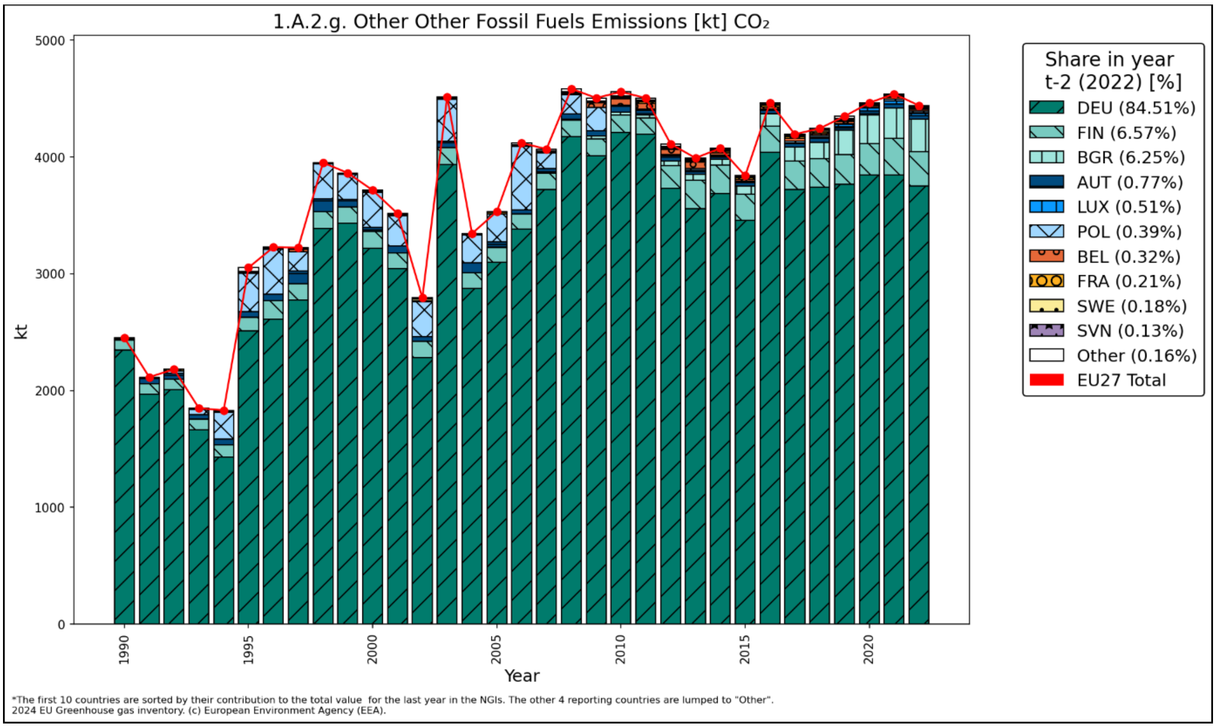
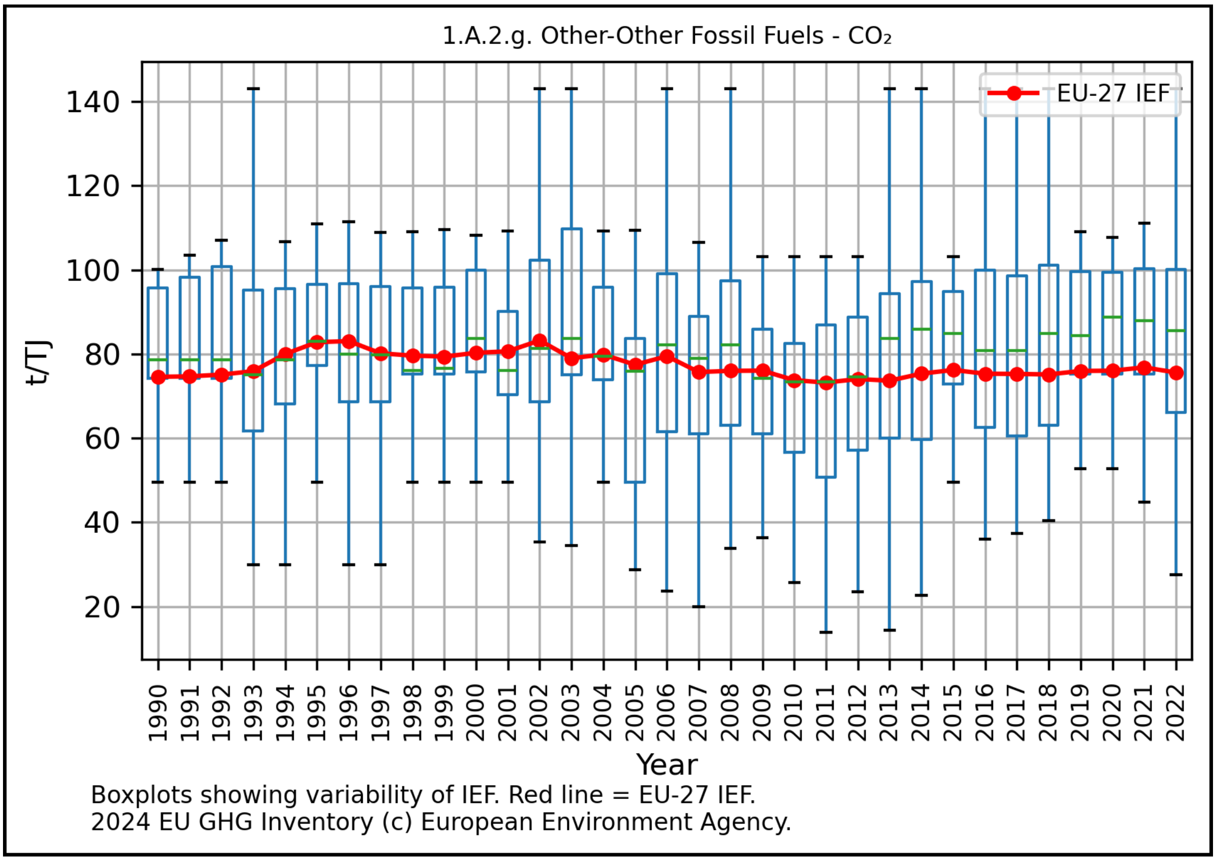


Figure 3.104 shows CO_2 implied emission factor (CO_2 IEF) calculated from EU submissions for 1990-2022. CO_2 IEF equaled to 77.24 t/TJ in 2022.

Figure 3.86: 1.A.2.g Other, other fossil fuels: Implied Emission Factors for CO_2 (in t/TJ)



3.5.3 Transport (CRT Source Category 1A3) (EU)

The time series of greenhouse gas (GHG) emissions and activity data from 1A3 Transport, years 1990-2022, are shown in Figure 3.106. In 2022, CO_2 emissions from the transport sector accounted for 24.5 %, CH_4 for 0.04 %, and N_2O for 0.23 % of total GHG emissions from all sources (including indirect CO_2, with LULUCF and international aviation).

Figure 3.87 1A3 Transport: Greenhouse gas emissions (in kt of CO_2 equ.) and activity data (in TJ)

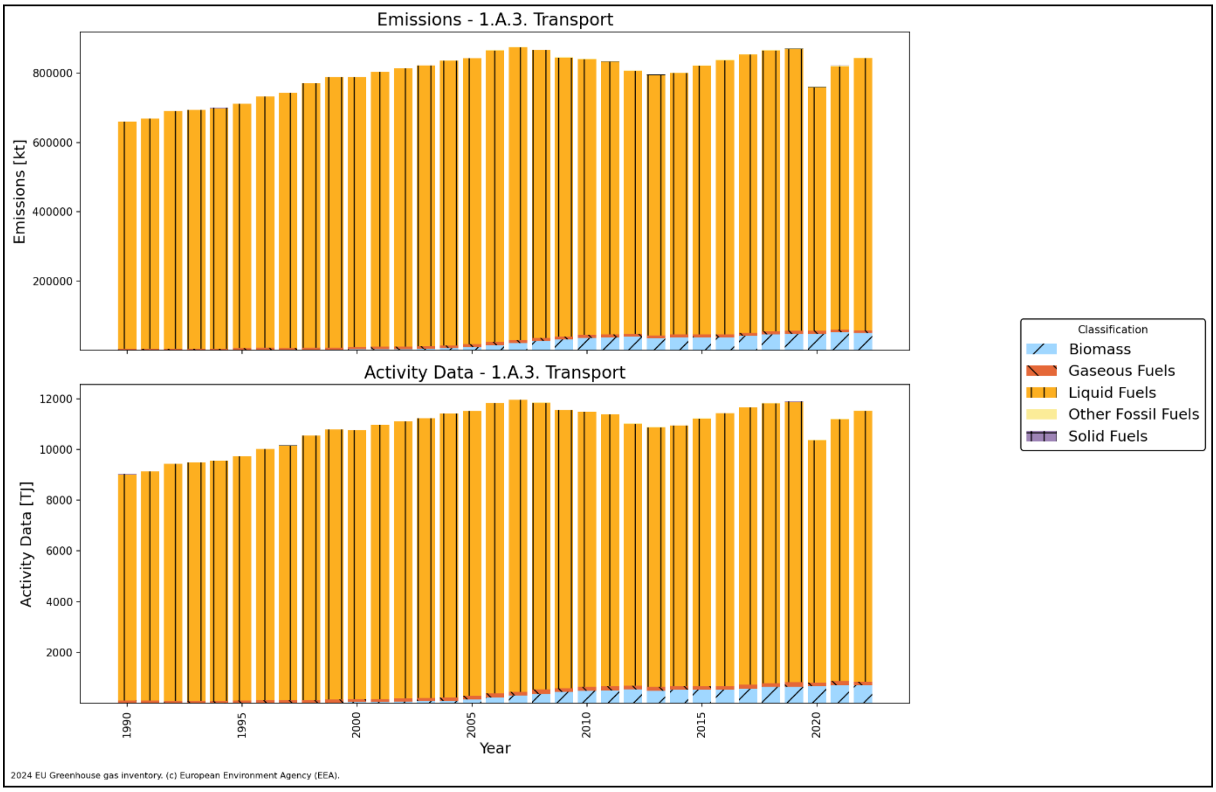


Table 3.52 summarizes the share of countries using higher tier methods for calculating emissions for the key categories of the transport sector. If the information on the tier methods used was not available, the countries NIRs were studied in order to obtain it and calculate the share of higher tiers. In general, most countries use higher tier methods, especially for road transport (83 - 99.8 %) and domestic aviation (94.1 %). Lower percentages are observed for domestic navigation (73.7 - 74.3 %) and railways (95 %). It should be noted that as 'high tier' are considered all methods apart from T1.

Table 3.59: Key category analysis for the EU (1A3): Key source categories for level and trend analyses and share of countries using higher tier methods

Source category (gas)	kt CO_2 equ.		Trend	Level		Share of higher Tier
	1990	2022		1990	2022	
1.A.3.a. Domestic aviation: Jet Kerosene (CO_2)	10813	12867	T	L	L	94.1 %
1.A.3.b. Road transportation: Diesel Oil (CO_2)	270372	533937	T	L	L	83 %
1.A.3.b. Road transportation: Diesel Oil (N_2O)	1320	6009	T	0	L	95.6 %
1.A.3.b. Road transportation: Gaseous Fuels (CO_2)	508	3673	T	0	0	91.4 %
1.A.3.b. Road transportation: Gasoline (CH_4)	5556	767	T	0	0	97.4 %
1.A.3.b. Road transportation: Gasoline (CO_2)	330645	201449	T	L	L	90 %
1.A.3.b. Road transportation: Liquefied Petroleum Gases (LPG) (CO_2)	7266	15085	T	L	L	99.8 %
1.A.3.c. Railways: Liquid Fuels (CO_2)	11549	3281	T	L	0	95 %
1.A.3.d. Domestic navigation: Gas/Diesel Oil (CO_2)	12831	9964	0	L	L	73.7 %

Source category (gas)	kt CO_2 equ.		Trend	Level		Share of higher Tier
	1990	2022		1990	2022	
1.A.3.d. Domestic navigation: Residual Fuel Oil (CO_2)	7006	6149	0	0	L	74.3 %

Table 3.53 shows the total GHG, CO_2, N_2O, and CH_4 emissions from 1A3 Transport per country and at EU level. Between 1990 and 2022, total GHG from transport increased by 20 % in the EU.

Table 3.60 1A3 Transport: Total GHG, CO_2, N_2O, CH_4, emissions per country (in kt of CO_2 equ.)

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	2022	1990	2022	1990	2022	1990	2022
Austria	13 949	20 712	13 754	20 472	112	219	83	21
Belgium	20 930	24 187	20 615	23 933	158	231	157	22
Bulgaria	6 371	9 940	6 213	9 831	81	88	77	21
Croatia	3 899	6 731	3 787	6 667	65	55	47	9
Cyprus	1 237	2 026	1 219	2 010	10	12	8	3
Czechia	11 249	19 391	11 078	19 190	85	175	87	26
Denmark	10 740	12 028	10 564	11 902	87	117	88	9
Estonia	2 571	2 645	2 511	2 614	35	28	25	3
Finland	12 091	9 777	11 821	9 690	143	74	126	13
France	121 908	127 979	119 976	126 628	836	1 183	1 096	169
Germany	164 457	148 629	161 430	146 992	1 183	1 384	1 844	253
Greece	14 503	17 909	14 137	17 623	242	216	124	70
Hungary	8 936	15 075	8 749	14 903	110	149	77	24
Ireland	5 143	11 751	5 030	11 616	59	125	55	10
Italy	102 190	109 774	100 319	108 654	860	923	1 010	197
Latvia	3 037	3 142	2 940	3 104	73	35	24	3
Lithuania	5 811	6 011	5 685	5 944	81	60	45	8
Luxembourg	2 627	4 217	2 599	4 171	14	43	14	3
Malta	351	723	346	718	2	4	3	1
Netherlands	27 796	25 406	27 494	25 156	95	186	207	65
Poland	20 741	69 333	20 277	68 513	284	720	180	100
Portugal	10 820	17 062	10 618	16 882	91	158	111	23
Romania	12 433	21 148	12 072	20 861	256	248	105	38
Slovakia	6 816	7 779	6 693	7 689	89	84	34	6
Slovenia	2 737	5 794	2 673	5 732	33	57	31	5
Spain	58 651	90 457	57 728	89 504	463	836	461	117
Sweden	20 043	14 002	19 688	13 779	172	178	183	45
EU-27	**672 037**	**803 627**	**660 017**	**794 776**	**5 719**	**7 587**	**6 302**	**1 264**

3.5.3.1 Domestic Aviation (1A3a) (EU)

This mobile source category includes emissions from civil domestic aviation, i.e. passenger and freight activity of flights having their origin and destination (O-D) within the same country. The main fuel used is jet kerosene, while there is also a small part of aviation gasoline. The emissions from military mobile sources related to aviation are excluded from 1A3a and are reported separately under category 1A5b (Other mobile military use).

CO_2 emissions from 1A3a Domestic Aviation

CO_2 emissions from domestic aviation accounted only for 0.4% of total GHG emissions in EU, 2022 (including indirect CO_2, with LULUCF and international aviation). Considering only domestic aviation, CO_2 accounted for 99.2 % of total GHG emissions from domestic aviation in EU, 2022.

The time series of CO_2 emissions and activity data from 1A3a Domestic aviation, years 1990-2022, are shown in Figure 3.107.

Figure 3.88 1A3a Domestic Aviation: CO_2 emissions (in kt) and activity data (in TJ)

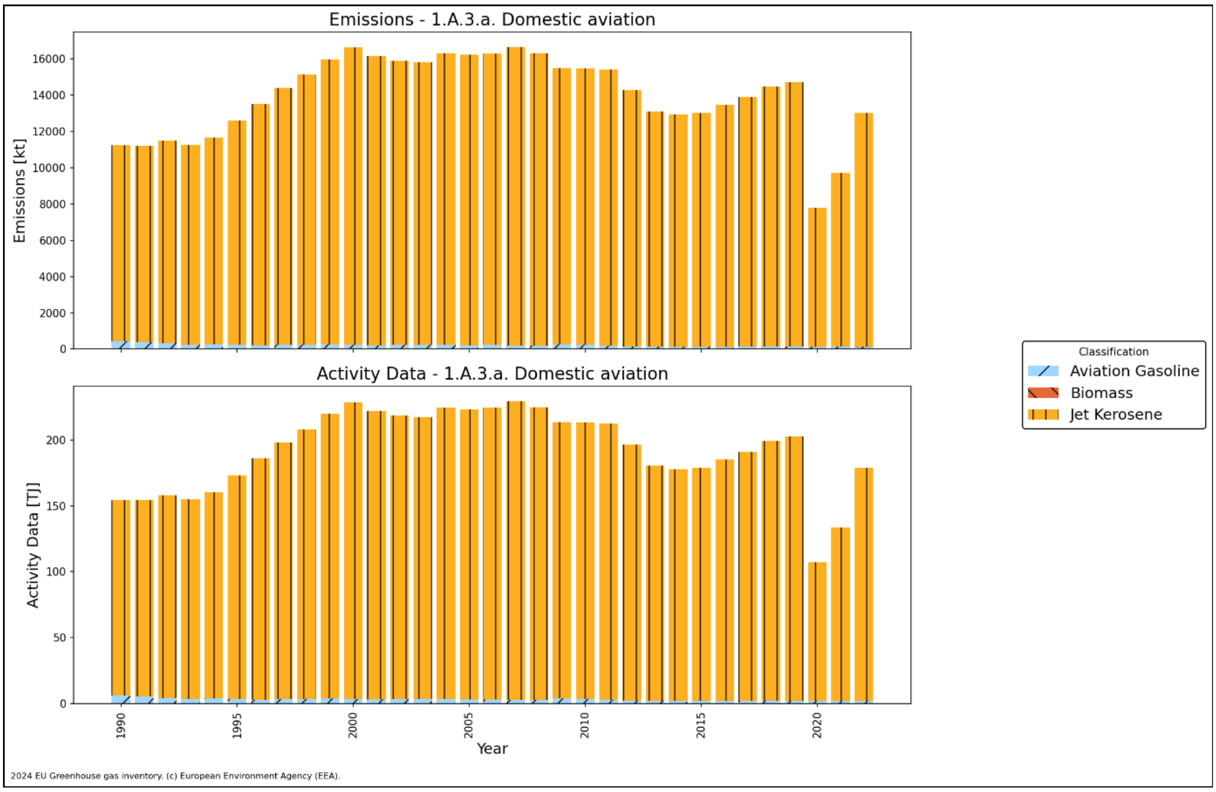


Table 3.54 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for domestic aviation. Between 1990 and 2022, CO_2 emissions from domestic aviation increased by 16% in the EU, while between 2021 and 2022 the corresponding change was 34 % increase. Top three countries in 2022 were France, Spain, Italy, which accounted for the 78 % of the EU value.

Table 3.61 1A3a Domestic Aviation: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	38	24	30	0.2%	-9	-23%	6	24%	T2,T3	CS
Belgium	15	7	7	0.1%	-7	-49%	0	2%	T1	D
Bulgaria	50	15	17	0.1%	-33	-67%	2	14%	T1,T3	CR,D
Croatia	7	22	26	0.2%	19	290%	3	16%	T1	D
Cyprus	26	0	1	0.0%	-25	-95%	1	251%	NA,T1	D,NA
Czechia	IE	12	12	0.1%	12	∞	0	0%	T1,T2	M
Denmark	216	83	118	0.9%	-98	-45%	35	43%	T2	CS
Estonia	6	6	5	0.0%	-1	-13%	-1	-13%	NA,T2	D,NA
Finland	385	79	135	1.0%	-250	-65%	56	71%	T1,T2	CS
France	3 614	3 767	4 583	35.3%	969	27%	816	22%	-	-
Germany	2 310	709	1 031	7.9%	-1 280	-55%	321	45%	CS,T1,T2	CS,D,M
Greece	336	320	389	3.0%	53	16%	69	22%	T2,T3	D
Hungary	6	10	15	0.1%	10	169%	5	49%	T1,T2	CS,D
Ireland	48	20	21	0.2%	-27	-55%	2	9%	M,T3	CS
Italy	1 493	1 703	2 485	19.1%	991	66%	781	46%	T1,T2	CS
Latvia	0	2	5	0.0%	5	6975%	3	156%	T1	D
Lithuania	8	2	2	0.0%	-6	-79%	-1	-23%	T1	CS
Luxembourg	0	1	1	0.0%	0	150%	0	-10%	NA,T1	D,NA
Malta	1	0	0	0.0%	-1	-75%	0	98%	T1	D
Netherlands	84	27	32	0.2%	-52	-62%	5	20%	T1	CS,D
Poland	63	53	128	1.0%	65	103%	75	141%	T1	D
Portugal	178	340	416	3.2%	238	134%	76	22%	T1,T3	D
Romania	25	140	199	1.5%	175	702%	60	43%	T1,T2	D,OTH
Slovakia	4	1	1	0.0%	-2	-60%	0	15%	T2	D
Slovenia	1	1	2	0.0%	1	57%	0	15%	T1	D
Spain	1 655	2 173	3 034	23.3%	1 380	83%	861	40%	T3	D
Sweden	673	190	301	2.3%	-372	-55%	111	59%	T1	D
EU-27	**11 241**	**9 709**	**12 997**	**100%**	**1 756**	**16%**	**3 289**	**34%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

1A3a Domestic Aviation – Jet Kerosene (CO_2)

CO_2 emissions from jet kerosene accounted for 98.2 % of total GHG emissions from domestic aviation in 2022.

Table 3.55 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for domestic aviation – jet kerosene. Between 1990 and 2022, CO_2 emissions increased by 19% in the EU, while between 2021 and 2022 the corresponding change was 35 % increase. Top three countries in 2022 were France, Spain, Italy, which accounted for the 78 % of the EU value.

Table 3.62 1A3a Domestic Aviation – Jet Kerosene: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	31	18	24	0.2%	-6	-21%	7	38%	T3	CS
Belgium	12	6	6	0.0%	-6	-48%	0	9%	T1	D
Bulgaria	28	14	16	0.1%	-12	-43%	2	16%	T3	CR
Croatia	6	21	25	0.2%	18	290%	4	18%	T1	D
Cyprus	26	0	1	0.0%	-25	-95%	1	251%	T1	D
Czechia	IE	6	6	0.0%	6	∞	0	0%	T1,T2	M
Denmark	207	81	118	0.9%	-90	-43%	37	46%	T2	CS
Estonia	6	6	5	0.0%	-1	-13%	-1	-13%	T2	D
Finland	377	77	134	1.0%	-244	-65%	57	73%	T2	CS
France	3 530	3 716	4 535	35.2%	1 005	28%	820	22%	-	-
Germany	2 161	699	1 019	7.9%	-1 142	-53%	320	46%	CS,T2	CS,M
Greece	311	314	385	3.0%	73	24%	70	22%	T3	D
Hungary	3	7	12	0.1%	10	354%	5	71%	T2	CS
Ireland	45	17	19	0.2%	-26	-57%	2	13%	M,T3	CS
Italy	1 459	1 692	2 479	19.3%	1 020	70%	788	47%	T1,T2	CS
Latvia	0	1	4	0.0%	4	6475%	3	333%	T1	D
Lithuania	7	1	1	0.0%	-7	-93%	0	-46%	T1	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	0	0	0.0%	-1	-82%	0	270%	T1	D
Netherlands	73	23	28	0.2%	-44	-61%	5	23%	T1	D
Poland	38	42	116	0.9%	78	204%	75	179%	T1	D
Portugal	176	339	414	3.2%	238	135%	75	22%	T3	D
Romania	25	135	197	1.5%	172	693%	62	46%	T2	OTH
Slovakia	4	1	1	0.0%	-2	-62%	0	12%	T2	D
Slovenia	NO	0	0	0.0%	0	∞	0	39%	T1	D
Spain	1 628	2 160	3 023	23.5%	1 395	86%	862	40%	T3	D
Sweden	658	187	299	2.3%	-359	-55%	111	60%	T1	D
EU-27	**10 813**	**9 563**	**12 867**	**100%**	**2 055**	**19%**	**3 305**	**35%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Figure 3.109 shows the time series of CO_2 emissions in EU from domestic aviation – jet kerosene and the highest shares of countries. Figure 3.110 shows the CO_2 implied emission factor (IEF) in EU. It is observed that the CO_2 IEF at EU level is almost constant over the years at 73 t/TJ.

Figure 3.89 1A3a Domestic Aviation – Jet Kerosene: Time series of CO_2 emissions in EU and highest shares of countries

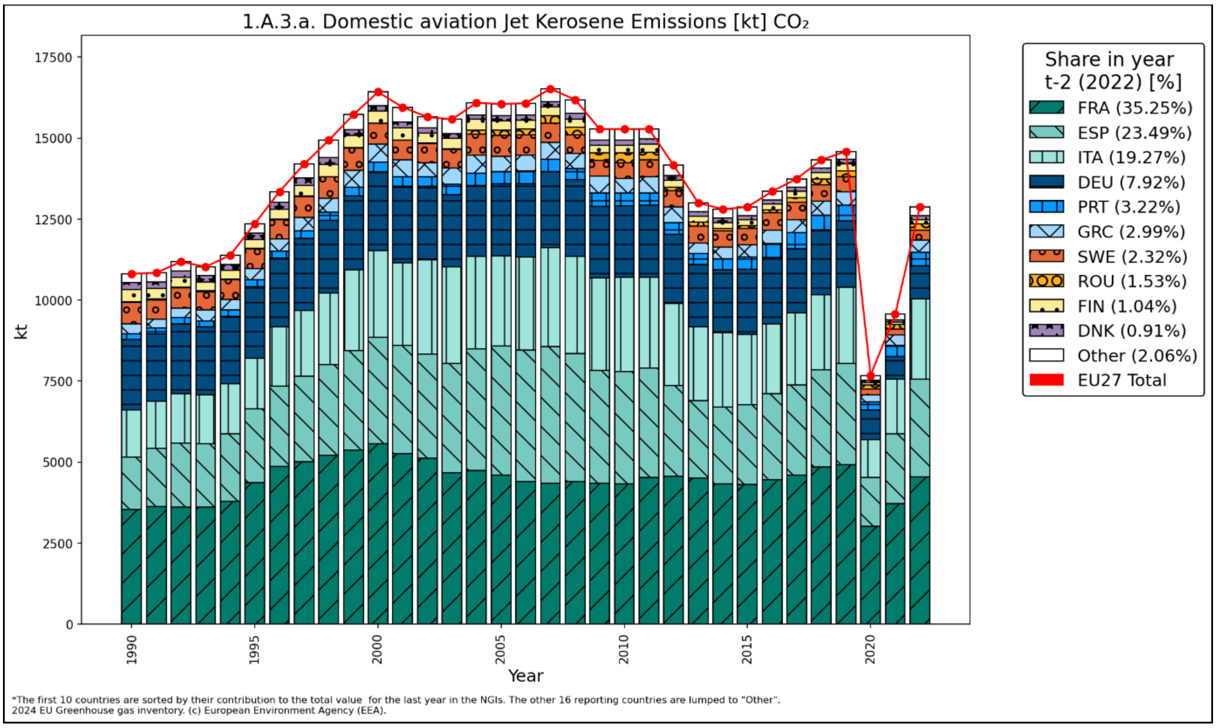
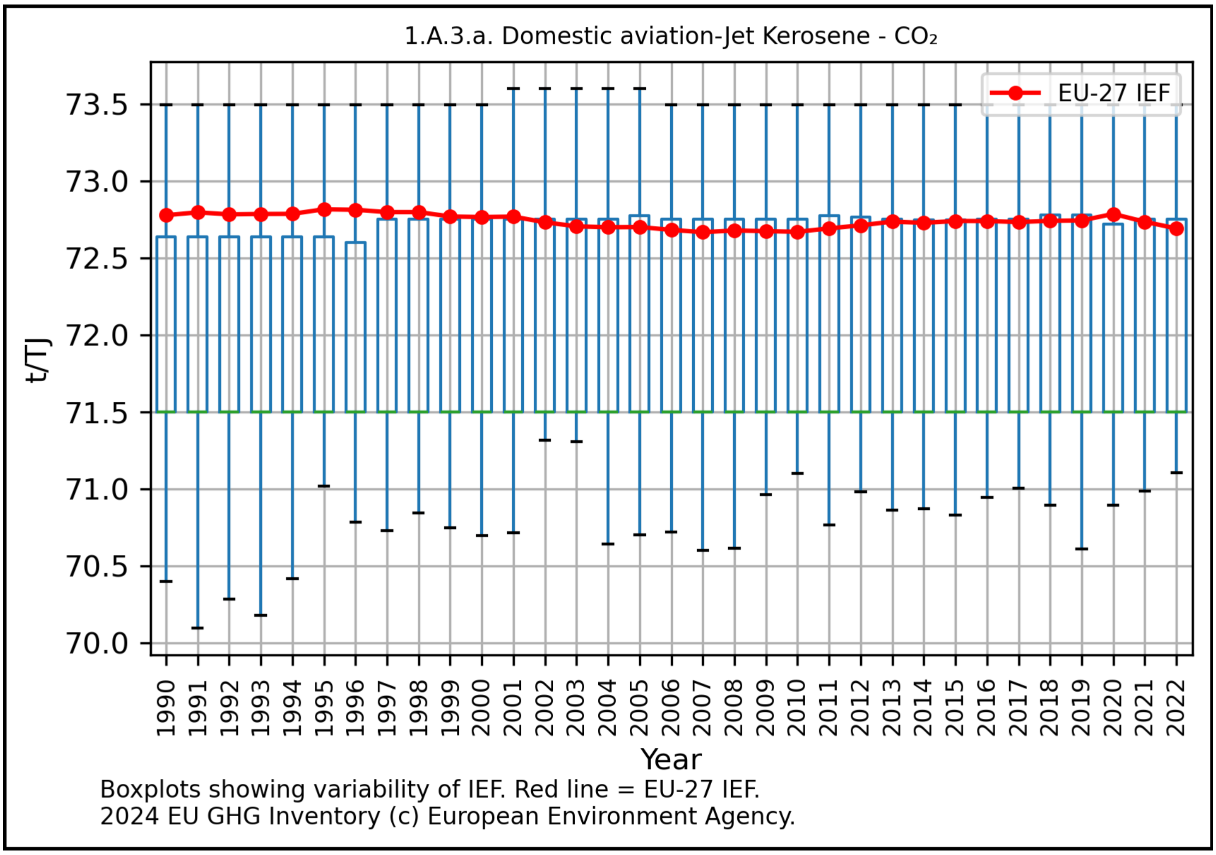


Figure 3.90 1A3a Domestic Aviation - Jet Kerosene: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



3.5.3.2 Road Transportation (1A3b) (EU)

The mobile source category 1A3b Road transportation includes all types of light and heavy duty vehicles, i.e. passenger cars, light commercial vehicles, lorries, tractors, trailers and semi-trailers, and buses; in addition, all types of two and three-wheelers, i.e. mopeds and motorcycles (including tricycles). All these vehicles operate on various liquid and gaseous fuel types.

CO_2 emissions from 1A3b Road Transportation

CO_2 emissions from road transport is one of the largest key source categories among all sources in the EU accounting for 23.3 % of total GHG emissions in 2022 (including indirect CO_2, with LULUCF and international aviation). Considering only road transport, CO_2 accounted for 98.92 % of total GHG emissions from road transport in EU, 2022.

The time series of CO_2 emissions and activity data from 1A3b Road transportation, years 1990-2022, are shown in Figure 3.111. From this figure it can be observed that the largest contribution to emissions comes from the usage of diesel oil and gasoline.

Figure 3.91 1A3b Road Transportation: CO_2 emissions (in Mt) and activity data (in TJ)

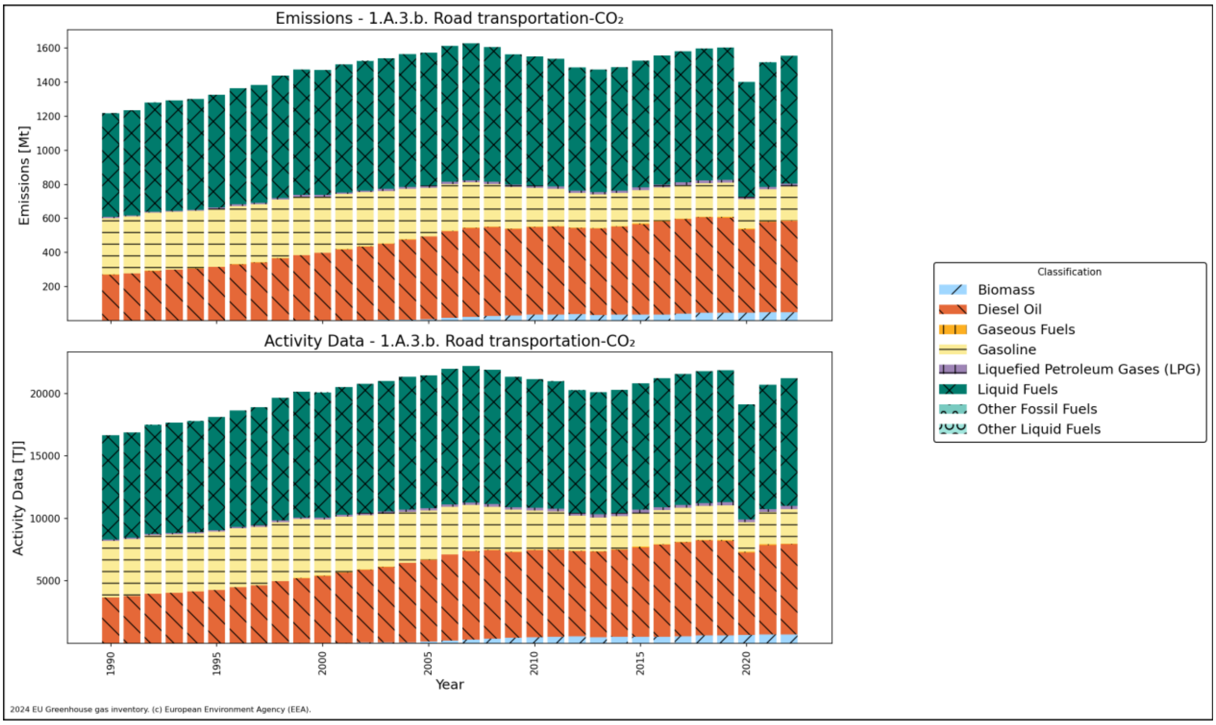


Table 3.56 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3b Road transportation. Between 1990 and 2022, CO_2 emissions increased by 24 % in the EU, while between 2021 and 2022 the corresponding change was 3% increase. Top three countries in 2022 were Germany, France, Italy, which accounted for the 48 % of the EU value.

Table 3.63 1A3b Road Transportation: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	13 280	21 152	20 130	2.7%	6 850	52%	-1 022	-5%	NA,T2	CS,NA
Belgium	19 677	22 712	22 917	3.0%	3 240	16%	205	1%	M,NA,T2	CS,M,NA
Bulgaria	5 784	9 635	9 583	1.3%	3 799	66%	-52	-1%	NA,T1,T2	CR,D,NA
Croatia	3 506	5 979	6 442	0.9%	2 936	84%	463	8%	NA,T1	D,NA
Cyprus	1 191	2 034	2 004	0.3%	813	68%	-30	-1%	NA,T1,T2	D,M,NA
Czechia	10 251	18 432	18 917	2.5%	8 666	85%	484	3%	NA,T2	M,NA
Denmark	9 337	11 200	11 135	1.5%	1 799	19%	-65	-1%	NA,T2	CR,CS,D,NA
Estonia	2 235	2 281	2 348	0.3%	113	5%	67	3%	NA,NO,T2	CS,NA,NO
Finland	10 804	9 383	9 156	1.2%	-1 648	-15%	-226	-2%	NA,T2	CS,NA
France	114 051	116 698	120 057	15.9%	6 006	5%	3 359	3%	NA	NA
Germany	151 890	139 668	142 447	18.8%	-9 442	-6%	2 780	2%	CS,M,NA,T2,T3	CS,D,M,NA
Greece	11 793	14 264	15 213	2.0%	3 420	29%	950	7%	NA,T1,T2,T3	CS,D,NA
Hungary	7 851	13 601	14 714	1.9%	6 863	87%	1 113	8%	NA,T1,T2	CS,D,NA
Ireland	4 690	10 328	11 020	1.5%	6 329	135%	692	7%	NA,T2,T3	CS,M,NA
Italy	92 332	94 635	99 435	13.2%	7 104	8%	4 800	5%	NA,T2	CS,M,NA
Latvia	2 402	3 099	3 021	0.4%	619	26%	-78	-3%	NA,T1,T2	CS,D,NA
Lithuania	5 247	5 839	5 803	0.8%	556	11%	-36	-1%	NA,T1,T2	CS,D,NA
Luxembourg	2 572	4 859	4 164	0.6%	1 591	62%	-696	-14%	NA,T1,T2	CS,D,NA
Malta	333	547	660	0.1%	327	98%	113	21%	NA,T1	D,NA
Netherlands	26 251	24 345	24 122	3.2%	-2 130	-8%	-223	-1%	NA,T1,T2	CS,NA
Poland	18 440	66 459	67 896	9.0%	49 456	268%	1 436	2%	NA,NO,T2	D,NA,NO
Portugal	10 001	15 174	16 166	2.1%	6 165	62%	992	7%	NA,NO,T2	NA,NO,OTH
Romania	10 366	18 557	20 185	2.7%	9 819	95%	1 627	9%	NA,T3	NA,OTH
Slovakia	4 503	7 226	7 584	1.0%	3 081	68%	358	5%	NA,T2	CS,D,NA
Slovenia	2 607	5 124	5 709	0.8%	3 102	119%	585	11%	M,NA	M,NA
Spain	50 429	79 279	82 594	10.9%	32 165	64%	3 316	4%	CR,NA	CR,CS,NA
Sweden	17 407	14 051	12 421	1.6%	-4 986	-29%	-1 630	-12%	D,T2	CS
EU-27	**609 231**	**736 561**	**755 844**	**100%**	**146 613**	**24%**	**19 283**	**3%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Table 3.57 shows the share of different fuels in total EU fuel consumption for road transport in 2022. Diesel oil has the largest percentage with 65.6 %, followed by gasoline with 25.1%, biomass 6.3 %, LPG 2.1 %, gaseous fuels 0.5 %, and other fossil fuels 0.3 %.

Table 3.64 1A3b Road Transportation: Share of different fuels in total EU consumption (2022)

Diesel oil	Gasoline	Biomass	Liquefied petroleum gases (LPG)	Gaseous fuels	Other fossil
65.6 %	25.1 %	6.3 %	2.1 %	0.5%	0.3 %

1A3b Road Transportation – Diesel Oil (CO_2)

CO_2 emissions from diesel oil accounted for 69.9 % of total GHG emissions from road transport in 2022. Table 3.8 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3b Road transportation – diesel oil. Between 1990 and 2022, CO_2 emissions increased by 97 % in the EU, while between 2021 and 2022 the corresponding change was 1 % increase. Top three countries in 2022 were Germany, France, Italy, which accounted for the 47 % of the EU value.

Table 3.8 1A3b Road Transportation – Diesel Oil: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	5 358	16 829	15 639	2.9%	10 281	192%	-1 189	-7%
Belgium	11 027	16 907	16 376	3.1%	5 349	49%	-531	-3%
Bulgaria	1 539	6 779	6 620	1.2%	5 081	330%	-159	-2%
Croatia	1 159	4 454	4 859	0.9%	3 700	319%	404	9%
Cyprus	671	1 050	1 005	0.2%	334	50%	-45	-4%
Czechia	6 655	13 584	13 860	2.6%	7 205	108%	276	2%
Denmark	4 417	7 552	7 450	1.4%	3 034	69%	-101	-1%
Estonia	693	1 633	1 682	0.3%	989	143%	49	3%
Finland	4 923	5 963	5 993	1.1%	1 070	22%	30	1%
France	54 622	91 011	91 608	17.2%	36 986	68%	598	1%
Germany	54 478	91 887	92 208	17.3%	37 731	69%	321	0%
Greece	4 264	7 232	8 100	1.5%	3 836	90%	867	12%
Hungary	2 388	9 369	10 226	1.9%	7 837	328%	857	9%
Ireland	1 914	8 501	8 937	1.7%	7 023	367%	436	5%
Italy	47 808	66 254	68 668	12.9%	20 860	44%	2 414	4%
Latvia	623	2 487	2 493	0.5%	1 870	300%	6	0%
Lithuania	2 134	4 846	4 739	0.9%	2 605	122%	-107	-2%
Luxembourg	1 286	3 884	3 173	0.6%	1 887	147%	-710	-18%
Malta	150	323	414	0.1%	264	176%	91	28%
Netherlands	13 008	13 279	12 785	2.4%	-224	-2%	-494	-4%
Poland	8 769	46 705	47 092	8.8%	38 324	437%	388	1%
Portugal	5 625	12 006	12 684	2.4%	7 059	125%	679	6%
Romania	3 648	14 389	15 921	3.0%	12 272	336%	1 531	11%
Slovakia	3 123	5 586	5 780	1.1%	2 658	85%	194	3%
Slovenia	867	3 971	4 395	0.8%	3 528	407%	424	11%
Spain	24 706	62 525	64 082	12.0%	39 376	159%	1 557	2%
Sweden	4 518	8 400	7 146	1.3%	2 628	58%	-1 254	-15%
EU-27	**270 372**	**527 406**	**533 937**	**100%**	**263 564**	**97%**	**6 531**	**1%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Figure 3.113 shows the time series of CO_2 emissions in EU from road transport – diesel oil and the highest shares of countries. Figure 3.114 shows the CO_2 implied emission factor (IEF) in EU. It is observed that the CO_2 IEF at EU level is almost constant over the years at 74 t/TJ.

Figure 3.92 1A3b Road Transportation - Diesel Oil: Time series of CO_2 emissions in EU and highest shares of countries

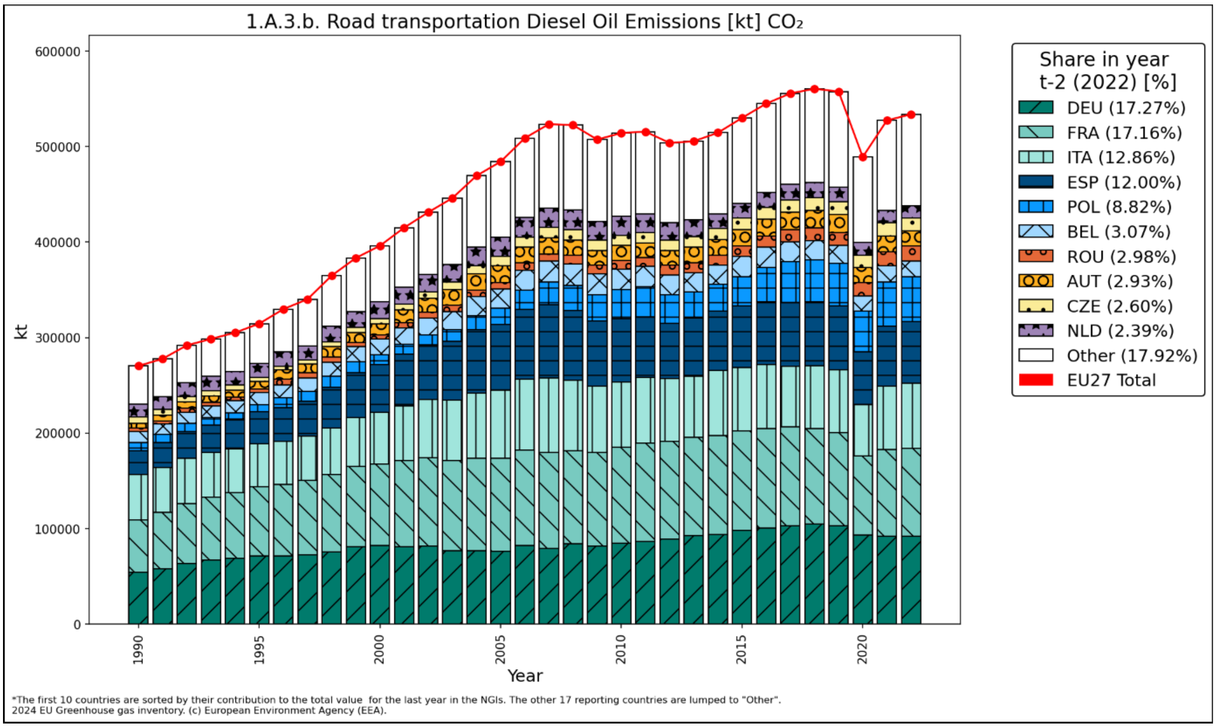
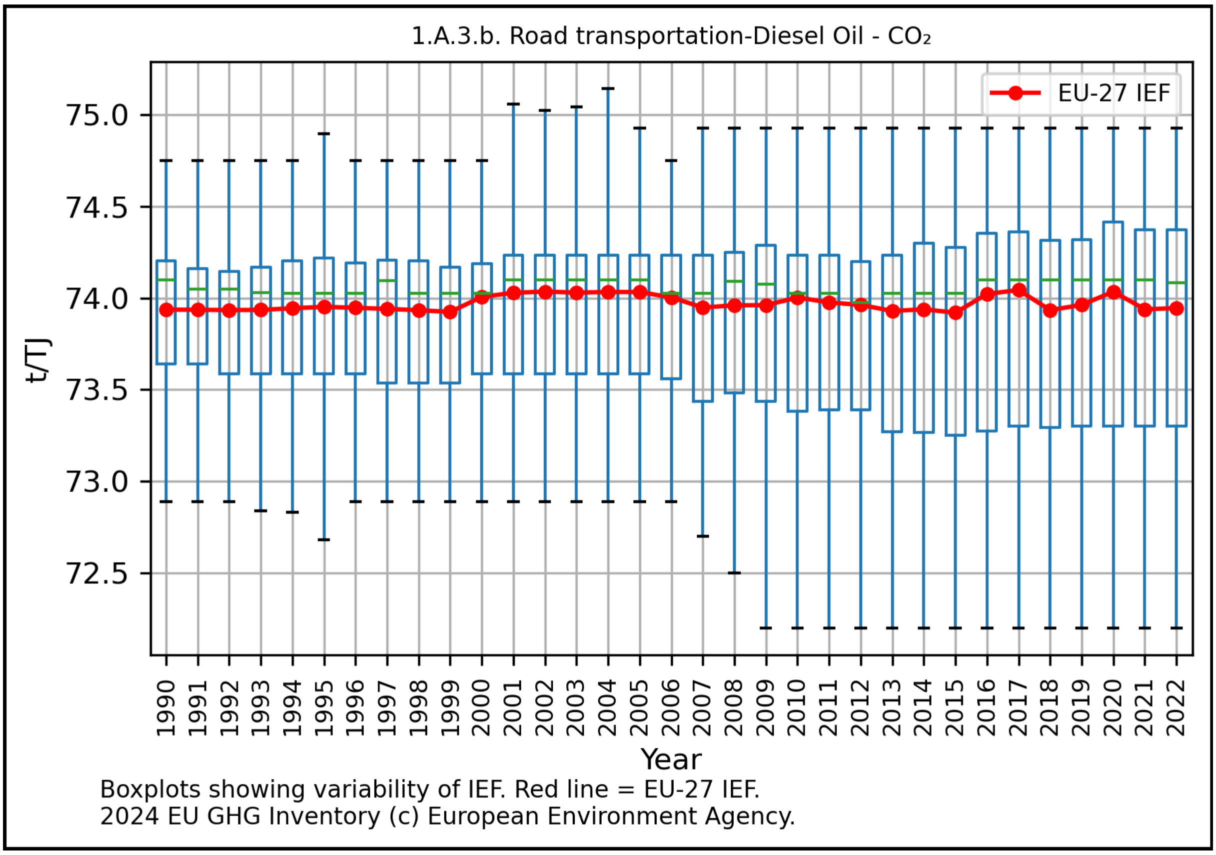


Figure 3.93 1A3b Road Transportation – Diesel Oil: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



1A3b Road Transportation – Gasoline (CO_2)

CO_2 emissions from gasoline accounted for 26.3 % of total GHG emissions from road transport in 2022. Table 3.9 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3b Road transportation – gasoline. Between 1990 and 2022, CO_2 emissions decreased by 39 % in the EU, while between 2021 and 2022 the corresponding change was 7 % increase. Top three countries in 2022 were Germany, France, Italy, which accounted for the 50 % of the EU value.

Table 3.9 1A3b Road Transportation – Gasoline: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	7 896	4 213	4 389	2.2%	-3 507	-44%	176	4%
Belgium	8 479	5 467	6 228	3.1%	-2 252	-27%	760	14%
Bulgaria	4 241	1 508	1 575	0.8%	-2 666	-63%	68	4%
Croatia	2 347	1 336	1 434	0.7%	-913	-39%	98	7%
Cyprus	519	978	993	0.5%	474	91%	15	2%
Czechia	3 596	4 405	4 598	2.3%	1 001	28%	193	4%
Denmark	4 910	3 601	3 641	1.8%	-1 270	-26%	40	1%
Estonia	1 542	578	614	0.3%	-928	-60%	36	6%
Finland	5 880	3 398	3 162	1.6%	-2 719	-46%	-236	-7%
France	59 268	24 898	27 454	13.6%	-31 814	-54%	2 556	10%
Germany	97 217	46 415	48 790	24.2%	-48 427	-50%	2 375	5%
Greece	7 438	6 326	6 391	3.2%	-1 048	-14%	65	1%
Hungary	5 429	4 143	4 395	2.2%	-1 033	-19%	252	6%
Ireland	2 758	1 793	2 042	1.0%	-716	-26%	250	14%
Italy	39 949	21 994	24 616	12.2%	-15 333	-38%	2 621	12%
Latvia	1 722	495	423	0.2%	-1 299	-75%	-72	-14%
Lithuania	3 053	697	770	0.4%	-2 283	-75%	73	10%
Luxembourg	1 275	963	978	0.5%	-297	-23%	15	2%
Malta	183	222	244	0.1%	60	33%	22	10%
Netherlands	10 664	10 604	10 863	5.4%	199	2%	259	2%
Poland	9 671	14 131	14 974	7.4%	5 303	55%	843	6%
Portugal	4 370	3 016	3 296	1.6%	-1 073	-25%	281	9%
Romania	6 591	3 933	4 030	2.0%	-2 560	-39%	97	2%
Slovakia	1 380	1 492	1 646	0.8%	266	19%	154	10%
Slovenia	1 740	1 082	1 260	0.6%	-480	-28%	178	16%
Spain	25 639	15 789	17 426	8.7%	-8 213	-32%	1 637	10%
Sweden	12 886	5 584	5 217	2.6%	-7 668	-60%	-367	-7%
EU-27	**330 645**	**189 060**	**201 449**	**100%**	**-129 196**	**-39%**	**12 389**	**7%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Figure 3.115 shows the time series of CO_2 emissions in EU from road transport – gasoline and the highest shares of countries. Figure 3.116 shows the CO_2 implied emission factor (IEF) in EU. It is observed that the CO_2 IEF at EU level is almost constant over the years at 73 t/TJ.

Figure 3.94 1A3b Road Transportation – Gasoline: Time series of CO_2 emissions in EU and highest shares of countries

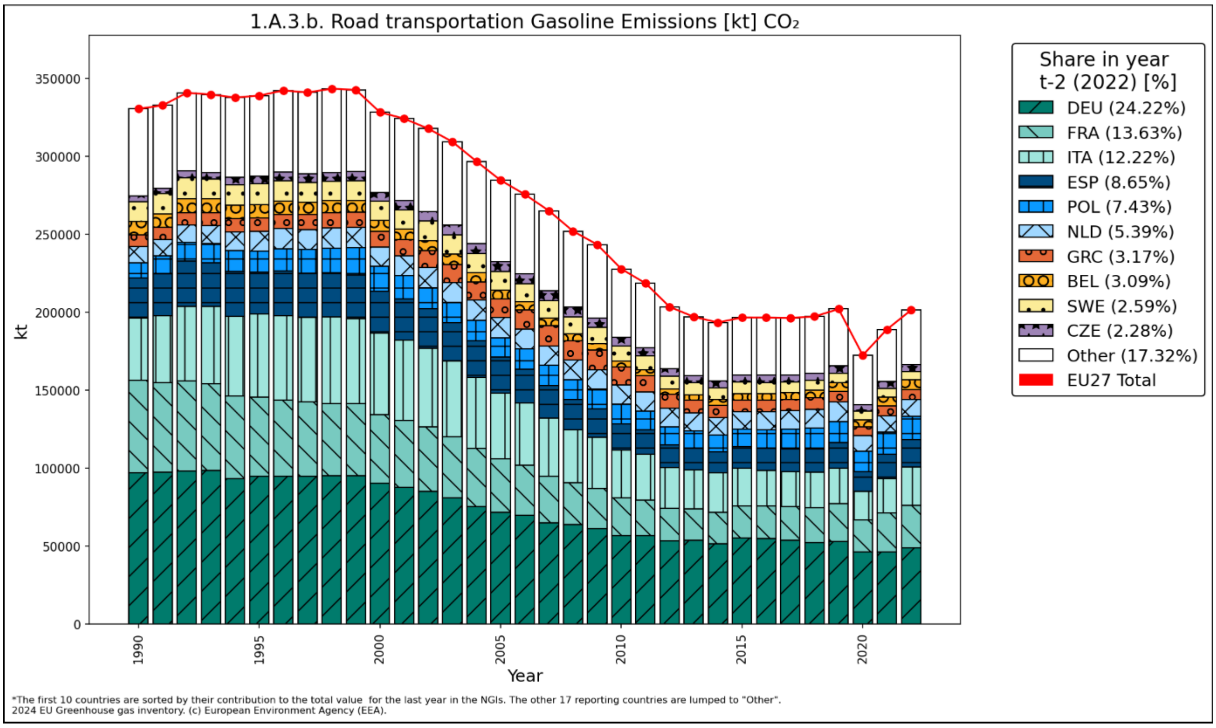
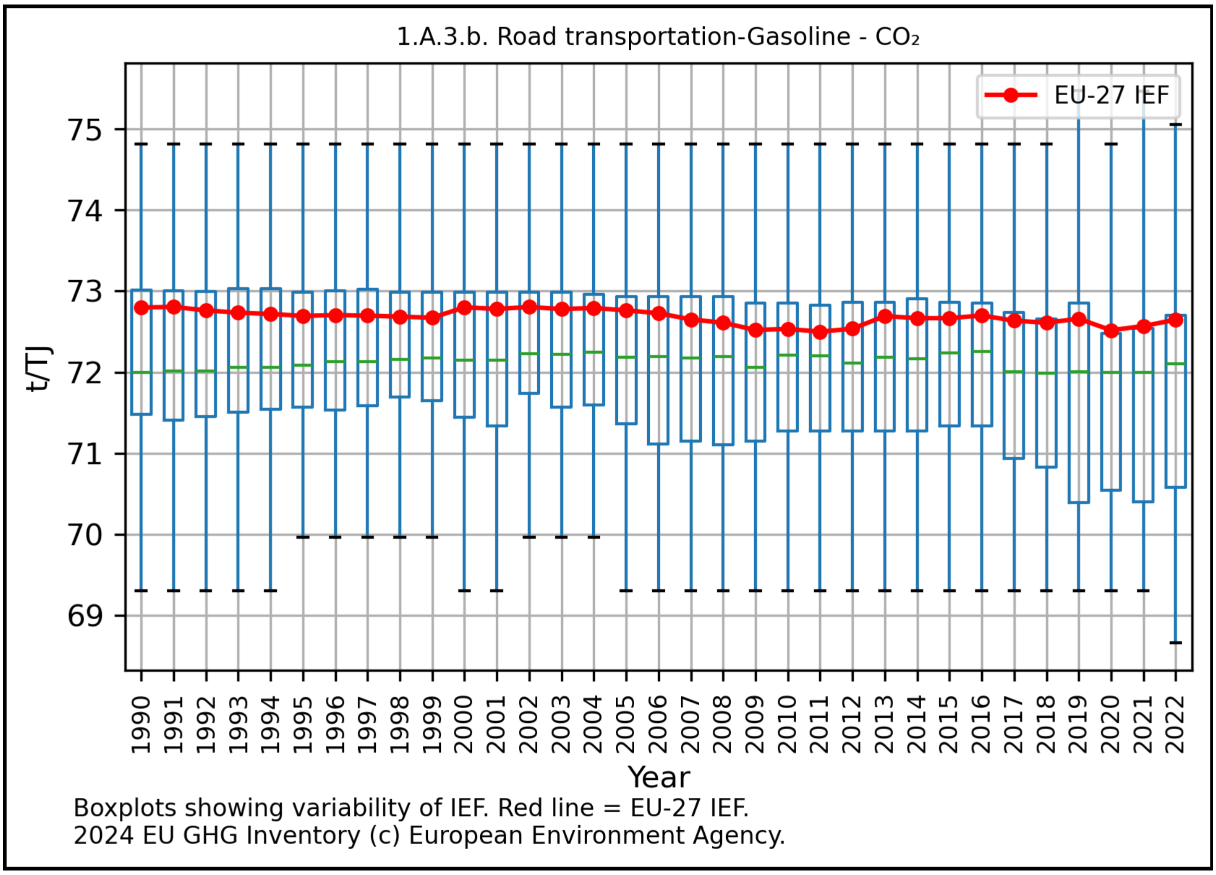


Figure 3.95 1A3b Road Transportation – Gasoline: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



1A3b Road Transportation – LPG (CO_2)

CO_2 emissions from LPG accounted for 2 % of total GHG emissions from road transport in 2022. Table 3.10 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3b Road transportation – LPG. Between 1990 and 2022, CO_2 emissions increased by 108 % in the EU, while between 2021 and 2022 the corresponding change was 7 % increase. Top three countries in 2022 were Poland, Italy, Bulgaria, which accounted for the 76 % of the EU value.

Table 3.10 1A3b Road Transportation – LPG: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	26	10	7	0.0%	-20	-75%	-3	-33%
Belgium	169	129	129	0.9%	-40	-24%	1	0%
Bulgaria	NO	1 107	1 209	8.0%	1 209	∞	102	9%
Croatia	NO	164	137	0.9%	137	∞	-26	-16%
Cyprus	NO	1	1	0.0%	1	∞	0	9%
Czechia	NO	227	257	1.7%	257	∞	30	13%
Denmark	10	0	0	0.0%	-10	-100%	0	-2%
Estonia	1	28	29	0.2%	28	4763%	1	4%
Finland	NA,NO	NA,NO	NA,NO	-	-	-	-	-
France	150	149	251	1.7%	101	67%	101	68%
Germany	9	673	782	5.2%	773	8549%	110	16%
Greece	91	519	525	3.5%	434	479%	6	1%
Hungary	NO	38	38	0.3%	38	∞	0	0%
Ireland	19	3	4	0.0%	-14	-77%	1	39%
Italy	4 026	4 257	4 646	30.8%	620	15%	388	9%
Latvia	37	104	95	0.6%	57	155%	-9	-9%
Lithuania	60	258	259	1.7%	199	330%	0	0%
Luxembourg	11	1	1	0.0%	-11	-93%	0	0%
Malta	NA,NO	2	2	0.0%	2	∞	0	7%
Netherlands	2 578	269	291	1.9%	-2 287	-89%	22	8%
Poland	IE,NO	5 421	5 615	37.2%	5 615	∞	194	4%
Portugal	0	94	105	0.7%	105	166017%	11	12%
Romania	NO	235	234	1.5%	234	∞	-1	-1%
Slovakia	NO	117	113	0.8%	113	∞	-4	-3%
Slovenia	NO	44	30	0.2%	30	∞	-15	-33%
Spain	79	251	325	2.2%	246	313%	73	29%
Sweden	0	IE,NO	IE,NO	-	0	-100%	-	-
EU-27	**7 266**	**14 101**	**15 085**	**100%**	**7 818**	**108%**	**983**	**7%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

1A3b Road Transportation – Gaseous Fuels (CO_2)

CO_2 emissions from gaseous fuels accounted for 0.4 % of total GHG emissions from road transport in 2022. Table 3.8 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3b Road transportation – gaseous fuels. Between 1990 and 2022, CO_2 emissions increased by 624 % in the EU, while between 2021 and 2022 the corresponding change was 13 % decrease. Top three countries in 2022 were Italy, France, Spain, which accounted for the 71 % of the EU value.

Table 3.8 1A3b Road Transportation – Gaseous Fuels: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	43	40	1.1%	40	∞	-2	-5%
Belgium	IE,NO	42	43	1.2%	43	∞	1	3%
Bulgaria	NO	215	150	4.1%	150	∞	-65	-30%
Croatia	NO	9	9	0.2%	9	∞	-1	-10%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	179	168	4.6%	168	∞	-11	-6%
Denmark	0	17	18	0.5%	18	115955%	1	4%
Estonia	NO	40	24	0.6%	24	∞	-16	-41%
Finland	NA,NO	22	1	0.0%	1	∞	-21	-94%
France	0	636	739	20.1%	739	207508%	103	16%
Germany	NA	205	175	4.8%	175	∞	-29	-14%
Greece	NO	55	65	1.8%	65	∞	11	20%
Hungary	0	17	18	0.5%	18	5847%	1	5%
Ireland	NO	4	2	0.0%	2	∞	-2	-58%
Italy	487	1 901	1 281	34.9%	794	163%	-620	-33%
Latvia	17	3	5	0.1%	-12	-72%	2	56%
Lithuania	NO	23	23	0.6%	23	∞	0	-2%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	146	146	4.0%	146	∞	0	0%
Poland	NO	66	67	1.8%	67	∞	0	1%
Portugal	NO	57	78	2.1%	78	∞	21	37%
Romania	NO	0	0	0.0%	0	∞	0	33%
Slovakia	NO	8	20	0.5%	20	∞	11	135%
Slovenia	NO	11	12	0.3%	12	∞	1	6%
Spain	NO	517	574	15.6%	574	∞	57	11%
Sweden	3	22	15	0.4%	12	424%	-7	-32%
EU-27	**508**	**4 239**	**3 673**	**100%**	**3 165**	**624%**	**-566**	**-13%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Figure 3.117 shows the time series of CO_2 emissions in EU from road transport – gaseous fuels and the highest shares of countries. Figure 3.118 shows the CO_2 implied emission factor (IEF) in EU It is observed that the CO_2 IEF at EU level is almost constant over the years at 56 - 57 t/TJ.

Figure 3.96: 1A3b Road Transportation – Gaseous Fuels: Time series of CO_2 emissions in EU and highest shares of countries

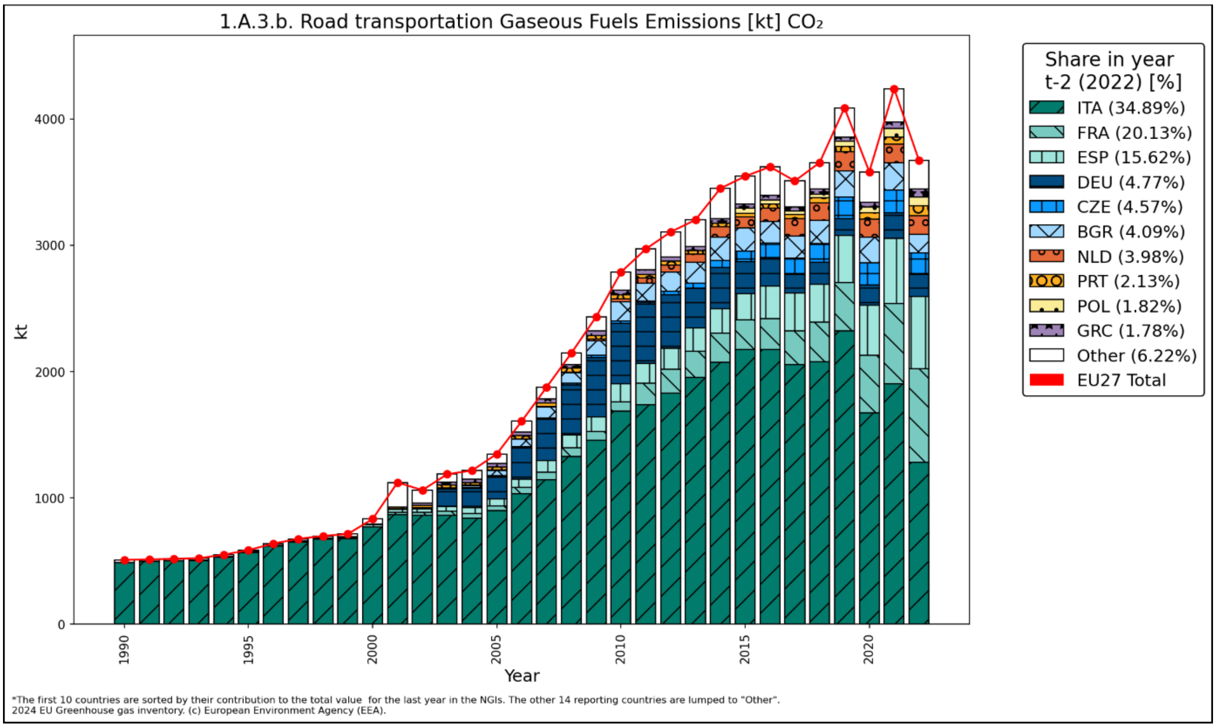
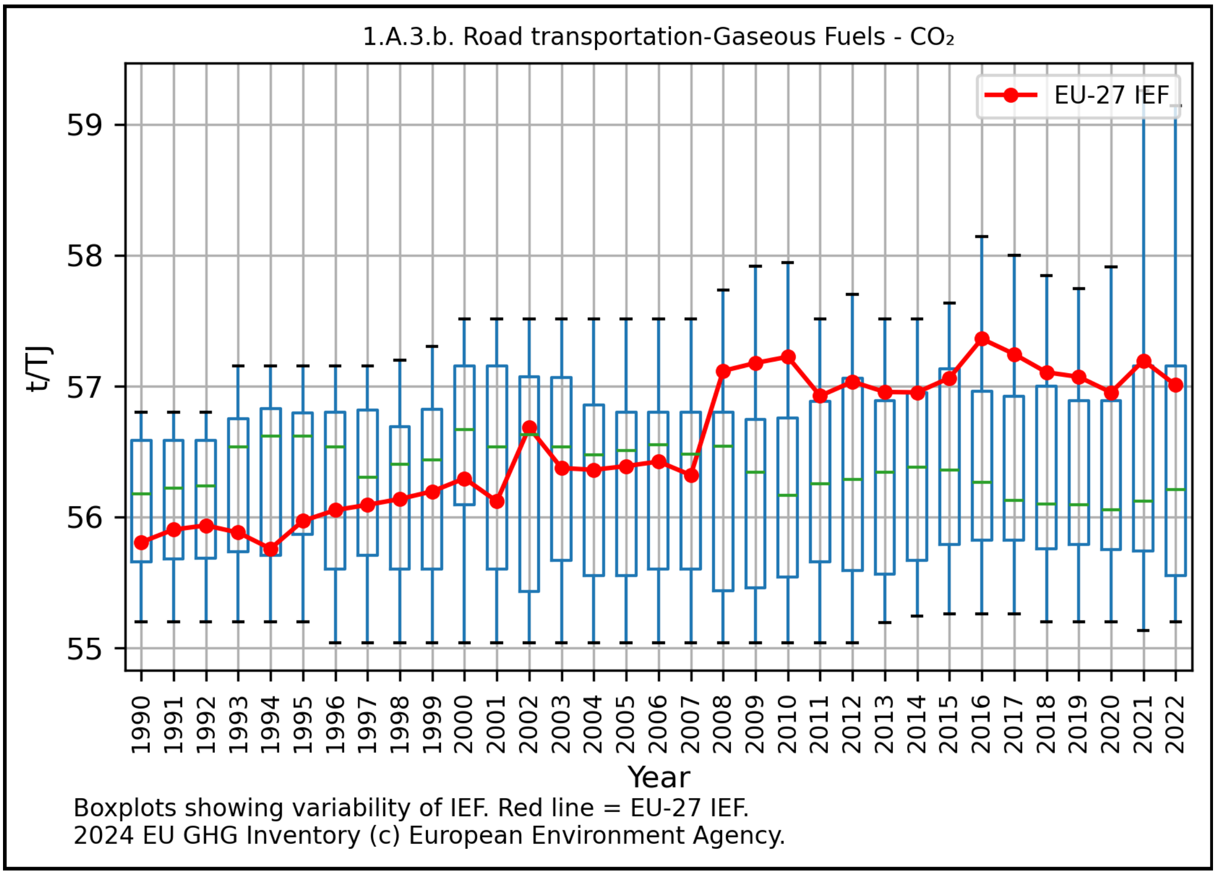


Figure 3.97 1A3b Road Transportation – Gaseous Fuels: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



1.A.3.b Road Transportation: Other Fossil Fuels (CO_2)

This category covers the CO_2 emissions from the fossil part of biofuels. According to the 2006 IPCC Guidelines (vol. 2, chapter 3, section 'CO2 emissions from biofuels'. p. 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 Guidelines 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. Some processes may generate biogenic by-products such as glycol or glycerine, which may then be used elsewhere."*

Based on the above, all countries are encouraged to calculate these emissions and include them separately in the CRT tables under "Other fossil fuels". The contribution of this category to total GHG emissions from road transport was 0.3 % in 2022 (i.e. very small), hence, no further analysis per country is considered necessary.

CH_4 emissions from 1A3b Road Transportation

CH_4 emissions from road transport accounted only for 0.035 % of total GHG emissions in EU, 2022 (including indirect CO_2, with LULUCF and international aviation). Considering only road transport, CH_4 accounted for 0.15 % of total GHG emissions from road transport in EU, 2022.

The time series of CH_4 emissions and activity data from 1A3b Road transportation, years 1990-2022, are shown in Figure 3.119. From this figure it can be observed that the largest contribution to emissions comes from the usage of gasoline.

Figure 3.98 1A3b Road Transportation: CH_4 emissions (in Mt of CO_2 equ.) and activity data (in TJ)

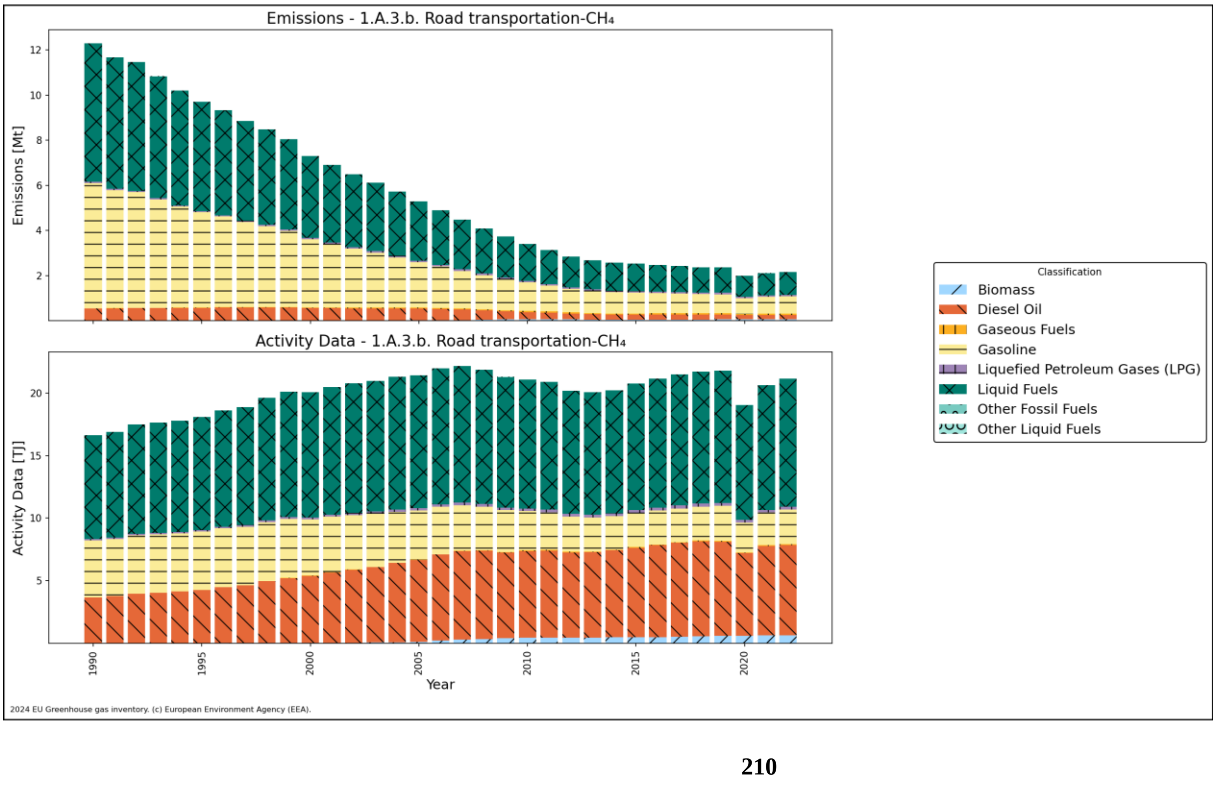


Table 3.58 shows the CH_4 emissions per country and at EU level (in kt of CO_2 equ.), share of each country in EU (%), change between years, method and EF information for 1A3b Road transportation. Between 1990 and 2022, CH_4 emissions decreased by 81 % in the EU, while between 2021 and 2022 the corresponding change was 3 % increase. Top three countries in 2022 were Germany, Italy, France, which accounted for the 48 % of the EU value.

Table 3.65 1A3b Road Transportation: CH_4 emissions per country (in kt of CO_2 equ.), share in EU (%), change, method and EF information

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	82	21	21	1.8%	-61	-75%	0	0%	NA,T3	CS,NA
Belgium	156	20	22	1.9%	-134	-86%	2	9%	M,NA,T3	CS,M,NA
Bulgaria	76	22	21	1.8%	-55	-73%	-2	-7%	NA,T2	CR,NA
Croatia	46	10	8	0.7%	-38	-82%	-2	-18%	NA,T1,T3	CR,D,NA
Cyprus	8	3	3	0.3%	-5	-58%	0	0%	NA,T1,T2	D,M,NA
Czechia	86	25	25	2.2%	-61	-71%	0	-1%	NA,T3	M,NA
Denmark	88	8	8	0.7%	-79	-91%	0	-2%	NA,T3	CR,NA
Estonia	24	3	3	0.3%	-21	-87%	0	2%	NA,NO,T3	CS,NA,NO
Finland	120	8	8	0.7%	-111	-93%	0	-1%	NA,T3	CR,NA
France	1 073	136	143	12.5%	-930	-87%	7	5%	NA	NA
Germany	1 813	222	234	20.4%	-1 579	-87%	12	5%	CS,M,NA,T2,T3	CS,M,NA
Greece	120	64	65	5.7%	-54	-45%	1	2%	M,NA,T1,T2	D,M,NA
Hungary	75	23	24	2.1%	-52	-69%	1	2%	NA,T1,T3	D,M,NA
Ireland	55	8	9	0.8%	-46	-84%	1	11%	NA,T3	M,NA
Italy	969	169	176	15.4%	-793	-82%	7	4%	NA,T3	M,NA
Latvia	23	4	3	0.3%	-20	-86%	0	-10%	NA,T1,T3	CR,D,M,NA
Lithuania	44	8	7	0.7%	-37	-83%	0	-2%	NA,T1,T3	CR,D,NA
Luxembourg	14	3	3	0.3%	-11	-75%	0	1%	NA,T3	M,NA
Malta	3	1	1	0.1%	-2	-64%	0	11%	NA,T3	M,NA
Netherlands	204	60	60	5.3%	-144	-70%	0	1%	NA,T1,T2,T3	CS,NA
Poland	177	102	99	8.7%	-78	-44%	-3	-3%	NA,NO,T2,T3	D,NA,NO
Portugal	109	21	22	1.9%	-87	-80%	1	7%	NA,NO,T3	NA,NO,OTH
Romania	101	37	37	3.3%	-64	-63%	1	1%	NA,T1,T3	D,NA,OTH
Slovakia	33	5	6	0.5%	-27	-82%	1	12%	NA,T3	D,NA
Slovenia	31	5	5	0.4%	-26	-84%	0	6%	M,NA	M,NA
Spain	446	104	107	9.3%	-340	-76%	2	2%	CR,NA	CR,NA
Sweden	178	23	23	2.0%	-155	-87%	-1	-2%	M,T1,T2	CS,D
EU-27	**6 152**	**1 116**	**1 144**	**100%**	**-5 008**	**-81%**	**28**	**3%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

1A3b Road Transportation – Gasoline (CH_4)

CH_4 emissions from gasoline accounted for 0.10 % of total GHG emissions from road transport in 2022. Table 3.59 shows the CH_4 emissions per country and at EU level (in kt of CO_2 equ.), share of each country in EU (%), change between years, method and EF information for 1A3b Road transportation – gasoline. Between 1990 and 2022, CH_4 emissions decreased by 86 % in the EU, while between 2021 and 2022 the corresponding change was 3 % increase. Top three countries in 202 were Germany, Italy, France, which accounted for the 50 % of the EU value.

Table 3.66 1A3b Road Transportation – Gasoline: CH_4 emissions per country (in kt of CO_2 equ.), share in EU (%), change, method and EF information

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	77	7	7	0.9%	-70	-91%	0	-4%
Belgium	129	15	17	2.3%	-112	-87%	2	12%
Bulgaria	72	7	7	1.0%	-64	-90%	0	-1%
Croatia	43	7	5	0.7%	-38	-88%	-1	-22%
Cyprus	6	3	3	0.4%	-4	-57%	0	1%
Czechia	66	17	17	2.2%	-48	-74%	0	0%
Denmark	77	7	7	0.9%	-70	-91%	0	-3%
Estonia	22	2	2	0.3%	-20	-91%	0	-2%
Finland	104	6	6	0.7%	-99	-95%	0	-6%
France	964	100	103	13.5%	-861	-89%	4	4%
Germany	1 762	144	151	19.6%	-1 611	-91%	7	5%
Greece	109	47	47	6.2%	-62	-57%	0	0%
Hungary	68	16	17	2.2%	-51	-75%	1	3%
Ireland	49	6	7	0.9%	-42	-85%	1	16%
Italy	821	121	129	16.9%	-691	-84%	9	7%
Latvia	20	2	1	0.2%	-19	-93%	0	-15%
Lithuania	36	2	3	0.3%	-34	-93%	0	7%
Luxembourg	13	1	1	0.1%	-12	-92%	0	-1%
Malta	2	1	1	0.1%	-2	-69%	0	8%
Netherlands	164	47	48	6.2%	-117	-71%	0	1%
Poland	155	51	51	6.7%	-103	-67%	0	0%
Portugal	94	14	15	1.9%	-79	-84%	1	8%
Romania	91	24	24	3.1%	-67	-74%	0	-1%
Slovakia	23	3	3	0.4%	-20	-85%	0	9%
Slovenia	28	4	4	0.5%	-24	-86%	0	11%
Spain	384	78	79	10.4%	-305	-79%	2	2%
Sweden	174	12	12	1.5%	-162	-93%	-1	-5%
EU-27	**5 556**	**743**	**767**	**100%**	**-4 788**	**-86%**	**24**	**3%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Figure 3.120 shows the time series of CH_4 emissions in EU from road transport – gasoline and the highest shares of countries. Figure 3.121 shows the CH_4 implied emission factor (IEF) in EU. It is observed that the CH_4 IEF at EU level decreases over time from 44 kg/TJ in 1990 to 10 kg/TJ in 2022.

Figure 3.99 1A3b Road Transportation – Gasoline: Time series of CH_4 emissions in EU and highest shares of countries

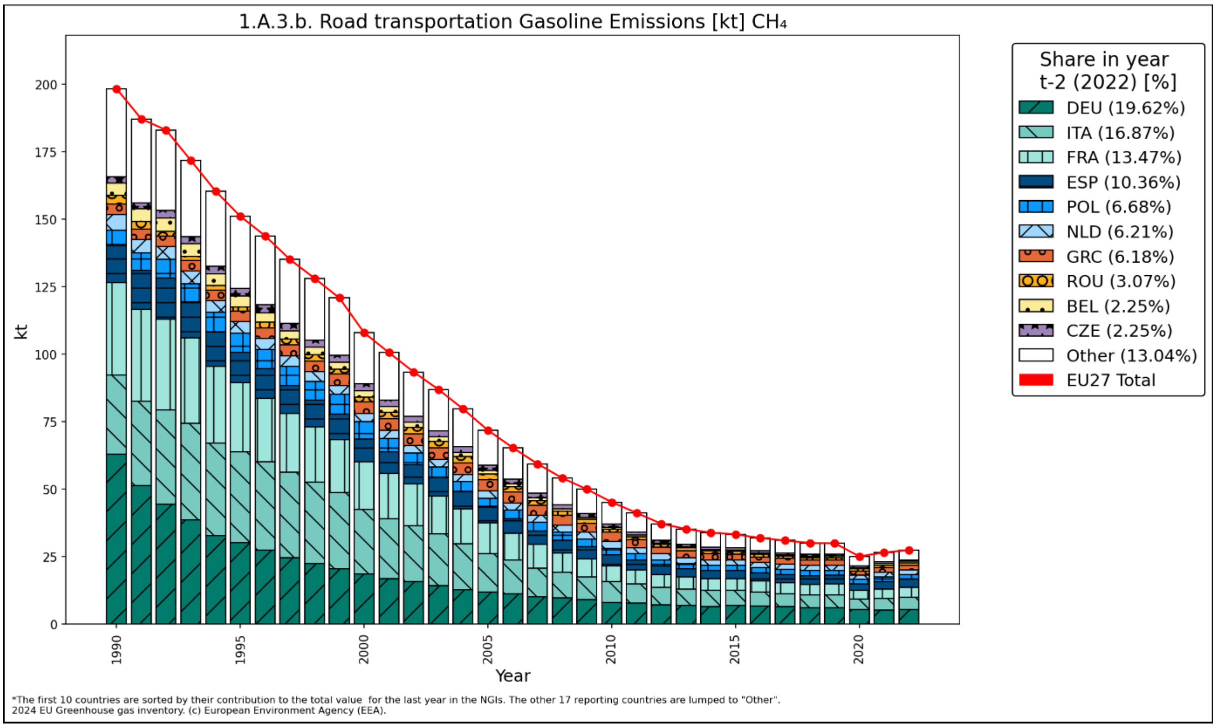
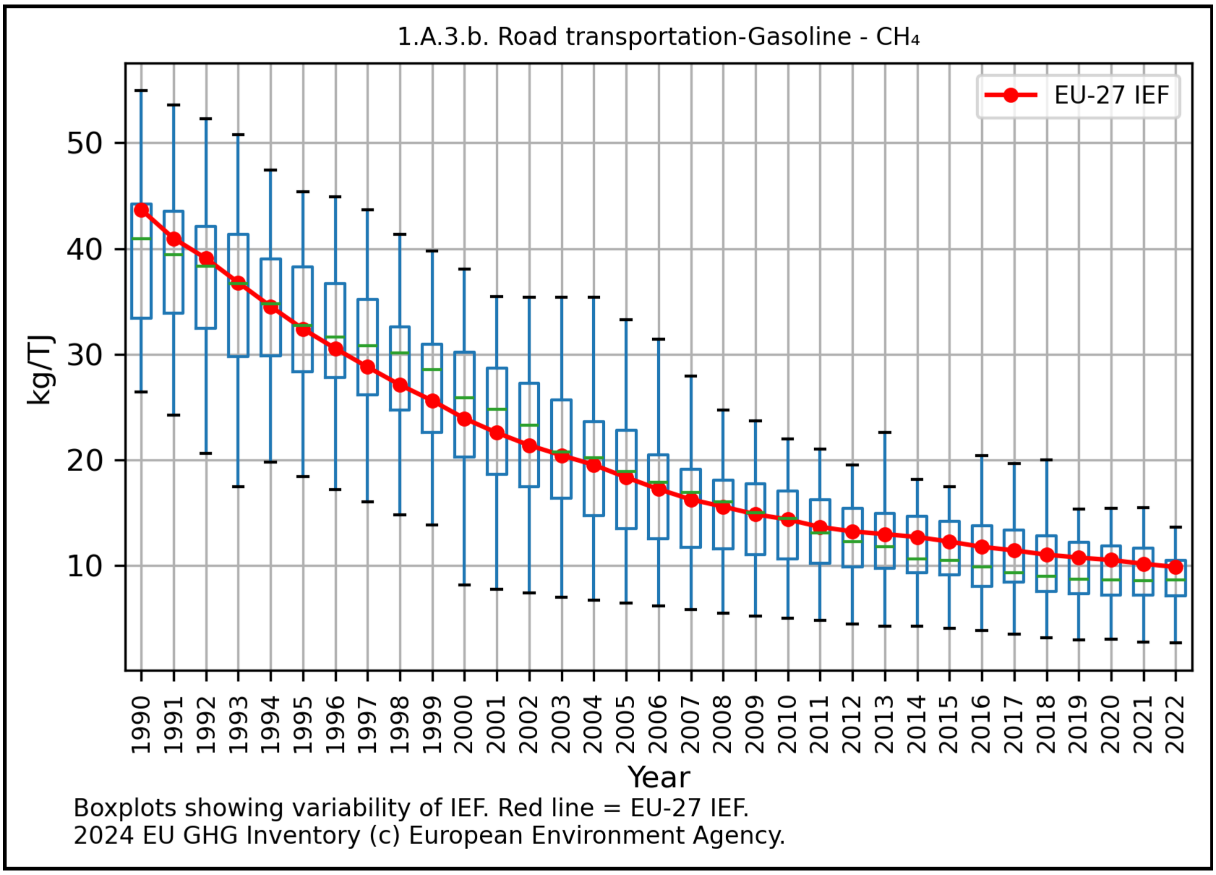


Figure 3.100 1A3b Road Transportation – Gasoline: CH_4 Implied Emission Factor (IEF) in EU and per country (in kg/TJ)



N_2O emissions from 1A3b Road Transportation

N_2O emissions from road transport accounted only for 0.22 % of total GHG emissions in EU, 2022 (including indirect CO_2, with LULUCF and international aviation). Considering only road transport, N_2O accounted for 0.93 % of total GHG emissions from road transport in EU, 2022.

The time series of N_2O emissions and activity data from 1A3b Road transportation, years 1990-2022, are shown in Figure 3.122. From this figure it can be observed that the largest contribution to emissions comes from the usage of diesel oil since 2006; for years prior to 2006 the higher contribution was coming from gasoline.

Figure 3.101 1A3b Road Transportation: N_2O emissions (in Mt of CO_2 equ.) and activity data (in TJ)

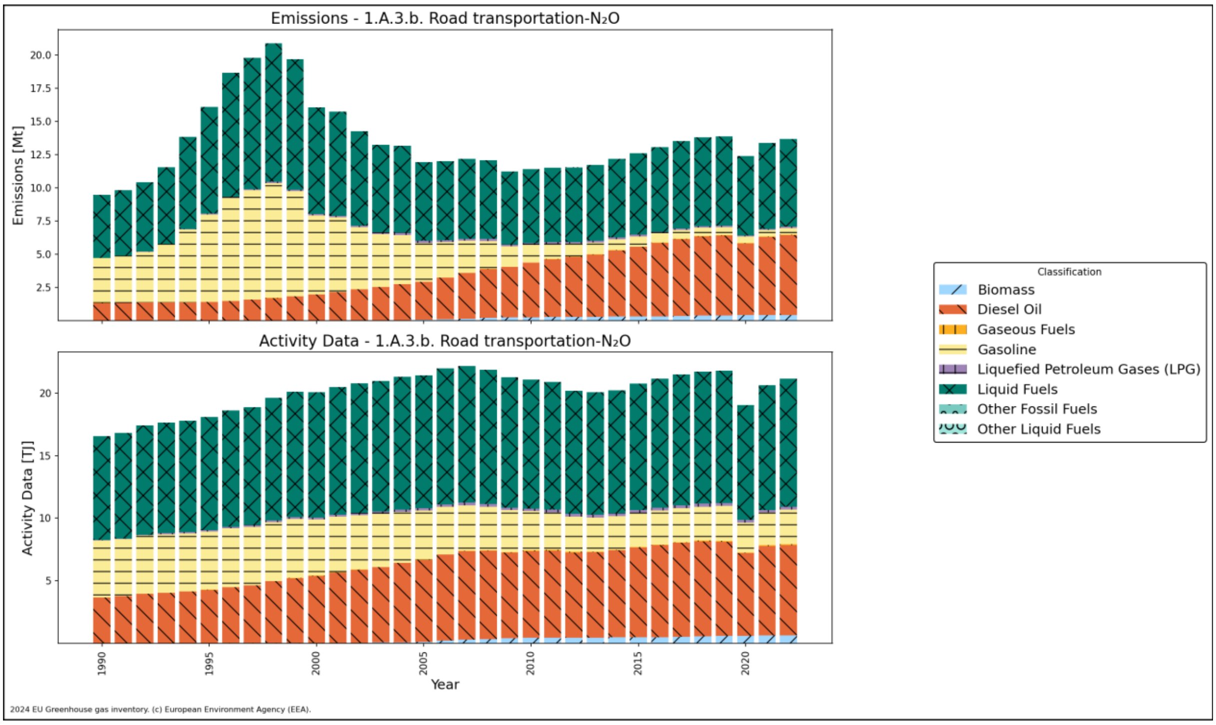


Table 3.60 shows the N_2O emissions per country and at EU level (in kt of CO_2 equ.), share of each country in EU (%), change between years, method and EF information for 1A3b Road transportation. Between 1990 and 2022, N_2O emissions increased by 50 % in the EU, while between 2021 and 2022 the corresponding change was 2 % increase. Top three countries in 2022 were Germany, France, Italy, which accounted for the 47 % of the EU value.

Table 3.67 1A3b Road Transportation: N_2O emissions per country (in kt of CO_2 equ.), share in EU (%), change, method and EF information

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	94	220	209	3.0%	115	123%	-11	-5%	NA,T3	CS,NA
Belgium	140	223	221	3.1%	81	58%	-2	-1%	M,NA,T3	CS,M,NA
Bulgaria	47	84	85	1.2%	38	80%	0	0%	NA,T2	CR,NA
Croatia	52	48	49	0.7%	-3	-6%	1	2%	NA,T1,T3	CR,D,NA
Cyprus	10	13	12	0.2%	3	28%	0	-4%	NA,T1,T2	D,M,NA
Czechia	83	172	174	2.5%	92	111%	3	2%	NA,T3	M,NA
Denmark	77	112	111	1.6%	34	44%	-1	-1%	NA,T3	CR,NA
Estonia	19	20	21	0.3%	2	9%	1	5%	NA,NO,T3	CS,NA,NO
Finland	137	73	71	1.0%	-66	-48%	-2	-3%	NA,T3	CR,NA
France	791	1 117	1 136	16.0%	344	43%	19	2%	NA	NA
Germany	1 123	1 337	1 352	19.1%	229	20%	15	1%	CS,M,NA,T2,T3	CS,M,NA
Greece	104	99	106	1.5%	2	2%	8	8%	M,NA,T1,T2	D,M,NA
Hungary	54	127	138	1.9%	84	156%	10	8%	NA,T1,T3	D,M,NA
Ireland	44	103	111	1.6%	67	152%	8	8%	NA,T3	M,NA
Italy	745	823	850	12.0%	104	14%	26	3%	NA,T3	M,NA
Latvia	19	28	27	0.4%	8	43%	-1	-3%	NA,T1,T3	CR,D,M,NA
Lithuania	44	48	49	0.7%	5	11%	1	3%	NA,T1,T3	CR,D,NA
Luxembourg	14	48	43	0.6%	29	212%	-5	-11%	NA,T3	M,NA
Malta	2	3	4	0.1%	2	78%	1	23%	NA,T3	M,NA
Netherlands	89	189	180	2.5%	91	101%	-9	-5%	NA,T1,T2	CS,NA
Poland	146	663	690	9.7%	544	372%	27	4%	NA,NO,T2,T3	D,NA
Portugal	70	139	150	2.1%	80	115%	11	8%	NA,NO,OTH,T3	CR,NA,NO,OTH
Romania	202	193	213	3.0%	11	6%	20	10%	NA,T1,T3	D,NA,OTH
Slovakia	50	72	75	1.1%	24	49%	3	4%	NA,T3	D,NA
Slovenia	27	51	55	0.8%	28	107%	3	7%	M,NA	M,NA
Spain	413	769	790	11.2%	377	91%	21	3%	CR,NA	CR,NA
Sweden	138	160	160	2.3%	22	16%	0	0%	M,T1,T2	CS,D
EU-27	**4 734**	**6 933**	**7 080**	**100%**	**2 346**	**50%**	**148**	**2%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

1A3b Road Transportation – Diesel Oil (N_2O)

N_2O emissions from diesel oil accounted for 0.79 % of total GHG emissions from road transport in 2022. Table 3.61 shows the N_2O emissions per country and at EU level (in kt of CO_2 equ.), share of each country in EU (%), change between years, method and EF information for 1A3b Road transportation – diesel oil. Between 1990 and 2022, N_2O emissions increased by 355 % in the EU, while between 2021 and 2022 the corresponding change was 2 % increase. Top three countries in 2022 were Germany, France, Spain, which accounted for the 48 % of the EU value.

Table 3.68 1A3b Road Transportation – Diesel Oil: N_2O emissions per country (in kt of CO_2 equ.), share in EU (%), change, method and EF information

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	11	199	190	3.2%	179	1672%	-10	-5%
Belgium	54	188	184	3.1%	130	241%	-4	-2%
Bulgaria	11	58	58	1.0%	46	420%	0	-1%
Croatia	15	41	44	0.7%	28	187%	3	8%
Cyprus	1	10	9	0.2%	9	1584%	0	-4%
Czechia	46	143	147	2.4%	101	219%	4	3%
Denmark	27	96	96	1.6%	69	259%	0	0%
Estonia	6	17	19	0.3%	12	193%	2	11%
Finland	58	49	50	0.8%	-8	-14%	1	2%
France	195	934	953	15.9%	759	390%	19	2%
Germany	129	1 194	1 206	20.1%	1 077	833%	12	1%
Greece	35	52	60	1.0%	25	72%	7	14%
Hungary	19	101	111	1.8%	92	489%	10	10%
Ireland	12	93	99	1.6%	86	694%	6	6%
Italy	305	684	708	11.8%	403	132%	24	3%
Latvia	6	24	24	0.4%	18	299%	0	1%
Lithuania	20	44	45	0.8%	25	125%	2	4%
Luxembourg	2	43	38	0.6%	35	1552%	-5	-12%
Malta	0	2	3	0.0%	2	527%	1	30%
Netherlands	24	143	136	2.3%	112	469%	-8	-5%
Poland	64	527	553	9.2%	489	764%	26	5%
Portugal	26	105	111	1.9%	85	329%	7	6%
Romania	27	148	165	2.8%	138	503%	18	12%
Slovakia	37	61	63	1.0%	26	70%	2	3%
Slovenia	9	44	48	0.8%	40	463%	4	9%
Spain	169	723	741	12.3%	572	340%	18	2%
Sweden	12	149	149	2.5%	137	1096%	1	0%
EU-27	**1 320**	**5 871**	**6 009**	**100%**	**4 689**	**355%**	**138**	**2%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Figure 3.124 shows the time series of N_2O emissions in EU from road transport – diesel oil and the highest shares of countries. Figure 3.125 shows the N_2O implied emission factor (IEF) in EU. It is observed that the N_2O IEF at EU level increased from 1.37 kg/TJ in 1990 to 3.2 kg/TJ in 2022.

Figure 3.102 1A3b Road Transportation – Diesel Oil: Time series of N_2O emissions in EU and highest shares of countries

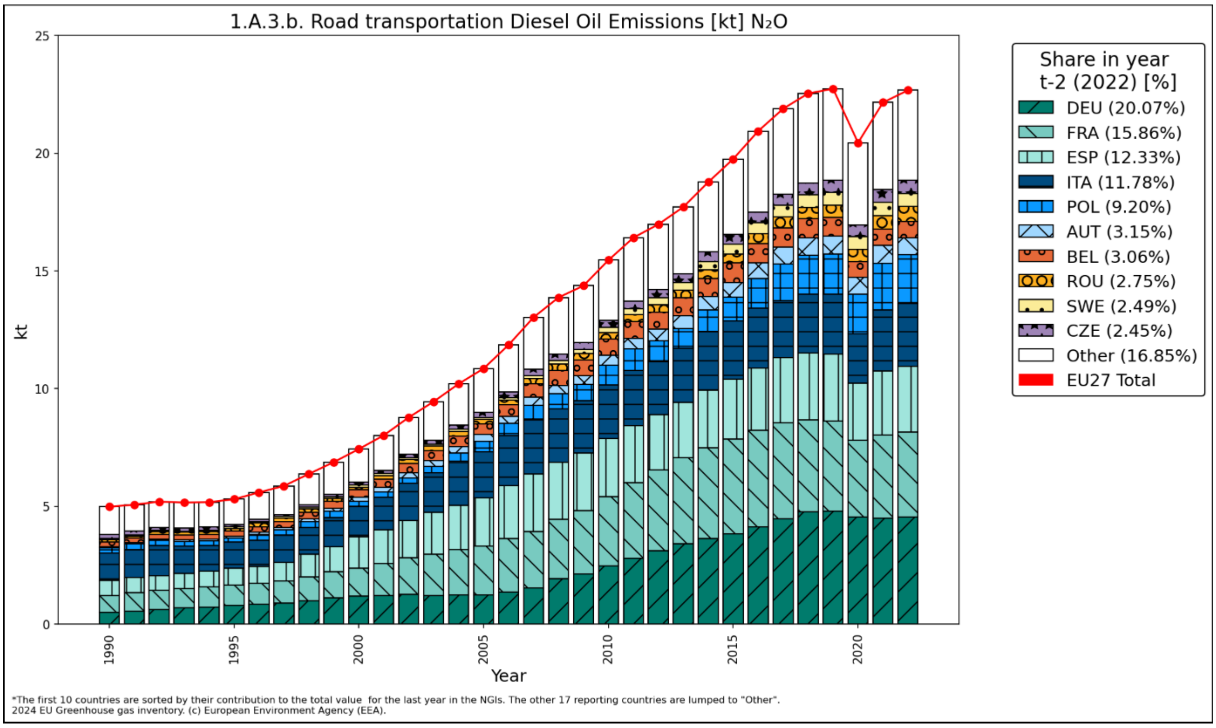
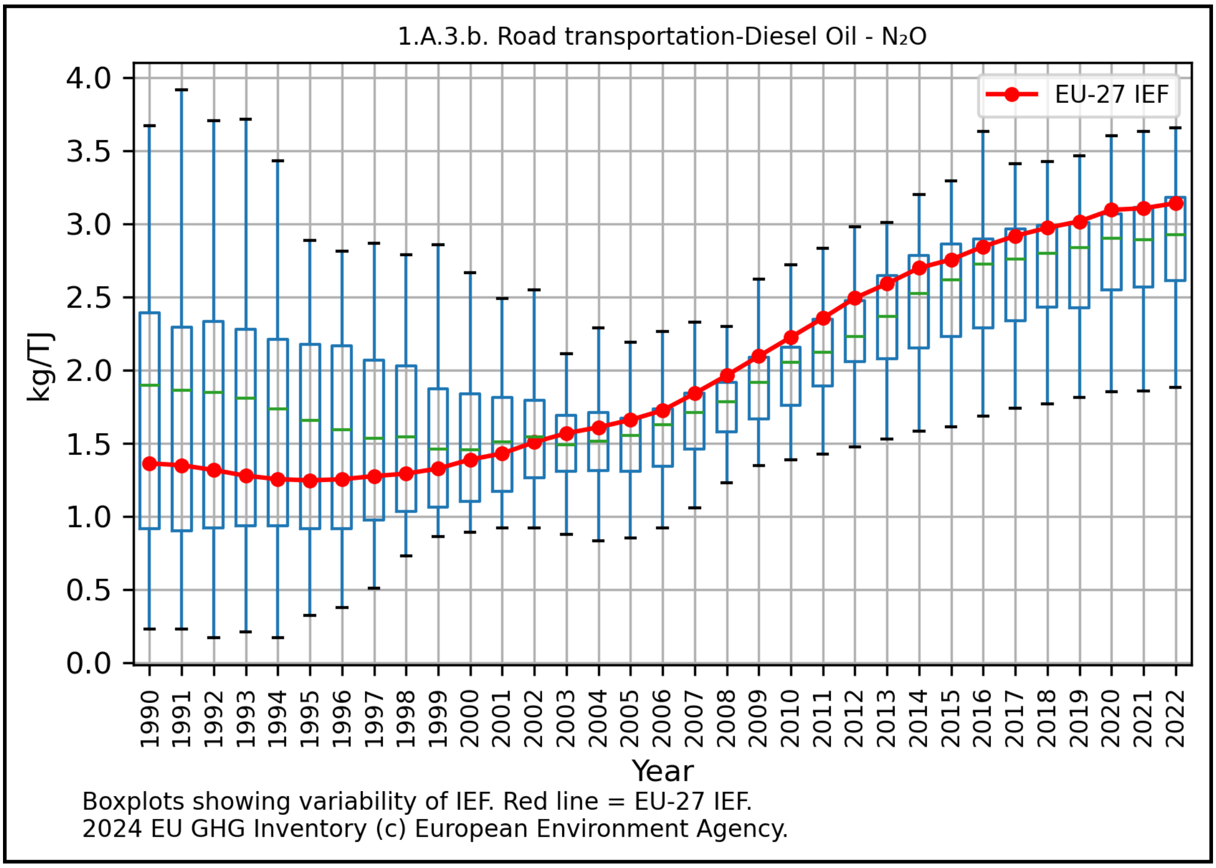


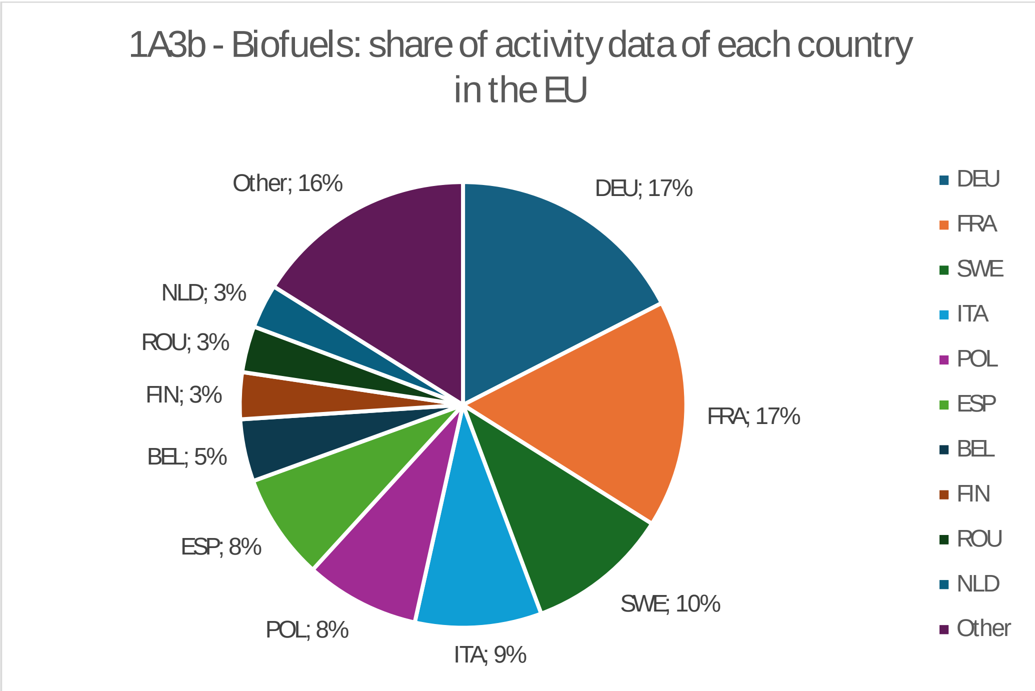
Figure 3.103 1A3b Road Transportation – Diesel Oil: N_2O Implied Emission Factor (IEF) in EU and per country (in kg/TJ)



1A3b Road Transportation – Biofuels (activity data)

Figure 3.126 shows the share of activity data biofuels of each country in EU (%) in 2022. Top five countries in 2022 were France, Germany, Italy, Sweden, and Spain, which accounted for the 61 % of the EU value.

Figure 3.104 1A3b Road Transportation – Biofuels: Share of activity data of each country in EU (%)



3.5.3.3 Railways (1A3c) (EU)

The mobile source category 1A3c Railways includes all types of locomotives operating mainly on liquid fuels; in addition, there is a small part of solid fuels usage.

CO_2 emissions from 1A3c Railways

CO_2 emissions from railways accounted only for 0.10 % of total GHG emissions in EU, 2022 (including indirect CO_2, with LULUCF and international aviation). Considering only railways, CO_2 accounted for 95.6 % of total GHG emissions from railways in EU, 2022.

The time series of CO_2 emissions and activity data from 1A3c Railways, years 1990-2022, are shown in Figure 3.127. From this figure it can be observed that the largest contribution to emissions comes from the usage of liquid fuels.

Figure 3.105 1A3c Railways: CO_2 emissions (in Mt) and activity data (in TJ)

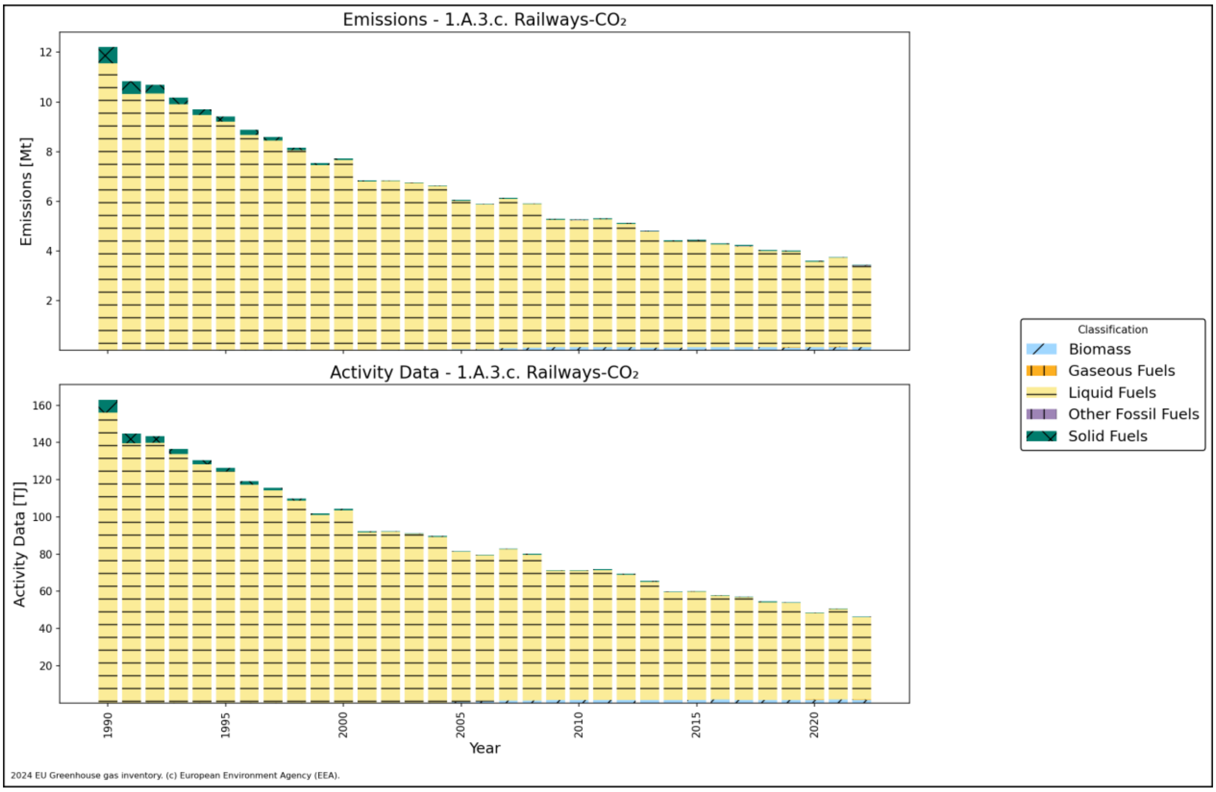


Table 3.62 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3c Railways. Between 1990 and 2022, CO_2 emissions decreased by 73 % in the EU, while between 2021 and 2022 the corresponding change was 8 % decrease. Top three countries in 2022 were Germany, Romania, France, which accounted for the 45 % of the EU value.

Table 3.69 1A3c Railways: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	178	81	80	2.4%	-97	-55%	0	0%	NA,T2	CS,NA
Belgium	227	74	69	2.1%	-158	-69%	-4	-5%	NA,T1	CS,D,NA
Bulgaria	323	32	32	1.0%	-291	-90%	0	1%	NA,T1	D,NA
Croatia	140	45	47	1.4%	-94	-67%	1	3%	NA,T1	D,NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	768	209	229	6.9%	-539	-70%	19	9%	NA,T1,T2	CS,D,NA
Denmark	297	184	154	4.6%	-143	-48%	-31	-17%	NA,T2	D,NA,OTH
Estonia	159	43	39	1.2%	-121	-76%	-4	-10%	NA,T2	CS,NA
Finland	191	71	59	1.8%	-132	-69%	-12	-17%	NA,T2	CS,NA
France	1 078	343	355	10.7%	-723	-67%	12	4%	NA	NA
Germany	3 133	853	808	24.3%	-2 325	-74%	-45	-5%	CS,M,NA,T1	CS,D,M,NA
Greece	199	21	21	0.6%	-178	-89%	1	4%	NA,T2	CS,NA
Hungary	534	105	108	3.2%	-426	-80%	3	3%	NA,T1,T2	CS,D,NA
Ireland	133	105	118	3.5%	-15	-12%	12	12%	NA,T2	CS,NA
Italy	613	118	35	1.1%	-578	-94%	-83	-70%	NA,T2	CS,NA
Latvia	537	76	72	2.2%	-465	-87%	-4	-6%	NA,T1,T2	CS,D,NA
Lithuania	350	153	83	2.5%	-267	-76%	-69	-45%	NA,T1,T2	CS,D,NA
Luxembourg	25	7	6	0.2%	-19	-76%	-2	-20%	NA,T1,T2	CS,D,NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	56	60	1.8%	-31	-34%	4	7%	NA,T2	CS,NA
Poland	1 624	280	280	8.4%	-1 344	-83%	0	0%	NA,T1	D,NA
Portugal	177	26	22	0.7%	-155	-88%	-4	-14%	T1	D
Romania	473	404	315	9.5%	-158	-33%	-89	-22%	NA,T1,T2	CS,D,NA
Slovakia	372	82	82	2.5%	-290	-78%	0	0%	NA,T1	CS,NA
Slovenia	65	21	21	0.6%	-44	-68%	0	2%	NA,T1	D,NA
Spain	422	191	188	5.6%	-234	-56%	-4	-2%	NA,T1	D,NA
Sweden	103	44	41	1.2%	-62	-60%	-3	-7%	T2	CS
EU-27	**12 213**	**3 625**	**3 325**	**100%**	**-8 888**	**-73%**	**-299**	**-8%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

1A3c Railways – Liquid Fuels (CO_2)

CO_2 emissions from liquid fuels accounted for 94.3 % of total GHG emissions from railways in 2022. Table 3.63 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3c Railways – liquid fuels. Between 1990 and 2022, CO_2 emissions decreased by 72 % in the EU, while between 2021 and 2022 the corresponding change was 8 % decrease. Top three countries in 2022 were Germany, Romania, France, which accounted for the 44 % of the EU value.

Table 3.70 1A3c Railways – Liquid Fuels: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	171	80	80	2.4%	-91	-53%	0	0%	T2	CS
Belgium	227	74	69	2.1%	-158	-69%	-4	-5%	T1	CS,D
Bulgaria	323	32	32	1.0%	-291	-90%	0	1%	T1	D
Croatia	119	45	47	1.4%	-72	-61%	1	3%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	768	208	227	6.9%	-541	-70%	19	9%	T2	CS
Denmark	297	178	147	4.5%	-151	-51%	-31	-18%	T2	D
Estonia	142	43	39	1.2%	-104	-73%	-4	-10%	T2	CS
Finland	191	71	59	1.8%	-132	-69%	-12	-17%	T2	CS
France	1 078	343	355	10.8%	-723	-67%	12	4%	-	-
Germany	2 858	820	775	23.6%	-2 083	-73%	-45	-5%	CS,M	CS,M
Greece	199	21	21	0.7%	-178	-89%	1	4%	T2	CS
Hungary	528	104	108	3.3%	-420	-80%	3	3%	T2	CS
Ireland	133	105	118	3.6%	-15	-12%	12	12%	T2	CS
Italy	613	118	35	1.1%	-578	-94%	-83	-70%	T2	CS
Latvia	537	76	72	2.2%	-465	-87%	-4	-6%	T2	CS
Lithuania	350	152	83	2.5%	-267	-76%	-69	-45%	T2	CS
Luxembourg	25	7	6	0.2%	-19	-76%	-2	-20%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	91	56	60	1.8%	-31	-34%	4	7%	T2	CS
Poland	1 319	280	280	8.5%	-1 039	-79%	0	0%	T1	D
Portugal	177	26	22	0.7%	-155	-88%	-4	-14%	T1	D
Romania	440	404	315	9.6%	-125	-28%	-89	-22%	T1,T2	CS,D
Slovakia	372	82	82	2.5%	-290	-78%	0	0%	T1	CS
Slovenia	65	21	21	0.6%	-44	-67%	0	2%	T1	D
Spain	422	191	188	5.7%	-234	-56%	-4	-2%	T1	D
Sweden	103	44	41	1.3%	-62	-60%	-3	-7%	T2	CS
EU-27	**11 549**	**3 580**	**3 281**	**100%**	**-8 268**	**-72%**	**-300**	**-8%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Figure 3.129 shows the time series of CO_2 emissions in EU from railways – liquid fuels and the highest shares of countries. Figure 3.130 shows the CO_2 implied emission factor (IEF) in EU . It is observed that the CO_2 IEF at EU level is almost constant over the years at 74 t/TJ.

Figure 3.106 1A3c Railways – Liquid Fuels: Time series of CO_2 emissions in EU and highest shares of countries

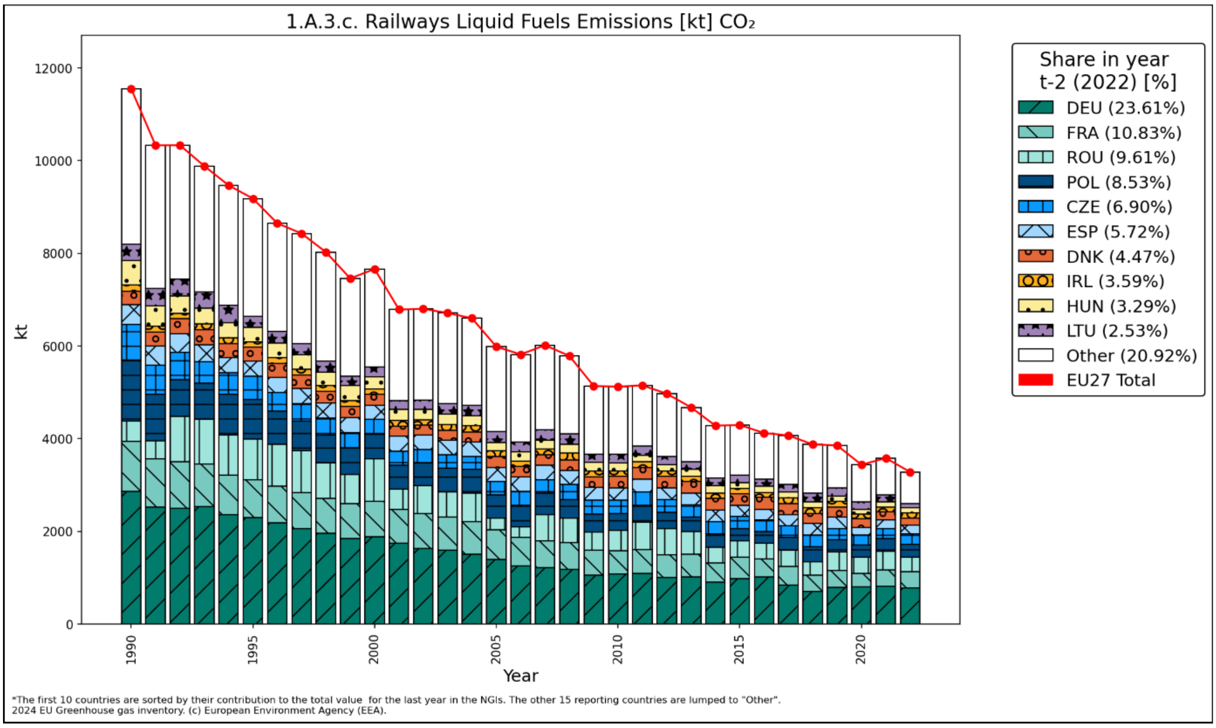
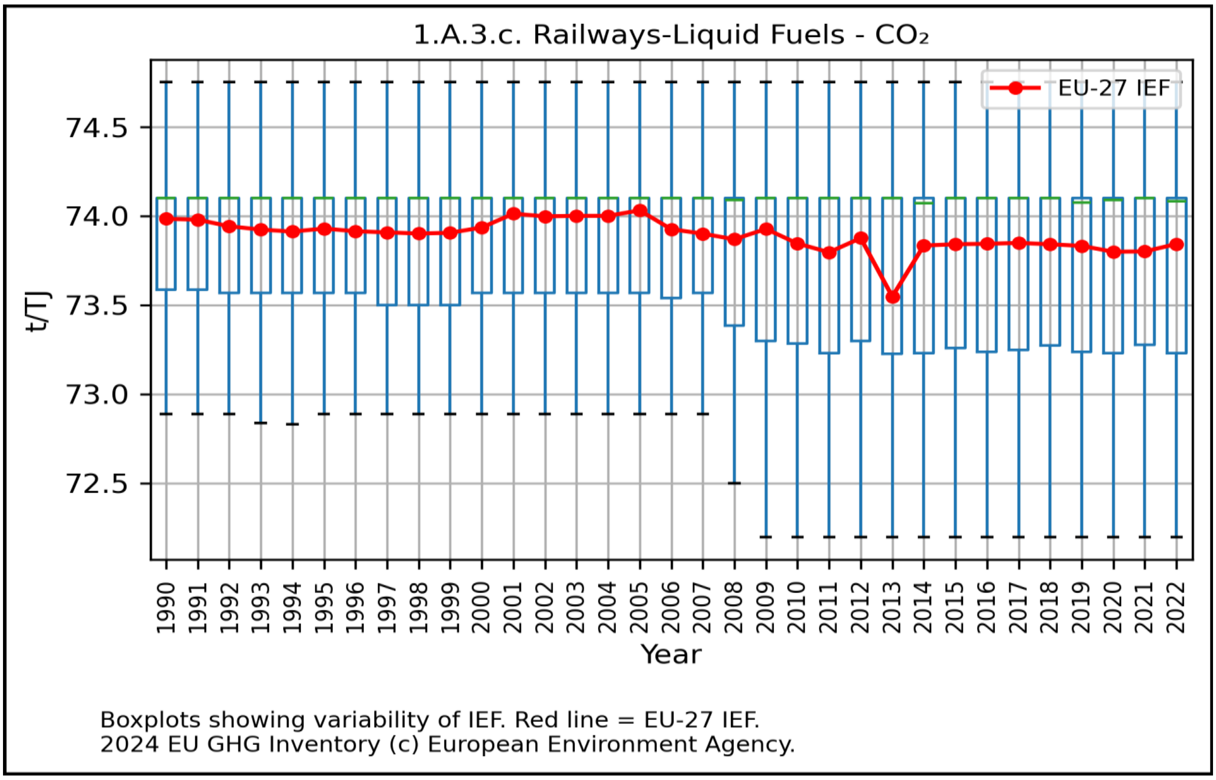


Figure 3.107 1A3c Railways – Liquid Fuels: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



3.5.3.4 Domestic Navigation (1A3d) (EU)

This mobile source category includes emissions from domestic waterborne transport, i.e. passenger and freight activity of trips having their origin and destination (O-D) within the same country. The main fuel used is gas/diesel oil, followed by residual fuel oil, while there is also a small part of gasoline. The emissions from military mobile sources related to navigation are excluded from 1A3d and are reported separately under category 1A5b (Other mobile military use). Fishing vessels are also excluded and they are reported separately under category 1A4ciii (Other sectors – Fishing).

CO_2 emissions from 1A3d Domestic Navigation

CO_2 emissions from domestic navigation accounted only for 0.5 % of total GHG emissions in EU, 2022 (including indirect CO_2, with LULUCF and international aviation). Considering only domestic navigation, CO_2 accounted for 98.2 % of total GHG emissions from domestic navigation in EU, 2022.

The time series of CO_2 emissions and activity data from 1A3d Domestic navigation, years 1990-2022, are shown in Figure 3.131. From this figure it can be observed that the largest contribution to emissions comes from the usage of gas/diesel oil, followed by residual fuel oil.

Figure 3.108 1A3d Domestic Navigation: CO_2 emissions (in Mt) and activity data (in TJ)

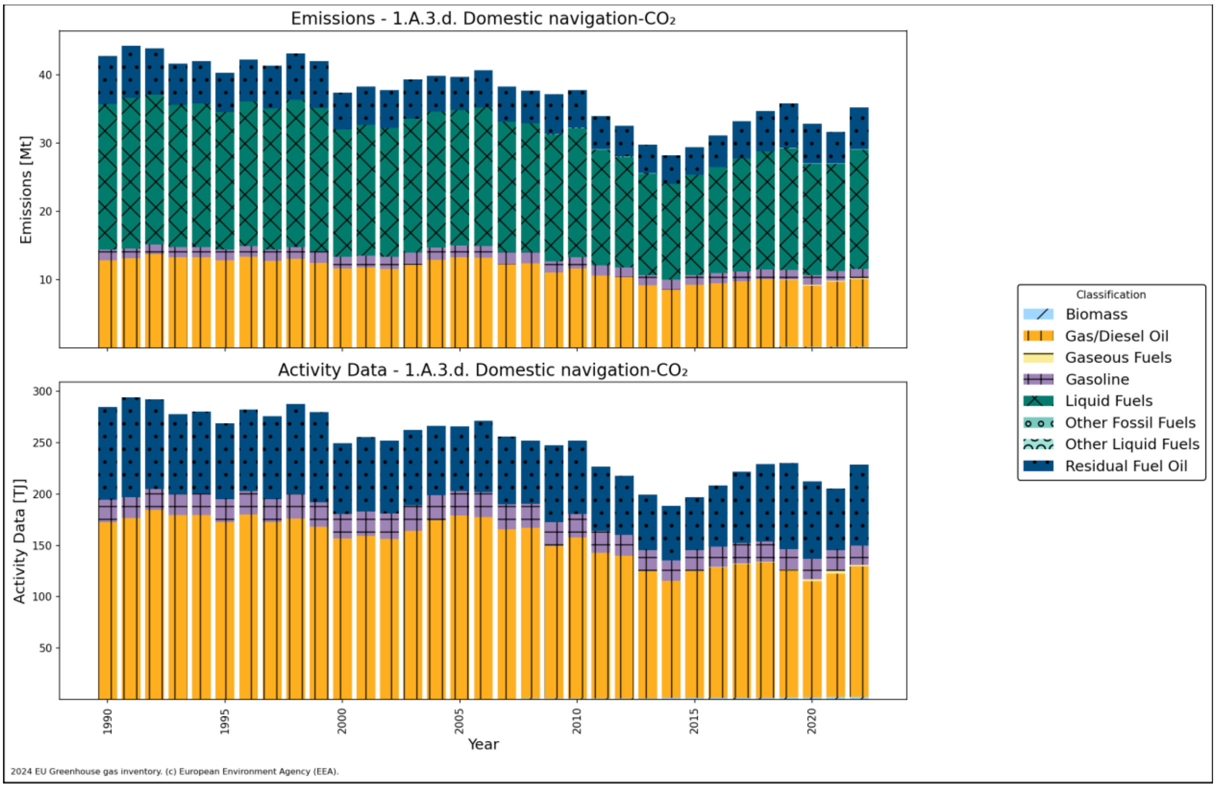


Table 3.64 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3d Domestic Navigation. Between 1990 and 2022, CO_2 emissions decreased by 18 % in the EU, while between 2021 and 2022 the corresponding change was 11 % increase. Top three countries in 2022 were Italy, Spain, Greece, which accounted for the 63 % of the EU value.

Table 3.71 1A3d Domestic Navigation: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	28	35	69	0.4%	41	146%	33	94%	NA,T2	CS,NA
Belgium	362	389	355	2.0%	-7	-2%	-34	-9%	NA,T1,T3	CS,D,NA
Bulgaria	56	4	5	0.0%	-52	-92%	0	4%	NA,T1	D,NA
Croatia	134	149	153	0.9%	18	14%	4	3%	NA,T1	D,NA
Cyprus	2	3	5	0.0%	3	121%	2	68%	NA,T1	D,NA
Czechia	54	13	10	0.1%	-44	-82%	-3	-25%	NA,T1	D,NA
Denmark	715	544	495	2.8%	-219	-31%	-49	-9%	NA,T2	CS,D,NA,OTH
Estonia	22	18	18	0.1%	-4	-18%	-1	-3%	NA,NO,T2	CS,NA,NO
Finland	441	353	340	1.9%	-101	-23%	-14	-4%	NA,T2	CS,NA
France	1 022	1 262	1 255	7.1%	233	23%	-7	-1%	NA	NA
Germany	3 014	1 583	1 378	7.8%	-1 636	-54%	-205	-13%	CS,M,NA	CS,M,NA
Greece	1 809	1 835	1 993	11.3%	185	10%	158	9%	NA,T1	CS,NA
Hungary	209	9	13	0.1%	-196	-94%	3	34%	NA,T1	D,NA
Ireland	85	359	303	1.7%	218	256%	-56	-16%	NA,T2	CS,NA
Italy	5 470	4 540	5 718	32.5%	247	5%	1 178	26%	NA,T1,T2	CS,NA
Latvia	1	8	5	0.0%	4	442%	-2	-31%	NA,T1,T2	CS,D,NA
Lithuania	15	12	10	0.1%	-6	-38%	-3	-22%	NA,T1	CS,NA
Luxembourg	1	0	1	0.0%	-1	-59%	0	28%	NA,T1,T2	CS,D,NA
Malta	12	69	57	0.3%	45	385%	-11	-17%	NA,T1	D,NA
Netherlands	725	820	857	4.9%	131	18%	37	5%	NA,T2	CS,NA
Poland	151	28	29	0.2%	-122	-81%	0	1%	NA,T1	D,NA
Portugal	263	207	278	1.6%	15	6%	71	34%	NA,NO,T2	D,NA,NO
Romania	1 143	160	144	0.8%	-1 000	-87%	-17	-10%	NA,T2	CS,NA
Slovakia	0	6	5	0.0%	5	23447%	-1	-9%	NA,T1	CS,NA
Slovenia	0	0	0	0.0%	0	442%	0	-11%	NA,T1	D,NA
Spain	5 203	2 809	3 446	19.6%	-1 757	-34%	637	23%	NA,T1,T2	CS,D,NA
Sweden	452	625	660	3.7%	207	46%	34	5%	T2	CS
EU-27	**21 389**	**15 842**	**17 597**	**100%**	**-3 792**	**-18%**	**1 755**	**11%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

1A3d Domestic Navigation – Gas/Diesel Oil (CO_2)

CO_2 emissions from gas/diesel oil accounted for 56 % of total GHG emissions from domestic navigation in 2022. Table 3.65 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3d Domestic navigation – gas/diesel oil. Between 1990 and 2022, CO_2 emissions decreased by 22 % in the EU, while between 2021 and 2022 the corresponding change was 4 % increase. Top three countries in 2022 were Italy, Spain, Germany, Italy, which accounted for the 58 % of the EU value.

Table 3.72 1A3d Domestic Navigation – Gas/Diesel Oil: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	18	29	62	0.6%	44	237%	33	116%	T2	CS
Belgium	362	389	355	3.6%	-7	-2%	-34	-9%	T1,T3	CS,D
Bulgaria	56	4	5	0.0%	-52	-92%	0	4%	T1	D
Croatia	128	148	153	1.5%	25	20%	4	3%	T1	D
Cyprus	2	3	5	0.0%	3	120%	2	68%	T1	D
Czechia	54	13	10	0.1%	-44	-82%	-3	-25%	T1	D
Denmark	358	372	359	3.6%	1	0%	-13	-4%	T2	D
Estonia	22	18	18	0.2%	-4	-18%	-1	-3%	T2	CS
Finland	186	181	197	2.0%	10	6%	15	9%	T2	CS
France	324	388	400	4.0%	76	23%	12	3%	-	-
Germany	2 754	1 516	1 311	13.2%	-1 444	-52%	-206	-14%	CS	CS,M
Greece	1 063	842	944	9.5%	-119	-11%	102	12%	T1	CS
Hungary	28	9	13	0.1%	-16	-56%	3	34%	T1	D
Ireland	22	359	303	3.0%	280	1262%	-56	-16%	T2	CS
Italy	2 326	2 448	2 527	25.4%	201	9%	80	3%	T1,T2	CS
Latvia	1	7	5	0.1%	4	504%	-2	-31%	T2	CS
Lithuania	15	12	10	0.1%	-6	-38%	-3	-22%	T1	CS
Luxembourg	1	0	0	0.0%	0	-50%	0	27%	T2	CS
Malta	6	67	56	0.6%	50	784%	-11	-16%	T1	D
Netherlands	697	712	747	7.5%	50	7%	35	5%	T2	CS
Poland	81	28	29	0.3%	-52	-65%	0	1%	T1	D
Portugal	73	58	77	0.8%	4	6%	20	34%	T2	D
Romania	112	158	139	1.4%	27	24%	-20	-12%	T2	CS
Slovakia	0	6	5	0.1%	5	23447%	-1	-9%	T1	CS
Slovenia	0	0	0	0.0%	0	397%	0	-8%	T1	D
Spain	3 960	1 529	1 908	19.1%	-2 053	-52%	379	25%	T1	D
Sweden	181	247	330	3.3%	149	82%	83	33%	T2	CS
EU-27	**12 831**	**9 545**	**9 964**	**100%**	**-2 867**	**-22%**	**420**	**4%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Figure 3.133 shows the time series of CO_2 emissions in EU from domestic navigation – gas/diesel oil and the highest shares of countries. Figure 3.134 shows the CO_2 implied emission factor (IEF) in EU. It is observed that the CO_2 IEF at EU level is almost constant over the years at 74 t/TJ.

Figure 3.109 1A3d Domestic Navigation – Gas/Diesel Oil: Time series of CO_2 emissions in EU and highest shares of countries

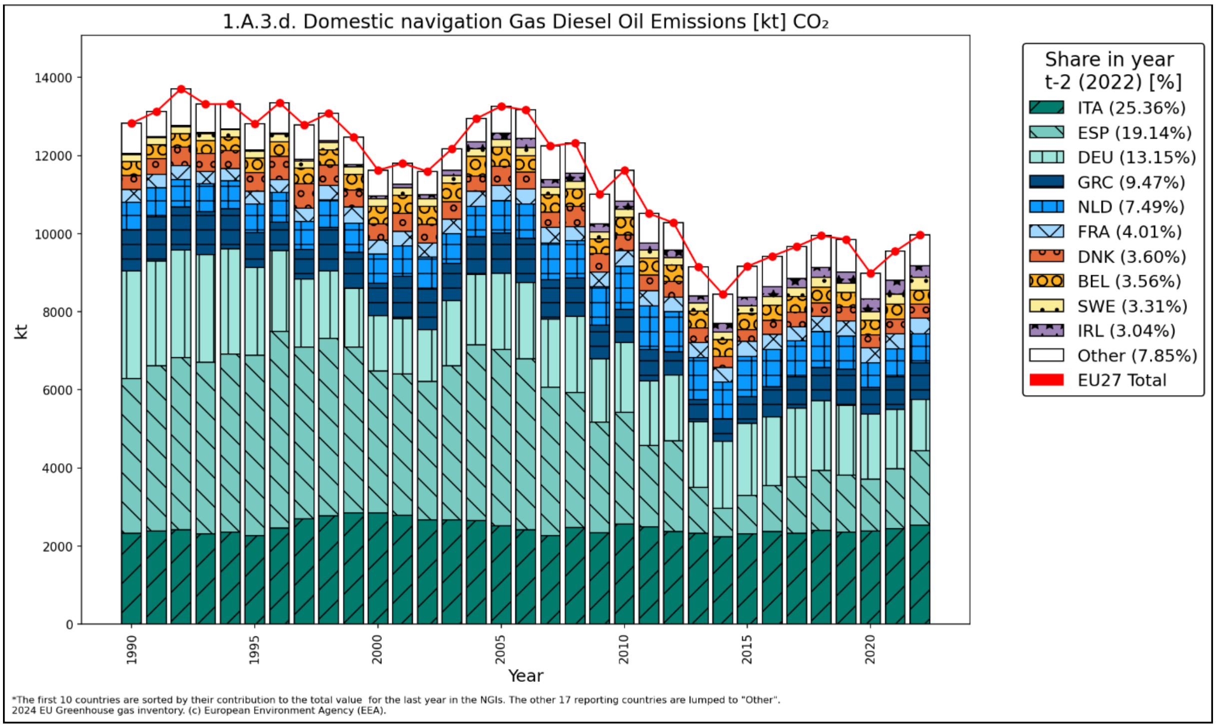
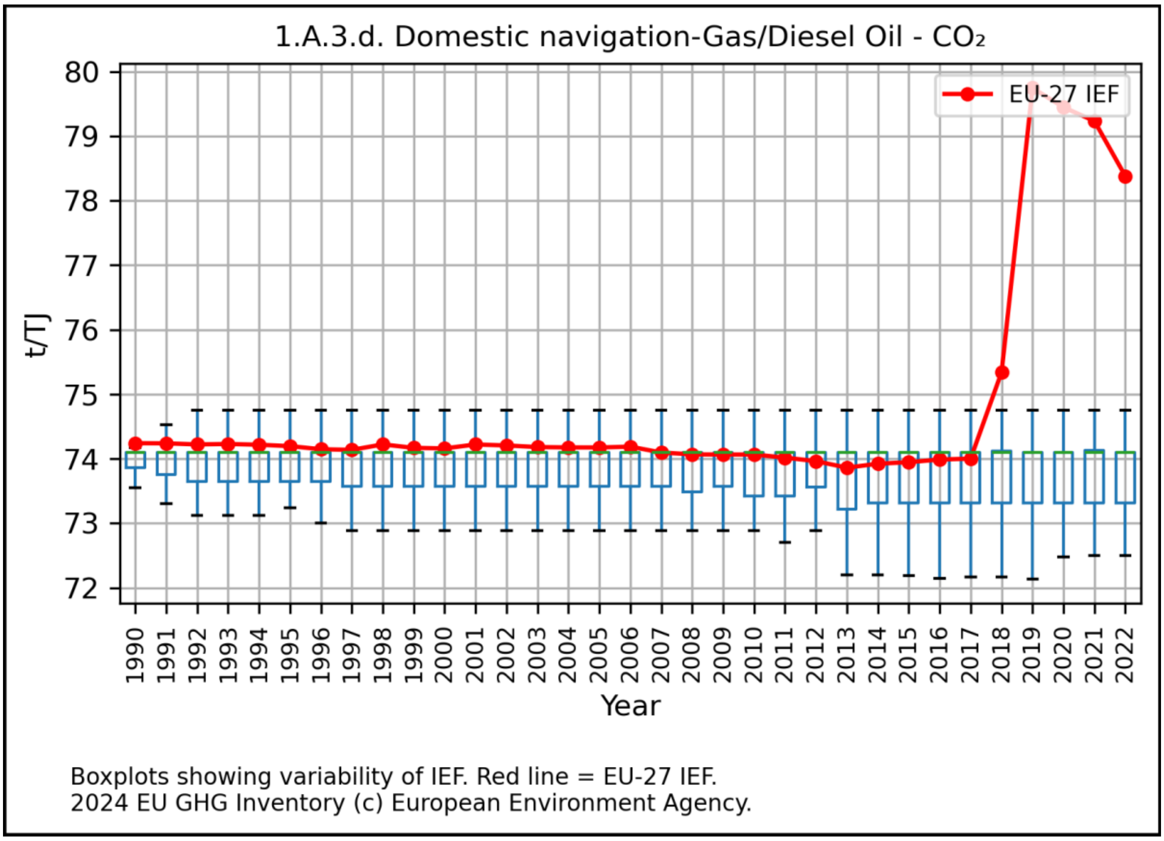


Figure 3.110 1A3d Domestic Navigation – Gas/Diesel Oil: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



1A3d Domestic Navigation – Residual Fuel Oil (CO_2)

CO_2 emissions from residual fuel oil accounted for 34 % of total GHG emissions from domestic navigation in 2022. Table 3.66 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3d Domestic navigation – residual fuel oil. Between 1990 and 2022, CO_2 emissions decreased by 12 % in the EU, while between 2021 and 2022 the corresponding change was 32 % increase. Top three countries in 2022 were Italy, Spain, Greece, which accounted for the 90 % of the EU value.

Table 3.73 1A3d Navigation, residual fuel oil: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
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	163	132	2.1%	-225	-63%	-31	-19%	T2	CS
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	123	13	13	0.2%	-110	-89%	0	1%	T2	CS
France	159	70	59	1.0%	-100	-63%	-10	-15%	-	-
Germany	240	30	18	0.3%	-221	-92%	-12	-40%	CS	CS,M
Greece	746	993	1 049	17.1%	304	41%	56	6%	T1	CS
Hungary	3	NO	NO	-	-3	-100%	-	-	NA	NA
Ireland	63	NO	NO	-	-63	-100%	-	-	NA	NA
Italy	2 576	1 797	2 970	48.3%	394	15%	1 173	65%	T1,T2	CS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	5	1	NO	-	-5	-100%	-1	-100%	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	70	NO	NO	-	-70	-100%	-	-	NA	NA
Portugal	190	149	201	3.3%	11	6%	51	34%	T2	D
Romania	1 031	NO	NO	-	-1 031	-100%	-	-	NA	NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1 242	1 280	1 538	25.0%	296	24%	258	20%	T2	CS
Sweden	195	177	168	2.7%	-27	-14%	-9	-5%	T2	CS
EU-27	**7 006**	**4 673**	**6 149**	**100%**	**-857**	**-12%**	**1 475**	**32%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Methods and emission factor information refer to the last inventory year.

Figure 3.136 shows the time series of CO_2 emissions in EU from domestic navigation – residual fuel oil and the highest shares of countries. Figure 3.137 shows the CO_2 implied emission factor (IEF) in EU. It is observed that the CO_2 IEF at EU level is almost constant over the years at 77.6 - 78.0 t/TJ.

Figure 3.111 1A3d Domestic Navigation – Residual Fuel Oil: Time series of CO_2 emissions in EU and highest shares of countries

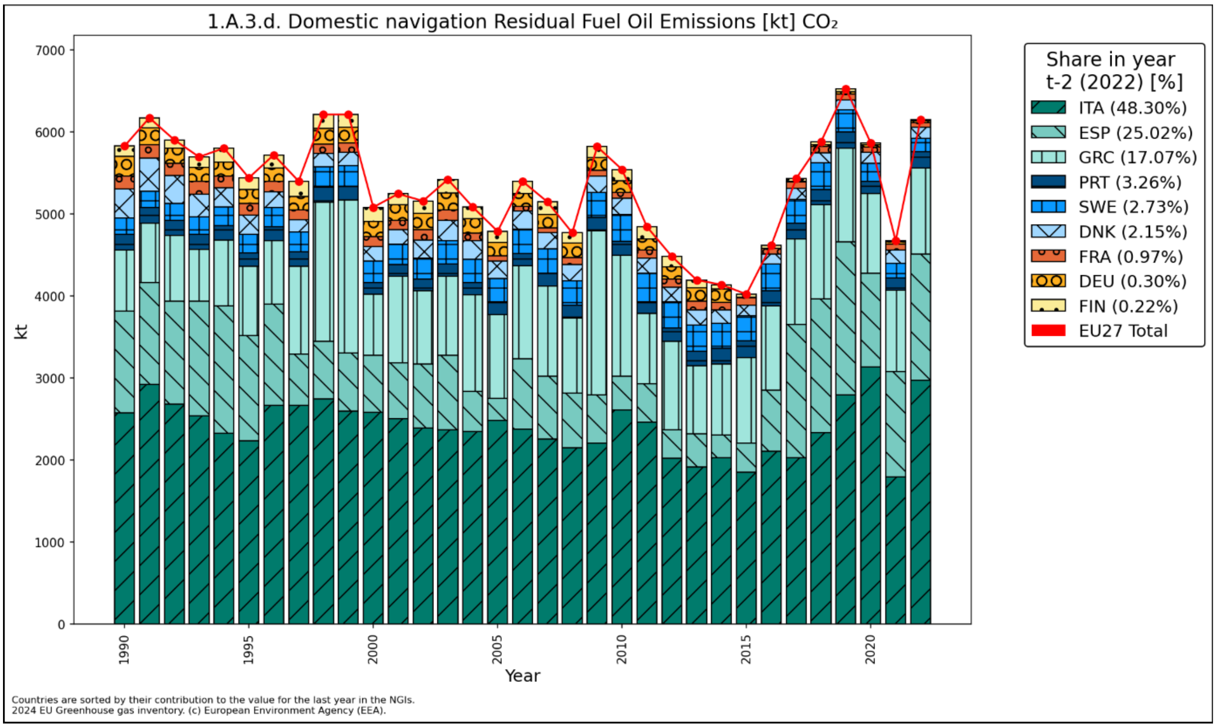
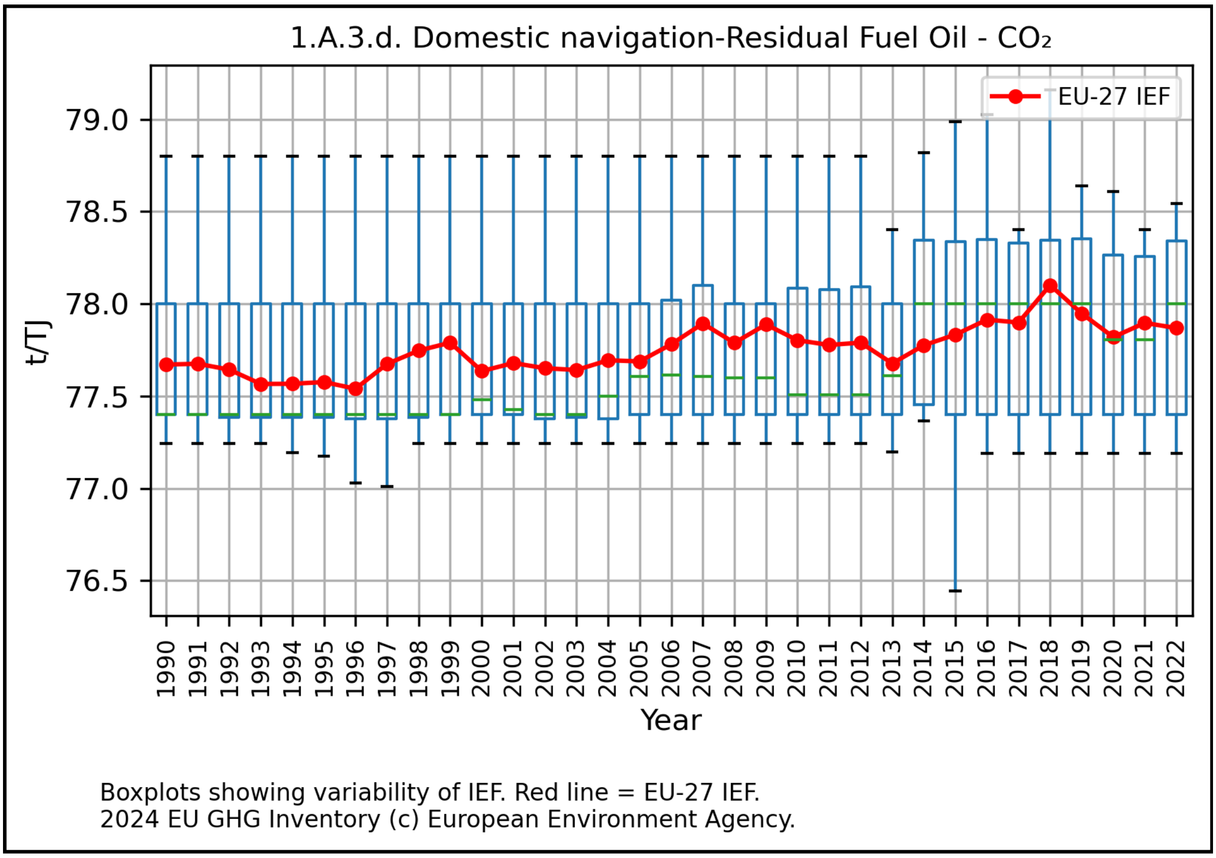


Figure 3.112 1A3d Domestic Navigation – Residual Fuel Oil: CO_2 Implied Emission Factor (IEF) in EU and per country (in t/TJ)



3.5.3.5 Other (1A3e) (EU)

This mobile source category includes mainly emissions from pipeline transport using gaseous fuels; in addition, there is a small part from ground activities in airports and harbours using liquid fuels.

CO_2 emissions from 1A3e Other

CO_2 emissions from 1A3e Other accounted only for 0.15 % of total GHG emissions in EU, 2022 (including indirect CO_2, with LULUCF and international aviation).

Table 3.67 shows the CO_2 emissions per country and at EU level (in kt), share of each country in EU (%), change between years, method and EF information for 1A3e Other. Between 1990 and 2022, CO_2 emissions decreased by 16 % in the EU, while between 2021 and 2022 the corresponding change was 6 % increase. Top three countries in 2022 were Italy, Germany, Belgium, which accounted for the 58 % of the EU value.

Table 3.74 1A3e Other: CO_2 emissions per country (in kt), share in EU (%), change, method and EF information

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	229	382	163	3.3%	-66	-29%	-219	-57%	NA,T2	CS,NA
Belgium	334	422	584	11.7%	250	75%	163	39%	CS,NA,T3	D,NA
Bulgaria	NO	129	194	3.9%	194	∞	65	51%	NA,T2	CS,NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	5	47	22	0.4%	17	311%	-24	-52%	NA,T2	CS,NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	90	159	204	4.1%	115	128%	46	29%	NA,NO	NA,NO
Finland	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
France	210	238	378	7.5%	167	79%	139	59%	NA	NA
Germany	1 083	836	1 328	26.5%	245	23%	492	59%	CS,NA	CS,NA
Greece	NO	IE,NO	5	0.1%	5	∞	5	∞	NA,T1	CS,NA
Hungary	149	63	52	1.0%	-97	-65%	-11	-17%	NA,T2	CS,NA
Ireland	73	152	155	3.1%	82	112%	3	2%	NA,T2	CS,NA
Italy	411	851	982	19.6%	571	139%	131	15%	NA,T2	CS,NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	64	41	46	0.9%	-18	-29%	5	12%	NA,T2	CS,NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	342	93	85	1.7%	-257	-75%	-8	-9%	NA,T2	CS,NA
Poland	NO	655	180	3.6%	180	∞	-475	-72%	NA,T1	D,NA
Portugal	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA,NO	NA,NO
Romania	65	20	18	0.4%	-47	-72%	-2	-11%	NA,T1,T2	CS,D,NA
Slovakia	1 814	121	16	0.3%	-1 798	-99%	-105	-87%	NA,T2	CS,NA
Slovenia	NO	1	0	0.0%	0	∞	0	-49%	NA,T2	CS,NA
Spain	19	148	242	4.8%	223	1163%	94	63%	NA,T1	CS,D,NA
Sweden	1 053	370	357	7.1%	-696	-66%	-14	-4%	T2	CS
EU-27	**5 943**	**4 728**	**5 013**	**100%**	**-930**	**-16%**	**285**	**6%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Methods and emission factor information refer to the last inventory year.

3.5.4 Other Sectors (CRT 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.

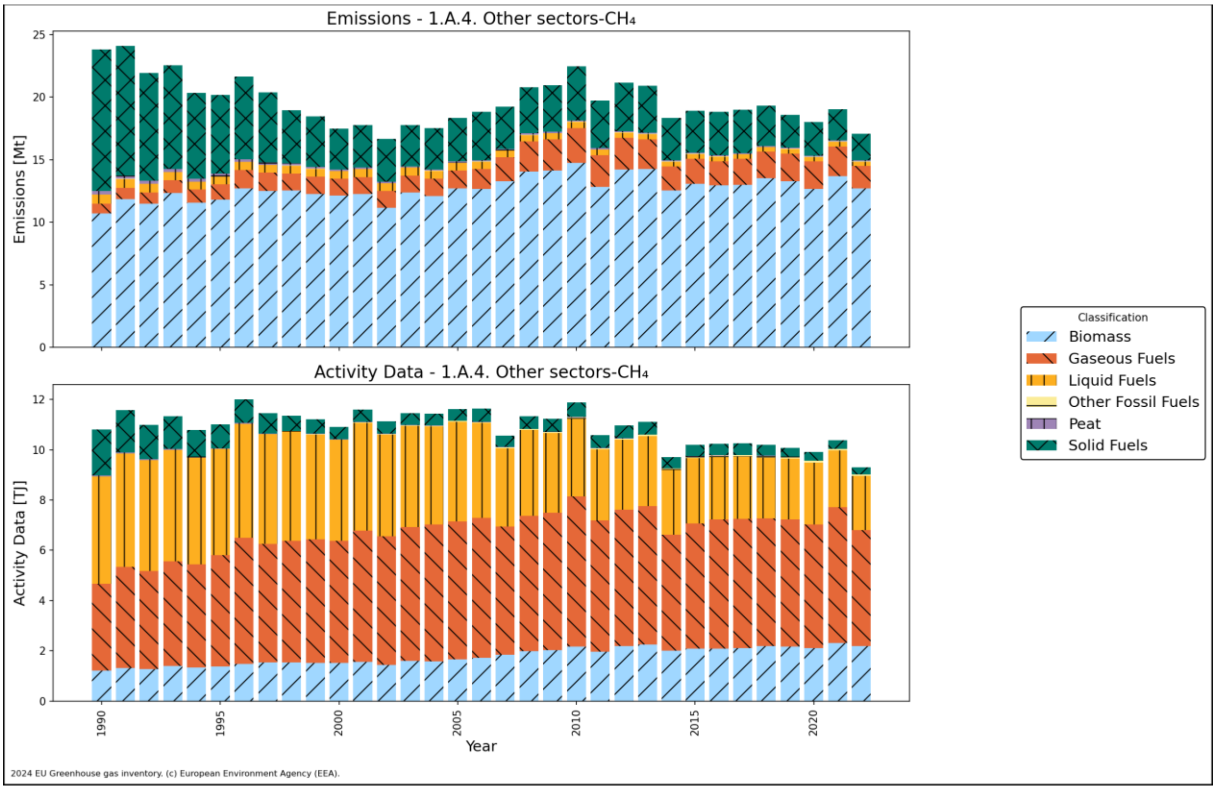
The following enumeration shows the correspondence of 1.A.4 subcategories and ISIC 3.1 rev codes:

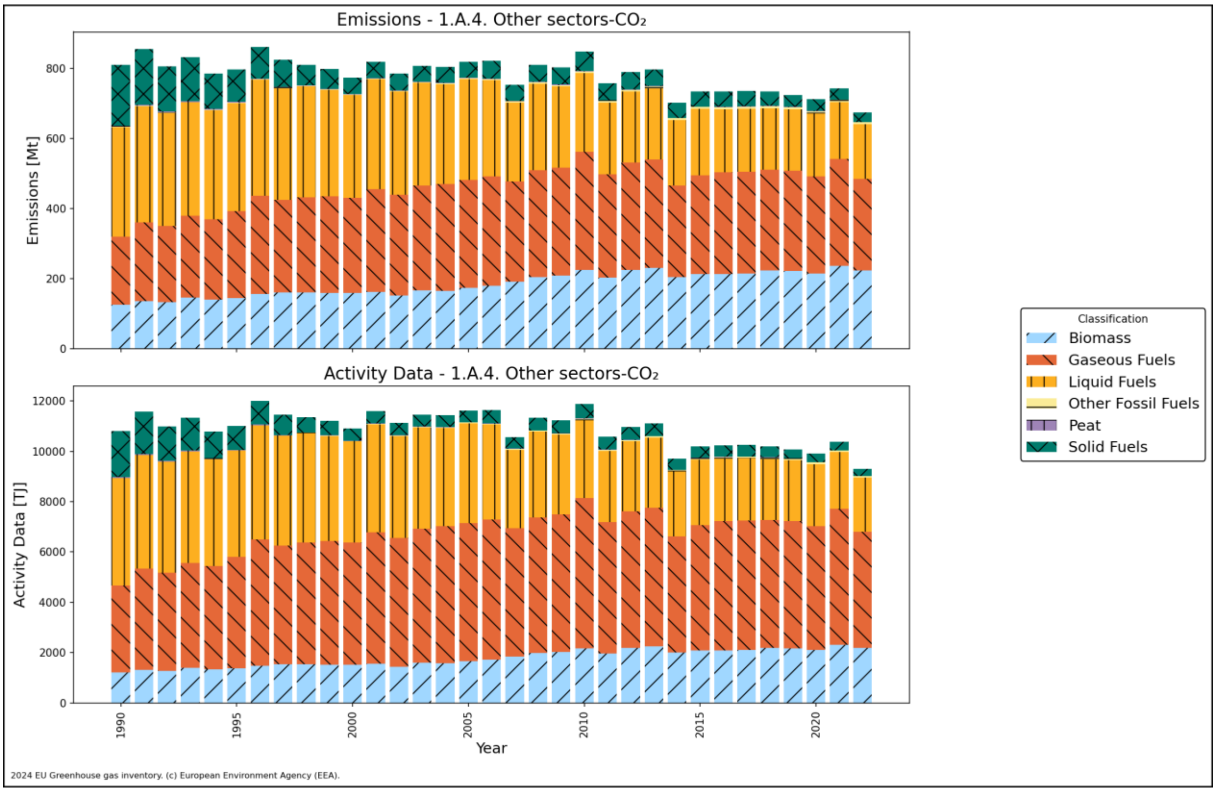
- 1.A.4.a Commercial/Institutional: ISIC categories 4103, 42, 6, 719, 72, 8, and 91-96
- 1.A.4.b Residential: All emissions from fuel combustion in households
- 1.A.4.c Agriculture/Forestry/Fishing: ISIC categories 05, 11, 12, 1302

In 2022 category 1.A.4 contributed to 437 666 kt CO_2 equivalents of which 94.9 % CO_2, 3.7 % CH_4 and 1.4 % N_2O.

Figure 3.138 shows the trend of total GHG emissions within source category 1.A.4 and the dominating sources that 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 2022. Between 1990 and 2022, emissions from 1.A.4 decreased by 33 %. From 2021 to 2022 emissions decreased by 11 % (59.1 Mt CO_2 equivalents) which is mainly due to the decrease of category 1.A.4.a CO_2 emissions which decreased by 13 %. The trend of 1.A.4 CO_2 emissions between 1990 and 2022 is mostly influenced by Germany (-89.8 Mt CO_2).

Figure 3.113 1.A.4. Other Sectors: Total, CO_2 and CH_4 emission trends





Data displayed as dashed line refers to the secondary axis.

In 2022 GHG emissions from source category 1.A.4. accounted for 22 % of total GHG emissions. This source category includes twelve key sources which contributed to 98 % of total 1.A.4. GHG emissions in 2022. The following list shows the key sources and their contribution to total 1.A.4 GHG emissions for the year 2022:

1.A.4.a Commercial/Institutional: Gaseous Fuels (CO_2) - 15.8 %

1.A.4.a Commercial/Institutional: Liquid Fuels (CO_2) - 4.4 %

1.A.4.a Commercial/Institutional: Other Fuels (CO_2) - 1.2 %

1.A.4.a Commercial/Institutional: Solid Fuels (CO_2) - 0.4 %

1.A.4.b Residential: Biomass (CH_4) - 2.4

1.A.4.b Residential: Gaseous Fuels (CO_2) - 37.1 %

1.A.4.b Residential: Liquid Fuels (CO_2) - 16.4 %

1.A.4.b Residential: Solid Fuels (CH_4) - 0.4 %

1.A.4.b Residential: Solid Fuels (CO_2) - 4.7 %

1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CO_2) - 2.1 %

1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CO_2) - 12.1 %

1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CO_2) - 0.4 %

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 3.75: Key source categories for level and trend analyses and share of EU emissions using higher tier methods for sector 1.A.4. (Table excerpt)

Source category gas	kt CO_2 eq.		Trend	Level		Share of higher Tier
	1990	2022		1990	2022	
1.A.4.a. Commercial/institutional: Gaseous Fuels (CO_2)	50344	74915	T	L	L	94 %
1.A.4.a. Commercial/institutional: Liquid Fuels (CO_2)	73102	20751	T	L	L	80 %
1.A.4.a. Commercial/institutional: Other Fuels (CO_2)	748	5822	T	0	L	97 %
1.A.4.a. Commercial/institutional: Solid Fuels (CO_2)	44975	2108	T	L	0	98 %
1.A.4.b. Residential: Biomass (CH_4)	10438	11625	T	L	L	50 %
1.A.4.b. Residential: Gaseous Fuels (CO_2)	129940	176067	T	L	L	94 %
1.A.4.b. Residential: Liquid Fuels (CO_2)	174026	78065	T	L	L	83 %
1.A.4.b. Residential: Solid Fuels (CH_4)	8905	1956	T	L	0	8 %
1.A.4.b. Residential: Solid Fuels (CO_2)	118831	22233	T	L	L	98 %
1.A.4.c. Agriculture/forestry/fishing: Gaseous Fuels (CO_2)	12291	9802	0	L	L	87 %
1.A.4.c. Agriculture/forestry/fishing: Liquid Fuels (CO_2)	65657	57365	T	L	L	77 %
1.A.4.c. Agriculture/forestry/fishing: Solid Fuels (CO_2)	9740	2136	T	L	0	97 %

The following table shows the share of specific tier methods used for each 1.A.4 category emission estimates. Most countries use combination of T1 and T2 method for emission estimates.

Table 3.76: 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
T1	0,8%
T1,T2	27,4%
T1,T3	0.02 %
T2	20,2%
T2,T3	0,8%
T3	0.01 %
T1,T2,T3	3,4%
CS,T1,T2	4,8%
CS,T1,T3	28,0%
CS,T1,T2,T3	14,7%
Other combination	1.9 %

Table 3.70 shows total GHG, CO_2 and CH_4 emissions from 1.A.4. Other sectors. Between 1990 and 2022 CO_2 emissions from 1.A.4. Other Sectors decreased by 34%, CH_4 decreased by 28 % and N_2O emissions decreased by 1 %.

Table 3.77 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		CH4 emissions in kt CO2 equivalents	
	1990	2022	1990	2022	1990	2022
Austria	14 287	8 318	13 543	7 920	574	273
Belgium	28 176	20 394	27 809	19 854	287	447
Bulgaria	8 146	1 606	7 654	1 228	320	300
Croatia	4 245	3 198	3 719	2 722	401	365
Cyprus	434	512	430	499	3	11
Czechia	33 990	11 716	31 954	10 537	1 879	1 055
Denmark	9 011	3 317	8 768	3 144	193	117
Estonia	1 800	415	1 718	392	76	17
Finland	7 750	3 381	7 490	3 136	183	194
France	98 274	63 691	91 742	60 922	5 224	1 548
Germany	209 539	117 785	203 967	116 076	4 692	1 297
Greece	8 643	6 555	8 066	6 224	267	253
Hungary	21 972	11 506	20 920	10 923	962	506
Ireland	10 515	8 129	9 918	7 903	505	137
Italy	78 868	72 929	76 042	68 336	1 278	2 550
Latvia	5 933	1 553	5 493	1 316	300	159
Lithuania	7 304	1 547	6 903	1 345	235	167
Luxembourg	1 361	1 418	1 343	1 402	13	12
Malta	265	159	264	156	1	1
Netherlands	39 735	27 371	39 053	25 961	637	1 358
Poland	57 185	47 441	53 442	42 817	3 142	3 623
Portugal	4 139	4 223	3 463	3 836	483	239
Romania	11 387	12 286	10 877	10 848	468	1 169
Slovakia	11 543	4 828	11 067	4 530	435	247
Slovenia	1 906	1 261	1 686	1 114	180	109
Spain	NO	NO	NO	NO	NO	NO
Sweden	11 093	2 125	10 878	1 996	132	65
EU-27	**687 502**	**437 666**	**658 209**	**415 137**	**22 869**	**16 221**

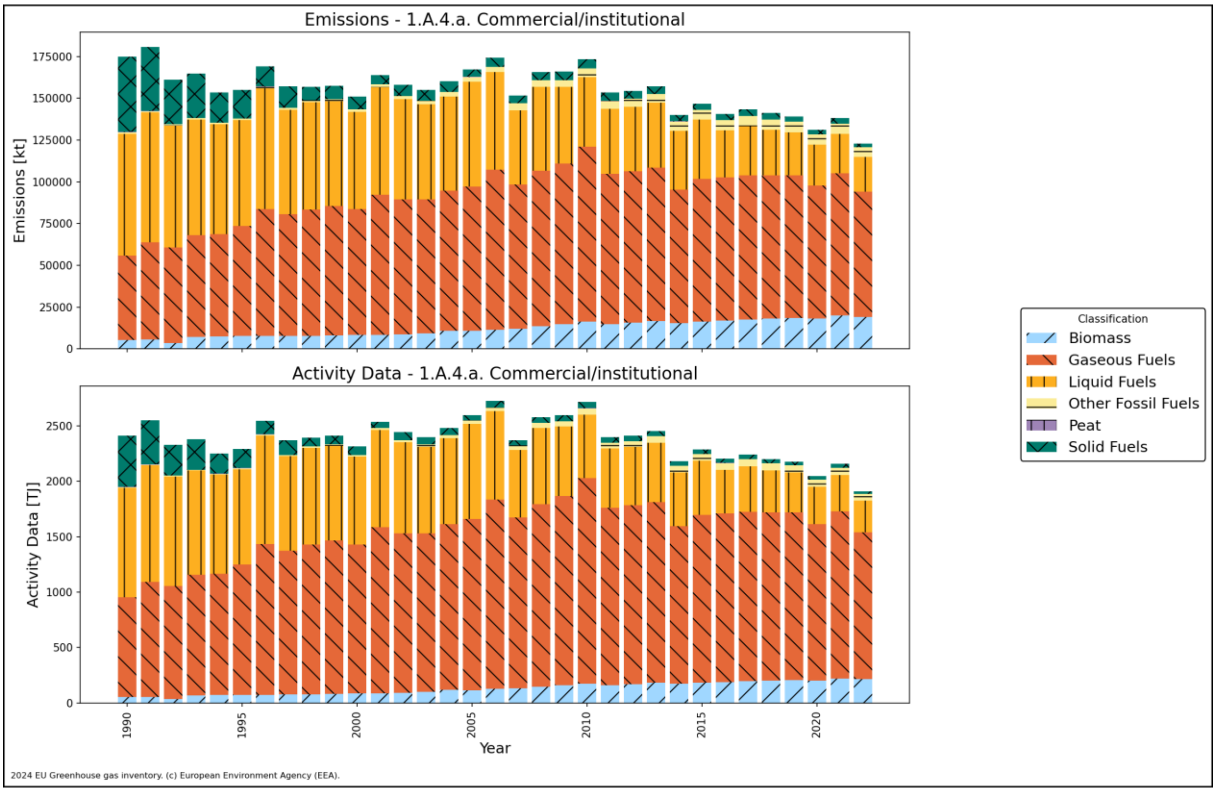
Abbreviations explained in the Chapter 'Units and abbreviations'.

3.5.4.1 Commercial/Institutional (1.A.4.a)

CO_2 emissions from 1.A.4.a Commercial/Institutional accounted for 4 % of total GHG emissions from 1.A Fuel Combustion in 2022 and were in total 94 655 kt CO_2 eq.. 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 3.139 shows the emission trend within the category 1.A.4.a, which is mainly dominated by CO_2 emissions from gaseous fuels. Between 1990 and 2022 CO_2 emissions decreased by 43 % (see also the Table 3.71), mainly due to decreases in CO_2 emissions from solid (-95 %) and liquid (-72 %) fuels while CO_2 emissions from gaseous fuels increased by 51 % and show a fluctuating trend since 2006. Between 2021 and 2022 the GHG emissions decreased by 13 %, mainly driven by the decrease in solid fuels, mild winter and higher prices caused by the war in Ukraine.

Figure 3.114   1.A.4.a Commercial/Institutional: Total emission and activity trends



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 20 % between 1990 and 2022 and biomass consumption increased by 298 %.

Table 3.78 1.A.4.a Commercial/Institutional: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	2 292	1 524	1 214	1.3%	-1 078	-47%	-310	-20%	NA,T2	CS,NA
Belgium	4 289	5 852	4 890	5.2%	601	14%	-961	-16%	NA,T1,T2	CS,D,NA
Bulgaria	3 117	337	335	0.4%	-2 782	-89%	-3	-1%	NA,T1,T2	CS,D,NA
Croatia	855	654	563	0.6%	-292	-34%	-91	-14%	NA,T1	D,NA
Cyprus	75	93	102	0.1%	27	36%	9	10%	NA,T1	D,NA
Czechia	9 907	2 559	2 320	2.5%	-7 588	-77%	-239	-9%	NA,T1,T2	CS,D,NA
Denmark	1 567	824	624	0.7%	-943	-60%	-200	-24%	NA,T2,T3	CS,NA
Estonia	165	250	181	0.2%	16	10%	-70	-28%	T1,T2	CS,D
Finland	2 473	1 168	1 094	1.2%	-1 379	-56%	-74	-6%	NA,T2,T3	CS,NA
France	26 581	21 746	17 301	18.3%	-9 280	-35%	-4 445	-20%	NA	NA
Germany	64 037	25 726	24 027	25.4%	-40 010	-62%	-1 699	-7%	CS,NA,T2,T3	CS,NA
Greece	519	624	612	0.6%	93	18%	-12	-2%	NA,T2	CS,NA
Hungary	2 766	2 893	2 452	2.6%	-315	-11%	-442	-15%	NA,T1,T2	CS,D,NA
Ireland	2 121	1 424	1 408	1.5%	-713	-34%	-15	-1%	T2	CS
Italy	11 902	21 708	19 315	20.4%	7 413	62%	-2 393	-11%	NA,T2	CS,NA
Latvia	2 726	442	420	0.4%	-2 306	-85%	-22	-5%	NA,T1,T2	CS,D,NA
Lithuania	3 059	290	285	0.3%	-2 774	-91%	-5	-2%	NA,T2	CS,NA
Luxembourg	639	622	473	0.5%	-166	-26%	-148	-24%	NA,T2	CS,NA
Malta	165	53	65	0.1%	-99	-60%	13	24%	NA,T1	D,NA
Netherlands	8 372	6 695	5 696	6.0%	-2 676	-32%	-999	-15%	NA,T2	CS,D,NA
Poland	9 715	7 609	5 926	6.3%	-3 789	-39%	-1 683	-22%	NA,T1,T2	CS,D,NA
Portugal	704	982	1 018	1.1%	313	44%	36	4%	NA,NO,T1	D,NA,NO
Romania	IE,NO	2 006	2 089	2.2%	2 089	∞	83	4%	NA,T1,T2	CS,D,NA
Slovakia	4 148	1 450	1 365	1.4%	-2 782	-67%	-85	-6%	NA,T2	CS,NA
Slovenia	624	250	288	0.3%	-336	-54%	38	15%	NA,T1,T2	CS,D,NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	2 777	618	592	0.6%	-2 185	-79%	-26	-4%	T1,T2	CS
EU-27	**165 593**	**108 400**	**94 655**	**100%**	**-70 938**	**-43%**	**-13 745**	**-13%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4. a Commercial/Institutional – Liquid Fuels (CO_2)

In 2022 CO_2 emissions from liquid fuels had a share of 20 % within source category 1.A.4.a (compared to 41 % in 1990). Between 1990 and 2022, CO_2 emissions decreased by 72 % (Table 3.**72**) to 20 751 kt CO_2 eq.. Only three Member States increased the use of liquid fuels in the time series. Between 2021 and 2022 EU CO_2 emissions decreased by 12 %.

Table 3.79 1.A.4.a Commercial/Institutional, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	1 420	585	495	2.4%	-924	-65%	-89	-15%
Belgium	2 315	1 078	936	4.5%	-1 379	-60%	-142	-13%
Bulgaria	2 986	83	99	0.5%	-2 886	-97%	17	20%
Croatia	526	106	104	0.5%	-422	-80%	-3	-3%
Cyprus	75	93	102	0.5%	27	36%	9	10%
Czechia	2 000	58	40	0.2%	-1 960	-98%	-18	-32%
Denmark	1 162	260	235	1.1%	-927	-80%	-25	-10%
Estonia	140	62	68	0.3%	-71	-51%	6	10%
Finland	2 423	1 089	1 026	4.9%	-1 397	-58%	-62	-6%
France	16 555	6 196	4 345	20.9%	-12 210	-74%	-1 851	-30%
Germany	28 064	4 587	4 241	20.4%	-23 823	-85%	-346	-8%
Greece	499	276	334	1.6%	-165	-33%	58	21%
Hungary	864	89	77	0.4%	-788	-91%	-13	-14%
Ireland	1 759	565	562	2.7%	-1 197	-68%	-3	-1%
Italy	1 530	1 579	1 443	7.0%	-87	-6%	-136	-9%
Latvia	1 017	131	134	0.6%	-884	-87%	2	2%
Lithuania	1 166	9	7	0.0%	-1 159	-99%	-2	-22%
Luxembourg	469	351	274	1.3%	-196	-42%	-77	-22%
Malta	165	53	65	0.3%	-99	-60%	13	24%
Netherlands	513	317	327	1.6%	-186	-36%	11	3%
Poland	IE,NO	1 283	1 115	5.4%	1 115	∞	-168	-13%
Portugal	704	274	347	1.7%	-358	-51%	73	27%
Romania	IE,NO	255	243	1.2%	243	∞	-12	-5%
Slovakia	384	17	28	0.1%	-355	-93%	12	70%
Slovenia	391	199	175	0.8%	-216	-55%	-24	-12%
Spain	3 284	3 590	3 563	17.2%	279	8%	-26	-1%
Sweden	2 691	396	366	1.8%	-2 325	-86%	-30	-8%
EU-27	**73 102**	**23 580**	**20 751**	**100%**	**-52 351**	**-72%**	**-2 829**	**-12%**

Notes: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. 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 3.140 and Figure 3.141 show CO_2 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. Fuel consumption decreased by 71 % between 1990 and 2022. The CO_2 implied emission factor for liquid fuels was 72.20 t/TJ in 2022.

Figure 3.115 1.A.4.a Commercial/Institutional, liquid fuels: Emission trend and share for CO_2

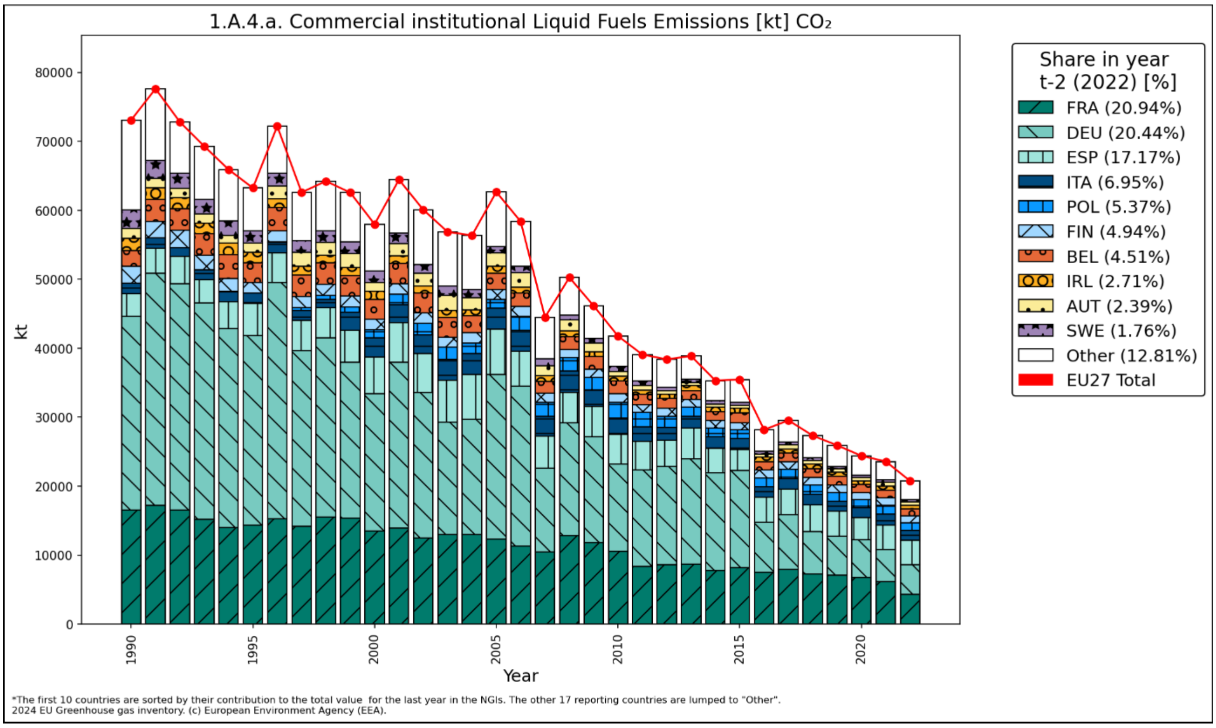
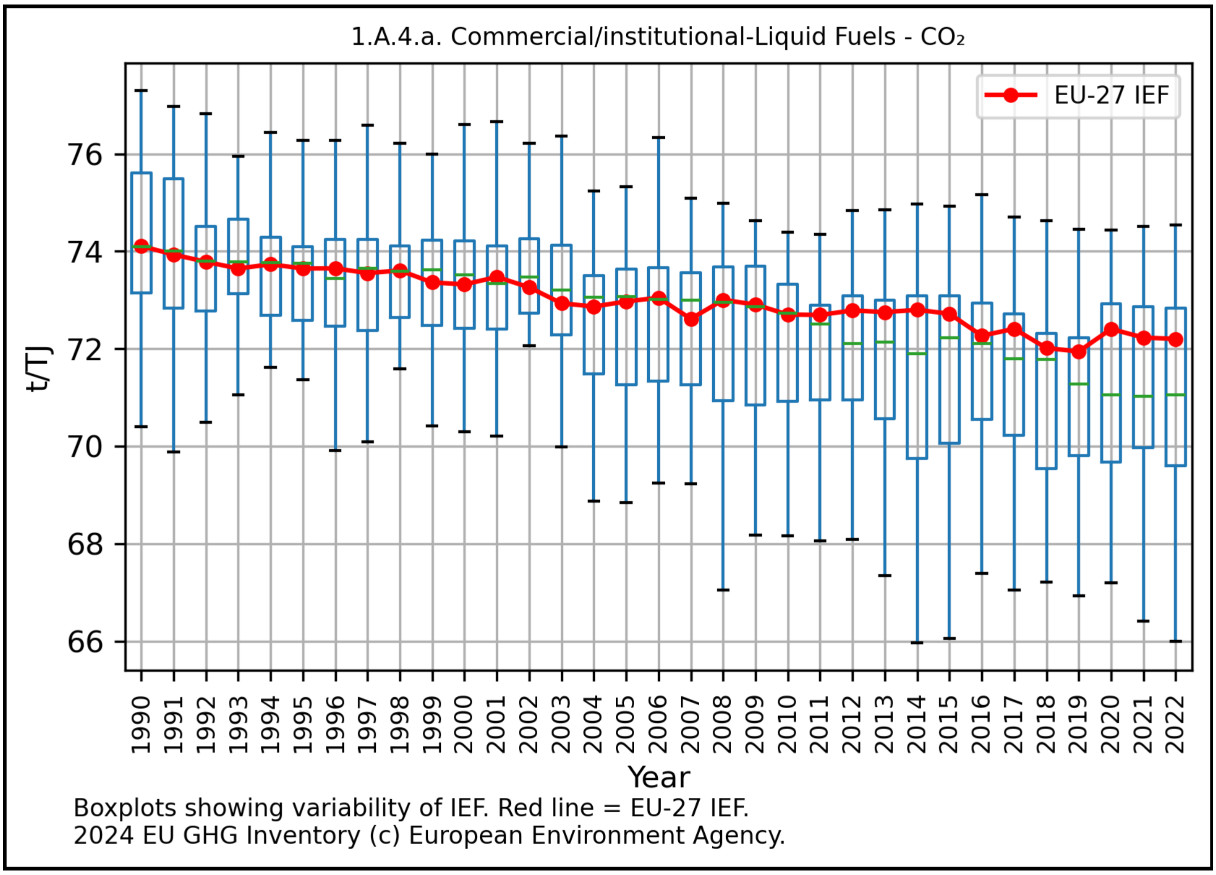


Figure 3.116 1.A.4.a Commercial/Institutional, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.a Commercial/Institutional – Solid Fuels (CO_2)

In 2022, 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 2022 CO_2 emissions decreased by 95 % (Table 3.73). Between 2021 and 2022 CO_2 emissions decreased by 40 %.

Table 3.80 1.A.4.a Commercial/Institutional, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	91	NO	NO	-	-91	-100%	-	-
Belgium	9	0	0	0.0%	-9	-100%	0	-50%
Bulgaria	89	10	6	0.3%	-83	-93%	-3	-36%
Croatia	88	IE,NO	IE,NO	-	-88	-100%	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	6 237	96	113	5.4%	-6 124	-98%	17	18%
Denmark	8	NO	NO	-	-8	-100%	-	-
Estonia	NO	4	NO	-	-	-	-4	-100%
Finland	NO	NO	NO	-	-	-	-	-
France	1 930	150	137	6.5%	-1 793	-93%	-13	-8%
Germany	22 426	3	4	0.2%	-22 423	-100%	0	14%
Greece	20	NO	NO	-	-20	-100%	-	-
Hungary	473	5	6	0.3%	-467	-99%	1	21%
Ireland	3	1	1	0.0%	-2	-69%	0	0%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	1 366	6	3	0.2%	-1 363	-100%	-3	-48%
Lithuania	1 173	93	85	4.0%	-1 088	-93%	-8	-8%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	101	3	0	0.0%	-101	-100%	-3	-98%
Poland	8 881	2 524	1 192	56.6%	-7 689	-87%	-1 331	-53%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	IE,NO	0	0	0.0%	0	∞	0	6%
Slovakia	1 729	238	178	8.4%	-1 551	-90%	-60	-25%
Slovenia	203	NO	NO	-	-203	-100%	-	-
Spain	147	359	383	18.2%	236	161%	24	7%
Sweden	NO	NO	NO	-	-	-	-	-
EU-27	**44 975**	**3 490**	**2 108**	**100%**	**-42 867**	**-95%**	**-1 382**	**-40%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Greece reports emissions from stationary combustion as 'NO' and emissions from mobile sources as 'IE'
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.142 and Figure 3.143 show CO_2 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. Fuel consumption in the EU decreased by 95 % between 1990 and 2022. The CO_2 implied emission factor for solid fuels was 95.23 t/TJ in 2022.

Figure 3.117 1.A.4.a Commercial/Institutional, solid fuels: Emission trend and share for CO_2

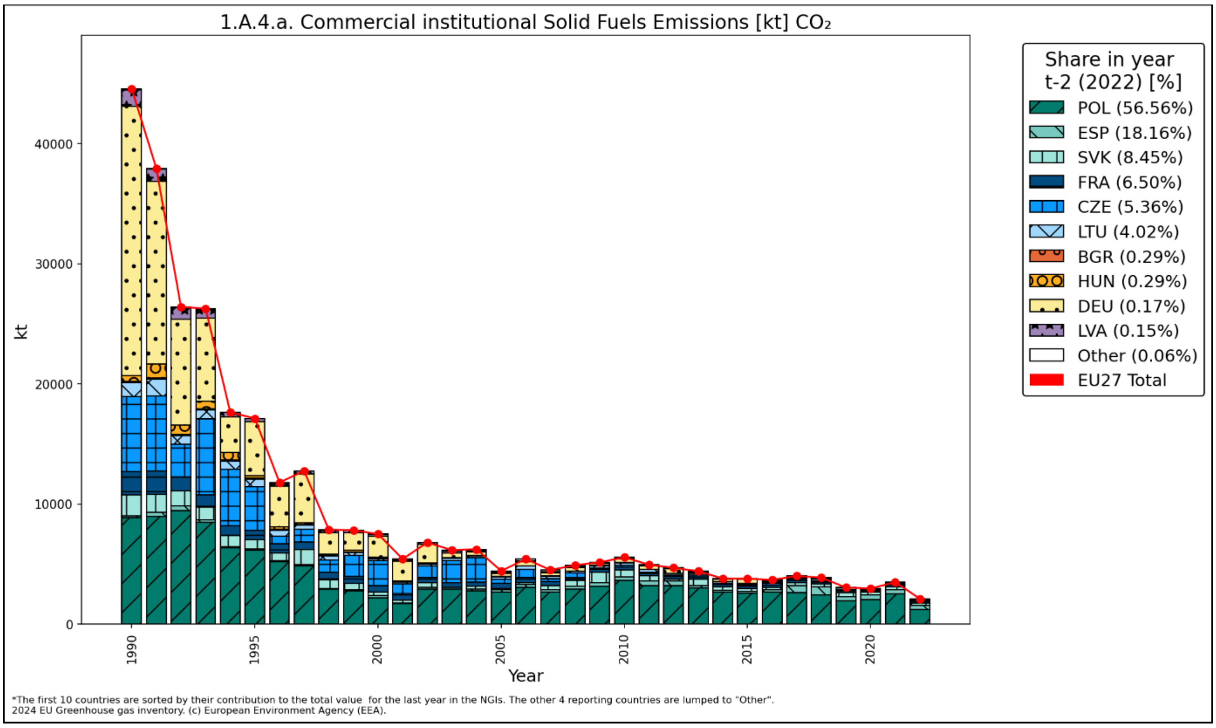
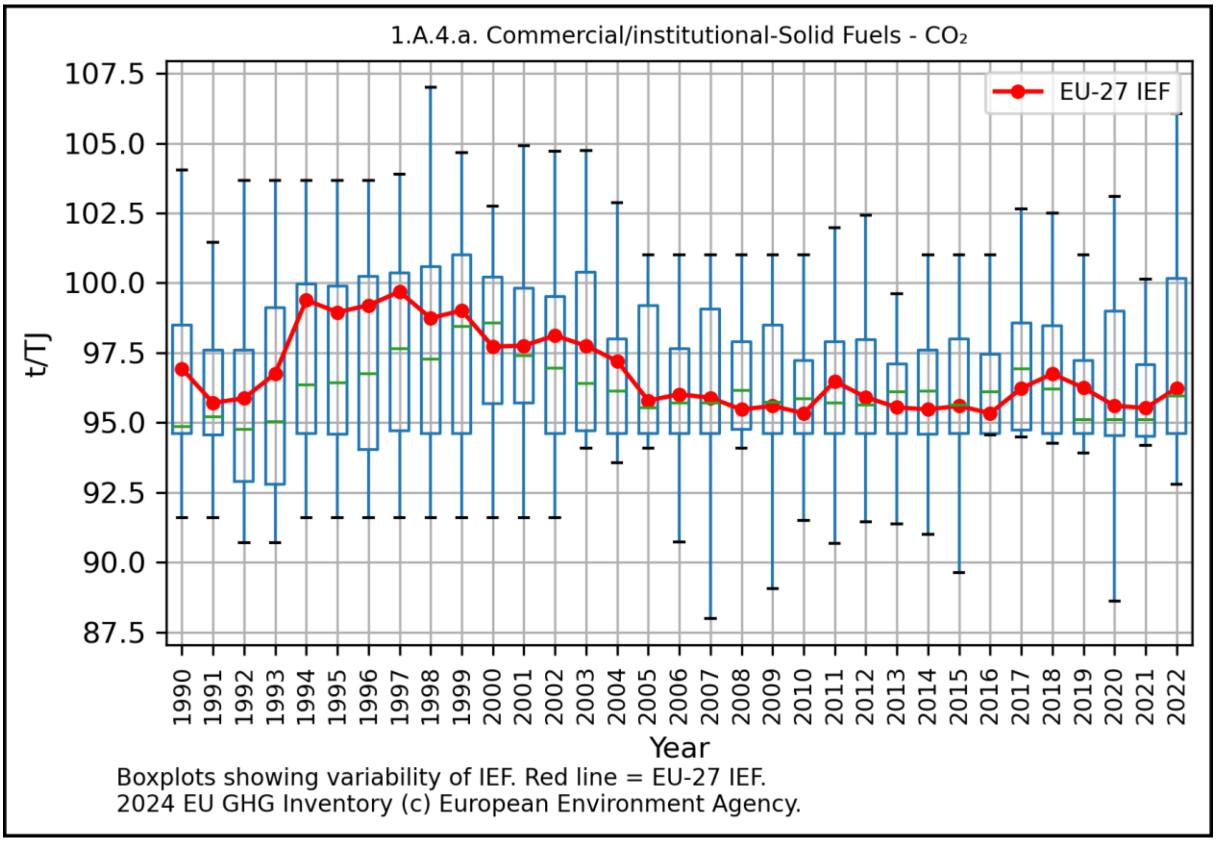


Figure 3.118 1.A.4.a Commercial/Institutional, solid fuels: of Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.a Commercial/Institutional – Gaseous Fuels (CO_2)

In 2022 CO_2 from gaseous fuels had a share of 73 % within source category 1.A.4.a (compared to 34% in 1990). Between 1990 and 2022, the emissions increased by 49 % (Table 3.74). All Member States except the Netherlands, Slovakia and Lithuania reported increasing emissions. The highest absolute increases occurred in France, Germany and Spain. Between 2021 and 2022 CO_2 emissions decreased by 12 %.

Table 3.81 1.A.4.a Commercial/Institutional, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	698	939	718	1.0%	20	3%	-221	-24%
Belgium	1 936	4 653	3 867	5.2%	1 931	100%	-786	-17%
Bulgaria	42	245	229	0.3%	187	445%	-16	-6%
Croatia	241	547	459	0.6%	219	91%	-88	-16%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	1 670	2 405	2 167	2.9%	497	30%	-238	-10%
Denmark	363	564	389	0.5%	26	7%	-175	-31%
Estonia	19	184	108	0.1%	89	479%	-76	-41%
Finland	37	68	58	0.1%	20	54%	-11	-15%
France	8 096	15 400	12 819	17.1%	4 723	58%	-2 582	-17%
Germany	13 547	21 135	19 781	26.4%	6 234	46%	-1 354	-6%
Greece	NO	349	278	0.4%	278	∞	-71	-20%
Hungary	1 429	2 638	2 204	2.9%	775	54%	-434	-16%
Ireland	223	858	846	1.1%	622	278%	-12	-1%
Italy	9 842	14 433	12 348	16.5%	2 506	25%	-2 085	-14%
Latvia	276	302	282	0.4%	6	2%	-20	-7%
Lithuania	708	168	167	0.2%	-541	-76%	-1	-1%
Luxembourg	170	271	200	0.3%	30	18%	-71	-26%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	7 758	6 375	5 368	7.2%	-2 390	-31%	-1 007	-16%
Poland	762	3 727	3 591	4.8%	2 829	372%	-136	-4%
Portugal	NO	708	671	0.9%	671	∞	-37	-5%
Romania	IE,NO	1 742	1 831	2.4%	1 831	∞	89	5%
Slovakia	2 035	1 196	1 159	1.5%	-876	-43%	-37	-3%
Slovenia	29	52	113	0.2%	84	287%	62	120%
Spain	379	5 824	5 038	6.7%	4 659	1231%	-786	-14%
Sweden	86	222	225	0.3%	139	161%	3	2%
EU-27	**50 344**	**85 002**	**74 915**	**100%**	**24 571**	**49%**	**-10 088**	**-12%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.144 and Figure 3.145 show CO_2 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. Fuel consumption increased by 49 % between 1990 and 2022. The CO_2 implied emission factor for gaseous fuels was 56.55 t/TJ in 2022.

Figure 3.119 1.A.4.a Commercial/Institutional, gaseous fuels: Emission trend and share for CO_2

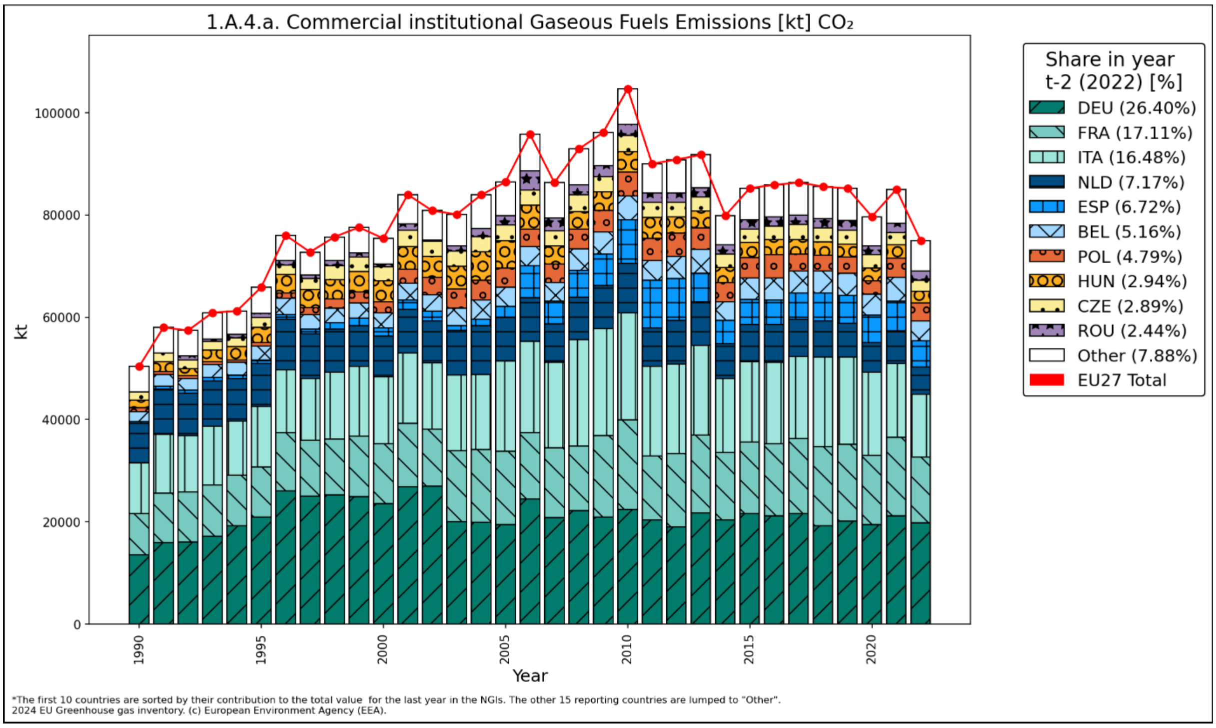
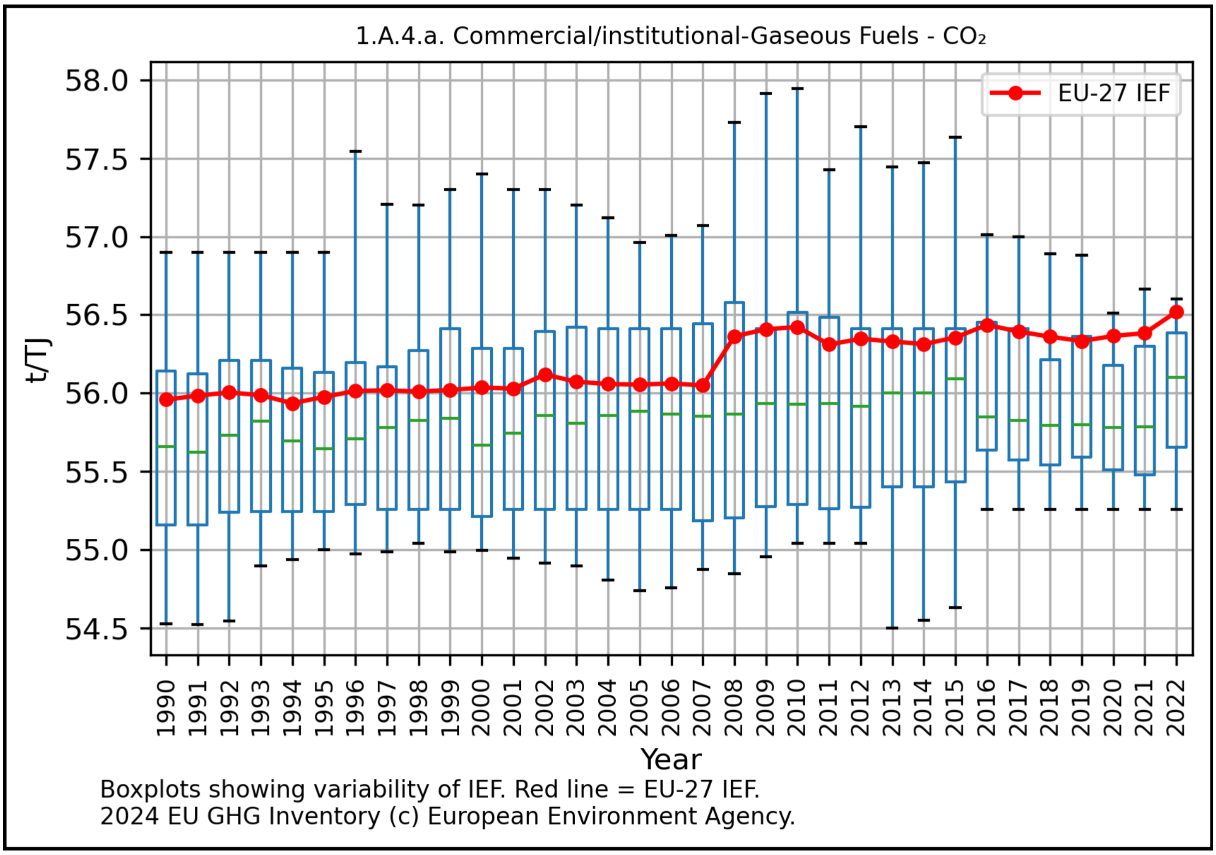


Figure 3.120 1.A.4.a Commercial/Institutional, gaseous fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)



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 2022, CO_2 from other fossil fuels had a share of 6 % within category 1.A.4.a. Between 1990 and 2022 CO_2 emissions increased by 678 % (Table 3.75). Fifteen Member States report emissions as 'Not occurring' or 'Included elsewhere' in 2022; between 2021 and 2022 CO_2 decreased by 4%. 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.

Table 3.82: 1.A.4.a Commercial/Institutional, other fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	83	0	0	0.0%	-83	-100%	0	-15%
Belgium	29	121	88	1.5%	58	201%	-33	-28%
Bulgaria	NO	NO	NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	0	0	0.0%	0	∞	0	-14%
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	34	NO	NO	-	-34	-100%	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	0	NO	NO	-	0	-100%	-	-
France	NO	NO	NO	-	-	-	-	-
Germany	NO	2	1	0.0%	1	∞	0	-13%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NO	161	165	2.8%	165	∞	4	3%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	530	5 695	5 523	94.9%	4 993	942%	-172	-3%
Latvia	NO	0	NO	-	-	-	0	-100%
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	1	1	0.0%	1	∞	0	-15%
Poland	72	75	27	0.5%	-45	-62%	-48	-63%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	IE,NO	10	15	0.3%	15	∞	6	59%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	NO	1	1	0.0%	1	∞	0	7%
EU-27	**748**	**6 066**	**5 822**	**100%**	**5 073**	**678%**	**-244**	**-4%**

Note: *Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.*

Figure 3.147 shows CO_2 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. The CO_2 implied emission factor for other fossil fuels was 96.17 t/TJ in 2022. The comparatively high implied emission factor is a calculated value from a mass balance calculation method and data from energy statistics.

Figure 3.121 1.A.4.a Commercial/Institutional, other fuels: Emission trend and share for CO_2

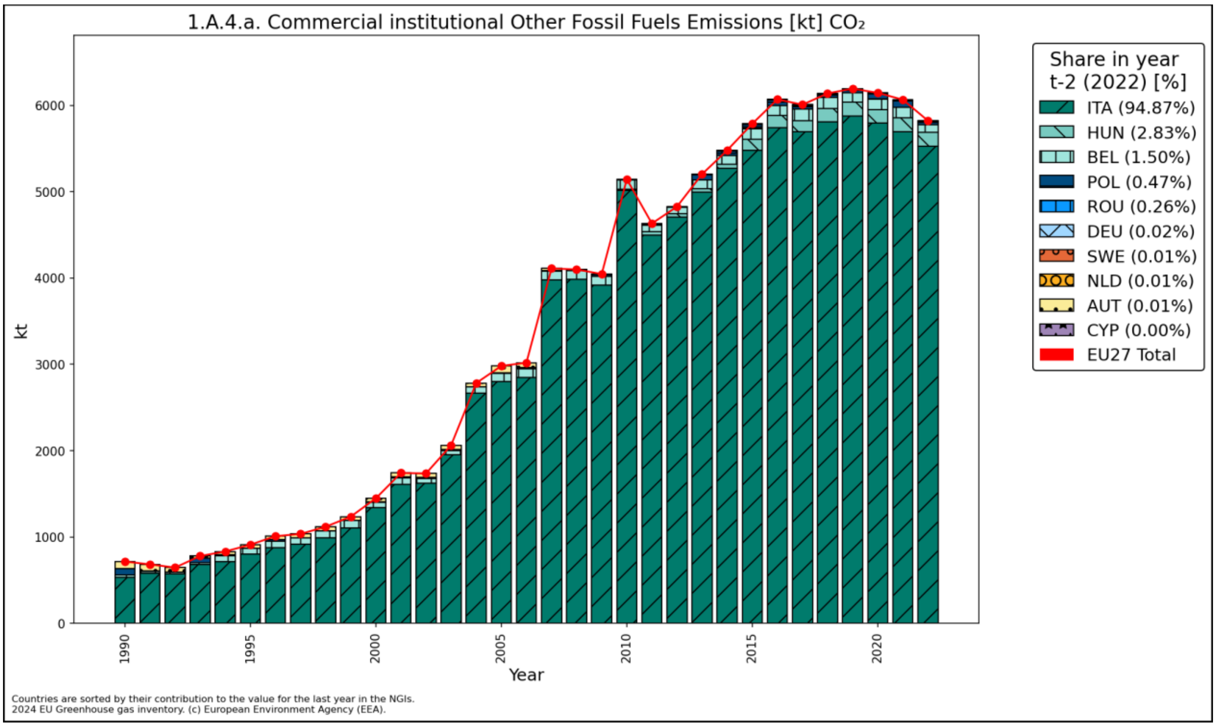
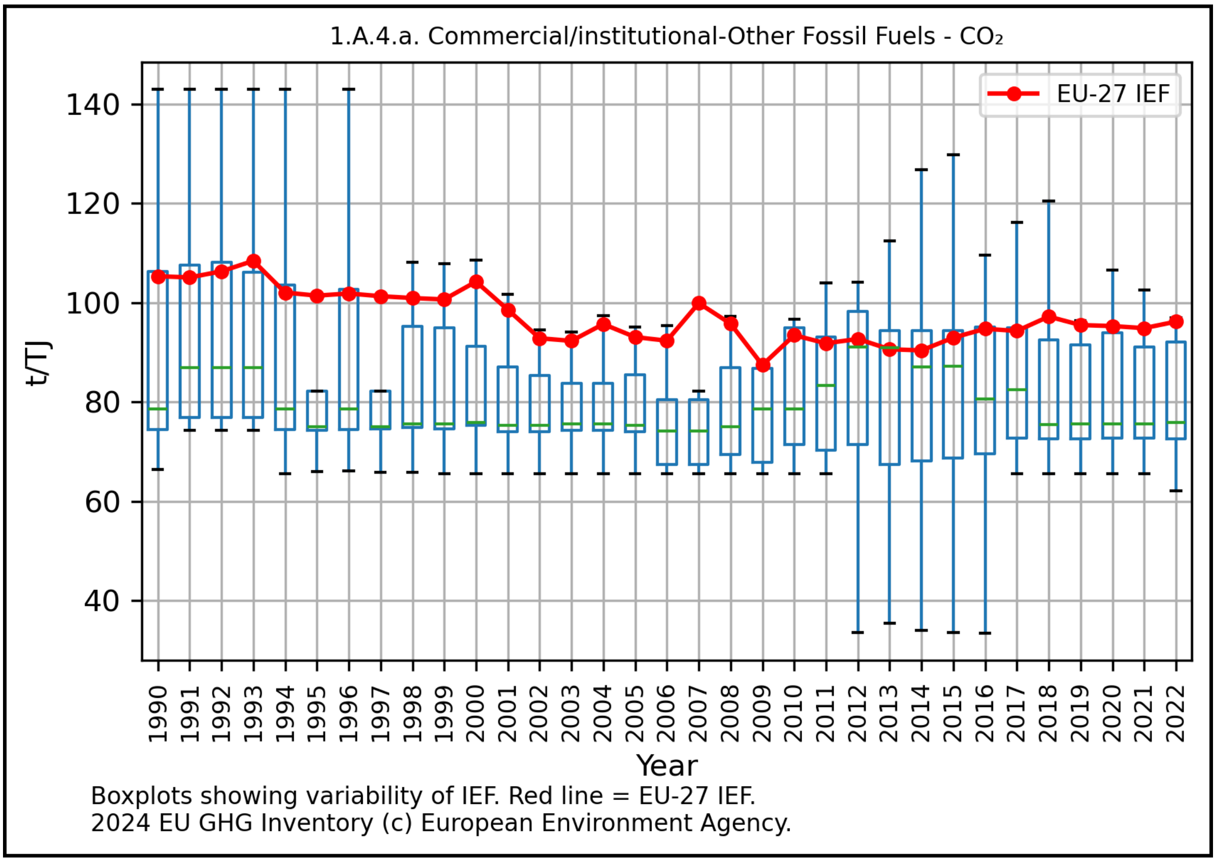


Figure 3.122 1.A.4.a Commercial/Institutional, other fuels: Overview of outliers of Implied Emission Factors for CO_2 (in t/TJ)



3.5.4.2 Residential (1.A.4.b)

CO_2 emissions from 1.A.4.b Residential account for 12 % of total GHG emissions from 1.A Fuel Combustion in 2022.

Figure 3.148 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 35 % since 1990, although CO_2 emissions from gaseous fuels increased strongly (35 %) which was counterbalanced by decreasing emissions from liquid and solid fuels. From 2021 to 2022, CO_2 emissions decreased by 15 % and energy consumption decreased by 12 %. Biomass consumption reached a share of 29 % in the year 2022 while the share of solid fossil fuels consumption dropped to 4 %.

Almost of the Member States experienced decreasing trend in heating degree days due to the mild winter. Nevertheless, for most of the Member States trend in fuel consumption correlates with trend in heating degree days. The following Table 3.76: EU heating degree days 2021 and 2022 and 1.A.4.b trend in total fuel consumption. presents the (15°/18°) heating degree days in 2021 and 2022 for Member States and trend in 1.A.4.b total fuel consumption. Not only the mild winter but also higher prices due to the war in Ukraine have affected the consumption.

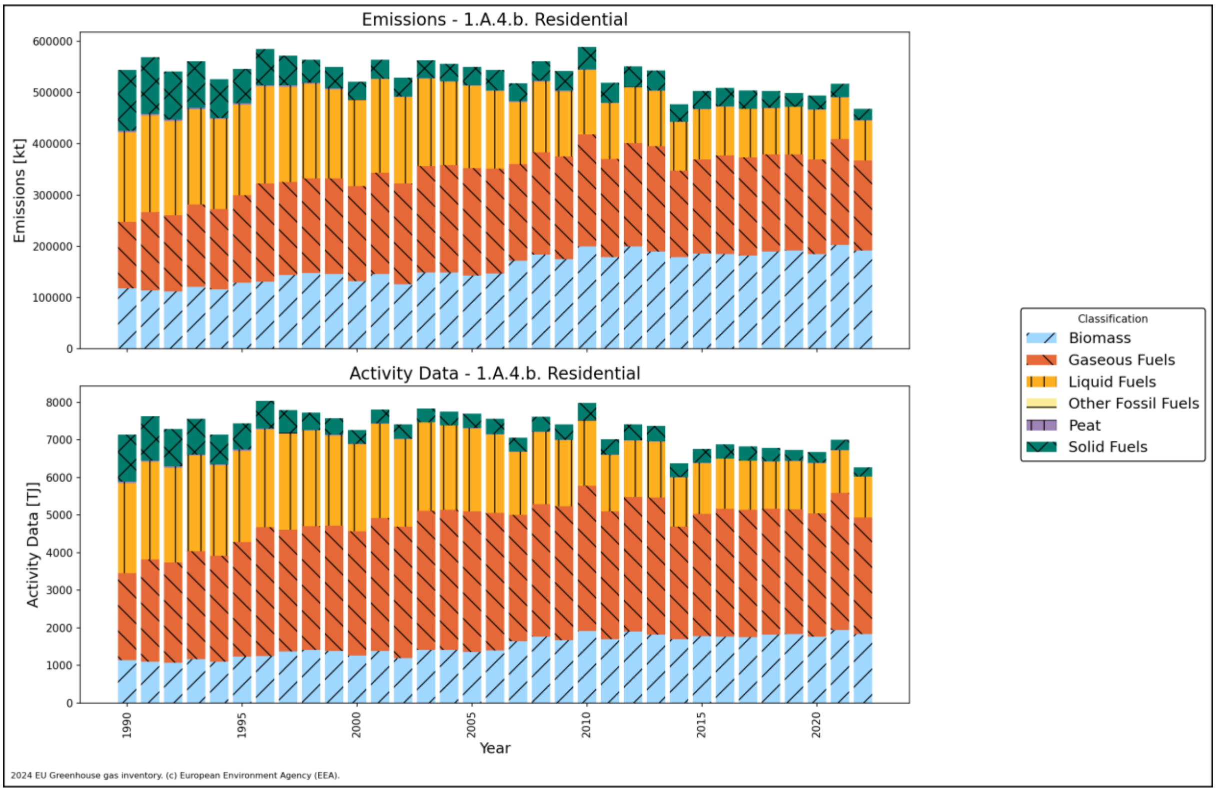
Table 3.83: EU heating degree days 2021 and 2022 and 1.A.4.b trend in total fuel consumption.

	2021	2022	Trend 2021 – 2022 [%]	Trend fuel consumption 1.A.4.b [%]
Austria	3633	3229	-11	-18
Belgium	2711	2377	-12	-16
Bulgaria	2503	2307	-8	-23
Croatia	2366	2115	-11	-8
Cyprus	610	696	14	7
Czechia	3452	3083	-11	-10
Denmark	3264	3019	-8	-19
Estonia	4283	4118	-4	1
Finland	5623	5277	-6	-11
France	2413	2036	-16	-16
Germany	3114	2736	-12	-7
Greece	1536	1538	0	8
Hungary	2803	2550	-9	-11
Ireland	2644	2549	-4	-15
Italy	1917	1735	-9	-13
Latvia	4144	4026	-3	-5
Lithuania	4016	3773	-6	-5
Luxembourg	3174	2671	-16	-6
Malta	466	544	17	-7
Netherlands	2722	2396	-12	-20
Poland	3491	3200	-8	-7
Portugal	1065	968	-9	-4
Romania	2994	2751	-8	-10
Slovakia	3383	3043	-10	-11
Slovenia	2986	2644	-11	-14
Spain	1663	1478	-11	3
Sweden	5201	4919	-5	0

	2021	2022	Trend 2021 – 2022 [%]	Trend fuel consumption 1.A.4.b [%]
EU (weighted)	3126	2858	-9	-11

Source: Eurostat and EEA 2024

Figure 3.123 1.A.4.b Residential: Total emission and activity trends



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CO_2 emissions from 1.A.4.b Residential

Between 1990 and 2022, CO_2 emissions from households decreased by 36 % in the EU (Table 3.77). 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 12 % between 1990 and 2022, 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 2022, the largest CO_2 reduction in absolute terms was reported by Germany. 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.

Table 3.84 1.A.4.b Residential: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	10 000	6 955	5 857	2.2%	-4 143	-41%	-1 098	-16%	NA,T2	CS,NA
Belgium	20 483	15 322	12 753	4.9%	-7 730	-38%	-2 570	-17%	CS,M,NA,T1,T2	CS,D,NA
Bulgaria	2 887	838	417	0.2%	-2 470	-86%	-420	-50%	NA,T1,T2	CS,D,NA
Croatia	2 029	1 518	1 466	0.6%	-563	-28%	-52	-3%	NA,T1	D,NA
Cyprus	300	294	316	0.1%	16	5%	22	8%	NA,T1	D,NA
Czechia	18 375	7 848	7 044	2.7%	-11 331	-62%	-804	-10%	NA,T1,T2	CS,D,NA
Denmark	4 996	1 419	1 061	0.4%	-3 936	-79%	-358	-25%	NA,T2,T3	CS,NA
Estonia	1 021	155	122	0.0%	-900	-88%	-33	-22%	T1,T2	CS,D
Finland	3 148	841	641	0.2%	-2 506	-80%	-200	-24%	NA,T2,T3	CS,NA
France	53 936	40 083	32 853	12.5%	-21 083	-39%	-7 230	-18%	NA	NA
Germany	128 636	91 203	84 253	32.1%	-44 382	-35%	-6 949	-8%	CS,NA,T2	CS,NA
Greece	4 654	4 549	5 023	1.9%	369	8%	474	10%	NA,T2	CS,NA
Hungary	15 448	8 208	7 125	2.7%	-8 323	-54%	-1 083	-13%	NA,T1,T2	CS,D,NA
Ireland	7 050	6 706	5 650	2.2%	-1 399	-20%	-1 056	-16%	T2	CS
Italy	55 788	48 073	41 775	15.9%	-14 012	-25%	-6 298	-13%	NA,T2	CS,NA
Latvia	1 182	431	408	0.2%	-774	-65%	-23	-5%	NA,T2	CS,NA
Lithuania	2 361	836	801	0.3%	-1 560	-66%	-35	-4%	NA,T2	CS,NA
Luxembourg	670	986	907	0.3%	237	35%	-80	-8%	NA,T1,T2	CS,D,NA
Malta	95	34	32	0.0%	-63	-66%	-2	-5%	NA,T1	D,NA
Netherlands	20 809	17 020	13 486	5.1%	-7 323	-35%	-3 534	-21%	NA,T1,T2	CS,D,NA
Poland	35 222	31 457	28 034	10.7%	-7 188	-20%	-3 423	-11%	NA,T1,T2	CS,D,NA
Portugal	1 640	1 730	1 587	0.6%	-52	-3%	-143	-8%	NO,T1,T2	CS,D,NO
Romania	8 881	8 328	7 198	2.7%	-1 683	-19%	-1 129	-14%	NA,T1,T2	CS,D,NA
Slovakia	6 773	3 173	2 869	1.1%	-3 904	-58%	-304	-10%	NA,T2	CS,NA
Slovenia	896	614	611	0.2%	-286	-32%	-3	-1%	NA,T1,T2	CS,D,NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	6 298	460	441	0.2%	-5 856	-93%	-19	-4%	T1,T2	CS
EU-27	**413 579**	**299 082**	**262 733**	**100%**	**-150 846**	**-36%**	**-36 348**	**-12%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.b Residential – Liquid Fuels (CO_2)

In 2022 CO_2 from liquid fuels had a share of 28 % CO_2 emissions within source category 1.A.4.b (compared to 36 % in 1990). Between 1990 and 2022, emissions decreased by 55 % (Table 3.78). Only three Member States reported increasing emissions since 1990. Between 2021 and 2022 EU CO_2 emissions decreased by 4 %.

Table 3.85 1.A.4.b Residential, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	5 633	3 232	2 791	3.6%	-2 842	-50%	-441	-14%
Belgium	12 825	6 590	5 827	7.5%	-6 998	-55%	-763	-12%
Bulgaria	158	56	48	0.1%	-109	-69%	-7	-13%
Croatia	1 137	279	312	0.4%	-825	-73%	32	12%
Cyprus	300	294	316	0.4%	16	5%	22	8%
Czechia	239	139	130	0.2%	-109	-46%	-9	-7%
Denmark	3 937	365	314	0.4%	-3 623	-92%	-51	-14%
Estonia	244	13	9	0.0%	-235	-96%	-4	-32%
Finland	3 024	760	584	0.7%	-2 440	-81%	-177	-23%
France	30 915	12 774	10 905	14.0%	-20 010	-65%	-1 869	-15%
Germany	56 382	31 928	32 660	41.8%	-23 722	-42%	732	2%
Greece	4 565	3 371	3 916	5.0%	-650	-14%	544	16%
Hungary	3 540	214	194	0.2%	-3 346	-95%	-20	-10%
Ireland	1 173	3 776	3 172	4.1%	1 999	170%	-604	-16%
Italy	28 444	5 435	4 838	6.2%	-23 606	-83%	-598	-11%
Latvia	332	157	160	0.2%	-173	-52%	3	2%
Lithuania	397	153	179	0.2%	-218	-55%	26	17%
Luxembourg	474	418	402	0.5%	-72	-15%	-16	-4%
Malta	95	34	32	0.0%	-63	-66%	-2	-5%
Netherlands	854	173	169	0.2%	-685	-80%	-4	-2%
Poland	110	1 691	1 615	2.1%	1 504	1362%	-76	-5%
Portugal	1 640	1 050	955	1.2%	-685	-42%	-96	-9%
Romania	922	736	813	1.0%	-109	-12%	76	10%
Slovakia	93	23	20	0.0%	-73	-78%	-3	-12%
Slovenia	527	349	374	0.5%	-153	-29%	25	7%
Spain	9 855	7 001	6 967	8.9%	-2 888	-29%	-35	0%
Sweden	6 212	386	366	0.5%	-5 845	-94%	-20	-5%
EU-27	**174 026**	**81 398**	**78 065**	**100%**	**-95 960**	**-55%**	**-3 333**	**-4%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.149 and Figure 3.150 show CO_2 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. Fuel consumption in the EU decreased by 55 % between 1990 and 2022. The CO_2 implied emission factor for liquid fuels was 71.77 t/TJ in 2022. 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 3.124 1.A.4.b Residential, liquid fuels: Emission trend and share for CO_2

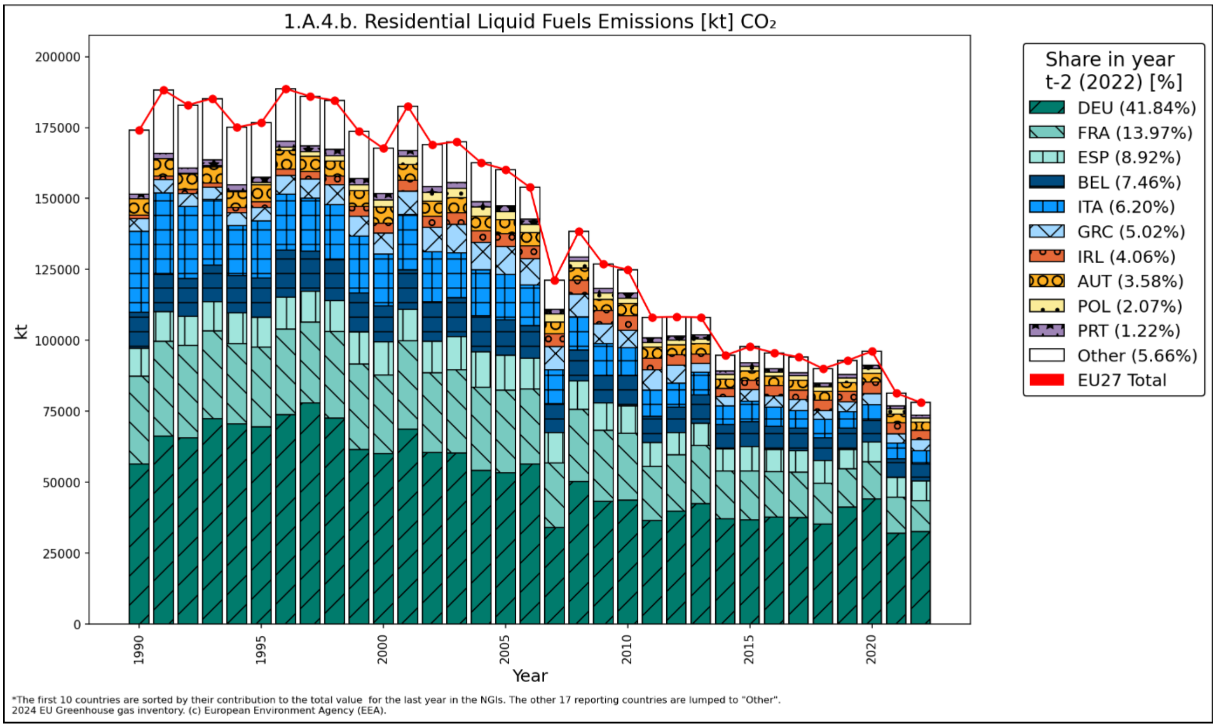
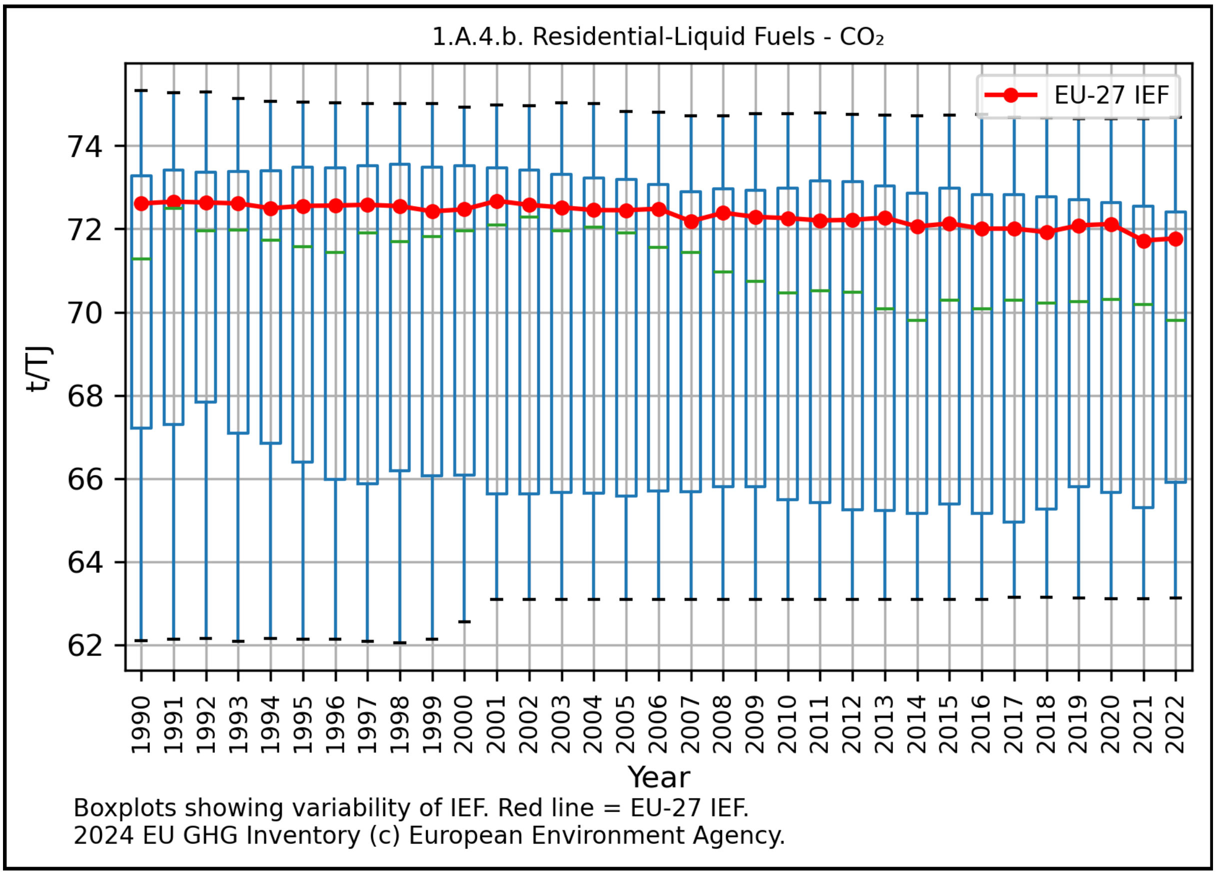


Figure 3.125 1.A.4.b Residential, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.b Residential –Solid Fuels (CO_2)

In 2022, 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 2022 CO_2 emissions decreased by 81 % (Table 3.79). Between 2021 and 2022 CO_2 emissions decreased by 14 %. Six Member States and Iceland report emissions as 'Not occurring' in 2022. According to the methodology as described in chapter 3.2.4 98 % of EU emissions are calculated by using higher tier methods in 2022.

Table 3.86 1.A.4.b Residential, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	2 511	45	34	0.2%	-2 477	-99%	-11	-25%
Belgium	1 796	81	68	0.3%	-1 728	-96%	-13	-16%
Bulgaria	2 730	518	166	0.7%	-2 564	-94%	-353	-68%
Croatia	436	8	6	0.0%	-431	-99%	-2	-26%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	16 038	2 866	3 022	13.6%	-13 016	-81%	156	5%
Denmark	72	NO	NO	-	-72	-100%	-	-
Estonia	337	2	NO	-	-337	-100%	-2	-100%
Finland	33	NO	NO	-	-33	-100%	-	-
France	1 957	104	105	0.5%	-1 852	-95%	1	1%
Germany	40 661	1 439	1 156	5.2%	-39 505	-97%	-284	-20%
Greece	89	13	20	0.1%	-69	-78%	6	48%
Hungary	8 083	188	198	0.9%	-7 885	-98%	10	5%
Ireland	2 483	753	508	2.3%	-1 976	-80%	-245	-33%
Italy	899	NO	NO	-	-899	-100%	-	-
Latvia	587	5	5	0.0%	-582	-99%	0	-2%
Lithuania	1 440	120	105	0.5%	-1 335	-93%	-16	-13%
Luxembourg	26	1	2	0.0%	-24	-92%	1	44%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	61	2	0	0.0%	-61	-100%	-1	-81%
Poland	28 362	19 181	16 310	73.4%	-12 052	-42%	-2 871	-15%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	2 729	144	147	0.7%	-2 583	-95%	3	2%
Slovakia	5 122	256	236	1.1%	-4 886	-95%	-19	-8%
Slovenia	345	0	NO	-	-345	-100%	0	-100%
Spain	2 035	193	146	0.7%	-1 888	-93%	-47	-24%
Sweden	NO	NO	NO	-	-	-	-	-
EU-27	**118 831**	**25 920**	**22 233**	**100%**	**-96 598**	**-81%**	**-3 687**	**-14%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.151 and Figure 3.152 show CO_2 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. That the highest shares on total CO_2 emissions (above the average share calculated for EU) corresponds to Poland. Fuel consumption in the EU decreased by 81 % between 1990 and 2022. The CO_2 implied emission factor for solid fuels was 94.71 t/TJ in 2022. 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 3.126 1.A.4.b Residential, solid fuels: Emission trend and share for CO_2

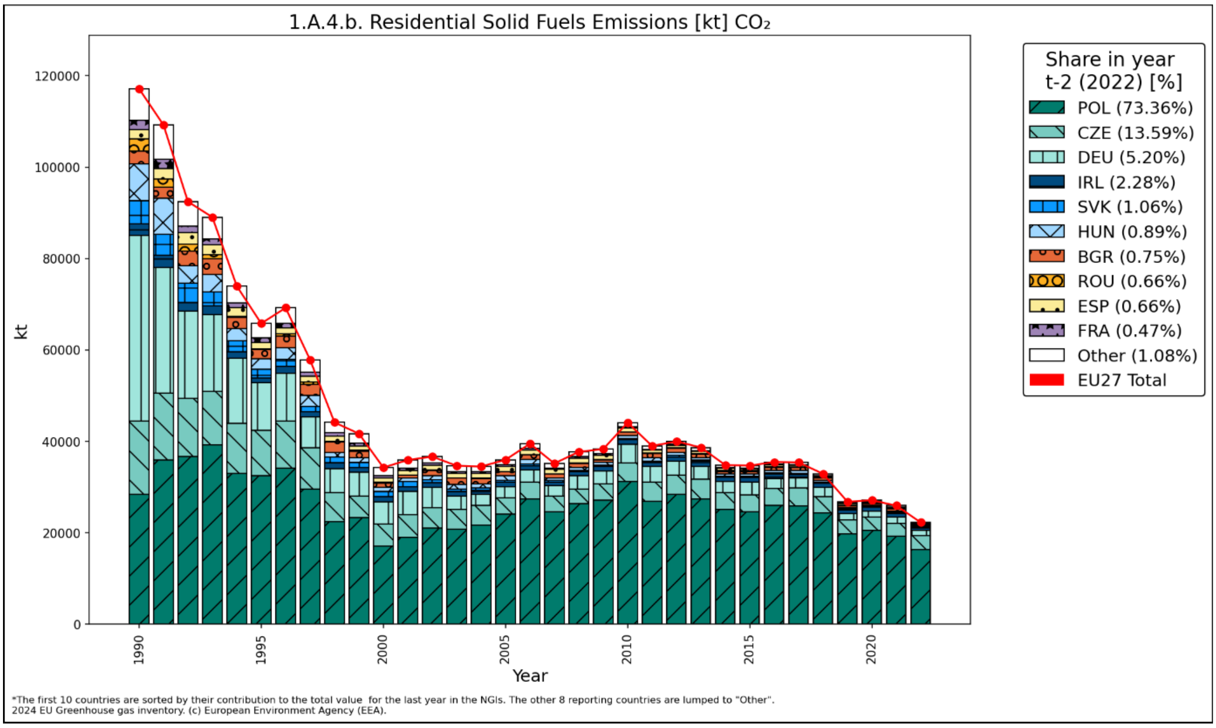
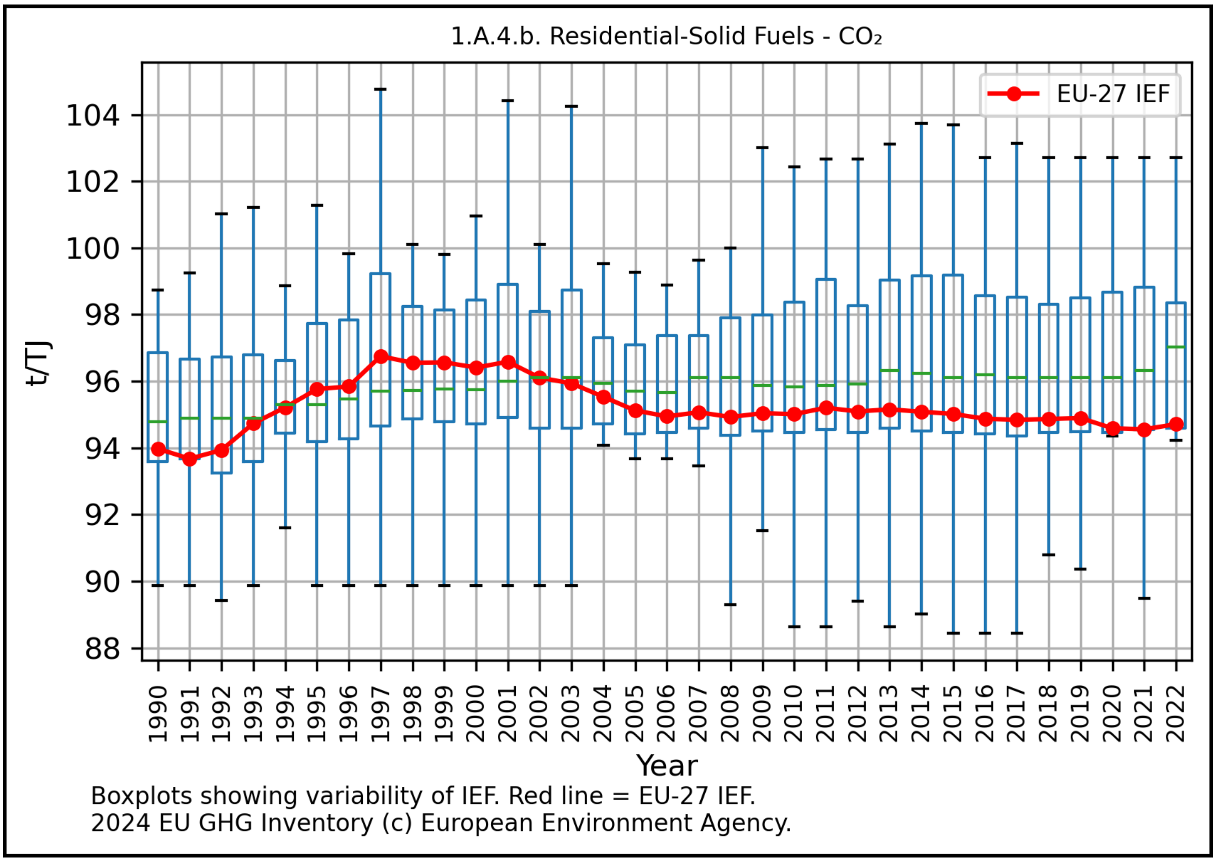


Figure 3.127 1.A.4.b Residential, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.b Residential – Gaseous Fuels (CO_2)

In 2022, CO_2 from gaseous fuels had a share of 60 % CO_2 emissions within source category 1.A.4.b (compared to 37 % in 1990). Between 1990 and 2022, the emissions increased by 35 % (Table 3.80). Between 2021 and 2022 EU emissions decreased by 15 %.

Table 3.87 1.A.4.b Residential, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	1 856	3 677	3 032	1.7%	1 176	63%	-646	-18%
Belgium	5 862	8 652	6 858	3.9%	996	17%	-1 794	-21%
Bulgaria	NO	263	203	0.1%	203	∞	-60	-23%
Croatia	456	1 231	1 149	0.7%	693	152%	-82	-7%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	2 098	4 842	3 892	2.2%	1 794	85%	-950	-20%
Denmark	988	1 054	747	0.4%	-241	-24%	-307	-29%
Estonia	132	140	113	0.1%	-19	-14%	-27	-19%
Finland	25	64	43	0.0%	18	72%	-21	-32%
France	21 064	27 205	21 843	12.4%	779	4%	-5 362	-20%
Germany	31 564	57 834	50 437	28.6%	18 873	60%	-7 397	-13%
Greece	NO	1 164	1 088	0.6%	1 088	∞	-76	-7%
Hungary	3 825	7 806	6 734	3.8%	2 908	76%	-1 073	-14%
Ireland	270	1 404	1 279	0.7%	1 009	374%	-125	-9%
Italy	26 444	42 638	36 938	21.0%	10 493	40%	-5 700	-13%
Latvia	221	269	243	0.1%	23	10%	-25	-9%
Lithuania	509	509	458	0.3%	-51	-10%	-51	-10%
Luxembourg	170	567	502	0.3%	332	196%	-65	-11%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	19 894	16 846	13 317	7.6%	-6 577	-33%	-3 529	-21%
Poland	6 750	10 585	10 110	5.7%	3 360	50%	-476	-4%
Portugal	NO	680	633	0.4%	633	∞	-47	-7%
Romania	5 230	7 448	6 239	3.5%	1 009	19%	-1 209	-16%
Slovakia	1 559	2 894	2 613	1.5%	1 054	68%	-281	-10%
Slovenia	25	265	237	0.1%	212	838%	-28	-11%
Spain	912	8 121	7 286	4.1%	6 373	699%	-835	-10%
Sweden	86	74	75	0.0%	-11	-13%	1	1%
EU-27	**129 940**	**206 233**	**176 067**	**100%**	**46 128**	**35%**	**-30 166**	**-15%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.153 shows CO_2 emissions for EU and the Member States as well as the share of the Member States with the highest contributions. Fuel consumption in the EU increased by 34 % between 1990 and 2022. The CO_2 implied emission factor for gaseous fuels was 56.65 t/TJ in 2022.

Figure 3.128 1.A.4.b Residential, gaseous fuels: Emission trend and share for CO_2

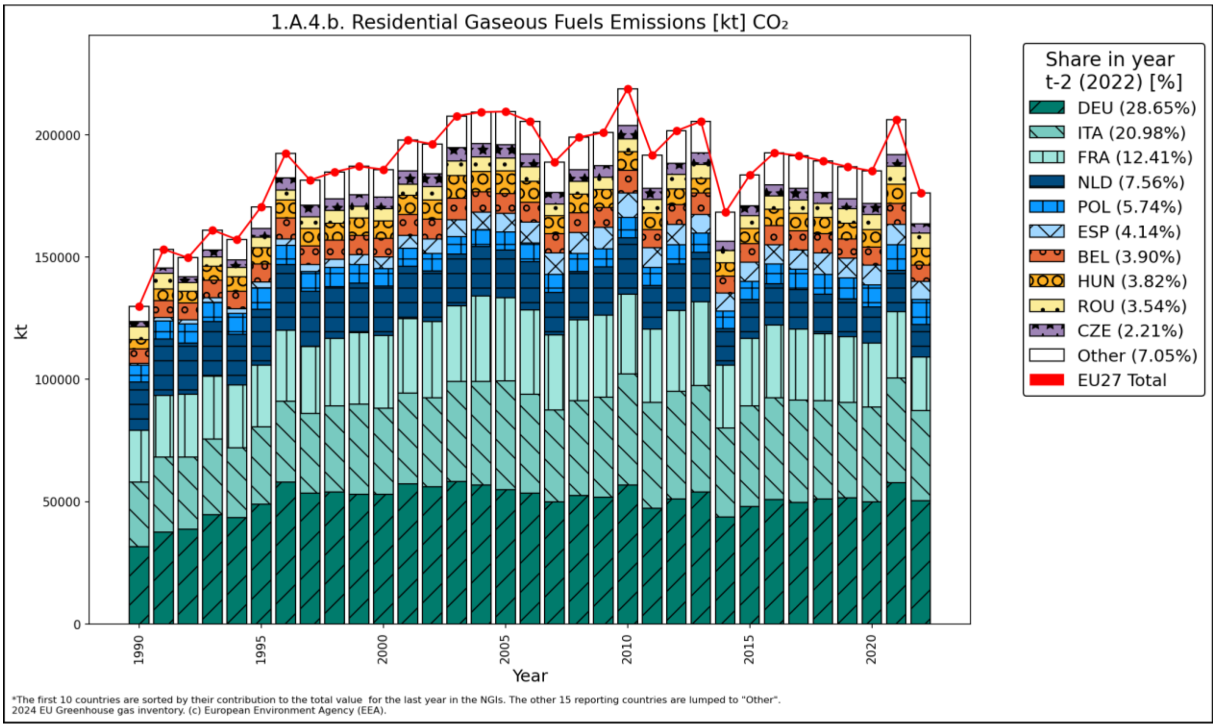
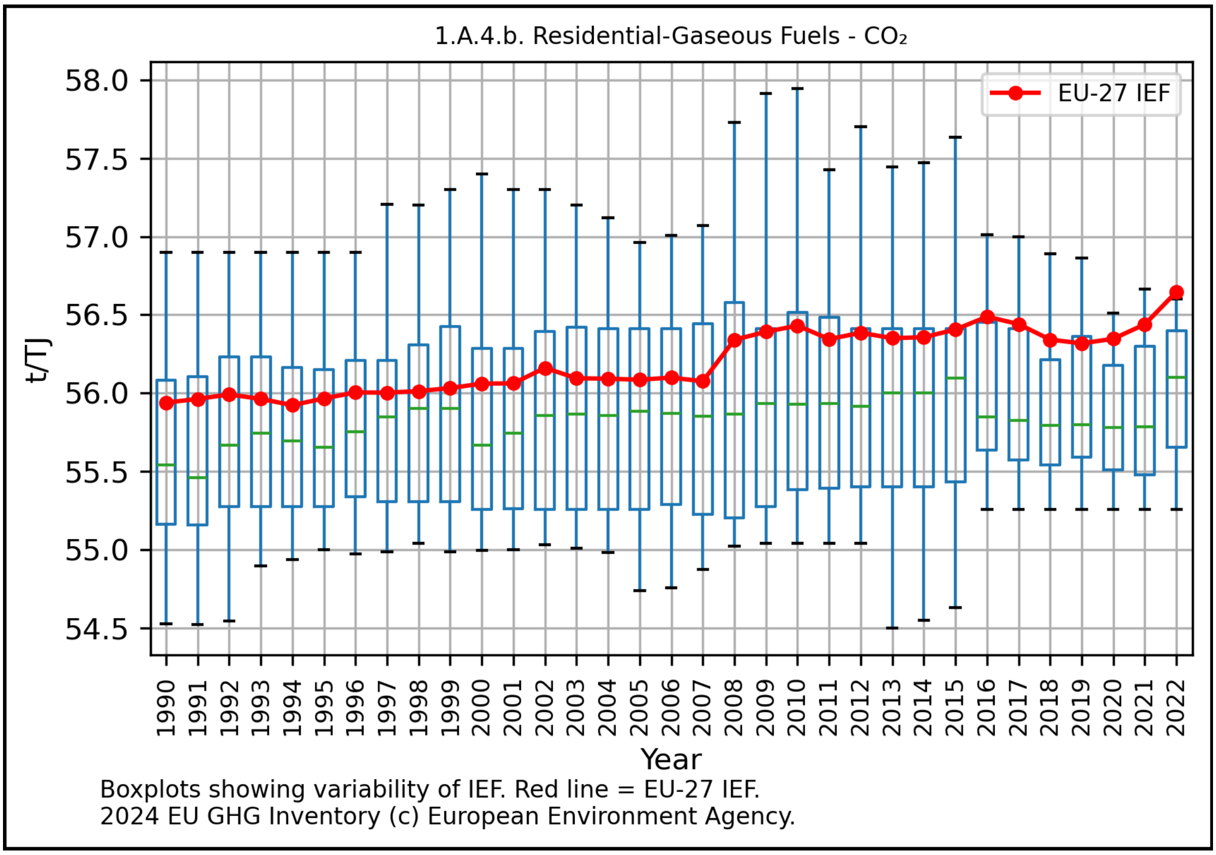


Figure 3.129 1.A.4.b Residential, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



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 54 % of total CH_4 emissions in 1.A and 0.6 % of total GHG emissions in 1.A in 2022. Between 1990 and 2022, CH_4 emissions from households decreased by 31 % in the EU (Table 3.81). Between 2021 and 2022 CH_4 emissions decreased by 9 %.

Table 3.88 1.A.4.b Residential: Member States' contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	514	269	215	1.6%	-299	-58%	-55	-20%	NA,T1,T2,T3	CS,D,NA
Belgium	262	310	282	2.1%	19	7%	-28	-9%	CS,M,NA,T1	CR,D,NA
Bulgaria	293	314	241	1.8%	-53	-18%	-73	-23%	NA,T1	D,NA
Croatia	396	395	358	2.6%	-39	-10%	-37	-9%	NA,T1	D,NA
Cyprus	2	8	8	0.1%	6	274%	0	6%	NA,T1	D,NA
Czechia	1 697	1 077	1 038	7.6%	-660	-39%	-39	-4%	NA,T1	D,NA
Denmark	152	93	81	0.6%	-71	-47%	-12	-13%	NA,T1,T3	D,NA,OTH
Estonia	64	14	15	0.1%	-49	-77%	0	3%	T1,T2	CS,D
Finland	166	199	183	1.3%	17	10%	-16	-8%	NA,T1,T2,T3	CR,CS,D,NA
France	5 112	1 813	1 481	10.8%	-3 631	-71%	-332	-18%	NA	NA
Germany	2 783	994	985	7.2%	-1 798	-65%	-10	-1%	NA,T2,T3	CS,M,NA
Greece	256	230	240	1.8%	-16	-6%	9	4%	NA,T1	D,NA
Hungary	925	501	485	3.5%	-440	-48%	-16	-3%	NA,T1	D,NA
Ireland	496	157	124	0.9%	-372	-75%	-33	-21%	T1	D
Italy	1 226	2 607	2 364	17.3%	1 138	93%	-243	-9%	NA,T2	CR,NA
Latvia	221	128	122	0.9%	-98	-45%	-6	-4%	NA,T1,T2	CS,D,NA
Lithuania	196	158	150	1.1%	-46	-24%	-8	-5%	NA,T1,T2	CS,D,NA
Luxembourg	10	9	11	0.1%	0	3%	2	21%	NA,T1,T3	D,M,NA
Malta	0	1	0	0.0%	0	59%	0	-25%	NA,T1	D,NA
Netherlands	504	416	342	2.5%	-161	-32%	-74	-18%	NA,T1,T2	CS,D,NA
Poland	2 772	3 484	3 203	23.4%	431	16%	-281	-8%	NA,T1	D,NA
Portugal	479	238	236	1.7%	-243	-51%	-2	-1%	NO,T1,T2	D,NO,OTH
Romania	457	1 179	1 114	8.1%	656	144%	-66	-6%	NA,T1	D,NA
Slovakia	424	271	235	1.7%	-189	-45%	-36	-13%	NA,T1	D,NA
Slovenia	159	135	102	0.7%	-58	-36%	-33	-25%	NA,T1,T2	CS,D,NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	115	59	58	0.4%	-58	-50%	-2	-3%	M,T1	CS
EU-27	**19 683**	**15 059**	**13 670**	**100%**	**-6 013**	**-31%**	**-1 389**	**-9%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.b Residential – Biomass (CH_4)

In 2022 CH_4 from biomass had a share of 81 % within source category on the total CH_4 emissions from 1.A.4.b (compared to 47% in 1990). Between 1990 and 2022 CH_4 emissions increased by 11 % (Table 3.82). Between 2021 and 2022, CH_4 emissions decreased by 7 %.

Table 3.89 1.A.4.b Residential, biomass: Member States' contributions to CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	264	251	200	1.7%	-64	-24%	-51	-21%
Belgium	109	280	256	2.2%	146	134%	-24	-9%
Bulgaria	61	264	225	1.9%	165	271%	-39	-15%
Croatia	354	390	353	3.0%	-1	0%	-37	-9%
Cyprus	1	7	7	0.1%	6	506%	0	6%
Czechia	363	809	759	6.5%	396	109%	-50	-6%
Denmark	124	72	66	0.6%	-58	-47%	-6	-8%
Estonia	6	14	14	0.1%	8	124%	1	5%
Finland	147	192	177	1.5%	30	20%	-15	-8%
France	4 765	1 679	1 366	11.8%	-3 398	-71%	-312	-19%
Germany	313	794	816	7.0%	502	160%	22	3%
Greece	247	228	236	2.0%	-11	-4%	9	4%
Hungary	209	463	450	3.9%	241	115%	-14	-3%
Ireland	16	10	8	0.1%	-7	-46%	-1	-15%
Italy	1 115	2 548	2 314	19.9%	1 198	107%	-235	-9%
Latvia	162	126	120	1.0%	-42	-26%	-6	-5%
Lithuania	66	141	134	1.2%	69	105%	-7	-5%
Luxembourg	5	6	8	0.1%	2	41%	2	35%
Malta	NO	1	0	0.0%	0	∞	0	-27%
Netherlands	99	74	72	0.6%	-27	-27%	-2	-3%
Poland	327	1 745	1 723	14.8%	1 397	428%	-22	-1%
Portugal	476	236	234	2.0%	-242	-51%	-2	-1%
Romania	202	1 144	1 080	9.3%	878	434%	-64	-6%
Slovakia	40	242	209	1.8%	168	419%	-33	-14%
Slovenia	129	133	100	0.9%	-30	-23%	-33	-25%
Spain	729	643	643	5.5%	-86	-12%	0	0%
Sweden	107	56	55	0.5%	-53	-49%	-2	-3%
EU-27	**10 438**	**12 547**	**11 625**	**100%**	**1 188**	**11%**	**-921**	**-7%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviation'.

Figure 3.155 and Figure 3.156 show CH_4 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. Biomass fuel consumption in the EU increased by 61 % between 1990 and 2022. The CH_4 implied emission factor for biomass fuels was 226.68 kg/TJ in 2022.

The decreasing trend of IEF 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 that are using the default emission factor value (300 kg/TJ) for the whole time series.

Figure 3.130 1.A.4.b Residential, biomass: Emission trend and share for CH_4

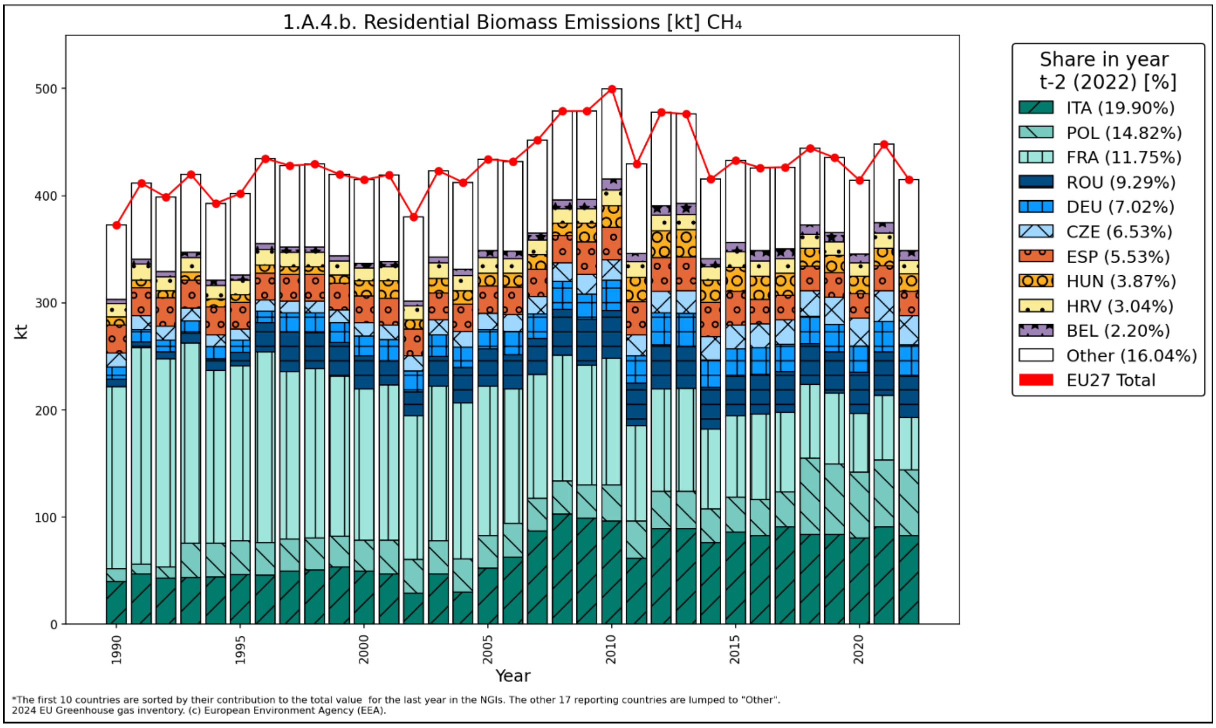
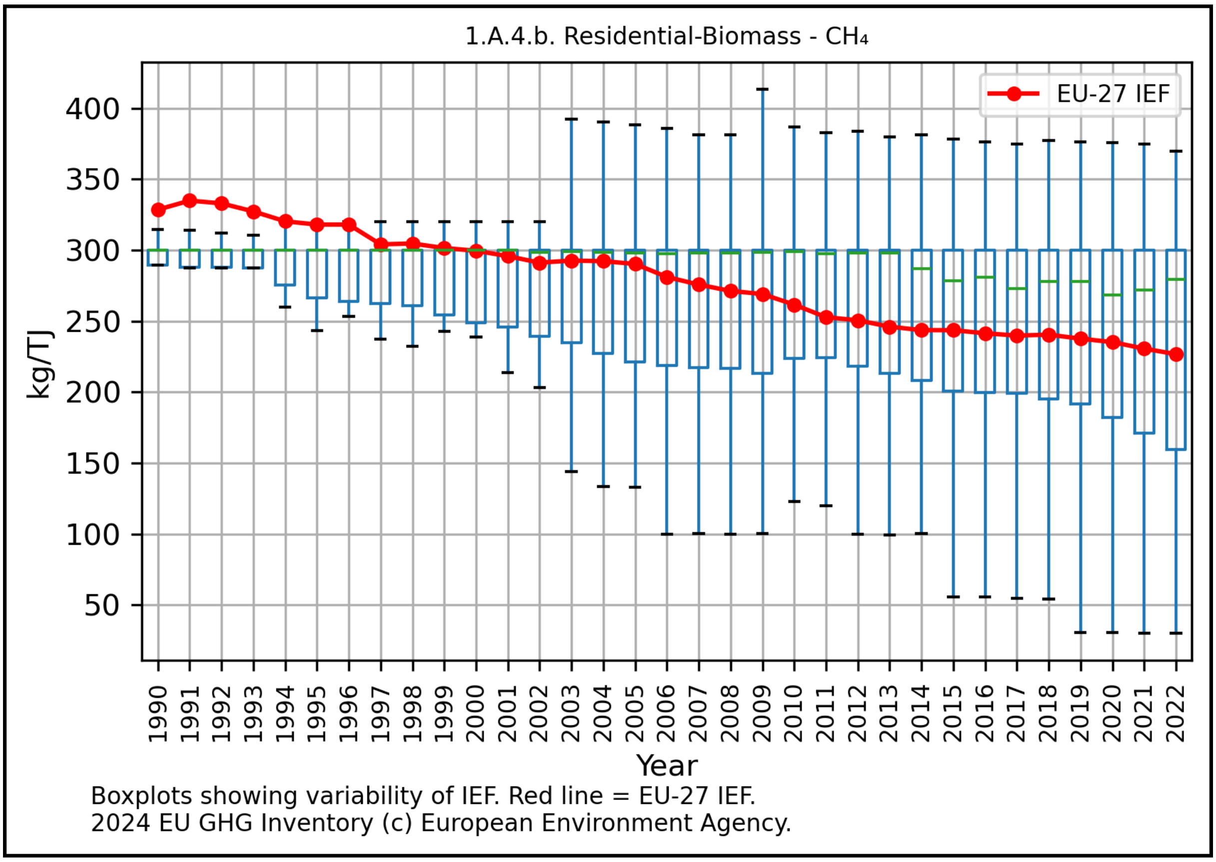


Figure 3.131 1.A.4.b Residential, biomass: Implied Emission Factors for CH_4 (in kg/TJ)



1.A.4.b Residential – Solid Fuels (CH_4)

In 2022, CH_4 from solid fuels had a share of 14 % within source category on the total CH_4 emissions from 1.A.4.b (compared to 46 % in 1990). Between 1990 and 2022 CH_4 emissions decreased by 78 % (Table 3.82). All Member States reported decreasing emissions since 1990. Between 2021 and 2022 CH_4 emissions decreased by 14 %.

Table 3.90: 1.A.4.b Residential, solid fuels: Member States' contributions to CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	224	4	3	0.2%	-221	-99%	-1	-25%
Belgium	123	6	5	0.2%	-118	-96%	-1	-19%
Bulgaria	232	49	15	0.8%	-217	-94%	-34	-70%
Croatia	37	1	0	0.0%	-37	-99%	0	-26%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	1 328	255	269	13.7%	-1 060	-80%	14	5%
Denmark	6	NO	NO	-	-6	-100%	-	-
Estonia	30	0	NO	-	-30	-100%	0	-100%
Finland	3	NO	NO	-	-3	-100%	-	-
France	174	9	9	0.5%	-164	-95%	0	1%
Germany	2 429	104	85	4.4%	-2 343	-96%	-19	-18%
Greece	8	1	2	0.1%	-6	-79%	1	48%
Hungary	693	16	17	0.8%	-677	-98%	1	4%
Ireland	220	65	44	2.2%	-176	-80%	-22	-33%
Italy	11	NO	NO	-	-11	-100%	-	-
Latvia	54	0	0	0.0%	-53	-99%	0	-2%
Lithuania	127	11	9	0.5%	-118	-93%	-1	-13%
Luxembourg	2	0	0	0.0%	-2	-92%	0	44%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	-99%	0	-96%
Poland	2 428	1 708	1 450	74.1%	-978	-40%	-258	-15%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	239	15	16	0.8%	-223	-93%	1	3%
Slovakia	379	22	20	1.0%	-360	-95%	-2	-9%
Slovenia	28	0	NO	-	-28	-100%	0	-100%
Spain	130	16	12	0.6%	-118	-91%	-4	-24%
Sweden	NO	NO	NO	-	-	-	-	-
EU-27	**8 905**	**2 283**	**1 956**	**100%**	**-6 949**	**-78%**	**-326**	**-14%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.155 and Figure 3.156 show CH_4 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. Solid fuel consumption in the EU decreased by 81 % between 1990 and 2022. The CH_4 implied emission factor for solid fuels was 297.62 kg/TJ in 2022.

Figure 3.132: 1.A.4.b Residential, solid fuels: Emission trend and share for CH_4

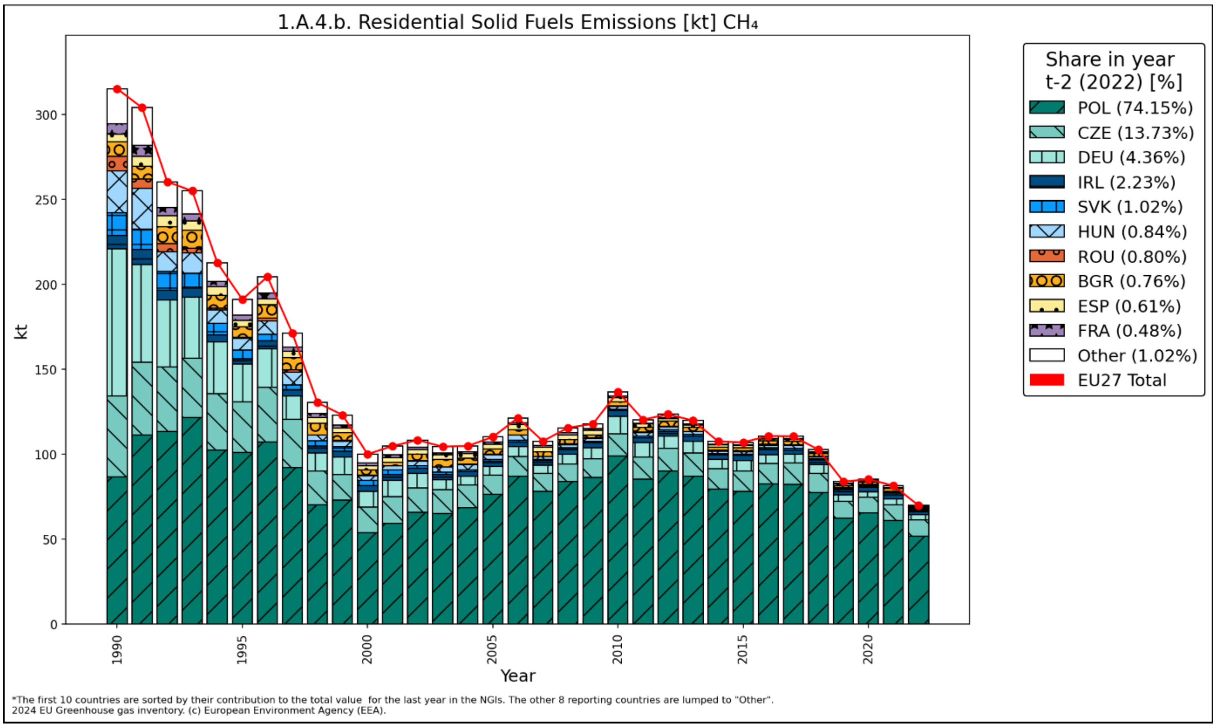
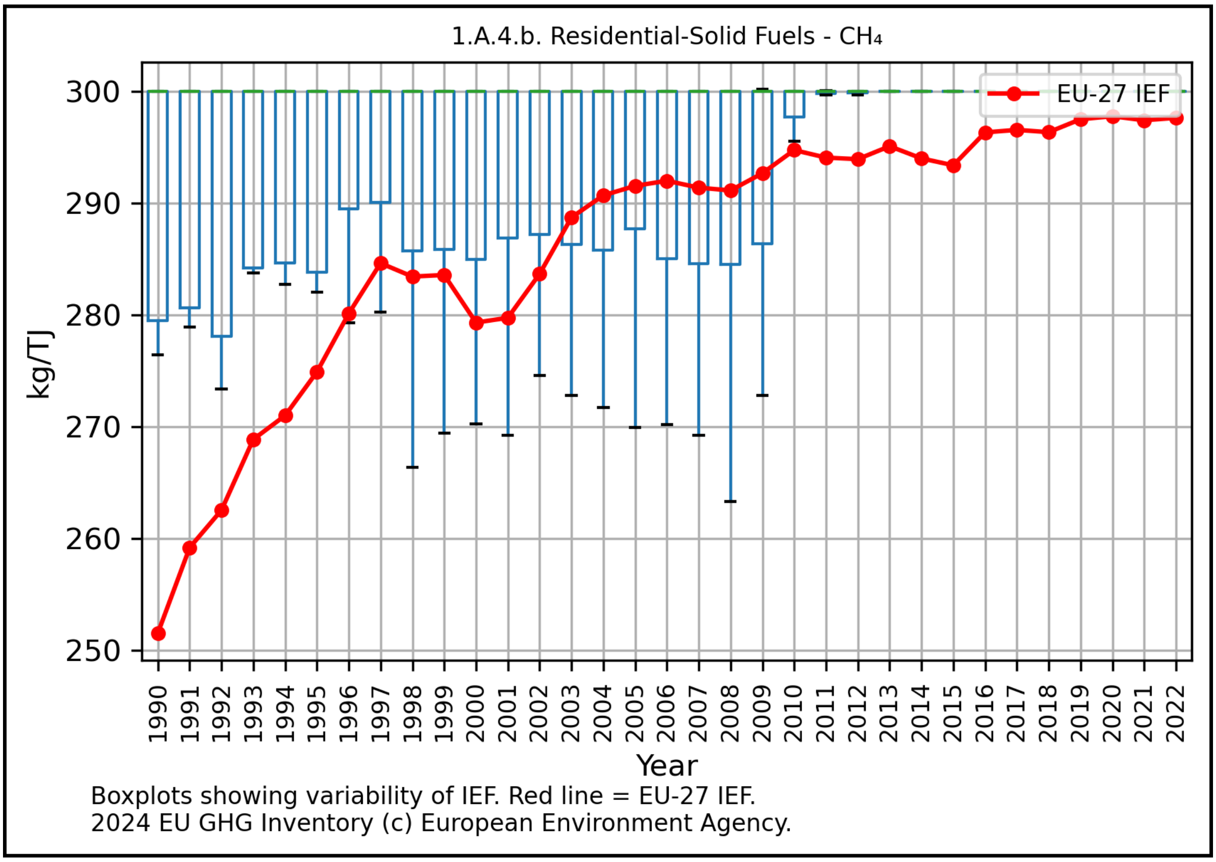


Table 3.91: 1.A.4.b Residential, solid fuels: Implied Emission Factors for CH_4 (in kg/TJ)



3.5.4.3 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 2.7 % of total EU GHG emissions from 1.A Fuel Combustion in 2022. Between 1990 and 2022, CO_2 emissions from 1.A.4.c Agriculture/Forestry/Fisheries decreased by 27 % in the EU (Table 3.85).

Figure 3.158 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 12 % between 1990 and 2022, mainly due to decreases in CO_2 emissions from liquid fuels.

Figure 3.133 1.A.4.c Agriculture/Forestry/Fisheries: Total emission and activity trends

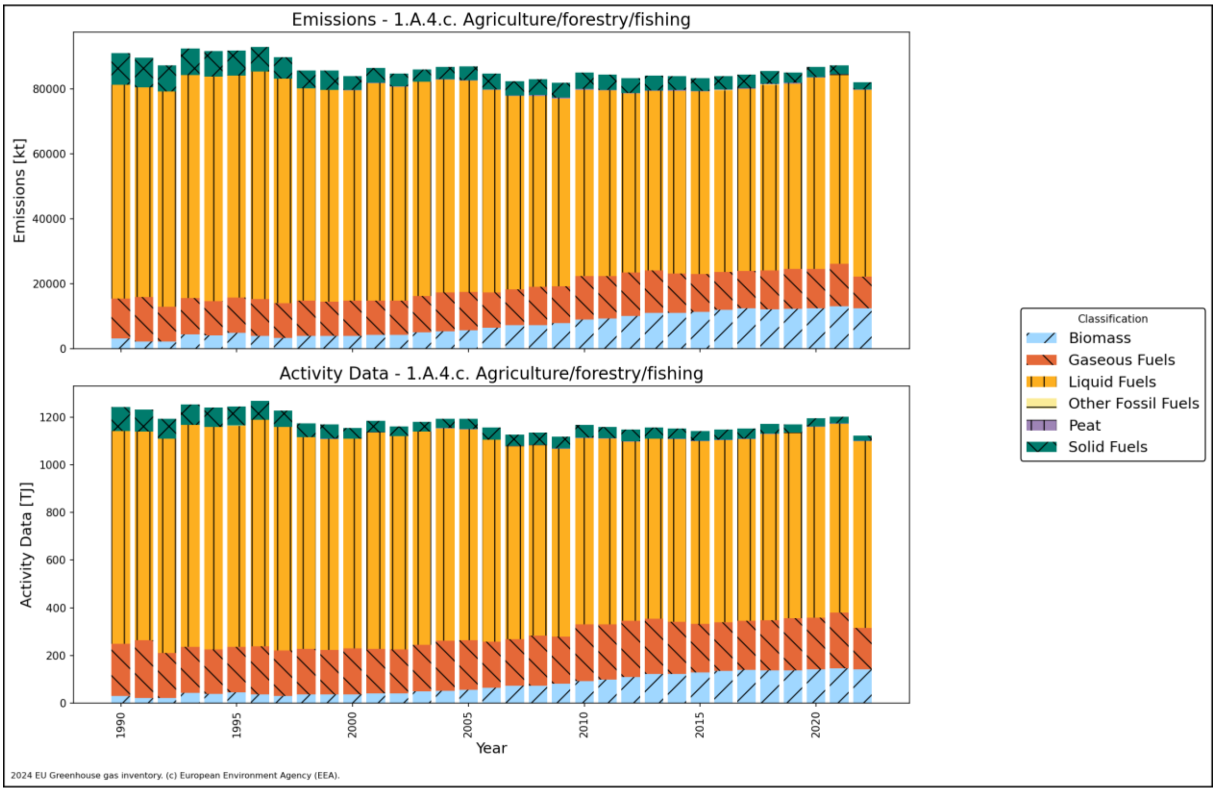


Table 3.92 1.A.4.c Agriculture/Forestry/Fisheries: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 251	865	849	1.5%	-402	-32%	-16	-2%	NA,T2	CS,NA
Belgium	3 037	2 584	2 211	3.8%	-826	-27%	-373	-14%	CS,M,NA,T1,T2	CS,D,NA
Bulgaria	1 649	455	477	0.8%	-1 173	-71%	22	5%	NA,T1,T2	CS,D,NA
Croatia	835	687	693	1.2%	-142	-17%	6	1%	NA,T1	D,NA
Cyprus	55	85	81	0.1%	25	46%	-4	-4%	NA,T1	D,NA
Czechia	3 672	1 211	1 173	2.0%	-2 499	-68%	-38	-3%	NA,T1,T2	CS,D,NA
Denmark	2 204	1 352	1 459	2.5%	-745	-34%	108	8%	NA,T2,T3	CS,D,NA
Estonia	532	95	89	0.2%	-442	-83%	-5	-6%	NA,NO,T1,T2	CS,D,NA,NO
Finland	1 870	1 339	1 400	2.4%	-469	-25%	61	5%	NA,T1,T2,T3	CS,NA
France	11 226	10 598	10 768	18.6%	-457	-4%	171	2%	NA	NA
Germany	11 294	7 844	7 795	13.5%	-3 499	-31%	-48	-1%	CS,NA,T2,T3	CS,NA
Greece	2 893	557	589	1.0%	-2 304	-80%	32	6%	NA,T2	CS,NA
Hungary	2 706	1 543	1 346	2.3%	-1 360	-50%	-198	-13%	NA,T1,T2,T3	CS,D,NA
Ireland	747	627	844	1.5%	97	13%	217	35%	NA,T1,T2	CS,D,NA
Italy	8 352	7 465	7 246	12.5%	-1 106	-13%	-220	-3%	NA,T2	CS,NA
Latvia	1 585	473	488	0.8%	-1 097	-69%	15	3%	NA,T1,T2	CS,D,NA
Lithuania	1 483	237	259	0.4%	-1 224	-83%	22	9%	NA,T2	CS,NA
Luxembourg	34	22	22	0.0%	-12	-35%	0	2%	NA,T1,T2	CS,D,NA
Malta	4	43	59	0.1%	55	1392%	16	37%	NA,T1	D,NA
Netherlands	9 872	9 076	6 779	11.7%	-3 093	-31%	-2 297	-25%	NA,T1,T2	CS,D,NA
Poland	8 505	10 231	8 857	15.3%	352	4%	-1 374	-13%	NA,T1,T2	CS,D,NA
Portugal	1 119	1 303	1 230	2.1%	111	10%	-73	-6%	NA,NO,T1,T2	CS,D,NA,NO
Romania	1 996	1 567	1 560	2.7%	-436	-22%	-7	0%	NA,T1,T2	CS,D,NA
Slovakia	146	345	296	0.5%	149	102%	-49	-14%	NA,T1,T2	CS,NA
Slovenia	166	212	215	0.4%	49	29%	4	2%	NA,T1	D,NA
Spain	NO	NO	NO	-	-	-	-	-	NA	NA
Sweden	1 803	1 102	963	1.7%	-841	-47%	-140	-13%	T1,T2	CS
EU-27	**79 037**	**61 917**	**57 749**	**100%**	**-21 289**	**-27%**	**-4 169**	**-7%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviations'.

1.A.4.c Agriculture/Forestry/Fisheries – Liquid Fuels (CO_2)

In 2022, CO_2 from liquid fuels had a share of 82 % within source category 1.A.4.c (compared to 76 % in 1990). Between 1990 and 2022 CO_2 decreased by 13 % (Table 3.86). Between 2021 and 2022 EU emissions decreased by 1 %.

Table 3.93 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	1 180	808	800	1.4%	-380	-32%	-8	-1%
Belgium	2 757	1 096	1 047	1.8%	-1 710	-62%	-48	-4%
Bulgaria	1 498	389	408	0.7%	-1 090	-73%	19	5%
Croatia	788	616	633	1.1%	-155	-20%	17	3%
Cyprus	55	85	81	0.1%	25	46%	-4	-4%
Czechia	1 536	1 063	1 054	1.8%	-482	-31%	-10	-1%
Denmark	1 841	1 262	1 416	2.5%	-425	-23%	154	12%
Estonia	504	87	84	0.1%	-421	-83%	-3	-4%
Finland	1 784	1 201	1 275	2.2%	-510	-29%	73	6%
France	10 905	10 127	10 382	18.1%	-523	-5%	255	3%
Germany	7 951	7 023	7 005	12.2%	-946	-12%	-18	0%
Greece	2 882	552	585	1.0%	-2 297	-80%	33	6%
Hungary	2 084	1 208	1 118	1.9%	-966	-46%	-90	-7%
Ireland	747	627	844	1.5%	97	13%	217	35%
Italy	8 300	6 626	6 311	11.0%	-1 989	-24%	-315	-5%
Latvia	701	444	476	0.8%	-225	-32%	32	7%
Lithuania	1 173	178	203	0.4%	-970	-83%	26	14%
Luxembourg	34	22	22	0.0%	-12	-35%	0	2%
Malta	4	43	59	0.1%	55	1392%	16	37%
Netherlands	2 543	1 716	1 632	2.8%	-911	-36%	-84	-5%
Poland	4 725	7 668	6 847	11.9%	2 122	45%	-821	-11%
Portugal	1 119	1 267	1 204	2.1%	85	8%	-63	-5%
Romania	9	1 161	1 218	2.1%	1 208	12871%	56	5%
Slovakia	104	280	214	0.4%	110	105%	-66	-24%
Slovenia	166	212	215	0.4%	49	29%	4	2%
Spain	8 652	11 154	11 281	19.7%	2 629	30%	127	1%
Sweden	1 613	1 092	952	1.7%	-661	-41%	-140	-13%
EU-27	**65 657**	**58 004**	**57 365**	**100%**	**-8 292**	**-13%**	**-640**	**-1%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.159 and Figure 3.160 show CO_2 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. Fuel consumption in the EU decreased by 12 % between 1990 and 2022. The CO_2 implied emission factor for liquid fuels was 73.12 t/TJ in 2022.

Figure 3.134 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Emission trend and share for CO_2

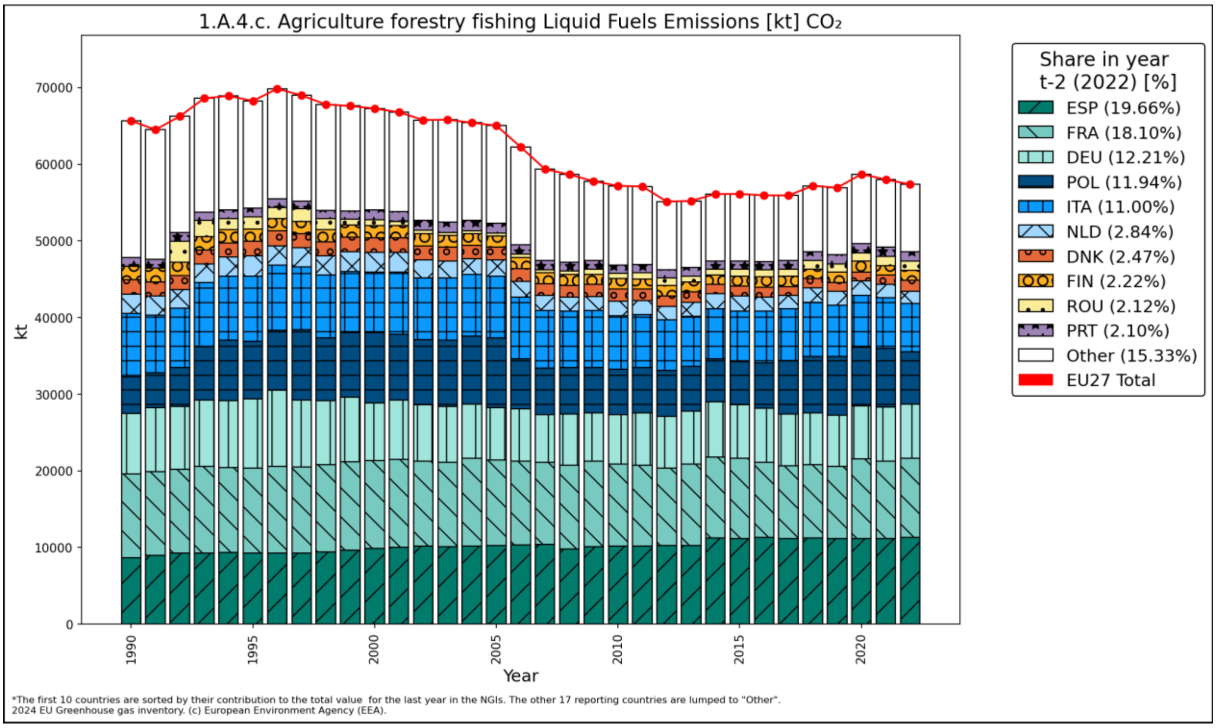
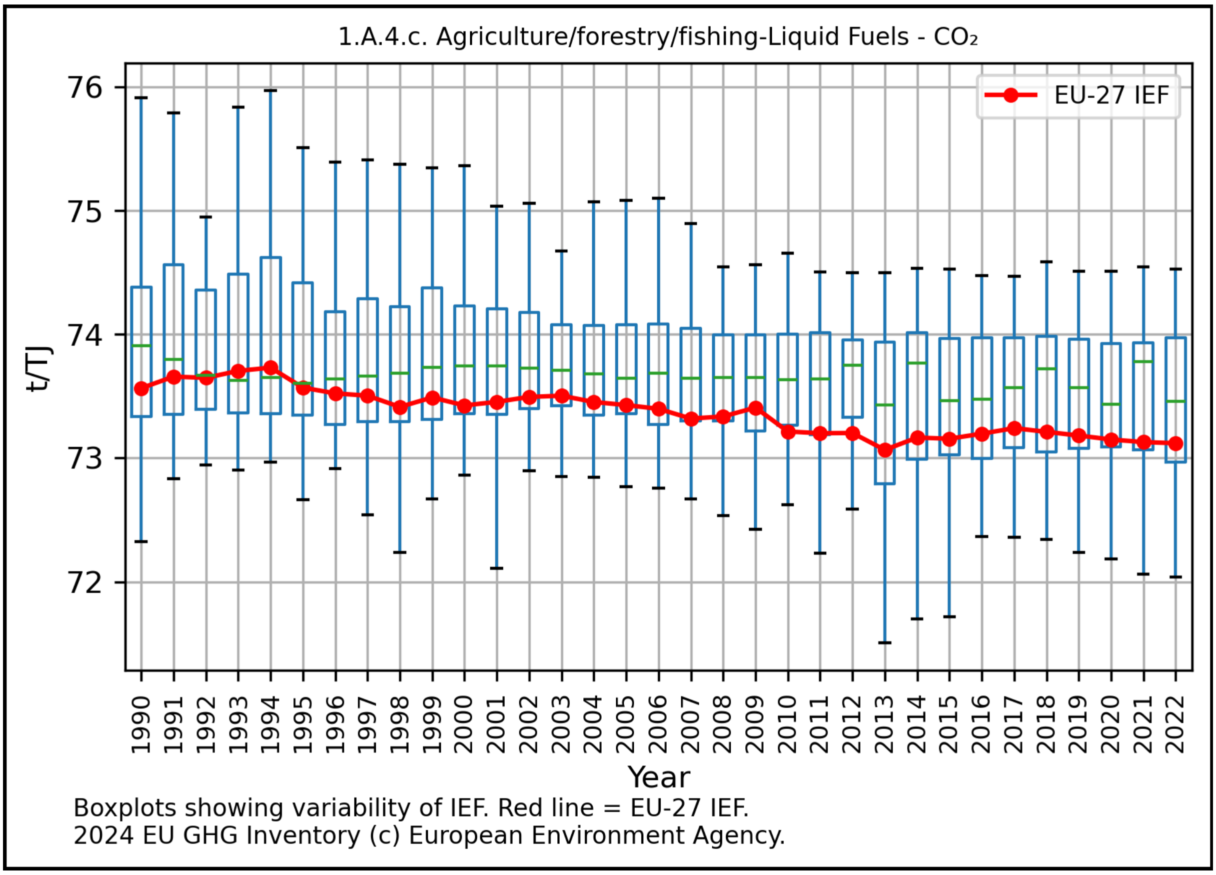


Figure 3.135 1.A.4.c Agriculture/Forestry/Fisheries, liquid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.c Agriculture/Forestry/Fisheries – Solid Fuels (CO_2)

In 2022 CO_2 from solid fuels had a share of 3 % within source category 1.A.4.c (compared to 10 % in 1990). Between 1990 and 2022, CO_2 decreased by 78 % (Table 3.87). Between 2021 and 2022, EU emissions decreased by 19 %.

Table 3.94 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	51	1	1	0.0%	-50	-98%	0	-30%
Belgium	212	25	25	1.2%	-187	-88%	0	0%
Bulgaria	151	37	45	2.1%	-106	-70%	8	21%
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	1 730	24	23	1.1%	-1 707	-99%	-1	-4%
Denmark	237	12	12	0.6%	-224	-95%	1	4%
Estonia	22	1	NO	-	-22	-100%	-1	-100%
Finland	13	9	7	0.3%	-6	-45%	-1	-17%
France	NO	NO	NO	-	-	-	-	-
Germany	2 861	NO	NO	-	-2 861	-100%	-	-
Greece	11	6	5	0.2%	-6	-59%	-1	-22%
Hungary	188	6	5	0.2%	-184	-98%	-1	-24%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-
Latvia	99	NO	NO	-	-99	-100%	-	-
Lithuania	148	3	7	0.3%	-141	-95%	4	106%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	3 755	2 443	1 925	90.1%	-1 830	-49%	-518	-21%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	66	78	80	3.8%	14	22%	2	2%
Slovakia	1	1	1	0.0%	0	-30%	0	-20%
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	37	NO	NO	-	-37	-100%	-	-
Sweden	157	NO	NO	-	-157	-100%	-	-
EU-27	**9 740**	**2 647**	**2 136**	**100%**	**-7 605**	**-78%**	**-511**	**-19%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.161 and Figure 3.162 show CO_2 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. Fuel consumption in the EU decreased by 78 % between 1990 and 2022. The CO_2 implied emission factor for solid fuels was 94.71 t/TJ in 2022.

Figure 3.136 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Emission trend and share for CO_2

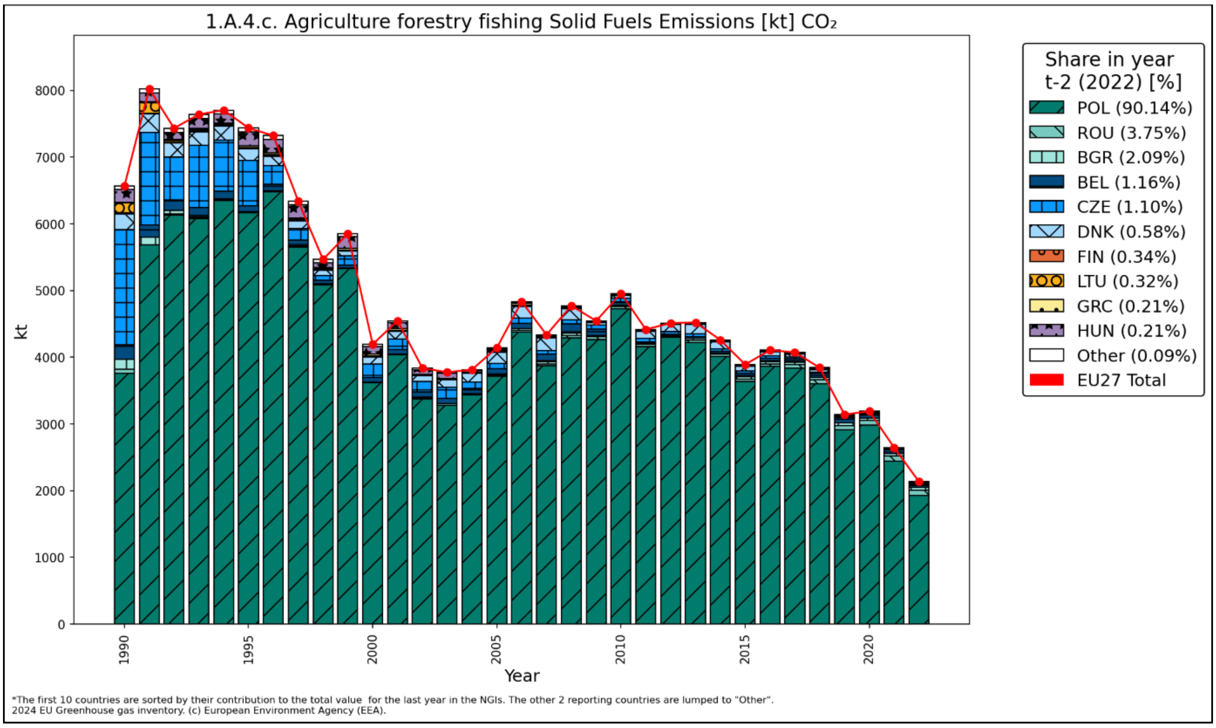
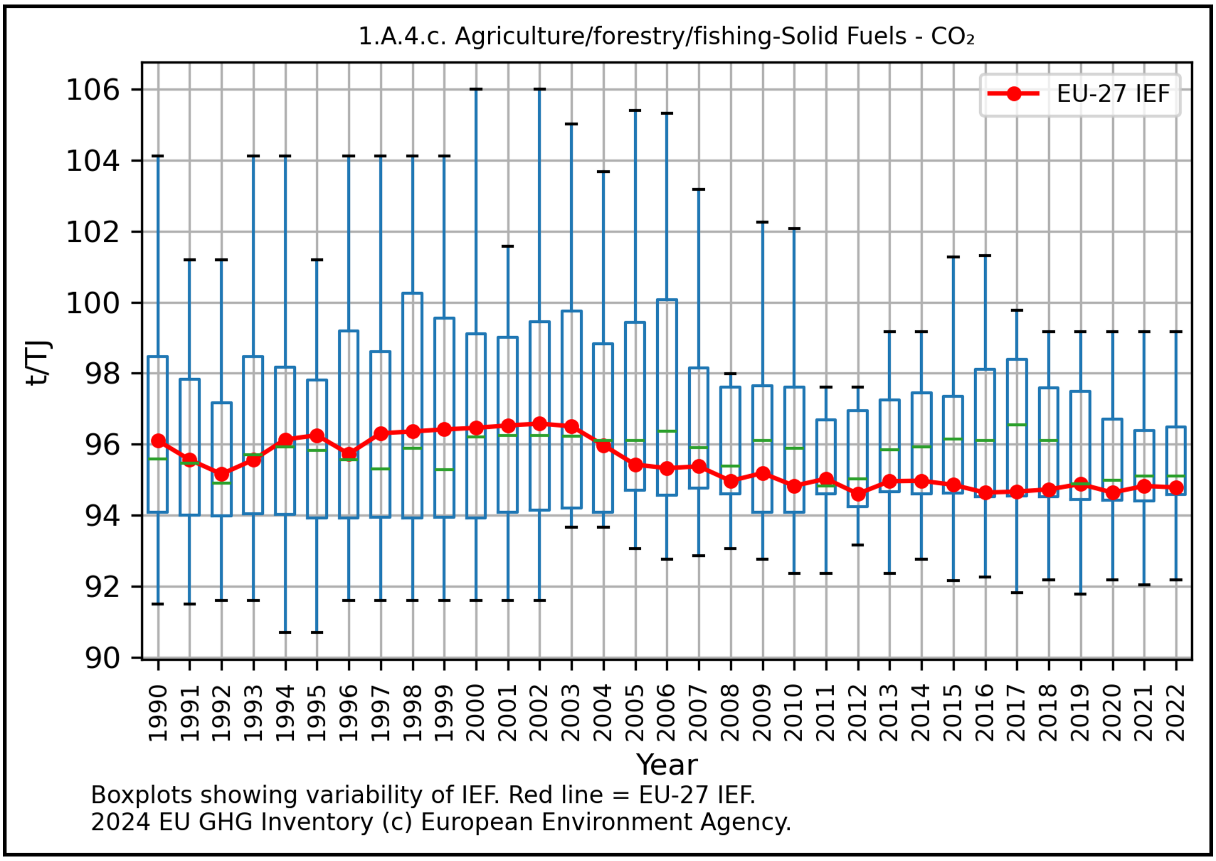


Figure 3.137 1.A.4.c Agriculture/Forestry/Fisheries, solid fuels: Implied Emission Factors for CO_2 (in t/TJ)



1.A.4.c Agriculture/Forestry/Fisheries –Gaseous Fuels (CO_2)

In 2022, CO_2 from gaseous fuels had a share of 14 % within source category 1.A.4.c (compared to 13 % in 1990). Between 1990 and 2022 CO_2 emissions decreased by 20 % (Table 3.88). Between 2021 and 2022, EU emissions decreased by 25 %. This source of emissions is dominated by the Netherlands where natural gas is used for greenhouse horticulture.

Table 3.95 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	20	54	46	0.5%	26	127%	-8	-15%
Belgium	67	1 464	1 138	11.6%	1 071	1588%	-325	-22%
Bulgaria	0	29	24	0.2%	24	11866%	-5	-18%
Croatia	48	71	60	0.6%	12	26%	-11	-16%
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	405	123	96	1.0%	-310	-76%	-27	-22%
Denmark	126	77	31	0.3%	-95	-75%	-46	-60%
Estonia	4	7	6	0.1%	2	54%	-1	-18%
Finland	32	6	4	0.0%	-27	-86%	-2	-30%
France	320	471	386	3.9%	65	20%	-85	-18%
Germany	483	800	770	7.9%	287	59%	-30	-4%
Greece	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Hungary	433	330	223	2.3%	-210	-49%	-107	-32%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	52	839	935	9.5%	883	1697%	96	11%
Latvia	782	29	12	0.1%	-770	-98%	-17	-58%
Lithuania	162	55	47	0.5%	-115	-71%	-8	-14%
Luxembourg	NO	NO	0	0.0%	0	∞	0	∞
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	7 329	7 356	5 144	52.5%	-2 185	-30%	-2 212	-30%
Poland	25	120	85	0.9%	60	243%	-35	-29%
Portugal	NO	36	26	0.3%	26	∞	-10	-28%
Romania	1 921	249	182	1.9%	-1 738	-90%	-67	-27%
Slovakia	41	64	81	0.8%	40	98%	17	27%
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	6	969	498	5.1%	492	7990%	-471	-49%
Sweden	33	8	8	0.1%	-25	-77%	0	2%
EU-27	**12 291**	**13 156**	**9 802**	**100%**	**-2 489**	**-20%**	**-3 355**	**-25%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.163 and Figure 3.164 show CO_2 emissions and implied emission factors for EU as well as the share of the Member States with the highest contributions. Fuel consumption in the EU decreased by 21 % between 1990 and 2022. The CO_2 implied emission factor for gaseous fuels was 56.58 t/TJ in 2022.

Figure 3.138 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Emission trend and share for CO_2

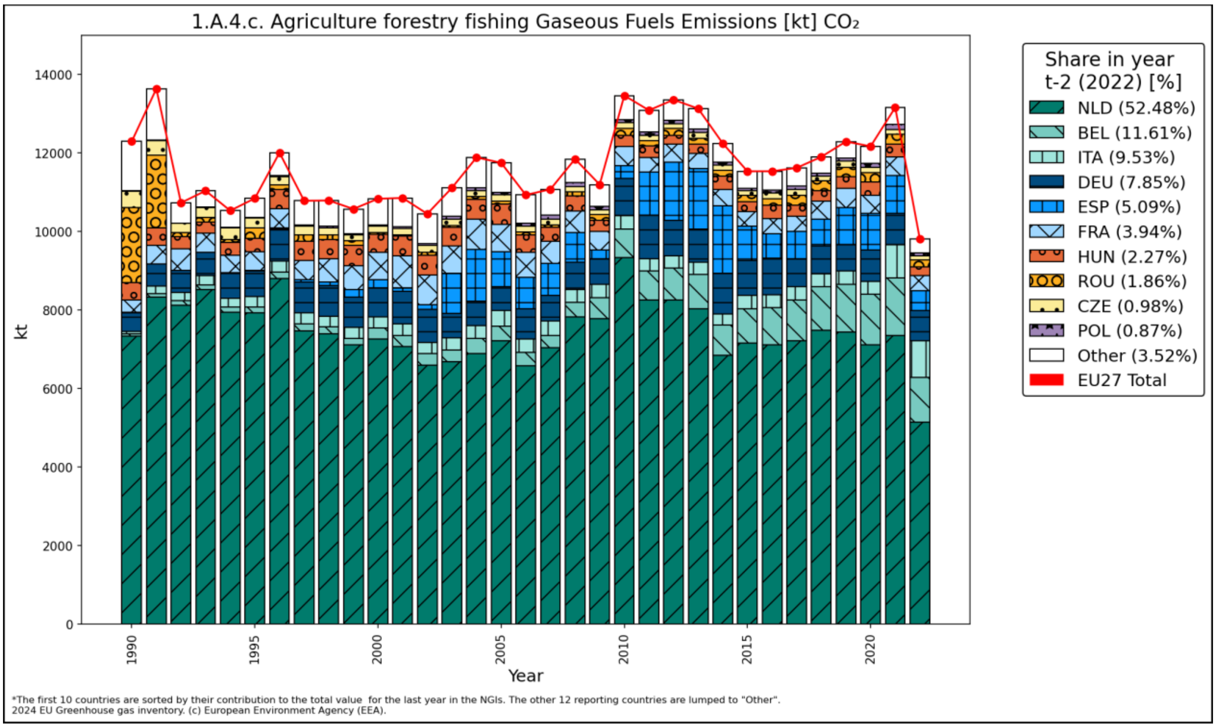
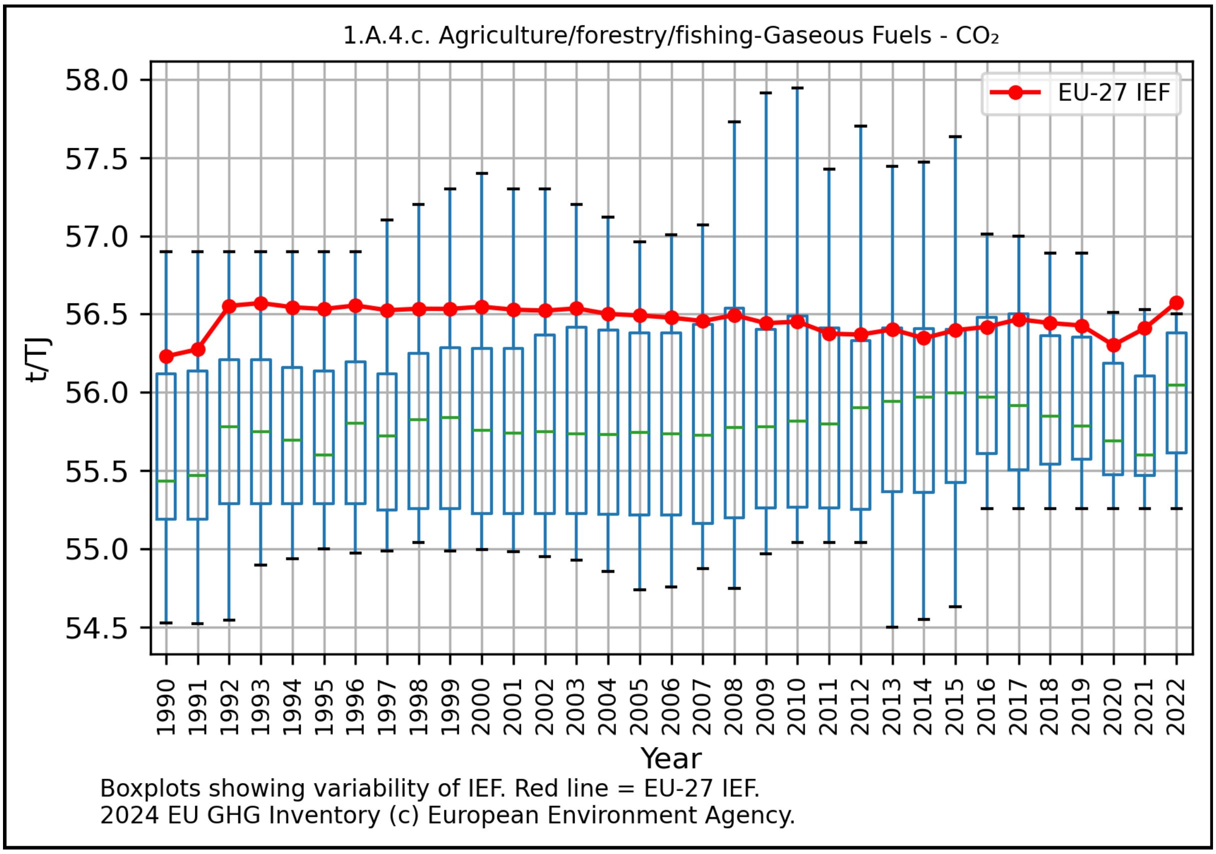


Figure 3.139 1.A.4.c Agriculture/Forestry/Fisheries, gaseous fuels: Implied Emission Factors for CO_2 (in t/TJ)



3.5.5 Other (CRT Source Category 1.A.5.)

Source category 1.A.5. Other includes emissions from stationary and mobile military fuel use including aircraft. In 2022, category 1.A.5 contributed to 7 037 kt CO_2 equivalents of which 99.2 % is CO_2, 0.2 % CH_4 and 0.7 % N_2O. A new key category has been added this year; 1.A.5.b Mobile: Liquid Fuels (CO_2).

Table 3.96: 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 eq.		Trend	Level		share of higher Tier
	1990	2022		1990	2022	
1.A.5.a Stationary: Liquid Fuels (CO_2)	7011	3968	0	L	0	96 %
1.A.5.a Stationary: Solid Fuels (CO_2)	6065	4	T	0	0	99.5 %
1.A.5.b Mobile: Liquid Fuels (CO_2)	8088	2490	T	L	0	83 %

Table 3.90 provides an overview of Member States' source allocation to Source Category 1.A.5 Other as reported in CRT Table1.A(a)s4.

Table 3.97 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

Member State	Source allocation to 1.A.5 Other
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
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'

Figure 3.165 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.

Figure 3.140 1.A.5 Other: Total and CO_2 emission and activity trends

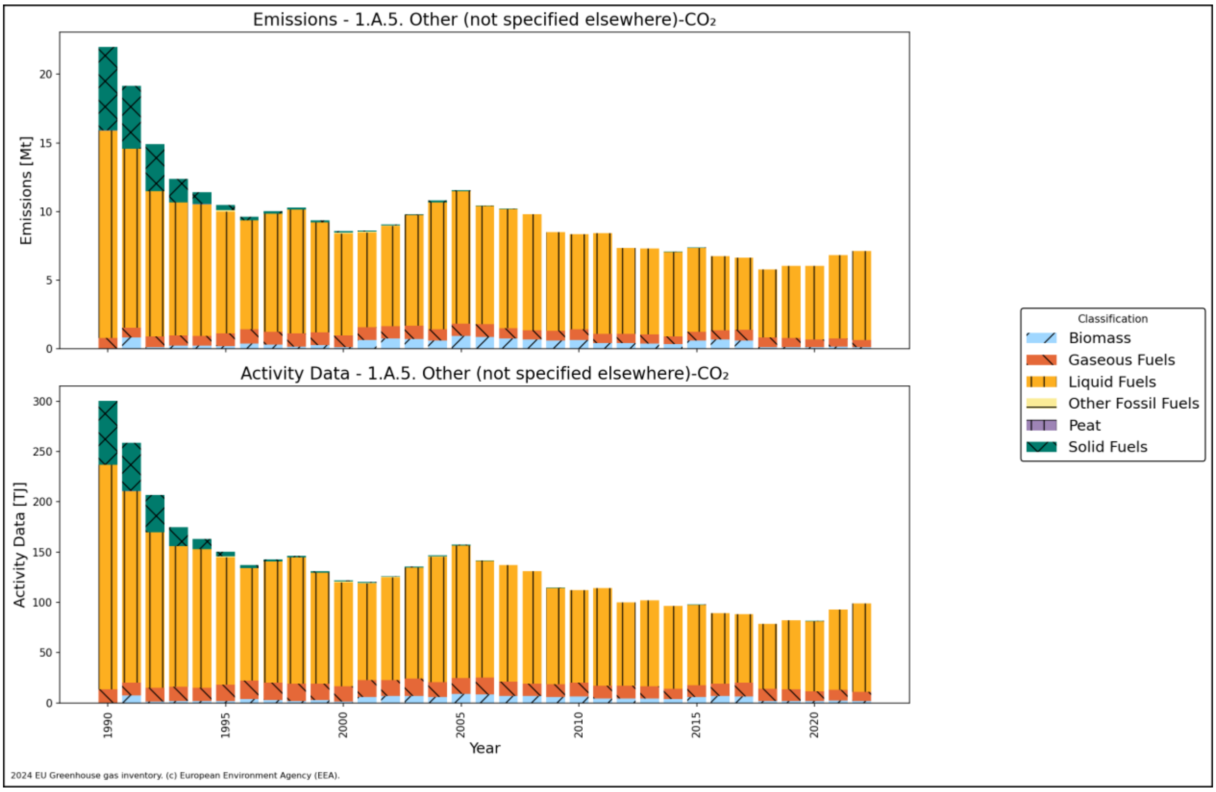


Table 3.91 shows total GHG and CO_2 emissions by Member State from 1.A.5. CO_2 emissions from 1.A.5 Other accounted for 0.3 % of total EU GHG emissions in 1.A in 2022. Between 1990 and 2022, CO_2 emissions from this source decreased by 69 % in the EU. Between 1990 and 2022, the largest reduction in absolute terms was reported by Germany, which was partly due to reduced military operations after the reunification. Germany has therefore the biggest influence on the overall trend; it reports minus 93 % of CO_2 emissions since 1990 and contributes to 12 % in 2022. The German NID states that only military sources (incl. aircraft) are included in its inventory. Since 2014, the main contributor is France; contributing together 28 % of CO_2 emissions in 2022. France includes in this category other non-specified sources from its national energy balance.

Table 3.98 1.A.5. Other: Member States' contributions to CO_2 emissions

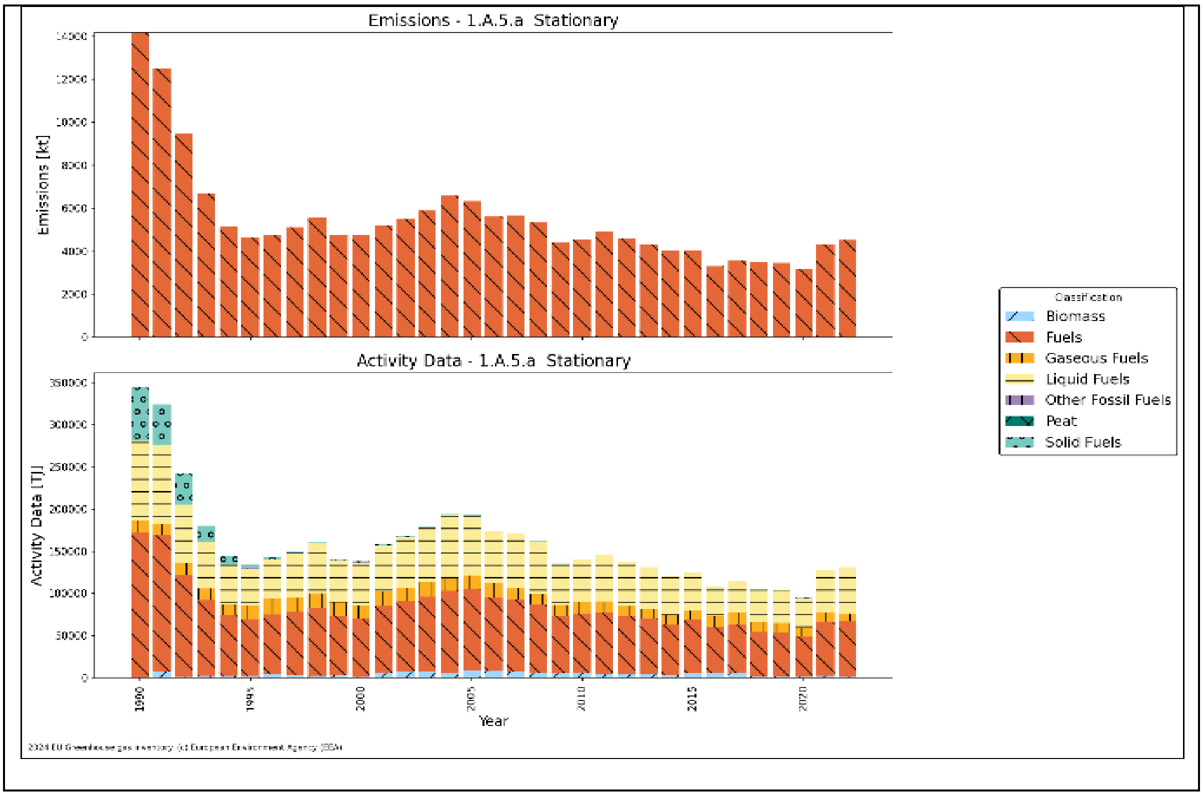
Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt	
	1990	2022	1990	2022
Austria	38	28	37	27
Belgium	173	97	172	96
Bulgaria	86	39	85	39
Croatia	IE,NO	IE,NO	IE,NO	IE,NO
Cyprus	11	24	11	24
Czechia	194	269	192	266
Denmark	171	187	167	185
Estonia	NO	NO	NO	NO
Finland	1 138	839	1 126	833
France	4 499	1 980	4 464	1 966
Germany	12 132	844	11 765	839
Greece	IE,NO	301	IE,NO	299
Hungary	388	73	385	73
Ireland	IE,NO	IE,NO	IE,NO	IE,NO
Italy	1 136	523	1 071	511
Latvia	NE,NO	24	NE,NO	24
Lithuania	0	30	0	30
Luxembourg	3	0	3	0
Malta	1	3	1	3
Netherlands	320	215	314	212
Poland	NO	NO	NO	NO
Portugal	97	90	96	89
Romania	1 230	1 173	1 222	1 169
Slovakia	479	62	476	62
Slovenia	32	5	32	5
Spain	300	227	298	225
Sweden	IE,NO	IE,NO	IE,NO	IE,NO
EU-27	**22 429**	**7 037**	**21 917**	**6 979**

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'.

3.5.5.1 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 0.2 % of total GHG emissions in 1.A in 2022. Figure 3.166 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 68 % in the period 1990 - 2022, mainly due to decreases in emissions from solid fuels (-100 %) and liquid fuels (-43 %).

Figure 3.141 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 2022 (Table 3.92). Luxembourg reported emissions for 1990 - 2003. Hungary reports emissions since 2015.

Table 3.99 1.A.5.a Stationary: Member States' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	-	-	-	-	-	-	-	-	-	-
Cyprus	11	19	19	0.4%	8	76%	0	2%	NA,T1	D,NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 126	686	833	18.6%	-294	-26%	147	21%	NA,T2	CS,NA
France	4 464	1 931	1 966	43.8%	-2 498	-56%	35	2%	NA	NA
Germany	6 227	464	409	9.1%	-5 818	-93%	-55	-12%	CS	CS
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	370	49	38	0.8%	-332	-90%	-11	-23%	NA,T1,T2	CS,D,NA
Ireland	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	-	-	-	-	-	-	-	-	-	-
Luxembourg	3	NO	NO	-	-3	-100%	-	-	NA	NA
Malta	NA	NA	NA	-	-	-	-	-	NA	NA
Netherlands	NO	NO	NO	-	-	-	-	-	NA	NA
Poland	NA	NA	NA	-	-	-	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	IE	IE
Romania	1 222	1 100	1 169	26.0%	-52	-4%	70	6%	NA,T1,T2	CS,D,NA
Slovakia	406	52	53	1.2%	-352	-87%	1	2%	NA,T2	CS,NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	-	-
EU-27	**13 829**	**4 301**	**4 488**	**100%**	**-9 341**	**-68%**	**187**	**4%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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.
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 – Liquid Fuels (CO_2)

A new key category has been added this year; 1.A.5.b Mobile: Liquid Fuels (CO_2). In 2022, CO_2 from liquid fuels had a share of 88 % within source category 1.A.5.a and the emissions were 3 968 kt CO_2. Between 1990 and 2022 CO_2 emissions decreased by 43 %. (**Chyba! Nebyl zadán název záložky.**

Table 3.100: 1.A.5.a Stationary, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	-	-
Belgium	-	-	-	-	-	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-	-	-
Croatia	-	-	-	-	-	-	-	-	-	-
Cyprus	11	19	19	0.5%	8	76%	0	2%	T1	D
Czechia	-	-	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-	-	-
Finland	1 036	603	708	17.8%	-328	-32%	104	17%	T2	CS
France	4 464	1 883	1 922	48.4%	-2 542	-57%	39	2%	-	-
Germany	1 166	86	146	3.7%	-1 020	-88%	60	69%	-	-
Greece	-	-	-	-	-	-	-	-	-	-
Hungary	259	3	3	0.1%	-256	-99%	0	0%	T1	D
Ireland	IE	IE	IE	-	-	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-	-	-
Lithuania	-	-	-	-	-	-	-	-	-	-
Luxembourg	3	NO	NO	-	-3	-100%	-	-	NA	NA
Malta	NA	NA	NA	-	-	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	37	1 100	1 169	29.5%	1 132	3032%	70	6%	T1,T2	CS,D
Slovakia	35	1	1	0.0%	-34	-96%	0	6%	T2	CS
Slovenia	-	-	-	-	-	-	-	-	-	-
Spain	IE	IE	IE	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	-	-
EU-27	**7 011**	**3 695**	**3 968**	**100%**	**-3 043**	**-43%**	**273**	**7%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'

1.A.5.a Stationary – Solid Fuels (CO_2)

In 2022 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 2022, CO_2 emissions decreased by nearly 100 % (Table 3.93). In 2022, only Germany, Slovakia and Hungary 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.

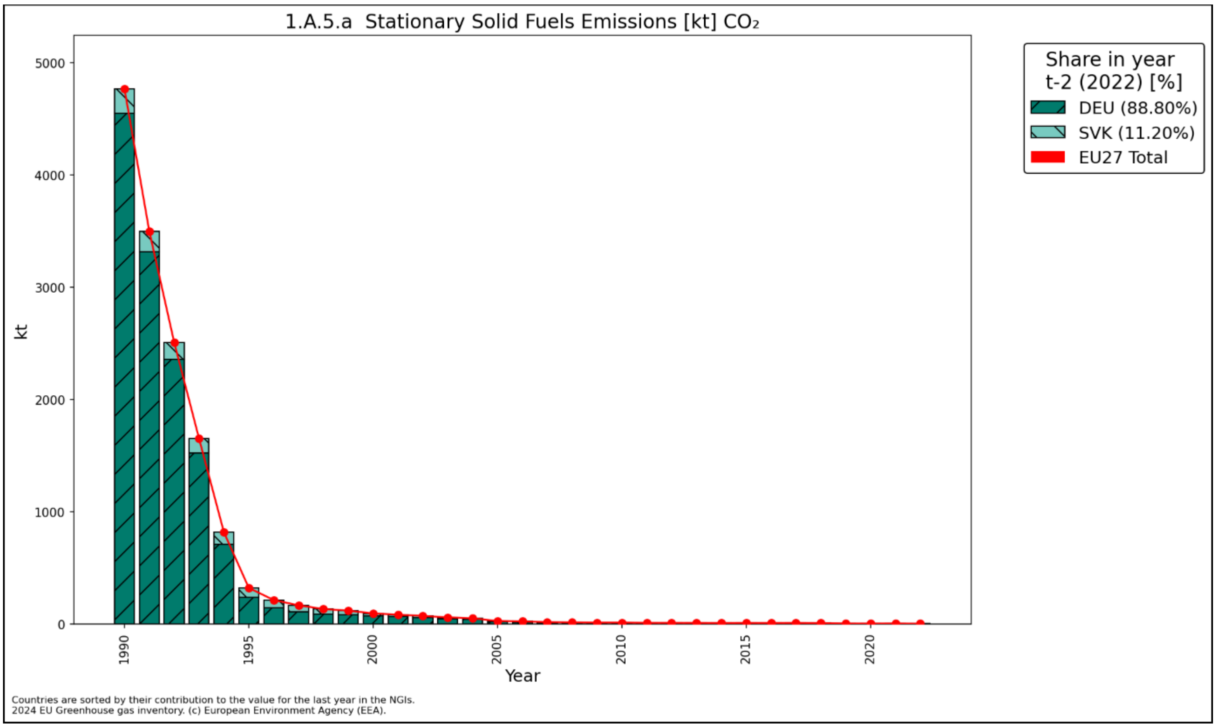
Table 3.101 1.A.5.a Stationary, solid fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	-	-
Belgium	-	-	-	-	-	-	-	-	-	-
Bulgaria	NO	NO	NO	-	-	-	-	-	-	-
Croatia	-	-	-	-	-	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	-	-	-	-	-	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-	-	-
Finland	1	NO	NO	-	-1	-100%	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	-	-
Germany	4 553	5	3	88.8%	-4 550	-100%	-1	-30%	-	-
Greece	-	-	-	-	-	-	-	-	-	-
Hungary	111	2	NO	-	-111	-100%	-2	-100%	NA	NA
Ireland	NO	NO	NO	-	-	-	-	-	-	-
Italy	NO	NO	NO	-	-	-	-	-	-	-
Latvia	NO	NO	NO	-	-	-	-	-	-	-
Lithuania	-	-	-	-	-	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NA	NA	NA	-	-	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-	-	-
Poland	NA	NA	NA	-	-	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-	-	-
Romania	1 184	NO	NO	-	-1 184	-100%	-	-	NA	NA
Slovakia	216	1	0	11.2%	-216	-100%	-1	-61%	T2	CS
Slovenia	-	-	-	-	-	-	-	-	-	-
Spain	IE	IE	IE	-	-	-	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	-	-
EU-27	**6 065**	**8**	**4**	**100%**	**-6 061**	**-100%**	**-4**	**-54%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
Abbreviations explained in the Chapter 'Units and abbreviations'.
The information on methodologies and emission factors is not available from the CRT/JSON on fuels level.

The CO_2 implied emission factor for solid fuels was 97.48t/TJ in 2022.

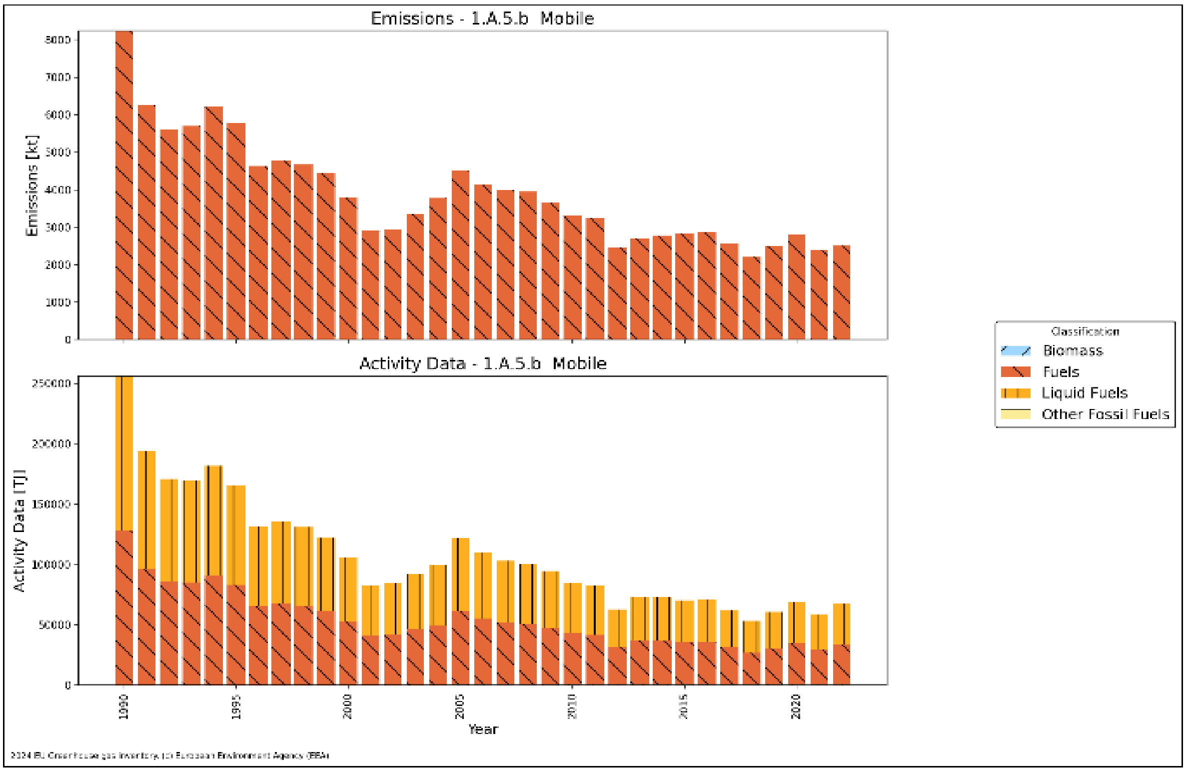
Figure 3.142 1.A.5.a Stationary, solid fuels: Emission trend and share for CO_2



3.5.5.2 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 GHG emissions in 1.A in 2022. Figure 3.169 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 71 % and were 2 341 kt CO_2 in the year 2022.

Figure 3.143 1.A.5.b Mobile: Total and CO_2 emission trends



Data displayed as dashed line refers to the secondary axis.

Eight Member States reported emissions as 'Not occurring' or 'Included elsewhere'. The EU emissions increased by 10 % between 2021 and 2022.

"Included elsewhere" often indicates, that the country reports these emissions under 1.A.3 Transport or 1.A.5.a.

Table 3.102 1.A.5.b Mobile: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	37	28	27	1.2%	-10	-27%	-1	-2%	NA,T2	CS,NA
Belgium	172	99	96	4.1%	-76	-44%	-2	-2%	NA,T1	D,NA
Bulgaria	85	28	39	1.7%	-46	-54%	11	39%	T1	D
Croatia	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Cyprus	NA,NO	4	5	0.2%	5	∞	1	17%	NA,T1	D,NA
Czechia	192	223	217	9.3%	25	13%	-7	-3%	NA,T1	D,NA
Denmark	119	127	93	4.0%	-26	-22%	-34	-27%	NA,T2	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
France	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Germany	5 538	512	430	18.4%	-5 108	-92%	-82	-16%	CS,D,M	CS
Greece	IE,NO	36	299	12.8%	299	∞	263	738%	NA,T1	D,NA
Hungary	14	57	35	1.5%	20	141%	-22	-39%	NA,T2	CS,NA
Ireland	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Italy	1 071	314	511	21.8%	-560	-52%	197	63%	T2	CS
Latvia	NE,NO	24	24	1.0%	24	∞	0	1%	NA,T1	D,NA
Lithuania	0	27	30	1.3%	29	8115%	3	9%	NA,T2	CS,NA
Luxembourg	0	0	0	0.0%	0	-14%	0	-1%	NA,T1,T2	CS,D,NA
Malta	1	3	3	0.1%	3	325%	0	6%	NA,T1	D,NA
Netherlands	314	164	212	9.0%	-102	-33%	47	29%	NA,T2	CS,NA
Poland	NA	NA	NA	-	-	-	-	-	NA	NA
Portugal	96	73	89	3.8%	-7	-7%	17	23%	-	-
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	0	0	0	0.0%	0	-8%	0	19%	NA,T1	D,NA
Slovenia	32	5	5	0.2%	-27	-85%	0	2%	NA,T1	D,NA
Spain	298	396	225	9.6%	-73	-24%	-171	-43%	CR,NA,T1,T2	CS,D,NA
Sweden	IE,NO	IE,NO	IE,NO	-	-	-	-	-	T2	CS
EU-27	**7 970**	**2 120**	**2 341**	**100%**	**-5 629**	**-71%**	**220**	**10%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
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 2022, CO_2 from liquid fuels had a share of 99.9 % within source category 1.A.5.b throughout the whole period. Between 1990 and 2022 CO_2 decreased by 69 % (Table 3.95 1.A.5.b Mobile, liquid fuels: Member States' contributions to CO_2 emissions).

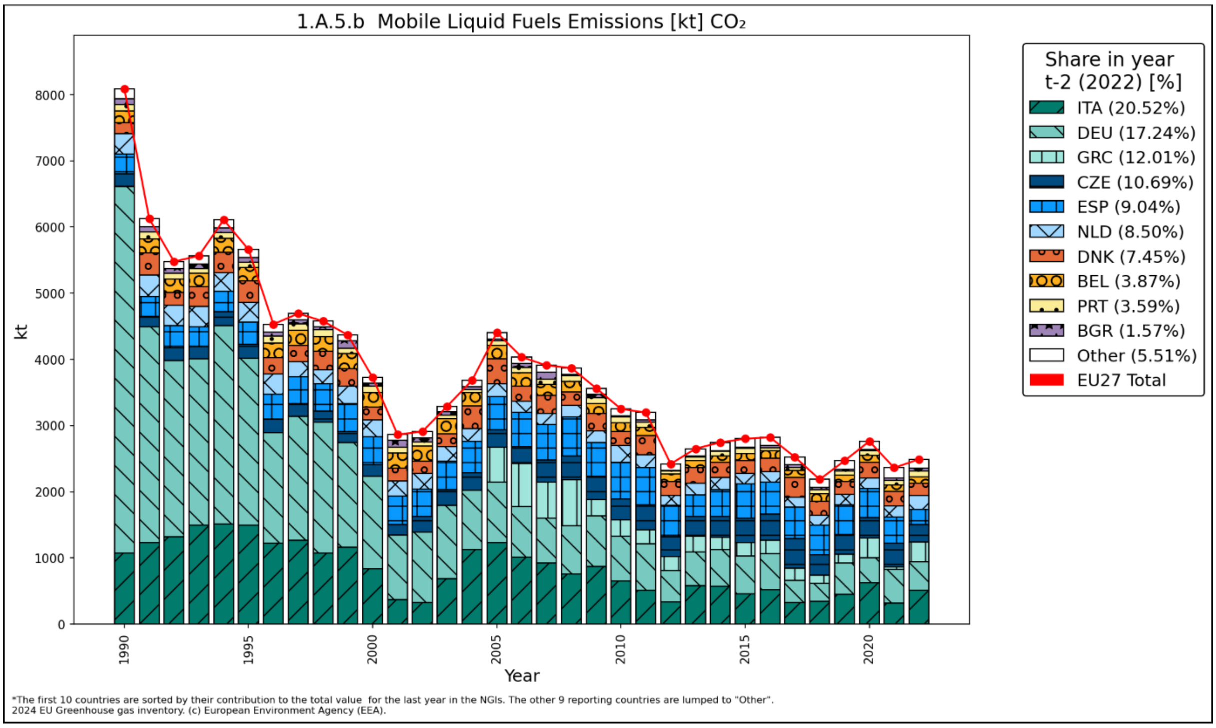
Table 3.103 1.A.5.b Mobile, liquid fuels: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	37	28	27	1.1%	-10	-27%	-1	-2%	T2	CS
Belgium	172	99	96	3.9%	-76	-44%	-2	-2%	T1	D
Bulgaria	85	28	39	1.6%	-46	-54%	11	39%	-	-
Croatia	IE	IE	IE	-	-	-	-	-	NA	NA
Cyprus	NO	4	5	0.2%	5	∞	1	17%	T1	D
Czechia	192	363	266	10.7%	74	39%	-96	-27%	T1	D
Denmark	167	219	185	7.5%	18	11%	-33	-15%	T2	CS,D
Estonia	NO	NO	NO	-	-	-	-	-	-	-
Finland	IE	IE	IE	-	-	-	-	-	NA	NA
France	IE	IE	IE	-	-	-	-	-	-	-
Germany	5 538	511	429	17.3%	-5 108	-92%	-82	-16%	-	-
Greece	IE	36	299	12.0%	299	∞	263	738%	T1	D
Hungary	14	57	35	1.4%	20	141%	-22	-39%	T2	CS
Ireland	IE	IE	IE	-	-	-	-	-	-	-
Italy	1 071	314	511	20.6%	-560	-52%	197	63%	-	-
Latvia	NE	24	24	1.0%	24	∞	0	1%	T1	D
Lithuania	0	27	30	1.2%	29	8115%	3	9%	T2	CS
Luxembourg	0	0	0	0.0%	0	-14%	0	-1%	T2	CS
Malta	1	3	3	0.1%	3	325%	0	6%	T1	D
Netherlands	314	164	212	8.5%	-102	-33%	47	29%	T2	CS
Poland	NA	NA	NA	-	-	-	-	-	-	-
Portugal	96	73	89	3.6%	-7	-7%	17	23%	-	-
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	0	0	0	0.0%	0	-85%	0	60%	T1	D
Slovenia	32	5	5	0.2%	-27	-85%	0	2%	T1	D
Spain	298	396	225	9.1%	-73	-24%	-171	-43%	CR,T1	CS,D
Sweden	IE	IE	IE	-	-	-	-	-	T2	CS
EU-27	**8 018**	**2 350**	**2 481**	**100%**	**-5 537**	**-69%**	**131**	**6%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period
*Information on methods and emission factors are identical with those described in Table **3.94** as emissions from this source only occur in liquid fuels*
Abbreviations explained in the Chapter 'Units and abbreviations'.

The CO_2 implied emission factor for liquid fuels was 88.26 t/TJ in 2022.

Figure 3.144 1.A.5.b Mobile, liquid fuels: Emission trend and share for CO_2

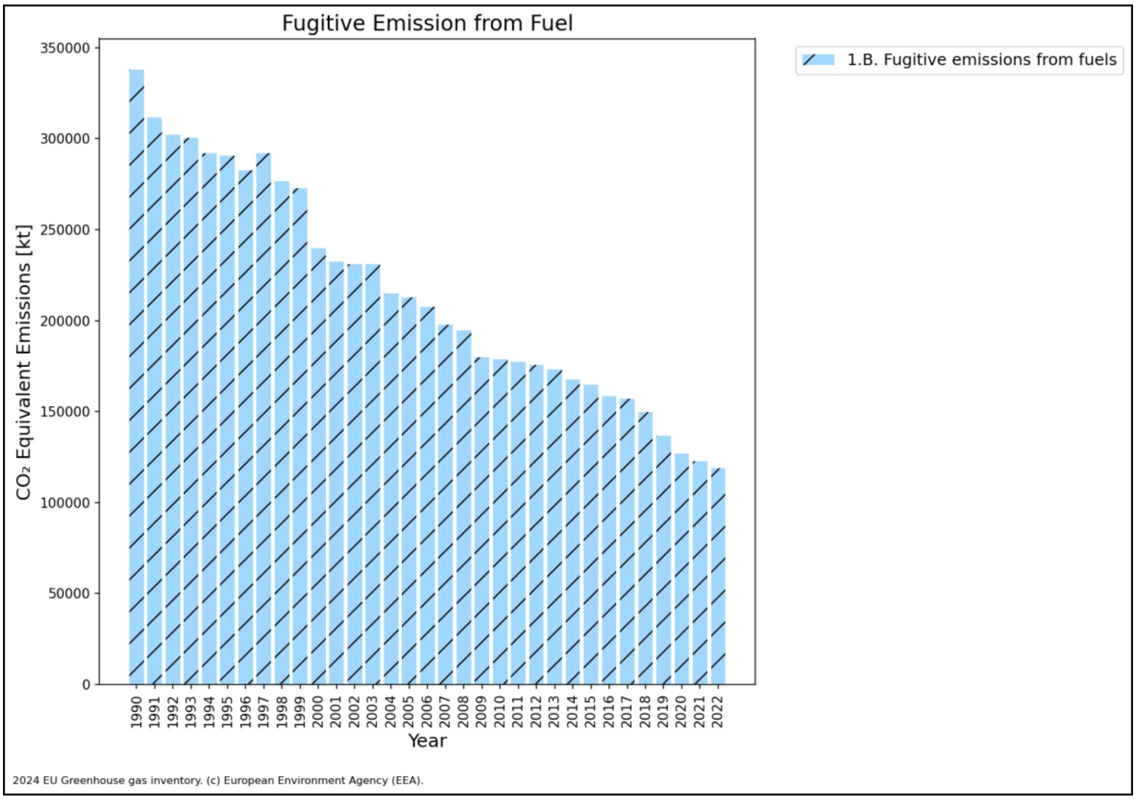


3.5.6 Fugitive emissions from fuels (CRT Source Category 1.B)

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 2022, in terms of CO_2 equivalents, about 69 % of emissions from source category 1.B were fugitive CH_4 emissions while 31 % were fugitive CO_2 emissions. Together, they represent 1.9 % of total GHG emissions in the EU. Fugitive GHG emissions have been steadily declining (Figure 3**.172**). Between 1990 and 2022, the total fugitive GHG emissions decreased by 65 %. This was mainly due to the decrease in underground mining activities: CH_4 emissions from underground mining activities have decreased by 74 % since 1990 (Figure 3**.175**) and decreases in CH_4 emissions from category 1B1ai1 underground mines are responsible for 51 % of the total decrease of fugitive emissions. Between 1990 and 2022, GHG emissions from 1.B.1 Solid Fuels decreased by 69 % (Figure 3**.173**), while emissions from 1.B.2 Oil and Natural Gas decreased by 59 % (Figure 3**.173**).

Figure 3.145   1.B Fugitive Emission from Fuel: GHG Emissions trend



Fugitive emissions include four key sources:

Table 3.104: 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	2022		1990	2022	
1.B.1.a. Coal mining and handling: no classification (CH_4)	84974	24874	T	L	L	69 %
1.B.2.a. Oil: no classification (CH_4)	6897	727	T	0	0	31%
1.B.2.a. Oil: no classification (CO_2)	8633	9709	T	L	L	72 %
1.B.2.b. Natural gas: no classification (CH_4)	46594	11994	T	L	L	63 %

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 64 % of total fugitive GHG emissions.

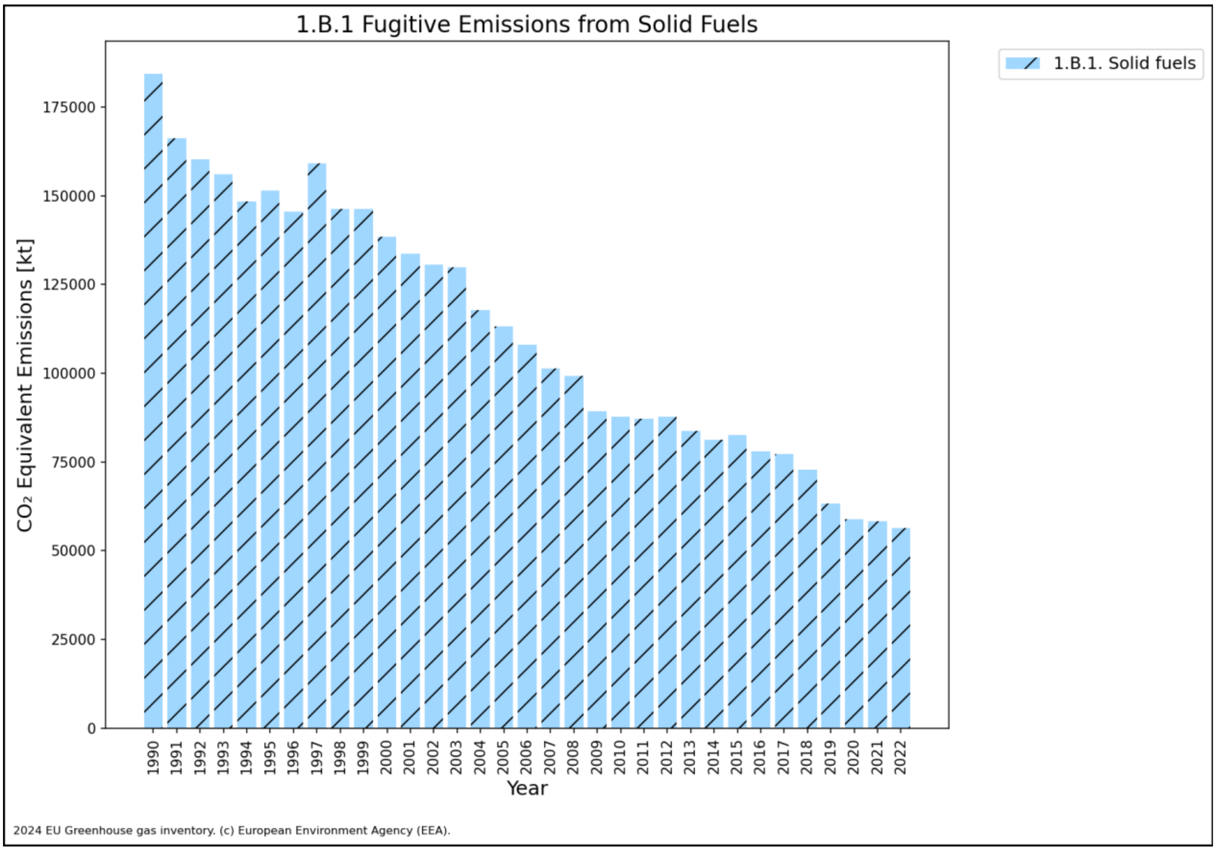
3.5.6.1 Fugitive emissions from Solid Fuels (1.B.1)

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 CRT. Five countries (Denmark, Estonia, Finland, Latvia and Lithuania) have peat extraction but no coal mining.

In 2022 fugitive emissions from solid fuels accounted for 0.9 % of the total GHG emissions in the EU and 48 % of total fugitive emissions:

- 88 % 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,
- 11 % 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 3.146   1.B.1 Fugitive Emissions from Solid Fuels: Trend



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

In 2022 three countries, Poland, Czechia and Romania represented 89 % of total fugitive GHG emissions from solid fuels (Table 3**.97**).

Table 3.105 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	2022	1990	2022	1990	2022
Austria	373	NA,IE,NO	IE,NA,NO	IE,NA,NO	373	IE,NA,NO
Belgium	485	44	0	NO	484	44
Bulgaria	2 244	1 074	64	29	2 180	1 046
Croatia	67	NO	NO	NO	67	NO
Cyprus	NO	NO	NO	NO	NO	NO
Czechia	12 638	1 927	456	41	12 181	1 886
Denmark	NO	NO	NO	NO	NO	NO
Estonia	NO	NO	NO	NO	NO	NO
Finland	NO	NO	NO	NO	NO	NO
France	5 387	11	NA,NO	NA,NO	5 387	11
Germany	30 412	770	1 833	656	28 579	114
Greece	1 266	348	NO	NO	1 266	348
Hungary	1 188	31	7	0	1 181	31
Ireland	62	19	NO	NO	62	19
Italy	148	30	0	NA,NO	148	30
Latvia	NO	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	123	76	110	71	12	5
Poland	27 896	17 415	4 188	2 152	23 707	15 263
Portugal	160	17	3	NO	157	17
Romania	6 571	5 833	NA,NO	NA,NO	6 571	5 833
Slovakia	815	201	20	20	795	180
Slovenia	505	267	101	87	404	181
Spain	1 832	119	18	95	1 815	25
Sweden	5	12	5	12	0	0
EU-27	**92 176**	**28 195**	**6 806**	**3 163**	**85 371**	**25 031**

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 2022 these emissions decreased by 71 % (Table 3.98). Large reductions (in absolute terms) were observed in Germany, Czechia and Poland (Table 3.**97**).

CH_4 recovery from coal mining

Romania is the only country that reports CH_4 recovery in category 1.B.1.a.i.1 (Mining activities) in the EU in 2022. The recovered CH_4 from Lupeni and Vulcan mines 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, 2024]

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 0.8 % of total GHG emissions in 2022 and for 42 % of all fugitive emissions in the EU-27. CH_4 emissions from this source decreased by 71 % in the EU-27 between 1990 and 2022 and also a decrease by -2 % between 2021 and 2022 due to decreases in Poland, Romania and Slovakia (Table 3.**98**).

Table **3.98** shows that 69 % of EU 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 3.106 1.B.1.a Coal Mining: Countries contribution to CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	373	NA,NO	NA,NO	-	-373	-100%	-	-	NA	NA
Belgium	443	44	44	0.2%	-399	-90%	0	-1%	D,NA	D,NA
Bulgaria	2 163	881	1 044	4.2%	-1 119	-52%	163	18%	NA,T1,T2	CS,D,NA
Croatia	67	NO	NO	-	-67	-100%	-	-	NA,NO	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	12 181	1 862	1 881	7.6%	-10 300	-85%	19	1%	NA,T1,T2	CS,D,NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	5 354	1	1	0.0%	-5 353	-100%	0	0%	NA	NA
Germany	28 554	105	103	0.4%	-28 451	-100%	-3	-2%	NA,T2,T3	CS,NA
Greece	1 266	302	348	1.4%	-918	-73%	45	15%	NA,T1	D,NA
Hungary	1 181	31	31	0.1%	-1 150	-97%	0	-1%	NA,T1,T2	CS,D,NA
Ireland	62	20	19	0.1%	-43	-69%	0	-1%	NA,NO,T1	D,NA,NO
Italy	59	8	7	0.0%	-52	-88%	-1	-7%	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	23 581	15 733	15 168	61.0%	-8 413	-36%	-565	-4%	NA,NO,T1,T2	D,NA,NO
Portugal	157	17	17	0.1%	-140	-89%	0	-1%	NO,T1	D,NO
Romania	6 524	5 955	5 833	23.4%	-691	-11%	-123	-2%	NA,T1,T2	D,NA
Slovakia	792	242	173	0.7%	-618	-78%	-69	-28%	NA,T1,T2	CS,D,NA
Slovenia	404	200	181	0.7%	-223	-55%	-19	-10%	NA,T2,T3	CS,D,NA,PS
Spain	1 815	27	25	0.1%	-1 790	-99%	-2	-7%	CS,NA,T2	CS,NA
Sweden	NO	NO	NO	-	-	-	-	-	-	-
EU-27	**84 974**	**25 428**	**24 874**	**100%**	**-60 100**	**-71%**	**-554**	**-2%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'.

CH_4 from Underground mines (1.B.1.a.1)

In 2021, 82% of fugitive CH_4 emissions from coal mines were due to underground mines. Within the EU coal mining in underground mines decreased substantially between 1990 and 2022 (-74 %) (Table **3.99** and Figure 3**.175**).

For detailed information on countries methodologies please see Annex III.

Table 3.107 1.B.1.a.1 Coal Mining – underground mining: Countries contribution to CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	335	NA,NO	NA,NO	-	-335	-100%	-	-	NA	NA
Belgium	443	44	44	0.2%	-399	-90%	0	-1%	D,NA	D,NA
Bulgaria	1 484	191	178	0.9%	-1 306	-88%	-14	-7%	NA,T2	CS,NA
Croatia	67	NO	NO	-	-67	-100%	-	-	NA,NO	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	9 140	708	566	2.8%	-8 575	-94%	-143	-20%	NA,T1,T2	CS,D,NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	5 302	1	1	0.0%	-5 300	-100%	0	0%	NA	NA
Germany	28 444	66	62	0.3%	-28 382	-100%	-4	-6%	NA,T3	CS,NA
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	1 181	31	31	0.1%	-1 151	-97%	0	-1%	NA,T1	D,NA
Ireland	62	20	19	0.1%	-43	-69%	0	-1%	NA,NO,T1	D,NA,NO
Italy	22	8	7	0.0%	-15	-67%	-1	-7%	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	21 933	14 456	13 836	67.4%	-8 097	-37%	-620	-4%	NA,NO,T1,T2	D,NA,NO
Portugal	157	17	17	0.1%	-140	-89%	0	-1%	NO,T1	D,NO
Romania	5 915	5 529	5 394	26.3%	-522	-9%	-135	-2%	NA,T1,T2	D,NA
Slovakia	792	242	173	0.8%	-618	-78%	-69	-28%	NA,T1,T2	CS,D,NA
Slovenia	404	200	181	0.9%	-223	-55%	-19	-10%	NA,T2,T3	CS,D,NA,PS
Spain	1 814	27	25	0.1%	-1 789	-99%	-2	-7%	CS,NA,T2	CS,NA
Sweden	NO	NO	NO	-	-	-	-	-	-	-
EU-27	**77 495**	**21 540**	**20 533**	**100%**	**-56 961**	**-74%**	**-1 007**	**-5%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.147 1.B.1.a.1.i Mining activities - Underground Mines: Emission trend and share for the EU and the emitting countries of CH_4

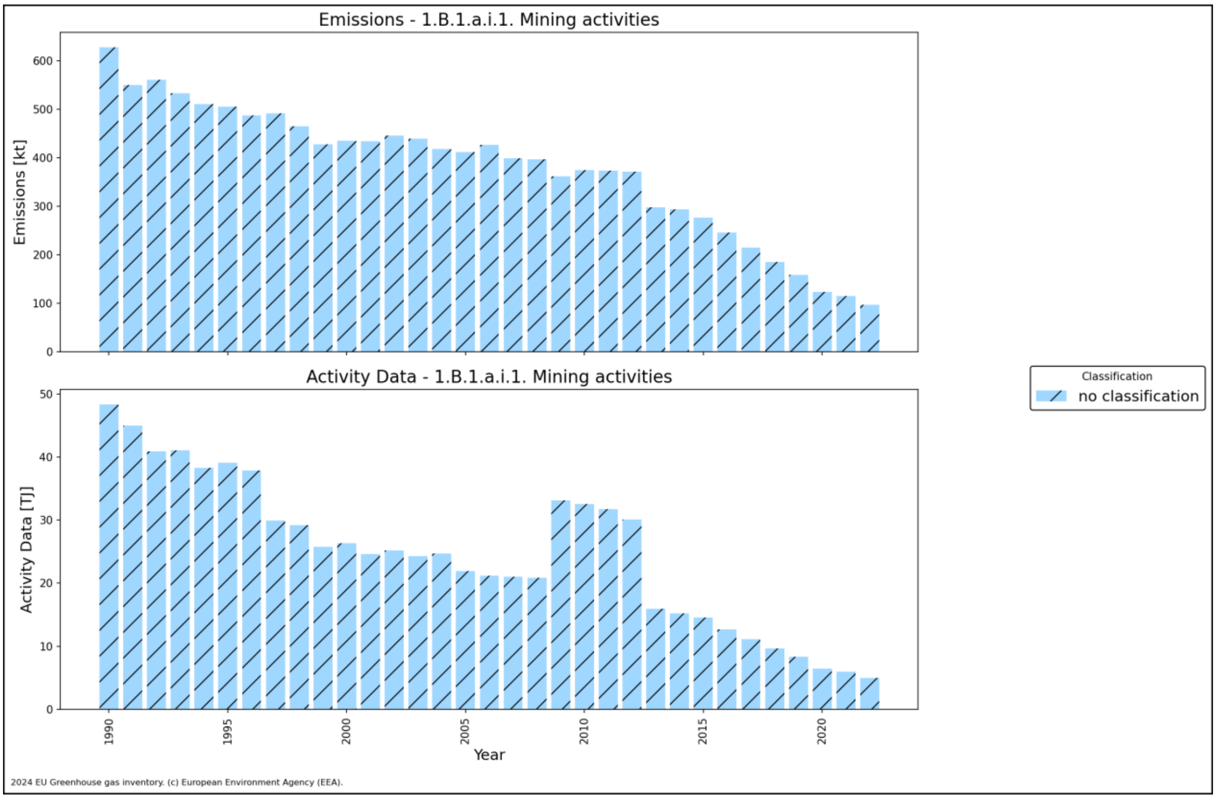


Figure 3.176 shows the implied emission factor of the EU CH_4 emissions in 1B1ai1 – underground mines, mining activities, which are responsible for 56 % of total GHG emissions from 1.B.1.a.i. The decrease of the implied emission factor is caused by the closure of underground mining in Germany. Between 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 2024).

Figure 3.148: 1.B.1.a.i.1: Mining activities – Underground mines - Implied Emission Factors for CH_4 (in kg/t)

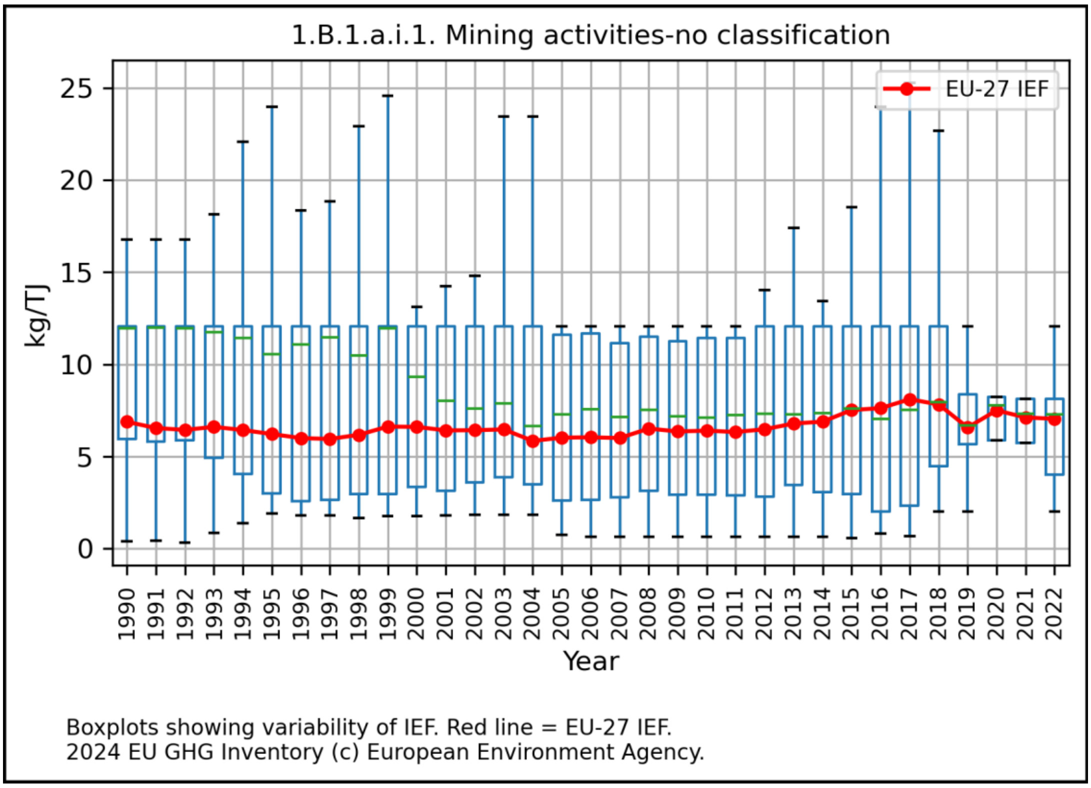
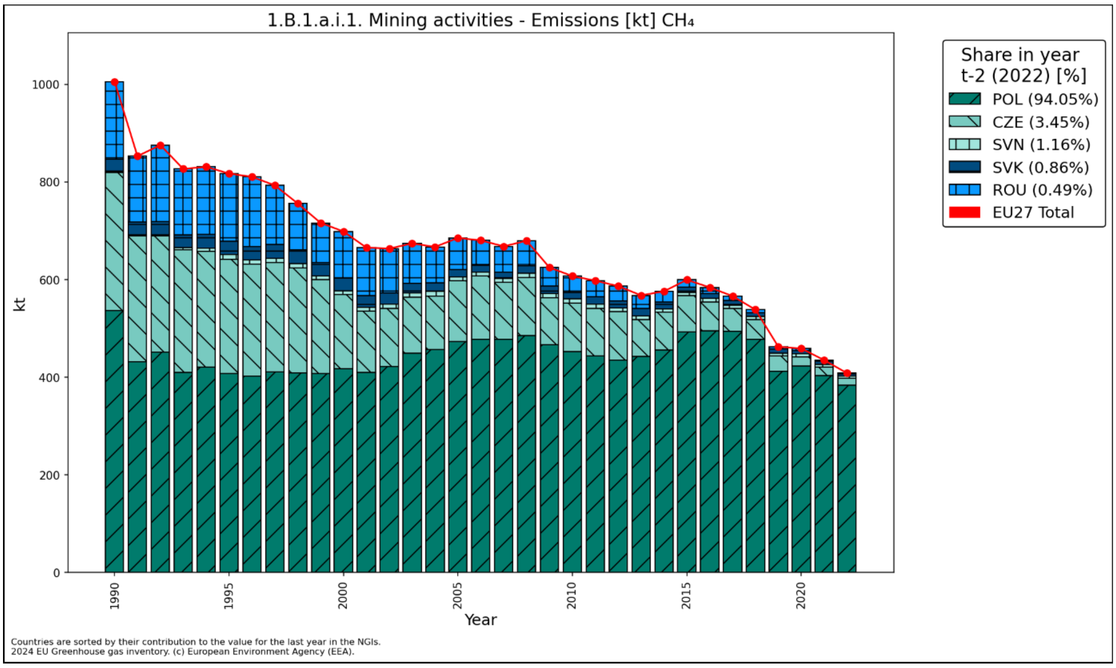


Figure 3.149 1.B.1.a.1.i Mining activities - Underground Mines: Emission trend and share for the emitting countries of CH_4



CH_4 from Surface mines (1.B.1.a.2)

In 2021, only 17% of CH_4 emissions from coal mining originate from surface mining. Overall, CH_4 emissions from the coal production of surface mines decreased by 42 % between 1990 and 2022 (Table **3.100** and Figure 3**.178**).

For detailed information on countries methodologies please see Table **3.100** and Annex III.

Table 3.108 1.B.1.a.2 Coal Mining – surface mining: Countries contribution to CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	38	NO	NO	-	-38	-100%	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	679	690	866	20.0%	188	28%	176	26%	NA,T1	D,NA
Croatia	NO	NO	NO	-	-	-	-	-	NA,NO	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	3 040	1 153	1 315	30.3%	-1 725	-57%	162	14%	T1	D
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	53	NO	NO	-	-53	-100%	-	-	NA	NA
Germany	110	39	40	0.9%	-70	-63%	1	4%	NA,T2	CS,NA
Greece	1 266	302	348	8.0%	-918	-73%	45	15%	NA,T1	D,NA
Hungary	NO	0	0	0.0%	0	∞	0	66%	NA,T2	CS,NA
Ireland	NO	NO	NO	-	-	-	-	-	NA,NO	NA,NO
Italy	37	NO	NO	-	-37	-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	1 648	1 277	1 332	30.7%	-316	-19%	55	4%	NO,T1	D,NO
Portugal	NO	NO	NO	-	-	-	-	-	NO	NO
Romania	609	426	439	10.1%	-170	-28%	13	3%	NA,T1	D,NA
Slovakia	NO	NO	NO	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	1	NO	NO	-	-1	-100%	-	-	NA	NA
Sweden	NO	NO	NO	-	-	-	-	-	-	-
EU-27	**7 480**	**3 888**	**4 341**	**100%**	**-3 139**	**-42%**	**453**	**12%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.150 1.B.1.a.2.i Mining activities - Surface Mines: Emission trend and share for the emitting countries of CH_4

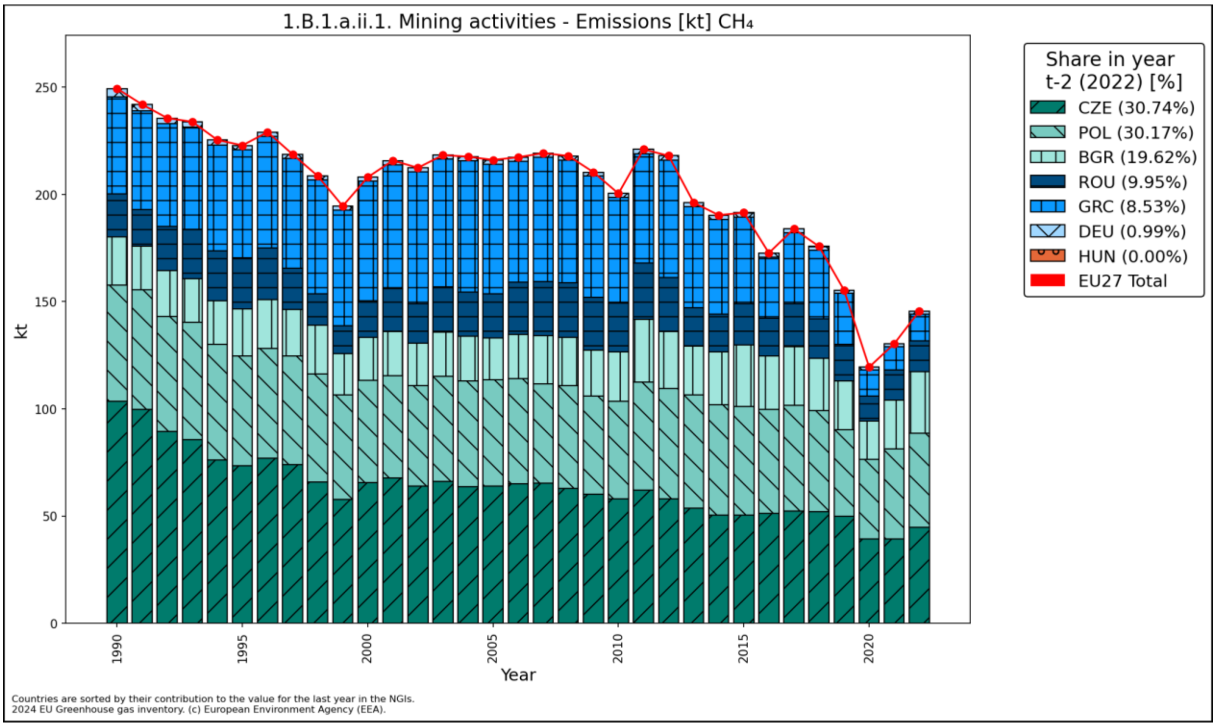
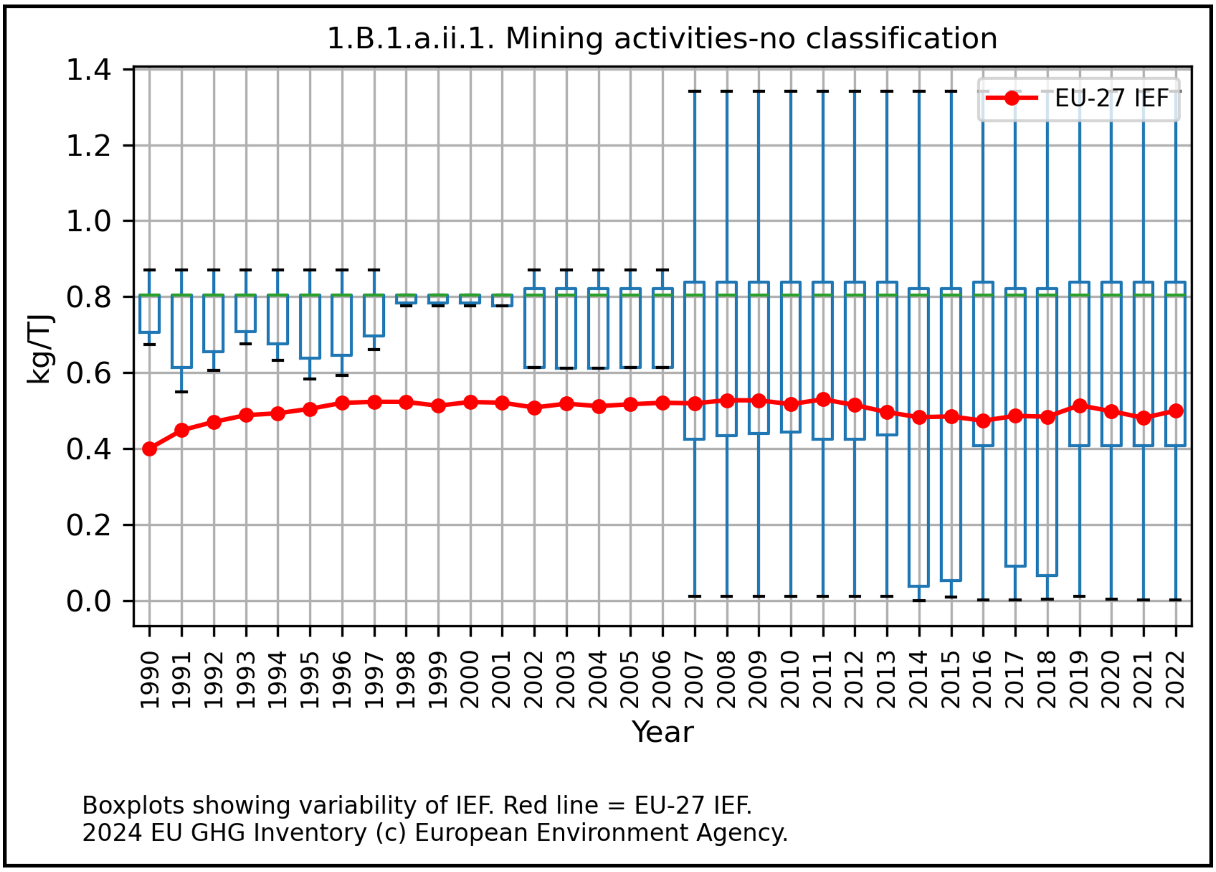


Figure **3.172** shows the Implied Emission factor of the EU for CH_4 emissions in 1.B.1.a.ii.1 – mining activities from surface mines, which are responsible for 93 % of total GHG emissions from 1.B.1.a.ii.

Figure 3.151: 1.B.1.a.2.i Mining activities – Surface mines - Overview 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 inTable 3.101.

Table 3.109 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

3.5.6.2 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).

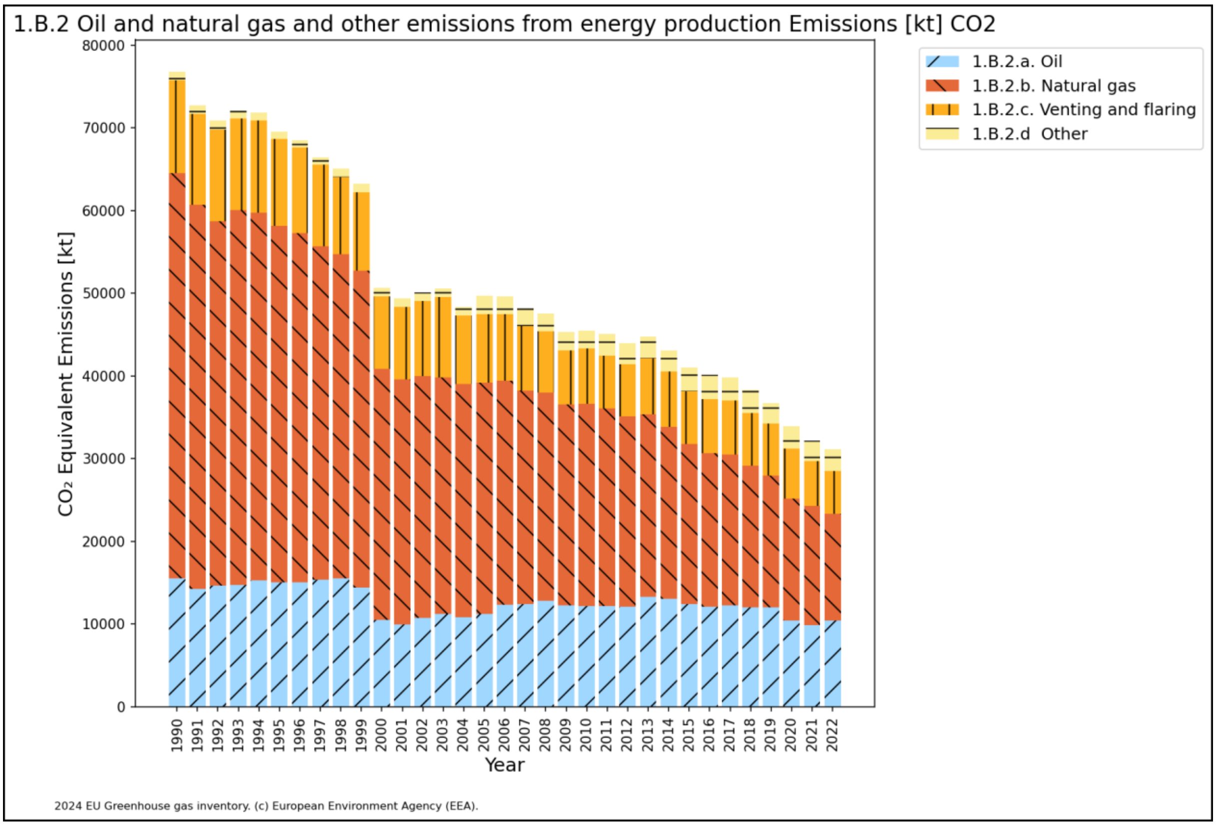
Fugitive emissions from 1.B.2 Oil and natural gas include all emissions from exploration, production, processing, transport, and handling of oil and natural gas. They account for 1 % of the total GHG emissions in 2022 and for 52 % (Figure 3.**180**) of all fugitive emissions in the EU.

Of all fugitive emissions from oil and natural gas, in 2022:

- 39 % were CH_4 emissions from natural gas (exploration, production, processing, transport and distribution)
- 31 % were CO_2 emissions from oil (exploration, production, transport, refining and storage and distribution)
- 8 % were CO_2 emissions from venting and flaring
- 9 % were CH_4 emissions from venting and flaring
- 4 % were CO_2 emissions due to Other emissions

Fugitive emissions from oil and natural gas occur in all countries but Malta (Table 3**.103**). Total greenhouse gas emissions from 1.B.2 decreased by 59 % between 1990 and 2022 (Figure **3.180**). This trend was mainly due to the reduction of fugitive CH_4 emissions from natural gas activities, which decreased by 74 % over that period.

Figure 3.152 1.B.2-Fugitive Emissions Oil and Natural Gas: Trend



In 2022, 54% of all fugitive GHG emissions from oil and natural gas were emitted by four countries: Italy, Poland, Romania and Spain (Table 3.103).

Table 3.110 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	2022	1990	2022	1990	2022
Austria	401	311	102	80	299	231
Belgium	892	600	85	111	807	489
Bulgaria	238	1 054	60	752	177	301
Croatia	986	511	583	356	403	155
Cyprus	0	NA,NO	NA,NO	NA,NO	0	NA,NO
Czechia	1 198	517	2	3	1 195	514
Denmark	670	193	341	95	329	98
Estonia	72	17	0	0	72	17
Finland	125	92	111	65	12	26
France	6 402	2 511	4 362	1 638	2 017	866
Germany	12 175	2 991	2 008	1 179	10 165	1 811
Greece	84	132	43	2	41	130
Hungary	2 623	1 506	478	135	2 143	1 371
Ireland	56	70	0	0	56	70
Italy	14 055	5 022	4 047	1 799	9 997	3 214
Latvia	277	98	0	0	277	98
Lithuania	321	418	24	238	297	180
Luxembourg	22	26	0	0	22	26
Malta	NO	NO	NO	NO	NO	NO
Netherlands	2 939	1 400	775	1 024	2 164	376
Poland	1 267	4 614	47	1 903	1 219	2 711
Portugal	58	1 236	54	1 175	2	59
Romania	27 618	3 343	1 177	808	26 439	2 535
Slovakia	1 953	411	57	37	1 895	375
Slovenia	56	41	0	0	56	41
Spain	1 926	3 974	1 746	3 730	180	244
Sweden	421	38	331	0	89	38
EU-27	**76 835**	**31 128**	**16 433**	**15 131**	**60 356**	**15 976**

Abbreviations explained in the Chapter 'Units and abbreviations'.

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 GHG emissions in 2022 and for 16 % of all fugitive emissions. Between 1990 and 2022, CO_2 emissions from this source increased by 12 % in the EU (Table 3**.104**). By contrast, during the same period 1990-2022, CH_4 emissions of this source category were reduced by 89 %.

Main contributor to these emissions in all countries is subcategory 1.B.2.a.4 (Oil – Refining/Storage). Table **3.104** shows that 72 % of EU 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 (DNM, FRK, DEU, ITA, LTA, NLD, POL, ROU, ESP) only emissions from subcategories of sector 1.B.2.a were considered 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, SVK) were calculated as a higher method, according to the IPCC 2006 Guidelines. For detailed information on countries methodologies please see Annex III.

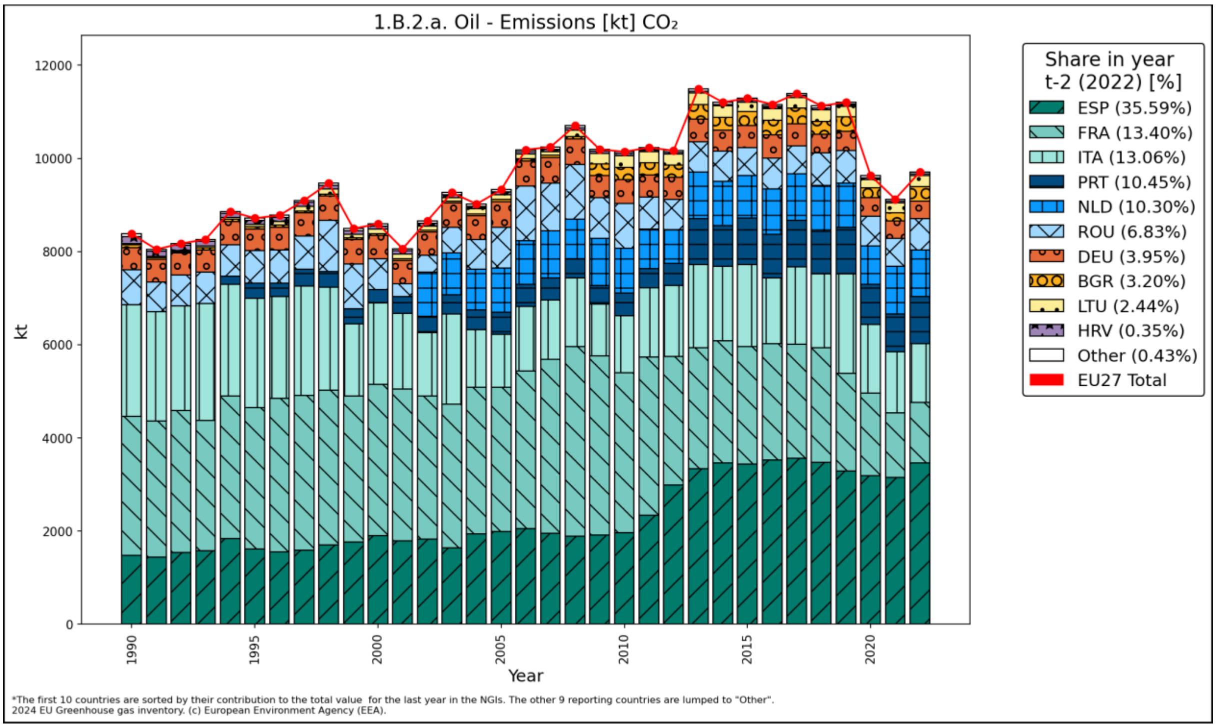
Table 3.**104** shows the member states contributions to the EU CO_2 emissions in this category. Increases are mainly driven by the reduction of CO_2 emissions from subcategory 1.B.2.a.4 (Oil – Refining/Storage).

Table 3.111 1.B.2.a Fugitive CO_2 emissions from oil: Countries' contributions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	0.005	0.005	0.003	0.0%	0	-27%	0	-31%	NA,T1	D,NA
Belgium	0.01	0.02	0.02	0.0%	0	10%	0	-3%	NA,T1	D,NA
Bulgaria	60	169	311	3.2%	251	420%	141	84%	NA,T1	D,NA
Croatia	158	35	34	0.4%	-124	-78%	-1	-3%	NA,T1	D,NA
Cyprus	NA,NO	NA,NO	NA,NO	-	-	-	-	-	NA	NA
Czechia	0.02	0.03	0.03	0.0%	0.01	45%	0	-8%	NA,T1	D,NA
Denmark	5	0.1	0.1	0.0%	-5	-99%	0	7%	NA,T3	NA,PS
Estonia	NE,NO	NE,NO	NE,NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	2 983	1 387	1 301	13.4%	-1 682	-56%	-85	-6%	NA	NA
Germany	478	374	383	3.9%	-95	-20%	9	2%	NA,T1,T2	CS,D,NA
Greece	0.000039	0.000003	0.000002	0.0%	0	-95%	0	-33%	NA,T1	D,NA
Hungary	5	1	0.5	0.0%	-5	-91%	0	-17%	NA,T1	CS,NA
Ireland	NO	NO	NO	-	-	-	-	-	NA,NO	NA,NO
Italy	2 402	1 316	1 268	13.1%	-1 134	-47%	-48	-4%	NA,T1,T2	CS,D,NA
Latvia	NA,NO	NA,NO	NA,NO	-	-	-	-	-	NA	NA
Lithuania	23	216	237	2.4%	214	917%	21	10%	NA,T1,T3	D,NA,PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	0.02	1 022	1 000	10.3%	1 000	5555776%	-23	-2%	CS,NA,T1	D,NA,PS
Poland	2	10	9	0.1%	7	428%	0	-4%	NA,NO,T1	CS,D,NA,NO
Portugal	0.4	819	1 015	10.5%	1 015	238507%	196	24%	D,NO	D,NO
Romania	746	601	663	6.8%	-83	-11%	63	10%	NA,T1,T2,T3	CS,D,NA,PS
Slovakia	40	32	32	0.3%	-8	-20%	-1	-2%	NA,T1	D,NA
Slovenia	0.03	0.06	0.06	0.0%	0.0	136%	0	-3%	NA,T1	D,NA
Spain	1 477	3 144	3 455	35.6%	1 979	134%	312	10%	NA,T1,T2	D,NA,PS
Sweden	255	E,NA,NE,NO	E,NA,NE,NO	-	-255	-100%	-	-	-	-
EU-27	**8 633**	**9 126**	**9 709**	**100%**	**1 076**	**12%**	**583**	**6%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.153 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 GHG emissions in 2022 and for 1.2 % of all fugitive emissions. Between 1990 and 2021, CH_4 emissions from this source decreased by 89 % in the EU (Table 3**.104**).

Table 3**.105** shows the member states contributions to the EU CH_4 emissions in this category. 31% of reported CH_4 emissions from this category are calculated with a higher tier method.

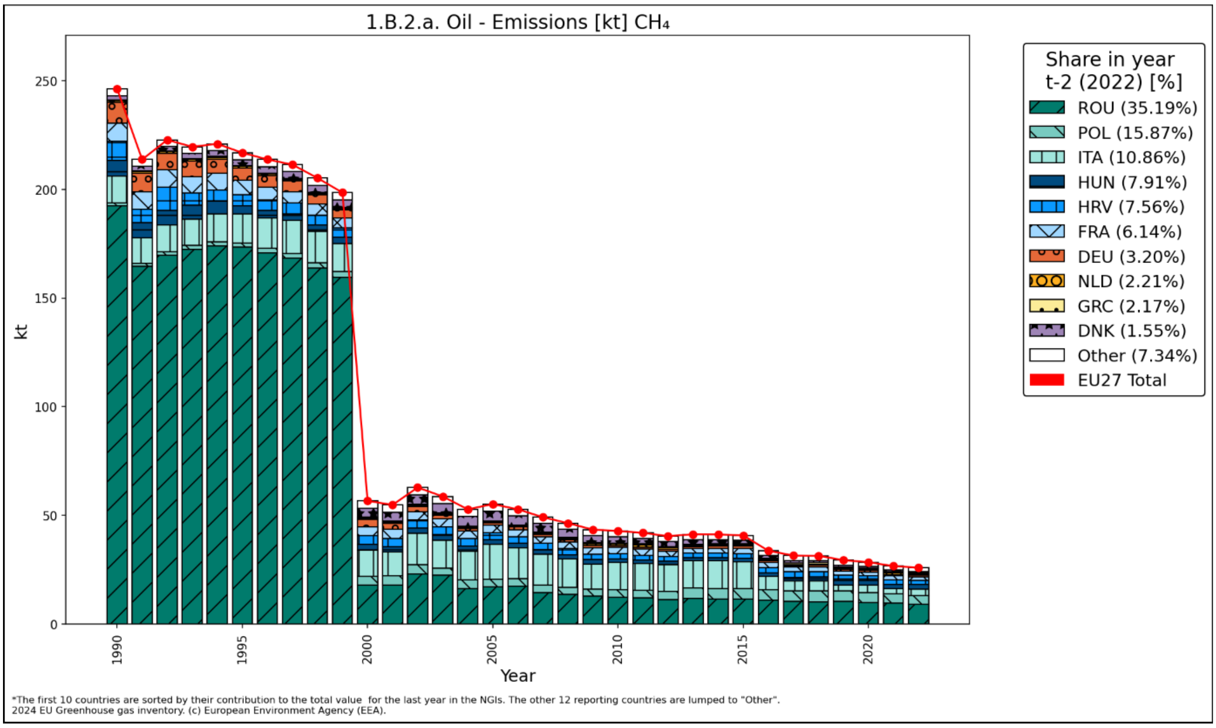
In Romania main contributions to CH_4 emissions come from subcategory 1.B.2.a.2 (Oil – Production). From 1990 to 2000 CH_4 emissions are estimated using a Tier 1 methodology with a default emission factor for developing countries of the 2006 IPCC Guidelines. From 2000 on the country applies a Tier 1 methodology with a default emission factor for developed countries, due to change of technology (ROU NIR 2022). This also explains the outlier in ***Figure 3.182***. For detailed information on countries methodologies please see Annex III.

Table 3.112 1.B.2.a Fugitive CH_4 emissions from oil: Countries' contributions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	8	9	6	0.8%	-2	-29%	-3	-32%	NA,T1	D,NA
Belgium	13	8	8	1.0%	-5	-41%	-1	-7%	CS,D,NA	CS,D,NA
Bulgaria	14	6	9	1.2%	-5	-35%	3	46%	NA,T1	D,NA
Croatia	247	57	55	7.6%	-192	-78%	-2	-3%	NA,T1	D,NA
Cyprus	0	NA,NO	NA,NO	-	0	-100%	-	-	NA	NA
Czechia	11	7	7	1.0%	-4	-39%	0	4%	NA,T1,T2	CS,D,NA
Denmark	48	20	11	1.6%	-37	-77%	-9	-45%	NA,T2,T3	D,NA,PS
Estonia	NE,NO	NE,NO	NE,NO	-	-	-	-	-	NA	NA
Finland	7	7	8	1.2%	1	19%	1	21%	NA,T1	D,NA
France	230	49	45	6.1%	-186	-81%	-5	-9%	NA	NA
Germany	271	22	23	3.2%	-248	-91%	1	6%	NA,T1,T2	CS,D,NA
Greece	11	17	16	2.2%	5	44%	-1	-7%	NA,T1	D,NA
Hungary	200	57	58	7.9%	-142	-71%	0	0%	NA,T1	CS,NA
Ireland	0	0	0	0.1%	0	65%	0	-1%	NA,NO,T1	D,NA,NO
Italy	347	69	79	10.9%	-268	-77%	10	14%	NA,T1,T2	CS,D,NA
Latvia	NA,NO	NA,NO	NA,NO	-	-	-	-	-	NA	NA
Lithuania	5	2	2	0.3%	-2	-50%	0	-1%	NA,T1	D,NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	23	16	16	2.2%	-7	-30%	0	-1%	NA,T1,T1b	D,NA
Poland	39	117	115	15.9%	76	194%	-2	-2%	NA,NO,T1	CS,D,NA,NO
Portugal	2	2	2	0.2%	0	-10%	0	7%	CR,NO,OTH	CR,NO,OTH
Romania	5 389	269	256	35.2%	-5 133	-95%	-14	-5%	NA,T1	D,NA
Slovakia	13	6	6	0.8%	-7	-53%	0	-3%	NA,T1	D,NA
Slovenia	0	0	0	0.0%	0	-100%	0	0%	NA,T1	D,NA
Spain	4	3	4	0.5%	-1	-16%	1	17%	NA,T1	D,NA
Sweden	14	1	1	0.2%	-12	-91%	0	-3%	T1	D
EU-27	**6 897**	**747**	**727**	**100%**	**-6 170**	**-89%**	**-20**	**-3%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.154: 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 0.4 % of total EU-27 GHG emissions in 2022 and for 20 % of all fugitive emissions in the EU. Between 1990 and 2022, CH_4 emissions from this source decreased by 74 % (Table 3.106).

The main sources of CH_4 emissions are subcategories Transmission and Storage -1B2biv (20% of CH_4 emissions in category 1B2b) and Distribution - 1B2bv (54% of CH_4 emissions in category 1B2b).

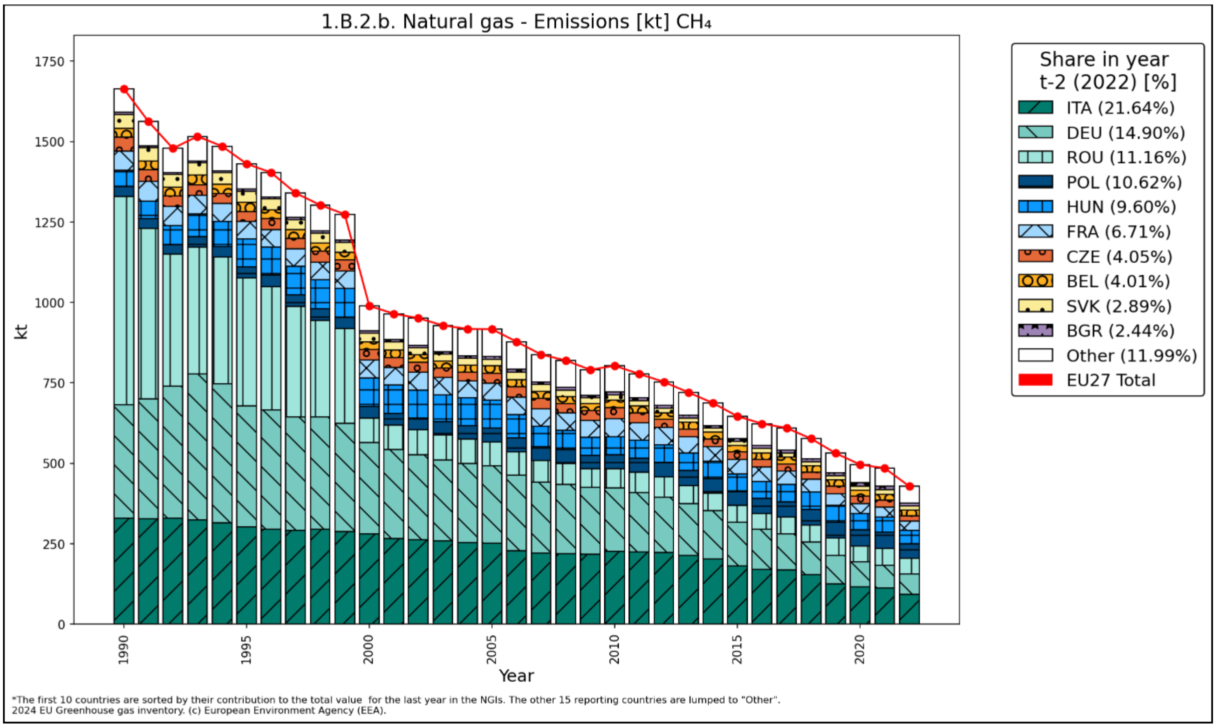
Emissions from natural gas production (1.B.2.b.2) and other operations on natural gas (1.B.2.b.6) are the main sources of CH_4 emissions in Romania in this category. From 1990 to 2000, CH_4 emissions are estimated using a Tier 1 methodology with a default emission factor for developing countries of the 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 2024). This also explains the outlier in Figure **3.183**. Table **3.106** shows that 63 % of EU-27 emissions are calculated using higher tier methods. In cases where countries report a mix of Tier 1 and higher Tier methods (AUT, DNM, FIN, ESP) only emissions from subcategories of sector 1.B.2.b were considered 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. For detailed information on countries methodologies, please see Annex III.

Table 3.113 1.B.2.b Fugitive CH_4 emissions from natural gas: Countries' contributions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	290	238	225	1.9%	-66	-23%	-14	-6%	NA,T1,T2	CS,D,NA
Belgium	795	506	481	4.0%	-313	-39%	-24	-5%	CS,NA	CS,NA
Bulgaria	164	298	292	2.4%	129	79%	-5	-2%	T1	D
Croatia	155	108	100	0.8%	-55	-35%	-8	-8%	NA,T1	D,NA
Cyprus	NO	NA,NO	NA,NO	-	-	-	-	-	NA	NA
Czechia	1 170	648	485	4.0%	-685	-59%	-163	-25%	NA,T1,T2	CS,NA
Denmark	246	76	76	0.6%	-170	-69%	0	0%	NA,T1,T2	CS,D,NA
Estonia	63	20	15	0.1%	-48	-76%	-5	-26%	NA,T1	D,NA
Finland	5	18	17	0.1%	13	268%	0	-1%	NA,T1,T2	CS,D,NA,PS
France	1 703	847	805	6.7%	-898	-53%	-43	-5%	NA	NA
Germany	9 893	1 985	1 787	14.9%	-8 105	-82%	-198	-10%	NA,T2,T3	CS,NA
Greece	10	108	87	0.7%	76	740%	-21	-20%	NA,T1	D,NA
Hungary	1 403	1 291	1 152	9.6%	-251	-18%	-140	-11%	NA,T1,T2	CS,NA
Ireland	25	71	70	0.6%	45	184%	-1	-1%	NA,T3	CS,NA,PS
Italy	9 225	3 142	2 596	21.6%	-6 629	-72%	-546	-17%	NA,T2	CS,NA
Latvia	199	92	90	0.7%	-109	-55%	-2	-2%	NA,T3	CS,NA
Lithuania	292	268	177	1.5%	-115	-39%	-91	-34%	NA,T2	CS,NA
Luxembourg	22	33	26	0.2%	4	20%	-7	-22%	NA,T1	D,NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	472	264	241	2.0%	-231	-49%	-23	-9%	NA,T3	CS,NA
Poland	844	1 459	1 273	10.6%	430	51%	-186	-13%	NA,NO,T1	D,NA,NO
Portugal	NO	59	55	0.5%	55	∞	-3	-5%	CR,NO,OTH	CR,NO,OTH
Romania	18 124	1 440	1 338	11.2%	-16 785	-93%	-102	-7%	NA,T1	D,NA
Slovakia	1 223	378	346	2.9%	-876	-72%	-31	-8%	D,NA,T1,T3	CS,D,NA
Slovenia	48	39	35	0.3%	-13	-26%	-4	-11%	NA,T1	D,NA
Spain	152	141	187	1.6%	35	23%	46	33%	CS,NA,T1	CS,D,NA
Sweden	75	40	37	0.3%	-39	-52%	-4	-9%	T2,T3	CS,PS
EU-27	**46 594**	**13 568**	**11 994**	**100%**	**-34 599**	**-74%**	**-1 574**	**-12%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.155 1.B.2.b Natural Gas: Emission trend and share for the emitting countries of CH_4



CRT Tables do not include activity data for sector 1.B.2 because countries use different types of activity data in category 1B2a and 1B2b, which cannot be aggregated. Information on the type of activity data is provided in the member states NIDs and CRT tables.

3.5.6.3 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 0.1% of total EU GHG emissions in 2021 and for 4 % of all fugitive emissions in the EU-27. Between 1990 and 2022 CO_2 emissions from this source decreased by 48 %.

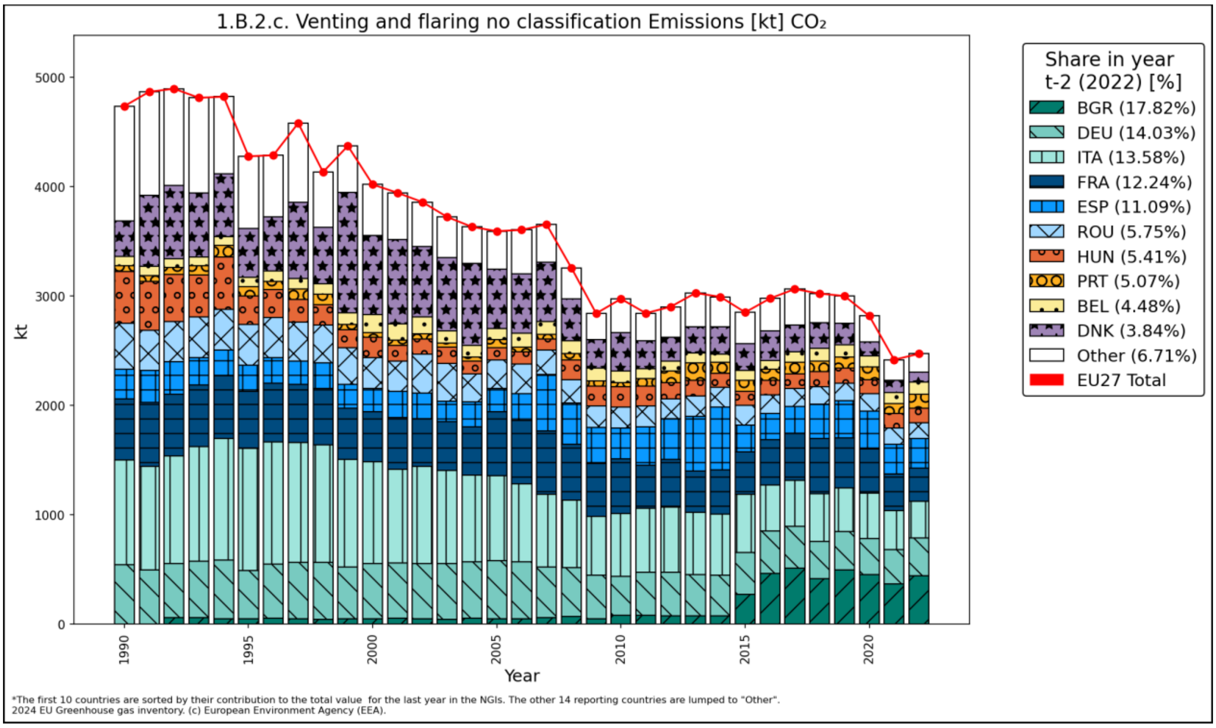
All but three countries (Austria, Cyprus, Malta) - are reporting CO_2 emissions in this category (*Table 3.109*).

Table 3.114: 1.B.2.c Fugitive CO_2 emissions from Other emissions: Countries' contributions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	84	98	111	4.5%	27	32%	13	13%	NA,T3	NA,PS
Bulgaria	IE,NO	369	440	17.8%	440	∞	71	19%	NA,T1	D,NA
Croatia	0	0	0	0.0%	0	-96%	0	41%	NA,T1	D,NA
Cyprus	NO	NA,NO	NA,NO	-	-	-	-	-	NA	NA
Czechia	2	3	3	0.1%	1	55%	0	-10%	NA,T1	D,NA
Denmark	328	111	95	3.8%	-233	-71%	-16	-15%	NA,T3	NA,PS
Estonia	0	0	0	0.0%	0	-76%	0	-26%	NA,T1	D,NA
Finland	111	68	65	2.6%	-46	-41%	-3	-4%	CS,NA	CS,NA
France	560	335	302	12.2%	-258	-46%	-33	-10%	NA	NA
Germany	544	314	347	14.0%	-197	-36%	33	10%	NA,T2	CS,NA
Greece	43	3	2	0.1%	-41	-96%	-1	-49%	NA,T1	D,NA
Hungary	471	130	134	5.4%	-338	-72%	3	3%	NA,T1,T3	CS,D,NA
Ireland	IE,NO	0	0	0.0%	0	∞	0	-59%	CS,NA,T3	CS,NA,PS
Italy	956	356	336	13.6%	-620	-65%	-20	-6%	NA,T1	D,NA
Latvia	0	0	0	0.0%	0	-77%	0	-77%	NA,T3	CS,NA
Lithuania	1	1	1	0.0%	1	90%	0	-17%	NA,T1	D,NA
Luxembourg	0	0	0	0.0%	0	-33%	0	-55%	CS,NA	CS,NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	774	29	24	1.0%	-750	-97%	-5	-16%	NA,T2	NA,PS
Poland	44	85	71	2.9%	27	62%	-14	-17%	NA,T1	D,NA
Portugal	52	94	125	5.1%	73	138%	31	33%	D,NO	D,NO
Romania	424	150	142	5.7%	-282	-66%	-8	-5%	NA,T1	D,NA
Slovakia	0	0	0	0.0%	0	-65%	0	-36%	NA,T1	D,NA
Slovenia	0	0	0	0.0%	0	-91%	0	-10%	NA,T1	D,NA
Spain	269	269	274	11.1%	5	2%	5	2%	CS,NA,T1,T2	CS,D,NA,PS
Sweden	73	0	0	0.0%	-73	-100%	0	118%	T2	CS
EU-27	**4 735**	**2 417**	**2 471**	**100%**	**-2 264**	**-48%**	**54**	**2%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period Austria includes CO_2 emissions from venting and flaring in 1.A.1b Petroleum refining Abbreviations explained in the Chapter 'Units and abbreviations'.

Figure 3.156: 1.B.2.c Venting and Flaring: Emission trend and share for the emitting countries of CO_2



3.5.6.4 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.

Six countries report CO_2 emissions in this sector, three are reporting CH_4 emissions and two countries report N_2O emissions. The description of the subcategories is presented inTable 3.110.

Table 3.115 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
Italy	CH_4, CO_2, N_2O	Flaring in refineries
Poland	CO_2	Underground storage of gas
Portugal	CO_2	Geothermal

3.5.7 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 2022.

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 0.002 % of total EU-27 GHG emissions in 2022. The emissions captured increased between 1993 and 2022 by 5 548 %.

3.5.8 Energy – non-key categories

Table 1.20 provides an overview on the role of non-key categories in the Energy sector.

Table 3.116 Aggregated GHG emission from non-key categories in the energy sector

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.1.a Public Electricity and Heat Production: Biomass (CH_4)	39.7	2 057.6	2 170.2	0.08%	2 130.5	5371%	112.6	5%
1.A.1.a Public Electricity and Heat Production: Biomass (N_2O)	203.5	1 416.3	1 363.6	0.05%	1 160.1	570%	-52.7	-4%
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (CH_4)	180.3	1 327.1	1 178.2	0.04%	998.0	554%	-148.9	-11%
1.A.1.a Public Electricity and Heat Production: Gaseous Fuels (N_2O)	134.2	685.7	801.1	0.03%	666.9	497%	115.4	17%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (CH_4)	157.3	25.6	29.0	0.00%	-128.2	-82%	3.4	13%
1.A.1.a Public Electricity and Heat Production: Liquid Fuels (N_2O)	332.7	64.8	73.9	0.00%	-258.7	-78%	9.1	14%
1.A.1.a Public Electricity and Heat Production: Other Fuels (CH_4)	17.2	42.7	41.8	0.00%	24.6	142%	-0.9	-2%
1.A.1.a Public Electricity and Heat Production: Other Fuels (N_2O)	115.2	278.5	274.4	0.01%	159.2	138%	-4.1	-1%
1.A.1.a Public Electricity and Heat Production: Peat (CH_4)	9.2	5.8	5.8	0.00%	-3.5	-38%	0.0	0%
1.A.1.a Public Electricity and Heat Production: Peat (N_2O)	110.3	47.5	48.3	0.00%	-62.0	-56%	0.8	2%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (CH_4)	193.3	77.7	85.3	0.00%	-108.0	-56%	7.6	10%
1.A.1.a Public Electricity and Heat Production: Solid Fuels (N_2O)	4 387.0	2 153.2	2 280.9	0.09%	-2 106.0	-48%	127.8	6%
1.A.1.b Petroleum Refining: Biomass (CH_4)	2.1	0.1	0.1	0.00%	-2.0	-96%	0.0	-13%
1.A.1.b Petroleum Refining: Biomass (N_2O)	3.1	1.1	1.2	0.00%	-1.9	-62%	0.1	9%
1.A.1.b Petroleum Refining: Gaseous Fuels (CH_4)	6.4	22.1	16.2	0.00%	9.8	153%	-6.0	-27%
1.A.1.b Petroleum Refining: Gaseous Fuels (N_2O)	120.3	40.5	21.4	0.00%	-98.9	-82%	-19.1	-47%
1.A.1.b Petroleum Refining: Liquid Fuels (CH_4)	68.6	55.6	50.6	0.00%	-18.0	-26%	-5.0	-9%
1.A.1.b Petroleum Refining: Liquid Fuels (N_2O)	248.2	205.5	242.8	0.01%	-5.4	-2%	37.3	18%
1.A.1.b Petroleum Refining: Other Fuels (CH_4)	6.5	0.2	0.2	0.00%	-6.3	-96%	0.1	53%
1.A.1.b Petroleum Refining: Other Fuels (CO_2)	920.7	34.1	203.3	0.01%	-717.4	-78%	169.3	497%
1.A.1.b Petroleum Refining: Other Fuels (N_2O)	8.6	0.5	0.5	0.00%	-8.1	-94%	0.1	16%

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
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)	0.6	0.0	0.0	0.00%	-0.6	-97%	0.0	60%
1.A.1.b Petroleum Refining: Solid Fuels (CO_2)	3 633.0	99.1	128.2	0.00%	-3 504.8	-96%	29.1	29%
1.A.1.b Petroleum Refining: Solid Fuels (N_2O)	26.6	0.4	0.5	0.00%	-26.1	-98%	0.1	26%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Biomass (CH_4)	100.7	140.1	123.3	0.00%	22.5	22%	-16.8	-12%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Biomass (N_2O)	3.4	42.1	40.9	0.00%	37.5	1103%	-1.2	-3%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (CH_4)	76.3	36.6	21.9	0.00%	-54.4	-71%	-14.8	-40%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Gaseous Fuels (N_2O)	15.9	26.0	24.4	0.00%	8.5	53%	-1.6	-6%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (CH_4)	3.8	1.3	1.1	0.00%	-2.7	-72%	-0.3	-20%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (CO_2)	3 136.5	1 237.7	999.9	0.04%	-2 136.6	-68%	-237.7	-19%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Liquid Fuels (N_2O)	12.7	2.5	2.0	0.00%	-10.7	-84%	-0.5	-20%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (CH_4)	5.5	0.0	0.0	0.00%	-5.5	-100%	0.0	-10%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (CO_2)	456.1	0.1	0.1	0.00%	-456.0	-100%	0.0	-10%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Other Fuels (N_2O)	8.1	0.0	0.0	0.00%	-8.1	-100%	0.0	-10%
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	-51%	0.0	-13%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (CO_2)	175.5	77.5	65.0	0.00%	-110.4	-63%	-12.5	-16%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Peat (N_2O)	0.6	0.3	0.2	0.00%	-0.4	-61%	0.0	-11%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (CH_4)	174.2	17.7	14.9	0.00%	-159.4	-91%	-2.8	-16%
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries: Solid Fuels (N_2O)	612.8	96.0	91.4	0.00%	-521.4	-85%	-4.5	-5%
1.A.2.a Iron and Steel: Biomass (CH_4)	0.3	0.5	0.2	0.00%	-0.1	-21%	-0.3	-52%
1.A.2.a Iron and Steel: Biomass (N_2O)	0.4	0.8	0.5	0.00%	0.2	46%	-0.2	-31%
1.A.2.a Iron and Steel: Gaseous Fuels (CH_4)	20.6	17.2	21.2	0.00%	0.6	3%	4.0	23%
1.A.2.a Iron and Steel: Gaseous Fuels (N_2O)	111.0	38.8	39.8	0.00%	-71.3	-64%	0.9	2%

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.a Iron and Steel: Liquid Fuels (CH_4)	14.1	0.5	0.6	0.00%	-13.5	-96%	0.0	8%
1.A.2.a Iron and Steel: Liquid Fuels (N_2O)	26.0	2.1	2.4	0.00%	-23.6	-91%	0.3	15%
1.A.2.a Iron and Steel: Other Fuels (CH_4)	4.1	0.0	0.0	0.00%	-4.1	-99%	0.0	-4%
1.A.2.a Iron and Steel: Other Fuels (CO_2)	655.4	11.6	8.7	0.00%	-646.7	-99%	-2.9	-25%
1.A.2.a Iron and Steel: Other Fuels (N_2O)	5.2	0.0	0.0	0.00%	-5.2	-99%	0.0	-15%
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)	240.0	131.5	115.1	0.00%	-124.9	-52%	-16.4	-12%
1.A.2.a Iron and Steel: Solid Fuels (N_2O)	297.2	145.2	129.6	0.00%	-167.7	-56%	-15.6	-11%
1.A.2.b Non-Ferrous Metals: Biomass (CH_4)	0.0	1.2	1.2	0.00%	1.2	33971%	0.0	-2%
1.A.2.b Non-Ferrous Metals: Biomass (N_2O)	0.0	1.6	1.5	0.00%	1.5	35389%	0.0	-2%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (CH_4)	2.2	43.6	25.5	0.00%	23.3	1044%	-18.1	-41%
1.A.2.b Non-Ferrous Metals: Gaseous Fuels (N_2O)	4.1	10.6	8.4	0.00%	4.3	103%	-2.2	-21%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CH_4)	4.2	0.6	0.7	0.00%	-3.6	-85%	0.0	4%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (CO_2)	4 188.3	732.9	758.3	0.03%	-3 430.0	-82%	25.4	3%
1.A.2.b Non-Ferrous Metals: Liquid Fuels (N_2O)	10.7	3.0	3.0	0.00%	-7.7	-72%	0.0	0%
1.A.2.b Non-Ferrous Metals: Other Fuels (CH_4)	0.4	0.0	0.0	0.00%	-0.4	-99%	0.0	41%
1.A.2.b Non-Ferrous Metals: Other Fuels (CO_2)	64.9	0.4	0.5	0.00%	-64.3	-99%	0.1	39%
1.A.2.b Non-Ferrous Metals: Other Fuels (N_2O)	0.5	0.0	0.0	0.00%	-0.5	-98%	0.0	41%
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)	9.8	2.6	2.9	0.00%	-6.8	-70%	0.4	15%
1.A.2.b Non-Ferrous Metals: Solid Fuels (CO_2)	4 706.3	1 082.7	1 225.6	0.05%	-3 480.7	-74%	142.9	13%
1.A.2.b Non-Ferrous Metals: Solid Fuels (N_2O)	25.6	4.2	4.7	0.00%	-20.9	-82%	0.5	12%
1.A.2.c Chemicals: Biomass (CH_4)	1.7	13.2	12.1	0.00%	10.4	595%	-1.1	-8%
1.A.2.c Chemicals: Biomass (N_2O)	7.3	21.5	21.7	0.00%	14.4	199%	0.2	1%
1.A.2.c Chemicals: Gaseous Fuels (CH_4)	55.8	416.7	293.8	0.01%	238.1	427%	-122.8	-29%
1.A.2.c Chemicals: Gaseous Fuels (N_2O)	40.5	48.4	37.8	0.00%	-2.7	-7%	-10.6	-22%
1.A.2.c Chemicals: Liquid Fuels (CH_4)	36.9	10.3	12.8	0.00%	-24.2	-65%	2.4	24%
1.A.2.c Chemicals: Liquid Fuels (N_2O)	131.0	47.1	62.5	0.00%	-68.5	-52%	15.4	33%
1.A.2.c Chemicals: Other Fuels (CH_4)	17.1	8.0	8.4	0.00%	-8.7	-51%	0.4	5%
1.A.2.c Chemicals: Other Fuels (CO_2)	3 026.8	1 290.2	1 317.0	0.05%	-1 709.8	-56%	26.7	2%
1.A.2.c Chemicals: Other Fuels (N_2O)	24.1	16.2	17.3	0.00%	-6.8	-28%	1.1	7%
1.A.2.c Chemicals: Peat (CH_4)	0.2	0.0	0.0	0.00%	-0.2	-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)	3.4	0.0	0.0	0.00%	-3.4	-100%	0.0	0%
1.A.2.c Chemicals: Solid Fuels (CH_4)	28.3	26.1	23.7	0.00%	-4.5	-16%	-2.3	-9%
1.A.2.c Chemicals: Solid Fuels (N_2O)	63.4	37.0	33.7	0.00%	-29.7	-47%	-3.3	-9%

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.d Pulp, Paper and Print: Biomass (CH_4)	52.0	125.8	126.1	0.00%	74.2	143%	0.4	0%
1.A.2.d Pulp, Paper and Print: Biomass (N_2O)	171.8	320.9	316.0	0.01%	144.2	84%	-4.9	-2%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (CH_4)	35.9	135.3	107.5	0.00%	71.7	200%	-27.8	-21%
1.A.2.d Pulp, Paper and Print: Gaseous Fuels (N_2O)	25.7	42.7	38.2	0.00%	12.5	49%	-4.4	-10%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (CH_4)	13.2	7.7	8.0	0.00%	-5.3	-40%	0.3	4%
1.A.2.d Pulp, Paper and Print: Liquid Fuels (N_2O)	32.7	5.3	7.2	0.00%	-25.6	-78%	1.8	34%
1.A.2.d Pulp, Paper and Print: Other Fuels (CH_4)	0.4	3.5	4.1	0.00%	3.8	1059%	0.6	16%
1.A.2.d Pulp, Paper and Print: Other Fuels (CO_2)	57.8	461.9	561.1	0.02%	503.3	871%	99.3	21%
1.A.2.d Pulp, Paper and Print: Other Fuels (N_2O)	0.6	5.5	6.4	0.00%	5.8	997%	0.9	17%
1.A.2.d Pulp, Paper and Print: Peat (CH_4)	0.7	0.4	0.3	0.00%	-0.4	-61%	-0.2	-39%
1.A.2.d Pulp, Paper and Print: Peat (CO_2)	1 117.6	590.2	379.4	0.01%	-738.2	-66%	-210.8	-36%
1.A.2.d Pulp, Paper and Print: Peat (N_2O)	8.7	4.0	2.4	0.00%	-6.3	-72%	-1.5	-39%
1.A.2.d Pulp, Paper and Print: Solid Fuels (CH_4)	15.7	4.6	4.2	0.00%	-11.6	-74%	-0.5	-10%
1.A.2.d Pulp, Paper and Print: Solid Fuels (N_2O)	35.4	25.3	24.6	0.00%	-10.7	-30%	-0.6	-3%
1.A.2.e Food Processing, Beverages and Tobacco: Biomass (CH_4)	7.5	283.4	275.1	0.01%	267.6	3566%	-8.2	-3%
1.A.2.e Food Processing, Beverages and Tobacco: Biomass (N_2O)	14.5	98.3	95.5	0.00%	81.0	559%	-2.8	-3%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (CH_4)	21.0	248.0	208.9	0.01%	187.9	896%	-39.2	-16%
1.A.2.e Food Processing, Beverages and Tobacco: Gaseous Fuels (N_2O)	15.0	32.0	27.9	0.00%	12.9	86%	-4.1	-13%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (CH_4)	18.6	2.8	18.4	0.00%	-0.2	-1%	15.6	560%
1.A.2.e Food Processing, Beverages and Tobacco: Liquid Fuels (N_2O)	66.4	9.3	38.7	0.00%	-27.6	-42%	29.4	315%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (CH_4)	0.0	0.8	0.8	0.00%	0.8	2443%	0.0	5%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (CO_2)	4.8	85.4	87.5	0.00%	82.7	1732%	2.0	2%
1.A.2.e Food Processing, Beverages and Tobacco: Other Fuels (N_2O)	0.0	1.0	1.0	0.00%	1.0	2146%	0.0	5%
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	0%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (CO_2)	139.1	0.0	0.0	0.00%	-139.1	-100%	0.0	0%
1.A.2.e Food Processing, Beverages and Tobacco: Peat (N_2O)	1.3	0.0	0.0	0.00%	-1.3	-100%	0.0	0%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (CH_4)	32.4	10.3	9.2	0.00%	-23.2	-72%	-1.1	-11%
1.A.2.e Food Processing, Beverages and Tobacco: Solid Fuels (N_2O)	55.9	16.5	14.9	0.00%	-41.0	-73%	-1.6	-10%

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.2.f Non-metallic minerals: Biomass (CH_4)	24.5	59.9	64.5	0.00%	40.0	163%	4.5	8%
1.A.2.f Non-metallic minerals: Biomass (N_2O)	49.0	118.4	125.6	0.00%	76.6	156%	7.2	6%
1.A.2.f Non-metallic minerals: Gaseous Fuels (CH_4)	29.8	98.9	98.3	0.00%	68.5	230%	-0.6	-1%
1.A.2.f Non-metallic minerals: Gaseous Fuels (N_2O)	122.0	143.7	127.4	0.00%	5.4	4%	-16.3	-11%
1.A.2.f Non-metallic minerals: Liquid Fuels (CH_4)	59.9	30.0	30.0	0.00%	-29.9	-50%	-0.1	0%
1.A.2.f Non-metallic minerals: Liquid Fuels (N_2O)	635.7	308.2	325.4	0.01%	-310.3	-49%	17.2	6%
1.A.2.f Non-metallic minerals: Other Fuels (CH_4)	4.9	90.3	89.4	0.00%	84.5	1742%	-0.9	-1%
1.A.2.f Non-metallic minerals: Other Fuels (N_2O)	12.5	189.1	188.8	0.01%	176.3	1411%	-0.3	0%
1.A.2.f Non-metallic minerals: Peat (CH_4)	0.0	0.0	0.0	0.00%	0.0	-86%	0.0	100%
1.A.2.f Non-metallic minerals: Peat (CO_2)	26.9	0.0	4.2	0.00%	-22.7	-84%	4.2	100%
1.A.2.f Non-metallic minerals: Peat (N_2O)	0.1	0.0	0.0	0.00%	-0.1	-79%	0.0	100%
1.A.2.f Non-metallic minerals: Solid Fuels (CH_4)	138.6	30.7	26.9	0.00%	-111.7	-81%	-3.8	-12%
1.A.2.f Non-metallic minerals: Solid Fuels (N_2O)	392.9	100.4	94.2	0.00%	-298.7	-76%	-6.3	-6%
1.A.2.g Other: Biomass (CH_4)	100.8	211.4	217.4	0.01%	116.6	116%	6.1	3%
1.A.2.g Other: Biomass (N_2O)	172.2	345.9	350.4	0.01%	178.3	104%	4.5	1%
1.A.2.g Other: Gaseous Fuels (CH_4)	80.3	411.8	346.8	0.01%	266.5	332%	-65.0	-16%
1.A.2.g Other: Gaseous Fuels (N_2O)	141.0	254.2	223.5	0.01%	82.5	59%	-30.7	-12%
1.A.2.g Other: Liquid Fuels (CH_4)	105.7	35.8	38.1	0.00%	-67.6	-64%	2.3	6%
1.A.2.g Other: Liquid Fuels (N_2O)	955.7	726.2	727.6	0.03%	-228.1	-24%	1.4	0%
1.A.2.g Other: Other Fuels (CH_4)	13.3	6.0	6.4	0.00%	-6.9	-52%	0.4	7%
1.A.2.g Other: Other Fuels (N_2O)	25.7	46.9	46.8	0.00%	21.2	83%	0.0	0%
1.A.2.g Other: Peat (CH_4)	0.1	0.0	0.0	0.00%	0.0	-36%	0.0	3%
1.A.2.g Other: Peat (CO_2)	21.5	28.5	26.6	0.00%	5.2	24%	-1.9	-7%
1.A.2.g Other: Peat (N_2O)	0.2	0.2	0.2	0.00%	0.0	-20%	0.0	2%
1.A.2.g Other: Solid Fuels (CH_4)	122.3	7.7	7.9	0.00%	-114.4	-94%	0.2	2%
1.A.2.g Other: Solid Fuels (N_2O)	645.0	117.0	111.6	0.00%	-533.4	-83%	-5.4	-5%
1.A.3.a Domestic Aviation: Aviation Gasoline (CH_4)	2.2	0.6	0.6	0.00%	-1.5	-72%	0.0	-3%
1.A.3.a Domestic Aviation: Aviation Gasoline (CO_2)	428.9	146.1	129.7	0.00%	-299.2	-70%	-16.4	-11%
1.A.3.a Domestic Aviation: Aviation Gasoline (N_2O)	6.5	2.9	2.8	0.00%	-3.6	-56%	-0.1	-4%
1.A.3.a Domestic Aviation: Biomass (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	586%
1.A.3.a Domestic Aviation: Biomass (N_2O)	0.0	0.0	0.1	0.00%	0.1	100%	0.1	284%
1.A.3.a Domestic Aviation: Jet Kerosene (CH_4)	7.2	5.1	6.2	0.00%	-1.1	-15%	1.1	22%
1.A.3.a Domestic Aviation: Jet Kerosene (N_2O)	91.1	72.8	98.2	0.00%	7.1	8%	25.4	35%
1.A.3.b Road Transportation: Biomass (CH_4)	0.0	58.0	62.4	0.00%	62.4	670907%	4.4	8%
1.A.3.b Road Transportation: Biomass (N_2O)	0.1	431.2	425.0	0.02%	424.9	337536%	-6.2	-1%
1.A.3.b Road Transportation: Diesel Oil (CH_4)	537.8	188.2	187.8	0.01%	-350.0	-65%	-0.3	0%

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.3.b Road Transportation: Gaseous Fuels (CH_4)	10.4	66.8	65.4	0.00%	54.9	526%	-1.4	-2%
1.A.3.b Road Transportation: Gaseous Fuels (N_2O)	1.3	30.5	31.9	0.00%	30.6	2293%	1.4	5%
1.A.3.b Road Transportation: Gasoline (N_2O)	3 396.5	508.8	524.3	0.02%	-2 872.2	-85%	15.5	3%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (CH_4)	47.2	57.3	58.7	0.00%	11.5	24%	1.4	2%
1.A.3.b Road Transportation: Liquefied Petroleum Gases (LPG) (N_2O)	15.6	81.6	81.1	0.00%	65.5	419%	-0.5	-1%
1.A.3.b Road Transportation: Other Fuels (CH_4)	0.0	2.3	2.2	0.00%	2.2	100%	-0.1	-4%
1.A.3.b Road Transportation: Other Fuels (N_2O)	0.0	8.8	8.8	0.00%	8.8	100%	0.1	1%
1.A.3.b Road Transportation: Other Liquid Fuels (CH_4)	1.0	0.1	0.1	0.00%	-1.0	-95%	0.0	1%
1.A.3.b Road Transportation: Other Liquid Fuels (CO_2)	439.5	69.1	66.1	0.00%	-373.4	-85%	-3.0	-4%
1.A.3.b Road Transportation: Other Liquid Fuels (N_2O)	0.3	0.4	0.4	0.00%	0.0	13%	0.0	-10%
1.A.3.c Railways: Biomass (CH_4)	0.0	0.2	0.2	0.00%	0.2	1751945%	0.0	-11%
1.A.3.c Railways: Biomass (N_2O)	0.0	1.8	1.7	0.00%	1.7	100%	-0.1	-5%
1.A.3.c Railways: Gaseous Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	5%
1.A.3.c Railways: Gaseous Fuels (CO_2)	0.0	6.8	7.1	0.00%	7.1	100%	0.3	5%
1.A.3.c Railways: Gaseous Fuels (N_2O)	0.0	0.1	0.1	0.00%	0.1	100%	0.0	5%
1.A.3.c Railways: Liquid Fuels (CH_4)	19.1	5.2	4.8	0.00%	-14.3	-75%	-0.4	-7%
1.A.3.c Railways: Liquid Fuels (N_2O)	596.4	169.1	144.4	0.01%	-452.0	-76%	-24.6	-15%
1.A.3.c Railways: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-20%
1.A.3.c Railways: Other Fuels (CO_2)	0.0	5.2	4.6	0.00%	4.6	100%	-0.6	-12%
1.A.3.c Railways: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-25%
1.A.3.c Railways: Solid Fuels (CH_4)	17.1	0.6	0.8	0.00%	-16.3	-95%	0.1	24%
1.A.3.c Railways: Solid Fuels (CO_2)	663.3	32.1	32.4	0.00%	-630.9	-95%	0.3	1%
1.A.3.c Railways: Solid Fuels (N_2O)	2.8	0.1	0.1	0.00%	-2.7	-95%	0.0	0%
1.A.3.d Domestic Navigation: Biomass (CH_4)	0.0	4.3	3.2	0.00%	3.2	100%	-1.1	-26%
1.A.3.d Domestic Navigation: Biomass (N_2O)	0.0	1.6	1.8	0.00%	1.8	100%	0.2	12%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (CH_4)	25.6	18.5	19.8	0.00%	-5.8	-23%	1.3	7%
1.A.3.d Domestic Navigation: Gas/Diesel Oil (N_2O)	192.7	152.5	168.3	0.01%	-24.4	-13%	15.8	10%
1.A.3.d Domestic Navigation: Gaseous Fuels (CH_4)	0.0	37.5	27.0	0.00%	27.0	100%	-10.5	-28%
1.A.3.d Domestic Navigation: Gaseous Fuels (CO_2)	0.0	151.6	99.9	0.00%	99.9	100%	-51.7	-34%
1.A.3.d Domestic Navigation: Gaseous Fuels (N_2O)	0.0	0.6	0.4	0.00%	0.4	100%	-0.1	-19%
1.A.3.d Domestic Navigation: Gasoline (CH_4)	48.7	35.1	31.6	0.00%	-17.1	-35%	-3.5	-10%
1.A.3.d Domestic Navigation: Gasoline (CO_2)	1 545.5	1 436.8	1 351.8	0.05%	-193.8	-13%	-85.0	-6%
1.A.3.d Domestic Navigation: Gasoline (N_2O)	6.0	7.3	7.0	0.00%	1.0	17%	-0.3	-3%

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.3.d Domestic Navigation: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-50%
1.A.3.d Domestic Navigation: Other Fuels (CO_2)	0.0	0.1	0.2	0.00%	0.2	100%	0.1	109%
1.A.3.d Domestic Navigation: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-18%
1.A.3.d Domestic Navigation: Other Liquid Fuels (CH_4)	0.1	0.3	0.3	0.00%	0.1	94%	0.0	-2%
1.A.3.d Domestic Navigation: Other Liquid Fuels (CO_2)	6.7	35.5	32.3	0.00%	25.6	381%	-3.3	-9%
1.A.3.d Domestic Navigation: Other Liquid Fuels (N_2O)	0.0	0.2	0.2	0.00%	0.1	328%	0.0	-8%
1.A.3.d Domestic Navigation: Residual Fuel Oil (CH_4)	16.2	11.1	15.1	0.00%	-1.1	-7%	4.0	36%
1.A.3.d Domestic Navigation: Residual Fuel Oil (N_2O)	49.7	32.6	42.3	0.00%	-7.4	-15%	9.7	30%
1.A.3.e Other Transportation: Biomass (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	11%
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)	11.1	8.1	10.2	0.00%	-0.9	-8%	2.1	25%
1.A.3.e Other Transportation: Gaseous Fuels (CO_2)	4 591.5	3 864.0	4 116.9	0.15%	-474.6	-10%	252.9	7%
1.A.3.e Other Transportation: Gaseous Fuels (N_2O)	21.0	20.0	25.7	0.00%	4.7	22%	5.7	29%
1.A.3.e Other Transportation: Liquid Fuels (CH_4)	2.1	0.5	0.4	0.00%	-1.7	-81%	-0.1	-19%
1.A.3.e Other Transportation: Liquid Fuels (CO_2)	1 296.8	863.2	895.1	0.03%	-401.7	-31%	31.8	4%
1.A.3.e Other Transportation: Liquid Fuels (N_2O)	18.1	12.6	13.5	0.00%	-4.6	-25%	0.9	7%
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	0.6	0.7	0.00%	0.7	100%	0.1	17%
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)	0.5	0.0	0.0	0.00%	-0.5	-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)	0.6	0.0	0.0	0.00%	-0.6	-100%	0.0	0%
1.A.4.a Commercial/Institutional: Biomass (CH_4)	160.1	472.9	467.7	0.02%	307.6	192%	-5.2	-1%
1.A.4.a Commercial/Institutional: Biomass (N_2O)	37.2	169.8	159.9	0.01%	122.7	330%	-9.9	-6%
1.A.4.a Commercial/Institutional: Gaseous Fuels (CH_4)	102.0	221.5	185.5	0.01%	83.5	82%	-36.0	-16%
1.A.4.a Commercial/Institutional: Gaseous Fuels (N_2O)	87.2	139.6	120.4	0.00%	33.2	38%	-19.2	-14%
1.A.4.a Commercial/Institutional: Liquid Fuels (CH_4)	148.0	82.8	76.4	0.00%	-71.6	-48%	-6.4	-8%

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.4.a Commercial/Institutional: Liquid Fuels (N_2O)	257.9	85.4	77.9	0.00%	-179.9	-70%	-7.4	-9%
1.A.4.a Commercial/Institutional: Other Fuels (CH_4)	9.5	32.8	24.4	0.00%	15.0	158%	-8.4	-26%
1.A.4.a Commercial/Institutional: Other Fuels (N_2O)	16.0	143.1	137.8	0.01%	121.8	763%	-5.3	-4%
1.A.4.a Commercial/Institutional: Peat (CH_4)	0.7	0.2	0.2	0.00%	-0.5	-70%	0.0	6%
1.A.4.a Commercial/Institutional: Peat (CO_2)	232.8	33.7	42.6	0.00%	-190.3	-82%	8.9	26%
1.A.4.a Commercial/Institutional: Peat (N_2O)	0.9	0.2	0.2	0.00%	-0.7	-77%	0.0	16%
1.A.4.a Commercial/Institutional: Solid Fuels (CH_4)	1 640.7	10.2	6.0	0.00%	-1 634.7	-100%	-4.2	-41%
1.A.4.a Commercial/Institutional: Solid Fuels (N_2O)	128.9	14.4	8.3	0.00%	-120.6	-94%	-6.1	-43%
1.A.4.b Residential: Biomass (N_2O)	1 516.0	2 594.5	2 402.1	0.09%	886.1	58%	-192.4	-7%
1.A.4.b Residential: Gaseous Fuels (CH_4)	589.5	704.4	576.8	0.02%	-12.7	-2%	-127.6	-18%
1.A.4.b Residential: Gaseous Fuels (N_2O)	224.1	343.6	292.7	0.01%	68.6	31%	-50.9	-15%
1.A.4.b Residential: Liquid Fuels (CH_4)	352.3	159.4	145.7	0.01%	-206.6	-59%	-13.7	-9%
1.A.4.b Residential: Liquid Fuels (N_2O)	531.9	191.6	181.8	0.01%	-350.1	-66%	-9.7	-5%
1.A.4.b Residential: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.4.b Residential: Other Fuels (CO_2)	0.0	1.1	1.0	0.00%	1.0	100%	-0.1	-9%
1.A.4.b Residential: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.4.b Residential: Peat (CH_4)	288.1	68.0	61.4	0.00%	-226.7	-79%	-6.5	-10%
1.A.4.b Residential: Peat (CO_2)	3 585.1	844.3	765.4	0.03%	-2 819.7	-79%	-78.9	-9%
1.A.4.b Residential: Peat (N_2O)	13.8	3.2	2.9	0.00%	-10.9	-79%	-0.3	-10%
1.A.4.b Residential: Solid Fuels (N_2O)	785.8	125.7	107.1	0.00%	-678.7	-86%	-18.5	-15%
1.A.4.c Agriculture/Forestry/Fishing: Biomass (CH_4)	110.9	653.9	615.7	0.02%	504.8	455%	-38.2	-6%
1.A.4.c Agriculture/Forestry/Fishing: Biomass (N_2O)	20.6	164.4	148.9	0.01%	128.3	623%	-15.4	-9%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (CH_4)	86.4	1 464.2	1 048.3	0.04%	961.9	1113%	-415.9	-28%
1.A.4.c Agriculture/Forestry/Fishing: Gaseous Fuels (N_2O)	7.5	10.7	9.4	0.00%	1.9	25%	-1.4	-13%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (CH_4)	221.2	105.0	103.1	0.00%	-118.2	-53%	-1.9	-2%
1.A.4.c Agriculture/Forestry/Fishing: Liquid Fuels (N_2O)	2 948.8	2 933.7	2 873.5	0.11%	-75.3	-3%	-60.2	-2%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (CH_4)	0.0	0.1	0.0	0.00%	0.0	100%	-0.1	-98%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (CO_2)	0.0	30.7	29.5	0.00%	29.5	100%	-1.2	-4%
1.A.4.c Agriculture/Forestry/Fishing: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	-32%
1.A.4.c Agriculture/Forestry/Fishing: Peat (CH_4)	1.0	8.0	8.1	0.00%	7.1	745%	0.1	1%
1.A.4.c Agriculture/Forestry/Fishing: Peat (CO_2)	45.0	202.2	196.1	0.01%	151.2	336%	-6.1	-3%
1.A.4.c Agriculture/Forestry/Fishing: Peat (N_2O)	0.4	1.5	1.5	0.00%	1.0	228%	-0.1	-6%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (CH_4)	743.3	230.0	185.0	0.01%	-558.3	-75%	-45.0	-20%

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
1.A.4.c Agriculture/Forestry/Fishing: Solid Fuels (N_2O)	33.8	11.1	8.9	0.00%	-24.9	-74%	-2.1	-19%
1.A.5.a Stationary: Biomass (CH_4)	0.7	3.1	1.9	0.00%	1.2	180%	-1.2	-38%
1.A.5.a Stationary: Biomass (N_2O)	0.3	0.6	0.4	0.00%	0.2	62%	-0.2	-29%
1.A.5.a Stationary: Gaseous Fuels (CH_4)	0.5	0.5	0.5	0.00%	0.0	7%	0.0	8%
1.A.5.a Stationary: Gaseous Fuels (CO_2)	728.8	596.8	515.9	0.02%	-212.9	-29%	-81.0	-14%
1.A.5.a Stationary: Gaseous Fuels (N_2O)	1.1	1.0	1.0	0.00%	-0.1	-7%	0.0	4%
1.A.5.a Stationary: Liquid Fuels (CH_4)	7.7	5.0	5.3	0.00%	-2.4	-31%	0.3	7%
1.A.5.a Stationary: Liquid Fuels (CO_2)	7 011.2	3 695.5	3 968.3	0.15%	-3 042.8	-43%	272.8	7%
1.A.5.a Stationary: Liquid Fuels (N_2O)	41.3	16.9	17.7	0.00%	-23.6	-57%	0.8	5%
1.A.5.a Stationary: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	12%
1.A.5.a Stationary: Other Fuels (CO_2)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	13%
1.A.5.a Stationary: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	13%
1.A.5.a Stationary: Peat (CH_4)	0.3	0.0	0.0	0.00%	-0.3	-100%	0.0	0%
1.A.5.a Stationary: Peat (CO_2)	24.0	0.0	0.0	0.00%	-24.0	-100%	0.0	0%
1.A.5.a Stationary: Peat (N_2O)	0.1	0.0	0.0	0.00%	-0.1	-100%	0.0	0%
1.A.5.a Stationary: Solid Fuels (CH_4)	284.4	0.3	0.2	0.00%	-284.2	-100%	-0.1	-31%
1.A.5.a Stationary: Solid Fuels (N_2O)	19.4	0.0	0.0	0.00%	-19.4	-100%	0.0	-73%
1.A.5.b Mobile: Biomass (CH_4)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	0%
1.A.5.b Mobile: Biomass (N_2O)	0.0	0.1	0.1	0.00%	0.1	100%	0.0	-6%
1.A.5.b Mobile: Gaseous Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Mobile: Gaseous Fuels (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Mobile: Gaseous Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Mobile: Liquid Fuels (CH_4)	42.0	3.4	3.8	0.00%	-38.2	-91%	0.5	14%
1.A.5.b Mobile: Liquid Fuels (N_2O)	113.6	25.6	27.2	0.00%	-86.4	-76%	1.6	6%
1.A.5.b Mobile: Other Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Mobile: Other Fuels (CO_2)	0.0	0.6	0.6	0.00%	0.6	100%	0.0	5%
1.A.5.b Mobile: Other Fuels (N_2O)	0.0	0.0	0.0	0.00%	0.0	100%	0.0	20%
1.A.5.b Mobile: Solid Fuels (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Mobile: Solid Fuels (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.A.5.b Mobile: 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: no classification (CO_2)	664.9	142.1	130.0	0.00%	-535.0	-80%	-12.1	-9%
1.B.1.a Coal mining and handling: no classification (N_2O)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
1.B.1.b Fuel transformation: no classification (CH_4)	269.5	59.7	62.4	0.00%	-207.1	-77%	2.7	5%
1.B.1.b Fuel transformation: no classification (CO_2)	6 133.8	3 314.9	2 973.2	0.11%	-3 160.6	-52%	-341.8	-10%
1.B.1.b Fuel transformation: no classification (N_2O)	0.0	0.1	0.1	0.00%	0.1	100%	0.0	3%
1.B.1.c Other: no classification (CH_4)	126.5	108.7	94.8	0.00%	-31.7	-25%	-13.9	-13%
1.B.1.c Other: no classification (CO_2)	6.9	79.1	60.2	0.00%	53.3	770%	-18.9	-24%
1.B.1.c Other: no classification (N_2O)	0.0	0.0	0.0	0.00%	0.0	75%	0.0	14%
1.B.2.a Oil: no classification (N_2O)	22.3	5.6	5.3	0.00%	-16.9	-76%	-0.2	-4%
1.B.2.b Natural gas: no classification (CO_2)	2 382.0	878.4	902.5	0.03%	-1 479.4	-62%	24.1	3%
1.B.2.c Venting and flaring: no classification (CH_4)	6 503.6	2 933.4	2 695.7	0.10%	-3 808.0	-59%	-237.7	-8%
1.B.2.c Venting and flaring: no classification (CO_2)	4 735.5	2 416.8	2 471.1	0.09%	-2 264.4	-48%	54.3	2%
1.B.2.c Venting and flaring: no classification (N_2O)	14.4	8.4	8.2	0.00%	-6.2	-43%	-0.2	-2%
1.B.2.d Other: no classification (CH_4)	361.6	565.7	559.3	0.02%	197.7	55%	-6.4	-1%

	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 1. Energy in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
1.B.2.d Other: no classification (CO_2)	682.3	1 908.2	2 048.0	0.08%	1 365.6	200%	139.7	7%
1.B.2.d Other: no classification (N_2O)	9.5	6.7	7.2	0.00%	-2.3	-24%	0.5	7%
1.C CO_2 transport and storage: Fuels (CO_2)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%

3.6 Methodological issues and uncertainties

The previous section presented for each EU 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. However, note that Annex III of the EU NIR also includes for each Member State an overview of methods amd emission factors used including a short explantation, where relevant. In addition the Member States' national inventory reports include more detailed information on national methods and circumstances.

Table 3.104 shows the total EU 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 1A2c. With regard to trend CH_4 from 1A1a shows the highest uncertainty estimates, CO_2 from 1A2a the lowest. The results of this year's uncertainty analysis are very similar to the results in 2022. For a description of the Tier 1 uncertainty analysis carried out for the EU see Chapter 1.6.

Table 3.117 Sector 1 Energy (excl. 1A3b and 1B): Uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2021	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	579 704	336 091	-42.0%	2.6%	0.9%
1.A.1.a Public electricity and heat production	CH_4	269	2 797	941.4%	54.0%	521.7%
1.A.1.a Public electricity and heat production	N_2O	2 475	1 999	-19.3%	17.2%	4.3%
1.A.1.b Petroleum refining	CO_2	57 434	48 592	-15.4%	5.5%	0.8%
1.A.1.b Petroleum refining	CH_4	21	18	-15.8%	16.8%	4.1%
1.A.1.b Petroleum refining	N_2O	204	89	-56.2%	26.1%	20.1%
1.A.1.c Manufacture of solid fuels and other energy industries	CO_2	70 684	16 036	-77.3%	7.2%	4.5%
1.A.1.c Manufacture of solid fuels and other energy industries	CH_4	113	129	14.4%	110.5%	21.5%
1.A.1.c Manufacture of solid fuels and other energy industries	N_2O	590	122	-79.4%	21.9%	17.9%
1.A.2.a Iron and Steel	CO_2	52 180	37 018	-29.1%	4.9%	0.5%
1.A.2.a Iron and Steel	CH_4	85	71	-17.1%	23.7%	5.0%
1.A.2.a Iron and Steel	N_2O	205	99	-51.7%	33.3%	42.4%
1.A.2.b Non-ferrous Metals	CO_2	2 219	839	-62.2%	2.5%	6.0%

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2021	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.2.b Non-ferrous Metals	CH_4	2	1	-68.2%	35.5%	31.7%
1.A.2.b Non-ferrous Metals	N_2O	15	2	-86.6%	55.0%	50.4%
1.A.2.c Chemicals	CO_2	24 316	5 685	-76.6%	1.7%	2.0%
1.A.2.c Chemicals	CH_4	18	22	21.7%	50.8%	51.9%
1.A.2.c Chemicals	N_2O	26	24	-6.1%	109.6%	56.0%
1.A.2.d Pulp, Paper and Print	CO_2	3 122	1 554	-50.2%	4.8%	2.1%
1.A.2.d Pulp, Paper and Print	CH_4	16	20	26.3%	28.2%	6.6%
1.A.2.d Pulp, Paper and Print	N_2O	64	72	12.3%	35.5%	8.0%
1.A.2.e Food Processing, Beverages and Tobacco	CO_2	7 725	3 888	-49.7%	1.8%	1.9%
1.A.2.e Food Processing, Beverages and Tobacco	CH_4	12	32	172.3%	47.3%	91.7%
1.A.2.e Food Processing, Beverages and Tobacco	N_2O	34	39	14.4%	48.2%	55.7%
1.A.2.f Non-metallic minerals	CO_2	28 181	20 549	-27.1%	2.8%	1.4%
1.A.2.f Non-metallic minerals	CH_4	75	48	-35.9%	25.7%	15.5%
1.A.2.f Non-metallic minerals	N_2O	210	188	-10.8%	39.3%	19.0%
1.A.2.g Other	CO_2	163 034	77 864	-52.2%	3.1%	1.3%
1.A.2.g Other	CH_4	208	261	25.5%	26.2%	12.5%
1.A.2.g Other	N_2O	1 015	591	-41.8%	27.6%	13.6%
1.A.4.a Commercial/Institutional	CO_2	84 172	38 687	-54.0%	6.3%	4.5%
1.A.4.a Commercial/Institutional	CH_4	1 772	258	-85.5%	46.2%	90.0%
1.A.4.a Commercial/Institutional	N_2O	230	118	-48.6%	83.3%	22.7%
1.A.4.b Residential	CO_2	192 701	120 070	-37.7%	6.2%	2.2%
1.A.4.b Residential	CH_4	4 560	3 006	-34.1%	56.6%	56.0%
1.A.4.b Residential	N_2O	875	550	-37.2%	65.6%	43.1%
1.A.4.c Agriculture/forestry/fishing	CO_2	32 383	21 484	-33.7%	6.2%	1.7%
1.A.4.c Agriculture/forestry/fishing	CH_4	457	1 379	201.9%	41.3%	97.7%
1.A.4.c Agriculture/forestry/fishing	N_2O	178	313	75.5%	68.7%	34.9%
1.A.5 Other	CO_2	21 616	6 425	-70.3%	3.6%	2.5%
1.A.5 Other	CH_4	335	12	-96.5%	38.0%	44.9%
1.A.5 Other	N_2O	174	44	-74.4%	77.5%	32.1%
1.A (where no subsector data were submitted)	*all*	87 358	*85 104*	*-2.6%*	*2.4%*	*1.8%*
1.A.1 (where no subsector data were submitted)	*all*	*716 711*	*448 816*	*-37.4%*	*12.4%*	*11.4%*
1.A.2 (where no subsector data were submitted)	*all*	*422 790*	*234 266*	*-44.6%*	*8.4%*	*3.0%*
1.A.3 (where no subsector data were submitted)	*all*	*122 940*	*179 118*	*45.7%*	*4.0%*	*2.3%*
1.A.4 (where no subsector data were submitted)	*all*	*354 525*	*242 065*	*-31.7%*	*5.3%*	*2.3%*
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**	**87 358**	**85 104**	**-2.6%**	**2.4%**	**1.8%**
Total - 1.A.1	**all**	**1 428 205**	**854 687**	**-40.2%**	**6.6%**	**5.7%**
Total - 1.A.2	**all**	**705 554**	**383 134**	**-45.7%**	**5.2%**	**1.8%**
Total - 1.A.3	**all**	**656 949**	**785 412**	**19.6%**	**2.7%**	**0.6%**
Total - 1.A.4	**all**	**671 853**	**427 930**	**-36.3%**	**3.5%**	**1.6%**
Total - 1.A.5	**all**	**22 125**	**6 481**	**-70.7%**	**3.6%**	**2.6%**
Total - 1.A	**all**	**3 572 043**	**2 542 748**	**-28.8%**	**2.7%**	**2.3%**

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 3.105 shows the total EU 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 2022.

Table 3.118 1B Fugitive Emissions: Uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2021	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.B.1 Solid Fuels	CO_2	6 788	3 069	-54.8%	15.1%	8.0%
1.B.1 Solid Fuels	CH_4	82 142	24 629	-70.0%	73.7%	14.6%
1.B.1 Solid Fuels	N_2O	0.0	0.0	75.0%	53.9%	40.4%
1.B.2. Oil and Natural Gas and other emissions from energy production	CO_2	12 385	13 331	7.6%	23.6%	15.8%
1.B.2. Oil and Natural Gas and other emissions from energy production	CH_4	50 179	12 518	-75.1%	42.0%	18.8%
1.B.2. Oil and Natural Gas and other emissions from energy production	N_2O	35	13	-64.0%	181.4%	52.7%
1.B (werhe no subsector data were submitted)	*all*	*17 481*	*5 763*	*-67.0%*	*36.6%*	*30.8%*
Total - 1.B	**all**	**169 011**	**59 322**	**-64.9%**	**36.1%**	**9.6%**

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 3.106 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 1A3e. With regard to trend CH_4 from 1A3d 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 2022.

Table 3.119 1A3 Transport: Uncertainty estimates for EU

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2021	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
1.A.3.a Domestic aviation	CO_2	9 349	9 995	6.9%	8.6%	3.0%
1.A.3.a Domestic aviation	CH_4	8	4	-43.4%	87.0%	24.6%
1.A.3.a Domestic aviation	N_2O	73	60	-18.8%	183.4%	34.2%
1.A.3.b Road transport	CO_2	486 666	573 300	17.8%	3.4%	0.5%
1.A.3.b Road transport	CH_4	4 560	762	-83.3%	25.7%	7.2%
1.A.3.b Road transport	N_2O	3 843	5 541	44.2%	30.2%	8.3%
1.A.3.c Railways	CO_2	9 355	2 801	-70.1%	4.9%	2.6%
1.A.3.c Railways	CH_4	32	5	-84.8%	74.0%	21.1%
1.A.3.c Railways	N_2O	398	114	-71.4%	82.9%	38.1%
1.A.3.d Domestic navigation	CO_2	13 959	9 858	-29.4%	33.9%	10.8%
1.A.3.d Domestic navigation	CH_4	35	65	83.3%	56.0%	36.5%
1.A.3.d Domestic navigation	N_2O	172	152	-11.4%	232.6%	20.2%
1.A.3.e Other transportation	CO_2	5 513	3 604	-34.6%	4.3%	2.0%
1.A.3.e Other transportation	CH_4	13	9	-29.7%	60.3%	17.3%
1.A.3.e Other transportation	N_2O	34	26	-23.5%	71.0%	38.8%
Total - 1.A.3	**all**	**656 949**	**785 412**	**19.6%**	**2.7%**	**0.6%**

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.

3.7 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 3.106 summarizes the main checks carried out on Member States' submissions.

Table 3.120 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 All years, but focus on last reporting year and also 1990 Focus on EU key categories
Time series of emissions	Check time series consistency of Member States' emission estimates for potential over- and underestimates: All years, but focus on last reporting year and also 1990 Focus on EU key categories
Time series of IEFs	Check time series consistency of Member States' IEFs for potential over- and underestimates: All years, but focus on last reporting year and also 1990 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 All years, but focus on last reporting year and also 1990 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. All years, but focus on last reporting year and also 1990 Focus on EU key categories
Follow-up from 2023	Check if issues that were classified as "Unresolved" or "Partly resolved" in 2023 have been resolved by Member States in 2024.
Implementation of UNFCCC recommendations	Check if recommendations from the latest UNFCCC review reports 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 2022 the energy-related webinar had 82 participants from 26 countries. Main issues discussed at the webinar were:

- Difference between CRF and Eurostat AD for subcategory 1.A.4.b
- Use of NCVs and CO_2 EFs from EU ETS reports to non-industrial sectors (1.A.4)
- High CO_2 IEF of other fuels (MSW)
- Adjustment of energy balance data to reflect EU- ETS data

In 2023 and 2024, capacity building activities were organised bilaterally with interested countries.

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 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[29]. The energy statistics regulation was adopted as part of the energy package and 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

[29] 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.

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, Annex V of the Governance Regulation in conjunction with Article 17 of the Commission Implementing Regulation 2020/1208 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 XIV of the Commission Implementing Regulation.

Eurocontrol data

Since 2010 there have been framework contracts in place between the European Commission and Eurocontrol, the European Organization for the Safety of Air Navigation, related to the improvement of GHG and air pollutant emission inventories submitted by the EU Member States to the UNFCCC and UNECE. The aim has been to assist the MS in improving their annual emission inventories, i.e. by providing better estimates of fuel split in domestic/international aviation using real flight data from Eurocontrol. In the framework of this cooperation, the European Environment Agency, with its ETC CM (European Topic Centre on Climate Change Mitigation) work programs, compares the MS inventory submissions with Eurocontrol data and produces a report where the outcome of these comparisons is presented and discussed.

The most recent data provided by Eurocontrol was in Aug.-Sep. 2023, following the information that has been given in previous years related to fuel consumption and emissions for CO_2, CH_4, N_2O and other pollutants for domestic and international aviation, covering the period from 2005 to 2022. The main update of the Aug.-Sep. 2023 version of data was the recalculations for years 2005-2022. Eurocontrol uses a bottom-up modelling approach with the Advanced Emissions Model (AEM). This is a Tier 3b methodology based on information of flight plan and trajectories. Flight plan data is only available for flights under Instrumental Flight Rules (IFR). Flights under Visual Flight Rules (VFR) are not included in the dataset of Eurocontrol.

The latest version of the report with the comparison of MS inventories (15 Jan. 2024 submission) with Eurocontrol data for years 2005-2022 has been prepared and delivered early March 2024. Main checks included domestic and international fuel consumption for jet kerosene and aviation gasoline; in addition, domestic share and implied emission factor (IEF) CO_2, CH_4, and N_2O for both jet kerosene and aviation gasoline. A general observation that can be made from the comparisons is that in most cases the Eurocontrol values present small differences compared to the MS inventories. Higher differences are observed in a few cases, i.e. for individual countries and for a specific fuel/data category. Specifically, at EU-27 level:

- Domestic kerosene Eurocontrol values are higher than MS GHG inventories for all years (differences from 27% to 43%).
- Domestic aviation gasoline Eurocontrol values are very low, i.e. slightly higher than 0 for all years; hence, there are big differences with MS inventories (from -92% to -81%).
- International kerosene Eurocontrol values are higher than MS GHG inventories for all years (differences from 8% to 15%).
- Eurocontrol values of domestic share in total (i.e. domestic + international) kerosene consumption are higher than the values from MS GHG inventories for all years (differences from 13% to 27%).
- Total kerosene Eurocontrol values are higher than the MS GHG inventories for all years (differences from 11% to 17%).

Methodological differences: There are possibly methodological differences between Eurocontrol and MS inventories. For example, in domestic aviation gasoline, the Eurocontrol methodology is based exclusively on flights under IFR; small aircrafts, which mostly use aviation gasoline, usually fly under VFR and, therefore, are not sufficiently covered. Another difference is that the Eurocontrol values strictly refer to aviation activities, i.e. flights, and the fuel consumed in these activities is modelled for individual trajectories. While in the MS inventories, the fuel consumption has to be adapted to the national energy balances.

Military aviation: This source is strictly excluded from Eurocontrol and, as clarified in the CRF tables, domestic aviation should not include emissions from military aviation. The emissions from military mobile sources should be reported under category 1.A.5.b (Other mobile military use).

Domestic share: Domestic share in total (i.e. domestic + international) fuel consumption is an important indicator for the aviation sector. Some MS mention in their NIRs that their national energy balances provide separately the fuel sold for domestic and international flights or that the fuel consumption at individual airports is defined as being used for domestic or international flights. In any case, Eurostat and Eurocontrol (which has detailed information for the origin/destination pairs of most flights) can be used to derive this indicator.

Tier method: A possible inconsistency may exist in the definition of Tier method reported by countries in their NIRs. For example, Tier 1 from the IPCC guidelines considers only the use of fuel from national energy statistics, whereas in the EMEP/EEA Guidebook the Tier 1 method already separates between LTO and cruise phase. It is proposed to report information based on the IPCC guidelines in order to allow for a consistent overview of applied methodologies. Specifically:

- Tier 1: Fuel consumption data split by domestic and international aviation.
- Tier 2: LTO data from number of flights (2a) or from flights by aircraft type (2b).

- Tier 3: LTO data for individual aircrafts and data on the origin/destination pairs of flights (3a) and on air traffic movements (3b).

Table 3.121 provides an overview of how the Eurocontrol data has been used by MS.

Table 3.121 Use of Eurocontrol data by Member States

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For planned improvements	Indirect use	Direct use	How has the 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 years 1996-2022		
Croatia	-	-	-	-	-
Cyprus				For domestic and international flights	Trend of domestic share from Eurocontrol data has been applied to years 2005-2022
Czechia				Emissions calculated with Eurocontrol IEFs	
Denmark			List of aircraft types provided by Eurocontrol		
Estonia	-	-	-	-	-
Finland				For domestic flights from 2005 onwards	Own model (ILMI) has been used for years before 2005 and partly until 2008; since 2010 the model was not updated; no specific adaptation
France	Not mentioned, numbers match very closely				
Germany	Yes				
Greece				For domestic and international flights	Emissions for 1990-2005 have been recalculated taking into account only international aviation fuel consumption and by applying Tier 1 methodology
Hungary				For domestic flights	Fuel use (and, consequently, emissions) for years before 2005 has been adapted with built-in extrapolation procedures; same share of kerosene use from Eurocontrol 2005-2015 for domestic flights has been applied for years 1985-2004
Ireland				Fuel consumption based on origin and destination data for domestic air travel provided by Eurocontrol (2005-2022)	
Italy	Yes			Domestic	Emissions recalculated based on Eurocontrol; linear interpolation between 1999 (the year of Tier 3) and 2005 for fuel consumption and emission factors
Latvia	Yes				
Lithuania					
Luxembourg	-	-	-	-	-
Malta				Domestic aviation (2005-2022)	

	Use of Eurocontrol data for kerosene consumption				
	For comparison / verification	For planned improvements	Indirect use	Direct use	How has the time series consistency been ensured?
Netherlands	-	-	-	-	-
Poland				For share of domestic flights	Due to lack of Eurocontrol data for years prior to 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				Eurocontrol data on the number of flights, fuel consumption and domestic share was used	For years 1990-2004, summary information from Eurocontrol database was used (emission factors and domestic share)
Slovenia				For domestic flights, since 2017 data on fuel consumption from Eurocontrol	Only a small amount of domestic flights has been recorded by Eurocontrol; no adaptation for years 1990-2004
Spain				For domestic and international flights	An adaptation model has been applied to link results based on national statistics with Eurocontrol
Sweden	-	-	-	-	-

3.8 Sector-specific recalculations

Recalculations are described in chapter add reference to recalculation chapter, including the explanations for significant changes (>500 kt CO_2eq) in categories.

3.9 Sector-specific improvements

In 2024, the reporting has been amended to be in line with the new CRT reporting tables, as well as the NID outline. Descriptions of categories have been aligned accordingly. Information across sectors has been streamlined to provide a harmonised approach across the whole NID. Any recommendations for improvement of earlier UNFCCC reviews have been continuously followed up and implemented.

Improvements planned for the next reporting are continuing the efforts to ensure consistency between CRT/JSON files and NID, and the provision of sufficient information to meet transparency requirements.

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF SECTOR 2)

This chapter starts with an overview of emission trends in CRF Sector 2 Industrial processes and Product Use[30]. 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.

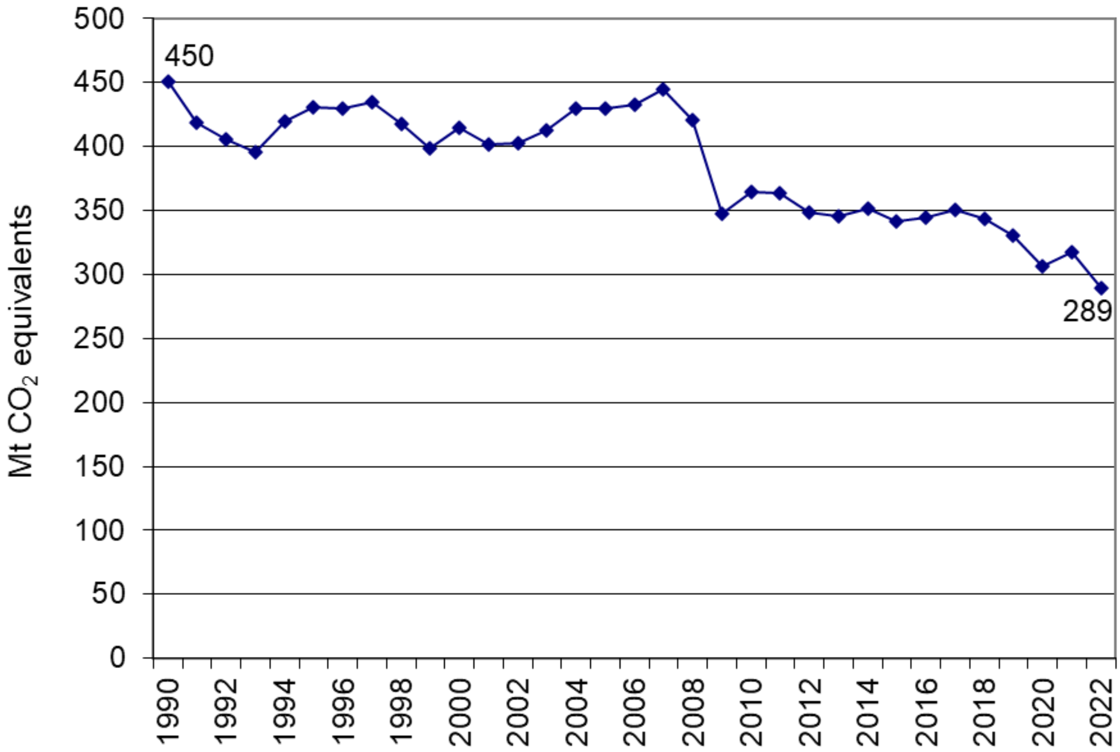
4.1 Overview of sector

CRF Sector 2 Industrial Processes and Product Use is the third largest sector contributing 9 % to total net EU GHG emissions in 2022. The most important GHGs from this sector are CO_2 (7 % of total net GHG emissions), HFCs (1.9 %) and N_2O (0.2 %).

The emissions from the sector Industrial Processes and Product Use decreased by 36 % from 450 Mt in 1990 to 289 Mt in 2022 (*Figure 4.1*). In 2022, the emissions decreased by 9 % compared to 2021. 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.

[30] The EU Greenhouse gas inventory data in this report was compiled using the September 2024 release of the 'CRT reporting tool' developed by the UNFCCC Secretariat. However, due to remaining technical shortcomings in the UNFCCC ETF tools, there have been substantial difficulties in preparing and finalizing the EU GHG inventory tables, which are based on the aggregation of emissions and removals from Member States' GHG inventories. In addition, because of the ongoing improvements and additional releases of the ETF tools by the UNFCCC secretariat after the compilation of the EU GHG inventory, reported data may differ from actual inventory data in some cases. The EU will provide additional information on sector-specific issues affected by the ETF tool during the technical expert review. For more information, see also footnote 4 of the executive summary.

Figure 4.1: CRF Sector 2 Industrial Processes and Product Use: EUGHG emissions for 1990–2022 in CO_2 equivalents (Mt)



The key categories in this sector are:

- 2.A.1 Cement Production: no classification (CO_2)
- 2.A.2 Lime Production: no classification (CO_2)
- 2.A.4 Other Process Uses of Carbonates: no classification (CO_2)
- 2.B.1 Ammonia Production: no classification (CO_2)
- 2.B.10 Other chemical industry: no classification (CO_2)
- 2.B.2 Nitric Acid Production: no classification (N_2O)
- 2.B.3 Adipic Acid Production: no classification (N_2O)
- 2.B.8 Petrochemical and Carbon Black Production: no classification (CO_2)
- 2.B.9 Fluorochemical Production: no classification (Unspecified mix of HFCs and PFCs)
- 2.C.1 Iron and Steel Production: no classification (CO_2)
- 2.F.1 Refrigeration and Air conditioning: no classification (HFCs)

Table 1 shows the key categories on an aggregated level, visualising, that CO_2 emissions from 2A Mineral Industry had the highest share in 2022, but decreased like almost all other categories since 1990. The only category showing increases are HFC emissions from refrigeration and air conditioning due its intensified use in last years.

Table 4.2: *CRF Sector 2 Industrial processes and Product Use: Emissions in CO_2 equivalents (Mt) for 1990 and 2022, ,absolute and relative change of GHG emissions and share of key categories 1990–2022*

GREENHOUSE GAS SOURCE CATEGORIES	1990 (kt)	2022 (kt)	absolute change (Mt)	% change (in Mt)	share 2022
2.B - Chemical Industry - N2O	78749	3149	-76	-96%	1%
2.C - Metal Industry - CO2	114931	65534	-49	-43%	23%
2.A - Mineral Industry - CO2	134078	97483	-37	-27%	34%
2.B - Chemical Industry - CO2	58210	44820	-13	-23%	16%
2.F.1 - Refrigeration and Air conditioning - HFCs	5	54307	54	1164580%	19%
All other IPPU categories	64380	23865	-39	-69%	6%
Total IPPU	**450353**	**289158**	**-161**	**-36%**	**100%**

Note: Colors visualize decreases (green), increases (red) and the share in sectoral total emissions (yellow). "Other" is calculated by subtracting the presented categories from the sector total.

4.2 Source categories and methodological issues

4.2.1 Mineral industry (CRT Source Category 2A)

The 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 2A Mineral industry

Source category and gas	kt CO_2eq		Trend	Level		share of higher Tier
	1990	2022		1990	2022	
2.A.1. Cement production (CO_2)	95237	67428	T	L	L	100 %
2.A.2. Lime production (CO_2)	23935	15894	0	L	L	97.6 %
2.A.4. Other process uses of carbonates (CO_2)	11061	10305	T	L	L	81.7 %

The mineral industry is dominated by cement production which contributes approx. 69 % of 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 mineral industry emissions. CO_2 is emitted during the calcination of the calcium carbonate in limestone or dolomite. The source category 2A4 Other process uses of carbonates accounts for 11 % of the mineral industry emissions and is composed of several sources with independent estimation methods. The remaining 4 % of emissions stem from 2A3 Glass production. All emissions from cement production are estimated using higher tiers. Under categories 2A2 and 2A4, several EU Member States use Tier 1 methods in cases where these are not a key category.

Mineral industry emissions decreased during the 2009 economic crisis. They showed additional, less pronounced decreases as a consequence of reduced economic activities during the COVID-19 pandemic in 2020 and as a result of the energy crisis in 2022. Overall, these emissions have fallen by 27 % since 1990 (Figure **4-1** and Table **4**.2).

Figure 4.2 2A Mineral industry CO_2 emissions

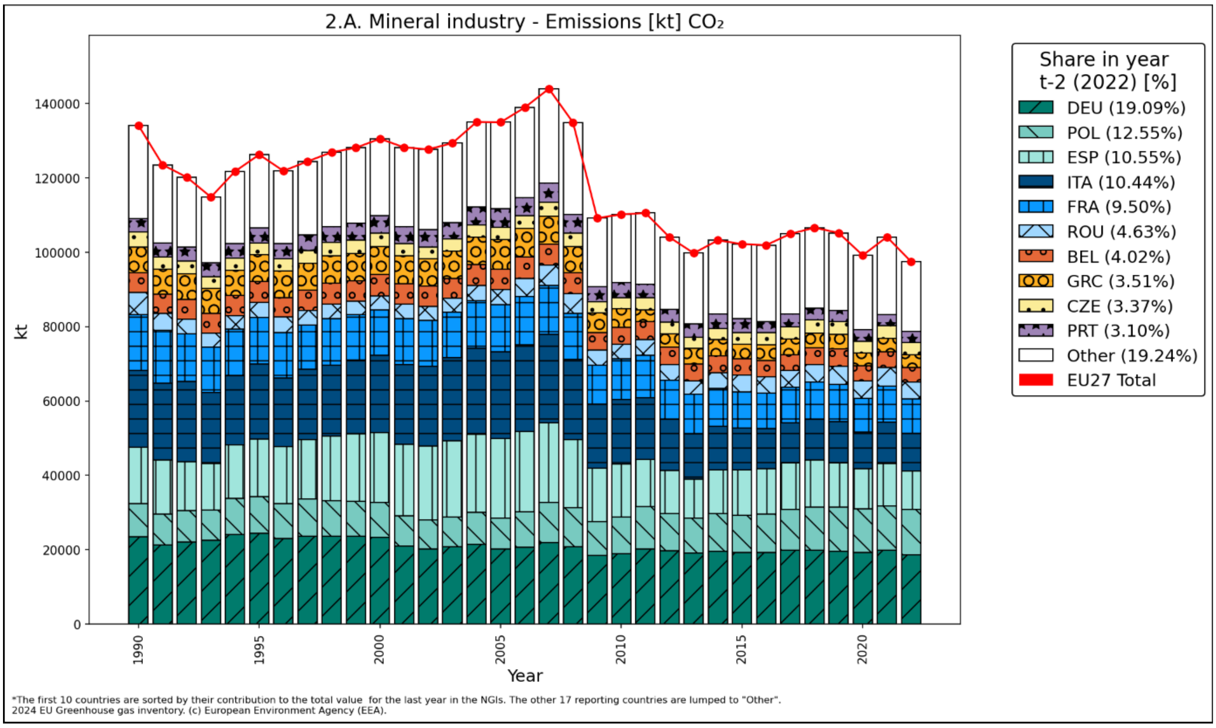


Table 4.2 2A Mineral industry: Member States total GHG and CO_2 emissions

Member State	GHG emissions in kt CO2 equivalents		CO2 emissions in kt	
	1990	2022	1990	2022
Austria	3 131	2 918	3 131	2 918
Belgium	5 320	3 916	5 320	3 916
Bulgaria	3 278	2 651	3 278	2 651
Croatia	1 298	1 255	1 298	1 255
Cyprus	717	900	717	900
Czechia	4 082	3 288	4 082	3 288
Denmark	973	1 217	973	1 217
Estonia	614	33	614	33
Finland	1 218	940	1 218	940
France	14 939	9 261	14 939	9 261
Germany	23 522	18 610	23 522	18 610
Greece	6 775	3 419	6 775	3 419
Hungary	2 890	1 128	2 890	1 128
Ireland	1 117	2 068	1 117	2 068
Italy	20 720	10 176	20 720	10 176
Latvia	537	547	537	547
Lithuania	2 130	703	2 130	703
Luxembourg	593	371	593	371
Malta	1	0	1	0
Netherlands	1 411	1 090	1 411	1 090
Poland	8 855	12 239	8 855	12 239
Portugal	3 672	3 020	3 672	3 020
Romania	6 083	4 517	6 083	4 517
Slovakia	2 714	2 333	2 714	2 333
Slovenia	694	574	694	574
Spain	15 120	10 285	15 120	10 285
Sweden	1 673	20	1 673	20
EU-27	**134 078**	**97 483**	**134 078**	**97 483**

Abbreviations are explained in the Chapter 'Units and abbreviations'.
For consistency reasons with other sub-sectors, this table shows GHG emissions in CO_2 equivalents and emissions of CO_2 separately. As there are no N_2O or CH_4 emissions in this category, the two sets of columns in this table contain the same numbers.

4.2.1.1 2A1 Cement production

CO_2 emissions from Cement production contributed 2.0 % of total GHG emissions in the EU (without LULUCF) in 2022. In that year, emissions were approx. 7 % below 2021 levels and approx. 29 % below 1990 levels (Figure 4-2 and Table **4**.3). This source is a key category of CO_2 emissions in terms of emissions level and trend.

Figure 4.3 2A1 Cement production: EU CO_2 emissions

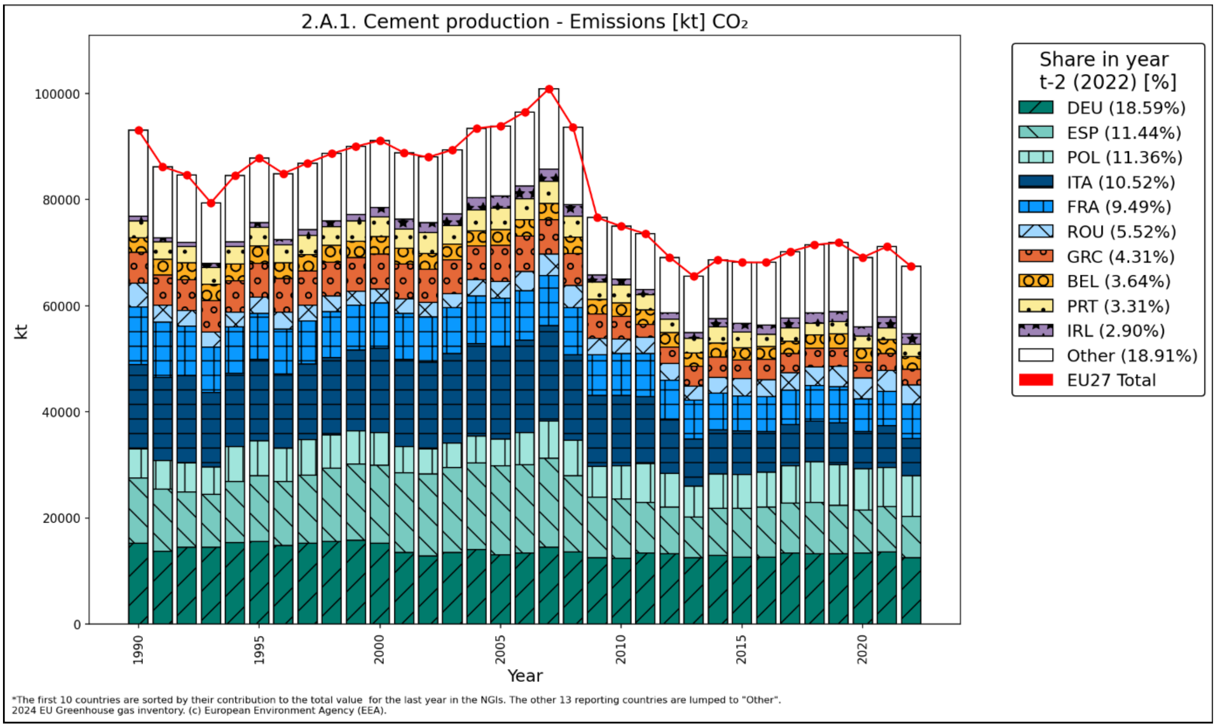


Table 4.3 2A1 Cement production: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	2 033	1 889	1 832	2.7%	-202	-10%	-57	-3%	T3	PS
Belgium	2 824	2 660	2 456	3.6%	-368	-13%	-204	-8%	T3	PS
Bulgaria	2 142	1 060	1 040	1.5%	-1 102	-51%	-20	-2%	T2	PS
Croatia	1 086	1 205	1 099	1.6%	13	1%	-106	-9%	T2,T3	PS
Cyprus	668	879	880	1.3%	212	32%	1	0%	CS	CS
Czechia	2 489	1 958	1 847	2.7%	-642	-26%	-111	-6%	T3	PS
Denmark	775	1 210	1 073	1.6%	299	39%	-136	-11%	T3	PS
Estonia	483	NO	NO	-	-483	-100%	-	-	NA	NA
Finland	729	623	597	0.9%	-132	-18%	-26	-4%	T3	PS
France	10 937	6 495	6 397	9.5%	-4 541	-42%	-98	-2%	-	-
Germany	15 297	13 640	12 538	18.6%	-2 759	-18%	-1 102	-8%	T2	CS
Greece	5 762	3 167	2 905	4.3%	-2 857	-50%	-262	-8%	CS	PS
Hungary	1 751	1 002	815	1.2%	-936	-53%	-187	-19%	T3	PS
Ireland	884	2 103	1 957	2.9%	1 073	121%	-146	-7%	T3	PS
Italy	15 846	7 919	7 093	10.5%	-8 753	-55%	-825	-10%	T2	CS,PS
Latvia	346	539	540	0.8%	194	56%	2	0%	T2	PS
Lithuania	1 668	633	682	1.0%	-986	-59%	49	8%	T2	PS
Luxembourg	539	351	369	0.5%	-170	-32%	18	5%	T2	CS,PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	416	NO	NO	-	-416	-100%	-	-	NA	NA
Poland	5 453	7 366	7 663	11.4%	2 209	41%	297	4%	T2	CS
Portugal	3 176	2 106	2 229	3.3%	-948	-30%	123	6%	T3	PS
Romania	4 445	3 962	3 723	5.5%	-722	-16%	-238	-6%	CS,T2	PS
Slovakia	1 464	1 453	1 490	2.2%	25	2%	37	3%	T2	PS
Slovenia	470	469	490	0.7%	20	4%	21	5%	T3	PS
Spain	12 279	8 472	7 715	11.4%	-4 564	-37%	-757	-9%	T2	CS
Sweden	1 272	1 259	C	-	-1 272	-100%	-1 259	-100%	T3	PS
EU-27	**95 237**	**72 416**	**67 428**	**100%**	**-27 808**	**-29%**	**-4 987**	**-7%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 and 2021 EU sums do include emission from Sweden.

4.2.1.2 2A2 Lime production

CO_2 emissions from 2A2 Lime production account for 0.4 % of total EU emissions (without LULUCF) in 2022. Between 1990 and 2022, CO_2 emissions from this category decreased by 34 %. Compared to 2021, emissions were 10 % lower in 2022 (Figure 4-3 and Table **4**.4).

Figure 4.4 2A2 Lime production: EU CO_2 emissions

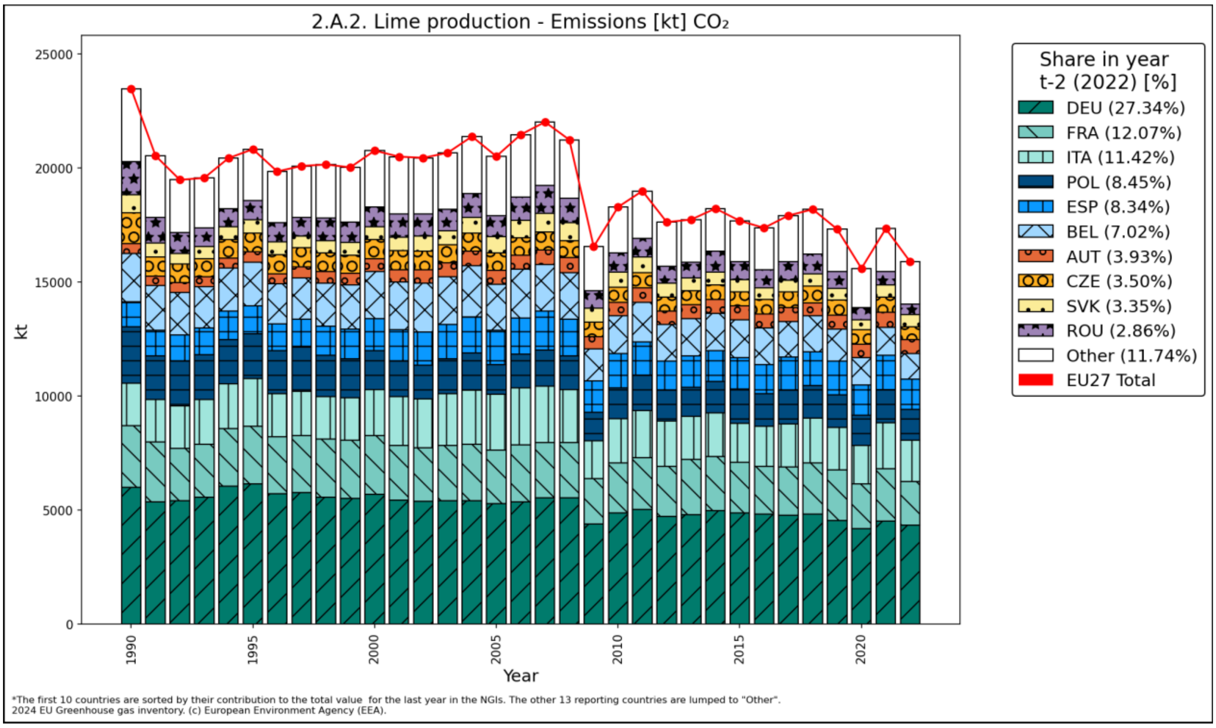


Table 4.4 2A2 Lime production: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	456	653	624	3.9%	168	37%	-29	-4%	T3	PS
Belgium	2 097	1 222	1 115	7.0%	-982	-47%	-107	-9%	T3	PS
Bulgaria	390	256	325	2.0%	-66	-17%	69	27%	T2	D
Croatia	157	123	111	0.7%	-46	-29%	-12	-10%	T3	PS
Cyprus	5	4	4	0.0%	-1	-27%	0	-2%	T1	D
Czechia	1 337	667	556	3.5%	-781	-58%	-111	-17%	T3	PS
Denmark	105	48	59	0.4%	-46	-44%	11	23%	T2	PS
Estonia	130	47	19	0.1%	-110	-85%	-27	-59%	T2	PS
Finland	401	309	260	1.6%	-141	-35%	-49	-16%	T3	CS
France	2 712	2 301	1 918	12.1%	-794	-29%	-384	-17%	-	-
Germany	5 987	4 525	4 345	27.3%	-1 642	-27%	-180	-4%	T2	D
Greece	404	193	254	1.6%	-150	-37%	61	32%	CS	PS
Hungary	614	111	104	0.7%	-510	-83%	-7	-7%	T3	PS
Ireland	214	148	107	0.7%	-107	-50%	-41	-27%	T3	PS
Italy	1 877	2 003	1 815	11.4%	-63	-3%	-188	-9%	T2	CS,PS
Latvia	122	NO	NO	-	-122	-100%	-	-	NA	NA
Lithuania	210	2	1	0.0%	-209	-99%	0	-20%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	1	NO	NO	-	-1	-100%	-	-	NA	NA
Netherlands	163	181	199	1.3%	37	23%	19	10%	CS	D
Poland	2 461	1 458	1 343	8.5%	-1 118	-45%	-114	-8%	T2	CS
Portugal	206	387	371	2.3%	165	80%	-16	-4%	T1,T3	D,OTH,PS
Romania	1 450	585	454	2.9%	-996	-69%	-131	-22%	T2	CS,D
Slovakia	795	540	532	3.3%	-262	-33%	-8	-1%	T2	PS
Slovenia	200	67	51	0.3%	-149	-74%	-16	-23%	T3	PS
Spain	1 109	1 515	1 325	8.3%	216	19%	-189	-13%	T3	PS
Sweden	332	375	C	-	-332	-100%	-375	-100%	T3	D
EU-27	**23 935**	**17 719**	**15 894**	**100%**	**-8 041**	**-34%**	**-1 825**	**-10%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Presented methods and emission factor information refer to the last inventory year. Abbreviations are explained in the Chapter 'Units and abbreviations'.

This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions. EU trends for 2022 in this table do not include emissions from Sweden for confidentiality reasons, but 1990 and 2021 EU sums do include emission from Sweden.

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 emissions (without LULUCF) in 2022. Emissions from this category in 2022 were 7 % below 1990 levels and 4 % below 2021 levels (Table **4**.5).

Table 4.5 2A4 Other process uses of carbonates: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	603	463	428	4.1%	-175	-29%	-35	-8%	T1,T3	D,PS
Belgium	136	202	196	1.9%	60	44%	-6	-3%	NA,T3	CS,NA,PS
Bulgaria	607	933	1 196	11.6%	589	97%	263	28%	NA,T1,T2	D,NA,PS
Croatia	11	16	15	0.1%	3	30%	-1	-6%	NA,T3	NA,PS
Cyprus	44	14	17	0.2%	-27	-62%	3	19%	CS,NA,T1	CS,D,NA
Czechia	114	675	739	7.2%	626	549%	64	10%	NA,T1,T3	D,NA,PS
Denmark	77	84	74	0.7%	-3	-4%	-11	-13%	NA,T3	CS,NA
Estonia	IE,NA,NO	1	3	0.0%	3	∞	2	210%	NA,T1,T2	D,NA,PS
Finland	67	83	82	0.8%	14	21%	-2	-2%	NA,T1,T3	CS,D,NA
France	488	430	449	4.4%	-39	-8%	19	4%	NA	NA
Germany	1 458	848	841	8.2%	-617	-42%	-6	-1%	NA,T1,T2	CS,D,NA
Greece	590	245	243	2.4%	-347	-59%	-2	-1%	CS,T1	CS,D
Hungary	449	183	176	1.7%	-272	-61%	-7	-4%	NA,T2,T3	CS,D,NA,PS
Ireland	5	6	4	0.0%	-1	-18%	-2	-29%	NA,T3	NA,PS
Italy	2 544	609	644	6.2%	-1 900	-75%	35	6%	NA,T2	CS,NA,PS
Latvia	69	8	7	0.1%	-62	-90%	-2	-21%	NA,T1,T2	D,NA,PS
Lithuania	240	13	13	0.1%	-226	-95%	0	0%	NA,T1,T2	CS,D,NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	0	0	0	0.0%	0	-28%	0	-13%	NA,T1	D,NA
Netherlands	690	884	891	8.6%	201	29%	6	1%	NA,T1	D,NA
Poland	771	2 463	2 644	25.7%	1 873	243%	182	7%	NA,T1,T2	CS,D,NA
Portugal	220	258	263	2.6%	43	20%	5	2%	IE,NO,T1,T3	IE,NO,OTH
Romania	38	292	269	2.6%	231	603%	-23	-8%	NA,OTH,T2,T3	D,NA,PS
Slovakia	447	323	294	2.9%	-152	-34%	-29	-9%	NA,T3	NA,PS
Slovenia	20	17	18	0.2%	-3	-13%	0	0%	NA,T2	D,NA
Spain	1 358	889	794	7.7%	-563	-41%	-94	-11%	T1,T2,T3	CS,D,PS
Sweden	15	7	4	0.0%	-11	-71%	-2	-35%	T3	D
EU-27	**11 061**	**9 948**	**10 305**	**100%**	**-756**	**-7%**	**357**	**4%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Presented methods and emission factor information refer to the last inventory year. Abbreviations are explained in the Chapter 'Units and abbreviations'.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions.

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 0.1 % of total EU emissions (without LULUCF) in 2022. Emissions in that year were roughly at the same level as in 1990 and 4 % below the level of 2021 (Table **4**.6).

Table 4.6 2A3 Glass production: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	39	36	35	0.9%	-4	-9%	-1	-2%	T3	PS
Belgium	263	156	149	3.9%	-114	-43%	-7	-5%	T3	CS,PS
Bulgaria	138	100	91	2.4%	-47	-34%	-9	-9%	T1	CS
Croatia	43	29	30	0.8%	-13	-30%	2	5%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	143	144	146	3.8%	3	2%	2	1%	T3	PS
Denmark	16	11	11	0.3%	-6	-35%	-1	-5%	T3	PS
Estonia	1	11	10	0.3%	9	728%	-1	-8%	T3	PS
Finland	21	2	2	0.1%	-19	-90%	0	12%	T3	CS
France	802	515	498	12.9%	-304	-38%	-17	-3%	-	-
Germany	780	884	886	23.0%	105	14%	1	0%	T2	CS
Greece	20	17	18	0.5%	-2	-11%	1	8%	CS	CS
Hungary	77	40	33	0.8%	-44	-58%	-7	-18%	T3	CS,PS
Ireland	13	NO	NO	-	-13	-100%	-	-	NA	NA
Italy	453	614	623	16.2%	170	37%	9	2%	T2	CS,PS
Latvia	0	1	1	0.0%	0	97%	0	-2%	T3	D,PS
Lithuania	12	7	7	0.2%	-5	-41%	-1	-7%	T2	D
Luxembourg	54	31	2	0.1%	-51	-96%	-29	-92%	CS	PS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	142	68	0	0.0%	-142	-100%	-68	-100%	T3	PS
Poland	169	630	588	15.3%	419	248%	-42	-7%	T2	D
Portugal	69	160	158	4.1%	89	129%	-2	-2%	T3	OTH
Romania	150	67	71	1.8%	-79	-53%	4	6%	T2	CS,D
Slovakia	8	20	16	0.4%	8	107%	-3	-17%	T3	PS
Slovenia	3	14	15	0.4%	12	356%	1	4%	T3	D
Spain	374	463	451	11.7%	76	20%	-13	-3%	T3	CS,D,PS
Sweden	54	15	16	0.4%	-38	-70%	1	5%	T3	CS,D,PS
EU-27	**3 845**	**4 035**	**3 855**	**100%**	**10**	**0%**	**-179**	**-4%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Presented methods and emission factor information refer to the last inventory year. Abbreviations are explained in the Chapter 'Units and abbreviations'.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions.

4.2.2 Chemical industry (CRT Source Category 2B)

The chemical industry includes six key categories, which are presented in ***Table** 4.7*.

Table 4.7: Key source categories for level and trend analyses and share of MS emissions using higher tier methods for 2B Chemical Industry

Source category and gas	kt CO_2eq		Trend	Level		share of higher Tier
	1990	2022		1990	2022	
2.B.1. Ammonia production (CO_2)	31628	14900	T	L	L	100 %
2.B.2. Nitric acid production (N_2O)	40776	1865	T	L	0	100 %
2.B.3. Adipic acid production (N_2O)	33558	79	T	L	0	100 %
2.B.8. Petrochemical and carbon black production (CO_2)	13613	14088	T	L	L	85.1 %
2.B.9. Fluorochemical production (Unspecified mix of HFCs and PFCs)	4670	23	T	0	0	100 %
2.B.10. Other (CO_2)	9157	13836	T	L	L	95.4 %

The key category 2B1 Ammonia production accounts for approx. 33 % of total GHG emissions in the chemical industry, followed by 2B8 Petrochemical and carbon black production (31 %), 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 is the third most important category, accounting for 31 % of chemical industry emissions 2022 (slightly below the level of category 2B8). 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 4-4 shows the time series of chemical industry CO_2 emissions. Notable decreases occurred during the 2009 economic crisis, and in 2022 due to high prices of fuels and feedstocks, such as natural gas.

Figure 4.5 2B Chemical industry CO_2 emissions

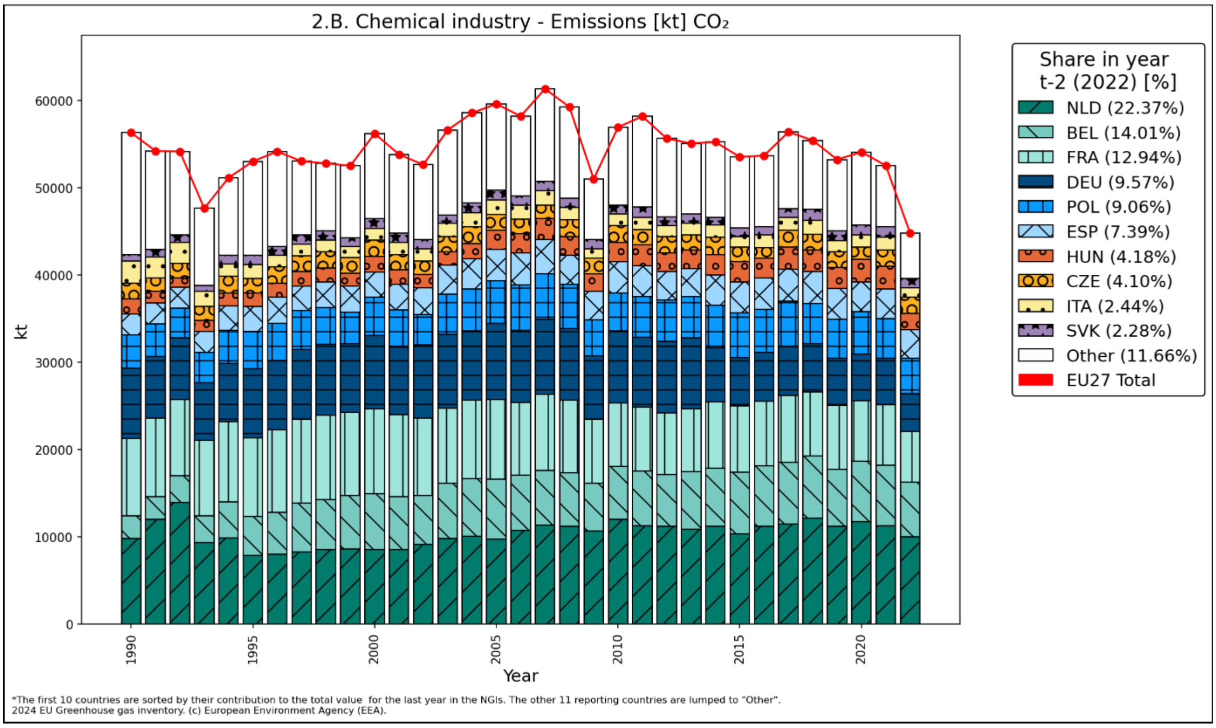


Table 4.8 shows chemical industry CO_2, CH_4, N_2O and total GHG emissions in CO_2 equivalents. Total CO_2 emissions also include F-gas emissions. Between 1990 and 2022 overall GHG emissions from the chemical industry sector have decreased markedly, largely due to the significant reduction in N_2O emissions which have decreased by approx. 96 %.

Table 4.8 2B Chemical industry: EU 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	2022	1990	2022	1990	2022	1990	2022
Austria	1 464	677	644	600	780	23	41	55
Belgium	9 563	6 962	2 590	6 280	3 385	519	20	13
Bulgaria	4 762	996	3 283	937	1 465	59	15	NA,NO
Croatia	1 428	96	751	84	671	12	6	IE,NE,NO
Cyprus	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Czechia	2 825	2 054	1 783	1 838	1 002	160	41	56
Denmark	892	1	1	1	892	NA,NO	NA,NO	NA,NO
Estonia	308	NA,NO	308	NA,NO	NO	NA,NO	NO	NO
Finland	1 697	1 117	277	970	1 415	145	5	1
France	35 501	6 355	8 868	5 801	21 087	375	125	35
Germany	32 243	5 200	8 058	4 288	19 075	349	440	539
Greece	2 621	761	681	755	948	7	1	NA,NO
Hungary	4 472	1 934	1 704	1 872	2 748	23	20	39
Ireland	1 875	NO	990	NO	885	NO	NO	NO
Italy	9 626	1 434	2 524	1 094	5 707	36	69	3
Latvia	NO	NO	NO	NO	NO	NO	NO	NO
Lithuania	2 061	1 019	1 261	928	794	91	6	NO
Luxembourg	NO	NO	NO	NO	NO	NO	NO	NO
Malta	0	0	0	0	NA,NO	NA,NO	NA,NO	NA,NO
Netherlands	21 129	11 118	9 833	10 027	6 288	570	310	365
Poland	6 991	4 550	3 802	4 060	3 144	438	45	52
Portugal	1 898	528	1 409	478	460	28	29	22
Romania	9 322	428	5 589	407	3 677	15	56	7
Slovakia	1 834	1 076	761	1 023	1 073	53	0	0
Slovenia	88	65	83	65	NA,NO	NA,NO	5	NA,NO
Spain	7 610	3 662	2 430	3 312	2 539	243	94	106
Sweden	1 297	6	582	C,IE,NA,NO	714	6	1	IE,NA,NO
EU-27	**161 507**	**50 039**	**58 210**	**44 820**	**78 749**	**3 149**	**1 328**	**1 295**

Note: Presented methods and emission factor information refer to the last inventory year. Abbreviations are explained in the Chapter 'Units and abbreviations'. Emissions from F-gases are not shown in separate columns but are included in the total GHG emissions.

4.2.2.1 2B1 Ammonia production

In most facilities, anhydrous ammonia is produced by catalytic steam reforming of natural gas 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 0.4 % of total EU emissions (without LULUCF) in 2022. Emissions have decreased by approx. 53 % since 1990 and by approx. 25 % since 2021 (Figure 4-5 and Table 4.9). The most recent decrease in GHG emissions can largely be explained by a decline in ammonia production as a consequence of to high natural gas prices.

Figure 4.6 2B1 Ammonia production: CO_2 emissions

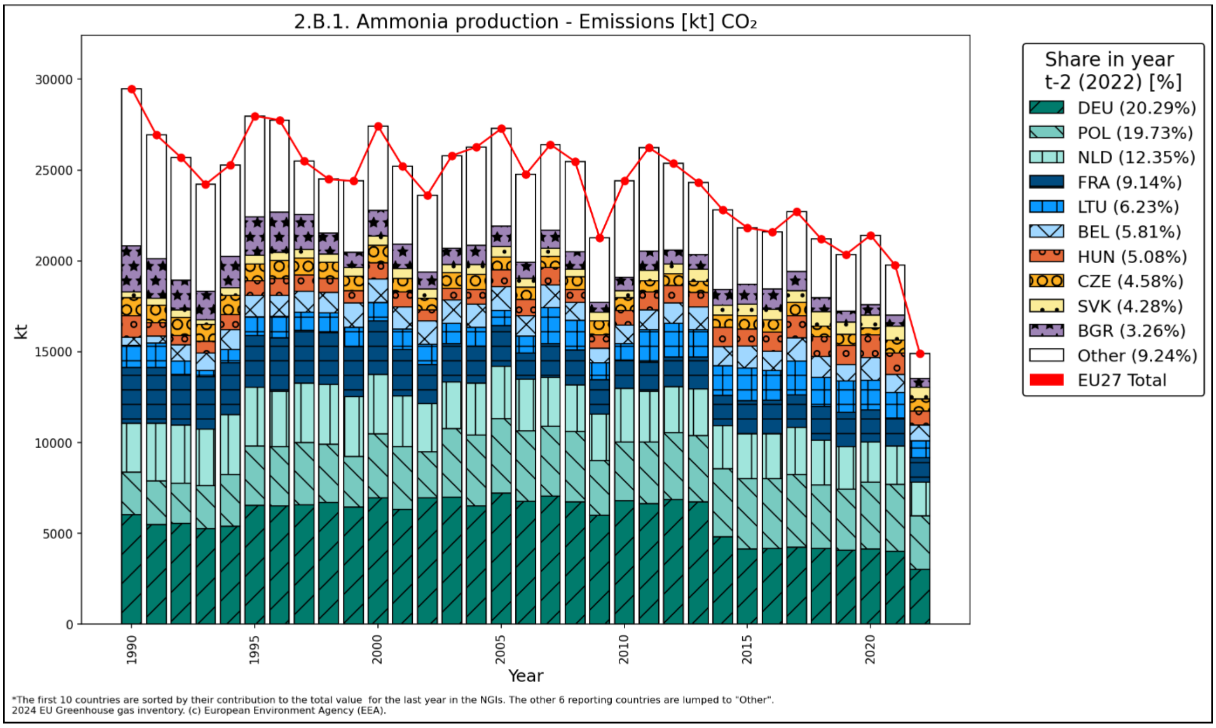


Table 4.9 2B1 Ammonia production: Member States' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	467	500	418	2.8%	-49	-11%	-82	-16%	T3	PS
Belgium	423	997	866	5.8%	443	105%	-131	-13%	T3	D,PS
Bulgaria	2 508	595	486	3.3%	-2 022	-81%	-109	-18%	T2	PS
Croatia	559	365	84	0.6%	-475	-85%	-282	-77%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	991	701	682	4.6%	-308	-31%	-19	-3%	T2	CS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	308	NO	NO	-	-308	-100%	-	-	NA	NA
Finland	93	NO	NO	-	-93	-100%	-	-	NA	NA
France	3 056	1 531	1 363	9.1%	-1 694	-55%	-168	-11%	-	-
Germany	6 025	4 012	3 024	20.3%	-3 001	-50%	-988	-25%	T3	PS
Greece	652	196	261	1.8%	-391	-60%	65	33%	T1a	CS
Hungary	1 200	1 201	757	5.1%	-443	-37%	-444	-37%	T3	PS
Ireland	990	NO	NO	-	-990	-100%	-	-	NA	NA
Italy	1 892	631	247	1.7%	-1 645	-87%	-384	-61%	T2	PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	1 237	1 402	928	6.2%	-308	-25%	-473	-34%	T3	CS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2 695	2 131	1 840	12.3%	-855	-32%	-292	-14%	T3	CS
Poland	2 344	3 665	2 940	19.7%	596	25%	-726	-20%	T2	CS
Portugal	763	NO	NO	-	-763	-100%	-	-	T1	D
Romania	4 693	763	100	0.7%	-4 594	-98%	-663	-87%	T3	PS
Slovakia	332	769	638	4.3%	306	92%	-131	-17%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	400	291	267	1.8%	-133	-33%	-24	-8%	T3	PS
Sweden	NO	NO	NO	-	-	-	-	-	-	-
EU-27	**31 628**	**19 751**	**14 900**	**100%**	**-16 727**	**-53%**	**-4 850**	**-25%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Presented methods and emission factor information refer to the last inventory year. Abbreviations are explained in the Chapter 'Units and abbreviations'.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions.

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. Emissions in the EU have decreased by 95 % since 1990. All countries have had marked emission reductions from this source, notably from 2008 onwards, when N_2O emissions from nitic acid production were included in the EU ETS. The substantial decrease 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. Between 2021 and 2022, emissions decreased by 23 % (Figure **4-6** and Table 4.11), and N_2O emissions from nitric acid production contributed less than 0.1 % of total EU emissions (without LULUCF) in 2022.

Figure 4.7 2B2 Nitric acid production N_2O emissions

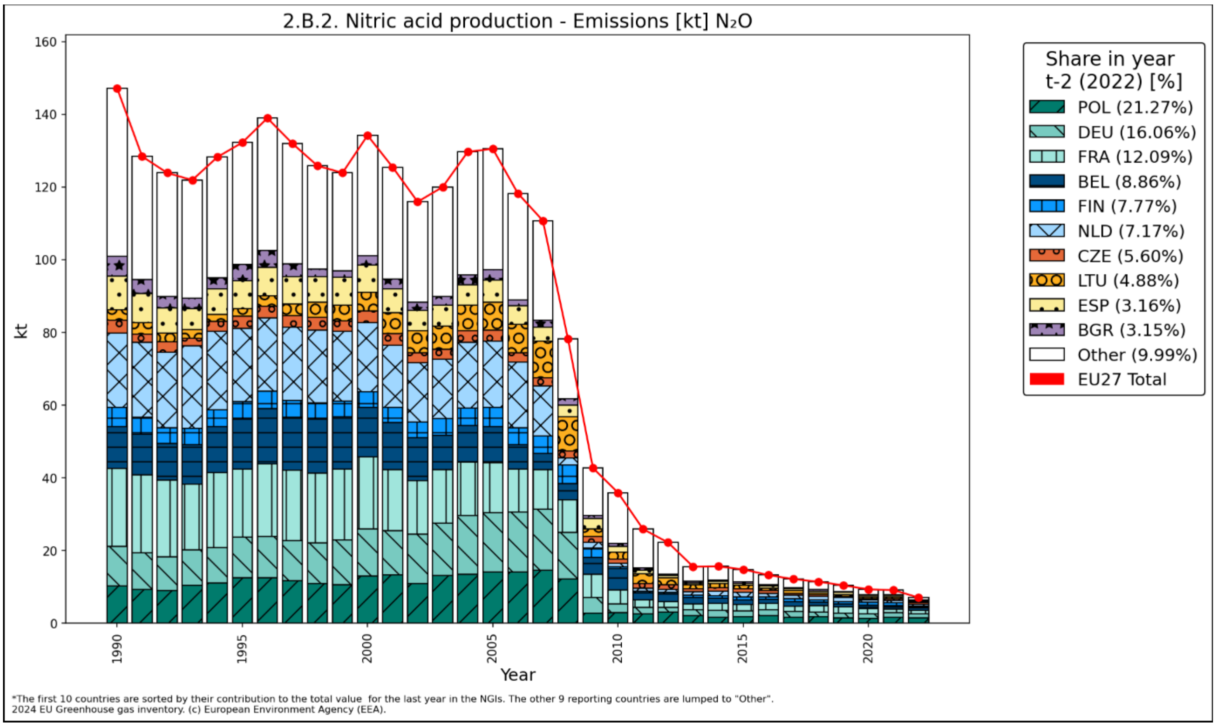


Table 4.10 2B2 Nitric acid production: Member States' contributions to N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	780	41	23	1.2%	-757	-97%	-18	-45%	T3	PS
Belgium	3 043	241	165	8.9%	-2 877	-95%	-76	-31%	T3	PS
Bulgaria	1 465	65	59	3.2%	-1 406	-96%	-6	-9%	T3	PS
Croatia	671	36	12	0.7%	-659	-98%	-24	-66%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	933	121	104	5.6%	-828	-89%	-17	-14%	T3	PS
Denmark	892	NO	NO	-	-892	-100%	-	-	NA	NA
Estonia	NO	NA	NA	-	-	-	-	-	NA	NA
Finland	1 415	219	145	7.8%	-1 271	-90%	-75	-34%	T3	PS
France	5 663	252	225	12.1%	-5 438	-96%	-27	-11%	-	-
Germany	2 897	342	299	16.1%	-2 597	-90%	-43	-13%	T3	PS
Greece	948	5	7	0.4%	-941	-99%	1	27%	CS	CS
Hungary	2 748	29	23	1.2%	-2 725	-99%	-6	-22%	T3	PS
Ireland	885	NO	NO	-	-885	-100%	-	-	NA	NA
Italy	1 783	23	21	1.1%	-1 762	-99%	-2	-8%	T3	D,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	794	139	91	4.9%	-703	-89%	-48	-34%	T3	PS
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	5 411	180	134	7.2%	-5 277	-98%	-46	-26%	T2	PS
Poland	2 704	423	397	21.3%	-2 308	-85%	-26	-6%	T2	CS
Portugal	460	33	28	1.5%	-433	-94%	-6	-17%	T3	PS
Romania	3 089	77	15	0.8%	-3 074	-100%	-62	-81%	T3	PS
Slovakia	1 073	57	53	2.8%	-1 020	-95%	-4	-7%	T3	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	2 428	116	59	3.2%	-2 369	-98%	-57	-49%	T3	PS
Sweden	696	10	6	0.3%	-690	-99%	-4	-44%	T2	PS
EU-27	**40 776**	**2 409**	**1 865**	**100%**	**-38 911**	**-95%**	**-545**	**-23%**	**-**	**-**

Note: *Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.*
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions.

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 have been reduced through catalytic and thermal abatement technologies and now account for less than 0.01% of total EU emissions (without LULUCF). Between 1990 and 2022, N_2O emissions from this source decreased by 99.8 % (Figure 4-7 and Table **4**.12). Emissions in 2022 were 35 % lower than in 2021.

Figure 4.8 2B3 Adipic acid production N_2O emissions

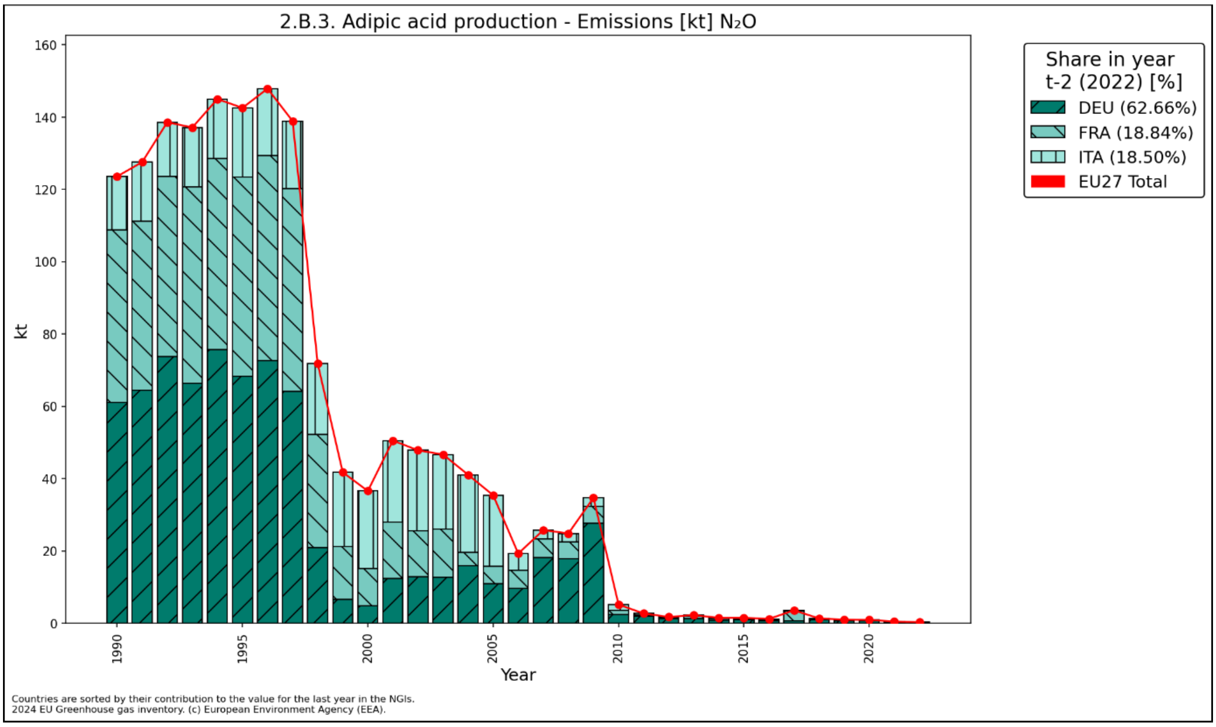


Table 4.11 2B3 Adipic acid production: Member States' contributions to N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
France	12 656	18	15	18.8%	-12 641	-100%	-4	-19%	-	-
Germany	16 178	68	50	62.7%	-16 129	-100%	-19	-27%	T3	PS
Italy	3 914	35	15	18.5%	-3 900	-100%	-21	-59%	T3	D,PS
Poland	318	NO	NO	-	-318	-100%	-	-	NA	NA
Romania	490	NO	NO	-	-490	-100%	-	-	NA	NA
EU-27	**33 558**	**122**	**79**	**100%**	**-33 478**	**-100%**	**-43**	**-35%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions.

4.2.2.4 2B8 Petrochemical and carbon black production

The European Union has a significant petrochemical industry, with production of all chemicals included in the 2006 IPCC Guidelines. Seventeen countries report CO_2 emissions from this category for at least part of the period 1990-2022 with this source being a key category of CO_2 emissions in terms of emissions level and trend.

CO_2 emissions from 2B8 Petrochemical and carbon black production decreased by 9 % between 2021 and 2022 and are now approx. 3 % above 1990 levels. They contributed 0.4 % of total EU emissions (without LULUCF) in 2022. Trends vary widely between countries, due to increases and decreases in production of the various chemicals over the past three decades.

Figure 4.9 2B8 Petrochemical and carbon black production: EU CO_2 emissions

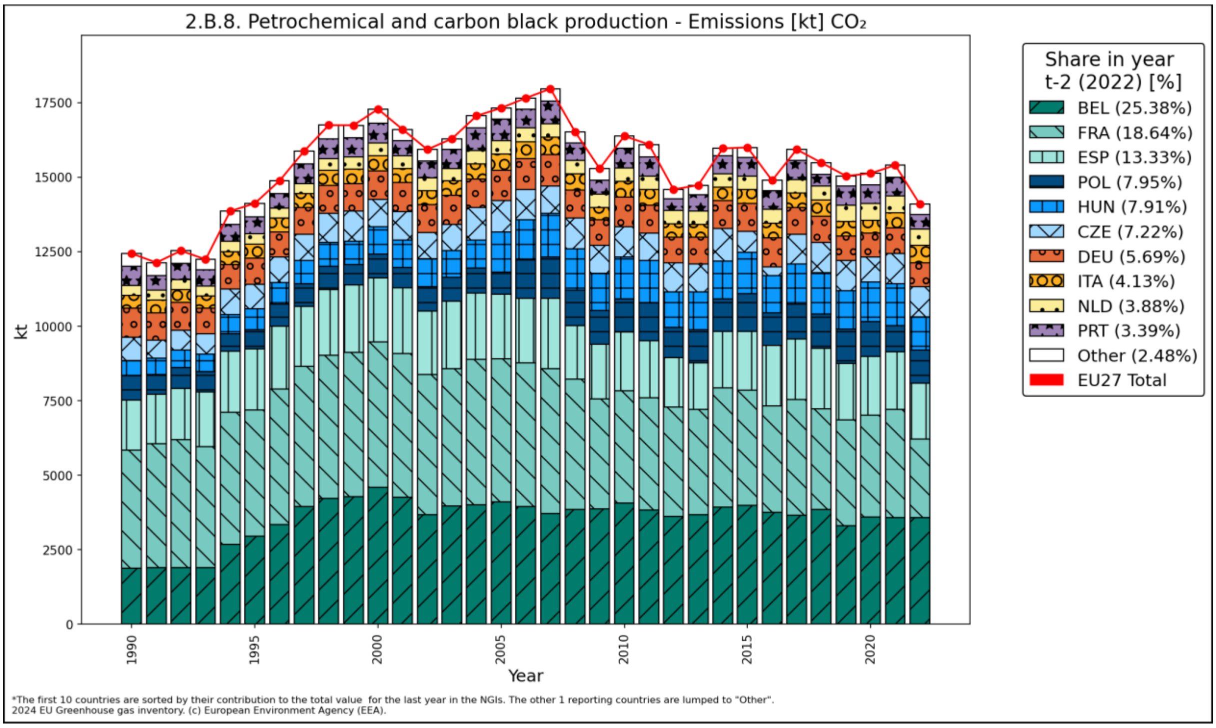


Table 4.12: 2B8 Petrochemical and carbon black production: Member States' contribution to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
Belgium	1 882	3 581	3 576	25.4%	1 694	90%	-5	0%	NA,T3	NA,PS
Bulgaria	346	NA,NO	NA,NO	-	-346	-100%	-	-	NA	NA
Croatia	192	IE,NO	IE,NO	-	-192	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	792	1 015	1 017	7.2%	224	28%	1	0%	NA,T1,T3	D,NA,PS
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA,NO	NA
Finland	IE,NO	IE,NO	IE,NO	-	-	-	-	-	NA	NA
France	3 960	3 624	2 627	18.6%	-1 333	-34%	-997	-28%	NA	NA
Germany	974	862	802	5.7%	-172	-18%	-60	-7%	NA,T1,T2	CS,D,NA
Greece	29	NO	NO	-	-29	-100%	-	-	NA	NA
Hungary	504	1 405	1 115	7.9%	611	121%	-290	-21%	NA,T3	NA,PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	422	511	581	4.1%	159	38%	70	14%	NA,T2	CR,NA,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	556	546	3.9%	210	63%	-10	-2%	CS,NA	CS,NA
Poland	806	888	1 120	7.9%	314	39%	232	26%	NA,T1	D,NA
Portugal	645	638	478	3.4%	-167	-26%	-159	-25%	D,NO	NA,NO
Romania	571	NO	NO	-	-571	-100%	-	-	NA	NA
Slovakia	429	395	350	2.5%	-79	-18%	-46	-12%	NA,T2	CS,NA,PS
Slovenia	16	NO	NO	-	-16	-100%	-	-	NA	NA
Spain	1 684	1 924	1 878	13.3%	195	12%	-46	-2%	NA,T1,T3	D,NA,PS
Sweden	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-	-	-
EU-27	**13 613**	**15 399**	**14 088**	**100%**	**476**	**3%**	**-1 311**	**-9%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.
This table lists methods and emission factors in the latest inventory year, as provided by Members States in their national inventory submissions.

4.2.2.5 Chemical industry – Fluorochemical production (CRT Source Category 2.B.9)

In this subcategory, by-product emissions and fugitive emissions are to be reported. Emissions from this subcategory decreased significantly since 1990, which is due to the closure of several production sites but also the installation of abatement technology as well as process optimisation.

As regards by-product emissions, HFCs account for major shares. Overall, 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. 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, especially in stationary air conditioning systems, but is also a component of several frequently used refrigerant blends such as the R407 series (10-30% R32) and R410A (50% R32). 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, 2001), 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. PFCs such as 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.

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.

Germany reports "unspecified mix of HFCs and PFCs" from 2.B.9 for confidentiality reasons.

Table 4.13: 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-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Belgium	NO	111	65	27.6%	65	∞	-46	-42%	NA	NA
France	4 202	35	26	10.9%	-4 176	-99%	-9	-27%	NA	NA
Greece	991	NO	NO	-	-991	-100%	-	-	NA	NA
Italy	372	1	1	0.4%	-371	-100%	0	-6%	CS,NA	NA,PS
Netherlands	4 697	245	144	61.1%	-4 553	-97%	-101	-41%	NA,T2	CS,NA
Spain	2 547	NO	NO	-	-2 547	-100%	-	-	NA,NO	NA,NO
EU-27	**12 810**	**392**	**236**	**100%**	**-12 574**	**-98%**	**-156**	**-40%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

Table 4.14: 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-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Germany	4 670	17	23	100.0%	-4 647	-100%	6	39%	NA	NA
EU-27	**4 670**	**17**	**23**	**100%**	**-4 647**	**-100%**	**6**	**39%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Presented methods and emission factor information refer to the last inventory year. Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.2.6 2B10 Other chemical industry

Fourteen countries reported CO_2, CH_4 or N_2O emissions in this category which contributed 14.4 Mt of CO_2eq or 0.4 % of total EU emissions (without LULUCF). Between 1990 and 2022, CO_2 emissions from this source increased by 51 % while CH_4 and N_2O emissions decreased by 5 % and 39 %, respectively. This category contains a wide range of emissions and sources as shown in Table 4.16.

Table 4.15 2B10 Other: CO_2, CH_4 and N_2O emissions for 1990 and 2022

Member State	Category	CO_2 emissions [kt]	CH_4 emissions [kt]	N_2O emissions [kt]	CO_2 emissions [kt]	CH_4 emissions [kt]	N_2O emissions [kt]
		1990			**2022**		
Austria	Other chemical bulk production	138.15	0.34	NA	137.99	0.43	NA
	CO_2 from nitric acid production	0.41	NA	NA	0.34	NA	NA
Belgium	Other non-specified	285.15	0.71	0.09	1 769.66	0.47	0.34
Czechia	Non selective catalytic reduction	IE	NO	NO	9.98	O	NO
	Other non energy use in chemical industry	IE	NO	NO	129.03	NO	NO
Denmark	Production of catalysts	0.57	NA	NA	1.34	NA	NA
Finland	Hydrogen production	116.22	NO	NO	870.87	NO	NO
	Chemicals production	6.71	NO	NO	2.17	NO	NO
	Limestone and dolomite use	36.52	NO	NO	65.09	NO	NO
	Phosphoric Acid Production	24.54	NO	NO	32.14	NO	NO
France	Other chemical industry	1 265.61	0.11	1.81	1 523.32	0.06	0.19
Germany	Storage of gaseous petroleum products	NA	2.38	IE	NA	2.34	IE
Greece	Hydrogen production	NO	NO	NO	493.40	NA	NA
Malta	Calcium carbide use	0.17	NA	NA	0.02	NA	NA
Netherlands	Other process emissions	6 738.86	0.31	0.83	7 641.32	0.39	1.18
Romania	Hydrogen production	48.28	NO	NO	301.93	NO	NO
Slovenia	Hydrogen production	16.94	NA	NA	12.20	NA	NA
Spain	Hydrogen production	NO	NO	NO	845,62	NA	NA
Sweden	Production of pharmaceuticals	NA	NE	0.05	C	NE	NE
	Production of organic chemicals	456.91	0.03	0.00	C	C	C
	Production of base chemicals for plastic industry	16.23	0.00	0.01	C	C	C
	Production of inorganic chemicals	40.87	0.00	0.01	C	C	0,00
Total		**9 192**	**3.87**	**2.80**	**13 836**	**3.68**	**1.71**

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

4.2.2.7 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 HFC, PFC and SF_6 emissions from 2B9 Fluorochemical production, as well as all gases from 2B10 except CO_2. In 2022 emissions from these categories contributed 5.0 Mt of CO_2 equivalent or 1.6 % of total emission in the IPPU sector.

4.2.3 Metal Industry (CRT 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 4.16).

Table 4.16: 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	2022		1990	2022	
2.C.1. Iron and steel production: no classification (CO_2)	103488	60475	T	L	L	100%

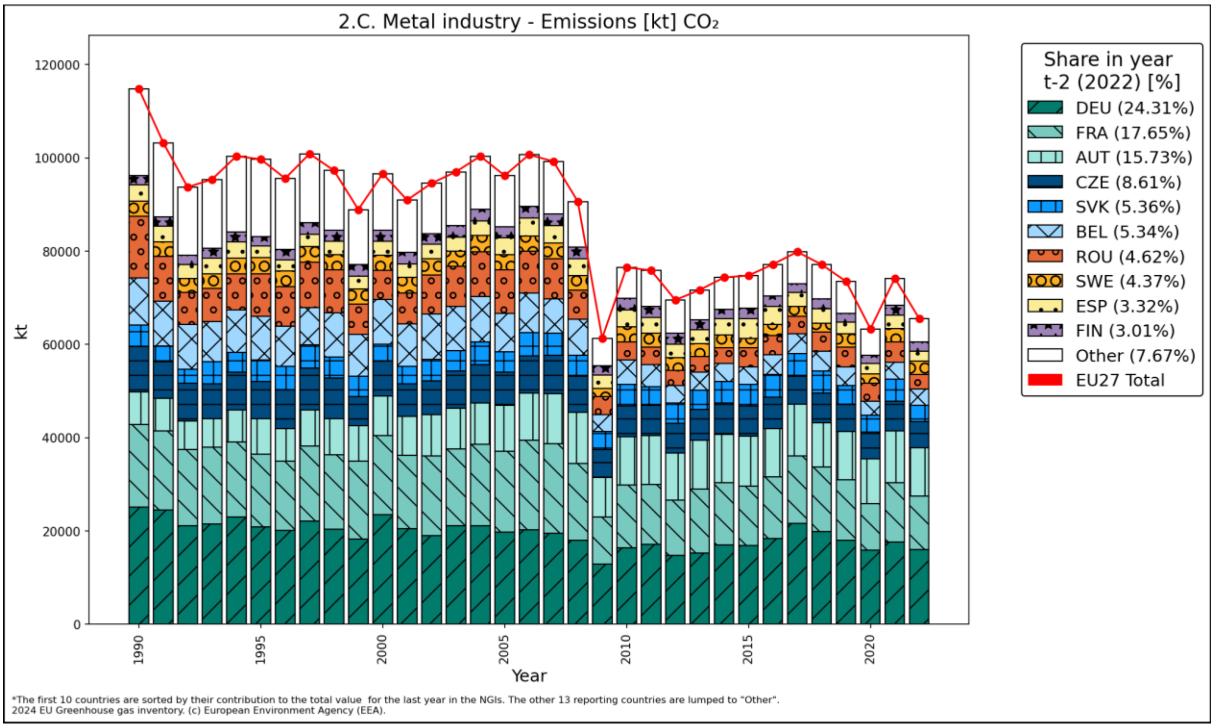
Table 4.17 summarises information by countries on total GHG emissions, CO_2, N_2O, CH_4 and HFC, PFC, NF_3 and SF_6 emissions from Metal Production. Between 1990 and 2022, GHG emissions decreased by 51% and CO_2 emissions from 2C Metal Production decreased by 43%. The largest absolute reductions in GHG emissions between 1990 and 2022 were observed in Romania, Germany, France, and Belgium (in decending order).

Table 4.17 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	2022	1990	2022	1990	2022	1990	2022	1990	2022	1990	2022	1990	2022	1990	2022
Austria	8 304	10 315	7 016	10 308	-	-	6	5	-	-	1 032	NO	-	-	249	2
Belgium	10 107	3 515	10 092	3 501	NO	NO	15	14	NO	NO	NO	NO	-	-	NO	NO
Bulgaria	1 633	151	1 603	151	NA	NA	30	NA,NO	NO	NO	NO	NO	NO	NO	NO	NO
Croatia	1 458	13	336	13	NO	NO	4	NA,NO	-	-	1 117	NO	-	-	-	-
Cyprus	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA	NA	NA	NA	NA	NA	NA	NA
Czechia	9 812	5 658	9 795	5 645	NA	NA	17	13	NO	NO	NO	NO	NO	NO	NO	NO
Denmark	61	0	30	0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	31	NO
Estonia	1	3	1	3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Finland	1 976	1 974	1 976	1 974	NO	NO	0	0	NO	NO	NO	NO	NO	NO	NO	NO
France	21 791	11 631	17 679	11 570	NO	NO	158	25	NA	NA	3 211	33	NO	NO	743	4
Germany	27 901	16 094	25 080	15 933	24	11	15	7	NA,NO	10	2 597	35	NO	NO	186	97
Greece	1 183	599	1 012	535	NO	NO	0	1	NO	NO	171	63	NO	NO	NO	NO
Hungary	3 663	639	3 317	637	NO	NO	8	3	NO	NO	338	NO	NO	NO	NO	NO
Ireland	26	NO	26	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Italy	6 232	1 628	4 378	1 589	NA	NO	76	35	NO	3	1 778	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	81	985	81	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-	-
Malta	NO	NO	NO	NO	-	-	NO	NO	NO	NO	NO	NO	NO	NO	-	-
Netherlands	2 827	31	453	31	NO	NO	IE,NO	IE,NA,NO	-	-	2 374	NO	-	-	-	-
Poland	5 805	1 840	5 652	1 830	NO	NO	26	9	NO	NO	127	NO	NO	NO	NO	NO
Portugal	447	70	446	70	NO	NO	1	NE,NO	NA,NO	NO	NA,NO	NO	NO	NO	NA,NO	NO
Romania	15 782	3 034	13 228	3 029	NO	NO	24	4	NO	NO	2 530	1	NO	NO	NA,NO	NA,NO
Slovakia	4 815	3 533	4 586	3 512	1	1	14	15	-	-	214	6	-	-	-	-
Slovenia	530	89	343	85	NO	NO	0	NA,NO	NO	NO	187	4	NO	NO	NO	NO
Spain	4 615	2 198	3 537	2 176	NA	NA	32	21	NA,NO	NA,NO	1 046	1	NO	NO	NA,NO	NA,NO
Sweden	3 829	2 896	3 273	2 861	NA	NA	22	0	NO	1	511	34	-	-	24	NO
EU-27	**133 869**	**65 993**	**114 931**	**65 534**	**25**	**12**	**449**	**152**	**NA,NO**	**14**	**17 234**	**177**	**NA,NO**	**NA,NO**	**1 232**	**103**

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 4.10: 2C Metal Industry CO_2 – Trend in EU-27



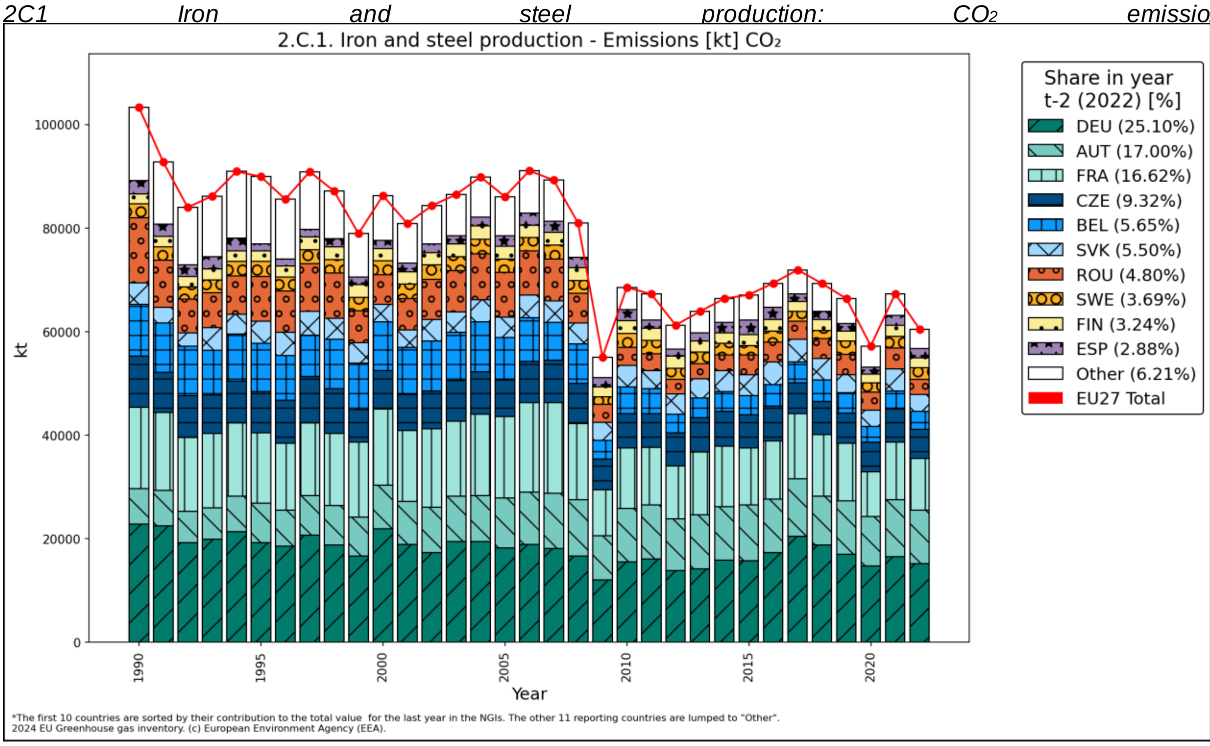
4.2.3.1 2C1 Iron and steel production

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 between energy (CRT 1A2a) and non-energy (CRT 2C1) uses, which are described in Table 4.18.

CO_2 emissions from 2C1 Iron and Steel Production amounted to approximately 1.9% of total GHG emissions (including indirect CO_2 and LULUCF, but without international aviation) in 2022. The two major contributors are Germany, which accounts for 25.1% of the CRT 2C1 emissions in the EU KP, and France with 16.6%, in 2022. Romania had the largest decrease in absolute terms between 1990 and 2022 (-9,720 kt CO_2). Increases were encountered (in increasing order of magnitude) in Austria (+50%) and Finland (+18%, but rather marginal in EU KP contribution) between 1990 and 2022.

The overall emission trend between 1990 and 2022 roughly follows the trend of the production figures. Between 1990 and 2022, overall CO_2 emissions from iron and steel production decreased by 42% (Table 4.18). Between 2021 and 2022, emissions have been reduced by 10%.

Figure 4.11 2C1 Iron and steel production: CO_2 emissions



For the whole timeseries, 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 longer from 2019. All countries follow higher-tier methods and most use country or plant specific methods (see Table 4.18).

Table 4.18 2C1 Iron and Steel Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	6 840	11 002	10 280	17.0%	3 439	50%	-722	-7%	NA,T3	NA,PS
Belgium	10 048	3 474	3 417	5.7%	-6 631	-66%	-57	-2%	CS,NA,T3	NA,PS
Bulgaria	1 283	11	11	0.0%	-1 273	-99%	0	-2%	NA,T2	CS,NA
Croatia	44	14	13	0.0%	-30	-69%	-1	-6%	NA,T3	NA,PS
Cyprus	NA,NO	NA,NO	NA,NO	-	-	-	-	-	NA	NA
Czechia	9 782	6 348	5 634	9.3%	-4 148	-42%	-714	-11%	CS,NA,T2	CS,D,NA,PS
Denmark	30	NO	NO	-	-30	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 967	2 075	1 957	3.2%	-11	-1%	-118	-6%	CS,NA,T3	CS,NA
France	15 789	11 172	10 050	16.6%	-5 738	-36%	-1 122	-10%	NA	NA
Germany	22 810	16 513	15 182	25.1%	-7 629	-33%	-1 331	-8%	NA,T2	CS,NA
Greece	105	84	82	0.1%	-23	-22%	-2	-3%	CS,NA	NA,PS
Hungary	3 155	838	637	1.1%	-2 518	-80%	-202	-24%	NA,T3	NA,PS
Ireland	26	NO	NO	-	-26	-100%	-	-	NA	NA
Italy	3 124	1 506	1 392	2.3%	-1 732	-55%	-114	-8%	NA,T2	CR,CS,NA,PS
Latvia	70	NO	NO	-	-70	-100%	-	-	NA	NA
Lithuania	17	0	0	0.0%	-17	-100%	0	-31%	NA,T2	D,NA
Luxembourg	985	90	79	0.1%	-905	-92%	-10	-12%	CS,NA,T2	CS,NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	45	19	16	0.0%	-29	-65%	-3	-16%	NA,T2	NA,PS
Poland	4 959	1 566	1 422	2.4%	-3 537	-71%	-144	-9%	NA,T2	CS,NA
Portugal	440	65	54	0.1%	-385	-88%	-11	-16%	NO,T1,T3	D,NO,PS
Romania	12 621	4 014	2 901	4.8%	-9 720	-77%	-1 113	-28%	NA,T3	CS,NA
Slovakia	4 168	4 275	3 324	5.5%	-844	-20%	-951	-22%	NA,T2	NA,PS
Slovenia	44	58	51	0.1%	8	18%	-6	-11%	NA,T3	NA,PS
Spain	2 501	1 872	1 740	2.9%	-760	-30%	-131	-7%	NA,T2	CS,NA,PS
Sweden	2 637	2 337	2 233	3.7%	-404	-15%	-104	-4%	T3	PS
EU-27	**103 488**	**67 332**	**60 475**	**100%**	**-43 013**	**-42%**	**-6 857**	**-10%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are 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) (see Table 4.19).

Table 4.19 2C1a Steel Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	6 821	10 962	10 241	20.9%	3 420	50%	-722	-7%	T3	PS
Belgium	8 445	3 391	3 315	6.8%	-5 130	-61%	-76	-2%	CS,T3	PS
Bulgaria	1 283	11	11	0.0%	-1 273	-99%	0	-2%	T2	CS
Croatia	20	14	13	0.0%	-6	-31%	-1	-6%	T3	PS
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	IE	IE	IE	-	-	-	-	-	NA	NA
Denmark	30	NO	NO	-	-30	-100%	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	1 967	2 075	1 957	4.0%	-11	-1%	-118	-6%	CS,T3	CS
France	15 789	11 137	10 018	20.5%	-5 770	-37%	-1 119	-10%	-	-
Germany	22 810	16 513	15 182	31.0%	-7 629	-33%	-1 331	-8%	T2	CS
Greece	105	84	82	0.2%	-23	-22%	-2	-3%	CS	PS
Hungary	348	96	76	0.2%	-272	-78%	-20	-21%	T3	PS
Ireland	26	NO	NO	-	-26	-100%	-	-	NA	NA
Italy	1 346	1 160	1 095	2.2%	-252	-19%	-65	-6%	T2	CR,CS,PS
Latvia	70	NO	NO	-	-70	-100%	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	404	90	79	0.2%	-325	-80%	-10	-12%	CS,T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	43	19	16	0.0%	-27	-63%	-3	-16%	T2	PS
Poland	IE	IE	IE	-	-	-	-	-	NA	NA
Portugal	73	65	54	0.1%	-19	-26%	-11	-16%	T1,T3	D,PS
Romania	12 621	4 014	2 901	5.9%	-9 720	-77%	-1 113	-28%	T3	CS
Slovakia	4 150	4 264	3 314	6.8%	-836	-20%	-951	-22%	T2	PS
Slovenia	44	58	51	0.1%	8	18%	-6	-11%	T3	PS
Spain	1 045	654	530	1.1%	-515	-49%	-124	-19%	T2	CS,PS
Sweden	158	164	C	-	-158	-100%	-164	-100%	T3	PS
EU-27	**77 597**	**54 771**	**48 934**	**100%**	**-28 663**	**-37%**	**-5 837**	**-11%**	**-**	**-**

Table 4.20 2C1b Pig Iron Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	IE	IE	IE	-	-	-	-	-	NA	NA
Bulgaria	IE	NO	NO	-	-	-	-	-	NA	NA
Croatia	24	NO	NO	-	-24	-100%	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	IE	IE	IE	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	IE	IE	IE	-	-	-	-	-	NA	NA
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	2 427	553	396	10.0%	-2 031	-84%	-157	-28%	T3	PS
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	1 778	346	297	7.5%	-1 481	-83%	-49	-14%	T2	CR,CS,PS
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	NO	NO	NO	-	-	-	-	-	NA	NA
Luxembourg	200	NO	NO	-	-200	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	IE	IE	IE	-	-	-	-	-	NA	NA
Poland	1 043	505	471	11.9%	-572	-55%	-35	-7%	T2	CS
Portugal	298	NO	NO	-	-298	-100%	-	-	NO	NO
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	IE	IE	IE	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	246	628	655	16.6%	409	166%	27	4%	T2	CS
Sweden	2 094	1 911	2 126	53.9%	32	2%	215	11%	T3	PS
EU-27	**8 109**	**3 942**	**3 945**	**100%**	**-4 165**	**-51%**	**2**	**0%**	**-**	**-**

CO_{2eq} emissions from 2C1c 'Direct Reduced Iron Production' and 2C1e 'Pellet Production' is only reported by Sweden, numerical values for historic years and confidential data in recent years.

Table 4.21 2C1d Sinter Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	IE	IE	IE	-	-	-	-	-	NA	NA
Belgium	1 589	76	96	14.7%	-1 493	-94%	20	26%	CS,T3	PS
Bulgaria	IE	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	IE	IE	IE	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	IE	IE	IE	-	-	-	-	-	NA	NA
France	IE	IE	IE	-	-	-	-	-	NA	NA
Germany	IE	IE	IE	-	-	-	-	-	NA	NA
Greece	NO	NO	NO	-	-	-	-	-	NA	NA
Hungary	380	190	165	25.3%	-215	-57%	-25	-13%	T3	PS
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	380	NO	NO	-	-380	-100%	-	-	NA	NA
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	IE	IE	IE	-	-	-	-	-	NA	NA
Poland	841	280	211	32.3%	-631	-75%	-70	-25%	T2	CS
Portugal	69	NO	NO	-	-69	-100%	-	-	T1	D
Romania	IE	IE	IE	-	-	-	-	-	NA	NA
Slovakia	IE	IE	IE	-	-	-	-	-	NA	NA
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	538	194	180	27.6%	-358	-67%	-14	-7%	T2	CS
Sweden	222	NO	NO	-	-222	-100%	-	-	-	-
EU-27	**4 019**	**740**	**652**	**100%**	**-3 368**	**-84%**	**-88**	**-12%**	**-**	**-**

Table 4.22 2C1f Other Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	20	40	39	3.8%	20	100%	0	-1%	T3	PS
Belgium	IE	7	6	0.6%	6	∞	-1	-15%	CS,T3	PS
Bulgaria	NA	NA	NA	-	-	-	-	-	NA	NA
Croatia	NO	NO	NO	-	-	-	-	-	NA	NA
Cyprus	NA	NA	NA	-	-	-	-	-	NA	NA
Czechia	602	371	346	33.9%	-256	-43%	-25	-7%	CS,T2	PS
Denmark	NO	NO	NO	-	-	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	NO	35	32	3.1%	32	∞	-3	-10%	-	-
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	-	-	-	-	-	-	-	-	-	-
Hungary	-	-	-	-	-	-	-	-	-	-
Ireland	NA	NA	NA	-	-	-	-	-	NA	NA
Italy	NO	NO	NO	-	-	-	-	-	NA	NA
Latvia	NO	NO	NO	-	-	-	-	-	NA	NA
Lithuania	17	0	0	0.0%	-17	-100%	0	-31%	T2	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	-	-	-	-	-	-	-	-	-	-
Netherlands	2	NO	NO	-	-2	-100%	-	-	NA	NA
Poland	85	227	212	20.8%	127	149%	-15	-7%	T2	CS
Portugal	NO	NO	NO	-	-	-	-	-	NO	NO
Romania	NO	NO	NO	-	-	-	-	-	NA	NA
Slovakia	18	10	10	1.0%	-8	-43%	0	-1%	T2	PS
Slovenia	NO	NO	NO	-	-	-	-	-	NA	NA
Spain	672	396	375	36.8%	-297	-44%	-21	-5%	T2	PS
Sweden	NA	NA	NA	-	-	-	-	-	-	-
EU-27	**1 416**	**1 086**	**1 020**	**100%**	**-396**	**-28%**	**-66**	**-6%**	**-**	**-**

As shown in the previous tables, several countries use the notation key "IE" for some subcategories. This can be explained by the fact that they apply carbon balances with several processes occuring within the same industrial plant, which makes differentiation into the various subcategories complex. 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 related to the use of solid fuels in iron and steel production (except eventual iron and steel gases sold to operators from other sectors) 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 4.23.

Table 4.23 CO_2 Emissions (2022) 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	CO2 Emissions in kt			Share in EU-27 Emissions in 2022	Share 2C1
	1A2a	2C1	Combined		
Austria	1 936	10 280	12 215	10%	84%
Belgium	978	3 417	4 395	4%	78%
Bulgaria	111	11	121	0%	9%
Croatia	64	13	77	0%	17%
Cyprus	0	NA,NO	0	0%	-
Czechia	1 622	5 634	7 257	6%	78%
Denmark	81	NO	81	0%	-
Estonia	1	NO	1	0%	-
Finland	799	1 957	2 756	2%	71%
France	3 798	10 050	13 849	11%	73%
Germany	33 691	15 182	48 872	39%	31%
Greece	123	82	205	0%	40%
Hungary	104	637	741	1%	86%
Ireland	2	NO	2	0%	-
Italy	8 758	1 392	10 150	8%	14%
Latvia	1	NO	1	0%	-
Lithuania	NO	0	0	0%	100%
Luxembourg	231	79	311	0%	26%
Malta	0	NO	0	0%	-
Netherlands	4 114	16	4 130	3%	0%
Poland	3 067	1 422	4 489	4%	32%
Portugal	96	54	150	0%	36%
Romania	1 024	2 901	3 925	3%	74%
Slovakia	2 474	3 324	5 798	5%	57%
Slovenia	191	51	243	0%	21%
Spain	NO	1 740	1 740	1%	100%
Sweden	1 323	2 233	3 556	3%	63%
EU-27	**64 590**	**60 475**	**125 065**	**100%**	**48%**

Note: Abbreviations are 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 4.23) varies significantly across countries. This indicates that the boundary between 1A2a and 2C1 is not uniformly interpreted by countries. The nine countries with largest combined CO_2 emissions from iron and steel production allocate their emissions in the following ways in 2022:

- Germany: Around 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, 73% are allocated in 2C1 in 2022 in the most recent inventory. Emissions from sinter production are reported under 1A2a.

- 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 (86%) 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: 78% of emissions are reported under category 2C1. It also includes emissions from limestone and dolomite use.
- Spain: Since the most recent inventory, all emissions are reported in the CRT 2C1 category.
- Slovakia: 57% 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 productions, total CO_2 emissions from total production processes were allocated directly in steel production category.
- Poland: 32% 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

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 4.24 summarises information by countries on emission trends for the key source PFCs from category 2C3 Aluminium Production. PFC emissions from 2C3 Aluminium production account for 0.006 % of total EU GHG emissions (including indirect CO_2 and LULUCF, but without international aviation) in 2022. Between 1990 and 2022, PFC emissions from this source decreased by 99.0%. In 2022, Greece contributed the highest share among the EU, amounting to 35.6% of overall GHG emissions, followed by Germany (19.8%), Sweden (19.4%) and France (18.4%). Of the eight countries reporting PFC emissions under this category in 2022, five use plant or country-specifc emission factors.

Table 4.24 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-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1 032	NO	NO	-	-1 032	-100%	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	1 117	NO	NO	-	-1 117	-100%	-	-	NA	NA
Cyprus	-	-	-	-	-	-	-	-	NA	NA
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	-	-	-	-	-	-	-	-	NA	NA
Finland	NO	NO	NO	-	-	-	-	-	NA	NA
France	3 211	38	33	18.4%	-3 178	-99%	-6	-15%	-	-
Germany	2 597	59	35	19.8%	-2 562	-99%	-24	-41%	NA,T2	CS,NA
Greece	171	86	63	35.6%	-108	-63%	-23	-27%	NA,T3	NA,PS
Hungary	338	NO	NO	-	-338	-100%	-	-	NA,NO	NA,NO
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	1 778	NO	NO	-	-1 778	-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	2 374	15	NO	-	-2 374	-100%	-15	-100%	NA	NA
Poland	NO	NO	NO	-	-	-	-	-	NA	NA
Portugal	NA,NO	NO	NO	-	-	-	-	-	NO	NO
Romania	2 530	3	1	0.7%	-2 529	-100%	-2	-63%	NA,T2	D,NA,PS
Slovakia	214	14	6	3.3%	-208	-97%	-8	-59%	NA,T1,T2	D,NA,PS
Slovenia	187	7	4	2.2%	-183	-98%	-3	-45%	NA,T3	D,NA,PS
Spain	1 046	28	1	0.5%	-1 045	-100%	-27	-97%	NA,T2	D,NA
Sweden	511	45	34	19.4%	-477	-93%	-10	-23%	T2	D
EU-27	**17 106**	**295**	**177**	**100%**	**-16 929**	**-99%**	**-118**	**-40%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

All countries reduced drastically their PFC emissions from this source between 1990 and 2022. France, Germany, Romania, and the Netherlands, had the largest decreases in absolute terms. The decreasing trend of PFC emissions from this key source between 1990 and 2022 is due to production stop or decline as well as to process improvements. The emission peak in 2002 (see Figure 4) can be explained by technological changes and sub-optimal conditions of operation (in France and in the Netherlands).

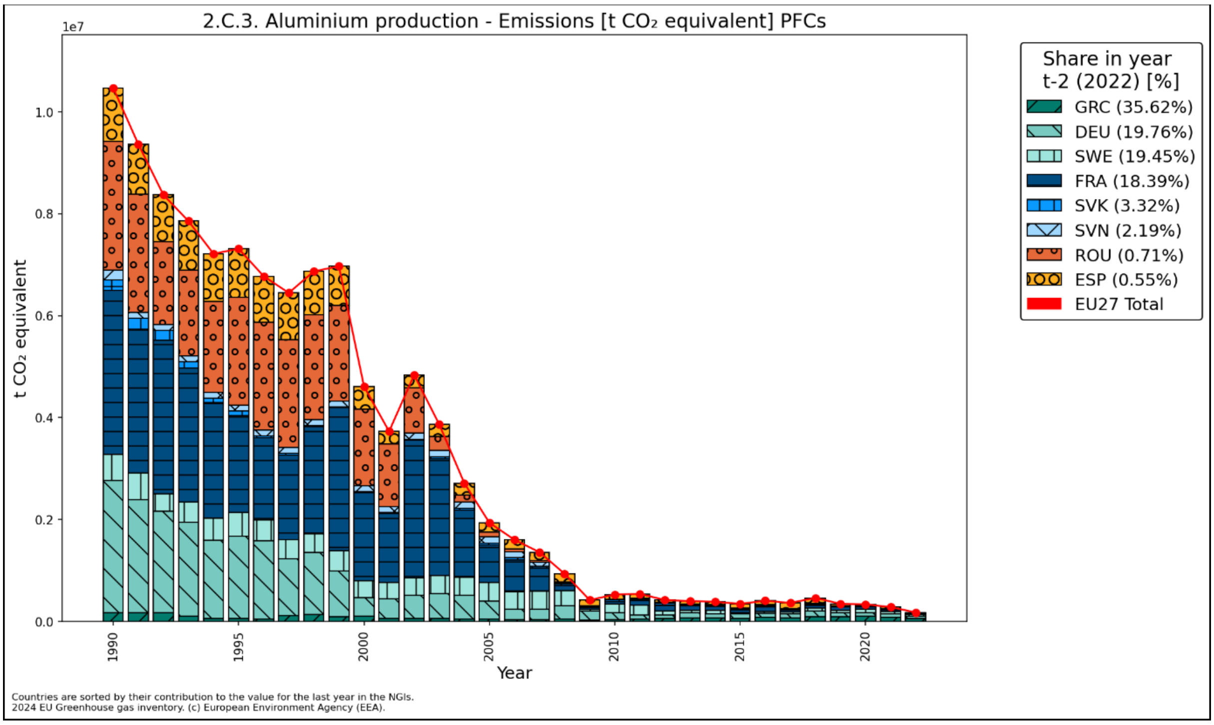
In the review of the 2014 inventory submission of the European Union, the ERT recommended that the European Union provides in the NIR adequate methodology overviews to enable the ERT to make a thorough review of the AD and EF used in the aluminium production emission estimations provided by Greece, the Netherlands and Sweden. This information is provided below. Additional information can be found in the individual NIDs (Greece: section 4.13, Netherlands: section 4.4, Sweden: section 4.4.3). An overview of methods can also be found in Annex III of 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 4.12 2C3 Aluminium Production: PFC emissions



Besides PFC emissions, aluminium production is a source of CO_2 emissions. Of the ten countries which reported CO_2 emissions from aluminium production for 2022, one uses 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, two use country-specific emission factors and seven use plant-specifc emission factors (Table 4.25). Information on the reported CO_2 emissions can be found in the overview table in chapter 4.2.3. Information on activity data can be found in the CRT tables. Further details, e.g. on assumptions made by the various countries, can be found in the countries' NIR/NIDs.

Table 4.25 2C3 Aluminium Production: Countries' contributions to CO_2 emissions and information on method applied and emission factor

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	150	6	5	0.3%	-145	-96%	-1	-15%	T3	PS
Belgium	-	-	-	-	-	-	-	-	-	-
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	693	622	33.5%	88	17%	-71	-10%	-	-
Germany	1 012	696	466	25.2%	-545	-54%	-230	-33%	T3	CS
Greece	225	299	302	16.3%	76	34%	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	82	15	0.8%	-393	-96%	-67	-82%	T1a	D
Poland	78	NO	NO	-	-78	-100%	-	-	NA	NA
Portugal	NO	NO	NO	-	-	-	-	-	NO	NO
Romania	268	337	120	6.4%	-149	-55%	-217	-65%	T3	PS
Slovakia	121	259	111	6.0%	-10	-8%	-147	-57%	T3	PS
Slovenia	170	56	30	1.6%	-140	-82%	-26	-47%	T2	D,PS
Spain	610	334	9	0.5%	-602	-99%	-326	-97%	T2,T3	D,PS
Sweden	133	174	175	9.4%	42	31%	1	1%	T3	PS
EU-27	**4 317**	**2 936**	**1 855**	**100%**	**-2 462**	**-57%**	**-1 081**	**-37%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are 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 4.2.3.

4.2.4 Non-energy products from fuels and solvent use (CRT Source Category 2D)

This source category includes greenhouse gas emissions from non-energy products from fuel and solvent use. In 2022, 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 4.26 summarises information by countries on total GHG emissions. Between 1990 and 2022, GHG emissions from 2D non-energy products from fuels and solvent use decreased by 21.5 %.

Table 4.26: 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	2022	1990	2022	1990	2022	1990	2022
Austria	349	172	349	172	NA,NO	NA	NA,NO	NA
Belgium	202	123	202	123	NA,NO	NA	NA,NO	NA
Bulgaria	82	16	82	16	NA,NO	NA,NO	NA,NO	NA,NO
Croatia	182	73	182	73	NA,NO	NA	NA,NO	NA
Cyprus	4	5	4	5	NA,NE,NO	NA,NE	NA,NE,NO	NA,NE
Czechia	126	120	126	120	NA,NO	NA,NO	NA,NO	NA,NO
Denmark	72	104	71	103	0	0	0	1
Estonia	36	36	36	36	NO	NO	NO	NO
Finland	220	134	218	133	1	1	0	0
France	1 027	1 122	1 024	1 120	1	2	2	0
Germany	2 983	2 122	2 982	2 121	1	1	NA	NA
Greece	130	64	130	64	NA,NO	NA,NO	NA,NO	NA,NO
Hungary	225	124	225	124	NA,NO	NA,NO	NA,NO	NA,NO
Ireland	96	111	96	111	NO	NO	NO	NO
Italy	370	287	370	287	NA,NO	NA,NO	NA,NO	NA,NO
Latvia	44	45	44	45	NA,NO	NA,NO	NA,NO	NA,NO
Lithuania	7	15	7	15	NO	NO	NO	NO
Luxembourg	23	26	23	26	NO	NO	NO	NO
Malta	4	6	4	6	NA,NO	NA	NA,NO	NA
Netherlands	188	341	187	341	NO	NA,NO	0	0
Poland	213	321	213	321	NA,NO	NA,NO	NA,NO	NA,NO
Portugal	276	209	276	209	NA,NO	NA,NO	NA,NO	NA,NO
Romania	720	376	720	376	NA,NO	NA,NO	NA,NE,NO	NA,NE,NO
Slovakia	50	41	50	41	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Slovenia	8	15	8	15	NA,NO	NA	NA,NO	NA
Spain	193	409	193	409	NA,NO	NA	NA,NO	NA
Sweden	393	30	393	30	NA	NA	NA	NA
EU-27	**8 220**	**6 449**	**8 214**	**6 443**	**3**	**4**	**2**	**1**

Abbreviations explained in the Chapter 'Units and abbreviations'.

4.2.4.1 2D1 Lubricant Use

CO_2 emissions from this sector amounted to approximately 0.06% of total GHG emissions in 2022. CO_2 emissions from this sector decreased by 34.1% since 1990.

Table 4.27 2D1 Lubricant use: countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	90	26	35	1.8%	-55	-61%	9	33%	T1	D
Belgium	199	74	78	4.1%	-121	-61%	4	5%	T1	D
Bulgaria	82	12	10	0.5%	-72	-88%	-1	-12%	-	-
Croatia	31	17	19	1.0%	-13	-41%	1	7%	T1	D
Cyprus	4	4	5	0.2%	1	13%	0	5%	T1	D
Czechia	116	98	88	4.7%	-28	-24%	-10	-10%	T1	D
Denmark	50	32	32	1.7%	-18	-36%	0	0%	T1	D
Estonia	16	4	5	0.3%	-11	-69%	1	28%	T1	D
Finland	208	108	90	4.8%	-118	-57%	-18	-17%	T1	D
France	533	326	311	16.6%	-221	-42%	-15	-5%	-	-
Germany	189	201	201	10.7%	12	7%	0	0%	T2	CS
Greece	78	35	43	2.3%	-35	-45%	8	22%	T1	D
Hungary	71	24	27	1.4%	-44	-62%	2	10%	T1	D
Ireland	36	25	26	1.4%	-10	-28%	0	2%	T1	D
Italy	351	207	180	9.6%	-170	-49%	-27	-13%	T1	D
Latvia	23	13	11	0.6%	-12	-51%	-2	-13%	T1	D
Lithuania	6	15	10	0.5%	4	67%	-5	-33%	T1	D
Luxembourg	6	4	5	0.2%	-2	-26%	1	18%	T1	D
Malta	3	4	4	0.2%	1	46%	1	19%	T1	D
Netherlands	85	92	93	5.0%	8	10%	1	1%	T1	D
Poland	202	148	130	6.9%	-71	-35%	-18	-12%	T1	D
Portugal	90	60	61	3.2%	-29	-33%	1	2%	NO	NO
Romania	175	68	68	3.6%	-107	-61%	-1	-1%	T1	D
Slovakia	48	22	28	1.5%	-20	-41%	7	30%	T1	D
Slovenia	4	26	6	0.3%	1	34%	-20	-78%	M	M
Spain	161	310	314	16.7%	154	96%	4	1%	T1	D
Sweden	158	C	C	-	-158	-100%	-	-	T1	D
EU-27	**3 013**	**1 955**	**1 879**	**100%**	**-1 134**	**-38%**	**-76**	**-4%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

4.2.4.2 2D3 Other non-energy products from fuels and solvent use

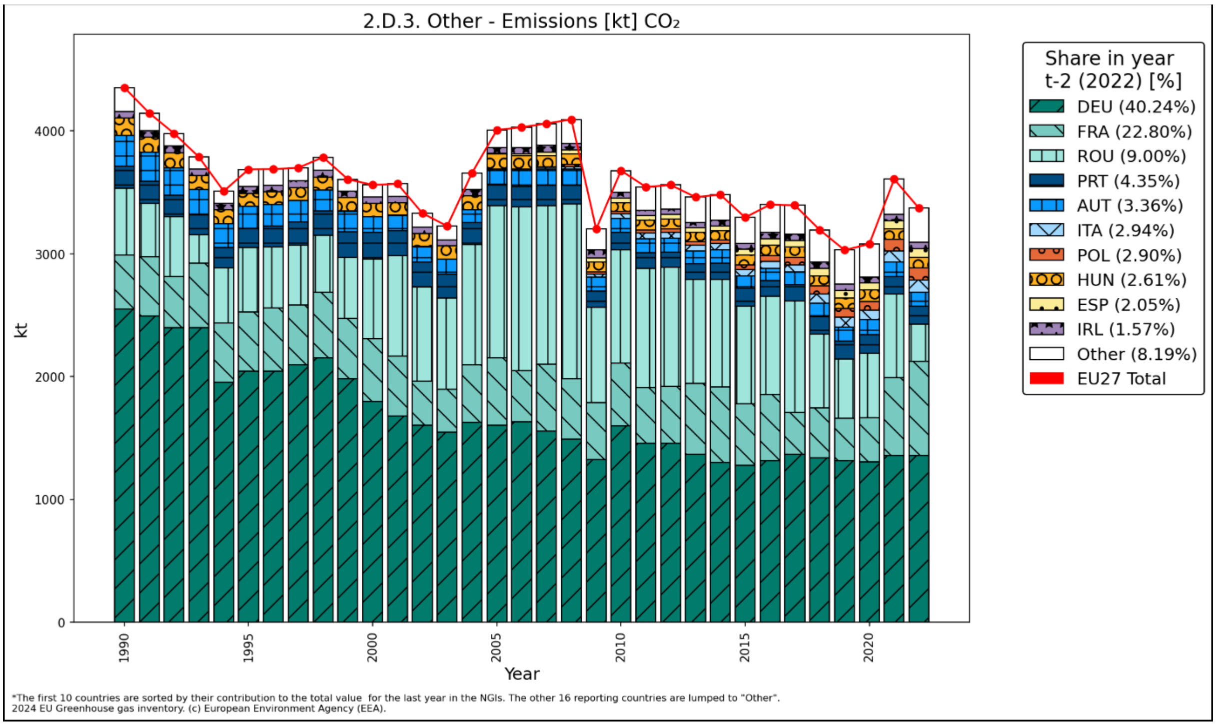
CO_2 emissions from this sector amounted to approximately 0.11 of total GHG emissions in 2022. CO_2 emissions decreased in 26% between 1990 and 2022. Some countries do not report emissions in this category for 1990, but report emissions, mainly from urea use in the transport sector, for more recent years.

Table 4.27 2D3 Other non-energy products from fuels and solvent use: countries' contributions to CO_2 emissions

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	252	119	113	3.4%	-138	-55%	-5	-4%	NA,T1,T2	CS,D,NA
Belgium	NA,NO	34	34	1.0%	34	∞	0	0%	M,NA,T3	CS,NA,OTH
Bulgaria	NA,NO	4	5	0.1%	5	∞	1	28%	NA,T2	D,NA
Croatia	140	60	51	1.5%	-89	-63%	-9	-15%	OTH,T1	D
Cyprus	IE,NO	0	0	0.0%	0	∞	0	0%	D,NA	D,NA
Czechia	NA,NO	22	22	0.7%	22	∞	0	2%	NA,T2	D,NA
Denmark	NA,NO	10	10	0.3%	10	∞	0	0%	NA	NA
Estonia	18	31	30	0.9%	11	62%	-1	-2%	D,T2	D
Finland	NO	19	19	0.6%	19	∞	1	4%	NA,T1,T2	D,NA
France	438	632	768	22.8%	330	75%	136	22%	NA	NA
Germany	2 551	1 358	1 356	40.2%	-1 195	-47%	-1	0%	NA	NA
Greece	NA,NO	6	7	0.2%	7	∞	1	19%	D,NA	D,NA
Hungary	139	85	88	2.6%	-51	-37%	3	3%	T1,T2	D
Ireland	53	51	53	1.6%	0	-1%	1	3%	T1,T2	D
Italy	NA,NO	93	99	2.9%	99	∞	7	7%	NA,T2	M,NA,PS
Latvia	21	33	27	0.8%	6	27%	-7	-20%	CS,D,T1,T2	D,PS
Lithuania	NO	2	2	0.1%	2	∞	1	41%	NA,T3	D,NA
Luxembourg	16	21	19	0.6%	2	15%	-2	-12%	CS,M	CS,D
Malta	0	1	1	0.0%	1	3693%	0	17%	NA,T1	CR,D,NA
Netherlands	NO	30	33	1.0%	33	∞	3	8%	T3	CS
Poland	NO	93	98	2.9%	98	∞	4	5%	T3	D
Portugal	179	141	147	4.3%	-33	-18%	6	4%	NA	NA
Romania	545	683	303	9.0%	-242	-44%	-379	-56%	CR,D,NA,OTH	R,CS,NA,OTH
Slovakia	NO	10	10	0.3%	10	∞	0	4%	CS,NA	CS,NA
Slovenia	NO	6	6	0.2%	6	∞	0	2%	M	M
Spain	NA,NO	65	69	2.1%	69	∞	4	6%	NA	NA
Sweden	217	139	NA	-	-217	-100%	-139	-100%	T1,T3	CS,D
EU-27	**4 570**	**3 746**	**3 371**	**100%**	**-1 199**	**-26%**	**-375**	**-10%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 4.13 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.

4.2.5 Electronics Industry (CRT 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. F-gases are used for plasma etching and wafer cleaning as well as cleaning of the chamber walls of thin-film deposition (TFD) and diffusion tools after processing substrates.

Emissions from photovoltaics industry and heat transfer fluids (HTFs) are reported by very few Member States only. Manufacture of TFT (thin-film transistors) Flat Panel Displays does currently not take place in the EU.

The gases emitted include PFCs, SF_6 and NF_3 while HFC emissions occur to a 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.

However, recent supply chain considerations as well as overall digitalization might result in strengthening of the EU electronics industry and related increase of emissions in the near future.

4.2.6 Product uses as substitutes for ODS (CRT 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. They were first introduced to the EU market 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 recently revised EU F-gas Regulation No. 2024/573, which establishes a reduction scheme for HFCs and other measures to limit use and emissions of F-gases. The revised EU F-gas Regulation has been strengthened as regards numerous measures that were in place already, but also features extended prohibitions for various applications and an enhanced schedule for HFC phase-out by 2050.

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 subcategory 2.F nowadays (see PFC column in Table.4.29 below) but mainly in electronics industry (2.E).

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) was common but decreased widely in recent years due to restrictions at EU level through the F-gas Regulation and national rules.

Table 4.28: Key categories for sector 2F (Table excerpt)

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2022		1990	2022	
2.F.1. Refrigeration and air-conditioning: no classification (HFCs)	5	54307	T	0	L	100%

For 2.F Product uses as substitutes for ODS, table 1 summarizes information by Member States on emission trends of total GHG emissions, 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 considered in the total greenhouse gas emission estimates.

Table.4.29 2F Product uses as substitutes for ODS in 1990 and 2022: 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	2022	1990	2022	1990	2022
Austria	NO	1 409	NO	1 409	NO	NO
Belgium	NO	2 148	NO	2 148	NO	NO
Bulgaria	NO	702	NO	702	NO	NO
Croatia	NO	1 812	NO	1 812	-	-
Cyprus	NE,NO	384	NE,NO	384	-	-
Czechia	NO	3 609	NO	3 609	NO	0
Denmark	NO	261	NO	261	NO	0
Estonia	NO	197	NO	197	-	-
Finland	0	760	0	760	NO	1
France	IE,NO	9 085	IE,NO	9 085	-	-
Germany	NA,IE,NO	7 585	IE,NA,NO	7 581	NA,NO	4
Greece	NO	4 581	NO	4 557	NO	24
Hungary	0	1 748	0	1 746	NO	2
Ireland	NO	663	NO	663	NO	NO
Italy	NO	9 073	NO	9 073	NO	NO
Latvia	NO	250	NO	250	NO	NO
Lithuania	NO	536	NO	536	NO	NO
Luxembourg	0	39	0	39	NO	NO
Malta	NE,IE,NO	205	IE,NE,NO	205	NO	0
Netherlands	NO	892	NO	892	-	-
Poland	NO	4 452	NO	4 442	NO	10
Portugal	NA,NO	1 998	NA,NO	1 968	NA,NO	30
Romania	0	1 972	0	1 972	NO	0
Slovakia	NO	481	NO	481	NO	0
Slovenia	NO	282	NO	282	NO	NO
Spain	NA,NO	5 223	NA,NO	4 230	NO	13
Sweden	6	811	6	811	NO	NO
EU-27	**6**	**61 158**	**6**	**60 095**	**NA,NO**	**84**

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 2022

F-gas emissions from 2.F Product uses as substitutes for ODS account for 2.4% of total EU-27 GHG emissions (without LULUCF) in 2022. HFC emissions account for almost all of 2.F emissions (98%) and were about 10000 times higher in 2022 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 implemented by the EU ODS Regulation, 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 grown in Europe in the last decades.

Table.4.30 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 ca. 90% (EU-27) of HFC emissions from this source category. While ODS were formerly widely used as aerosols and foam blowing agents, the subcategories 2.F.2 Foam blowing agents and 2.F.4 Aerosols/Metered Dose Inhalers contribute today approximately 3% each. Emissions from fire protection relate to 4% of HFC emissions from 2.F in 2022.

The EU F-gas Regulation 2024/573 sets out several measures to reduce use and emissions of F-gases which build on measures set out by the previous F-gas regulations . These measures include restrictions of the bulk supply of HFCs on the EU market (the so called HFC phase out) which started back in 2015 and resulted in significant price increases for HFCs on the EU market. Together with further restrictions, the HFC phase-out is eliminating the use of HFCs by 2050 apart from very few exceptions.

Other important measures of the F-gas Regulation relate to placing on the market bans for certain products as well as training of personnel, containment and recovery of F-gases, labelling and reporting

Table.4.30 2F Product uses as substitutes for ODS: Countries' sub-categories of HFC emissions (kt CO_2 equivalents) in 2022

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	1 409	1 355	14	12	27	NO	-
Belgium	2 148	2 023	69	10	46	NO	NO
Bulgaria	702	679	NO	13	10	NO	NO
Croatia	1 812	1 781	16	6	10	-	-
Cyprus	384	370	1	10	3	-	-
Czechia	3 609	3 573	2	31	3	NO	NO
Denmark	261	250	1	NO	11	NO	NO
Estonia	197	191	2	2	3	-	-
Finland	760	738	4	IE,NA,NO	17	NO	NO
France	9 085	8 288	177	31	565	24	IE,NO
Germany	7 581	6 799	319	93	369	IE,NO	NO
Greece	4 557	4 194	170	153	41	-	-
Hungary	1 746	1 553	146	16	31	NO	-
Ireland	663	576	NO	34	53	NO	NO
Italy	9 073	6 868	412	1 641	152	-	-
Latvia	250	244	1	0	6	NO	NO
Lithuania	536	473	50	4	9	NO	NO
Luxembourg	39	37	1	NO	1	NO	NO
Malta	205	201	1	2	1	NO	NO
Netherlands	892	764	-	-	-	-	129
Poland	4 442	4 282	72	87	1	1	NO
Portugal	1 968	1 793	52	107	17	NO	NO
Romania	1 972	1 948	1	3	21	NO	NO
Slovakia	481	447	2	22	10	NO	-
Slovenia	282	275	1	0	5	NO	-
Spain	4 230	3 820	36	74	301	NO	NO
Sweden	811	786	10	0	15	-	-
EU-27	**60 095**	**54 307**	**1 561**	**2 351**	**1 724**	**24**	**129**

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 4.31 shows the contribution of each country to EU-27 HFC emissions from 2.F.1 as well as information on the method applied, activity data and emission factor.

Table 4.31 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-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	1 379	1 355	2.5%	1 355	∞	-24	-2%	NA,T2	D,NA
Belgium	NO	2 173	2 023	3.7%	2 023	∞	-150	-7%	NA	NA
Bulgaria	NO	766	679	1.2%	679	∞	-87	-11%	NA,T2	D,NA
Croatia	NO	1 665	1 781	3.3%	1 781	∞	116	7%	T2	CS,D
Cyprus	NO	346	370	0.7%	370	∞	24	7%	T2	D
Czechia	NO	3 704	3 573	6.6%	3 573	∞	-131	-4%	-	-
Denmark	NO	264	250	0.5%	250	∞	-14	-5%	NA,T2	CS,D,NA
Estonia	NO	183	191	0.4%	191	∞	7	4%	T2	CS
Finland	0	810	738	1.4%	738	6285361%	-72	-9%	T2	CS,D
France	NO	9 431	8 288	15.3%	8 288	∞	-1 143	-12%	-	-
Germany	NA,NO	7 051	6 799	12.5%	6 799	∞	-251	-4%	T2	CS,D
Greece	NO	4 287	4 194	7.7%	4 194	∞	-93	-2%	IE,T2,T3	D,IE
Hungary	0	1 631	1 553	2.9%	1 553	72122294%	-79	-5%	T2	CS,D
Ireland	NO	573	576	1.1%	576	∞	4	1%	NA,T2,T3	CS,NA
Italy	NO	7 156	6 868	12.6%	6 868	∞	-288	-4%	T2	CS,D
Latvia	NO	252	244	0.4%	244	∞	-8	-3%	T2	CS,D,OTH
Lithuania	NO	459	473	0.9%	473	∞	14	3%	T2	CS,D,PS
Luxembourg	0	38	37	0.1%	37	57331913%	-1	-3%	NA,T2	CS,M,NA,PS
Malta	NO	206	201	0.4%	201	∞	-4	-2%	NA	NA
Netherlands	NO	784	764	1.4%	764	∞	-21	-3%	NA,T2	CS,NA
Poland	NO	4 802	4 282	7.9%	4 282	∞	-520	-11%	NA	NA
Portugal	NA,NO	1 820	1 793	3.3%	1 793	∞	-27	-1%	NO,T2	D,NO
Romania	NO	1 866	1 948	3.6%	1 948	∞	82	4%	T2	CS,D
Slovakia	NO	643	447	0.8%	447	∞	-195	-30%	T2	CS
Slovenia	NO	277	275	0.5%	275	∞	-1	0%	-	-
Spain	NA,NO	3 089	3 820	7.0%	3 820	∞	731	24%	T2	CS
Sweden	5	819	786	1.4%	781	16804%	-33	-4%	T2	CS,D
EU-27	**5**	**56 472**	**54 307**	**100%**	**54 302**	**1164580%**	**-2 165**	**-4%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

In 2022, HFC emissions from 2.F.1 enormously increased since 1990 (Table 4.31 and Figure 4.14 to Figure 4.18) but decreased by 4% compared to 2021 (EU-27) which is due to the measures of the EU F-gas Regulation.

France, Germany and Italy were responsible for 40% of total EU-27 emissions from this source in 2022.

Figure 4.14: 2F1 Refrigeration and Air conditioning: EU-27 HFC emissions

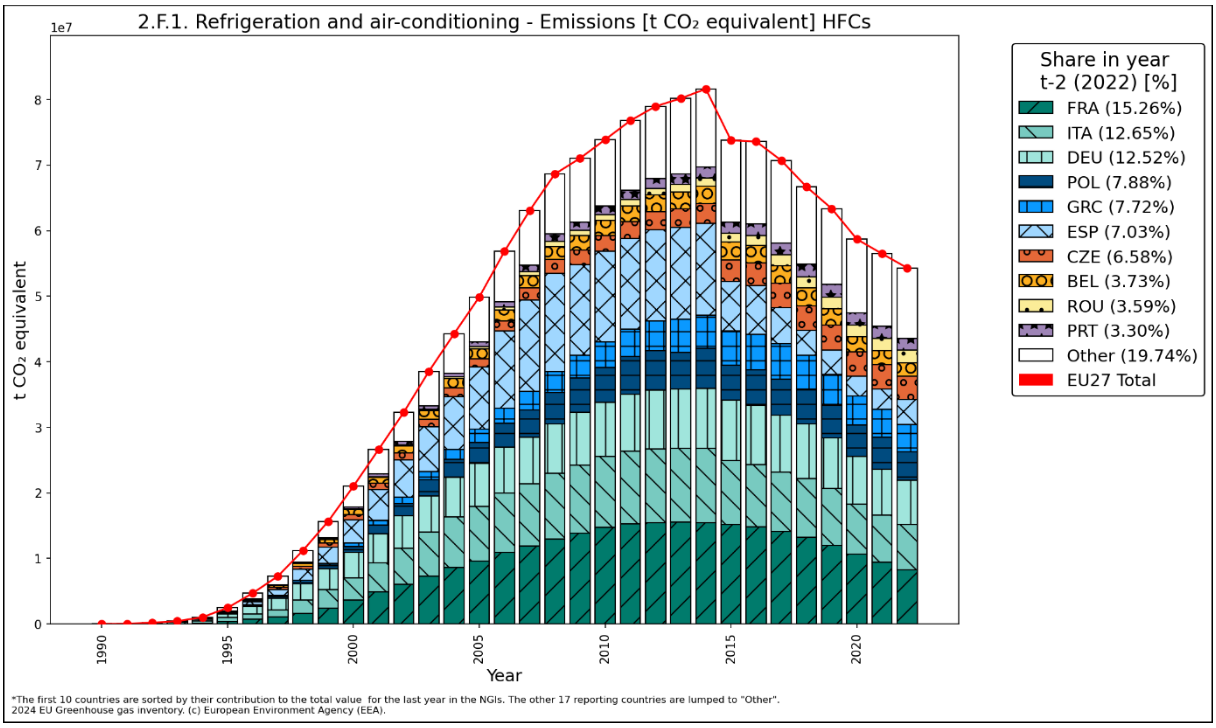


Figure 4.16 shows that emissions in sector 2.F.1 decreased again in 2022.

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 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 and 2017 onwards. This is in line with the policies and measures of the EU F-gas Regulation No. 2024/573 and preceeding F-gas regulations.

Figure 4.15: 2F1a Commercial refrigeration: EU-27 HFC emissions

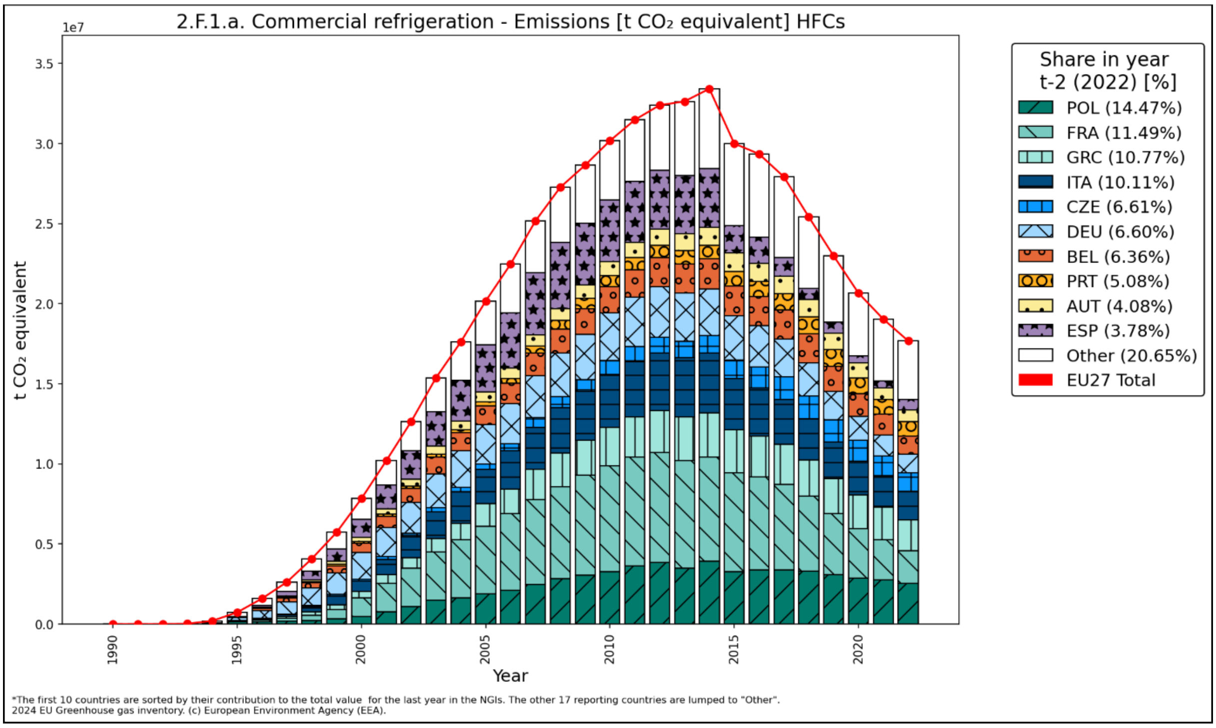


Figure 4.16: 2F1e Mobile air conditioning: EU-27 HFC emissions

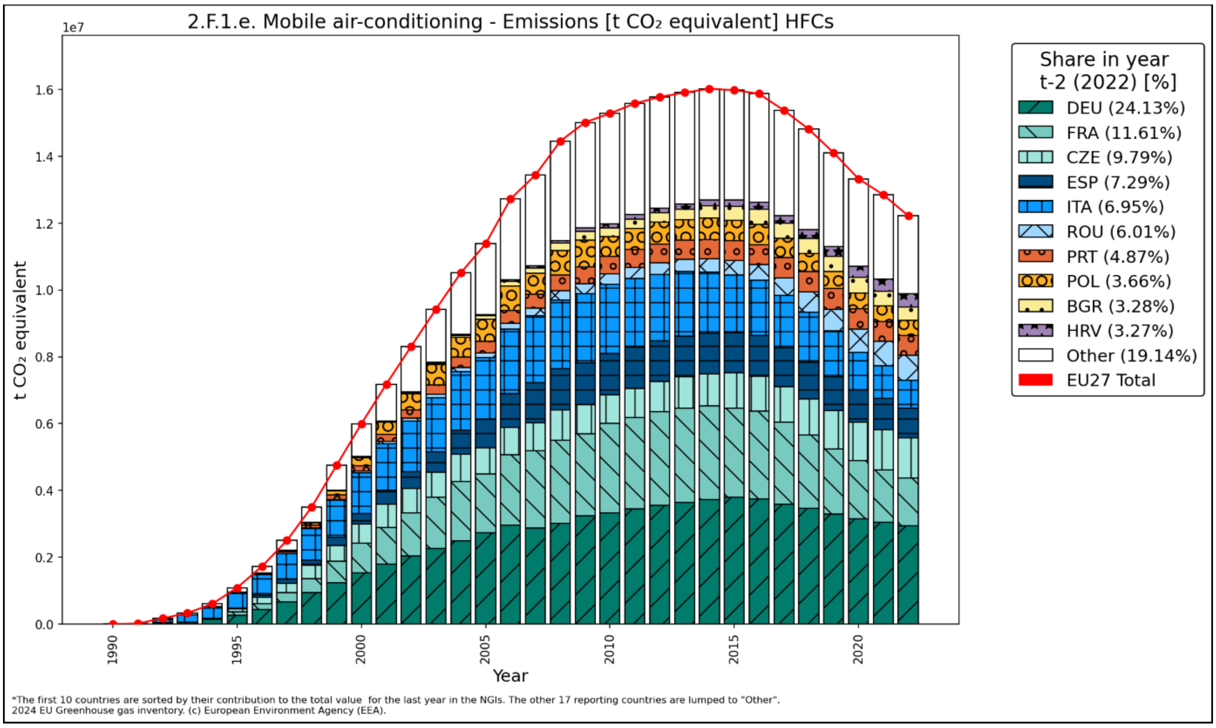


Figure 4.17 shows emission trends for mobile air-conditioning: The EU reported HFC-134a emissions from disposal in the subcategory mobile air conditioning (2.F.1.e) in CRT table 2(II)B-Hs2. Emissions

from 2.F.1.e decreased in all years from 2017 onwards. This relates to the introduction of the low-GWP refrigerants R1234yf and R744 in air-conditioning systems of new passenger cars.

Figure 4.17: 2F1f Stationary air conditioning: EU-27 HFC emissions

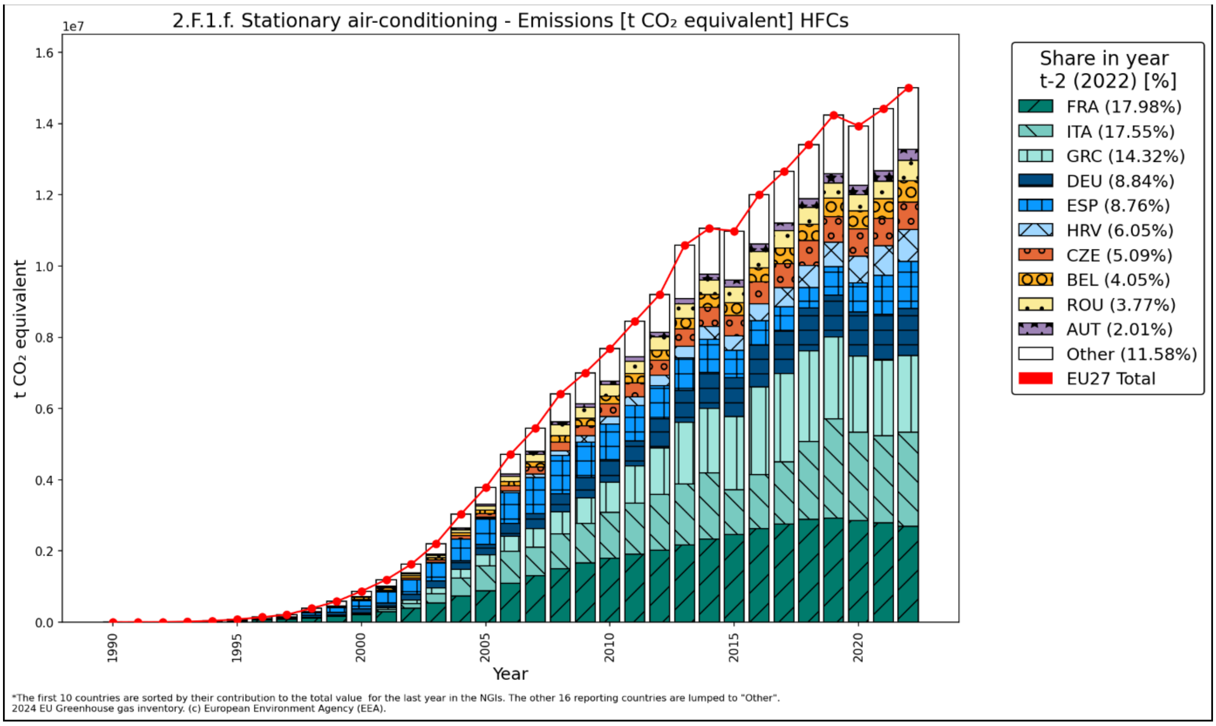


Figure 4.18 shows a consistent trend for sector 2.F.1.f with increasing emissions until 2019. This development reflects the growing use of air conditioning equipment, in particular in Southern Europe, and the delayed uptake of alternatives to HFCs in this sub-category. While emissions in 2020 decreased slightly, which might be a consequence of the COVID-19 pandemic, they increased again in 2021 and 2022.

Table 4.32 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-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	14	14	0.9%	14	∞	0	-1%	NA,T2	D,NA
Belgium	NO	46	69	4.4%	69	∞	23	49%	NA	NA
Bulgaria	NO	NO	NO	-	-	-	-	-	NA	NA
Croatia	NO	17	16	1.0%	16	∞	-1	-5%	CS,NA	D,NA
Cyprus	NE,NO	1	1	0.1%	1	∞	0	1%	CS,NA	CS,NA
Czechia	NO	1	2	0.1%	2	∞	1	121%	NA	NA
Denmark	NO	1	1	0.0%	1	∞	0	-8%	T2	CS,D
Estonia	NO	2	2	0.1%	2	∞	-1	-32%	T2	CS
Finland	NO	4	4	0.3%	4	∞	0	1%	NA,T2	D,NA
France	NO	189	177	11.3%	177	∞	-12	-6%	-	-
Germany	IE,NA,NO	333	319	20.5%	319	∞	-13	-4%	NA,T2	CS,NA
Greece	NO	189	170	10.9%	170	∞	-19	-10%	NA,T2	D,NA
Hungary	NO	156	146	9.4%	146	∞	-10	-6%	NA,T2	CS,NA
Ireland	NO	NO	NO	-	-	-	-	-	NA	NA
Italy	NO	429	412	26.4%	412	∞	-17	-4%	NA,T2	D,NA
Latvia	NO	0	1	0.1%	1	∞	1	159%	T1a	D,OTH
Lithuania	NO	41	50	3.2%	50	∞	9	21%	NA,T2	D,NA
Luxembourg	NO	1	1	0.1%	1	∞	0	-7%	NA,T1	CS,NA
Malta	IE,NO	1	1	0.1%	1	∞	0	8%	NA	NA
Netherlands	-	-	-	-	-	-	-	-	NA	NA
Poland	NO	75	72	4.6%	72	∞	-3	-4%	NA	NA
Portugal	NA,NO	51	52	3.3%	52	∞	2	3%	T2	D
Romania	NO	1	1	0.0%	1	∞	0	-6%	NA,T2	D,NA
Slovakia	NO	2	2	0.1%	2	∞	0	-1%	NA,T2	D,NA
Slovenia	NO	1	1	0.1%	1	∞	0	-5%	NA	NA
Spain	NA,NO	40	36	2.3%	36	∞	-4	-10%	NA	NA
Sweden	NO	16	10	0.7%	10	∞	-6	-36%	T2	PS
EU-27	**E,NA,IE,NO**	**1 612**	**1 561**	**100%**	**1 561**	**∞**	**-51**	**-3%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.
NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

In 2022, HFC emissions from 2.F.2 (Table 3.32 and Figure 4.19) decreased by 2% 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

Figure 4.18: 2F2 Foam Blowing Agents: EU-27 HFC emissions

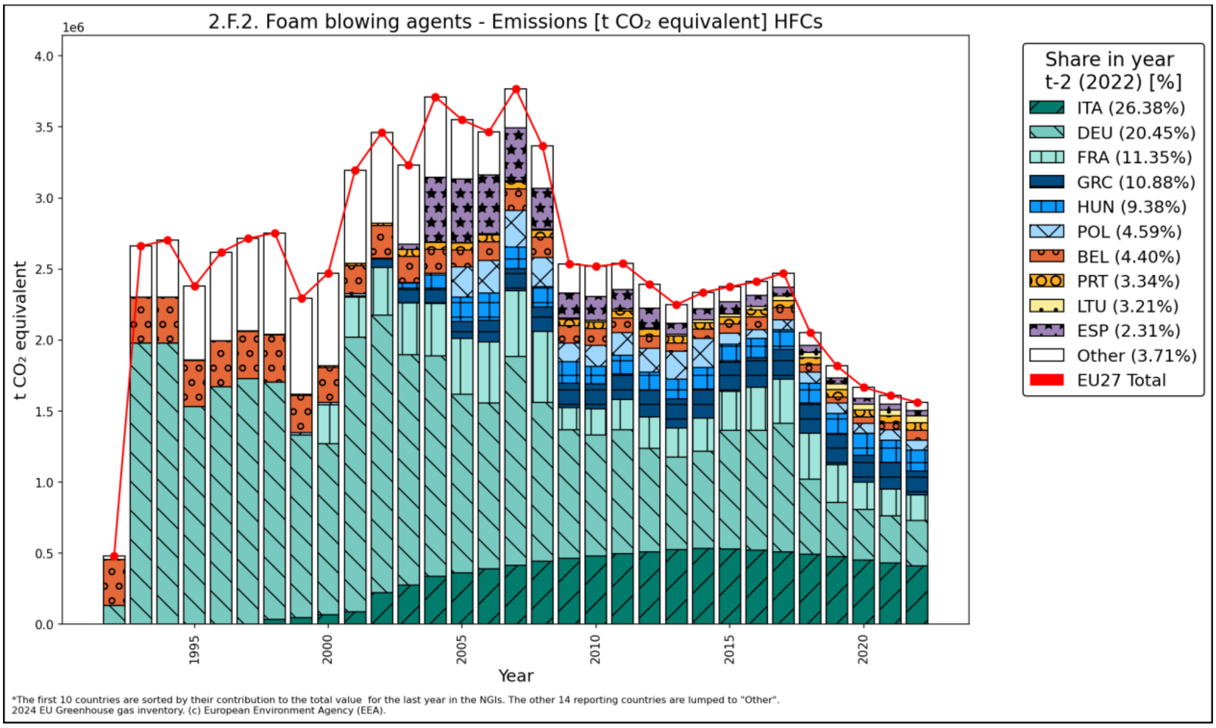


Figure 4.19 displays that emissions from sector 2.F.2 showed an overall increase until 2008 and then dropped to a lower level until 2017 followed by another decrease in recent years as major foam manufacturers converted their production to non-HFC blowing agents (usually hydrocarbons). The F-gas Regulation 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 has been 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 .

Table4.33 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. 1990	2021	2022	Share in EU-27 Emissions in 2022	Change 1990-2022 kt CO2 equiv.	Change 1990-2022 %	Change 2021-2022 kt CO2 equiv.	Change 2021-2022 %	Method	Emission factor Information
Austria	NO	12	12	0.5%	12	∞	1	6%	T2	D
Belgium	NO	10	10	0.4%	10	∞	0	5%	-	-
Bulgaria	NO	13	13	0.6%	13	∞	0	3%	T2	D
Croatia	NO	6	6	0.2%	6	∞	0	-1%	T1,T2	D,PS
Cyprus	NE,NO	9	10	0.4%	10	∞	0	2%	CS	CS
Czechia	NO	30	31	1.3%	31	∞	1	5%	-	-
Denmark	NO	NO	NO	-	-	-	-	-	NA	NA
Estonia	NO	2	2	0.1%	2	∞	0	2%	T2	CS
Finland	NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-	NA	NA
France	NO	36	31	1.3%	31	∞	-5	-14%	-	-
Germany	NA,NO	95	93	4.0%	93	∞	-2	-2%	-	-
Greece	NO	159	153	6.5%	153	∞	-6	-4%	CS	D
Hungary	NO	12	16	0.7%	16	∞	4	30%	T1	D
Ireland	NO	34	34	1.4%	34	∞	0	0%	T2	CS
Italy	NO	1 656	1 641	69.8%	1 641	∞	-14	-1%	T2	CS
Latvia	NO	0	0	0.0%	0	∞	0	0%	T2	D
Lithuania	NO	4	4	0.2%	4	∞	0	0%	T1b	D
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	NO	1	2	0.1%	2	∞	0	5%	-	-
Netherlands	-	-	-	-	-	-	-	-	NA	NA
Poland	NO	91	87	3.7%	87	∞	-3	-4%	-	-
Portugal	NA,NO	74	107	4.5%	107	∞	33	44%	T2	D
Romania	NO	3	3	0.1%	3	∞	0	-5%	T2	D
Slovakia	NO	19	22	0.9%	22	∞	3	15%	T1a	CS
Slovenia	NO	0	0	0.0%	0	∞	0	33%	-	-
Spain	NO	81	74	3.1%	74	∞	-8	-9%	-	-
Sweden	NO	0	0	0.0%	0	∞	0	17%	T1	CS
EU-27	**NE,NA,NO**	**2 347**	**2 351**	**100%**	**2 351**	**∞**	**4**	**0%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'. NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

HFC emissions from 2.F.3 (Table4.33) showed a strong increase from 1995 until peaking in 2016. 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. Since 2016 emissions have been quite stable. Emissions from this category arise on the one hand from assembly, leakage and decommissioning but also from releases in the case of fires and false alarms. 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 and Luxembourg 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. The Netherlands included estimated emissions from this subcategory in the 2.F.6 subcategory.

Figure 4.19: 2F3 Fire Protection, EU-27: HFC emissions

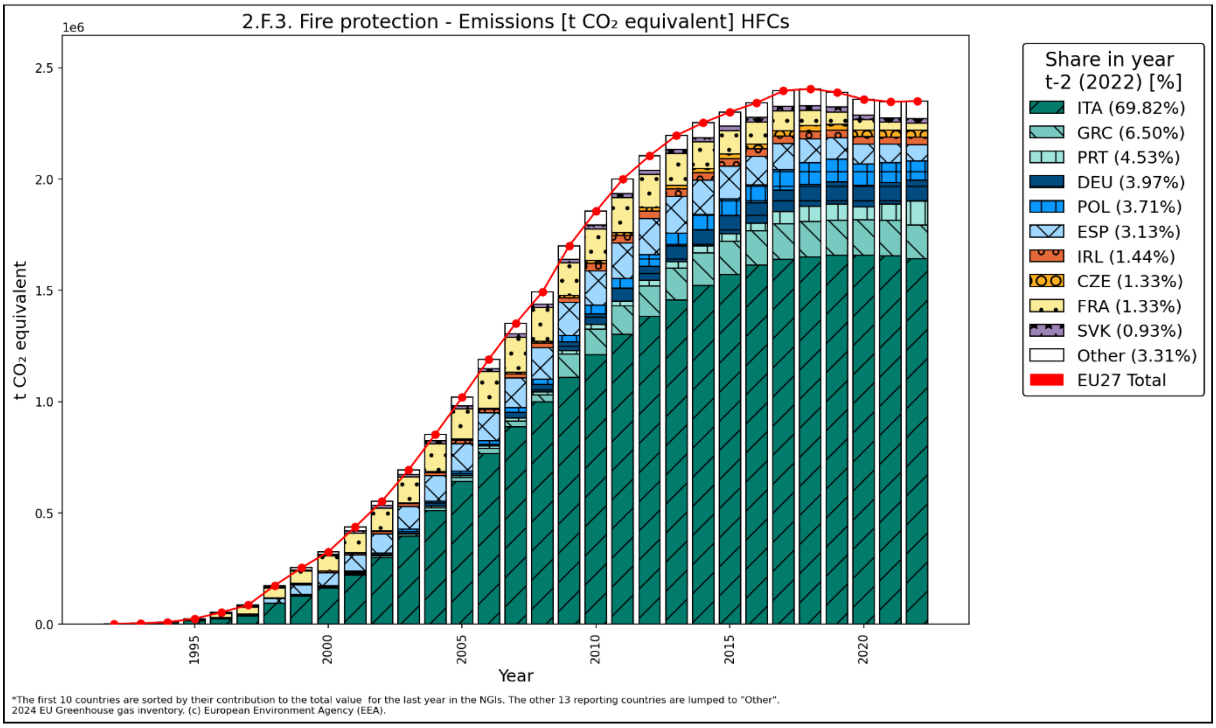


Figure 4.20 illustrates that emissions from fire protection were rather stable in recent years.

Table.4.34 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-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	23	27	1.5%	27	∞	3	14%	T2	D
Belgium	NO	45	46	2.7%	46	∞	0	0%	NA	NA
Bulgaria	NO	10	10	0.6%	10	∞	0	-2%	NA	NA
Croatia	NO	10	10	0.6%	10	∞	0	-1%	T1a	D
Cyprus	NO	3	3	0.2%	3	∞	0	2%	CS	CS
Czechia	NO	2	3	0.2%	3	∞	0	11%	NA	NA
Denmark	NO	10	11	0.6%	11	∞	1	6%	NA,T2	D,NA
Estonia	NO	3	3	0.2%	3	∞	0	12%	NA,T2	CS,NA
Finland	NO	18	17	1.0%	17	∞	-1	-4%	NA,T2	D,NA
France	NO	520	565	32.8%	565	∞	45	9%	NA	NA
Germany	IE,NO	375	369	21.4%	369	∞	-6	-2%	NA,T2	CS,NA
Greece	NO	41	41	2.4%	41	∞	0	0%	T3	D
Hungary	NO	31	31	1.8%	31	∞	1	2%	T2	CS,D
Ireland	NO	51	53	3.1%	53	∞	1	3%	NA,T1,T2	CS,NA
Italy	NO	158	152	8.8%	152	∞	-6	-4%	NA,T2	CS,NA
Latvia	NO	6	6	0.3%	6	∞	-1	-11%	NA,T1a	D,NA
Lithuania	NO	9	9	0.5%	9	∞	0	-2%	T1a	D
Luxembourg	NO	1	1	0.1%	1	∞	0	2%	NA,T1,T2	CS,NA
Malta	NE,NO	1	1	0.0%	1	∞	0	0%	NA	NA
Netherlands	-	-	-	-	-	-	-	-	NA	NA
Poland	NO	0	1	0.0%	1	∞	1	921%	NA	NA
Portugal	NA,NO	16	17	1.0%	17	∞	0	3%	NA,T2	NA,NO
Romania	0	39	21	1.2%	21	12802%	-18	-46%	NA,T2	D,NA
Slovakia	NO	9	10	0.6%	10	∞	1	12%	NA,T1a	D,NA
Slovenia	NO	5	5	0.3%	5	∞	0	6%	NA	NA
Spain	NO	288	301	17.4%	301	∞	13	5%	NA,T2	CS,NA
Sweden	1	14	15	0.9%	13	1030%	1	7%	T2	D
EU-27	**1**	**1 687**	**1 724**	**100%**	**1 723**	**117601%**	**37**	**2%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.
NLD reports HFC emissions from 2.F.2, 2.F.3, 2.F.4 and 2.F.5 in 2.F.6.

HFC emissions from 2.F.4 peaked in 2006 and this rise was due to increased use of medical aerosols throughout Europe, especially for asthma treatment (metered-dose inhalers) (Table.4.34 and Figure 4.20). The HFCs reported in 2.F.4 are HFC-134a (medical and technical aerosols), HFC-227ea (medical aerosols only) and HFC-152a (technical and medical aerosols). Emissions from technical aerosols have been playing 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.

Figure 4.20: 2F4 Aerosols/Metered Dose Inhalers: EU-27 HFC emissions

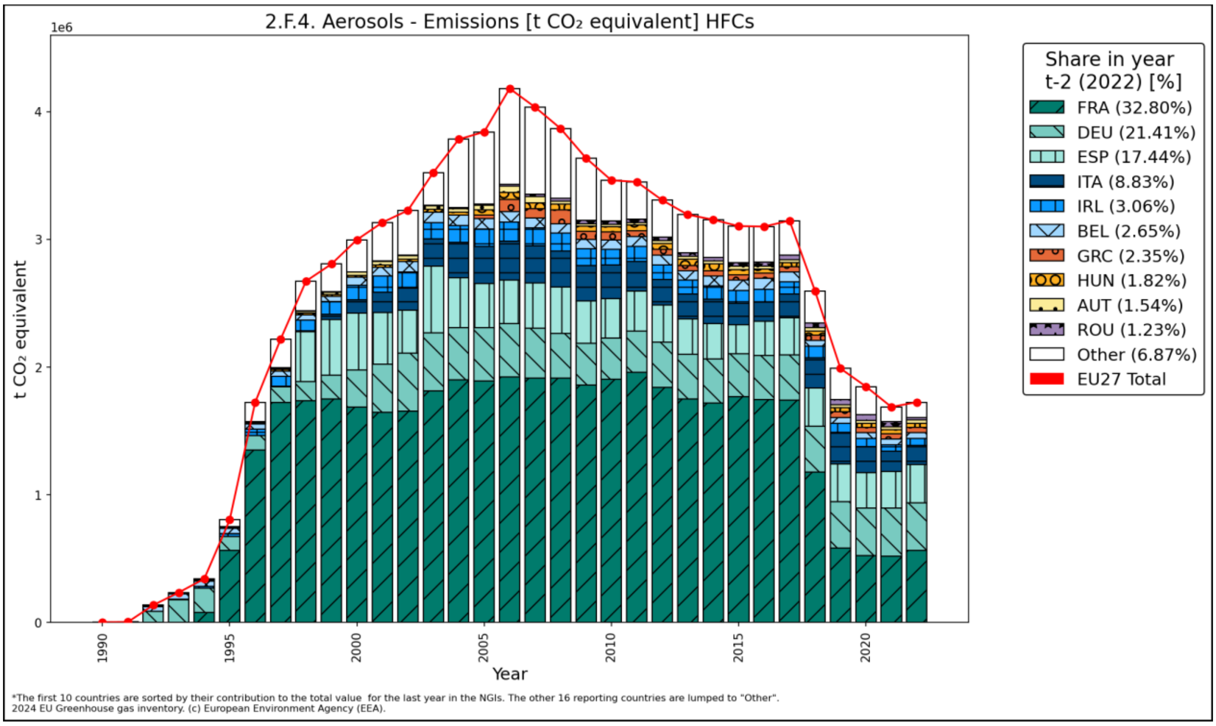


Figure 4.20 shows the stable emission level in 2022.

Only few companies are relevant in terms of HFC emissions from subcategories 2.F.5 Solvents and 2.F.6 Other applications, thus, for confidentiality reasons, MS report emissions together with other subcategories and no further details can be provided in this report.

4.2.7 Other product manufacture and use (CRT 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 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), such as military applications (SF_6), particle accelerators (SF_6), applications of adiabatic properties - shoes and tyres (SF_6, PFCs), soundproof 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 2021. 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.4.35 2G Other: Overview of sources reported under this source category in 2022

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	350	-	-	382	5.5%
BEL	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (C6F14)	NO	NO	87	NO	NO	133	1.9%
BGR	Electrical equipment (SF_6)	NO	NO	24	NO	-	58	0.8%
HRV	Electrical equipment (SF_6)	NO	NO	10	NO	NO	27	0.4%
CYP	Electrical equipment (SF_6)	-	-	18	-	-	24	0.3%
CZE	Electrical equipment (SF_6); Accelerators (SF_6); Soundproof windows (SF_6); Other (SF_6)	NO	NO	63	-	NO	262	3.8%
DNM	Electrical equipment (SF_6); Soundproof windows (SF_6); Other (SF_6)	NO	NO	13	NO	NO	34	0.5%
EST	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	3	NO	NO	6	0.1%
FIN	Electrical equipment (SF_6)	NO	IE,NO	23	NO	NO	44	0.6%
FRK	Electrical equipment (SF_6); Accelerators (SF_6); Other (SF_6, Unspecified mix of PFCs)	1	223	351	-	-	716	10.4%
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)	15	NA,NO	1 832	NO	NA,NO	2 101	30.5%
GRC	Electrical equipment (SF_6)	-	NO	5	-	-	215	3.1%
HUN	Electrical equipment (SF_6); Other (SF_6)	NO	NO	110	NO	NO	355	5.1%
IRL	Electrical equipment (SF_6); Soundproof windows (SF_6); Adiabatic properties: shoes and tyres (SF_6); Other (SF_6)	NO	NO	7	NO	NO	47	0.7%
ITA	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	350	-	NO	794	11.5%
LVA	Electrical equipment (SF_6)	NO	NO	12	NO	NO	16	0.2%

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
LTU	Electrical equipment (SF_6); Accelerators (SF_6)	NO	NO	1	NO	NO	4	0.1%
LUX	Electrical equipment (SF_6); Soundproof windows (SF_6), Other (HFC-43-10mee)	3	NO	9	NO	NO	17	0.2%
MLT	Electrical equipment (SF_6), Other (SF_6, C3F8)	NO	0	0	NO	NO	2	0.0%
NLD	Other (SF_6)	-	-	125	-	-	247	3.6%
POL	Electrical equipment (SF_6)	NO	NO	123	NO	NO	244	3.5%
PRT	Electrical equipment (SF_6)	NO	NO	25	NO	NO	52	0.8%
ROU	Electrical equipment (SF_6)	NO	NO	51	NO	NO	52	0.8%
SVK	Electrical equipment (SF_6)	NO	NO	15	NO	NO	72	1.0%
SVN	Electrical equipment (SF_6)	NA	NA,NO	17	NA	NA	114	1.7%
ESP	Electrical equipment (SF_6); Accelerators (SF_6), Other (SF_6)	NO	NO	247	NO	NO	773	11.2%
SWE	Electrical equipment (SF_6); Soundproof windows (SF_6)	-	NO	39	-	-	104	1.5%
EU-27	**TOTAL**	20	223	3 910	NA,NO	NA,NO	6 896	100.0%

Abbreviations explained in the Chapter 'Units and abbreviations'.

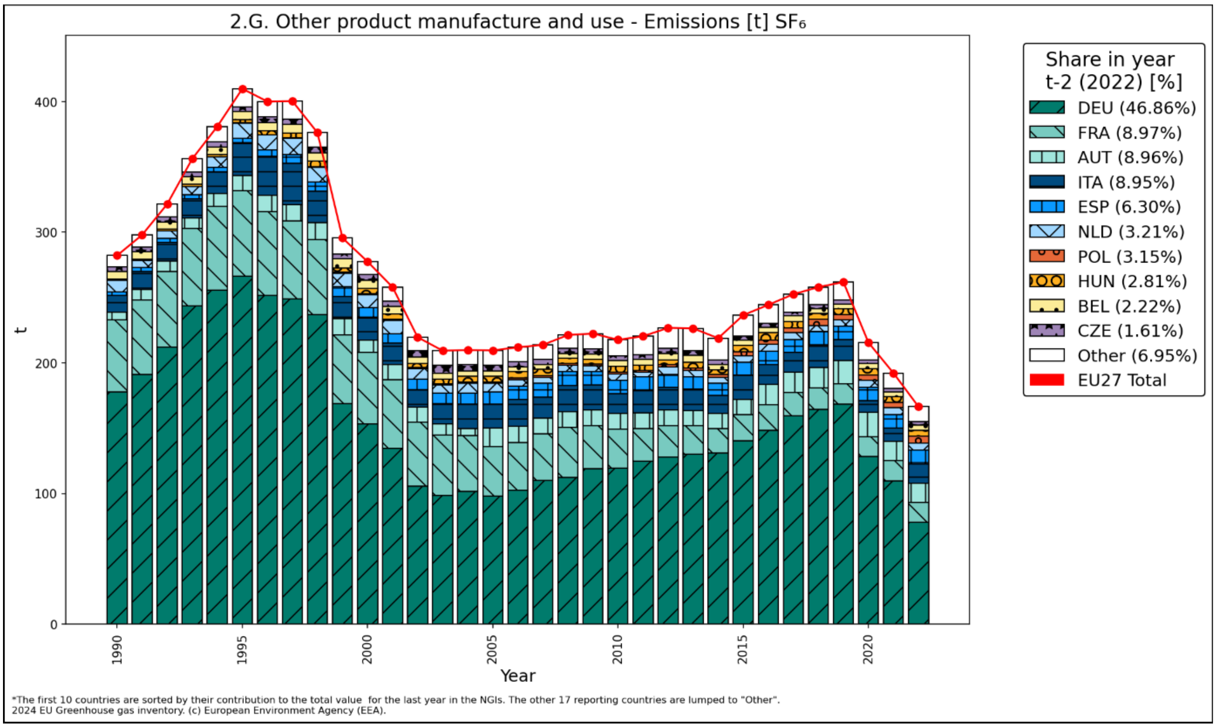
Figure 4.21 and Table 4.36 summarize information by Member State on SF_6 emissions for the key source 2.G. Emissions peaked in the mid 1990ies and have been relatively stable after that until 2002 and showing a small but rather steady increase in the period from 2014 to 2019. However, since 2020 emissions decreased considerably compared to 2019. The development of emissions from this category is dominated by the emission trend in Germany (46.86% of SF_6 emissions from EU-27 in 2022), where the disposal of sound-proof windows containing SF_6 represents a particularly high emission source, which however is decreasing.

Table 4.36: 2G - Member States' contributions to SF_6 emissions

Member State	SF_6 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	136	351	350	9.0%	215	158%	-1	0%	T2	D
Belgium	133	86	87	2.2%	-46	-35%	1	1%	NA,T1,T2	D,NA
Bulgaria	4	23	24	0.6%	20	529%	1	3%	NA,NO,T2	D,NA,NO
Croatia	11	10	10	0.3%	-1	-10%	0	4%	NA,T2	CS,NA
Cyprus	3	18	18	0.5%	15	553%	0	1%	NA,T1	D,NA
Czechia	87	63	63	1.6%	-24	-27%	0	0%	NA,T1	D,NA
Denmark	8	15	13	0.3%	5	55%	-2	-14%	NA,T2,T3	D,NA
Estonia	NO	3	3	0.1%	3	∞	0	2%	NA,T3	CS,NA
Finland	46	22	23	0.6%	-23	-51%	1	5%	NA,T2	CS,NA
France	1 299	366	351	9.0%	-948	-73%	-15	-4%	NA	NA
Germany	4 174	2 573	1 832	46.9%	-2 341	-56%	-740	-29%	CS,D,NA,T3	CS,D,NA
Greece	3	5	5	0.1%	2	67%	0	0%	CS,NA	CS,NA
Hungary	18	107	110	2.8%	92	511%	3	3%	NA,T1,T2	D,NA
Ireland	34	6	7	0.2%	-28	-80%	1	16%	NA,T1	D,NA
Italy	303	242	350	9.0%	47	15%	108	45%	CS,NA,T2	CS,NA,PS
Latvia	NO	12	12	0.3%	12	∞	0	1%	NA,T1	D,NA
Lithuania	NO	1	1	0.0%	1	∞	0	19%	NA,T3	CS,NA
Luxembourg	1	10	9	0.2%	8	917%	-1	-7%	D,NA,T1,T3	CS,D,M,NA,PS
Malta	0	0	0	0.0%	0	2213%	0	80%	D,NA	D,NA
Netherlands	213	124	125	3.2%	-88	-41%	2	1%	CS,NA	CS,NA
Poland	NO	93	123	3.1%	123	∞	31	33%	NA	NA
Portugal	NA	23	25	0.6%	25	∞	2	8%	NO,T1	NO
Romania	0	50	51	1.3%	50	10529%	1	1%	NA,T2	D,NA
Slovakia	0	17	15	0.4%	15	25460%	-2	-12%	NA,T3	CS,NA
Slovenia	10	17	17	0.4%	7	65%	0	-2%	NA,T1,T2,T3	CS,D,NA
Spain	66	240	247	6.3%	181	274%	6	3%	NA,NO,T2,T3	CS,D,NA,NO
Sweden	81	40	39	1.0%	-43	-53%	-1	-3%	T2,T3	CS,PS
EU-27	**6 631**	**4 515**	**3 910**	**100%**	**-2 721**	**-41%**	**-605**	**-13%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations.

Figure 4.21: 2G - Other Product Manufacture and Use: SF_6 Trend in the EU-27 in CO_2 equivalents



4.2.8 IPPU – non-key categories

Table 4.47 provides an overview on the role of non-key categories in the IPPU sector.

Table 4.37 Aggregated GHG emission from non-key categories in the IPPU sector

EU-27	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
2.A.3 Glass production: no classification (CO_2)	3 845.2	4 034.9	3 855.5	1.21%	10.3	0%	-179.4	-4%
2.B.1 Ammonia Production: no classification (CH_4)	2.1	1.8	1.7	0.00%	-0.3	-16%	-0.1	-6%
2.B.1 Ammonia Production: no classification (N_2O)	0.3	0.4	0.4	0.00%	0.1	23%	-0.1	-20%
2.B.10 Other: no classification (CH_4)	108.4	108.8	103.1	0.03%	-5.3	-5%	-5.7	-5%
2.B.10 Other: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other: no classification (N_2O)	741.8	484.9	453.5	0.14%	-288.4	-39%	-31.4	-6%
2.B.10 Other: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.B.10 Other: 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	23.6	15.9	0.00%	-10.6	-40%	-7.7	-33%
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%

EU-27	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production: no classification (N_2O)	3 673.7	1 035.4	751.8	0.24%	-2 921.9	-80%	-283.6	-27%
2.B.5 Carbide Production: no classification (CH_4)	6.2	15.6	8.3	0.00%	2.0	32%	-7.3	-47%
2.B.5 Carbide Production: no classification (CO_2)	1 798.9	246.3	149.7	0.05%	-1 649.2	-92%	-96.6	-39%
2.B.6 Titanium Dioxide Production: no classification (CO_2)	21.5	123.2	127.0	0.04%	105.4	490%	3.8	3%
2.B.7 Soda Ash Production: no classification (CO_2)	1 966.0	1 832.2	1 702.5	0.54%	-263.4	-13%	-129.6	-7%
2.B.8 Petrochemical and Carbon Black Production: no classification (CH_4)	1 211.4	1 293.2	1 182.0	0.37%	-29.4	-2%	-111.1	-9%
2.B.9 Fluorochemical Production: no classification (NF_3)	0.0	4.3	0.9	0.00%	0.9	100%	-3.4	-80%
2.B.9 Fluorochemical Production: no classification (PFCs)	3 955.4	440.4	396.2	0.12%	-3 559.2	-90%	-44.2	-10%
2.B.9 Fluorochemical Production: no classification (SF_6)	1 784.7	167.6	118.4	0.04%	-1 666.3	-93%	-49.2	-29%
2.B.9 Fluorochemical Production: no classification (HFC)	12 810.5	392.0	235.6	0.08%	-12 573.9	-98%	-156.5	-40%
2.C.1 Iron and Steel Production: no classification (CH_4)	419.8	155.3	136.9	0.04%	-283.0	-67%	-18.5	-12%
2.C.2 Ferroalloys Production: no classification (CH_4)	28.7	19.7	15.1	0.00%	-13.6	-47%	-4.6	-23%
2.C.2 Ferroalloys Production: no classification (CO_2)	4 659.8	2 167.6	1 661.5	0.52%	-2 998.3	-64%	-506.1	-23%
2.C.3 Aluminium Production: no classification (CO_2)	4 316.6	2 935.8	1 854.6	0.58%	-2 462.0	-57%	-1 081.2	-37%
2.C.3 Aluminium Production: no classification (SF_6)	14.1	0.0	0.0	0.00%	-14.1	-100%	0.0	0%
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	13.5	14.5	0.00%	14.5	100%	1.0	7%
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)	474.7	56.3	99.3	0.03%	-375.4	-79%	43.0	76%
2.C.5 Lead Production: no classification (CO_2)	391.5	204.4	186.6	0.06%	-204.9	-52%	-17.8	-9%
2.C.6 Zinc Production: no classification (CO_2)	1 610.3	1 004.2	912.7	0.29%	-697.6	-43%	-91.5	-9%
2.C.7 Other: no classification (CH_4)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.C.7 Other: no classification (CO_2)	464.8	526.6	443.6	0.14%	-21.3	-5%	-83.1	-16%
2.C.7 Other: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.C.7 Other: no classification (N_2O)	24.5	13.5	12.2	0.00%	-12.3	-50%	-1.3	-9%
2.C.7 Other: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.C.7 Other: no classification (PFCs)	127.5	0.0	0.0	0.00%	-127.5	-100%	0.0	0%
2.C.7 Other: no classification (SF_6)	742.7	7.9	4.1	0.00%	-738.6	-99%	-3.8	-48%
2.C.7 Other: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%

EU-27	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
2.D.1 Lubricant Use: no classification (CH_4)	1.9	0.4	0.4	0.00%	-1.5	-77%	0.0	0%
2.D.1 Lubricant Use: no classification (CO_2)	3 012.8	1 955.4	1 879.0	0.59%	-1 133.8	-38%	-76.4	-4%
2.D.1 Lubricant Use: no classification (N_2O)	2.7	2.8	2.9	0.00%	0.2	6%	0.1	4%
2.D.2 Paraffin Wax Use: no classification (CH_4)	0.2	0.4	0.4	0.00%	0.2	119%	0.1	19%
2.D.2 Paraffin Wax Use: no classification (CO_2)	631.4	1 121.7	1 193.3	0.38%	562.0	89%	71.7	6%
2.D.2 Paraffin Wax Use: no classification (N_2O)	0.7	1.4	1.6	0.00%	0.9	136%	0.1	10%
2.D.3 Other: no classification (CH_4)	0.3	0.4	0.5	0.00%	0.2	71%	0.1	20%
2.D.3 Other: no classification (CO_2)	4 570.0	3 745.6	3 370.7	1.06%	-1 199.3	-26%	-374.9	-10%
2.D.3 Other: 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)	68.6	35.0	35.7	0.01%	-32.9	-48%	0.7	2%
2.E.1 Integrated Circuit or Semiconductor: no classification (NF_3)	21.9	63.6	87.6	0.03%	65.8	301%	24.0	38%
2.E.1 Integrated Circuit or Semiconductor: no classification (PFCs)	392.2	495.0	508.7	0.16%	116.4	30%	13.6	3%
2.E.1 Integrated Circuit or Semiconductor: no classification (SF_6)	245.0	132.1	168.9	0.05%	-76.2	-31%	36.8	28%
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	0.1	0.0	0.00%	0.0	0%	-0.1	-100%
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: no classification (HFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.5 Other: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.5 Other: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.5 Other: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.E.5 Other: 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	81.5	74.4	0.02%	74.4	100%	-7.1	-9%
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%
2.F.1 Refrigeration and air-conditioning: no classification (Unspecified mix of HFCs and PFCs)	0.0	1 344.0	978.9	0.31%	978.9	100%	-365.1	-27%
2.F.2 Foam Blowing Agents: no classification (HFCs)	0.0	1 611.8	1 561.1	0.49%	1 561.1	100%	-50.7	-3%

EU-27	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
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	2 347.1	2 350.8	0.74%	2 350.8	100%	3.8	0%
2.F.3 Fire Protection: no classification (PFCs)	0.0	10.1	9.6	0.00%	9.6	100%	-0.5	-5%
2.F.4 Aerosols: no classification (HFCs)	1.5	1 686.9	1 724.0	0.54%	1 722.5	117600%	37.1	2%
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	30.1	24.2	0.01%	24.2	100%	-5.9	-20%
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)	0.0	130.2	128.7	0.04%	128.7	100%	-1.4	-1%
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)	1 375.4	190.1	259.3	0.08%	-1 116.1	-81%	69.2	36%
2.G.2 SF_6 and PFCs from Other Product Use: no classification (PFCs)	205.9	293.8	223.1	0.07%	17.2	8%	-70.6	-24%
2.G.2 SF_6 and PFCs from Other Product Use: no classification (SF_6)	4 275.2	3 061.0	2 367.2	0.74%	-1 908.0	-45%	-693.8	-23%
2.G.3 N_2O from Product Uses: no classification (N_2O)	4 406.2	2 448.0	2 539.7	0.80%	-1 866.5	-42%	91.7	4%
2.G.4 Other: no classification (CH_4)	65.2	79.0	75.3	0.02%	10.1	15%	-3.7	-5%
2.G.4 Other: no classification (CO_2)	158.6	124.1	118.6	0.04%	-39.9	-25%	-5.5	-4%
2.G.4 Other: no classification (HFCs)	0.0	18.7	19.5	0.01%	19.5	100%	0.8	4%
2.G.4 Other: no classification (N_2O)	4.0	9.2	9.6	0.00%	5.5	138%	0.4	4%
2.G.4 Other: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.G.4 Other: no classification (PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.G.4 Other: no classification (SF_6)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.G.4 Other: no classification (Unspecified mix of HFCs and PFCs)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%

EU-27	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 2. IPPU in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
2.H Other: no classification (CH_4)	6.8	9.7	0.0	0.00%	-6.8	-100%	-9.7	-100%
2.H Other: no classification (CO_2)	112.9	110.2	116.3	0.04%	3.4	3%	6.2	6%
2.H Other: no classification (HFCs)	0.0	4.8	3.7	0.00%	3.7	42690%	-1.1	-22%
2.H Other: no classification (N_2O)	56.7	80.0	80.4	0.03%	23.7	42%	0.4	0%
2.H Other: no classification (NF_3)	0.0	0.0	0.0	0.00%	0.0	0%	0.0	0%
2.H Other: no classification (PFCs)	0.2	0.9	0.9	0.00%	0.7	364%	0.0	-4%
2.H Other: no classification (SF_6)	7.7	6.0	5.0	0.00%	-3	-35%	-1.0	-16%
2.H Other: no classification (Unspecified mix of HFCs and PFCs)	289.9	120.9	110.4	0.03%	-179	-62%	-10.5	-9%

4.3 Methodological issues and uncertainties

The previous section presented for each EU 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 CRT 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 CRT only includes gap filled activity data for 2022 and only for the EU key categories where the criteria above apply. In 2024 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.
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 have been divided by this IEF in order to derive a gap-filled estimate for activity data for EU.

Table **4.48** shows the results for the gap filling of activity data for the three categories.

Table 4.38 Documentation of gap filling of activity data

Category	2022			
	Activity data Description	**(kt)**	**IEF (t/t)**	**Emissions (kt)**
2.A.1	Clinker Production	130 975	0.55	72 420
2.A.2	Lime Production	22 471	0.71	15 894
2.B.1	Ammonia Production	10 199	1.46	14 900

4.3.2 Uncertainty estimates

Table 4.**49** shows the total EU 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 (154 %) and the lowest for CO_2 from 2.A (3.3 %). 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 see Chapter 1.6.

Table 4.39 Sector 2 Industrial processes: Uncertainty estimates for the EU-27

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2022	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.A Mineral Industry	CO_2	134 078	97 483	-27.3%	3.3%	0.9%
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	58 210	44 820	-23.0%	9.8%	1.3%
2.B Chemical Industry	CH_4	1 166	1 185	1.7%	26.8%	8.7%
2.B Chemical Industry	N_2O	76 210	2 906	-96.2%	11.9%	3.6%
2.B Chemical Industry	HFC	10 263	236	-97.7%	10.5%	10.0%
2.B Chemical Industry	PFC	3 955	396	-90.0%	38.4%	9.0%
2.B Chemical Industry	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.B Chemical Industry	SF_6	1 785	118	-93.4%	42.3%	22.6%
2.B Chemical Industry	NF_3	0	1	Inf	26.0%	Inf
2.C Metal Industry	CO_2	114 931	65 534	-43.0%	5.6%	1.3%
2.C Metal Industry	CH_4	416	131	-68.5%	10.1%	5.2%
2.C Metal Industry	N_2O	24	11	-52.1%	69.8%	36.4%
2.C Metal Industry	HFC	0	14	Inf	11.0%	Inf
2.C Metal Industry	PFC	13 463	141	-99.0%	5.2%	13.5%

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2022	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.C Metal Industry	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.C Metal Industry	SF_6	1 015	6	-99.4%	20.9%	22.2%
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	8 021	6 034	-24.8%	36.1%	12.8%
2.D Non-energy products from fuels and solvent use	CH_4	2	1	-42.7%	52.6%	56.3%
2.D Non-energy products from fuels and solvent use	N_2O	3	4	31.4%	63.7%	37.3%
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	68	31	-54.7%	11.6%	32.8%
2.E Electronics industry	PFC	392	411	4.7%	12.3%	13.4%
2.E Electronics industry	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.E Electronics industry	SF_6	245	140	-42.6%	12.2%	64.8%
2.E Electronics industry	NF_3	22	76	248.1%	24.3%	37.9%
2.F Product uses as substitutes for ODS	CO_2	0	0	0.0%	0.0%	0.0%
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	6	44 156	720525.0 %	38.8%	154687.2%
2.F Product uses as substitutes for ODS	PFC	0	29	Inf	153.8%	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	158	119	-25.2%	11.5%	1.6%
2.G Other product manufacture and use	CH_4	65	75	15.5%	35.6%	9.0%
2.G Other product manufacture and use	N_2O	2 299	1 792	-22.1%	10.9%	2.9%
2.G Other product manufacture and use	HFC	0	17	Inf	18.8%	Inf

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2022	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
2.G Other product manufacture and use	PFC	206	223	8.3%	22.4%	1.9%
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	2 258	1 619	-28.3%	47.4%	18.9%
2.G Other product manufacture and use	NF_3	0	0	0.0%	0.0%	0.0%
2.H Other	CO_2	92	48	-47.3%	10.1%	5.9%
2.H Other	CH_4	7	0	-100.0%	0.0%	21.2%
2.H Other	N_2O	57	80	41.9%	21.0%	8.8%
2.H Other	HFC	0	4	40649.1%	60.2%	24468.0%
2.H Other	PFC	0	1	364.3%	60.0%	218.5%
2.H Other	Unspecified mix of HFCs and PFCs	0	0	0.0%	0.0%	0.0%
2.H Other	SF_6	8	5	-34.6%	64.0%	22.1%
2.H Other	NF_3	0	0	0.0%	0.0%	0.0%
2 (where no subsector data were submitted)	*all*	20 928	21 309	1.8%	12.3%	8.9%
Total - 2	**all**	**450 353**	**289 158**	**-35.8%**	**7.7%**	**2.3%**

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 3.120 (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 1.5.2). 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 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, 2021 and 2022.

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

Recalculations are described in chapter 10.1, including the explanations for significant changes (>500 kt CO_2eq) in categories.

4.6 Sector-specific improvements

In 2024, the reporting has been amended to be in line with the new CRT reporting tables, as well as the NID outline. Descriptions of categories have been aligned accordingly. Information across sectors has been streamlined to provide a harmonised approach across the whole NID. Any recommendations for improvement of earlier UNFCCC reviews have been continuously followed up and implemented.

Improvements planned for the next reporting are continuing the efforts to ensure consistency between.

5 AGRICULTURE (CRT SECTOR 3)

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. Today these shape the majority of the EU's landscapes and are home to many 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[31].

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 determined 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)[32].

- "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[33] in 2008 and a Commission Communication on the CAP towards 2020[34] in 2011. The four legislative texts that regulate the post-2013 CAP are (i) Rural Development: Regulation

31 http://ec.europa.eu/agriculture/envir/index_en.htm

32 http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32003R1782

33 http://ec.europa.eu/agriculture/healthcheck/index_en.htm

34 https://ec.europa.eu/agriculture/cap-post-2013_en

1305/2013[35]; (ii) “Horizontal” issues such as funding and controls: Regulation 1306/2013[36]; (iii) Direct payments for farmers: Regulation 1307/2013[37]; (iv) Market measures: Regulation 1308/2013[38].

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[39], 2001[40], 2000[41]). 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’).

The CAP 2023-27 entered into force on 1 January 2023. Support for farmers and rural stakeholders across the 27 EU countries is based on the CAP 2023-27 legal framework and the choices detailed in the national CAP Strategic Plans, approved by the Commission. Each EU country elaborated its own CAP Strategic Plan, including the anticipated intervention strategies, and the CAP instruments each EU country will use from 2023 to 2027 to achieve the CAP objectives. The approved Plans are designed to make a significant contribution to the ambitions of the European Green Deal, Farm to Fork Strategy and Biodiversity Strategy.

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 fertilizers are prohibited; (ii) capacity of and facilities for storage of animal manure; and (iii) limits to the amounts of animal manure and fertilizers 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 fertilizer 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

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35 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:en:PDF

36 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0549:0607:en:PDF

37 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0608:0670:en:PDF

38 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0671:0854:en:PDF

39 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.

40 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.

41 EC (2000). Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy. Commission of the European Communities.

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. This has affected NH_3 and N_2O emissions in most countries.

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[42]) 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[43]) sets upper limits for each country for the total emissions in 2010 of the four pollutants responsible for acidification, eutrophication and ground-level ozone pollution. It has been updated in 2016[44] setting new objectives for EU air policy for 2020 and 2030;
- The Industrial Emission Directive (IED[45][46]), 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). In April 2022, the Commission proposed to revise the former Industrial Emissions Directive to modernize it and make it more efficient in line with the European Green Deal objectives of zero pollution, climate neutrality and resource efficiency. This updated Directive entered in force on 2024. Member States will have 22 months to transpose the revised IED.

Legislation related with animal health may also affect emissions through changes in specific parameters. That is the case of Spain, where CH_4 emissions from enteric fermentation from swine decreased, partly due to the ban of the use of growth-promoting antibiotics in animal feeding that resulted in a radical change in feeding conditions.

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.

5.1 Overview of sector

In the year 2022, CH_4, N_2O and CO_2 emissions from CRT sector 3 Agriculture were 56.3 %, 71.9 %, and 0.38 % of total CH_4, N_2O and CO_2 EU emissions, respectively. Total emissions from agriculture

42 http://www.unece.org/env/lrtap/multi_h1.html

43 https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1554903780611&uri=CELEX:32016L2284

44 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284&from=EN

45 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

46 http://ec.europa.eu/environment/industry/stationary/index.htm

were 366 Mt CO_2-eq with contributions from CH_4, N_2O, and CO_2 of 230 Mt CO_2-eq, 126 Mt CO_2-eq and 9.5 Mt CO_2-eq, respectively[47].

Figure 5.1 shows the development of total GHG emissions from agriculture from 483 Mt CO_2-eq in 1990 to 366 Mt CO_2-eq in 2022. The reduction of emissions was most pronounced for CO_2 with a decrease of 33 %, followed by N_2O and CH_4 with respectively a decrease of 27 % and 22 %. The cut was most pronounced before 2010 with a total reduction of 22 % between 1990 and 2010, followed by a further decrease by 2 % between 2010 and 2023.

The largest reductions occurred in CH_4 emissions from enteric fermentation and direct N_2O from agricultural soils, mainly because of the decreasing use of fertilizer and manure and declining cattle numbers in most countries.

Figure 5.1: EU GHG emissions for 1990-2022 from CRT Sector 3: 'Agriculture' in CO_2 equivalents (Mt)

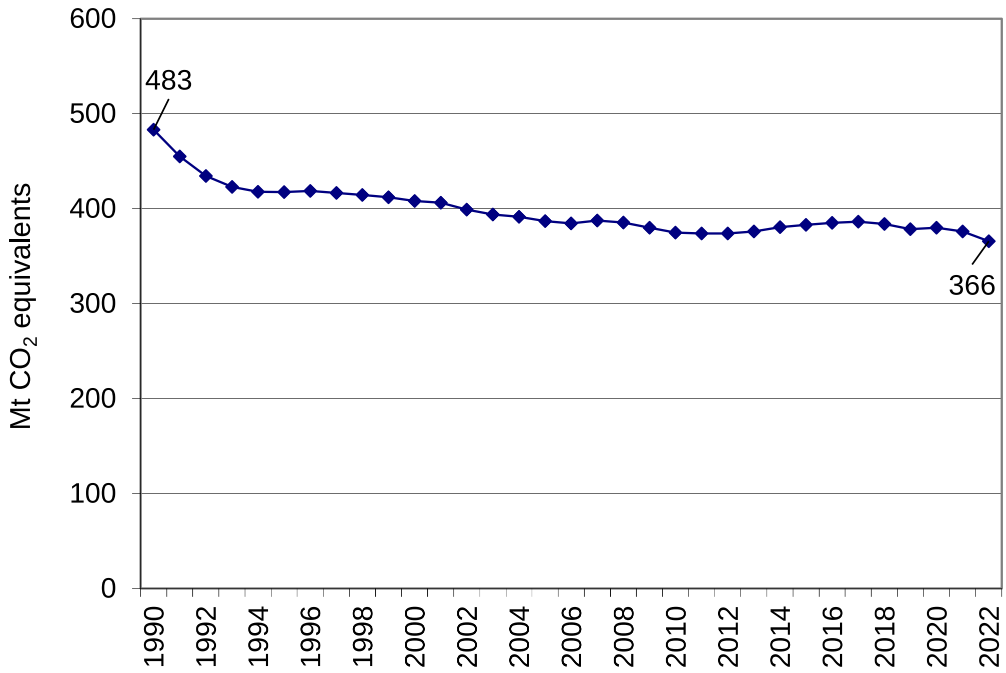


Table 5.1 Sector 3 Agriculture: Share of key source categories and all remaining categories in 2022 for EU

GREENHOUSE GAS SOURCE CATEGORIES	1990 (kt)	2022 (kt)	absolute change (Mt)	% change (in Mt)	share 2022
3.A. - Enteric Fermentation- CH4	237259	180808	-56	-24%	49%
3.B. - Manure Management - CH4	54611	44849	-10	-18%	12%
3.B. - Manure Management - N2O	25645	17362	-8	-32%	5%
3.D.1 - Agricultural Soils - Direct N2O Emissions From	115139	87488	-28	-24%	24%
3.D.2 - Agricultural Soils - Farming - N2O	31339	20739	-11	-34%	6%
All other Agriculture categories	19229	14473	-5	-25%	4%
Total Agriculture	**483222**	**365719**	**-118**	**-24%**	**100%**

[47] The EU Greenhouse gas inventory data in this report was compiled using the September 2024 release of the 'CRT reporting tool' developed by the UNFCCC Secretariat. However, due to remaining technical shortcomings in the UNFCCC ETF tools, there have been substantial difficulties in preparing and finalizing the EU GHG inventory tables, which are based on the aggregation of emissions and removals from Member States' GHG inventories. In addition, because of the ongoing improvements and additional releases of the ETF tools by the UNFCCC secretariat after the compilation of the EU GHG inventory, reported data may differ from actual inventory data in some cases. The EU will provide additional information on sector-specific issues affected by the ETF tool during the technical expert review. For more information, see also footnote 4 of the executive summary.

5.2 Emission trends

In this section we analyze the contribution of the different emission categories 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 1990-2022 and 2021-2022. 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 24 % compared to 1990, and 48 % 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.D.2 (9 %), 3.B-CH_4 (8 %) and 3.B-N_2O (7 %), while all the other categories contribute less. The decrease in emissions is mainly due to the decrease in the cattle population and the decrease in the quantities applied of fertilizers, both synthetic and organic.

Table 5.2 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 (2022)	Share of trend 1990-2022	Share of trend 2021-2022
3.A	CH_4	49%	48%	21%
3.B	CH_4	12%	8%	4%
3.B	N_2O	5%	7%	4%
3.C	CH_4	1%	1%	2%
3.D.1	N_2O	24%	24%	55%
3.D.2	N_2O	6%	9%	13%
3.F	CH_4	0.2%	1%	-2%
3.F	N_2O	0.1%	0.2%	-0.4%
3.G	CO_2	2%	3%	-1%
3.H	CO_2	1%	0.4%	3%
3.I	CO_2	0.2%	0.4%	1%
3.J	CH_4	0.4%	-1%	0%
3.J	N_2O	0.05%	-0.1%	0%

For the whole sector, there was a very slight decrease of emissions between 2021 and 2022 (2.7 % of total emissions). The main contributor to the total decrease in agricultural emissions from last year is category 3.D.1 (55 % of the total trend), followed by 3.A (21 %) and 3.D.2 (13 %). The contribution of the other categories is approximately 10 % of total change.

5.3 Source categories and methodological issues

In this section, we present the information relevant for EU key source categories in the sector 3 Agriculture.

The data presented in 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 or using country specific emission factors.

CH_4 emissions from enteric fermentation – mainly from cattle - are usually calculated with sophisticated methods. For indirect N_2O emissions from managed soils, the implementation of higher tier is more complex, most of the countries are still using Tier 1 method.

Table 5.3 Key categories for the EU (Agriculture - sector excerpt). Emissions in kt CO_2 eq.

Source category gas	kt CO_2 equ.		Trend	Level		share of higher Tier
	1990	2022		1990	2022	
3.A. Enteric fermentation (CH_4)	237259	180808	T	L	L	96 %
3.B. Manure management (CH_4)	54611	44849	T	L	L	80 %
3.B. Manure management (N_2O)	25645	17362	0	L	L	56 %
3.D.1. Direct N_2O emissions from managed soils (N_2O)	115139	87488	T	L	L	65 %
3.D.2. Indirect N_2O emissions from managed soils (N_2O)	31339	20739	0	L	L	28.5 %

Other source categories are not identified as key source in the analysis at EU level and are therefore not further discussed here. Emissions from source category J - other agriculture emissions are reported only from Germany (digestion of energy crops).

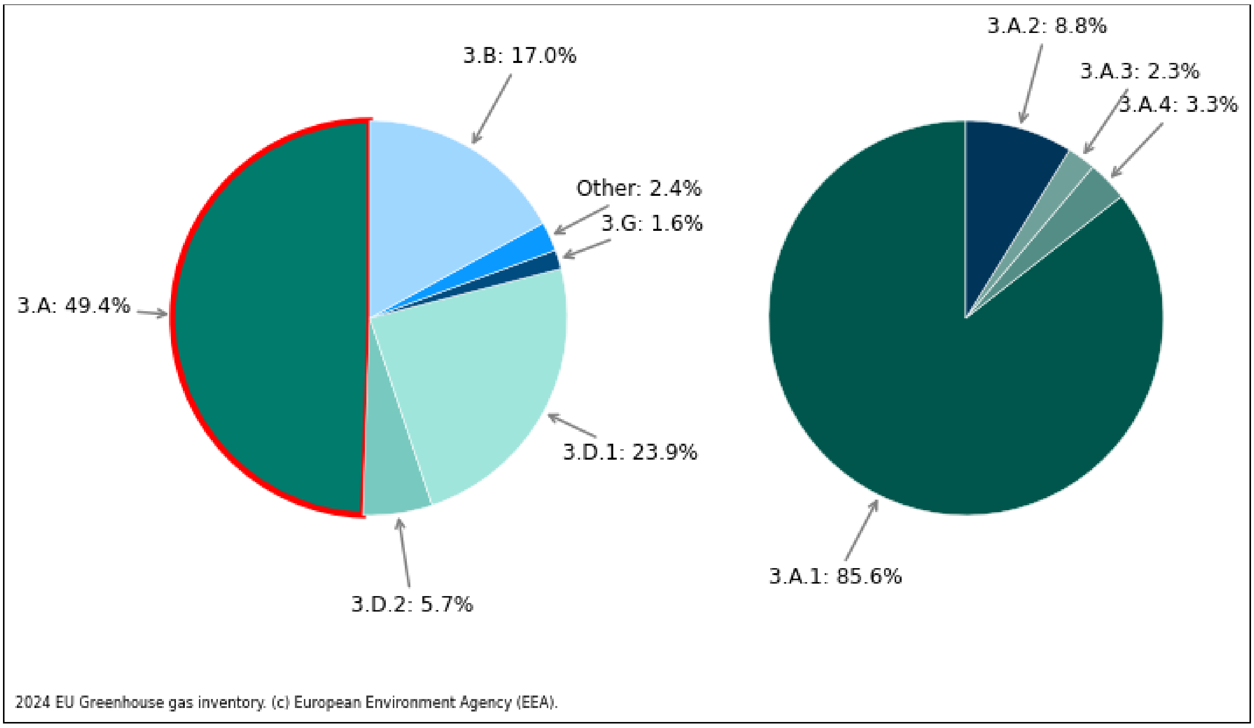
Many countries recognize that in the agriculture sector the emissions from the different categories are inherently linked and are best estimated in a comprehensive model that covers not only greenhouse gases (CH_4 and N_2O) in a consistent manner, but also ammonia. Estimations of ammonia emissions are 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 (CRT Source Category 3.A)

In 2022 CH_4 emissions in source category *3.A - Enteric Fermentation* in the EU were 180 808 kt CO_2 equivalent. This corresponds to 5.8 % of total EU GHG emissions and 44 % of total EU CH_4 emissions. They make 49 % of total agricultural emissions and 79 % of total agricultural CH_4 emissions. It is thus the largest GHG source in agriculture and the largest source of CH_4 emissions.

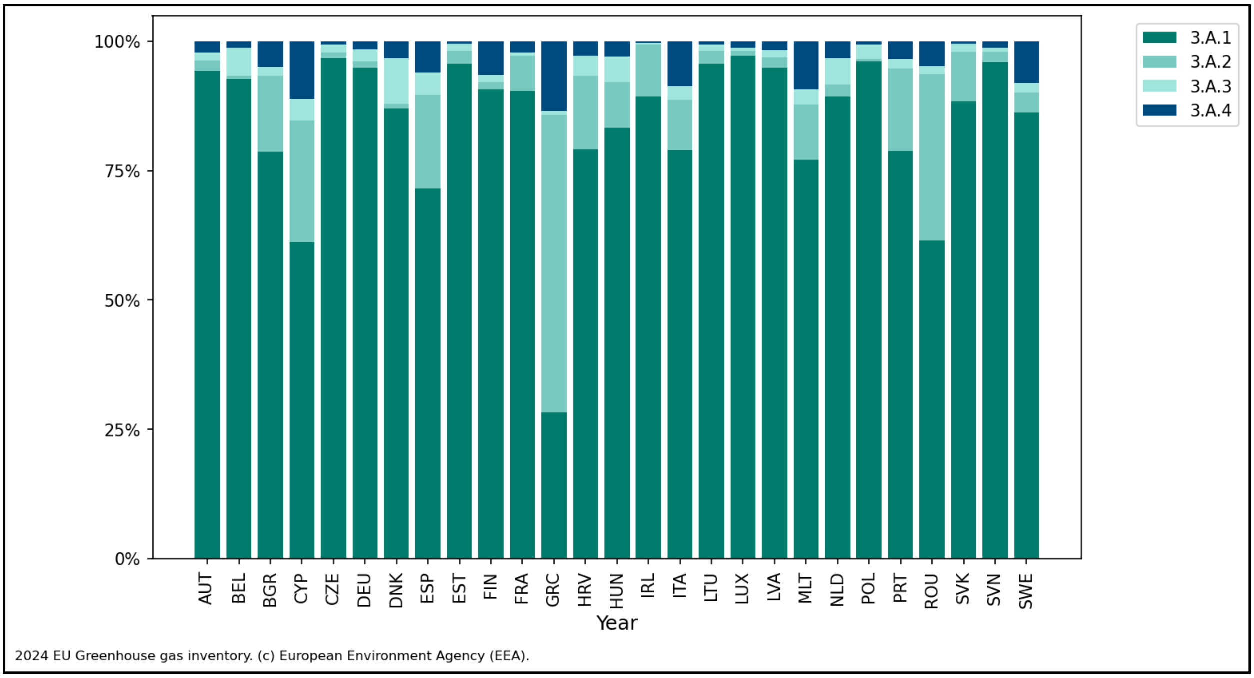
The main sub-categories are 3.A.1 (Cattle) and 3.A.2 (Sheep) as shown in Figure 5.4. Regarding the origin of emissions in the different countries, Figure 5.5 shows the distribution of CH_4 emissions from enteric fermentation by livestock category in all countries. Each bar represents the total emissions 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 agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2022.



In the left panel, some minor differences in the numbers might be present due to automatic rounding of numbers.

Figure 5.5: Decomposition of emissions in source category 3.A - Enteric Fermentation into its sub-categories by country in the year 2022.



CH_4 emissions by country from 3.A *Enteric Fermentation* are shown in Table 5.4 by country, and the total EU for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, CH_4 emission in this source category decreased by 24 % or 56.4 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 1.2 %.

Table 5.4 3.A - Enteric Fermentation: Countries' contributions to total EU-CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	5,055	4,271	4,284	2.4%	-771	-15%	13	0%	NA,T1,T2	CS,D,NA
Belgium	5,327	4,464	4,443	2.5%	-884	-17%	-21	0%	NA,T1,T2	CS,D,NA
Bulgaria	5,381	1,704	1,670	0.9%	-3,711	-69%	-34	-2%	NA,T1,T2	CS,D,NA
Croatia	2,336	1,079	1,021	0.6%	-1,315	-56%	-58	-5%	NA,T1,T2,T3	CS,D,NA
Cyprus	221	342	334	0.2%	114	52%	-8	-2%	NA,T1,T2	CS,D,NA
Czechia	6,612	3,629	3,681	2.0%	-2,931	-44%	52	1%	NA,T1,T2	CS,D,NA
Denmark	4,455	4,185	4,092	2.3%	-362	-8%	-92	-2%	NA,T1,T2	CS,D,NA,OTH
Estonia	1,421	623	622	0.3%	-798	-56%	-1	0%	NA,T1,T2	CS,D,NA,OTH
Finland	2,715	2,211	2,175	1.2%	-540	-20%	-36	-2%	NA,OTH,T1,T2	CS,D,NA,OTH
France	43,388	36,164	35,230	19.5%	-8,158	-19%	-934	-3%	NA	NA
Germany	37,247	26,345	26,082	14.4%	-11,165	-30%	-263	-1%	NA,T1,T2,T3	CS,D,NA
Greece	4,603	4,206	4,120	2.3%	-483	-10%	-86	-2%	NA,T1,T2	CS,D,NA
Hungary	4,108	2,364	2,326	1.3%	-1,782	-43%	-39	-2%	T1,T2	CS,D
Ireland	12,319	14,487	14,584	8.1%	2,265	18%	97	1%	CS,NA,T1,T2	CS,D,NA
Italy	17,093	14,695	14,487	8.0%	-2,606	-15%	-209	-1%	NA,T1,T2	CS,D,NA
Latvia	2,488	955	947	0.5%	-1,542	-62%	-8	-1%	NA,T1,T2	CS,D,NA,OTH
Lithuania	4,880	1,731	1,763	1.0%	-3,117	-64%	32	2%	NA,T1,T2	CS,D,NA,OTH
Luxembourg	429	423	421	0.2%	-8	-2%	-2	0%	NA,T1,T2	CS,D,NA
Malta	59	40	39	0.0%	-19	-33%	-1	-2%	NA,T1,T2	CS,D,NA
Netherlands	10,339	9,072	9,157	5.1%	-1,183	-11%	85	1%	NA,T1,T2,T3	CS,D,NA
Poland	22,008	14,543	14,427	8.0%	-7,581	-34%	-116	-1%	NA,NO,T1,T2	CS,D,NA,NO
Portugal	3,942	4,065	4,010	2.2%	69	2%	-54	-1%	-	-
Romania	17,195	8,471	8,430	4.7%	-8,765	-51%	-41	0%	NA,T1,T2	CS,D,NA
Slovakia	3,112	1,028	1,029	0.6%	-2,083	-67%	1	0%	NA,T1,T2	CS,D,NA
Slovenia	1,064	1,022	985	0.5%	-79	-7%	-37	-4%	NA,T1,T2	CS,D,NA
Spain	15,784	17,559	17,133	9.5%	1,350	9%	-426	-2%	S,NA,T1,T2,T3	CS,D,NA
Sweden	3,680	3,319	3,317	1.8%	-363	-10%	-2	0%	CS,T1	CS,D
EU-27	**237,259**	**182,994**	**180,808**	**100%**	**-56,451**	**-24%**	**-2,186**	**-1%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

CH_4 emissions by country from *3.A.1 - Cattle Enteric Fermentation* are shown in Table 5.5 and total EU for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, CH_4 emission in this source category decreased by 23 % or 46.5 Mt CO_2-eq.

Table 5.5 3.A.1 - Cattle: Countries' contributions to GHG- CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4,854	4,018	4,035	2.6%	-819	-17%	17	0%	T2	CS
Belgium	4,991	4,119	4,116	2.7%	-875	-18%	-3	0%	T2	CS
Bulgaria	3,313	1,321	1,312	0.8%	-2,000	-60%	-9	-1%	T2	CS
Croatia	2,052	864	808	0.5%	-1,244	-61%	-56	-6%	T2,T3	CS
Cyprus	113	212	205	0.1%	91	80%	-7	-3%	T1,T2	CS,D
Czechia	6,295	3,503	3,559	2.3%	-2,736	-43%	56	2%	T2	CS
Denmark	4,031	3,626	3,561	2.3%	-470	-12%	-65	-2%	T2	CS,D
Estonia	1,355	593	595	0.4%	-760	-56%	2	0%	T2	CS,D
Finland	2,491	2,006	1,972	1.3%	-518	-21%	-33	-2%	T2	CS
France	38,463	32,617	31,854	20.6%	-6,609	-17%	-764	-2%	-	-
Germany	35,543	24,963	24,766	16.0%	-10,778	-30%	-197	-1%	T2,T3	CS,D
Greece	1,423	1,220	1,164	0.8%	-258	-18%	-56	-5%	T2	CS,D
Hungary	3,221	1,966	1,937	1.3%	-1,284	-40%	-28	-1%	T2	CS
Ireland	10,185	12,970	13,023	8.4%	2,838	28%	53	0%	CS,T2	CS
Italy	14,405	11,662	11,433	7.4%	-2,972	-21%	-229	-2%	T2	CS
Latvia	2,372	905	898	0.6%	-1,474	-62%	-7	-1%	T2	CS
Lithuania	4,717	1,653	1,687	1.1%	-3,031	-64%	34	2%	T2	CS
Luxembourg	421	411	409	0.3%	-12	-3%	-2	-1%	T2	CS
Malta	49	30	30	0.0%	-18	-38%	0	0%	T2	CS
Netherlands	9,179	8,088	8,181	5.3%	-998	-11%	93	1%	T2,T3	CS
Poland	19,759	13,928	13,871	9.0%	-5,889	-30%	-57	0%	NA,T2	CS,NA
Portugal	2,755	3,216	3,163	2.0%	408	15%	-54	-2%	T2	CS
Romania	12,595	5,193	5,187	3.4%	-7,408	-59%	-6	0%	T2	CS
Slovakia	2,794	913	910	0.6%	-1,885	-67%	-3	0%	T2	CS
Slovenia	1,029	981	944	0.6%	-85	-8%	-37	-4%	T2	CS
Spain	9,571	12,515	12,246	7.9%	2,675	28%	-269	-2%	CS,T2	CS,D
Sweden	3,230	2,859	2,860	1.8%	-369	-11%	1	0%	CS	CS
EU-27	**201,206**	**156,351**	**154,727**	**100%**	**-46,479**	**-23%**	**-1,624**	**-1%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

CH_4 emissions by country from *3.A.2 - Sheep Enteric Fermentation* are shown in Table 5.6 and the total EU for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, CH_4 emission in this source category decreased by 33 % or 7.7 Mt CO_2-eq.

Table 5.6 3.A.2 - Sheep: Countries' contributions to total EU-CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	69	90	90	0.6%	20	29%	0	0%	T1	D
Belgium	43	30	31	0.2%	-13	-29%	0	1%	T1	D
Bulgaria	1,628	265	247	1.6%	-1,382	-85%	-18	-7%	T2	CS
Croatia	168	147	144	0.9%	-24	-14%	-3	-2%	T1	D
Cyprus	65	79	78	0.5%	13	20%	0	-1%	T1	D
Czechia	96	41	39	0.2%	-57	-59%	-2	-5%	T1	D
Denmark	44	38	37	0.2%	-8	-17%	-1	-3%	T2	D
Estonia	36	17	16	0.1%	-20	-56%	-1	-6%	T1	D
Finland	24	32	32	0.2%	8	35%	1	2%	CS	CS
France	3,957	2,503	2,364	14.9%	-1,593	-40%	-138	-6%	-	-
Germany	580	320	322	2.0%	-259	-45%	2	1%	T1	CS,D
Greece	2,300	2,400	2,372	14.9%	72	3%	-28	-1%	T2	CS,D
Hungary	439	210	205	1.3%	-234	-53%	-5	-2%	T1	D
Ireland	2,048	1,413	1,460	9.2%	-588	-29%	47	3%	T1	D
Italy	1,761	1,424	1,422	8.9%	-339	-19%	-2	0%	T2	CS
Latvia	37	20	20	0.1%	-17	-47%	-1	-3%	T1	D
Lithuania	21	43	43	0.3%	22	107%	-1	-2%	T2	CS
Luxembourg	3	4	4	0.0%	1	53%	0	4%	T1	D
Malta	4	4	4	0.0%	0	4%	0	12%	T2	CS
Netherlands	381	205	203	1.3%	-178	-47%	-2	-1%	T1	D
Poland	932	65	65	0.4%	-867	-93%	0	0%	NO	NO
Portugal	888	636	637	4.0%	-251	-28%	1	0%	T2	CS
Romania	3,498	2,691	2,710	17.0%	-788	-23%	19	1%	T2	CS
Slovakia	204	91	98	0.6%	-105	-52%	7	8%	T2	CS
Slovenia	3	20	20	0.1%	17	525%	0	2%	T1	D
Spain	4,246	3,224	3,106	19.5%	-1,140	-27%	-119	-4%	CS,T2	CS
Sweden	102	132	129	0.8%	26	26%	-3	-3%	T1	D
EU-27	**23,577**	**16,142**	**15,895**	**100%**	**-7,682**	**-33%**	**-246**	**-2%**	**-**	**-**

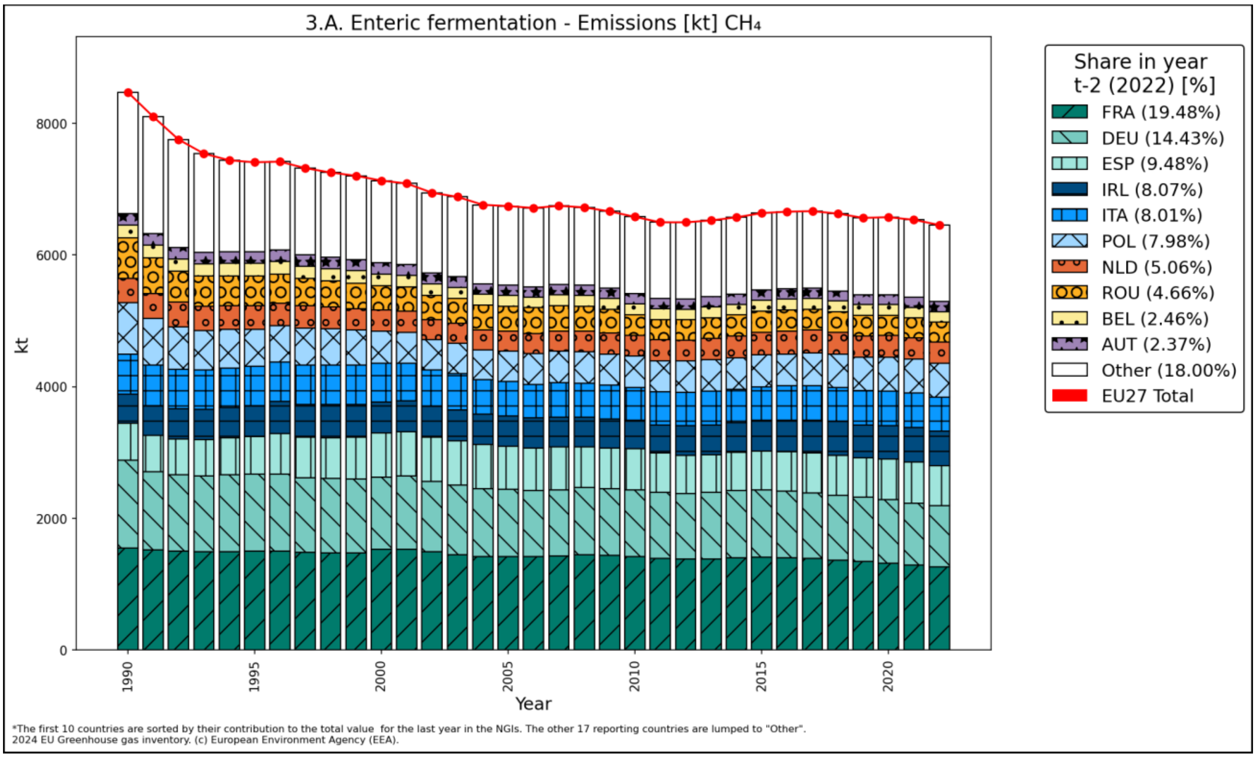
Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

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 the EU by 24 % or 56.4 Mt CO_2-eq in the period 1990 to 2022. Figure 5.6 shows the trend of emissions indicating the countries contributing most to EU total. The figure represents the trend in CH_4 emissions from enteric fermentation for the different countries along the inventory period.

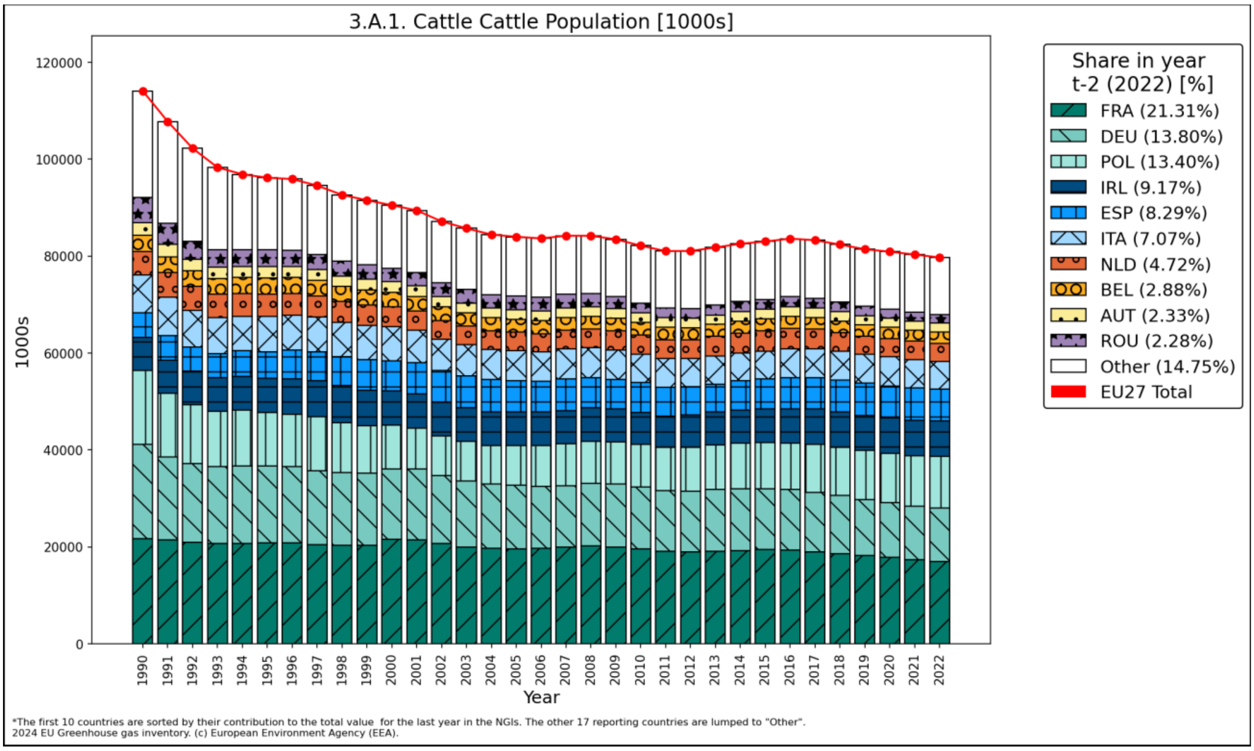
Figure 5.6: 3.A: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.A.1 - Cattle - Population

The main driver for the decrease of CH_4 emissions from enteric fermentation is the decrease in animal numbers that we can see in Figure 5.9, which represents a strong decrease in the EU in the period 1990 to 2022.

Figure 5.9: 3.A.1 Cattle: Trend in cattle population in the EU and the countries contributing most to EU values including their share to EU population in 2022

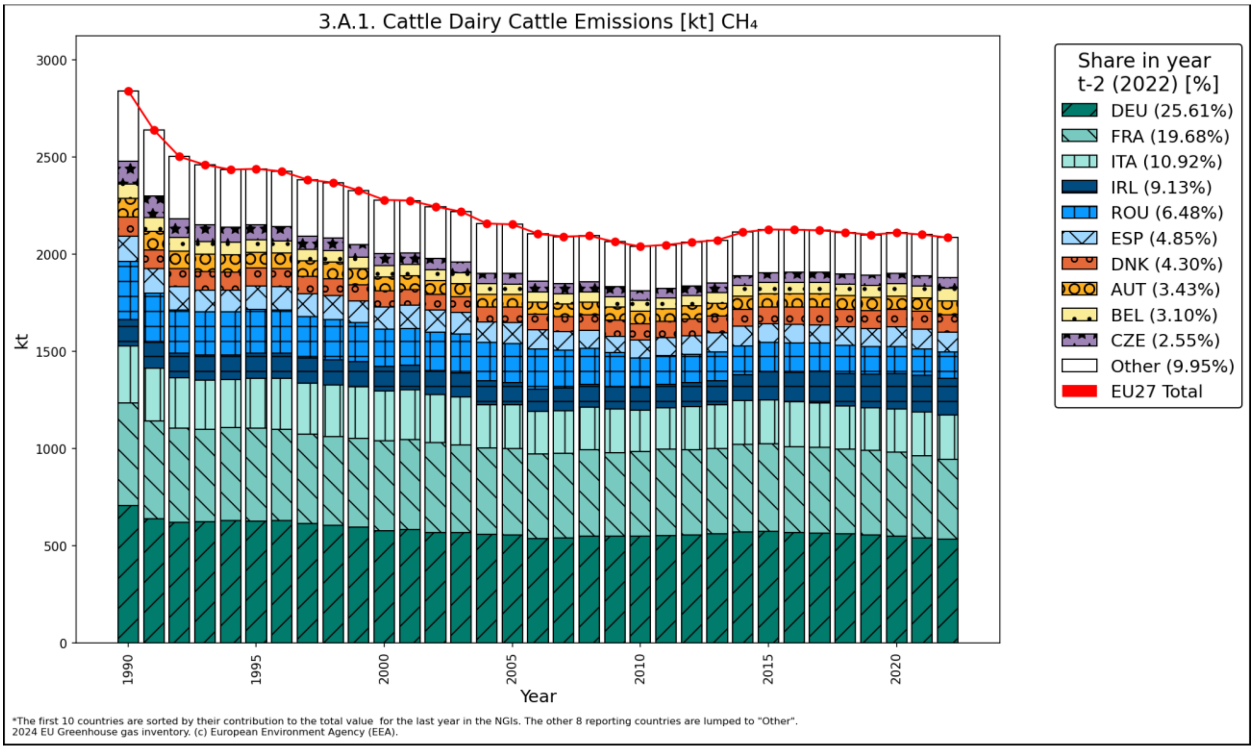


3.A.1 - Cattle - Emissions

Emissions in source category *3.A.1 - Cattle* decreased considerably in the EU by 23 % or 46.5 Mt CO_2-eq in the period 1990 to 2022.

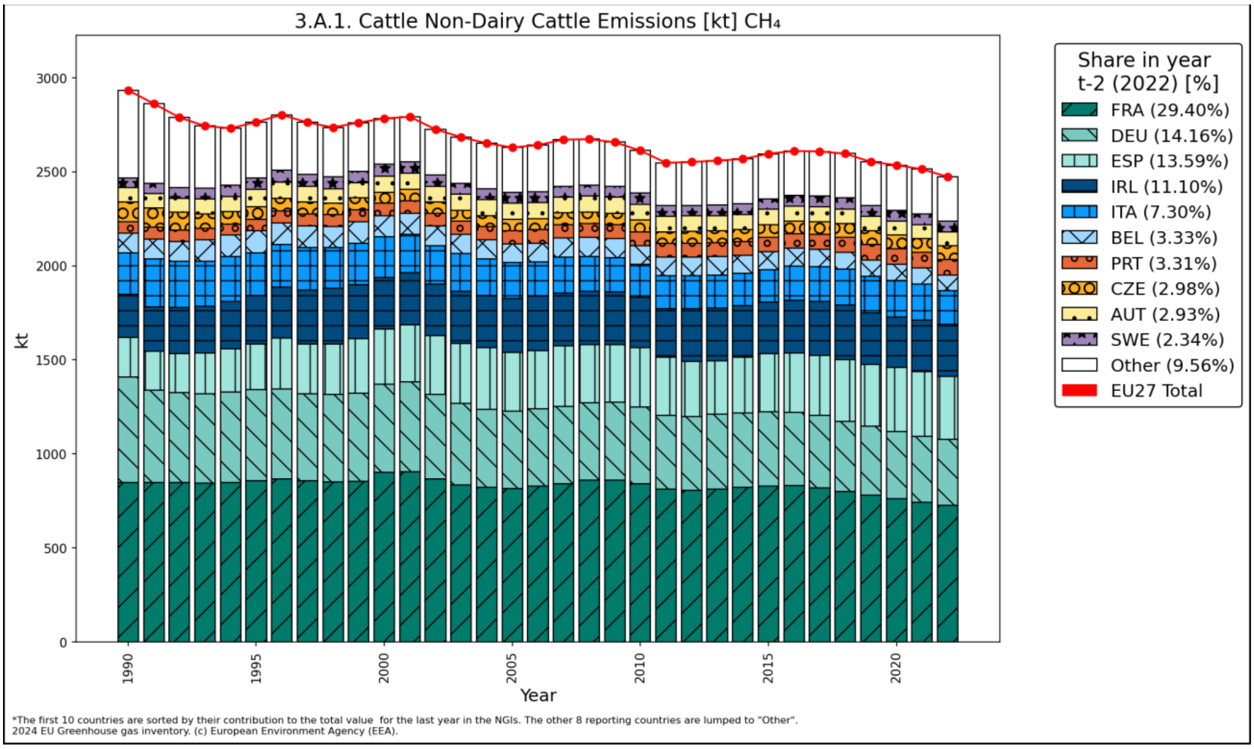
Figure 5.7 shows the trend of emissions in source category *3.A.1.a - Dairy Cattle*, indicating the countries contributing most to EU total. Figure 5.8 shows the trend of emissions in source category *3.A.1.b - Non-Dairy Cattle*, indicating the countries contributing most to EU total.

Figure 5.7: 3.A.1.a Dairy Cattle: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



Note: data from Poland not included as MS encountered issues with the new reporting tool.

Figure 5.8: 3.A.1.b Non-Dairy Cattle: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022

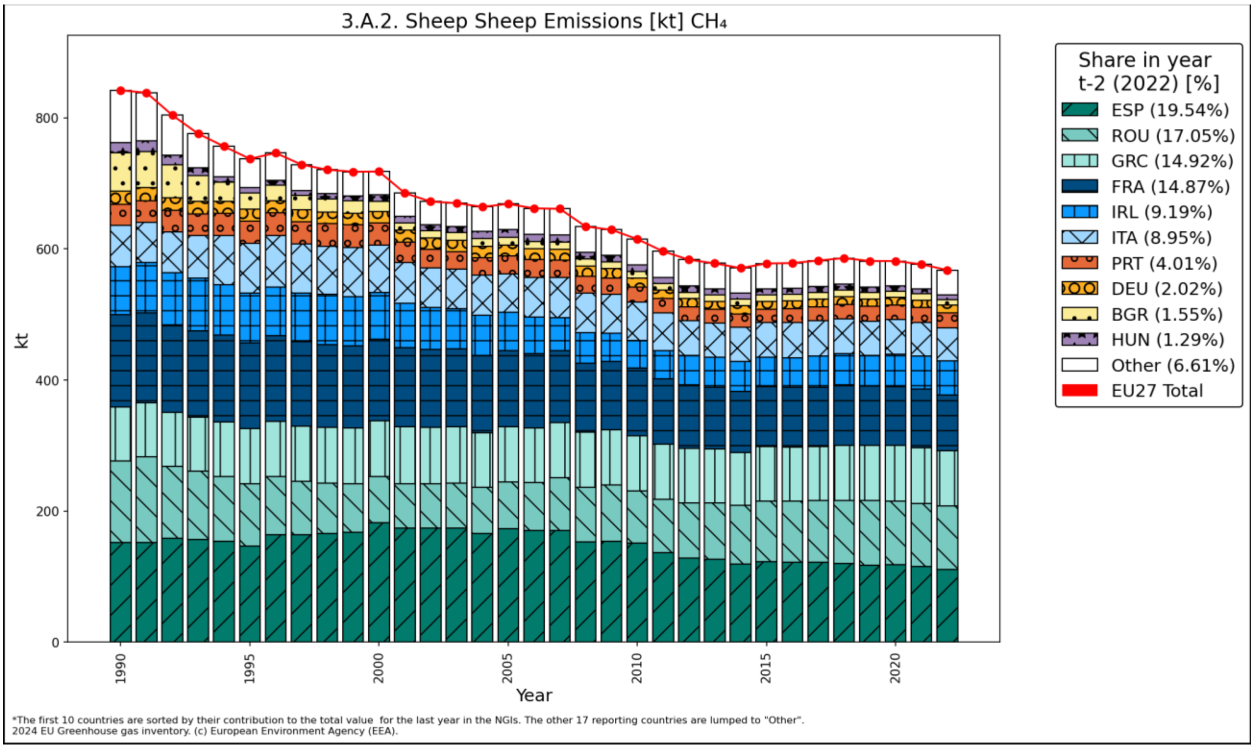


Note: data from Poland not included as MS encountered issues with the new reporting tool.

3.A.2 - Sheep - Emissions

Emissions in source category *3.A.2 - Sheep* decreased strongly in the EU by 32.6 % or 7.7 Mt CO_2-eq in the period 1990 to 2022. Figure 5.11 shows the trend of emissions indicating the countries contributing most to EU total.

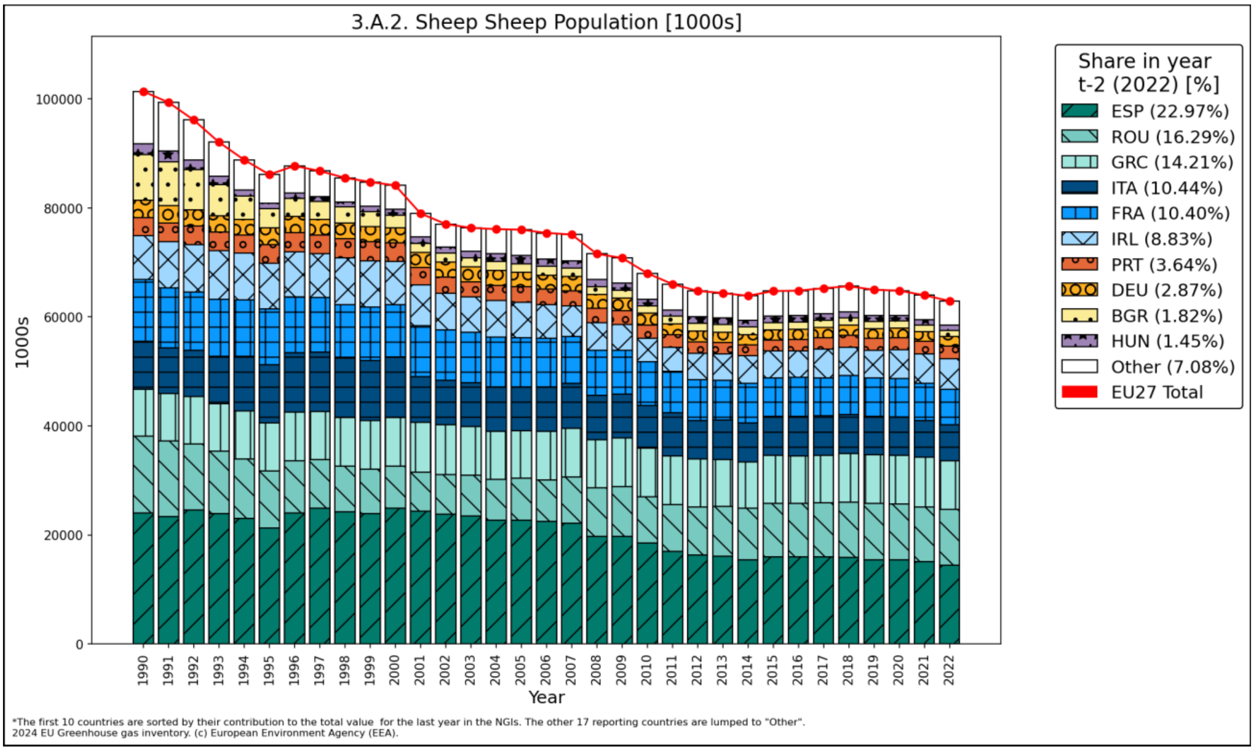
Figure 5.11: **3.A.2: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022**



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.

Figure 5.12: **3.A.2: Trend in sheep population in the EU and the countries contributing most to EU values including their share to EU emissions in 2022**



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 two options:

- Option A distinguishes 'Dairy Cattle' and 'Non-Dairy Cattle'.
- Option B distinguishes 'Mature Dairy Cattle', 'Other Mature Cattle' and 'Growing Cattle'.

To obtain values that can be aggregated to EU level, data reported under Option B 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'.

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.

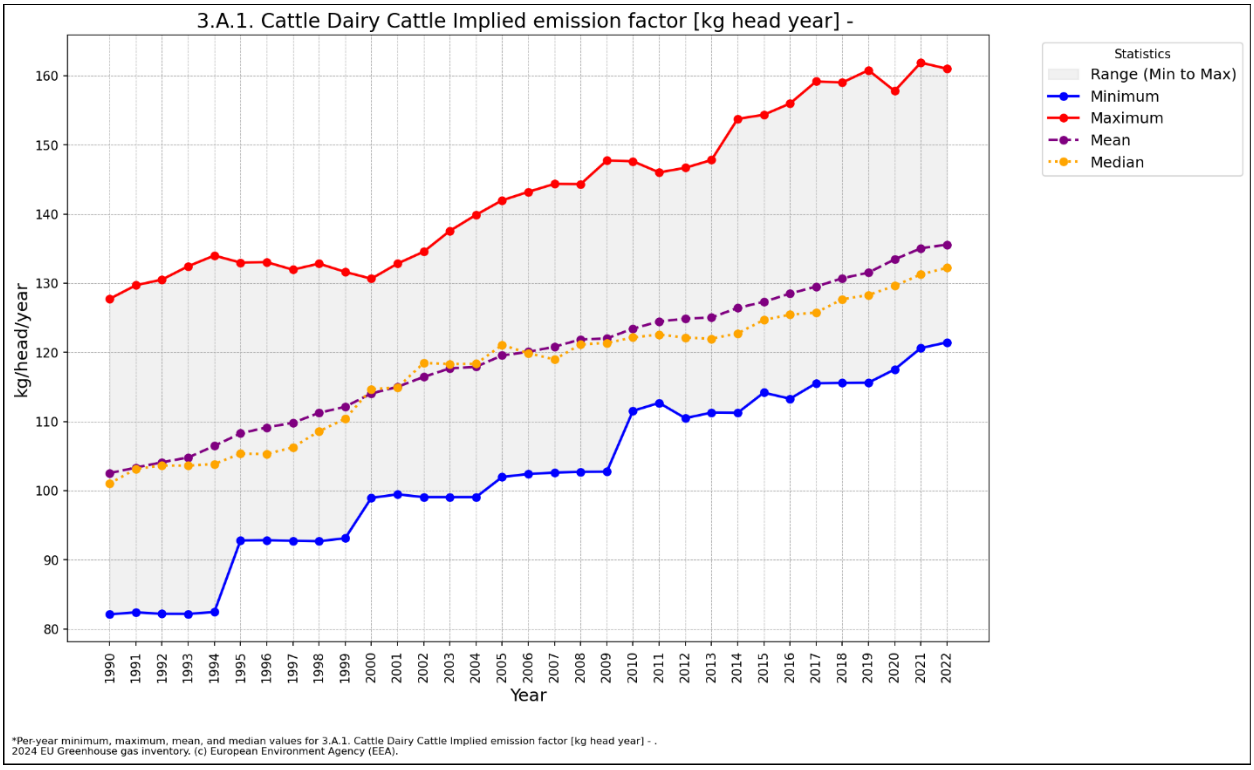
3.A.1 - Cattle - Implied emission factor

For cattle, the analysis is conducted per subcategory.

3.A.1.a - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1.a - Dairy Cattle* increased in the EU strongly between 1990 and 2022. Figure 5.13 shows the trend of the implied emission factor indicating also the range of values used by the countries.

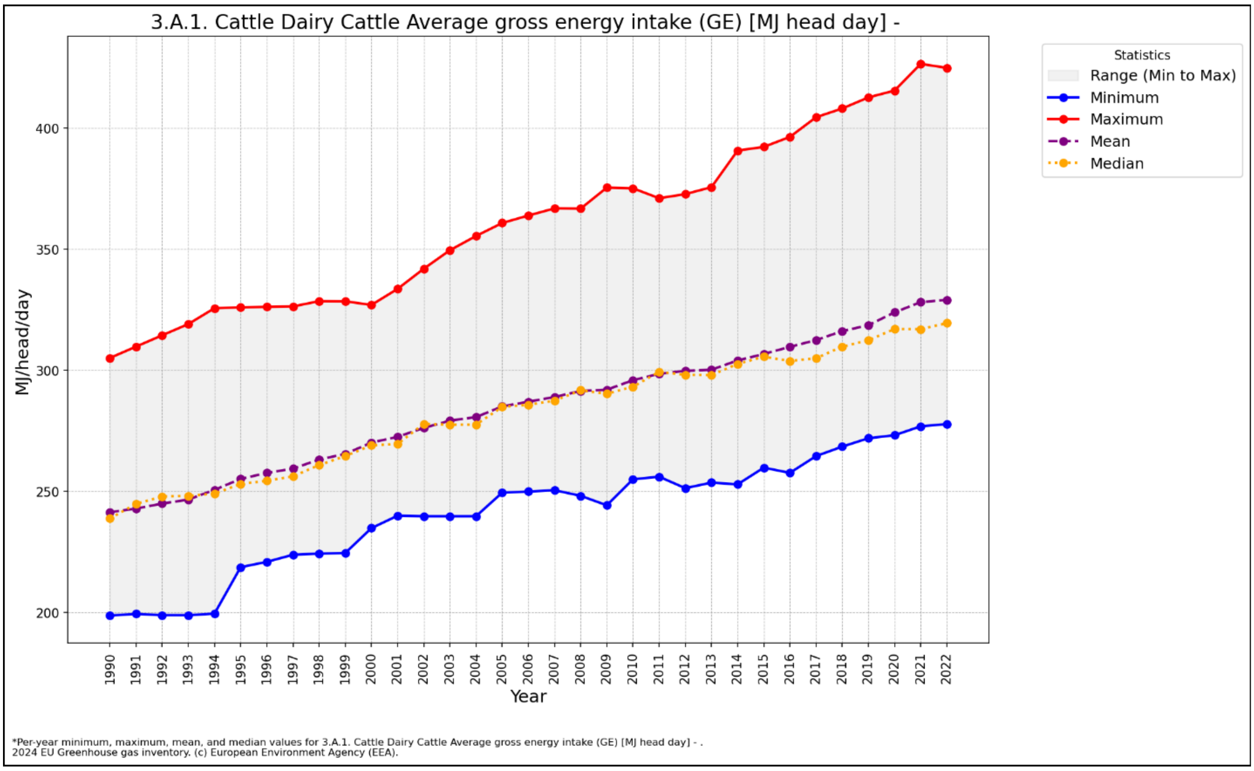
Figure 5.13: 3.A.1 - Dairy Cattle: Trend in implied emission factor and range of values reported by countries



3.A.1.a - Dairy Cattle - Gross energy

The gross energy, a parameter used for calculating CH_4 emissions in source category *3.A.1.a - Dairy Cattle*, increased in the EU strongly between 1990 and 2022. Figure 5.14 shows the trend of the gross energy indicating also the range of values used by the countries

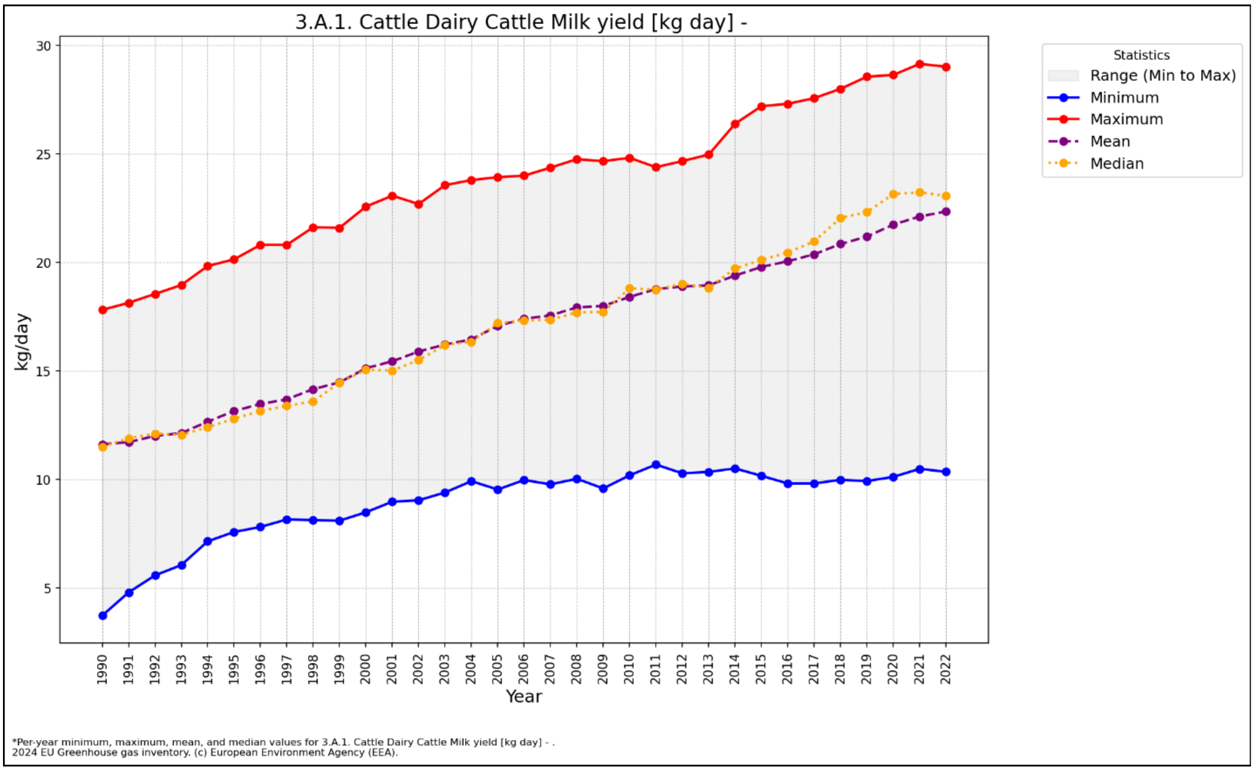
Figure 5.14: 3.A.1.a - Dairy Cattle: Trend in gross energy and range of values reported by countries



3.A.1.a - Dairy Cattle - Milk yield

The milk yield, a parameter used for calculating CH_4 emissions in source category *3.A.1.a - Dairy Cattle*, increased in the EU very strongly between 1990 and 2022. Figure 5.15 shows the trend of the milk yield indicating also the range of values used by the countries.

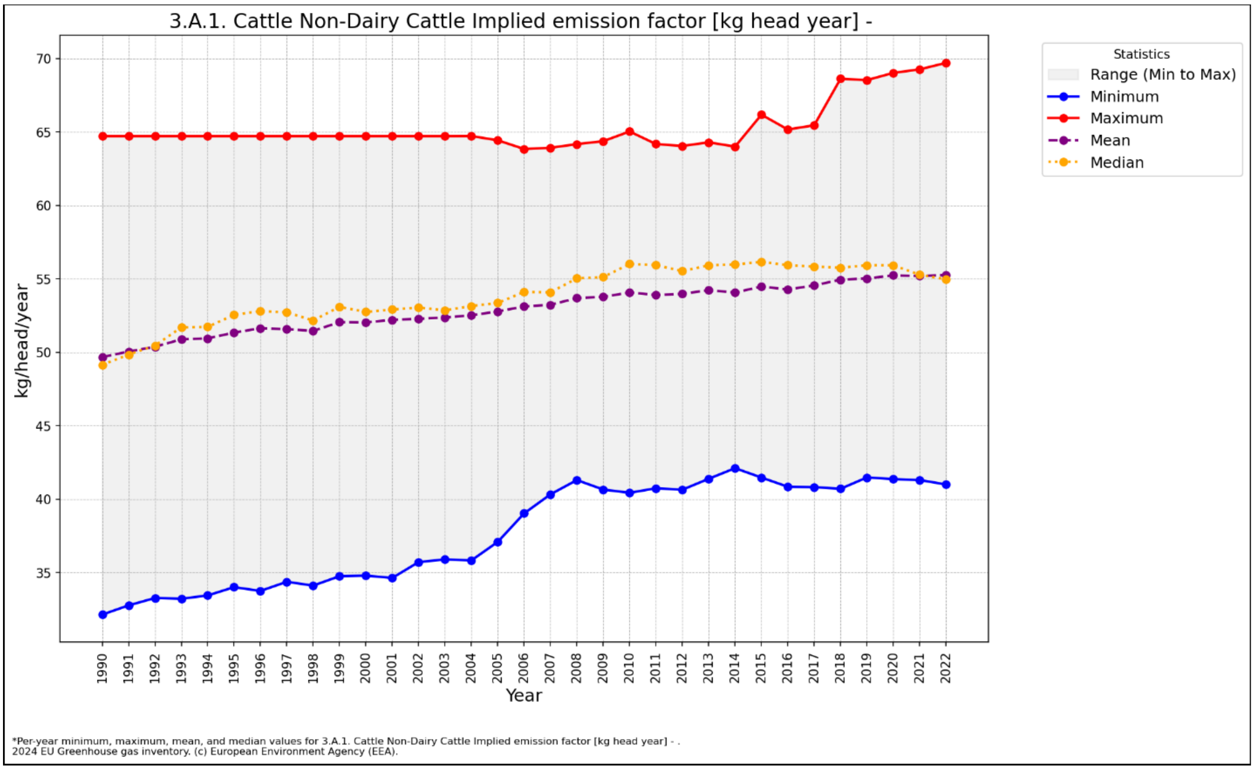
Figure 5.15: **3.A.1.a - Dairy Cattle: Trend in milk yield and range of values reported by countries**



3.A.1.b - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.1.b - Non-Dairy Cattle* increased in the EU moderately between 1990 and 2022. Figure 5.16 shows the trend of the implied emission factor indicating also the range of values used by the countries.

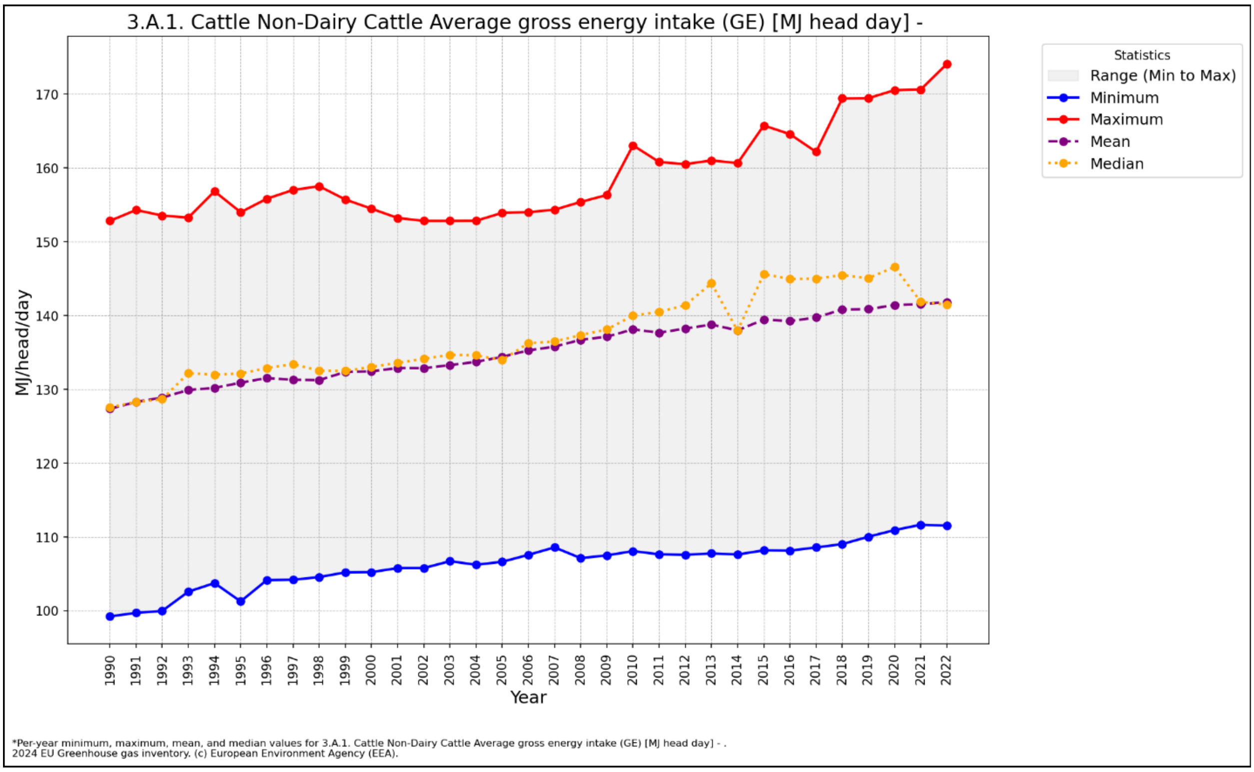
Figure 5.16: **3.A.1.b - Non-Dairy Cattle: Trend in implied emission factor and range of values reported by countries**



3.A.1.b - 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.b - Non-Dairy Cattle*, increased in the EU moderately between 1990 and 2022. Figure 5.17 shows the trend of the average gross energy intake indicating also the range of values used by the countries.

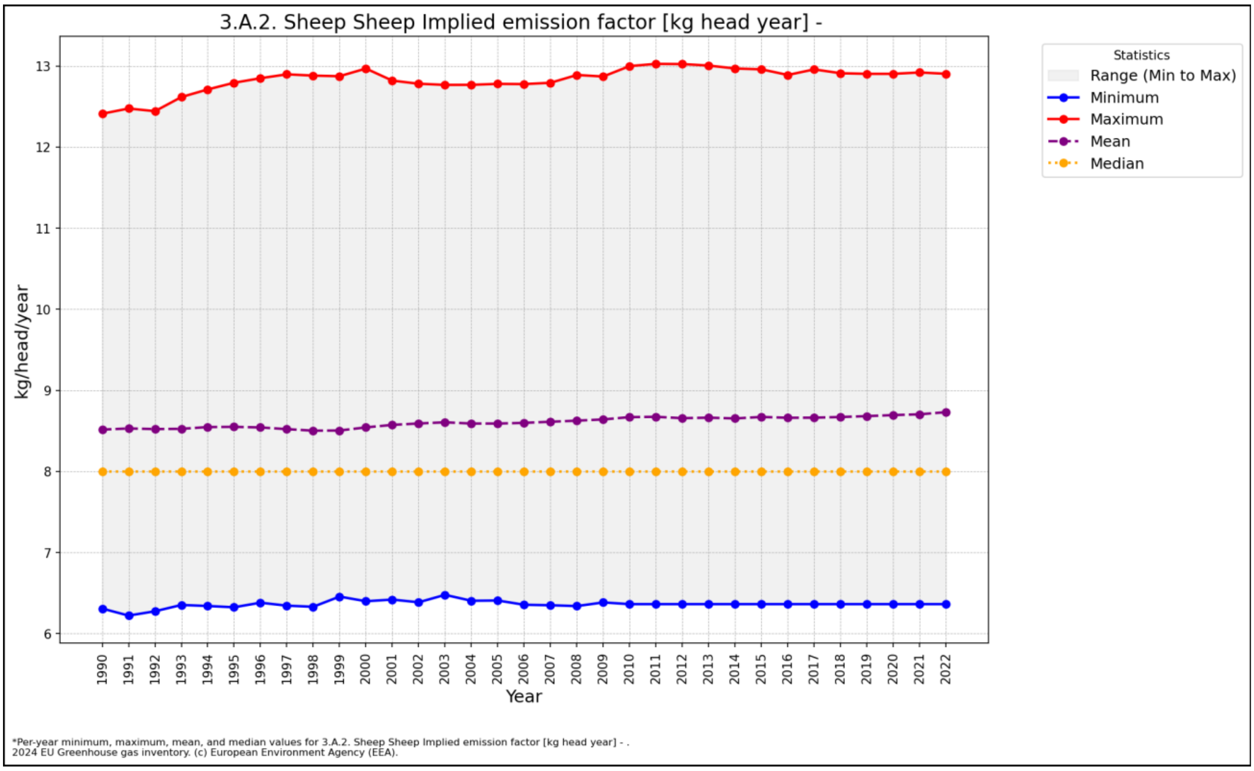
Figure 5.17: 3.A.1.b - Non-Dairy Cattle: Trend in average gross energy intake and range of values reported by countries



3.A.2 - Sheep - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.A.2 - Sheep* increased in the EU moderately between 1990 and 2022. Figure 5.18 shows the trend of the implied emission factor indicating also the range of values used by the countries.

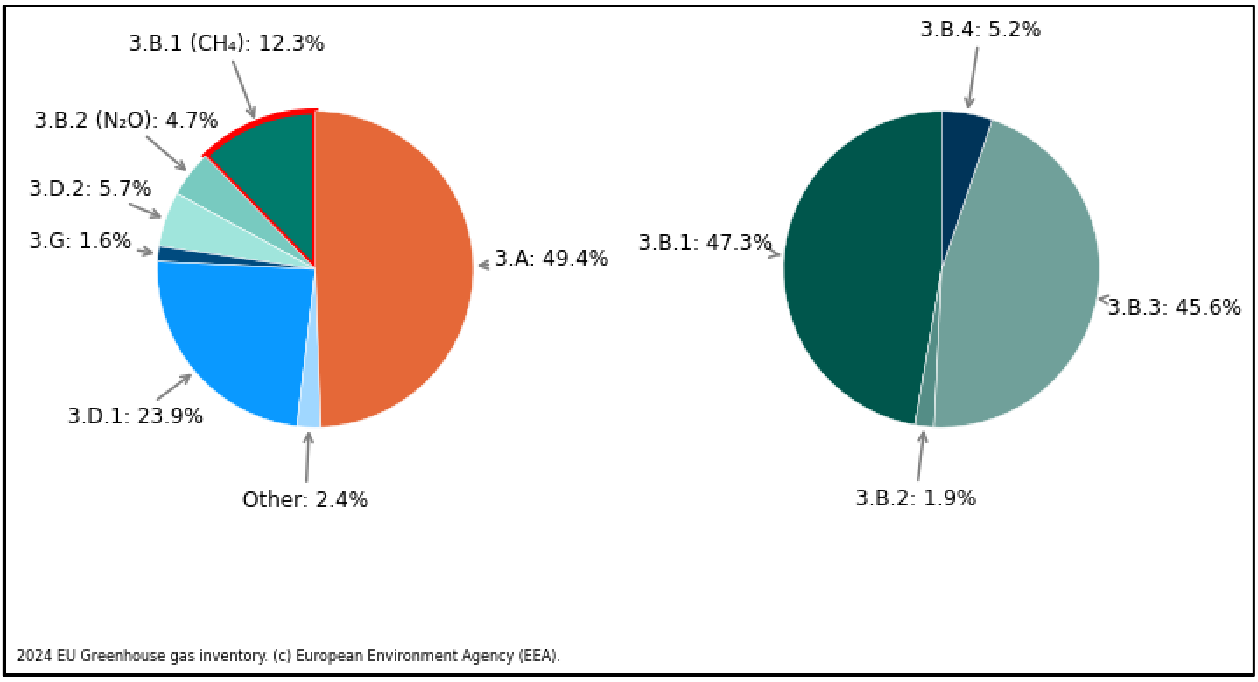
Figure 5.18: 3.A.2 - Sheep: Trend in implied emission factor and range of values reported by countries



5.3.2 Manure Management - CH_4 (CRT Source Category 3B)

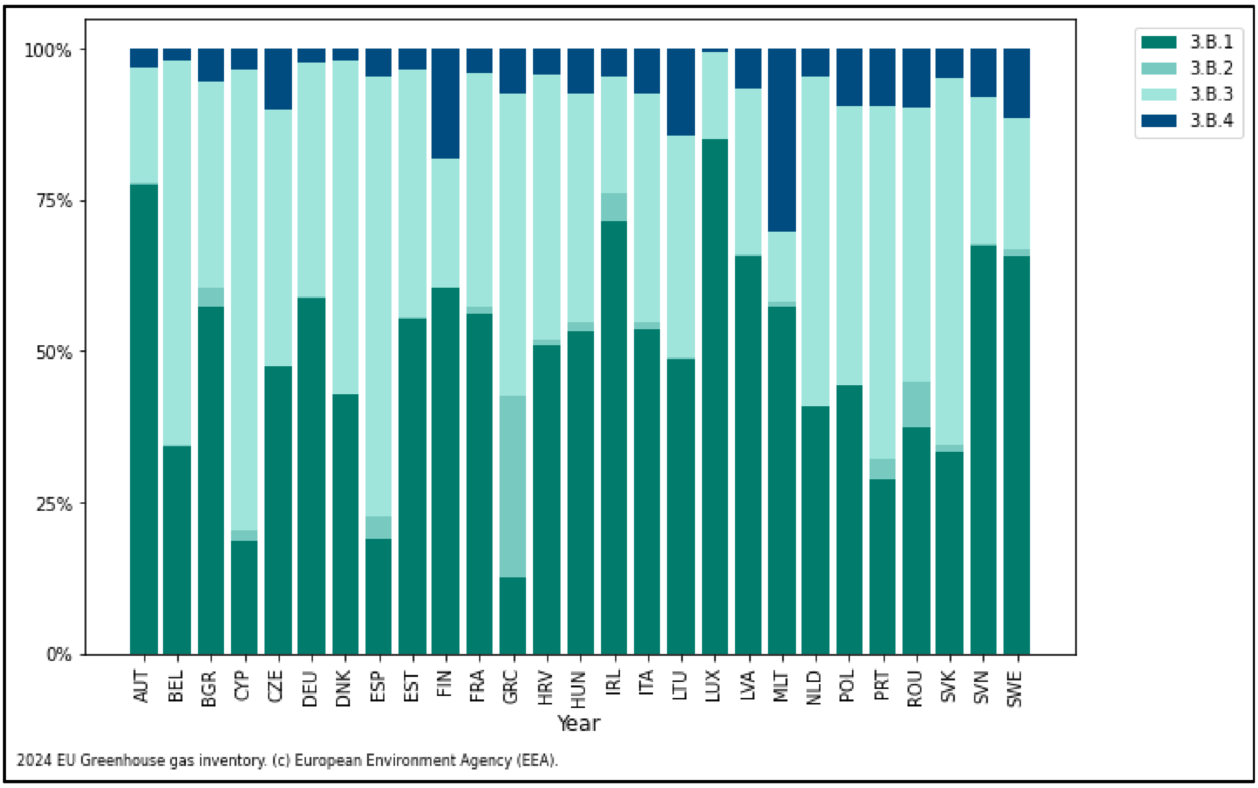
In 2022 CH_4 emissions in source category *3.B - Manure Management* in the EU were 44849 kt CO_2 equivalent. This corresponds to 1.4 % of total EU GHG emissions and 11 % of total EU CH_4 emissions. They make 12.3 % of total agricultural emissions and 19.5 % of total agricultural CH_4 emissions. The main sub-categories are Cattle (3.B.1) and Swine (3.B.3) as shown in Figure 5.20. 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. 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 on total EU agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2022.



In the left panel, some minor differences in the numbers might be present due to automatic rounding of numbers.

Figure 5.21: Decomposition of emissions in source category 3.B - Manure Management into its sub-categories by country in the year 2022.



CH_4 emissions by country and for the total EU from 3.B *Manure Management* are shown in Table 5.16 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, CH_4 emission in this source category decreased by 18 % or 9.8 Mt CO_2-eq. From 2022 to 2022 emissions in the current category decreased by 0.9 %.

Table 5.16 3.B - Manure Management: Countries' contributions to EU-CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	632	630	631	1.4%	-1	0%	1	0%	NA,T2	CS,D,NA
Belgium	1,376	1,322	1,266	2.8%	-110	-8%	-56	-4%	T1,T2	CS,D
Bulgaria	1,213	366	363	0.8%	-850	-70%	-3	-1%	T1,T2	CS,D
Croatia	492	422	391	0.9%	-101	-20%	-30	-7%	T2	CS,D
Cyprus	114	81	77	0.2%	-37	-32%	-4	-5%	T1,T2	D
Czechia	1,575	385	375	0.8%	-1,200	-76%	-10	-3%	T1,T2	CS,D
Denmark	2,480	3,125	2,964	6.6%	484	20%	-161	-5%	CS,T2	CS,D
Estonia	186	177	172	0.4%	-14	-8%	-5	-3%	T1,T2	CS,D
Finland	422	480	453	1.0%	31	7%	-27	-6%	T2	CS
France	6,211	6,264	5,941	13.2%	-270	-4%	-322	-5%	NA	NA
Germany	8,758	6,926	6,585	14.7%	-2,173	-25%	-341	-5%	NA,T2	CS,D,NA
Greece	939	726	713	1.6%	-226	-24%	-13	-2%	T1,T2	CS,D
Hungary	1,240	683	672	1.5%	-567	-46%	-10	-1%	T1,T2	CS,D
Ireland	1,667	2,119	2,091	4.7%	424	25%	-28	-1%	T1,T2	CS,D
Italy	5,424	4,787	4,791	10.7%	-633	-12%	4	0%	T1,T2	CS,D
Latvia	213	105	109	0.2%	-104	-49%	4	4%	T1,T2	CS,D
Lithuania	750	261	265	0.6%	-485	-65%	4	2%	NA,T1,T2	CS,D,NA
Luxembourg	87	101	100	0.2%	12	14%	-2	-2%	NA,T1,T1a,T2	CS,D,NA
Malta	10	7	6	0.0%	-4	-38%	0	-5%	NA,T1,T2	CS,D,NA
Netherlands	6,149	3,978	3,992	8.9%	-2,157	-35%	14	0%	NA,T1,T2	CS,D,NA
Poland	2,338	1,678	1,566	3.5%	-773	-33%	-112	-7%	NA,T1,T2	CS,D,NA
Portugal	907	839	832	1.9%	-75	-8%	-7	-1%	-	-
Romania	2,087	708	683	1.5%	-1,404	-67%	-25	-4%	NA,T1,T2	CS,D,NA
Slovakia	716	108	101	0.2%	-615	-86%	-7	-7%	NA,T1,T2	CS,NA
Slovenia	364	265	252	0.6%	-113	-31%	-14	-5%	T1,T2	CS,D
Spain	7,985	8,406	9,150	20.4%	1,164	15%	743	9%	T1,T2	CS,D
Sweden	275	297	306	0.7%	31	11%	10	3%	T1,T2	CS,D
EU-27	**54,611**	**45,246**	**44,849**	**100%**	**-9,762**	**-18%**	**-397**	**-1%**	**-**	**-**

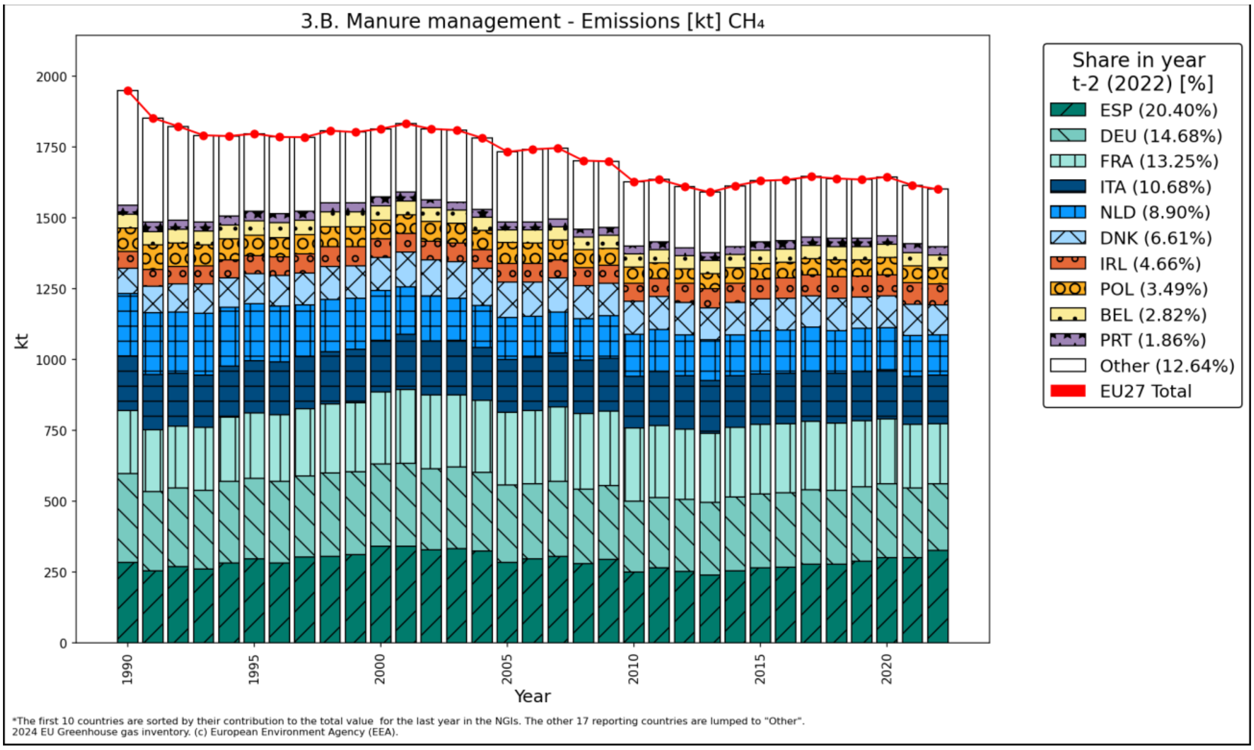
Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

5.3.2.1 Trends in Emissions and Activity Data

3.B- Manure Management - CH_4 Emissions

CH_4 emissions in source category *3.B- Manure Management* decreased considerably in the EU by 18 % or 9.7 Mt CO_2-eq in the period 1990 to 2022. Figure 5.22 shows the trend of emissions indicating the countries contributing most to the EU total.

Figure 5.22: 3.B: Trend in CH_4 emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.B. 1 - Cattle - Emissions

In 2022 CH_4 emissions in source category *3.B.1 - Cattle* in the EU were 21210 kt CO_2 equivalent. It represents 5.8 % of total agricultural emissions and 9.2 % 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.

CH_4 emissions by country and for the total EU from 3.B.1 *Manure Management* are shown in Table 5.17 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, CH_4 emission in this source category decreased by 15 % or 3.6 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 0.8%.

Table 5.17 **3.B.1.- Cattle: Countries' contributions to total EU-CH_4 emissions**

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	467	515	522	2.5%	54	12%	6	1%	T2	CS,D
Belgium	468	510	516	2.4%	48	10%	6	1%	T2	CS
Bulgaria	510	267	265	1.2%	-245	-48%	-2	-1%	T2	CS
Croatia	250	226	201	0.9%	-50	-20%	-25	-11%	T2	CS,D
Cyprus	19	32	31	0.1%	12	61%	-1	-3%	T2	D
Czechia	825	228	232	1.1%	-593	-72%	4	2%	T2	CS,D
Denmark	1,116	1,420	1,390	6.6%	273	24%	-30	-2%	CS,T2	CS
Estonia	60	126	127	0.6%	67	112%	1	1%	T2	CS,D
Finland	268	324	319	1.5%	50	19%	-5	-2%	T2	CS
France	3,875	3,379	3,266	15.4%	-609	-16%	-114	-3%	-	-
Germany	5,153	4,121	4,081	19.2%	-1,071	-21%	-40	-1%	T2	CS
Greece	137	87	80	0.4%	-58	-42%	-7	-8%	T2	CS,D
Hungary	680	436	426	2.0%	-254	-37%	-10	-2%	T2	CS
Ireland	1,204	1,541	1,542	7.3%	338	28%	1	0%	T2	CS
Italy	3,176	2,426	2,376	11.2%	-800	-25%	-50	-2%	T2	CS
Latvia	124	78	85	0.4%	-39	-32%	7	9%	T2	CS
Lithuania	286	187	194	0.9%	-92	-32%	7	4%	T2	CS
Luxembourg	76	87	87	0.4%	10	14%	0	0%	T2	CS
Malta	6	3	3	0.0%	-3	-51%	0	-1%	T2	CS
Netherlands	1,801	2,153	2,214	10.4%	413	23%	61	3%	T2	CS
Poland	1,074	725	702	3.3%	-372	-35%	-23	-3%	NA,T2	CS,NA
Portugal	222	249	245	1.2%	23	10%	-4	-2%	T2	CS,D
Romania	732	260	259	1.2%	-472	-65%	-1	0%	T2	CS
Slovakia	195	55	54	0.3%	-141	-72%	-1	-2%	T2	CS
Slovenia	183	219	210	1.0%	27	15%	-9	-4%	T2	CS
Spain	1,767	1,520	1,579	7.4%	-188	-11%	60	4%	T2	CS,D
Sweden	174	202	205	1.0%	31	18%	3	1%	T2	CS
EU-27	**24,851**	**21,377**	**21,210**	**100%**	**-3,641**	**-15%**	**-167**	**-1%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 5.23: 3.B.1.a: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022

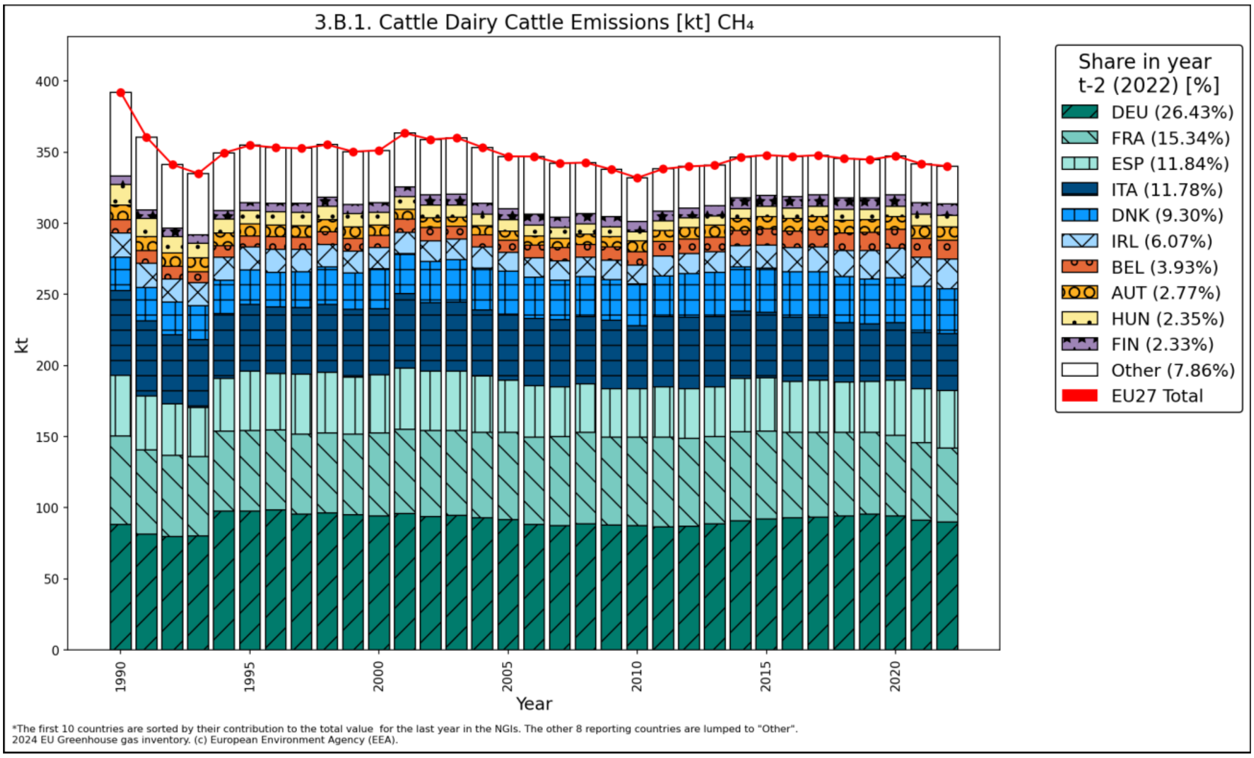
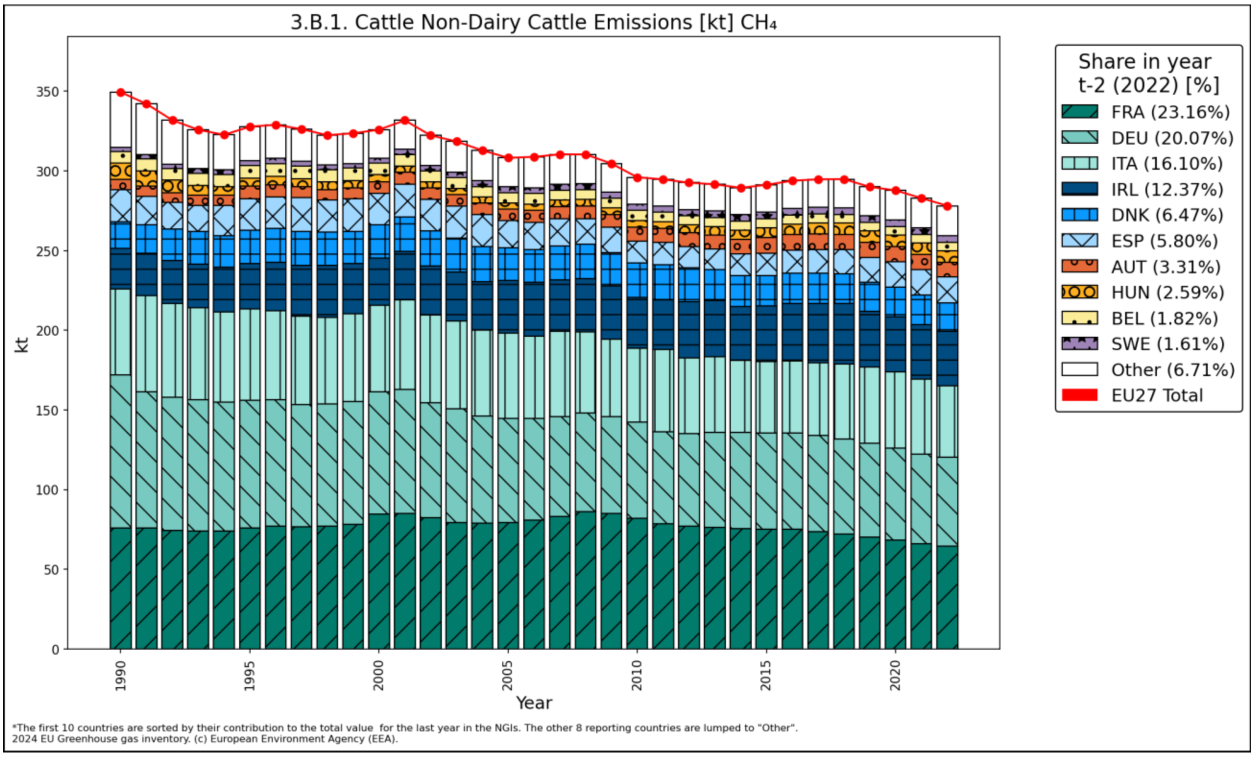


Figure 5.24: 3.B.1.b: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.B.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.3 - Swine - Emissions

In 2022 CH_4 emissions in source category *3.B.3 - Swine* in the EU were 20433 kt CO_2 equivalent. It represents 5.6 % of total agricultural emissions and 8.9 % of total agricultural CH_4 emissions.

CH_4 emissions by country and for the total EU from 3.B.3 *Manure Management* are shown in Table 5.18 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, CH_4 emission in this source category decreased by 21 % or 5.4 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 1.0 %.

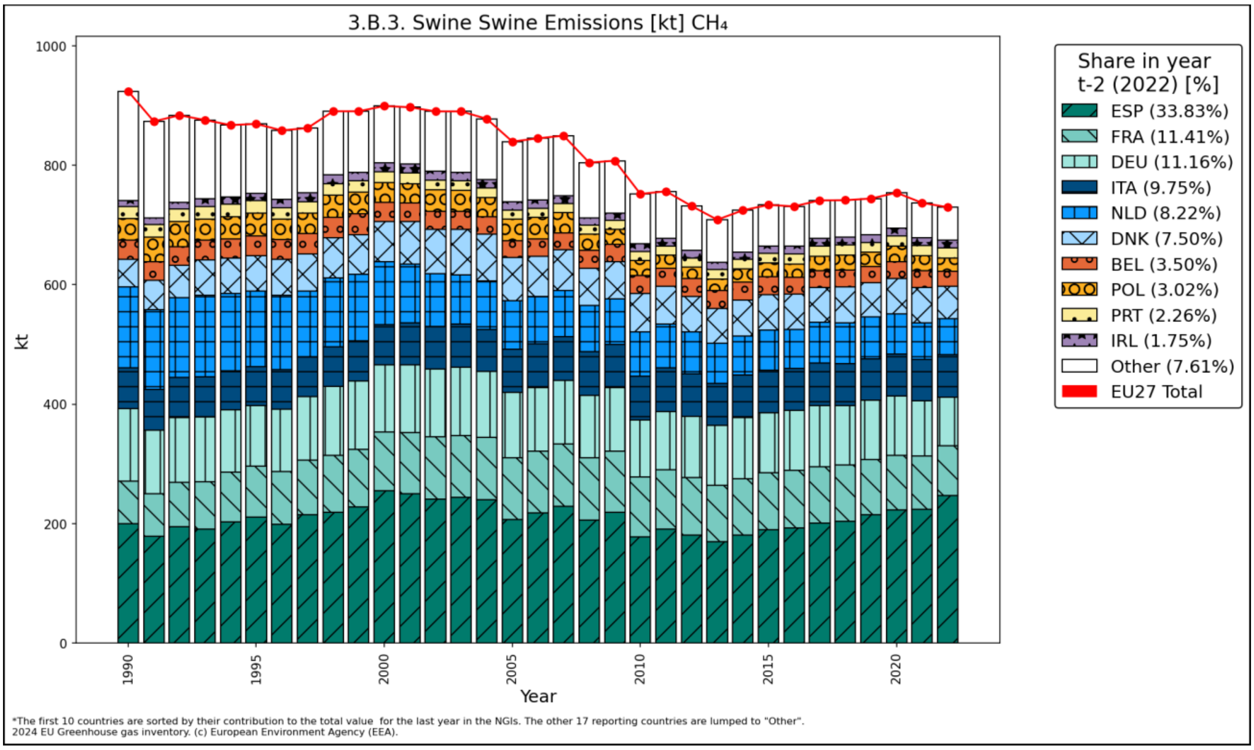
Figure 5.25 shows the trend of emissions indicating the countries contributing most to EU total.

Table 5.18 3.B.3 - Swine: Countries' contributions to total EU-GHG and CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	148	87	83	0.4%	-65	-44%	-5	-5%	T2	CS,D
Belgium	888	776	714	3.5%	-174	-20%	-62	-8%	T2	CS
Bulgaria	609	77	76	0.4%	-532	-87%	0	0%	T2	CS
Croatia	201	177	173	0.8%	-28	-14%	-4	-2%	T2	CS,D
Cyprus	89	43	40	0.2%	-49	-55%	-3	-7%	T2	D
Czechia	632	84	73	0.4%	-558	-88%	-11	-13%	T2	CS,D
Denmark	1,306	1,662	1,532	7.5%	226	17%	-130	-8%	-	CS
Estonia	116	49	42	0.2%	-74	-64%	-7	-14%	T2	CS,D
Finland	76	97	90	0.4%	14	19%	-8	-8%	T2	CS
France	1,983	2,522	2,331	11.4%	348	18%	-192	-8%	-	-
Germany	3,427	2,583	2,280	11.2%	-1,146	-33%	-303	-12%	T2	CS
Greece	484	323	320	1.6%	-164	-34%	-3	-1%	T1	D
Hungary	453	203	205	1.0%	-248	-55%	2	1%	T2	CS
Ireland	286	387	357	1.7%	72	25%	-30	-8%	T2	CS,D
Italy	1,908	1,920	1,992	9.7%	84	4%	71	4%	T2	CS
Latvia	73	21	19	0.1%	-55	-74%	-2	-9%	T2	CS
Lithuania	369	43	40	0.2%	-329	-89%	-3	-7%	T2	CS
Luxembourg	11	14	12	0.1%	1	11%	-1	-11%	T1	CS
Malta	1	1	0	0.0%	-1	-71%	0	-26%	NA,T2	CS,NA
Netherlands	3,773	1,726	1,680	8.2%	-2,093	-55%	-46	-3%	T2	CS
Poland	1,022	710	617	3.0%	-405	-40%	-93	-13%	T1	CS
Portugal	567	466	462	2.3%	-104	-18%	-3	-1%	-	-
Romania	1,143	285	262	1.3%	-881	-77%	-23	-8%	T2	CS
Slovakia	498	41	35	0.2%	-463	-93%	-6	-15%	T2	CS
Slovenia	143	23	22	0.1%	-121	-85%	-1	-6%	T1	D
Spain	5,596	6,258	6,913	33.8%	1,317	24%	655	10%	-	-
Sweden	67	57	63	0.3%	-4	-7%	6	10%	T2	CS
EU-27	**25,865**	**20,635**	**20,433**	**100%**	**-5,432**	**-21%**	**-202**	**-1%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

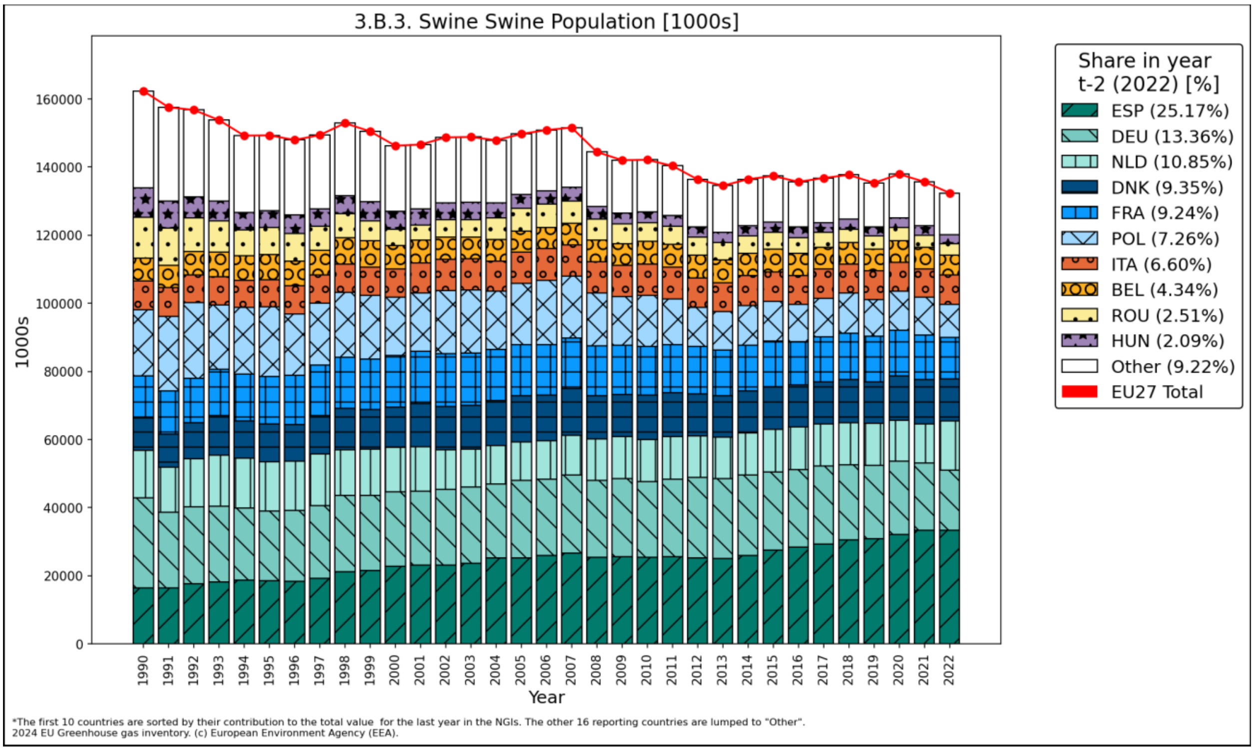
Figure 5.25: 3.B.3: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.B.3 - Swine - Population

The main activity data for CH_4 emissions from manure management - swine are the animal numbers. Swine population decreased considerably in the EU in the period 1990 to 2022. Figure 5.26 shows the trend of swine population indicating the countries contributing most to EU total.

Figure 5.26: 3.B.3: Trend in swine population in the EU and the countries contributing most to EU values including their share to EU population in 2022



5.3.2.2 Implied EFs and methodological issues

In this section, we discuss the implied emission factor for category 3.B for the main animal types.

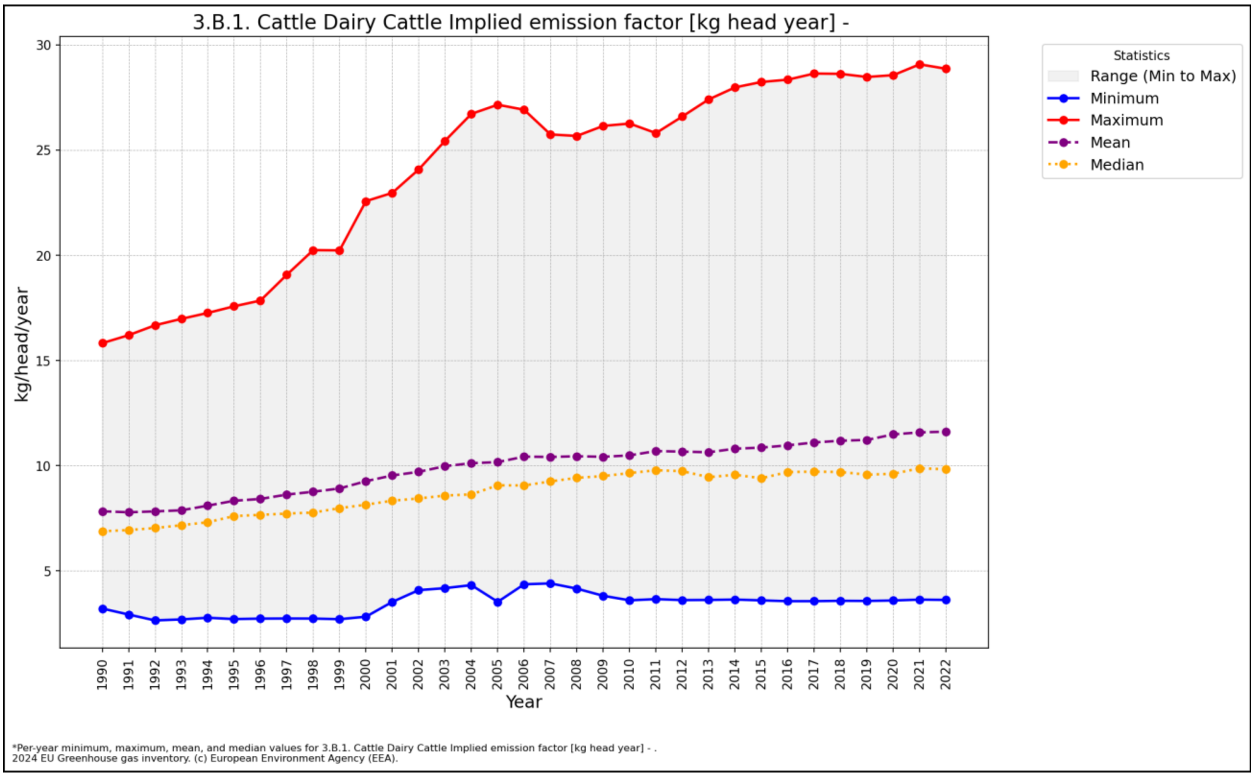
3.B.1 - Cattle - Implied emission factor

For cattle, the analysis is conducted per subcategory.

3.B.1.a - Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.a - Dairy Cattle* increased in the EU very strongly between 1990 and 2022. Figure 5.27 shows the trend of the implied emission factor indicating also the range of values used by the countries.

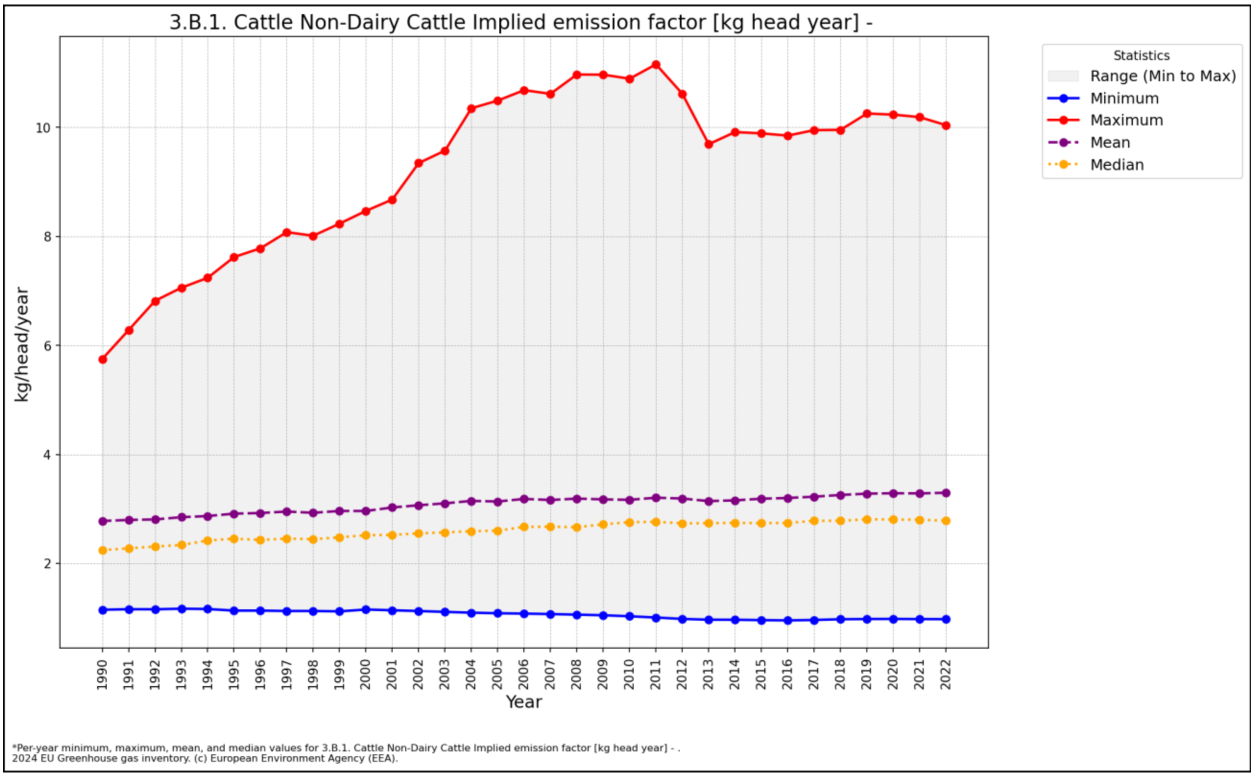
Figure 5.27: 3.B 1.a - Dairy Cattle: Trend in implied emission factor and range of values reported by countries



3.B.1.b - Non-Dairy Cattle - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.1.b - Non-Dairy Cattle* increased in the EU slightly between 1990 and 2022. Figure 5.30 shows the trend of the implied emission factor indicating also the range of values used by the countries.

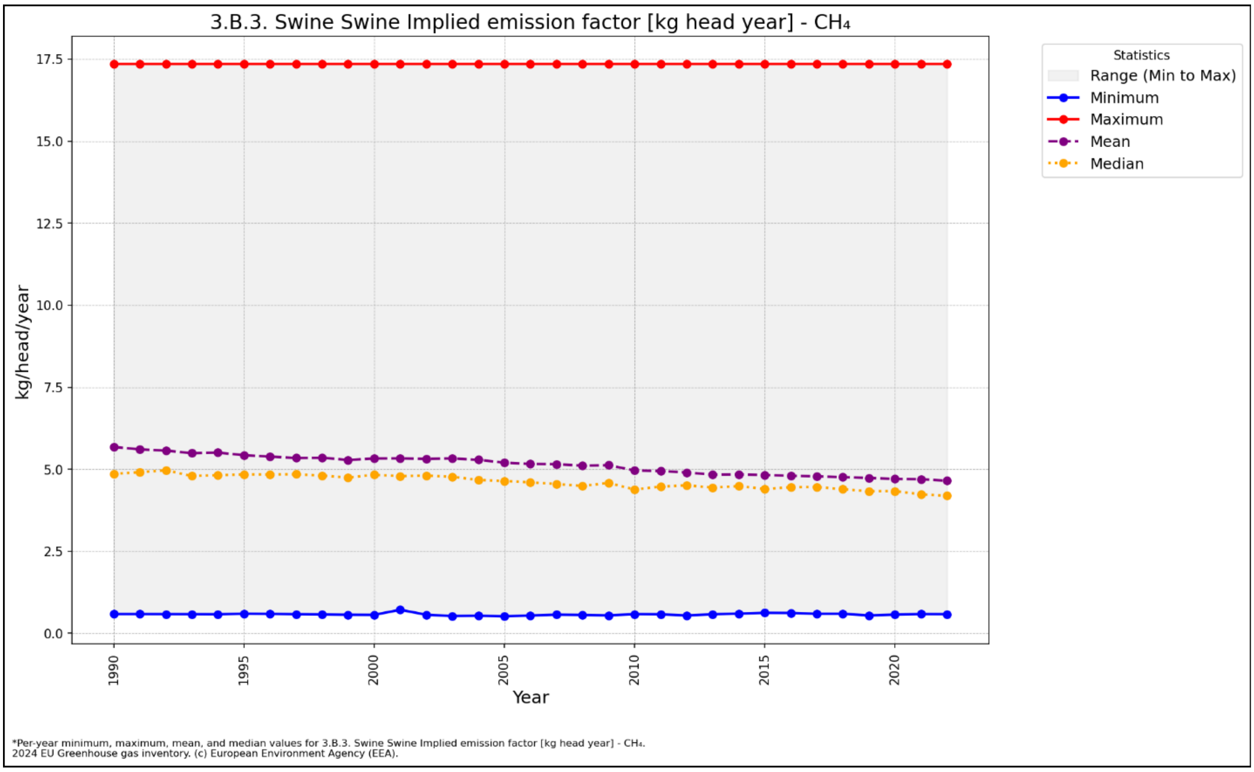
Figure 5.30: 3.B.1.b - Non-Dairy Cattle: Trend in implied emission factor and range of values reported by countries



3.B. 3 - Swine - Implied emission factor

The implied emission factor for CH_4 emissions in source category *3.B.3 - Swine* decreased in the EU moderately between 1990 and 2022. Figure 5.33 shows the trend of the implied emission factor indicating also the range of values used by the countries.

Figure 5.33: 3.B.3 - Swine: Trend in implied emission factor and range of values reported by countries

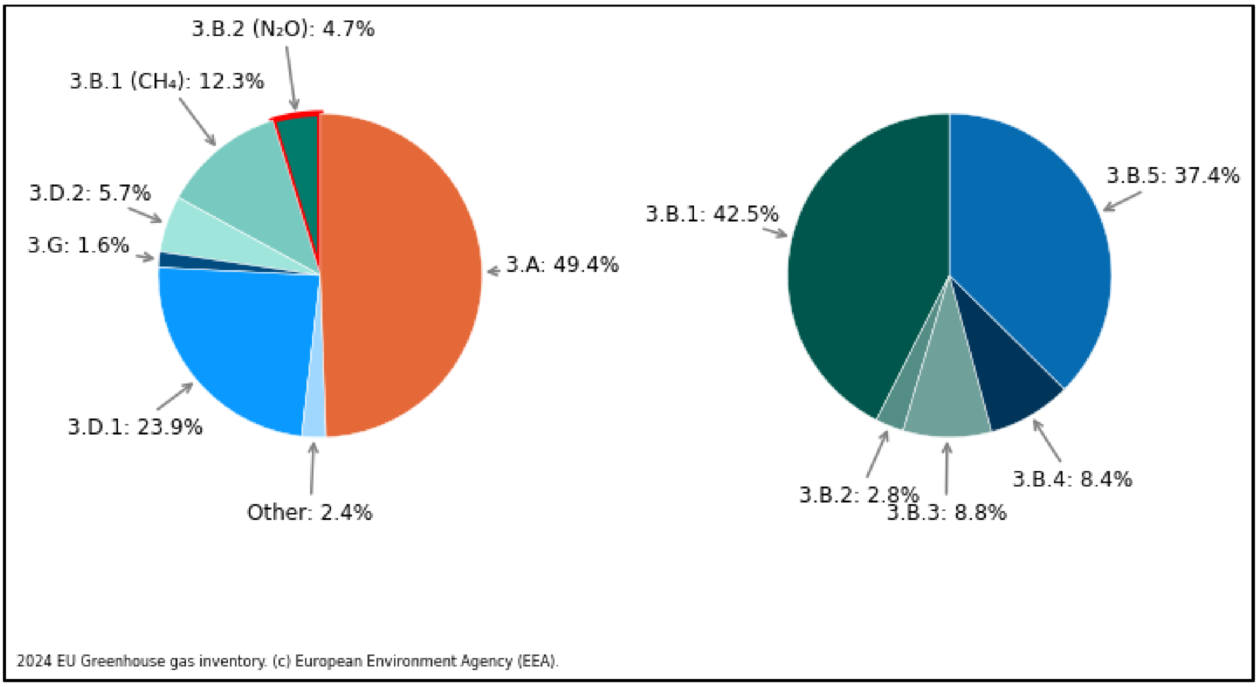


5.3.3 Manure Management - N_2O (CRT Source Category 3B)

In 2022 N_2O emissions in source category *3.B- Manure Management* in the EU were 17362 kt CO_2 equivalent. This corresponds to 0.55 % of total EU GHG emissions and 10 % of total EU N_2O emissions. They make 4.7 % of total agricultural emissions and 13.8 % of total agricultural N_2O emissions. The main sub-categories are Cattle (3.B.1) and Indirect Emissions (3.B.5), but substantial emissions are also reported for Swine (3.B.3) and Other Livestock (3.B.4), as presented in Figure 5.36.

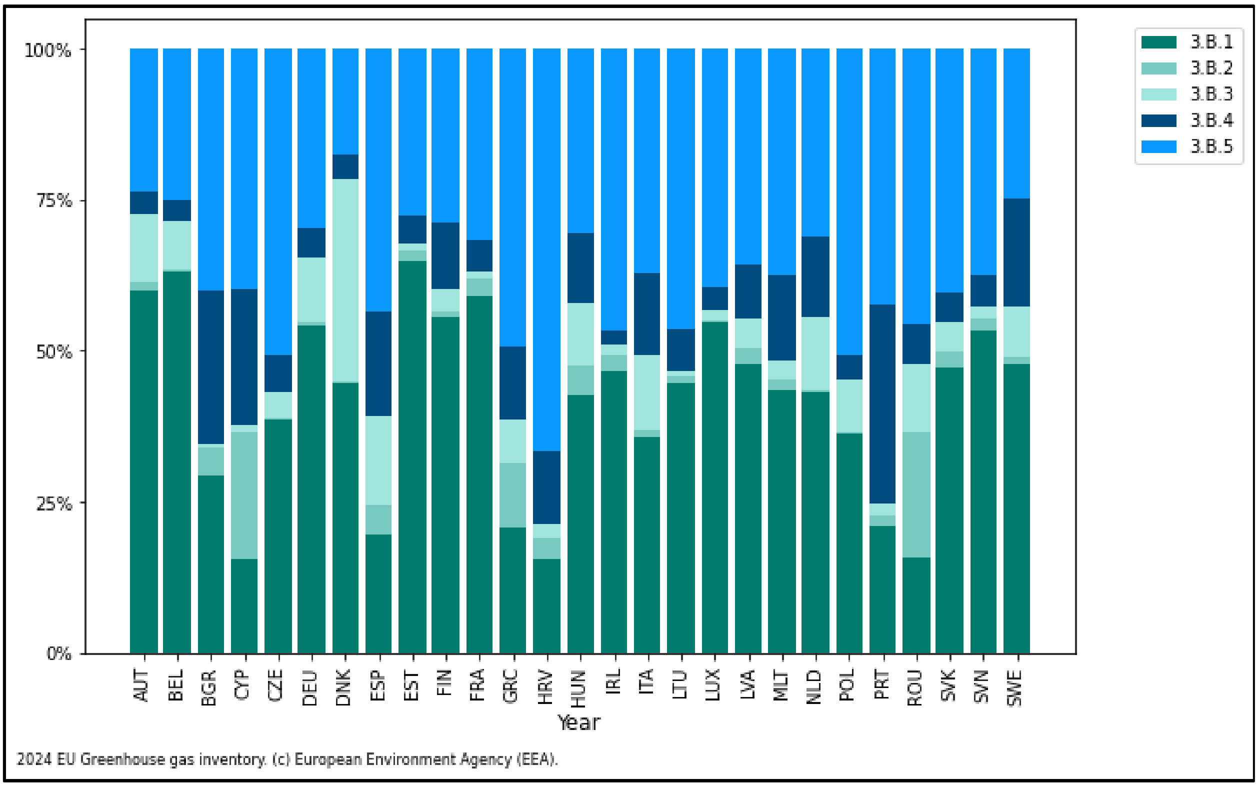
Regarding the origin of emissions in the different countries, Figure 5.37 shows the distribution of N_2O emissions from manure management by subcategory in all countries. Each bar represents the total emissions of a country in the current emission category, where different shades of blue correspond to the subcategory.

Figure 5.36: Share of source category 3.B-N_2O on total EU agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2022.3.B.1-3.B.4: emissions by animal types (cattle, sheep, swine, other livestock); 3.B.5:Indirect emissions from manure management.



In the left panel, some minor differences in the numbers might be present due to automatic rounding of numbers.

Figure 5.37: Decomposition of N_2O emissions in source category 3.B.2 - Manure Management into its sub-categories by country in the year 2022.



N_2O emissions by country and for the total EU from 3.B *Manure Management* are shown in Table 5.29 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, N_2O emission in this source category decreased by 32 % or 8.3 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 2.4 %.

Table 5.29 *3.B - Manure Management: Countries' contributions to total EU-N_2O emissions*

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	509	472	470	2.7%	-39	-8%	-2	-1%	NA,T2	D,NA,T2
Belgium	810	569	561	3.2%	-249	-31%	-8	-1%	T2	D,T2
Bulgaria	790	256	258	1.5%	-532	-67%	2	1%	T1,T2	D,T2
Croatia	284	106	103	0.6%	-181	-64%	-3	-3%	T2	CS,D,T2
Cyprus	59	70	69	0.4%	11	18%	-1	-1%	T1	D,T1
Czechia	996	392	387	2.2%	-609	-61%	-5	-1%	T1,T2	D,T2
Denmark	850	561	528	3.0%	-322	-38%	-33	-6%	CS,NA,T2	D,NA
Estonia	100	63	62	0.4%	-38	-38%	0	0%	T1,T2	CS,D,T2
Finland	270	236	224	1.3%	-46	-17%	-12	-5%	NA,T2	D,NA,T2
France	3,854	2,921	2,828	16.3%	-1,026	-27%	-93	-3%	NA	NA
Germany	3,218	2,375	2,297	13.2%	-921	-29%	-78	-3%	NA,T2	CS,D,NA,T2
Greece	335	268	261	1.5%	-74	-22%	-7	-3%	D,NA	D,NA
Hungary	758	384	377	2.2%	-380	-50%	-7	-2%	T1,T2	CS,D,T2
Ireland	507	633	633	3.6%	126	25%	0	0%	T2	CS,D,T2
Italy	2,518	1,767	1,722	9.9%	-796	-32%	-45	-3%	NA,T2	CS,D,NA,T2
Latvia	252	66	66	0.4%	-185	-74%	1	1%	NA,T1,T2	D,NA,T2
Lithuania	525	158	161	0.9%	-364	-69%	3	2%	NA,T1,T2	D,NA,T2
Luxembourg	39	34	34	0.2%	-5	-13%	-1	-2%	NA,T2	CS,NA,T2
Malta	17	12	11	0.1%	-6	-33%	0	-4%	T1,T2	CS,D,T2
Netherlands	837	668	653	3.8%	-185	-22%	-15	-2%	NA,T1	CS,NA,T1
Poland	3,624	2,492	2,449	14.1%	-1,175	-32%	-43	-2%	NA,T1,T2	CS,D,NA,T2
Portugal	239	202	202	1.2%	-37	-15%	0	0%	NO,T2	NO,T2
Romania	1,698	815	805	4.6%	-894	-53%	-10	-1%	NA,T2	D,NA,T2
Slovakia	518	173	179	1.0%	-339	-65%	7	4%	NA,T1,T2	CS,NA,T2
Slovenia	79	71	68	0.4%	-11	-13%	-2	-3%	T1,T2	D,T1,T2
Spain	1,630	1,738	1,661	9.6%	32	2%	-76	-4%	T1,T2	D,T2
Sweden	329	289	292	1.7%	-37	-11%	3	1%	CS,T2	CS,D,T2
EU-27	**25,645**	**17,791**	**17,362**	**100%**	**-8,283**	**-32%**	**-429**	**-2%**	**-**	**-**

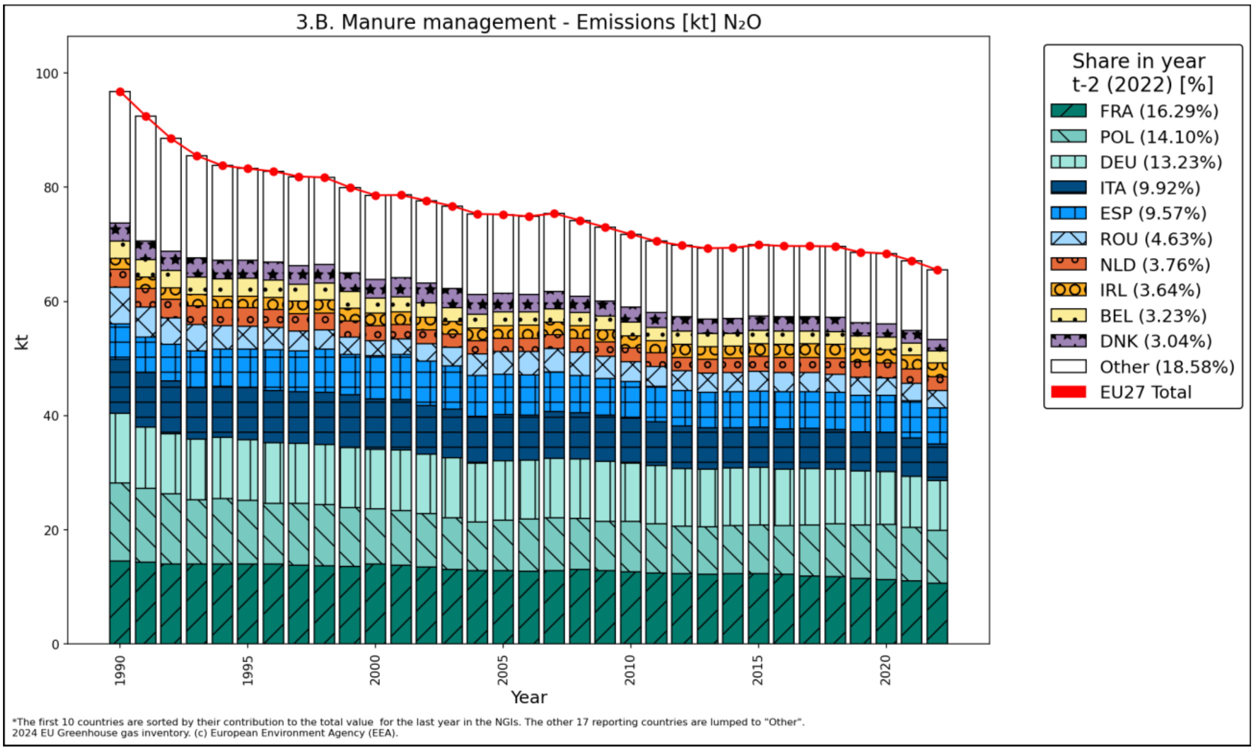
Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

5.3.3.1 Trends in Emissions and Activity Data

3.B.- Manure Management - Emissions

N_2O Emissions in source category *3.B - Manure Management* decreased strongly in the EU in the period 1990 to 2022. Figure 5.39 shows the trend of emissions indicating the countries contributing most to EU total.

Figure 5.39: 3.B Manure Management: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.B. 1 - Cattle - Emissions

In 2022 N_2O emissions in source category *3.B.1 - Cattle* in the EU were 7386 kt CO_2 equivalent. It represents 2 % of total agricultural emissions and 5.9 % 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 total.

N_2O emissions by country and for the total EU from 3.B.1 *Manure Management* are shown in Table 5.30 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, N_2O emission in this source category decreased by 30 % or 3.2 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 1.6 %.

Table 5.30 3.B.1 - Cattle: Countries' contributions to total EU-N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	294	280	281	3.8%	-12	-4%	1	0%	T2	T2
Belgium	552	358	355	4.8%	-198	-36%	-3	-1%	T2	T2
Bulgaria	189	77	76	1.0%	-113	-60%	-1	-2%	T2	T2
Croatia	80	15	16	0.2%	-64	-80%	1	6%	T2	T2
Cyprus	7	11	11	0.1%	3	44%	0	-1%	T1	T1
Czechia	378	147	149	2.0%	-229	-61%	2	1%	T2	T2
Denmark	280	245	236	3.2%	-43	-16%	-9	-4%	CS,T2	-
Estonia	54	40	40	0.5%	-14	-25%	0	0%	T2	T2
Finland	126	127	124	1.7%	-2	-1%	-3	-2%	T2	T2
France	2,291	1,720	1,672	22.6%	-619	-27%	-48	-3%	-	-
Germany	1,724	1,255	1,242	16.8%	-482	-28%	-13	-1%	T2	T2
Greece	78	58	54	0.7%	-24	-31%	-3	-6%	D	D
Hungary	248	164	161	2.2%	-87	-35%	-2	-1%	T2	T2
Ireland	229	296	296	4.0%	67	29%	1	0%	T2	T2
Italy	1,067	638	615	8.3%	-452	-42%	-24	-4%	T2	T2
Latvia	107	30	32	0.4%	-76	-70%	1	5%	T2	T2
Lithuania	188	70	72	1.0%	-116	-62%	2	3%	T2	T2
Luxembourg	23	19	18	0.2%	-5	-21%	0	-2%	T2	T2
Malta	8	5	5	0.1%	-3	-40%	0	0%	T2	T2
Netherlands	305	291	282	3.8%	-23	-8%	-9	-3%	T1	T1
Poland	1,255	882	892	12.1%	-364	-29%	9	1%	NA,T2	NA,T2
Portugal	70	44	43	0.6%	-27	-39%	-1	-2%	T2	T2
Romania	294	128	128	1.7%	-166	-57%	0	0%	T2	T2
Slovakia	261	86	85	1.1%	-176	-68%	-1	-1%	T2	T2
Slovenia	31	38	36	0.5%	5	17%	-1	-4%	T1,T2	T1,T2
Spain	284	344	327	4.4%	43	15%	-17	-5%	T2	T2
Sweden	156	139	139	1.9%	-17	-11%	0	0%	CS,T2	CS,T2
EU-27	**10,579**	**7,505**	**7,386**	**100%**	**-3,193**	**-30%**	**-119**	**-2%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 5.40: 3.B.1.a - Dairy cattle: Trend in N_2O emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022

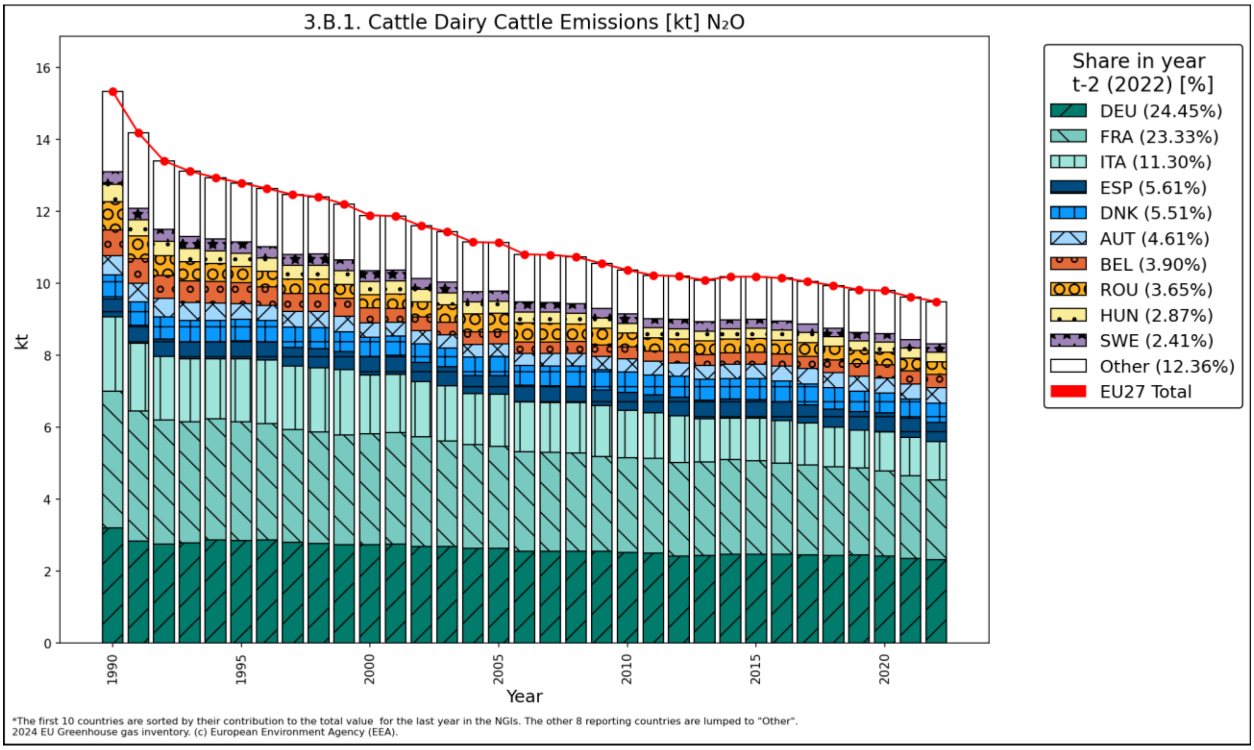
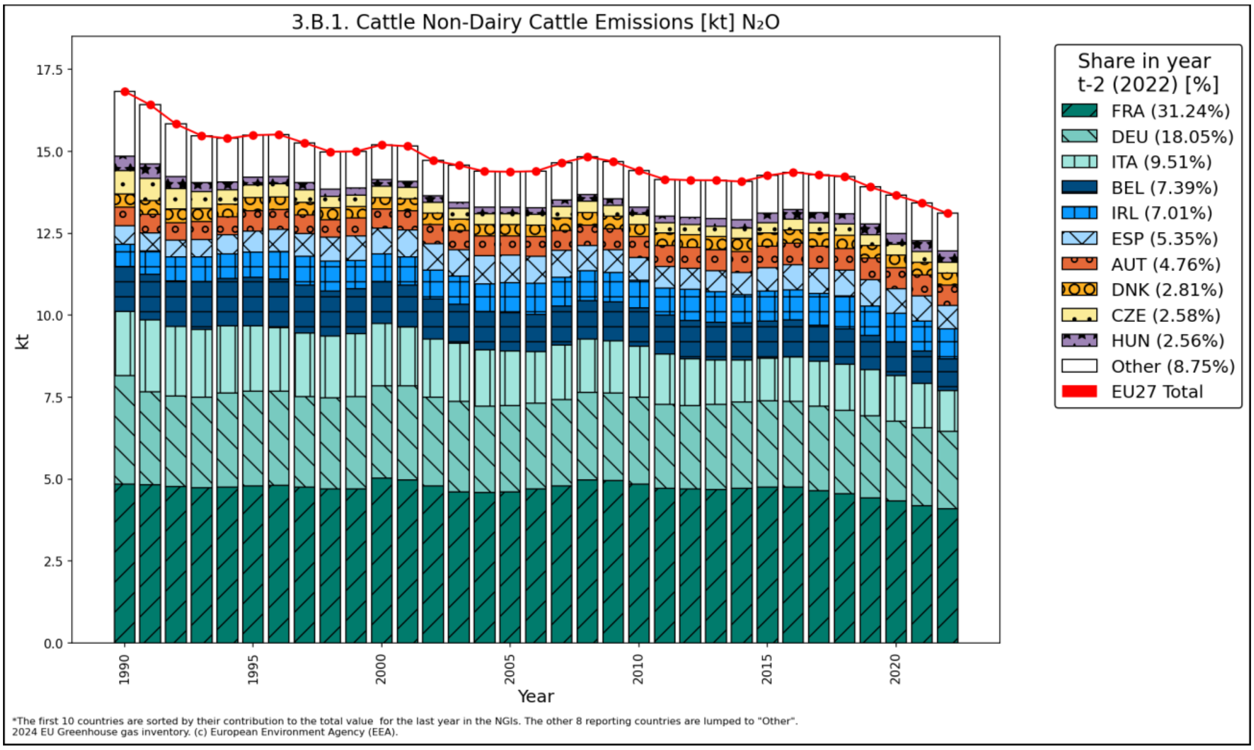


Figure 5.41: 3.B.1.b - Non-dairy cattle: Trend in N_2O emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.B. 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 relevant activity data are the allocation by manure management system (MMS).

3.B.3 - Swine - Emissions

In 2022 N_2O emissions in source category *3.B.3 - Swine* in the EU were 1534 kt CO_2 equivalent. It represents 0.4% of total agricultural emissions and 1.2% of total agricultural N_2O emissions. Figure 5.42 shows the trend of emissions indicating the countries contributing most to the EU total.

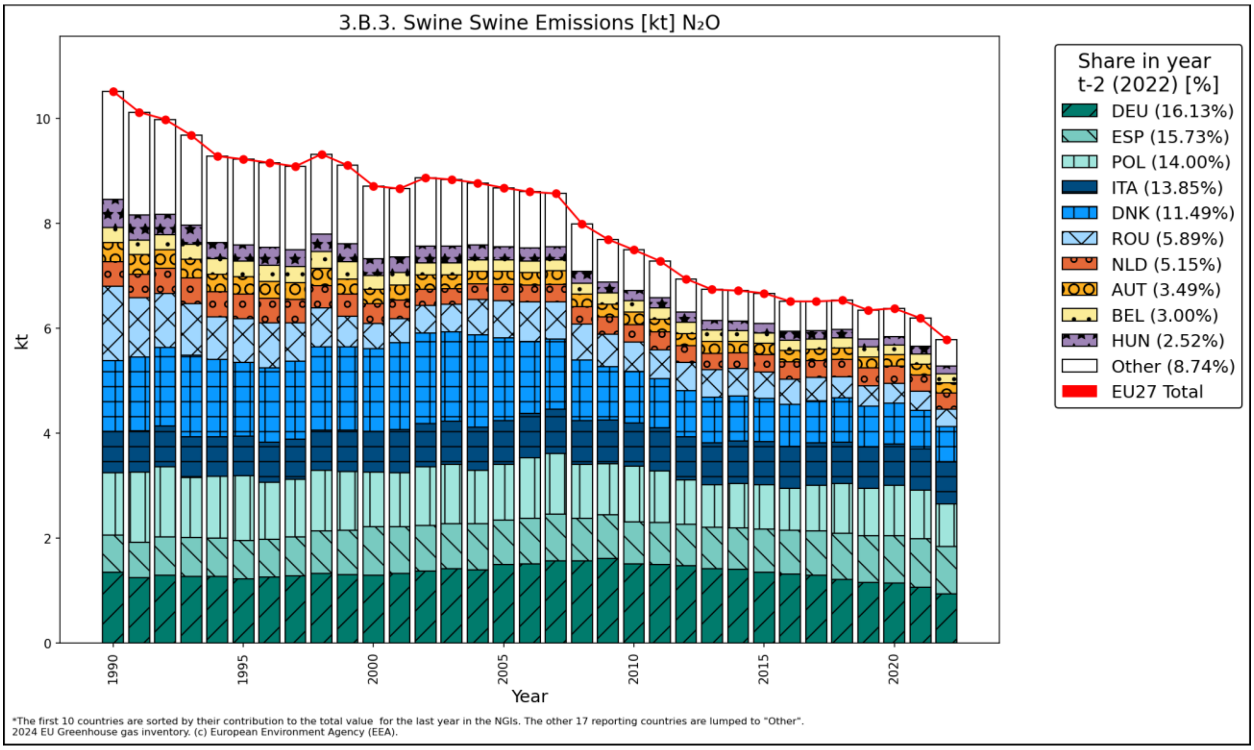
Total N_2O emissions by country and for the total EU from 3.B.3 *Manure Management* are shown in Table 5.31 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, N_2O emission in this source category decreased by 45 % or 1.2 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 6.5 %.

Table 5.31 3.B.3 - Swine: Countries' contributions to total EU-N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	99	56	53	3.5%	-45	-46%	-3	-5%	T2	D
Belgium	75	50	46	3.0%	-29	-39%	-4	-8%	T2	D
Bulgaria	9	1	1	0.1%	-8	-85%	0	0%	T2	D
Croatia	25	2	2	0.2%	-22	-90%	0	-3%	T2	CS,D
Cyprus	1	1	1	0.1%	0	14%	0	-6%	T1	D
Czechia	116	19	16	1.1%	-100	-86%	-3	-16%	T1,T2	D
Denmark	355	195	176	11.5%	-179	-50%	-18	-9%	-	D
Estonia	2	1	1	0.0%	-1	-69%	0	-13%	T2	CS,D
Finland	23	9	9	0.6%	-14	-63%	-1	-8%	T2	D
France	78	32	30	2.0%	-48	-61%	-2	-5%	-	-
Germany	356	281	247	16.1%	-109	-31%	-33	-12%	T2	CS,D
Greece	28	19	19	1.2%	-9	-34%	0	-1%	D	D
Hungary	141	40	39	2.5%	-102	-72%	-1	-4%	T2	CS
Ireland	9	12	11	0.7%	2	25%	-1	-5%	T2	CS,D
Italy	210	206	212	13.8%	2	1%	6	3%	T2	CS,D
Latvia	36	4	3	0.2%	-32	-91%	-1	-15%	T2	D
Lithuania	98	2	1	0.1%	-97	-98%	0	-10%	T1	D
Luxembourg	1	1	1	0.0%	0	-44%	0	-9%	T2	CS
Malta	1	0	0	0.0%	-1	-70%	0	-25%	T1	D
Netherlands	125	81	79	5.1%	-46	-37%	-2	-2%	T1	CS
Poland	314	246	215	14.0%	-99	-31%	-31	-13%	T2	CS
Portugal	10	4	4	0.2%	-6	-62%	0	-1%	NO	NO
Romania	375	98	90	5.9%	-285	-76%	-7	-7%	T2	D
Slovakia	66	8	9	0.6%	-57	-86%	1	9%	T2	CS
Slovenia	6	2	1	0.1%	-5	-77%	0	-10%	T1	D
Spain	190	247	241	15.7%	51	27%	-6	-2%	-	-
Sweden	38	24	24	1.6%	-14	-37%	0	1%	CS,T2	CS,D
EU-27	**2,787**	**1,641**	**1,534**	**100%**	**-1,253**	**-45%**	**-107**	**-7%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 5.42: 3.B.3 - Swine: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.B. 4 - Other Livestock - Emissions

In 2022 N_2O emissions in source category *3.B.4 - Other Livestock* in the EU were 1456 kt CO_2 equivalent. It represents 0.4 % of total agricultural emissions and 1.2 % of total agricultural N_2O emissions.

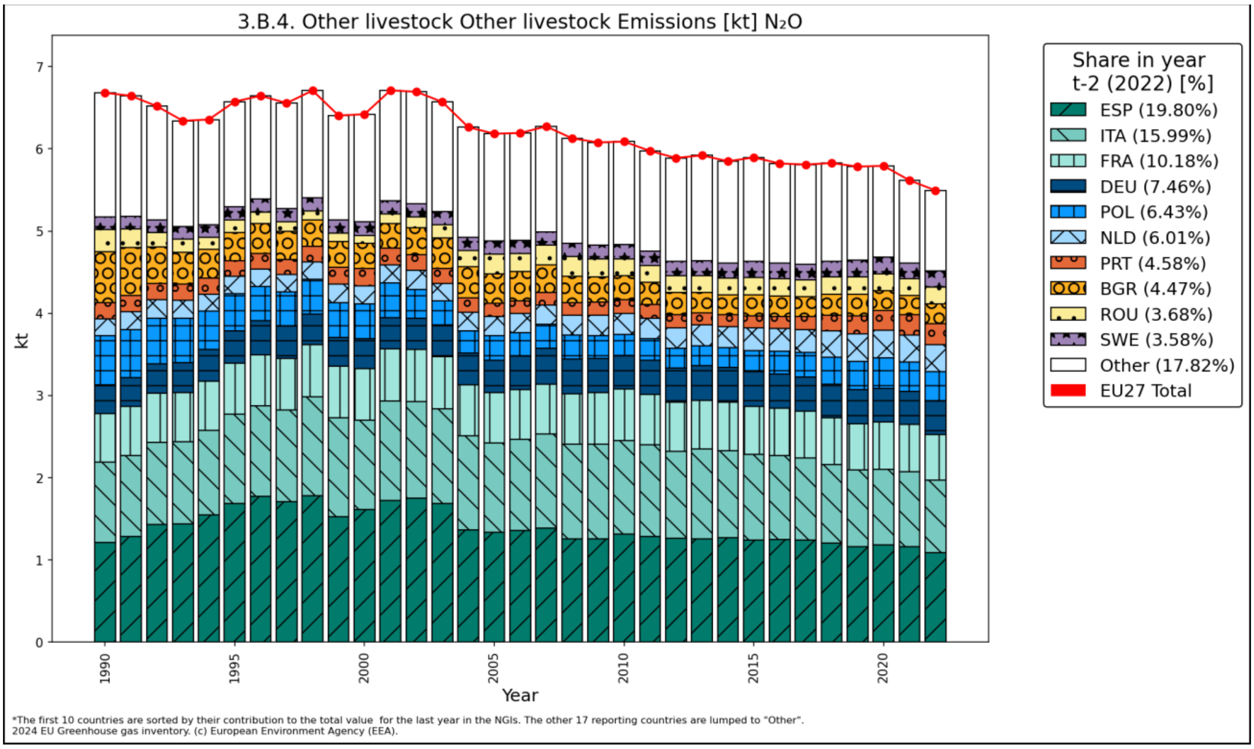
Total N_2O emissions by country and for the total EU from 3.B.4 *Manure Management* are shown in Table 5.32 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, N_2O emission in this source category decreased by 18 % or 315 kt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 2.2 %. Figure 5.44 shows the trend of emissions indicating the countries contributing most to EU total.

Table 5.32 3.B.4 - Other Livestock: Countries' contributions to total EU-N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	8	17	17	1.2%	9	106%	0	0%	NA,T2	D,NA
Belgium	9	19	19	1.3%	10	108%	0	1%	T2	D
Bulgaria	164	62	65	4.5%	-99	-60%	3	6%	T1,T2	D
Croatia	29	14	13	0.9%	-17	-57%	-1	-8%	T2	CS,D
Cyprus	15	16	16	1.1%	0	3%	0	0%	T1	D
Czechia	56	25	24	1.7%	-32	-56%	0	-2%	T1,T2	D
Denmark	40	21	21	1.4%	-19	-48%	0	-1%	NA	D,NA
Estonia	11	3	3	0.2%	-8	-75%	0	0%	T1	D
Finland	26	28	24	1.7%	-1	-6%	-4	-14%	NA,T2	D,NA
France	156	153	148	10.2%	-8	-5%	-4	-3%	NA	NA
Germany	92	108	109	7.5%	16	18%	1	1%	NA,T2	CS,D,NA
Greece	53	32	32	2.2%	-21	-39%	0	0%	D,NA	D,NA
Hungary	92	45	44	3.0%	-48	-52%	-2	-3%	T1,T2	CS,D
Ireland	16	15	15	1.1%	0	-3%	0	-1%	T2	CS,D
Italy	260	242	233	16.0%	-27	-10%	-9	-4%	NA,T2	CS,D,NA
Latvia	18	6	6	0.4%	-12	-67%	0	-5%	NA,T1,T2	D,NA
Lithuania	14	11	11	0.7%	-3	-24%	0	0%	NA,T1	D,NA
Luxembourg	0	1	1	0.1%	1	160%	0	2%	NA,T2	CS,NA
Malta	1	2	2	0.1%	1	91%	0	-11%	T1	CS,D
Netherlands	54	87	88	6.0%	34	62%	0	0%	NA,T1	CS,NA
Poland	158	94	94	6.4%	-65	-41%	0	0%	T1,T2	CS,D
Portugal	53	66	67	4.6%	13	25%	1	1%	NO	NO
Romania	71	54	54	3.7%	-17	-24%	0	-1%	NA,T2	D,NA
Slovakia	8	7	8	0.6%	0	4%	1	17%	NA,T1,T2	CS,NA
Slovenia	4	3	4	0.2%	0	1%	0	2%	T1	D
Spain	321	307	288	19.8%	-32	-10%	-18	-6%	T1,T2	D
Sweden	41	51	52	3.6%	12	28%	1	2%	T2	D
EU-27	**1,771**	**1,488**	**1,456**	**100%**	**-315**	**-18%**	**-32**	**-2%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 5.44: 3.B.4 - Other Livestock: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.B.5 - Manure Management - Indirect Emissions - Emissions

In 2022 N_2O emissions in source category *3.B.5 - Manure Management - Indirect Emissions - Indirect N_2O emissions* in the EU were 6496 kt CO_2 equivalent. It represents 1.8 % of total agricultural emissions and 5.2 % of total agricultural N_2O emissions. Those emissions include emissions from atmospheric deposition and leaching and run-off.

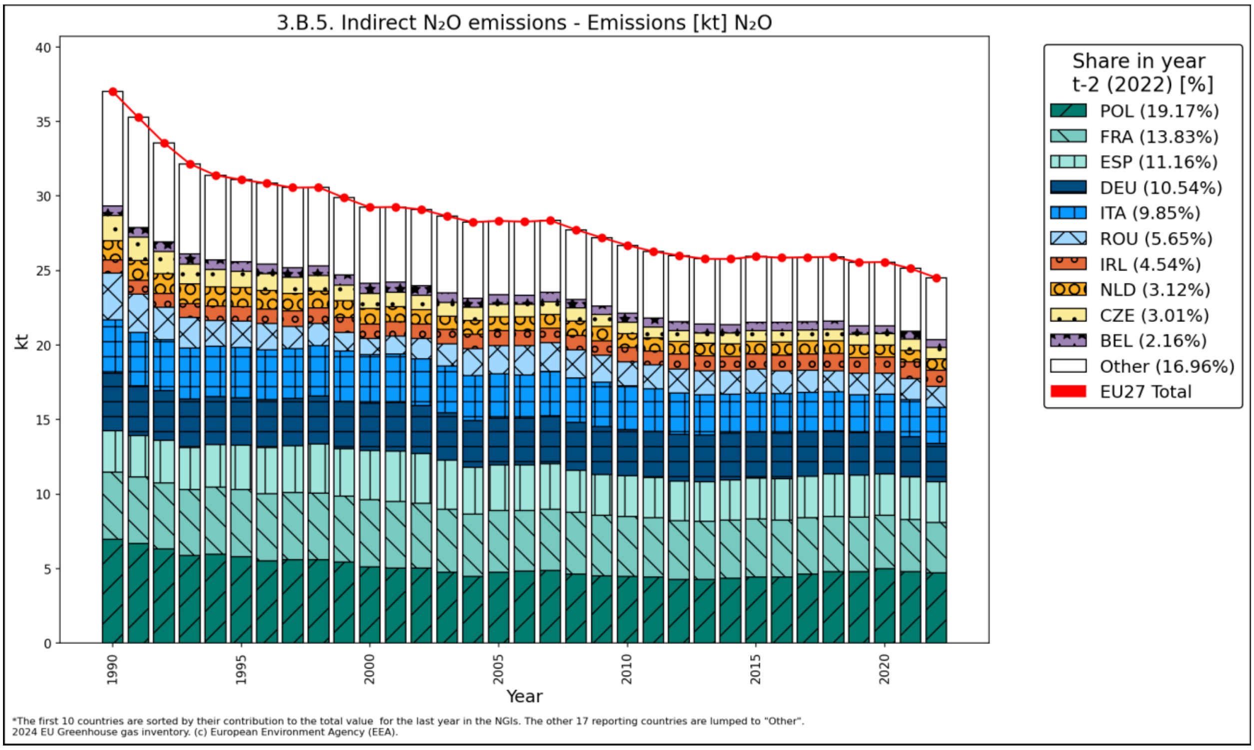
Total N_2O emissions by country and for the total EU from 3.B.5 *Manure Management - Indirect Emissions* are shown in Table 5.42 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, N_2O emission in this source category decreased by 34 % or 3.3 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 2 %. Figure 5.55 shows the trend of emissions indicating the countries contributing most to EU total.

Table 5.42 3.B.5 - Manure Management - Indirect Emissions: Countries' contributions to total EU- N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	103	111	111	1.7%	8	8%	0	0%	T2	D
Belgium	172	142	141	2.2%	-32	-18%	-1	-1%	T1	D
Bulgaria	343	103	104	1.6%	-239	-70%	1	1%	T1	D
Croatia	147	71	69	1.1%	-78	-53%	-2	-3%	T1	D
Cyprus	23	28	28	0.4%	4	20%	-1	-2%	-	-
Czechia	442	198	196	3.0%	-247	-56%	-3	-1%	T1,T2	D
Denmark	173	98	93	1.4%	-80	-46%	-5	-5%	CS,T2	D
Estonia	31	18	17	0.3%	-13	-43%	0	-2%	T2	CS,D
Finland	93	69	64	1.0%	-29	-31%	-5	-7%	T2	D
France	1,195	933	898	13.8%	-297	-25%	-34	-4%	-	-
Germany	1,020	717	685	10.5%	-335	-33%	-33	-5%	-	-
Greece	149	132	129	2.0%	-20	-14%	-3	-2%	D	D
Hungary	248	118	115	1.8%	-133	-54%	-3	-3%	T1,T2	CS,D
Ireland	233	295	295	4.5%	62	26%	0	0%	T1	D
Italy	951	658	640	9.9%	-311	-33%	-18	-3%	T2	CS,D
Latvia	86	24	24	0.4%	-63	-73%	0	0%	CS	D
Lithuania	224	74	75	1.2%	-149	-67%	1	1%	T1	D
Luxembourg	14	14	13	0.2%	-1	-4%	0	-2%	T2	D
Malta	7	4	4	0.1%	-2	-36%	0	-2%	T1	D
Netherlands	347	207	203	3.1%	-144	-42%	-4	-2%	CS	CS
Poland	1,848	1,267	1,245	19.2%	-602	-33%	-21	-2%	T1	D
Portugal	96	86	85	1.3%	-10	-11%	0	0%	-	-
Romania	828	372	367	5.6%	-461	-56%	-5	-1%	T1	D
Slovakia	174	67	73	1.1%	-102	-58%	6	8%	T1	D
Slovenia	37	26	25	0.4%	-12	-32%	-1	-3%	T1	D
Spain	734	756	725	11.2%	-10	-1%	-32	-4%	T2	D
Sweden	92	71	72	1.1%	-19	-21%	1	2%	-	-
EU-27	**9,811**	**6,660**	**6,496**	**100%**	**-3,315**	**-34%**	**-164**	**-2%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 5.55: 3.B.5 - Manure Management - Indirect Emissions: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



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.

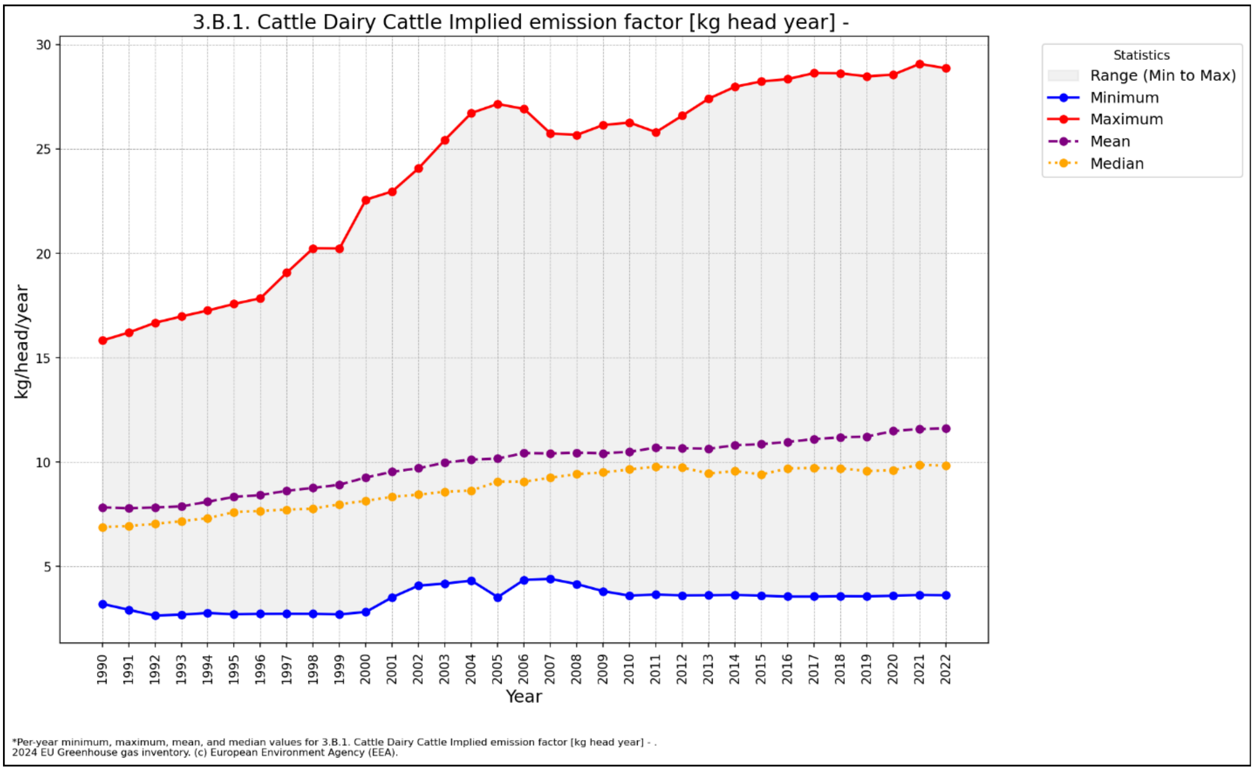
3.B.1 - Cattle - Implied emission factor

For cattle, the analysis is conducted per subcategory.

3.B.1.a - Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.1.a - Dairy Cattle* increased in the EU clearly between 1990 and 2022. Figure 5.47 shows the trend of the implied emission factor indicating also the range of values used by the countries. This increase is mainly explained by the increase in the nitrogen excreted per head.

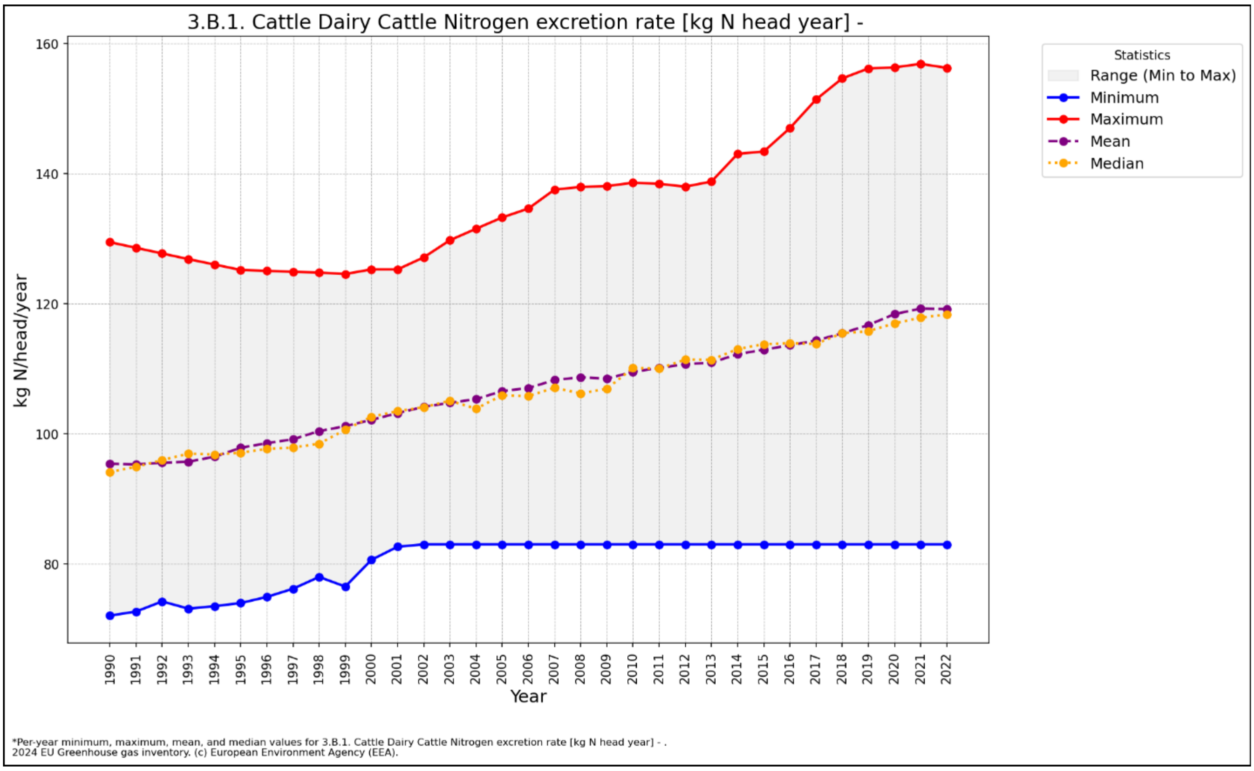
Figure 5.47: 3.B.1.a - Dairy Cattle: Trend in implied emission factor and range of values reported by countries



3.B.1.a - Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.1.1 - Dairy Cattle*, increased in the EU considerably between 1990 and 2022. Figure 5.48 shows the trend of the nitrogen excretion rate indicating also the range of values used by the countries.

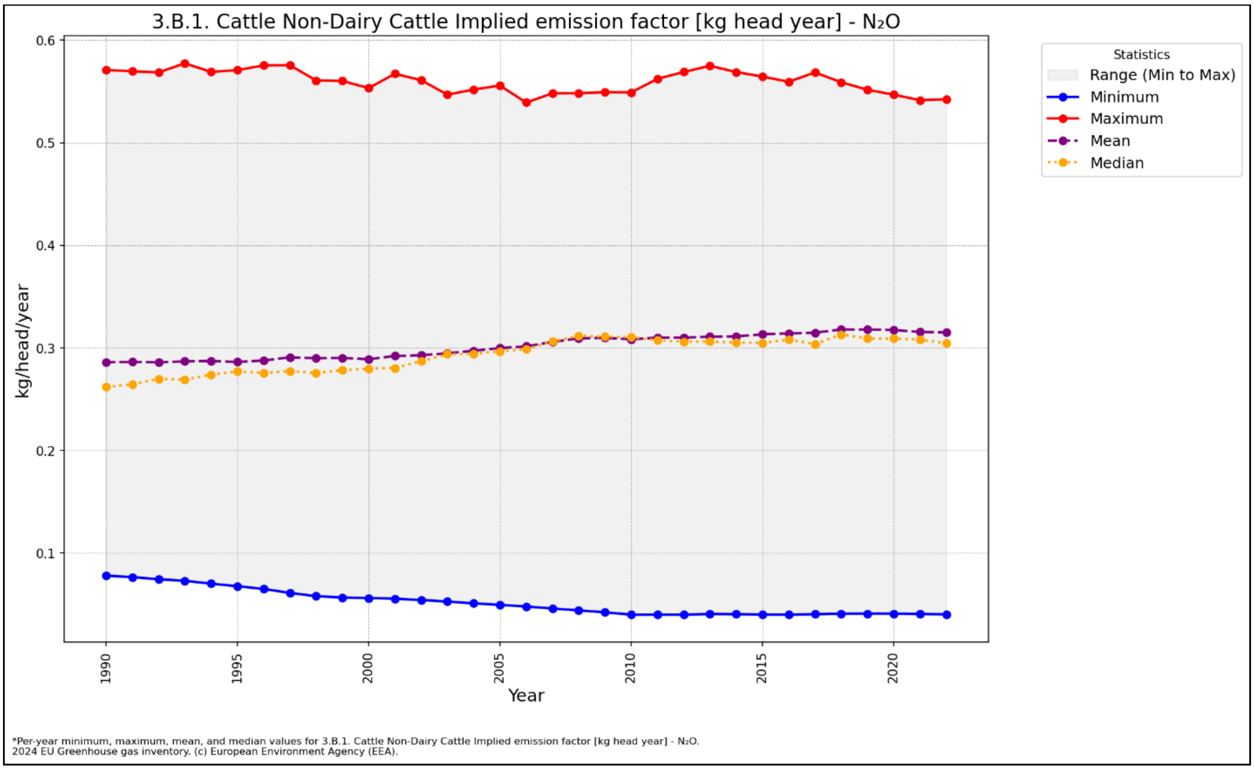
Figure 5.48: 3.B.1.a - Dairy Cattle: Trend in nitrogen excretion rate and range of values reported by countries



3.B.1.b - Non-Dairy Cattle - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.1.b - Non-Dairy Cattle* increased in the EU moderately between 1990 and 2022. Figure 5.49 shows the trend of the implied emission factor indicating also the range of values used by the countries. As mentioned for dairy cattle, one of the main drivers involved in the implied emission factor is the nitrogen excretion rate.

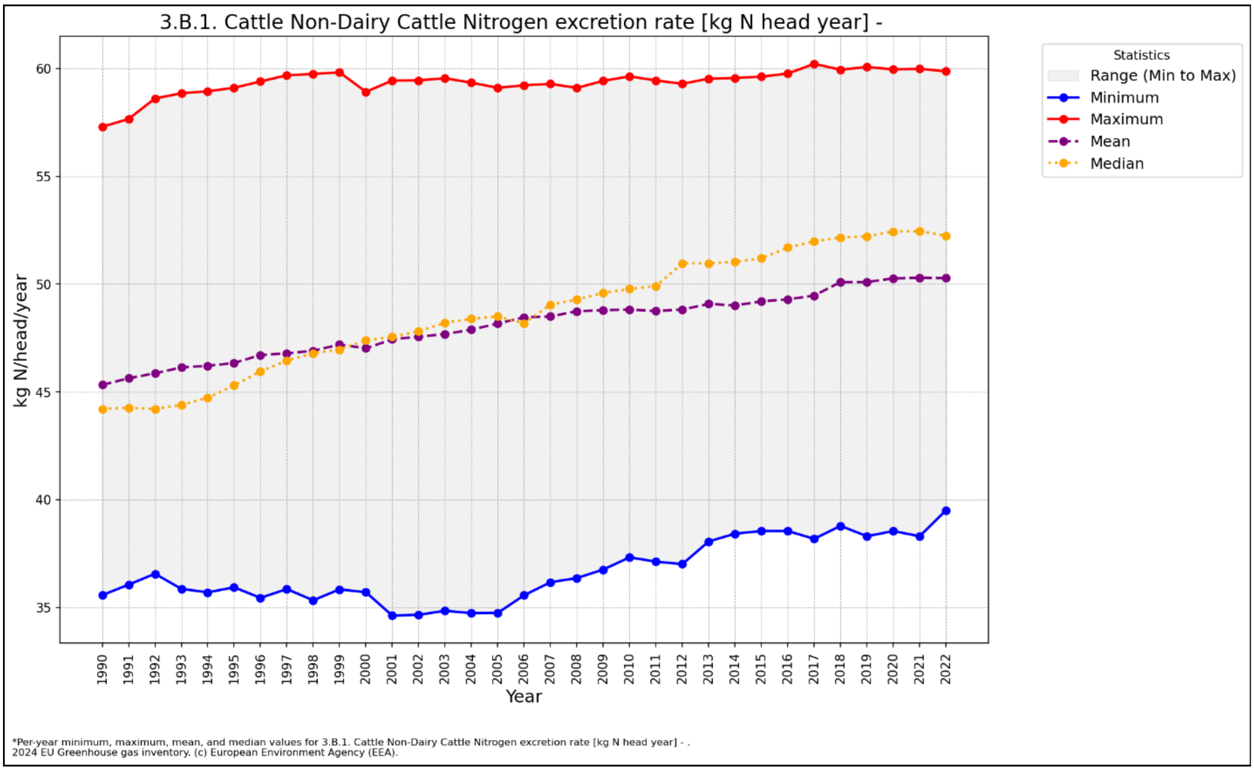
Figure 5.49: 3.B.1.b - Non-Dairy Cattle: Trend in implied emission factor and range of values reported by countries



3.B.1.b - Non-Dairy Cattle - Nitrogen excretion rate

The nitrogen excretion rate, a parameter used for calculating N_2O emissions in source category *3.B.1.b - Non-Dairy Cattle*, increased in the EU moderately between 1990 and 2022. Figure 5.50 shows the trend of the nitrogen excretion rate indicating also the range of values used by the countries.

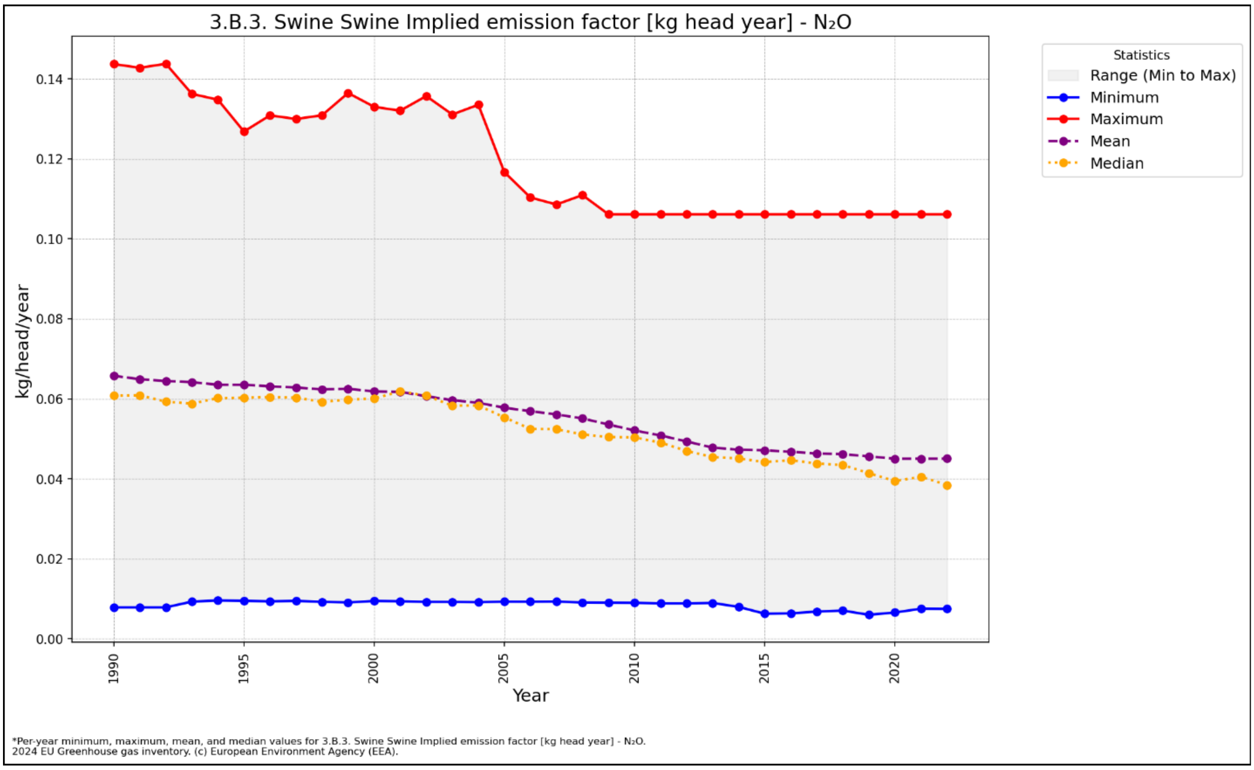
Figure 5.50: 3.B.1.b - Non-Dairy Cattle: Trend in nitrogen excretion rate and range of values reported by countries



3.B.3 - Swine - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.B.3 - Swine* decreased in the EU between 1990 and 2022. Figure 5.51 shows the trend of the implied emission factor indicating also the range of values used by the countries.

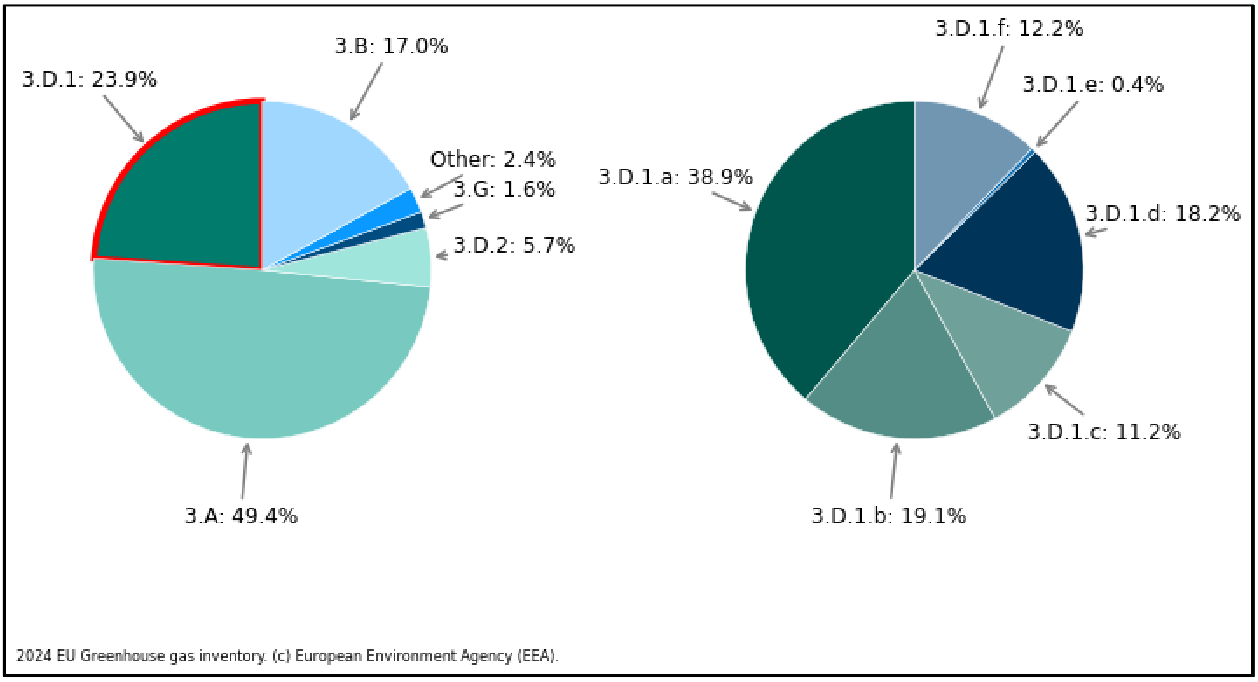
Figure 5.51: 3.B.3 - Swine: Trend in implied emission factor and range of values reported by countries



5.3.4 Direct Emissions from Managed Soils - N_2O (CRT Source Category 3D1)

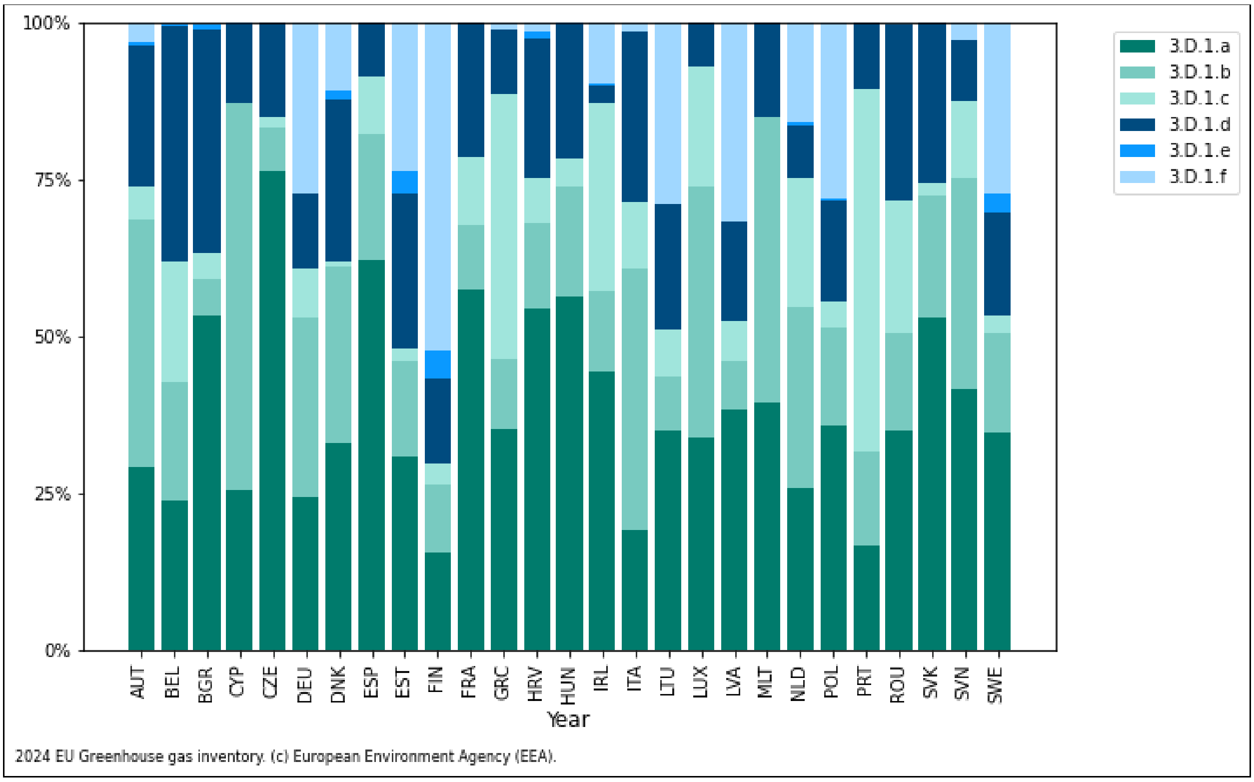
In 2022 N_2O emissions in source category *3.D.1 - Direct N_2O Emissions From Managed Soils* in the EU were 87488 kt CO_2 equivalent. This corresponds to 2.8 % of total EU GHG emissions and 49.9 % of total EU N_2O emissions. They make 23.9 % of total agricultural emissions and 69.5 % of total agricultural N_2O emissions. The main sub-categories are 3.D.1.a (Inorganic N Fertilizers), 3.D.1.b (Organic N Fertilizers) and 3.D.1.d (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. 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 agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2022. Categories 3.D.1.a-3.D.1.e: 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.f: cultivation of histosols.



In the left panel, some minor differences in the numbers might be present due to automatic rounding of numbers.

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 2022. 3.D.1.a inorganic N fertilizers, 3.D.1.b organic N fertilizers, 3.D.1.c urine and dung deposited by grazing animals, 3.D.1.d crop residues incorporated in the soil, 3.D.1.e mineralisation/immobilisation associated with loss/gain of soil organic matter, and 3.D.1.f cultivation of organic soils (histosols).



Total N_2O emissions by country and for the total EU from 3.D.1 *Direct N_2O Emissions From Managed Soils* are shown in Table 5.45 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, N_2O emission in this source category decreased by 24 % or 27.7 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 6.0 %.

Table 5.45 3.D.1 - Direct N_2O Emissions From Managed Soils: Countries' contributions to total EU- N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	1,776	1,502	1,455	1.7%	-322	-18%	-47	-3%
Belgium	2,979	2,261	2,134	2.4%	-845	-28%	-128	-6%
Bulgaria	3,637	2,757	2,690	3.1%	-947	-26%	-67	-2%
Croatia	952	751	678	0.8%	-275	-29%	-73	-10%
Cyprus	40	34	35	0.0%	-6	-14%	0	0%
Czechia	3,826	2,744	2,840	3.2%	-986	-26%	96	3%
Denmark	4,154	2,995	3,025	3.5%	-1,129	-27%	30	1%
Estonia	800	555	568	0.6%	-232	-29%	13	2%
Finland	2,940	2,817	2,734	3.1%	-207	-7%	-84	-3%
France	17,594	14,426	13,641	15.6%	-3,954	-22%	-785	-5%
Germany	15,035	12,316	11,986	13.7%	-3,049	-20%	-330	-3%
Greece	3,320	2,165	1,975	2.3%	-1,345	-41%	-191	-9%
Hungary	3,086	3,192	2,411	2.8%	-675	-22%	-782	-24%
Ireland	3,587	4,051	3,643	4.2%	55	2%	-408	-10%
Italy	7,755	7,229	6,150	7.0%	-1,605	-21%	-1,079	-15%
Latvia	1,436	888	894	1.0%	-543	-38%	6	1%
Lithuania	2,303	1,766	1,555	1.8%	-748	-32%	-211	-12%
Luxembourg	124	104	83	0.1%	-41	-33%	-21	-20%
Malta	17	20	22	0.0%	5	29%	2	10%
Netherlands	6,346	3,692	3,634	4.2%	-2,713	-43%	-59	-2%
Poland	14,720	11,362	10,949	12.5%	-3,771	-26%	-414	-4%
Portugal	1,600	1,552	1,381	1.6%	-219	-14%	-172	-11%
Romania	9,113	6,344	5,470	6.3%	-3,642	-40%	-873	-14%
Slovakia	777	496	454	0.5%	-323	-42%	-42	-9%
Slovenia	294	293	279	0.3%	-15	-5%	-14	-5%
Spain	4,312	4,614	4,583	5.2%	271	6%	-31	-1%
Sweden	2,617	2,173	2,226	2.5%	-391	-15%	52	2%
EU-27	**115,139**	**93,100**	**87,488**	**100%**	**-27,651**	**-24%**	**-5,612**	**-6%**

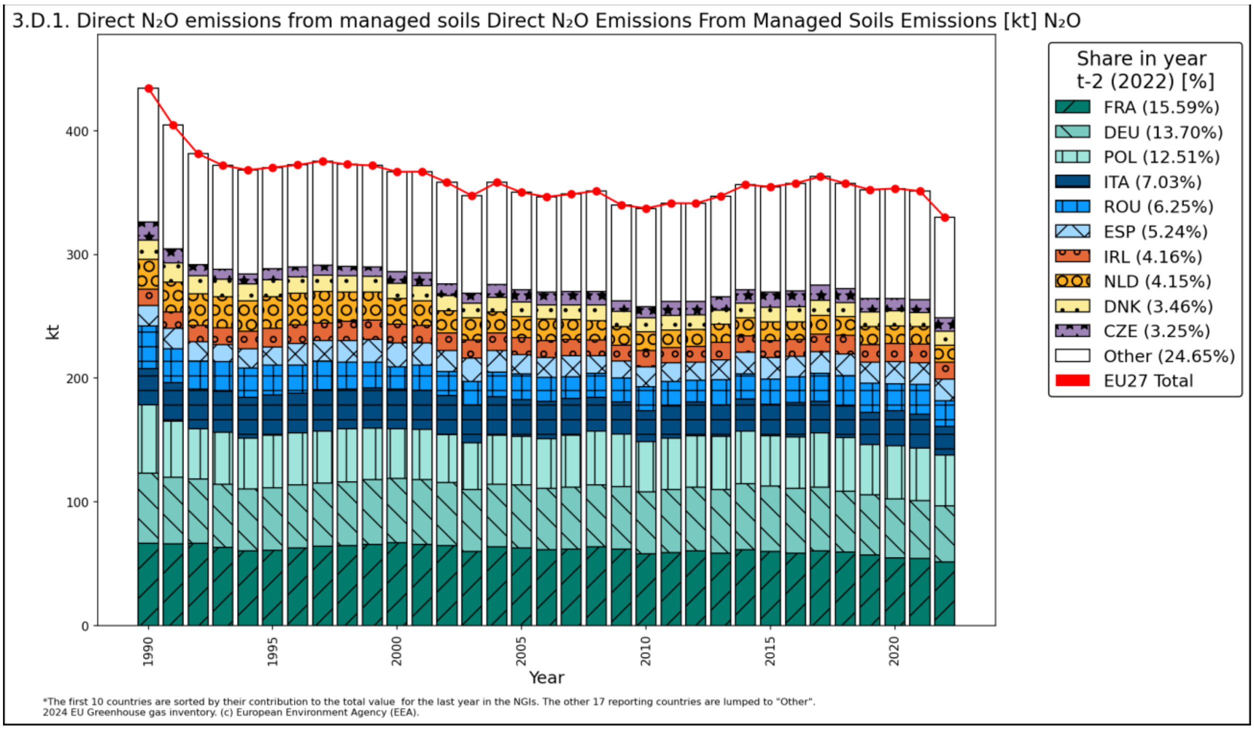
Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

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 the EU in the period 1990 to 2022. Figure 5.60 shows the trend of emissions indicating the countries contributing most to EU total.

Figure 5.60: 3.D.1 Direct N_2O Emissions From Managed Soils: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



The main driving forces of direct N_2O emissions from agricultural soils are the use of nitrogen fertiliser and animal manure. 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[48].

3.D.1.a - Direct N_2O emissions from inorganic N fertilizers - Emissions

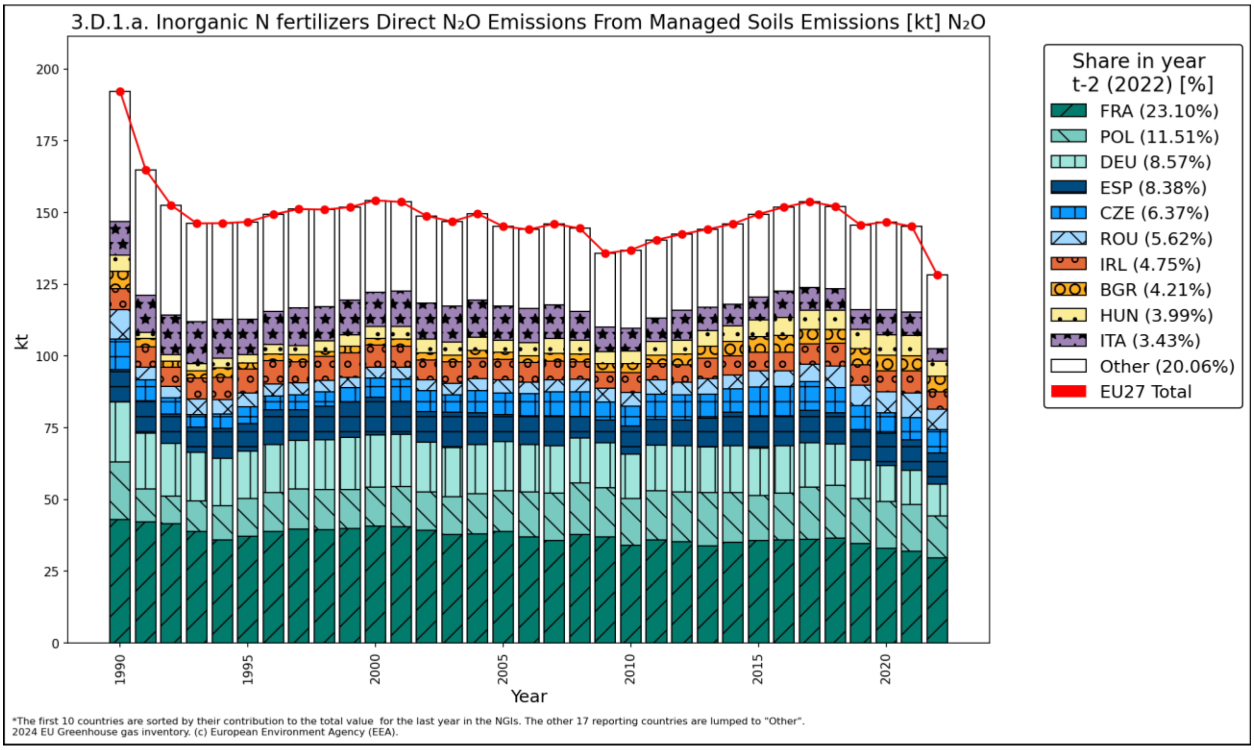
Emissions in source category *3.D.1.a - Direct N_2O Emissions From Inorganic N fertilizers* decreased considerably in the EU by 33 % or 16.9 Mt CO_2-eq in the period 1990 to 2022. Figure 5.61 shows the trend of emissions indicating the countries contributing most to EU total. N_2O emissions by country and for the total EU from *3.D.1.a Direct N_2O Emissions From Inorganic N fertilizers* are shown in Table 5.46 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 11.7 %.

48 http://ec.europa.eu/environment/water/water-urbanwaste/legislation/directive_en.htm

Table 5.46 3.D.1.a - Direct N_2O Emissions From Inorganic N fertilizers: Countries' contributions to total EU- N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	583	463	422	1.2%	-161	-28%	-40	-9%	T1	D
Belgium	876	624	510	1.5%	-366	-42%	-114	-18%	T1	D
Bulgaria	1 649	1 386	1 429	4.2%	-219	-13%	44	3%	T1	D
Croatia	447	426	368	1.1%	-79	-18%	-57	-13%	T1	D
Cyprus	16	9	9	0.0%	-7	-43%	0	-1%	T2	CS
Czechia	2 786	2 063	2 165	6.4%	-621	-22%	102	5%	T1	D
Denmark	1 667	952	995	2.9%	-673	-40%	43	4%	T1	D
Estonia	300	195	175	0.5%	-125	-42%	-20	-10%	T1	D
Finland	951	607	424	1.2%	-527	-55%	-183	-30%	T1	D
France	11 433	8 462	7 851	23.1%	-3 582	-31%	-611	-7%	-	-
Germany	5 547	3 146	2 914	8.6%	-2 633	-47%	-232	-7%	T2	CS
Greece	1 766	869	697	2.1%	-1 068	-61%	-172	-20%	T1	D
Hungary	1 491	1 900	1 356	4.0%	-135	-9%	-545	-29%	T1	D
Ireland	1 919	2 045	1 616	4.8%	-303	-16%	-429	-21%	T1	D
Italy	3 083	2 160	1 168	3.4%	-1 916	-62%	-993	-46%	T1	CS,D
Latvia	547	352	343	1.0%	-204	-37%	-10	-3%	T1	D
Lithuania	883	781	544	1.6%	-339	-38%	-237	-30%	T1	D
Luxembourg	67	47	28	0.1%	-39	-58%	-19	-40%	T1	CS
Malta	2	9	9	0.0%	6	248%	0	0%	T1	D
Netherlands	1 762	1 004	940	2.8%	-822	-47%	-64	-6%	T2	CS
Poland	5 305	4 323	3 914	11.5%	-1 391	-26%	-409	-9%	T1	D
Portugal	648	370	229	0.7%	-419	-65%	-141	-38%	T1	CS,D
Romania	2 732	2 243	1 911	5.6%	-821	-30%	-331	-15%	T1	D
Slovakia	463	265	240	0.7%	-223	-48%	-25	-10%	T1	D
Slovenia	113	121	116	0.3%	3	2%	-5	-5%	T1	D
Spain	2 974	2 849	2 849	8.4%	-125	-4%	0	0%	CS,T1	D
Sweden	935	812	770	2.3%	-165	-18%	-42	-5%	T2	CS
EU-27	**50 946**	**38 481**	**33 992**	**100%**	**-16 954**	**-33%**	**-4 490**	**-12%**	**-**	**-**

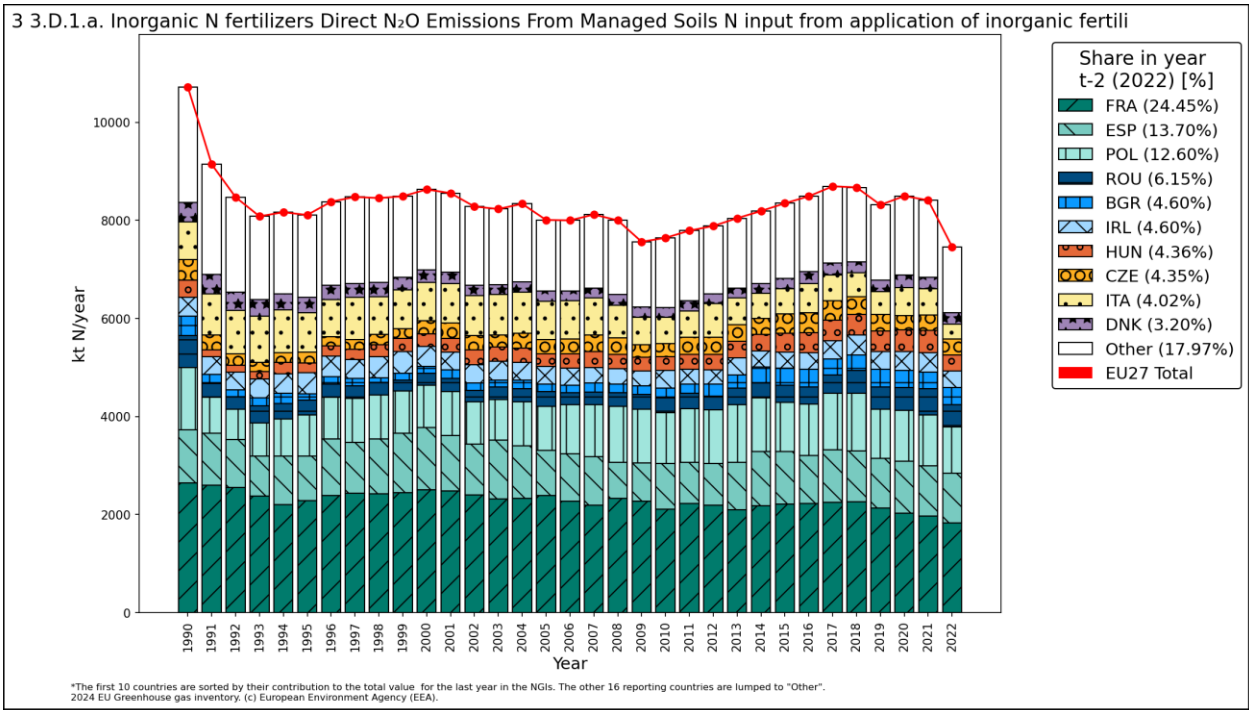
Figure 5.61: 3.D.1.a - Direct N_2O Emissions From Inorganic N fertilizers: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.D.1.a- Direct N_2O emissions from inorganic N fertilizers - Application of inorganic fertilizers

Application of inorganic fertilizers decreased strongly in the EU in the period 1990 to 2022. Figure 5.62 shows the trend of application of inorganic fertilizers indicating the countries contributing most to EU total.

Figure 5.62: 3.D.1.a - Direct N_2O Emissions From Inorganic N fertilizers: Trend in application of inorganic fertilizers in the EU and the countries contributing most to EU values including their share to EU application of inorganic fertilizers in 2022



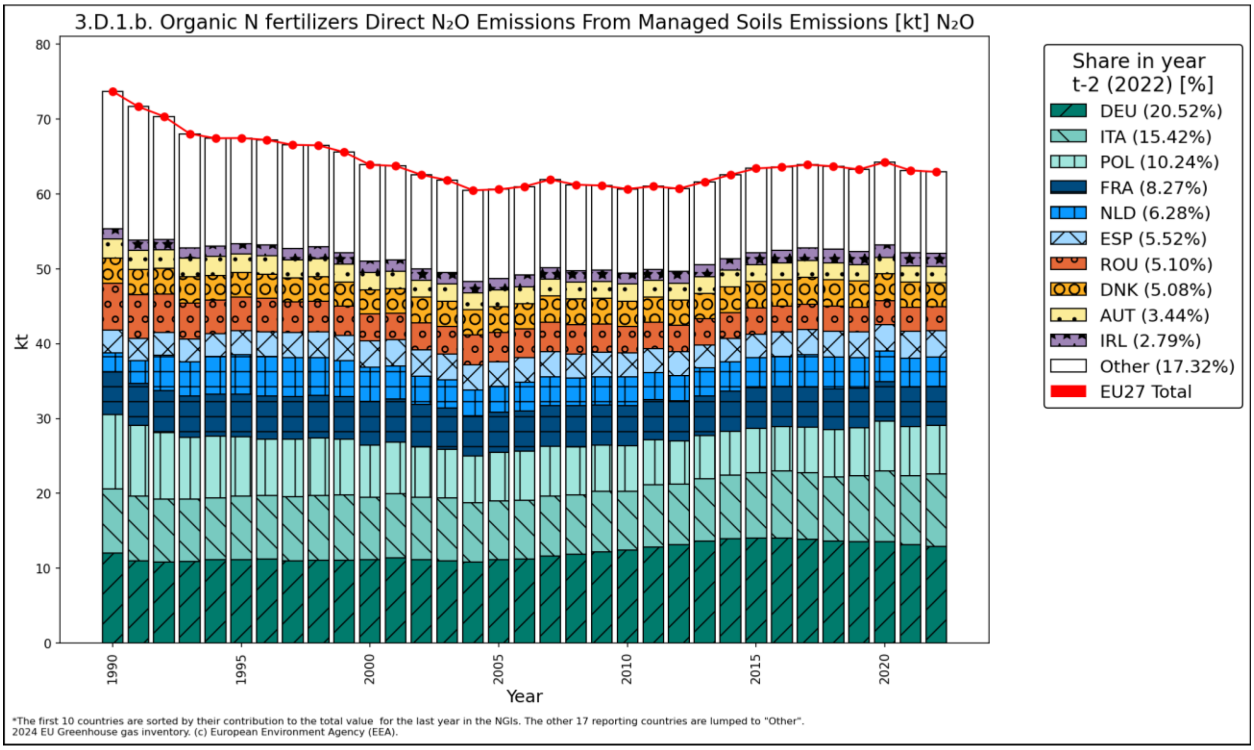
3.D.1.b - Direct N_2O emissions from organic N fertilizers - Emissions

Emissions in source category *3.D.1.b - Direct N_2O Emissions from organic N fertilizers* decreased considerably in the EU by 15 % or 2.8 Mt CO_2-eq in the period 1990 to 2022. Figure 5.63 shows the trend of emissions indicating the countries contributing most to EU total. N_2O emissions by country and for the total EU from *3.D.1.b Direct N_2O Emissions From organic N fertilizers* are shown in Table 5.47 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 0.3 %.

Table 5.47 3.D.1.b - Direct N_2O Emissions From organic N fertilizers: Countries' contributions to total EU- N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	689	578	574	3.4%	-114	-17%	-3	-1%	CS,T1	D
Belgium	748	411	404	2.4%	-344	-46%	-7	-2%	T1	D
Bulgaria	569	165	163	1.0%	-406	-71%	-3	-2%	NA,T1	D,NA
Croatia	210	96	92	0.6%	-117	-56%	-4	-4%	NA,T1	D,NA
Cyprus	17	21	21	0.1%	4	23%	0	-1%	T2	CS
Czechia	368	198	196	1.2%	-172	-47%	-2	-1%	T1	D
Denmark	888	886	848	5.1%	-40	-4%	-38	-4%	CS,T1,T2	D
Estonia	124	87	87	0.5%	-37	-30%	0	-1%	T1	D
Finland	321	305	293	1.8%	-29	-9%	-12	-4%	T1	D
France	1 497	1 401	1 380	8.3%	-116	-8%	-21	-1%	-	-
Germany	3 191	3 479	3 423	20.5%	232	7%	-56	-2%	T2	CS
Greece	292	225	219	1.3%	-73	-25%	-5	-2%	NA,T1	D,NA
Hungary	788	430	426	2.6%	-361	-46%	-4	-1%	T1	D
Ireland	350	466	466	2.8%	116	33%	0	0%	NA,T1	D,NA
Italy	2 269	2 439	2 572	15.4%	303	13%	134	5%	T1	CS,D
Latvia	213	70	70	0.4%	-143	-67%	0	0%	T1	D
Lithuania	326	132	133	0.8%	-193	-59%	1	1%	T1	D
Luxembourg	33	35	33	0.2%	0	1%	-1	-4%	T1,T2	CS
Malta	11	8	10	0.1%	-1	-7%	2	26%	NA,T1	D,NA
Netherlands	691	1 032	1 048	6.3%	356	52%	15	1%	T1,T1b	CS,D
Poland	2 635	1 739	1 708	10.2%	-926	-35%	-31	-2%	NA,T1	CS,D,NA
Portugal	256	208	208	1.2%	-48	-19%	-1	0%	T1	CS,D
Romania	1 666	857	851	5.1%	-815	-49%	-6	-1%	T1	D
Slovakia	133	82	88	0.5%	-44	-33%	6	8%	T1	CS,D
Slovenia	124	97	94	0.6%	-30	-24%	-2	-3%	NA,T1	D,NA
Spain	793	945	922	5.5%	128	16%	-23	-2%	CS,T1	D
Sweden	332	342	351	2.1%	20	6%	9	3%	T1,T2	CS,D
EU-27	**19 534**	**16 734**	**16 682**	**100%**	**-2 853**	**-15%**	**-53**	**0%**	**-**	**-**

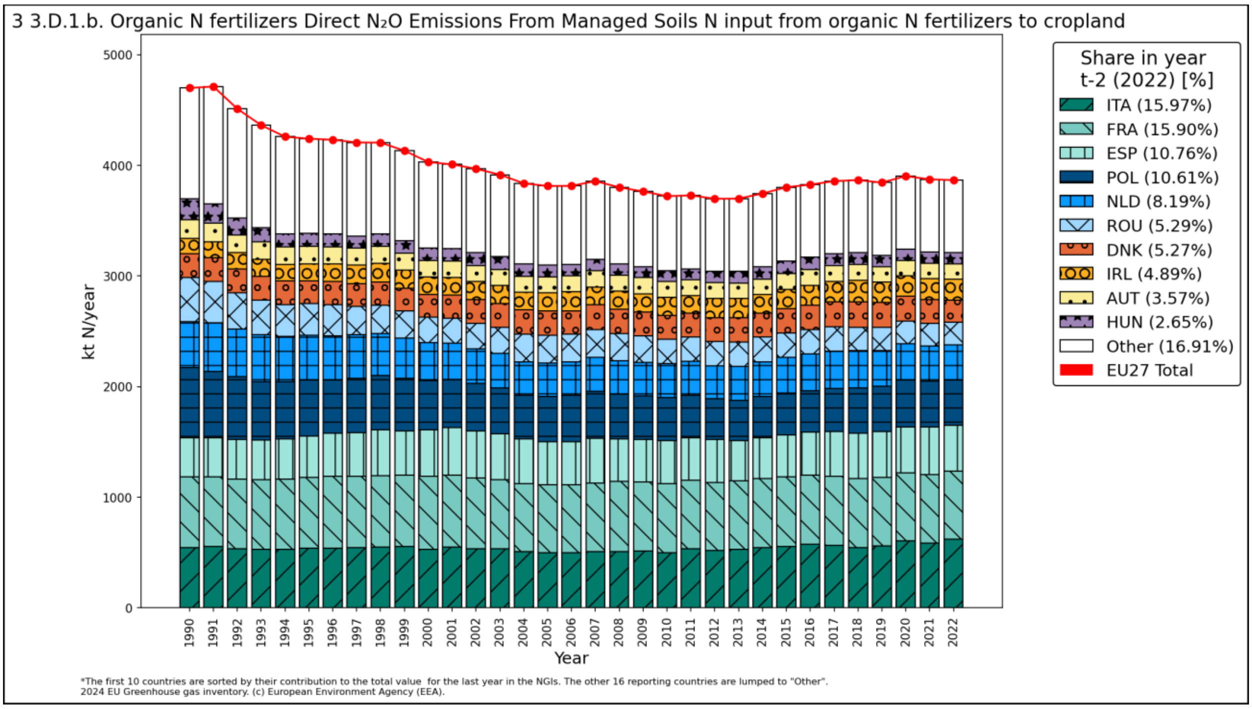
Figure 5.63: 3.D.1.b- Direct N_2O Emissions From Organic N fertilizers: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.D.1.b - Direct N_2O emissions from organic N fertilizers - amount of N applied

N from applied organic N fertilizers decreased clearly in the EU in the period 1990 to 2022. Figure 5.64 shows the trend of N from applied organic N fertilizers indicating the countries contributing most to EU total.

Figure 5.64: 3.D.1.b - Direct N_2O Emissions From Organic N fertilizers: Trend in application of organic fertilizers in the EU and the countries contributing most to EU values including their share to EU application of organic fertilizers in 2022



3.D.1.c - Urine and Dung Deposited by Grazing Animals - Emissions

In 2022 N_2O emissions in source category *3.D.1.c - Urine and Dung Deposited by Grazing Animals* in the EU were 9773 kt CO_2 equivalent. It represents 2.7 % of total agricultural emissions and 7.8 % of total agricultural N_2O emissions.

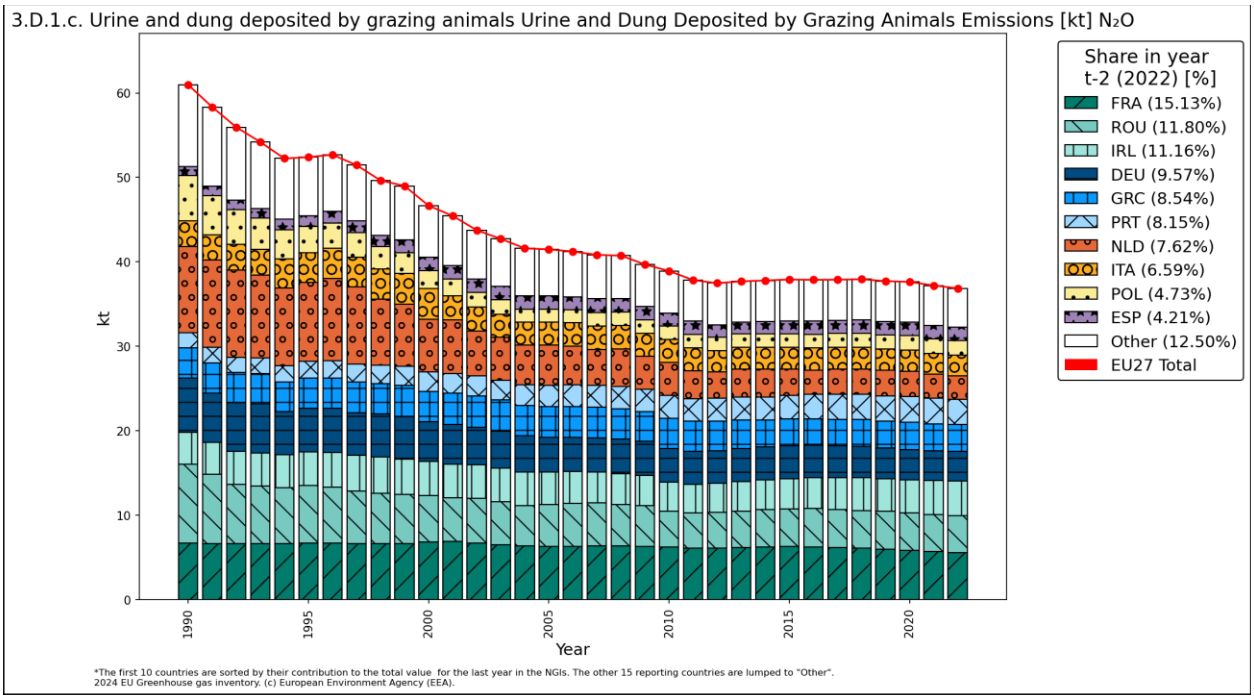
Total N_2O emissions by country and for the total EU from 3.D.1.c *Grazing Animals* are shown in Table 5.48 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, N_2O emission in this source category decreased by 40 % or 6.4 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 0.9 %. Figure 5.65 shows the trend of emissions indicating the countries contributing most to EU total.

Table 5.48 3.D.1.c - Urine and Dung Deposited by Grazing Animals: Countries' contributions to total EU-GHG and N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	148	80	77	0.8%	-70	-48%	-3	-3%	T2	D
Belgium	615	409	405	4.1%	-209	-34%	-4	-1%	T1	D
Bulgaria	548	114	107	1.1%	-440	-80%	-7	-6%	T1	D
Croatia	120	49	49	0.5%	-70	-59%	0	0%	T1	D
Cyprus	NO	NO	NO	-	-	-	-	-	NA	NA
Czechia	49	46	47	0.5%	-2	-4%	1	1%	T1	D
Denmark	60	27	26	0.3%	-33	-56%	0	-1%	T2	D
Estonia	67	11	10	0.1%	-57	-85%	-1	-7%	T1	D
Finland	147	91	90	0.9%	-56	-38%	-1	-1%	T1	D
France	1,782	1,513	1,478	15.1%	-304	-17%	-35	-2%	-	-
Germany	1,705	937	935	9.6%	-770	-45%	-2	0%	T1	D
Greece	943	844	834	8.5%	-109	-12%	-10	-1%	T1	D
Hungary	172	123	107	1.1%	-65	-38%	-15	-12%	T1	D
Ireland	996	1,078	1,090	11.2%	94	9%	12	1%	T1	D
Italy	818	660	644	6.6%	-174	-21%	-16	-2%	T1	CS,D
Latvia	133	56	57	0.6%	-76	-57%	1	1%	T1	D
Lithuania	382	116	117	1.2%	-264	-69%	1	1%	T1	D
Luxembourg	19	16	16	0.2%	-3	-17%	0	0%	T2	CS
Malta	NO	NO	NO	-	-	-	-	-	NA	NA
Netherlands	2,693	743	745	7.6%	-1,948	-72%	1	0%	T1	D
Poland	1,413	455	462	4.7%	-951	-67%	7	2%	T1	CS,D
Portugal	479	809	797	8.2%	318	66%	-13	-2%	T1	D
Romania	2,477	1,150	1,153	11.8%	-1,323	-53%	4	0%	T1	D
Slovakia	18	10	10	0.1%	-8	-45%	0	1%	T1	CS
Slovenia	17	35	34	0.3%	17	102%	-1	-3%	T1	D
Spain	293	420	412	4.2%	119	41%	-8	-2%	CS,T1	D
Sweden	67	68	68	0.7%	0	0%	-1	-1%	T1	D
EU-27	**16,159**	**9,861**	**9,773**	**100%**	**-6,386**	**-40%**	**-88**	**-1%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. *Abbreviations are explained in the Chapter 'Units and abbreviations'.*

Figure 5.65: 3.D.1.c - Urine and Dung Deposited by Grazing Animals: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.D.1.d – Direct N_2O emissions from crop residues – Emissions

In 2022 N_2O emissions in source category *3.D.1.d – Direct N_2O emissions from crop residues* in the EU were 15943 kt CO_2 equivalent. It represents 4.4 % of total agricultural emissions and 12.7 % of total agricultural N_2O emissions.

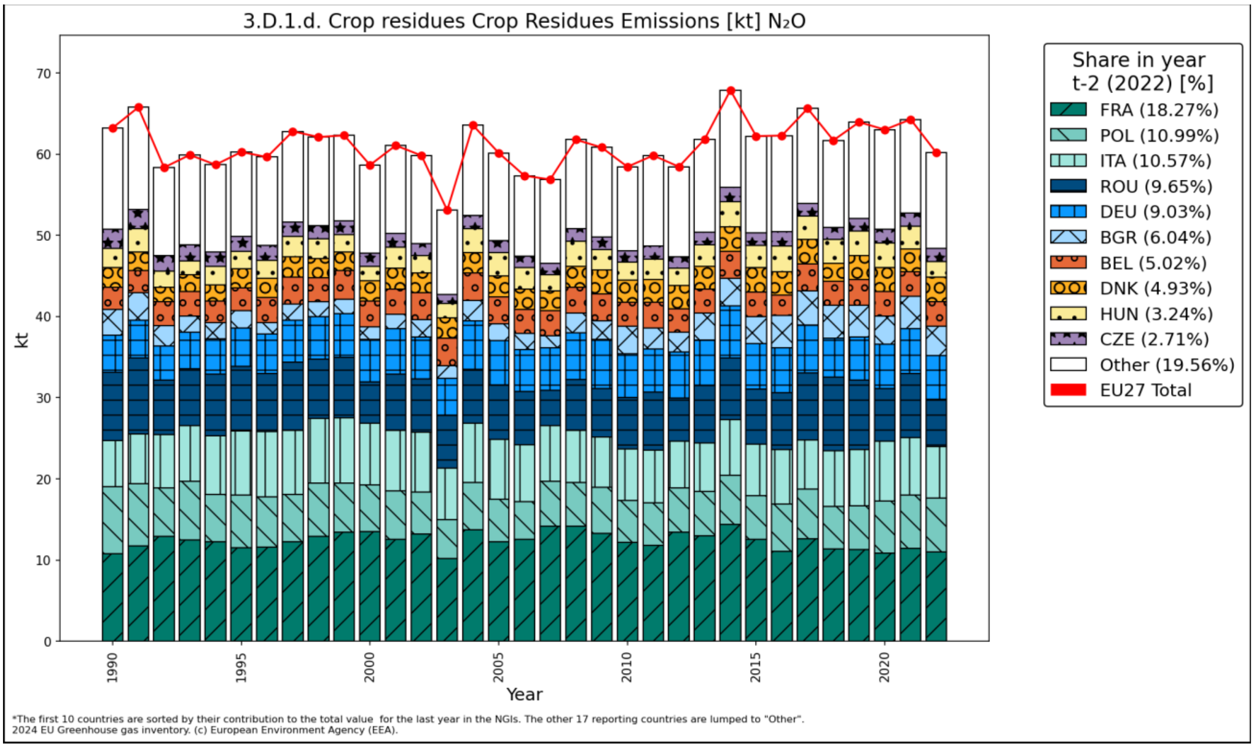
Total N_2O emissions by country and for the total EU from 3.D.1.d *Direct N_2O emissions from crop residues* are shown in Table 5.48 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, N_2O emission in this source category decreased by 5 % or 0.8 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 6.4 %. Figure 5.65 shows the trend of emissions indicating the countries contributing most to EU total.

Table 5.48 3.D.1.d – Direct N_2O emissions from crop residues: Countries' contributions to total EU- N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	312	334	329	2.1%	17	5%	-5	-2%	T1	D
Belgium	715	804	801	5.0%	86	12%	-3	0%	T1	D
Bulgaria	843	1 065	963	6.0%	120	14%	-102	-10%	T1	D
Croatia	166	162	150	0.9%	-16	-10%	-12	-7%	T1	D
Cyprus	8	4	4	0.0%	-3	-42%	0	11%	T1	D
Czechia	623	437	432	2.7%	-191	-31%	-5	-1%	T1,T2	D
Denmark	643	745	786	4.9%	143	22%	41	5%	CS,T1	D
Estonia	168	118	140	0.9%	-28	-17%	22	19%	T1	D
Finland	350	327	376	2.4%	26	8%	49	15%	T1	D
France	2 864	3 031	2 913	18.3%	49	2%	-118	-4%	-	-
Germany	1 222	1 466	1 439	9.0%	218	18%	-27	-2%	T2	CS
Greece	297	205	201	1.3%	-95	-32%	-4	-2%	T1	D
Hungary	634	735	516	3.2%	-118	-19%	-219	-30%	T1	D
Ireland	133	102	106	0.7%	-27	-20%	4	4%	T1	D
Italy	1 501	1 890	1 685	10.6%	184	12%	-204	-11%	T1	CS,D
Latvia	136	135	142	0.9%	6	5%	6	5%	T1	D
Lithuania	238	290	309	1.9%	70	29%	19	7%	T2	D
Luxembourg	5	7	6	0.0%	1	11%	-1	-12%	T1	CS
Malta	4	3	3	0.0%	0	-11%	0	-1%	T1	D
Netherlands	420	297	300	1.9%	-120	-29%	3	1%	T1b	CS
Poland	2 185	1 733	1 752	11.0%	-433	-20%	19	1%	T1	CS,D
Portugal	218	165	147	0.9%	-70	-32%	-18	-11%	T1	D
Romania	2 222	2 078	1 538	9.6%	-684	-31%	-540	-26%	T1	D
Slovakia	163	139	116	0.7%	-48	-29%	-23	-17%	T2	CS
Slovenia	32	32	27	0.2%	-5	-15%	-5	-15%	T1	D
Spain	252	401	401	2.5%	149	59%	0	0%	CS,T1	D
Sweden	402	329	360	2.3%	-42	-10%	31	9%	T2	CS
EU-27	**16 755**	**17 033**	**15 943**	**100%**	**-811**	**-5%**	**-1 090**	**-6.4%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 5.65: 3.D.1.d – Direct N_2O emissions from crop residues: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



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.a - Direct N_2O Emissions From Inorganic N fertilizers - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.a - Direct N_2O Emissions From Inorganic N fertilizers* is quite constant for EU between 1990 and 2022.

3.D.1.b - Direct N_2O Emissions From Organic N fertilizers - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.b - Direct N_2O Emissions From Organic N fertilizers* decreased in the EU between 1990 and 2022.

3.D.1.c - Urine and Dung Deposited by Grazing Animals - Implied emission factor

The implied emission factor for N_2O emissions in source category *3.D.1.c - Urine and Dung Deposited by Grazing Animals* decreased in the EU between 1990 and 2022.

3.D.1.d – Crop residues - Implied emission factor

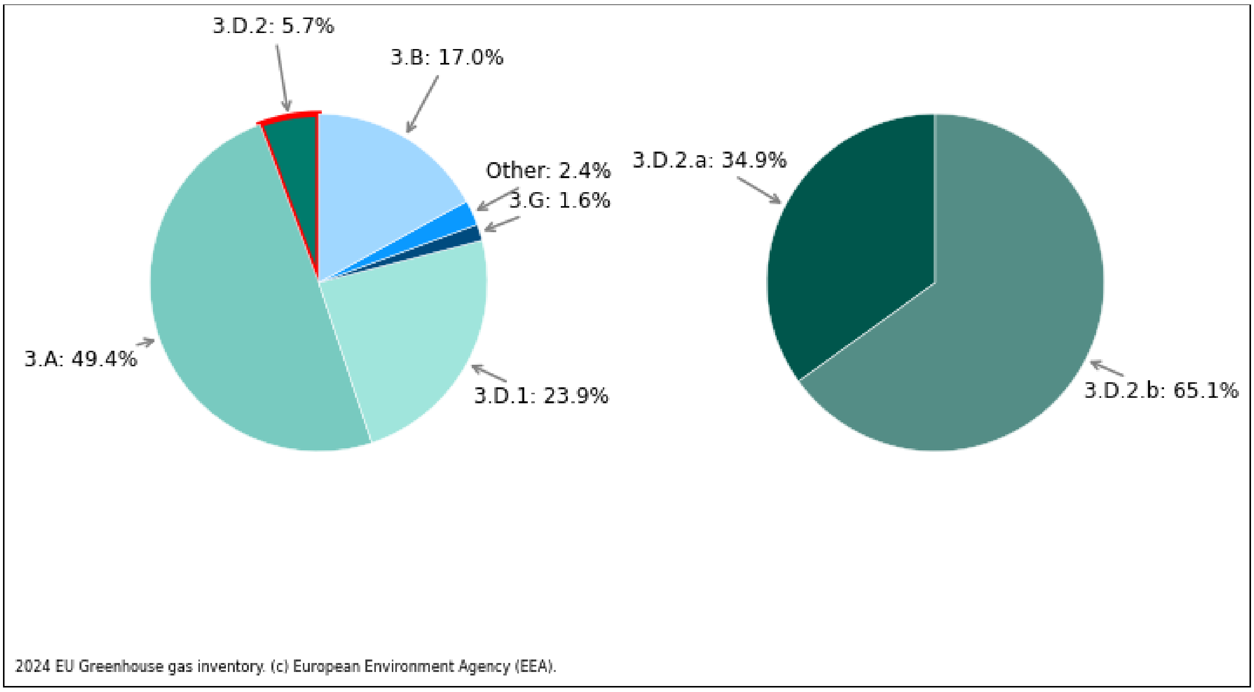
The implied emission factor for N_2O emissions in source category 3.D.1.4 - Direct N_2O Emissions From Crop Residues has almost remained constant from 1990 to 2022.

5.3.5 Indirect Emissions from Managed Soils - N_2O (CRT Source Category 3D2)

In 2022 N_2O emissions in source category *3.D.2 - Indirect Emissions from Managed Soils* in the EU were 20739 kt CO_2 equivalent. This corresponds to 0.7 % of total EU GHG emissions and 11.8 % of total EU N_2O emissions. They make 5.7 % of total agricultural emissions and 16.5 % of total agricultural N_2O emissions. Those emissions include emissions from atmospheric deposition and leaching and run-off.

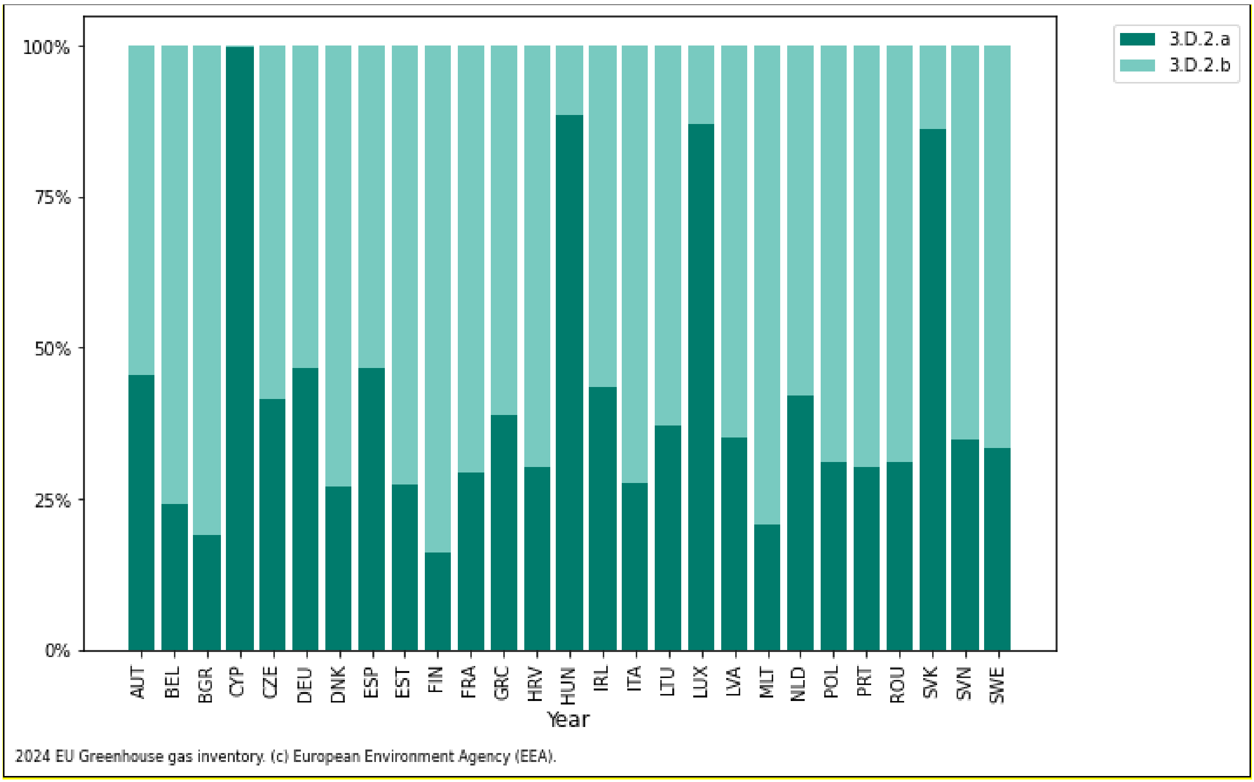
The main sub-categories are 3.D.2.b (Nitrogen Leaching and Run-off), and 3.D.2.a (Atmospheric Deposition) as shown in Figure 5.68. Regarding the origin of emissions in the different countries, Figure 5.69 shows the distribution of indirect N_2O emissions from managed soils by emission source in all countries. 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 agricultural emissions (left panel) and decomposition into its sub-categories (right panel). The percentages refer to the emissions in the year 2022.



In the left panel, some minor differences in the numbers might be present due to automatic rounding of numbers.

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 2022. 3.D.2.a Atmospheric Deposition and 3.D.2.b Nitrogen Leaching and Run-off.



Total N_2O emissions by country and for the total EU from 3.D.2 *Indirect Emissions from Managed Soils* are shown in Table 5.52 for the first and the last year of the inventory (1990 and 2022). Values are given in kt CO_2-eq. Between 1990 and 2022, N_2O emission in this source category decreased by 34 % or 10.6 Mt CO_2-eq. From 2021 to 2022 emissions in the current category decreased by 6.1 %.

Table 5.52 *3.D.2 - Indirect Emissions from Managed Soils: Countries' contributions to total EU-GHG and N_2O emissions*

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	357	297	288	1.4%	-69	-19%	-9	-3%	CS,T1	D
Belgium	966	607	572	2.8%	-394	-41%	-35	-6%	T1	D
Bulgaria	1,106	752	738	3.6%	-367	-33%	-14	-2%	T1	D
Croatia	310	237	214	1.0%	-96	-31%	-23	-10%	T1	D
Cyprus	17	17	17	0.1%	0	3%	0	-1%	T1	D
Czechia	1,393	768	794	3.8%	-599	-43%	26	3%	T1	D
Denmark	1,277	649	642	3.1%	-634	-50%	-7	-1%	T2	D
Estonia	204	132	133	0.6%	-71	-35%	1	1%	T1	D
Finland	316	250	231	1.1%	-84	-27%	-19	-8%	T2	D
France	5,017	4,232	4,006	19.3%	-1,011	-20%	-226	-5%	-	-
Germany	4,132	2,168	2,234	10.8%	-1,898	-46%	66	3%	T1	D
Greece	1,148	765	702	3.4%	-446	-39%	-63	-8%	T1	D
Hungary	301	235	198	1.0%	-103	-34%	-37	-16%	T1	D
Ireland	725	766	736	3.5%	11	2%	-30	-4%	T1	CS,D
Italy	2,533	2,234	1,822	8.8%	-711	-28%	-412	-18%	T1	CS,D
Latvia	277	156	155	0.7%	-122	-44%	-1	-1%	T1	D
Lithuania	384	273	218	1.0%	-167	-43%	-55	-20%	T1	D
Luxembourg	24	22	19	0.1%	-5	-21%	-3	-12%	T1,T2	D
Malta	6	7	7	0.0%	2	28%	1	11%	T1	D
Netherlands	1,436	528	515	2.5%	-921	-64%	-12	-2%	T1	D
Poland	3,663	2,647	2,508	12.1%	-1,156	-32%	-139	-5%	T1	D
Portugal	439	380	334	1.6%	-105	-24%	-46	-12%	T1,T2	D
Romania	2,934	1,971	1,735	8.4%	-1,200	-41%	-237	-12%	T1	D
Slovakia	583	158	111	0.5%	-472	-81%	-48	-30%	T1,T2	CS,D
Slovenia	103	94	90	0.4%	-13	-13%	-4	-4%	T1	D
Spain	1,359	1,494	1,468	7.1%	110	8%	-26	-2%	CS,T2	D
Sweden	328	251	250	1.2%	-78	-24%	-1	0%	CS	D
EU-27	**31,339**	**22,093**	**20,739**	**100%**	**-10,600**	**-34%**	**-1,354**	**-6%**	**-**	**-**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.

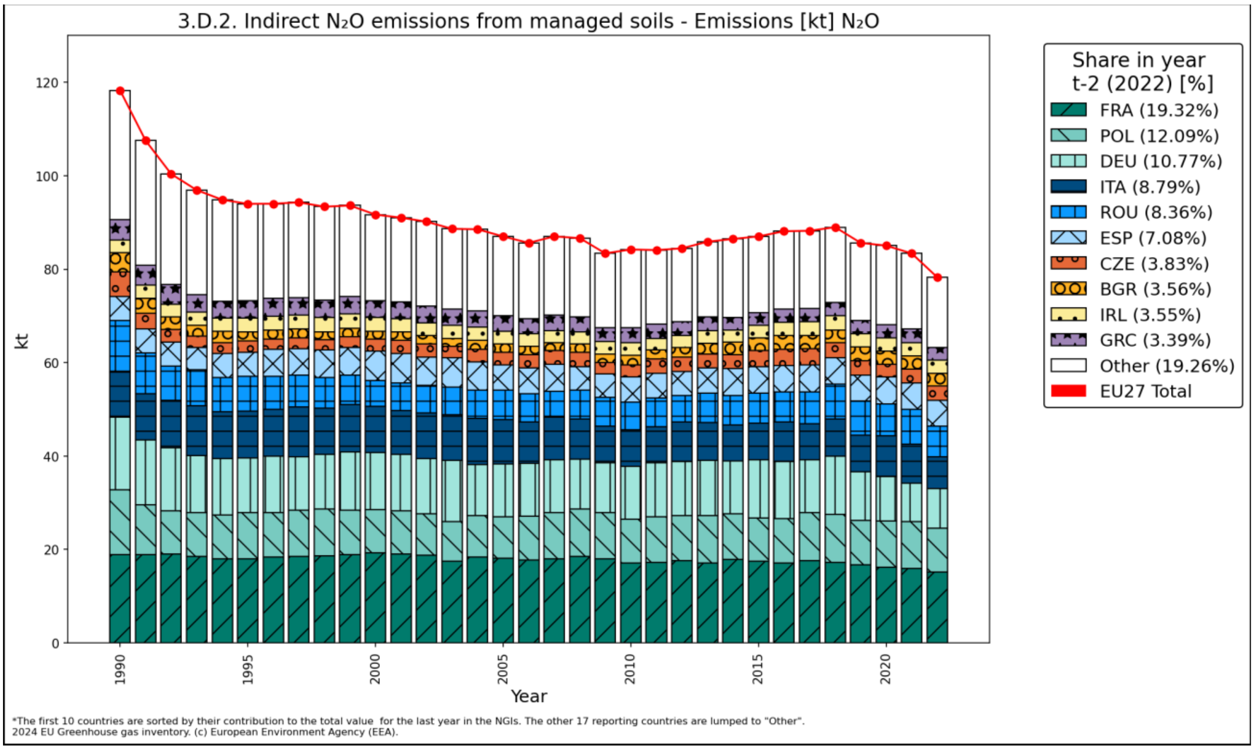
Abbreviations are explained in the Chapter 'Units and abbreviations'.

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 strongly in the EU in the period 1990 to 2022. Figure 5.70 shows the trend of emissions indicating the countries contributing most to EU total.

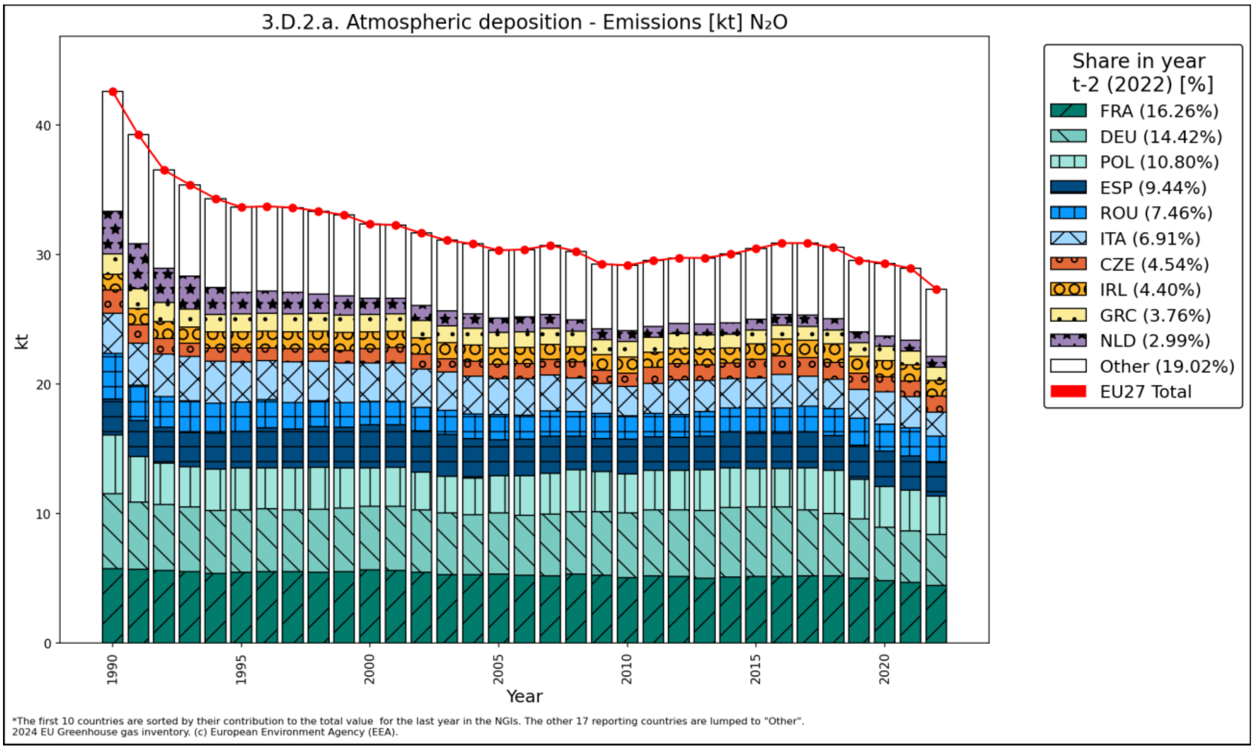
Figure 5.70: 3.D.2 Indirect Emissions from Managed Soils: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.D.2.a - Indirect N_2O Emissions from Atmospheric Deposition - Emissions

Emissions in source category *3.D.2.a - Indirect N_2O Emissions from Atmospheric Deposition* decreased strongly in the EU by 36 % or 4 Mt CO_2-eq in the period 1990 to 2022. Figure 5.71 shows the trend of emissions indicating the countries contributing most to EU total.

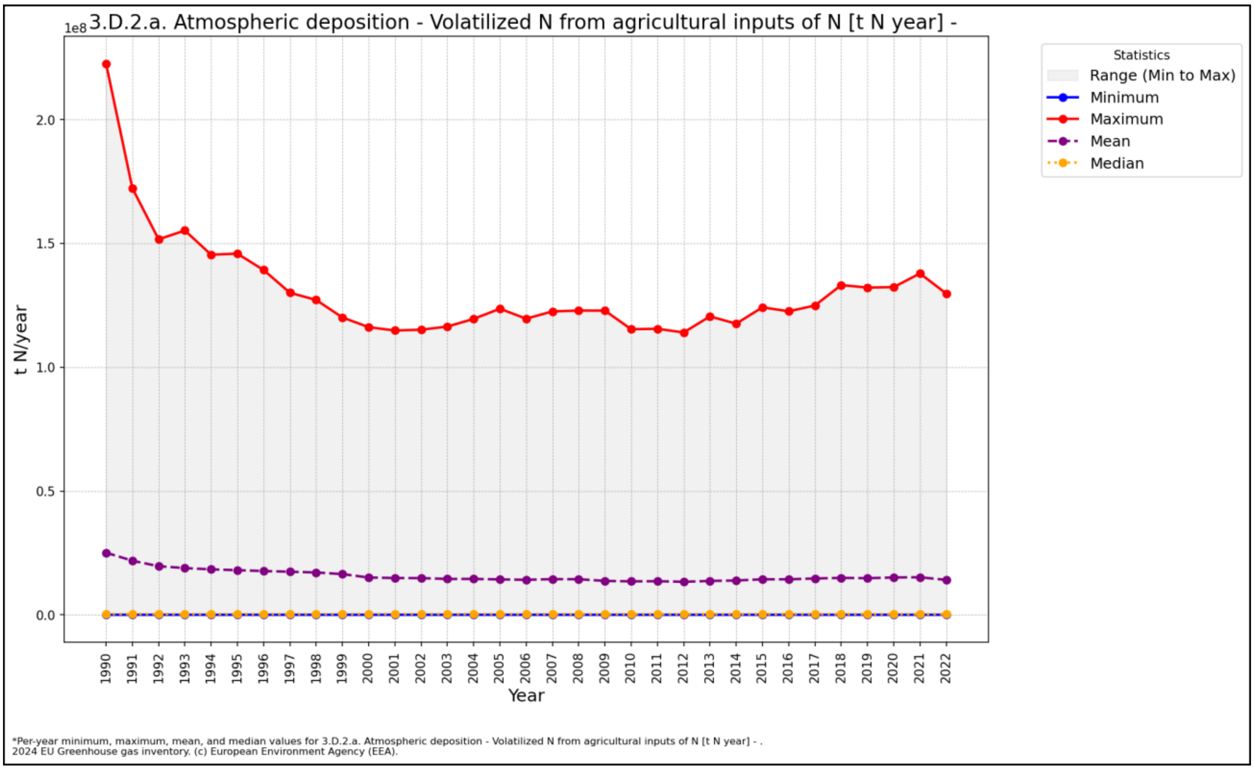
Figure 5.71: 3.D.2.a - Indirect N_2O Emissions from Atmospheric Deposition: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.D.2.a - Indirect N_2O Emissions from Atmospheric Deposition - Volatilized N from agricultural N inputs

Volatilized N from agricultural N inputs decreased in the EU in the period 1990 to 2022. Figure 5.72 shows the trend of volatilized N from agricultural N inputs indicating also the range of values within EU countries.

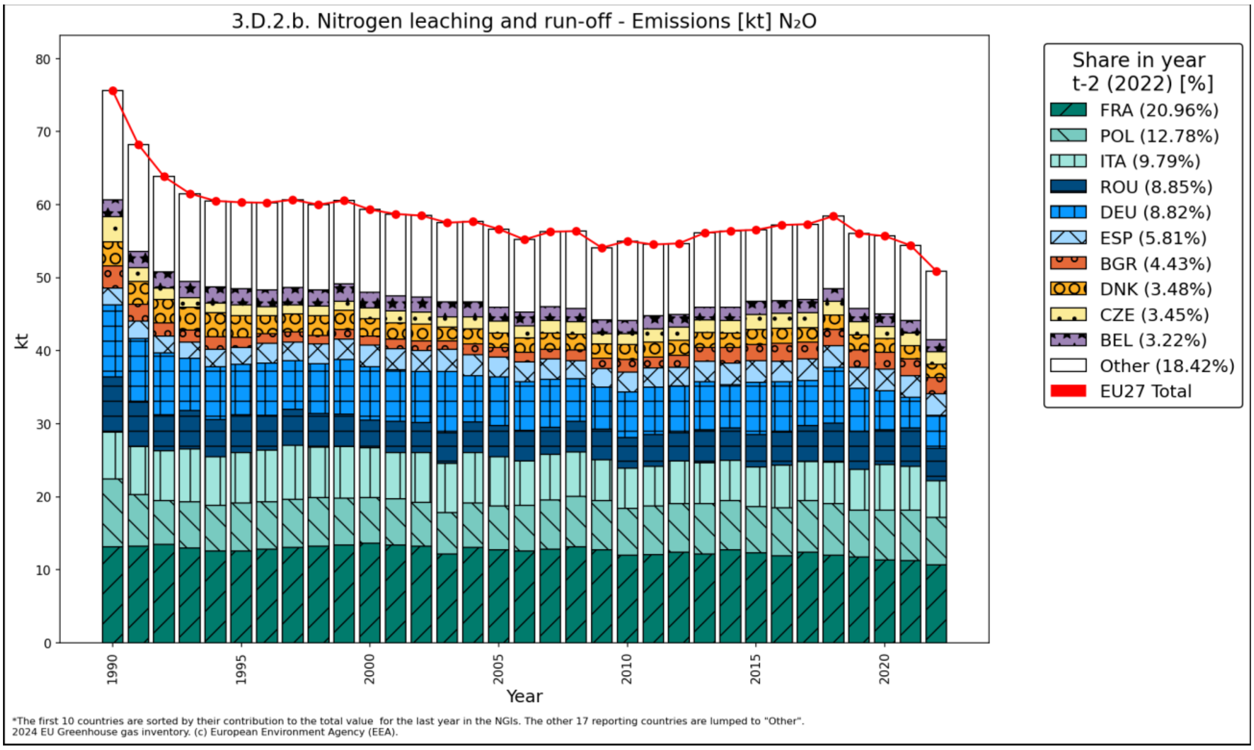
Figure 5.72: 3.D.2.a - Indirect N_2O Emissions from Atmospheric Deposition: Trend in volatilized N from agricultural N inputs and range of values within EU countries



3.D.2.b - Indirect N_2O Emissions from Nitrogen leaching and run-off - Emissions

Emissions in source category *3.D.2.b - Indirect N_2O Emissions from Nitrogen leaching and run-off* decreased considerably in the EU by 33 % or 6.6 Mt CO_2-eq in the period 1990 to 2022. Figure 5.73 shows the trend of emissions indicating the countries contributing most to EU total.

Figure 5.73: 3.D.2.b - Indirect N_2O Emissions from Nitrogen leaching and run-off: Trend in emissions in the EU and the countries contributing most to EU values including their share to EU emissions in 2022



3.D.2.b- 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 the EU in the period 1990 to 2022.

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

3.D.2.a - Indirect N_2O Emissions from Atmospheric Deposition

The implied emission factor for N_2O emissions in source category *3.D.2.a - Indirect N_2O Emissions from Atmospheric Deposition* increased in the EU barely between 1990 and 2022.

3.D.2.b - Indirect N_2O Emissions from Nitrogen leaching and run-off

The implied emission factor for N_2O emissions in source category *3.D.2.b - Indirect N_2O Emissions from Nitrogen leaching and run-off* is quite constant through time in the EU between 1990 and 2022.

5.3.6 Agriculture - non-key categories

EU	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 3. Agriculture in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
3.C.1 Irrigated: no classification (CH_4)	3 095.1	2 671.4	2 494.5	0.7%	-601	-19%	-176.9	-7%
3.C.2 Rain-fed: no classification (CH_4)	0.0	0.0	0.0	0.0%	0	0%	0.0	0%
3.C.3 Deep water(CH_4)	-	-	-	-	-	-	-	-

EU	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 3. Agriculture in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
3.C.4 Other (CH_4)	-	-	-	-	-	-	-	-
3.E.1 Forest land (specify ecological zone): no classification (CH_4)	0.0	0.0	0.0	0.0%	0	0%	0.0	0%
3.E.1 Forest land (specify ecological zone): no classification (N_2O)	0.0	0.0	0.0	0.0%	0	0%	0.0	0%
3.E.2 Grassland (specify ecological zone): no classification (CH_4)	0.0	0.0	0.0	0.0%	0	0%	0.0	0%
3.E.2 Grassland (specify ecological zone): no classification (N_2O)	0.0	0.0	0.0	0.0%	0	0%	0.0	0%
3.F.1 Cereals: Cereals (CH_4)	1 257.4	466.6	622.8	0.2%	-635	-50%	156.1	33%
3.F.1 Cereals: Cereals (N_2O)	332.4	128.1	173.8	0.0%	-158.5	-48%	45.7	36%
3.F.2 Pulses: Pulses (CH_4)	2.9	0.3	0.3	0.0%	-3	-88%	0.0	17%
3.F.2 Pulses: Pulses (N_2O)	0.8	0.1	0.1	0.0%	-1	-83%	0.0	32%
3.F.3 Tubers and roots: Tubers and Roots (CH_4)	126.0	3.4	3.1	0.0%	-123	-98%	-0.4	-10%
3.F.3 Tubers and roots: Tubers and Roots (N_2O)	34.0	1.4	1.3	0.0%	-33	-96%	-0.2	-12%
3.F.4 Sugar cane: Sugar Cane (CH_4)	8.5	1.4	1.6	0.0%	-7	-82%	0.1	8%
3.F.4 Sugar cane: Sugar Cane (N_2O)	2.1	0.4	0.4	0.0%	-2	-82%	0.0	8%
3.F.5 Other: Other Agricultural residues (CH_4)	141.2	59.7	61.0	0.0%	-80	-57%	1.3	2%
3.F.5 Other: Other Agricultural residues (N_2O)	36.5	19.5	19.8	0.0%	-17	-46%	0.3	2%
3.G.2 Dolomite $CaMg(CO_3)_2$ (CO_2)	-	-	-	-	-	-	-	-
3.H Urea application(CO_2)	-	-	-	-	-	-	-	-
3.I Other carbon-containing fertilizers (CO_2)	-	-	-	-	-	-	-	-
3.J Other: no classification (CH_4)	0.3	1 457.1	1 457.1	0.4%	1 456.8	464689%	0.0	0%
3.J Other: no classification (CO_2)	0.0	0.0	0.0	0.0%	0	0%	0.0	0%
3.J Other: no classification (N_2O)	0.1	165.5	165.5	0.0%	165	157589%	0.0	0%

5.4 Uncertainties

Table 5.59 shows the total EU 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 see Chapter 1.6.

Table 5.59 Sector Agriculture: EU uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2021	Level uncertainty estimates based on MS uncertainty	Trend uncertainty estimates based on MS uncertainty
3.A Enteric Fermentation	CO2	0	0	0.0%	0.0%	0.0%
3.A Enteric Fermentation	CH4	237 259	180 808	-23.8%	13.7%	1.6%
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	54 611	44 849	-17.9%	22.0%	1.7%
3.B Manure Mangement	N2O	25 645	17 362	-32.3%	69.4%	12.0%
3.C Rice Cultivation	CO2	0	0	0.0%	0.0%	0.0%
3.C Rice Cultivation	CH4	2 750	2 039	-25.9%	17.1%	21.6%
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	146 478	108 227	-26.1%	68.6%	9.4%
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	804	671	-16.5%	49.1%	5.2%
3.F Field Burning of Agricultural Residues	N2O	226	191	-15.5%	48.2%	5.5%
3.G Liming	CO2	9 352	5 662	-39.5%	23.5%	6.4%
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	3 210	2 849	-11.3%	22.5%	3.3%
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	964	553	-42.7%	14.6%	4.8%
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	1 457	464688.0%	22.4%	103904.2%
3.J Other	N2O	0	166	157588.7%	97.6%	153759.3%
3 (w here no subsector data w ere submitte	all	1 922	886	-53.9%	24.2%	20.4%
Total - 3	**all**	**483 222**	**365 719**	**-24.3%**	**21.9%**	**3.0%**

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-NID because uncertainty estimates are not available for all source categories in each of this EU countries

5.5 Sector-specific quality assurance and quality control and verification

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[21].

In the 2024 submission, the main improvement consisted in implementing the new reporting format (CRT tables).

5.5.1 QA/QC system in the agriculture sector

Quality checks

Several quality checks are performed. 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**[23] 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 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 level) is important to ensure correct comparison of countries' values and a correct calculation of EU background data. An automated check[24] 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[25]. 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 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[26]. 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[27,28]. 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.

  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.

  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 N_2O with AD in 3.D.1.c (Urine and Dung Deposited by Grazing Animals). The sum of FPRP over all animal types should therefore equal the AD in category 3.D.1.c.

  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[29] 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[30] 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.

The same number of issues were identified (120 for 2024) compared to last year (118 were identified for 2023):

- 22 completeness issues (related to 'NE'/'empty'/'notation keys')
- 3 country-outlier issues
- 25 agricheck issues
- 31 previous recommendations (ESD and UNFCCC review)
- 20 recalculation issues
- 19 consistency issues in Annexe IX

5.5.1.1 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[31].

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 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 weighted averages to avoid biases in the results. Therefore, the EU weighted averages - in some cases - could not represent 100% of EU activity data.

5.5.1.2 Compilation of the chapter agriculture for the EU-GHG inventory report

The presented data was automatically generated using an automated process from the member state submitted data. This minimizes the risk of transcription or copying errors but does not eliminate completely the existence of errors.

5.1 Sector-specific recalculations

Recalculations are described in chapter 10.1, including the explanations for significant changes (>500 kt CO_2eq) in categories.

5.2 Sector-specific improvements

In 2024, the reporting has been amended to be in line with the new CRT reporting tables, as well as the NID outline. Descriptions of categories have been aligned accordingly. Information across sectors has been streamlined to provide a harmonised approach across the whole NID. Any recommendations for improvement of earlier UNFCCC reviews have been continuously followed up and implemented.

Improvements planned for the next reporting are continuing the efforts to ensure consistency between.

6 LAND USE, LAND–USE CHANGE AND FORESTRY (CRT SECTOR 4)

6.1 Overview of the sector

Within the EU GHG inventory, the LULUCF sector shows higher removals by sinks than emissions by sources, as a result the sector represents a net carbon sink[49].

In terms of land use categories, a net carbon sink is reported under Forest 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 2022, the **LULUCF sector** of the **EU** results in a total net sink of **-262 740 kt CO_2**, which represents an increase of 7% as compared to the net sink reported for the year 1990 (Table 6. 1).

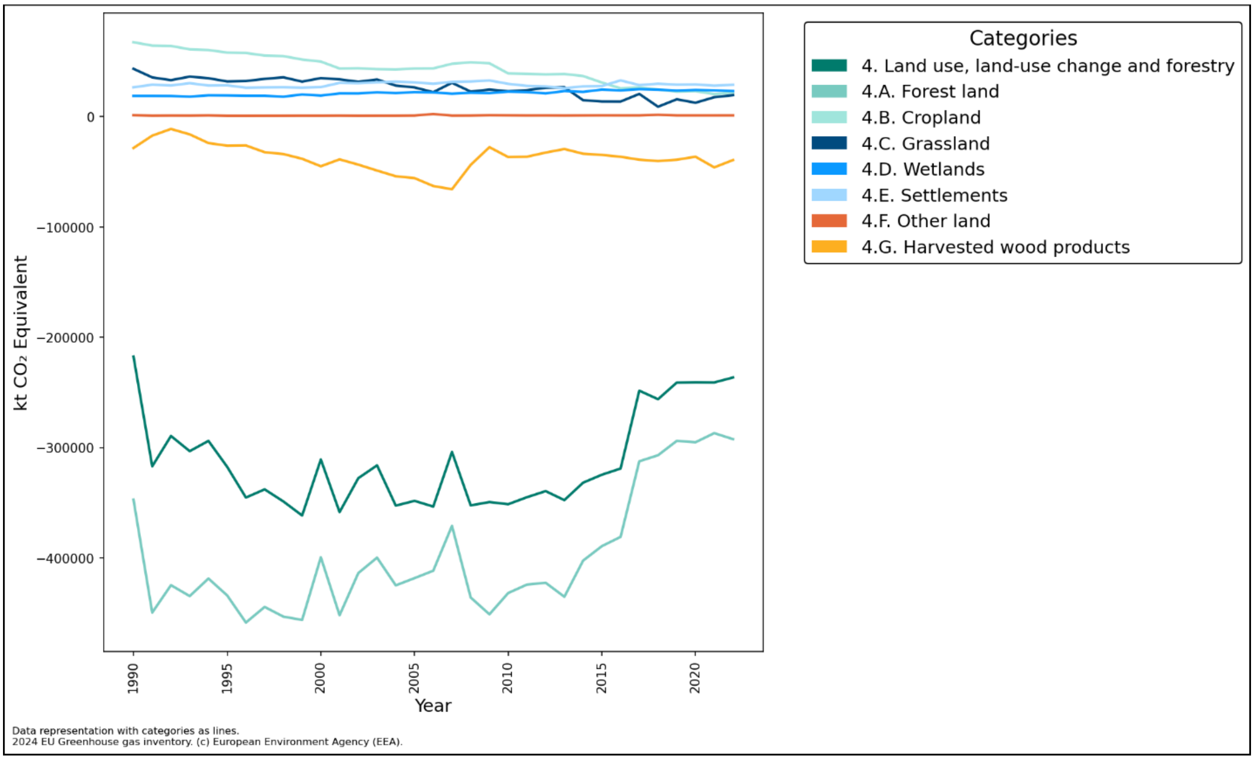
Within the LULUCF sector, the carbon pool Harvested Wood Products is in 2022 reported as a net carbon sink of -39 739 kt CO_2. On the other hand, emissions of CH_4 and N_2O in 2022 represent about 11% of annual net carbon sink.

In terms of CO_2 equivalent *LULUCF* results for the year 2022 in **-236 402 kt CO_2 equivalent**.

Moreover, France and Germany have reported GHG emissions in the CRT 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 reports in CRT 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 GHG net emissions (+) / removals (-) for 1990–2022, in CO_2 eq. (kt).

[49] The EU Greenhouse gas inventory data in this report was compiled using the September 2024 release of the 'CRT reporting tool' developed by the UNFCCC Secretariat. However, due to remaining technical shortcomings in the UNFCCC ETF tools, there have been substantial difficulties in preparing and finalizing the EU GHG inventory tables, which are based on the aggregation of emissions and removals from Member States' GHG inventories. In addition, because of the ongoing improvements and additional releases of the ETF tools by the UNFCCC secretariat after the compilation of the EU GHG inventory, reported data may differ from actual inventory data in some cases. The EU will provide additional information on sector-specific issues affected by the ETF tool during the technical expert review. For more information, see also footnote 4 of the executive summary.



Source: EU MS submissions 2024, CRT table 4

The overall trend of the LULUCF sector is largely driven by the Forest Land category.

Table 5.1: Sector 4. LULUCF: individual Member States contributions to net CO_2 removals

Member State	CO_2 Emissions in kt CO_2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equiv.	%	kt CO_2 equiv.	%
Austria	-11 852	-11 231	-4 629	1.8%	7 223	61%	6 602	59%
Belgium	-2 945	-379	-518	0.2%	2 427	82%	-139	-37%
Bulgaria	-17 845	-9 684	-9 665	3.7%	8 180	46%	19	0%
Croatia	-6 394	-5 930	-5 074	1.9%	1 320	21%	856	14%
Cyprus	-153	-245	-301	0.1%	-148	-96%	-56	-23%
Czechia	-8 875	6 572	3 344	-1.3%	12 219	138%	-3 228	-49%
Denmark	6 332	-145	-731	0.3%	-7 063	-112%	-586	-403%
Estonia	-5 546	470	-2	0.0%	5 543	100%	-473	-101%
Finland	-26 366	840	1 836	-0.7%	28 202	107%	995	118%
France	-20 985	-20 641	-20 272	7.7%	713	3%	369	2%
Germany	25 738	-4 970	-3 252	1.2%	-28 990	-113%	1 717	35%
Greece	-2 345	-5 190	-5 470	2.1%	-3 125	-133%	-280	-5%
Hungary	-3 345	-7 222	-6 920	2.6%	-3 574	-107%	302	4%
Ireland	716	392	-356	0.1%	-1 072	-150%	-748	-191%
Italy	-5 271	-25 895	-22 108	8.4%	-16 837	-319%	3 787	15%

Latvia	-13 399	768	3 485	-1.3%	16 884	126%	2 718	354%
Lithuania	-5 453	-5 648	-6 490	2.5%	-1 036	-19%	-842	-15%
Luxembourg	-1	-614	-651	0.2%	-650	-55900%	-37	-6%
Malta	-10	0	0	0.0%	10	102%	0	442%
Netherlands	4 678	3 708	4 382	-1.7%	-295	-6%	674	18%
Poland	-30 281	-25 966	-37 747	14.4%	-7 466	-25%	-11 781	-45%
Portugal	5 705	-6 875	-6 769	2.6%	-12 475	-219%	105	2%
Romania	-26 435	-48 224	-46 616	17.7%	-20 181	-76%	1 608	3%
Slovakia	-9 023	-7 263	-7 317	2.8%	1 707	19%	-53	-1%
Slovenia	-4 451	-360	-221	0.1%	4 230	95%	139	39%
Spain	-34 728	-47 877	-47 870	18.2%	-13 142	-38%	8	0%
Sweden	-53 020	-45 171	-42 788	16.3%	10 232	19%	2 383	5%
EU-27	**-245 556**	**-266 779**	**-262 719**	**100%**	**-17 162**	**-7%**	**4 061**	**2%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

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. The last years of the time series are increasingly affected by the maturity of the forests leading to lower net increment, and higher harvest rates. The impact of natural disturbances has also played a role leading to increased harvesting and less increment.

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, 2017 and 2022) in Mediterranean countries are reflected in Figure 6.1. In 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.

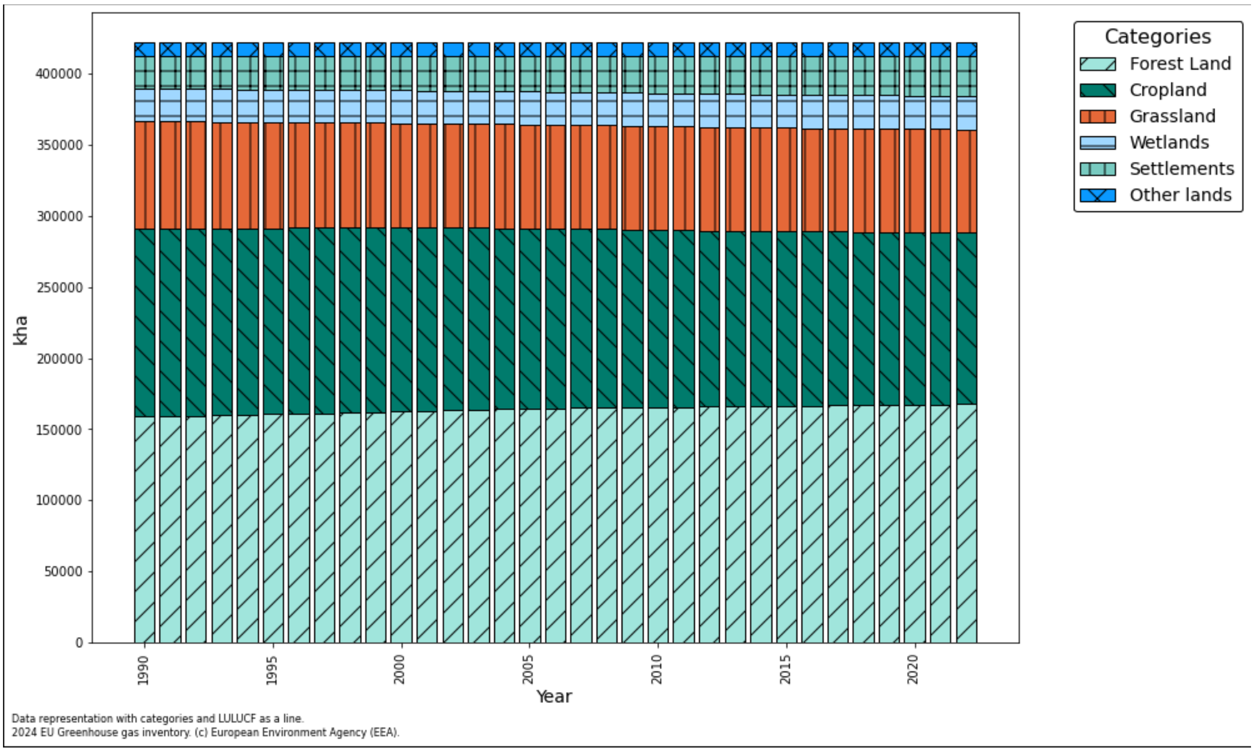
Natural disturbances also explain the sharp change in the sink observed in the base year, which result largely from the reporting of Germany. As explained by the Party, in spring 1990, Germany was impacted by a storm that caused an unprecedented number of windfalls (about 70 million m^3 of wood), and this explains the notably low LULUCF sink in 1990 for Germany that is reflected in the EU trend.

Finally, the LULUCF sector of the EU GHG inventory is also impacted by the state of the economy such as the economic crisis that EU economies underwent in 2008, which led to less demand for wood and lower forest harvesting rates than usual, which 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.

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. 423 000 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.

Figure 6. 2 *Total area for each of the land use categories (kha), as reported by EU MS in 2024.*



Source: EU MS submissions 2024, CRT table 4.1

Although the LULUCF sector results in a net carbon sink at the level of EU, the sector is reported by countries ranging 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 in the relevant sections for each land use category of this chapter.

At the EU level, the LULUCF sector offsets about 7% of the total emissions from other sectors ("Total without LULUCF"), with significant differences among MS.

6.1.1 Coverage of pools

LULUCF reporting includes all the carbon pools, living biomass (below and above ground), dead wood, litter and soil carbon in mineral and organic soils as well as harvested wood products. In some case countries report a notation key, NO, NA, NE or IE, as appropriate.

Whenever the Tier 1 assumption of “equilibrium” for carbon stock changes is implemented, countries used the notation key NO, NE, or NA. Efforts have been devoted, and are ongoing 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.

6.1.2 Methodological tiers by category

According to EU Governance Regulation (EU) 2018/1999, annex V, part 3, EU member States shall for the period 2021-2025, use at least Tier 1 methodologies in accordance with the 2006 IPCC guidelines for national GHG inventories, except for a carbon pool that accounts for at least 25 % of emissions or removals in a source or sink category which is prioritised within a Member State's national inventory system because its estimate has a significant influence on a country's total inventory of GHGs in terms of the absolute level of emissions and removals, the trend in emissions and removals, or the uncertainty in emissions and removals in the land use categories, in which case, at least Tier 2 methodologies in accordance with the 2006 IPCC guidelines for national GHG inventories shall be used.

Adherence to this requirement is being checked as part of the QA/QC done by the European Environment Agency for all EU Member States. This is an ongoing improvement process.

An assessment done based on the 2022 inventory submission found that 15% of the absolute emissions and removals are reported using tier 1, 62% using tier 2 and 23% using tier 3 methodology, with large differences among the countries (including Norway and Iceland).

Also, there are differences for different carbon pools within each category. As an example in forest land, all but one Member States use higher tiers for living biomass, while about half the countries use tier 1 equilibrium for litter in forest land remaining forest land.

Soil carbon fluxes in mineral soils in forest land remaining forest land are for more than half the countries estimated using tier 1 assuming equilibrium, seven countries use tier 3 methods, five of those using soil models, and two using inventory-based models.

In cropland remaining cropland and grassland remaining grassland many countries use tier 1 for biomass in annual crops and higher tier for perennial crops. Only a few countries have country specific carbon stocks for living biomass in annual crops in cropland and for grassland. Also, DOM is in most cases reported using tier 1 equilibrium assumption.

Soil carbon in mineral soils in cropland remaining cropland is estimated using higher tiers for all Member States but one that based on a pilot study found there is no net carbon loss in mineral soils in cropland and it is therefore reported as NA.

Carbon in mineral soils in grassland remaining grassland is estimated by several Member States according to tier 1 assuming equilibrium. However more than half the Member States estimate this using higher tiers.

Carbon fluxes due to land use conversions on mineral soils are generally estimated using tier 2 and for a few Member States using tier 3.

Emissions from organic soils are mostly reported using tier 2 but also tier 1 using default emission factors are used. This includes non-CO_2 emissions for areas subject to drainage and rewetting. A few Member States also use tier 3 models for estimating emissions from drainage of soils including water-level data and nutrient status.

6.2 Land use definitions

6.2.1 Forest land

Table 6. 2 Thresholds used for the forest definition

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	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

Country	Crown cover (%)	Height (m)	Area (ha)	Minimal width (m)
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	-

Additional information used by the countries to define the area of forests is provided in the table below:

Table 6. 3 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.
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.

Country	Forest land definition
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	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.
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.

Country	Forest land definition
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.

6.2.2 Cropland

Table 6. 4 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.
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

Country	*Definition*
	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 m² or above in case of berries and 400 m² 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 m². 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.
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").

Country	*Definition*
Sweden	Regularly tilled agricultural land.

6.2.3 Grassland

Table 6. 5 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.
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.

Country	*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.
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.

6.2.4 Wetlands

Table 6. 6 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

Country	*Definition*
	artificial watercourses serving as water drainage channels, natural or artificial stretches of water, coastal lagoons, wetlands areas and peatbogs.
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

Country	*Definition*
	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.
Sweden	Wetlands is assumed unmanaged (mires and areas saturated by fresh water) and managed (cca 10 000 ha used for peat extraction).

6.2.5 Settlements

Table 6. 7 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.

Country	*Definition*
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.
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.

6.2.6 Other land

Table 6. 8 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.

Country	*Definition*
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.

6.3 Source categories and methodological issues

6.3.1 Country-specific approaches

6.3.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

Most EU Member States use several land-use datasets for representing land, this includes national datasets as well as EU datasets such as Corine Land Cover and the Land Parcel Information System (LPIS). Some Member States use data from their National Forest Inventory for the forest land category and in a few cases, it also covers non-forest land.

Approach 1 as described in the IPCC guidelines is only used by a few countries and only for specific land use categories. Most countries apply an approach 2, using both statistical and spatially explicit data and a few Member States apply an approach 3.

The EU LULUCF regulation requests Member States to use geographically explicit land-use conversion data in accordance with the 2006 IPCC Guidelines for national GHG inventories. Several Member States are therefore improving their current systems for tracking land use conversions.

Most Member States have a national soil sampling survey with less frequent sampling allowing identification of mineral and organic soils.

6.3.3 Information on approached used for natural disturbance

The EU GHG inventory includes all emissions and removals on managed land regardless of whether fluxes can be attributed to a natural disturbance event.

6.3.4 Information on approaches used for reporting harvested wood products

The methods and data sources for estimating carbon stock changes in HWPs are consistent with methodologies provided by 2006 IPCC GL. Individual inventories implement the IPCC Approach B (i.e., production approach) to provide estimates on HWPs consistently with the reporting of the carbon pool under the and subsequently according to EU Regulations No 2018/841.

6.3.5 Category: Forest land (CRT 4.A)

6.3.5.1 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 40% of the entire territory. Based on individual submissions reported this year, total forest area reached 167 770 kha in 2022, which represents an increase of 6% 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.

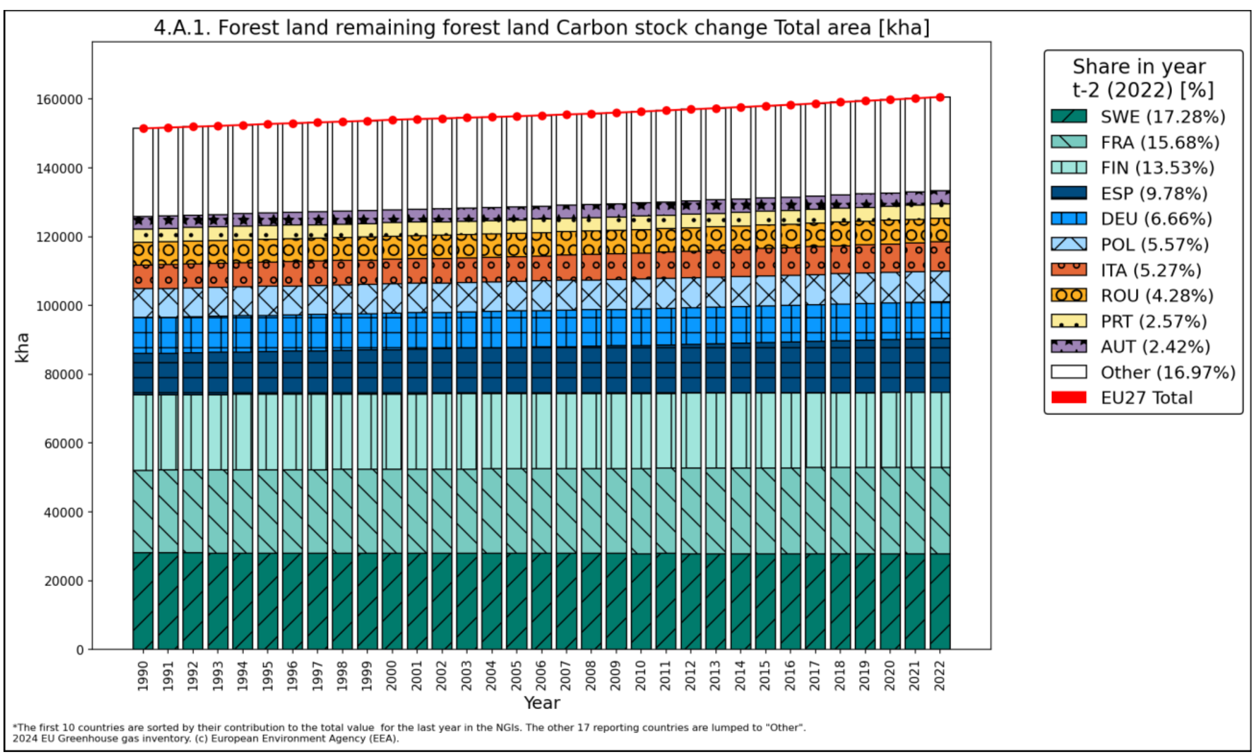
The largest forest areas are reported by Sweden, France and Finland, which together report about 46% of the total forest area at EU level (Figure 6.3). Deforestation does not appear to be a major issue in Europe. Moreover, the absolute area under conversion from forest is by far compensated by new afforested areas and natural forest expansion.

6.3.5.2 Forest Land remaining Forest Land (CRT 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 6% as compared with 1990. However, at the level of individual submissions there are significant differences.

Figure 6. 3 Trend of activity data in subcategory 4A1 "Forest land remaining Forest Land" in EU



For this inventory year, the total land area reported under the sub-category 4.A1 by EU MS reached 160 626 kha, out of which about 83% 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 -299 707 kt CO_2, decreasing by 16% as compared to 1990. The largest contributors are Spain, Germany and Sweden (Table 6. 9).

Table 6. 9 4A1 Forest Land remaining Forest Land: EU contributions to net CO_2 emissions (+)/removals (-) (CRT table 4)

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	-11,077	-11,406	-4,612	1.5%	6,464	58%	6,794	60%
Belgium	-1,921	-1,994	-1,988	0.7%	-67	-4%	6	0%
Bulgaria	-16,361	-8,485	-8,380	2.8%	7,981	49%	105	1%
Croatia	-6,496	-5,868	-5,239	1.7%	1,257	19%	629	11%
Cyprus	1	-121	-178	0.1%	-179	-12302%	-56	-46%
Czechia	-7,501	9,140	5,497	-1.8%	12,998	173%	-3,644	-40%
Denmark	-1,236	-2,933	-3,418	1.1%	-2,182	-176%	-485	-17%
Estonia	-6,143	-676	-1,676	0.6%	4,466	73%	-1,001	-148%
Finland	-32,008	-7,434	-7,204	2.4%	24,804	77%	231	3%
France	-40,990	-34,528	-34,875	11.6%	6,115	15%	-347	-1%
Germany	-20,123	-39,149	-40,238	13.4%	-20,115	-100%	-1,089	-3%
Greece	-1,310	-2,153	-2,188	0.7%	-878	-67%	-35	-2%
Hungary	-3,416	-6,673	-6,294	2.1%	-2,879	-84%	379	6%
Ireland	-2,925	-1,440	-1,879	0.6%	1,046	36%	-438	-30%
Italy	-17,852	-28,920	-26,375	8.8%	-8,524	-48%	2,544	9%
Latvia	-17,558	-1,614	463	-0.2%	18,021	103%	2,077	129%
Lithuania	-7,813	-5,886	-6,488	2.2%	1,325	17%	-602	-10%
Luxembourg	-43	-646	-689	0.2%	-647	-1516%	-43	-7%
Malta	0	0	0	0.0%	0	-1026%	0	-5%
Netherlands	-2,168	-2,282	-1,425	0.5%	743	34%	857	38%
Poland	-33,794	-21,655	-34,167	11.4%	-373	-1%	-12,511	-58%
Portugal	3,403	-2,540	-2,299	0.8%	-5,701	-168%	242	10%
Romania	-27,296	-28,238	-27,628	9.2%	-332	-1%	610	2%
Slovakia	-8,262	-6,330	-6,644	2.2%	1,619	20%	-313	-5%
Slovenia	-4,820	-180	28	0.0%	4,848	101%	208	116%
Spain	-34,546	-41,967	-41,759	13.9%	-7,213	-21%	209	0%
Sweden	-53,155	-40,060	-40,054	13.4%	13,101	25%	6	0%
EU-27	**-355,408**	**-294,041**	**-299,707**	**100%**	**55,701**	**16%**	**-5,666**	**-2%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

For the year 2022, with the exception of Czechia, Latvia, Malta and Slovenia, individual submissions report a net carbon sink under Forest Land remaining Forest Land.

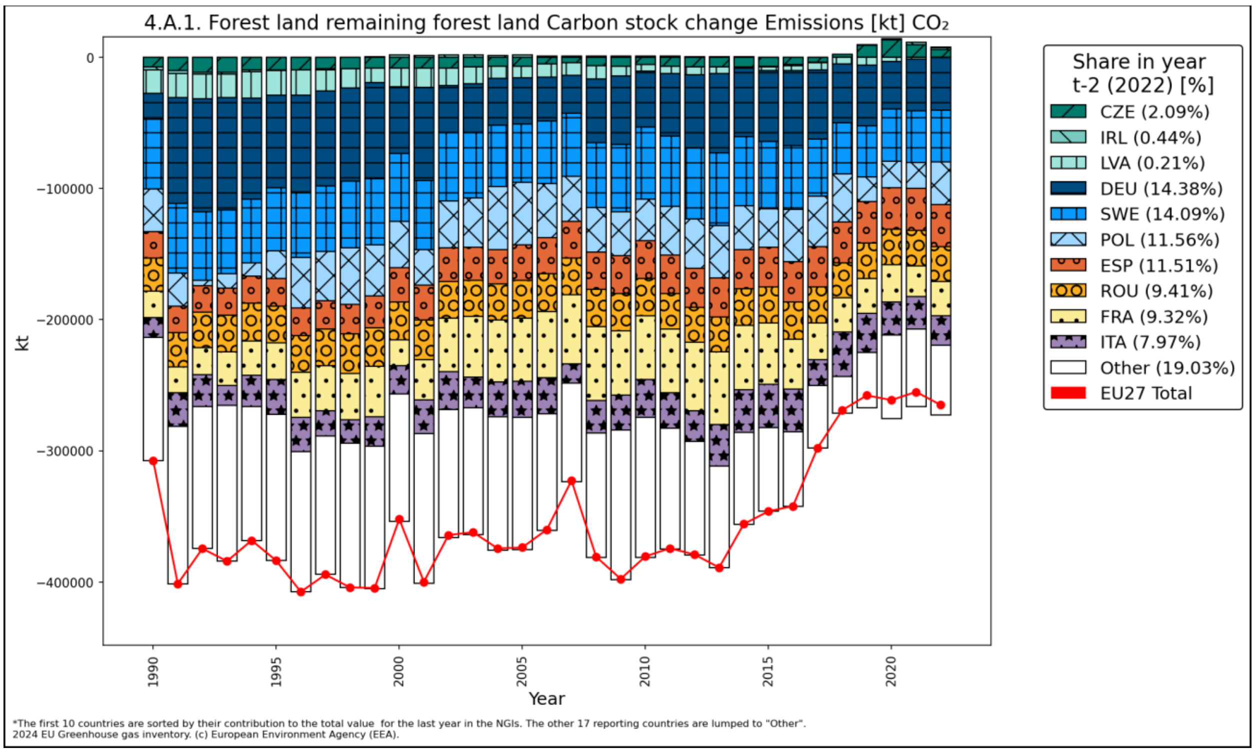
Important changes in terms of reported amounts, as compared with 1990, are mainly due to the increase in harvesting rates as reported by Czechia, which apply significant salvage logging practices after recent bark beetle infestation). But also, the impact of natural disturbances in forest, as in 1990 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 which both also tend to result in more harvesting. Increased demand for woody biomass also impacts harvesting levels.

The 10 MS with the largest contribution to the total net carbon sink account for about 81% of the EU removals (Figure 6.4).

Figure 6. 4 Trend of emissions (+)/removals (-) in subcategory 4A1 "Forest land remaining Forest Land" in EU (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 emissions of CO_2 from biomass burning are, in many cases, implicitly reported in CRT 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 CRT table 4(IV).

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.

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 individual inventories with the largest inter-annual variability in GHG estimates that affect the EU trend of this category are:

- Forest fires (e.g., Portugal in 1990, 2003, 2005 and 2017; Italy in 1990, 1993, 2007, 2017 and 2021; Greece 2007; Spain 2022; France 2003 and 2022).
- 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 6.2; Table 6.3). 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. 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.

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 getting 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.

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 on 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 areas, 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 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) up 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. 10 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	*Gain-loss*
Finland	*Gain-loss*
France	*Gain-loss*
Germany	*Stock-difference*
Greece	*Stock-difference*
Hungary	*Stock-difference*
Ireland	*Gain-loss*

Country	**IPCC method**
Italy	*Gain-loss*
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*

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.

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 CRT table 4.A.

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 the 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 a 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.

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.

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 cases as a net source of emissions.

6.3.5.3 Land converted to Forest Land (CRT 4.A2)

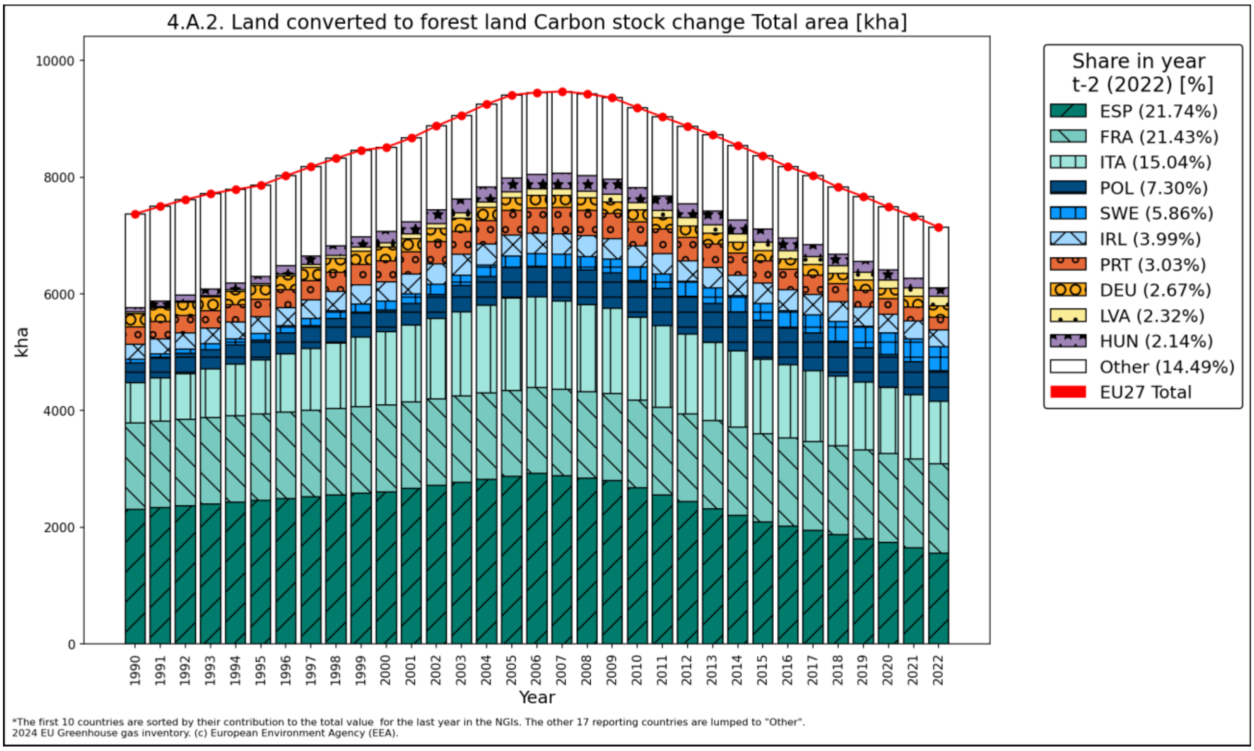
Overview of Land converted to Forest Land category

In this submission, the area reported under this subcategory represents 4% of the total Forest Land area. This subcategory first increased up to the year 2007 and then decreased so it is now almost the same as in 1990 (Figure 6.5).

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 12% to the total carbon sink of the European forests.

In term of areas, Spain, France, Italy, Poland and Sweden together contribute with about 72% 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 (kha)



This subcategory has been always reported as a net carbon sink at the EU level. In this submission, it reaches -42 104 kt CO_2, which represents a decrease of the sink by 27% as compared with 1990. (Figure 6.6;Table 6.11).

Nevertheless, some MS reports this subcategory as a net source of emissions. This fact is explained by the emissions caused during the preparatory practices that preceded the afforestation or reforestation activities.

Table 6. 11 4A2 Land converted to Forest Land: EU contributions to net CO_2 emissions (+)/removals (-) (CRT table 4)

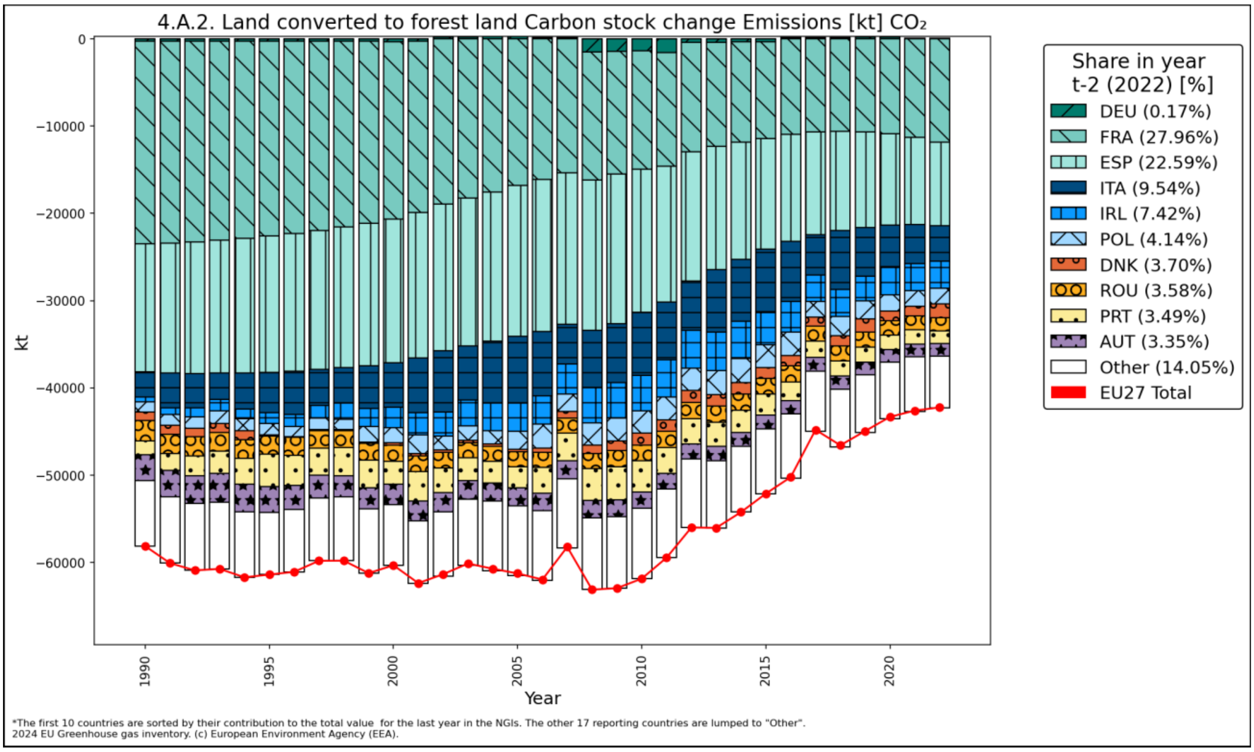
Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	-2,955	-1,441	-1,420	3.4%	1,535	52%	21	1%
Belgium	-11	-303	-309	0.7%	-297	-2659%	-6	-2%
Bulgaria	-2,776	-296	-191	0.5%	2,585	93%	105	36%
Croatia	-29	-261	-241	0.6%	-212	-735%	19	7%
Cyprus	0	-17	-18	0.0%	-18	-18771%	-1	-5%
Czechia	-235	-578	-551	1.3%	-316	-135%	27	5%
Denmark	-1,005	-1,113	-1,567	3.7%	-562	-56%	-454	-41%
Estonia	-8	-262	-247	0.6%	-239	-2833%	14	6%
Finland	-62	-171	-158	0.4%	-96	-153%	13	8%
France	-23,221	-11,264	-11,853	28.2%	11,368	49%	-588	-5%
Germany	-243	82	74	-0.2%	316	130%	-9	-11%
Greece	NE,NO	-44	-41	0.1%	-41	-∞	3	7%
Hungary	-394	-1,147	-1,062	2.5%	-668	-169%	85	7%
Ireland	-522	-3,059	-3,138	7.5%	-2,616	-501%	-79	-3%
Italy	-2,849	-4,489	-4,042	9.6%	-1,192	-42%	447	10%
Latvia	-10	-182	-264	0.6%	-254	-2496%	-82	-45%
Lithuania	-784	-1,154	-1,196	2.8%	-412	-53%	-42	-4%
Luxembourg	-33	-12	-9	0.0%	24	73%	4	28%
Malta	NO	0	0	0.0%	0	-∞	0	-5%
Netherlands	-770	-669	-635	1.5%	136	18%	34	5%
Poland	-1,187	-1,803	-1,757	4.2%	-570	-48%	46	3%
Portugal	-1,584	-1,663	-1,474	3.5%	110	7%	189	11%
Romania	-2,291	-1,582	-1,520	3.6%	771	34%	63	4%
Slovakia	-2,263	-344	-339	0.8%	1,924	85%	5	1%
Slovenia	-233	-178	-77	0.2%	156	67%	101	57%
Spain	-14,359	-9,958	-9,506	22.6%	4,853	34%	452	5%
Sweden	94	-605	-564	1.3%	-658	-698%	42	7%
EU-27	**-57,731**	**-42,513**	**-42,104**	**100%**	**15,627**	**27%**	**409**	**1%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.

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

As shown in Table 6.11, some MS reported significant changes in this subcategory as compared with 1990, for instance, France, Spain and Bulgaria.

Figure 6. 6 Trend of emissions (+)/removals (-) in subcategory 4A2 "Land converted to Forest Land" in EU (kt CO_2)



For this year, about 51% of total carbon sink reported in the subcategory 4A.2 was reported by France and Spain while the 10 MS with the larger contribution represent about the 86% 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 subcategory 4.A1. Nevertheless, different parameters are involved under each subcategory due to differences among others in growth rates and management practices of these young forests.

Most countries use the default of 20 years for land converted to forest before it is being reported under Forest land remaining forest land but a few countries in the northern part of Europe use a 30 year period before land converted to forest land is transferred to Forest land remaining forest land

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 4A2 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.

6.3.6 Cropland (CRT 4B)

6.3.6.1 Overview of the Cropland category

Subject to intensive agriculture practices, the 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 2022 a total of 120 756 kha, which represent 29% of the lands reported by EU MS. However, the category shows a steady decreasing trend. For this inventory year the area is about 8% less than in the year 1990.

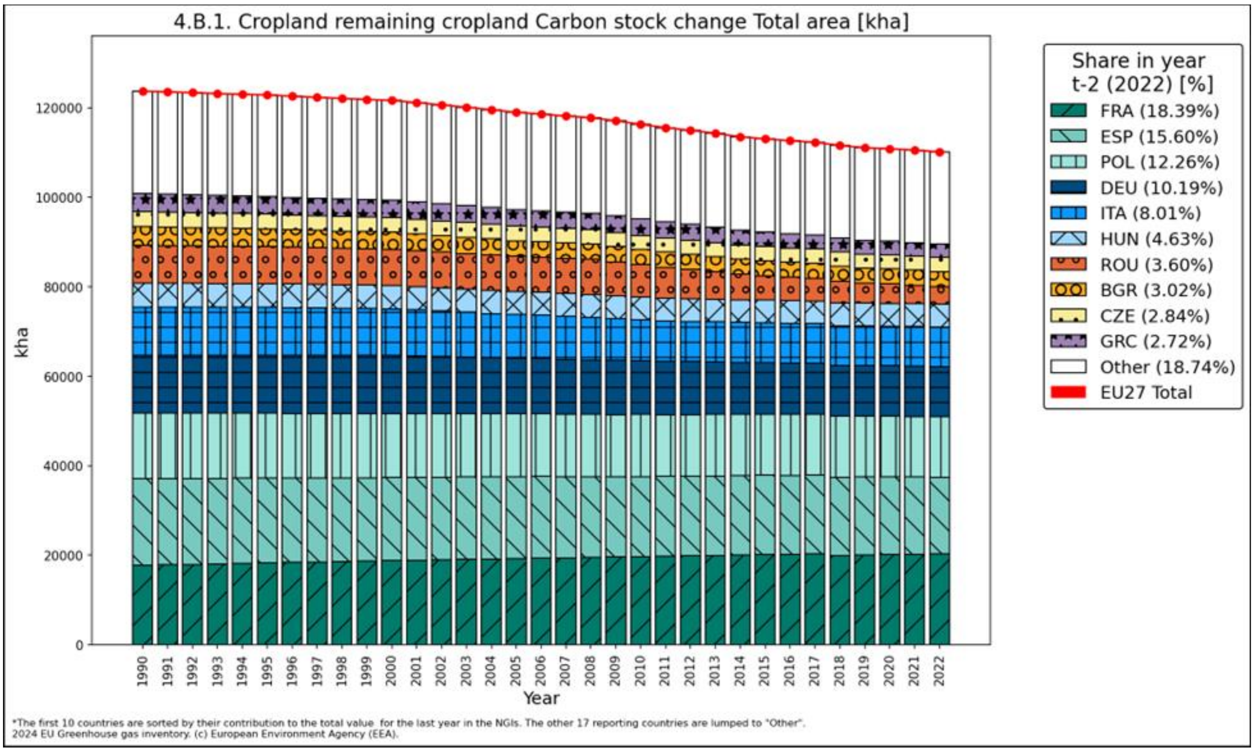
6.3.6.2 Cropland remaining Cropland (CRT 4B1)

Overview of Cropland remaining Cropland category

In line with the overall category, this subcategory has constantly decreased since 1990 (Figure 6.7).

The overall trend of this subcategory is driven by 10 MS which together contribute to about 81% of the total area, and more specifically, Spain, France, Poland, and Germany which represent more than half of the area reported under this subcategory.

Figure 6. 7 Trend of activity data in subcategory 4B1 "Cropland remaining Cropland" in EU (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 2022, based on individual submissions, GHG emissions from Cropland remaining Cropland reached 4 755 kt CO_2 which represents a decrease of 84% as compared to 1990 (Table 6.12).

This trend is mainly driven by Denmark, Poland and Spain that report fewer net emissions in 2022 compared to 1990. At the same time some Member States, Finland, Slovakia and Sweden report more emissions in 2022 compared to 1990 (Table 6.12). 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.

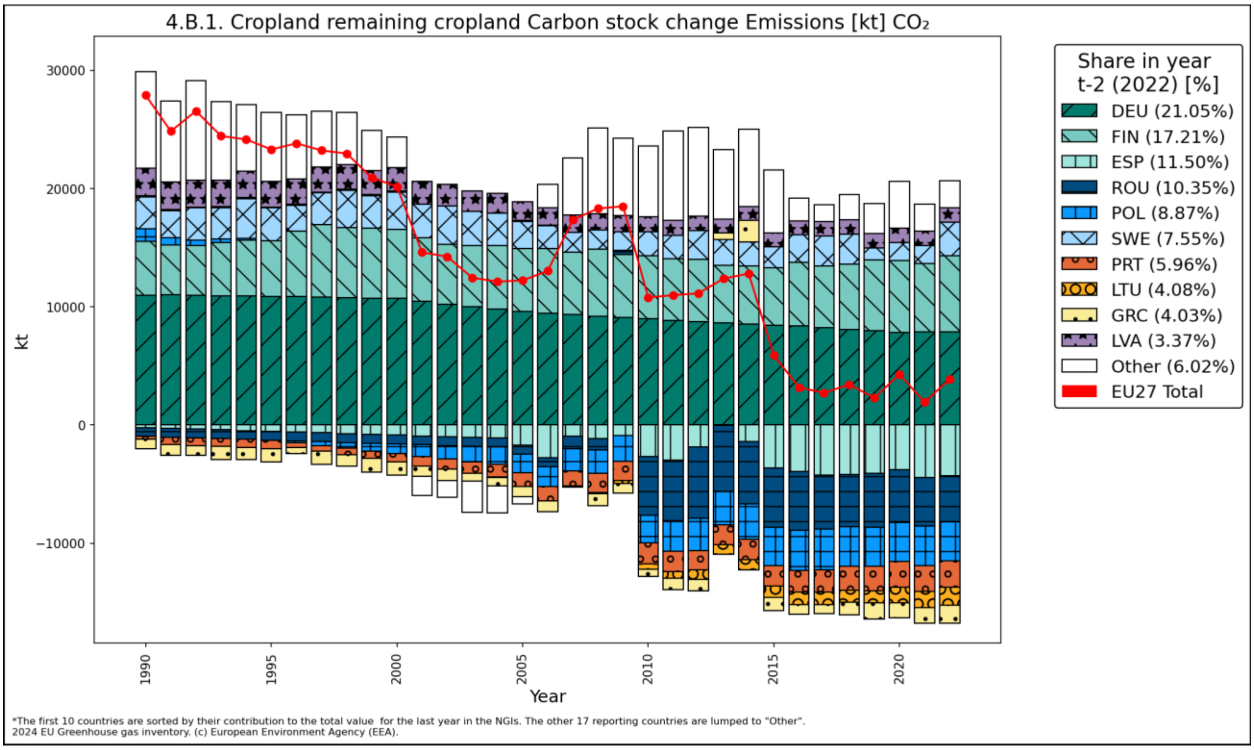
Nevertheless, some MS report a considerable carbon sink in Cropland remaining Cropland. For instance, Spain, Poland and Romania report a substantial net carbon sink in mineral soils and, in some cases, also in the living biomass carbon pool. This is generally justified by the implementation of IPCC methodologies (i.e. tier 1 and tier 2) that result in a net sink when current management practices of soils add more organic matter to the soil 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.

Table 6. 12 4B1 Cropland remaining Cropland: EU-27 contributions to net CO_2 emissions (+)/removals (-) (CRT table 4)

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	-18	49	84	1.8%	102	562%	35	72%
Belgium	213	115	109	2.3%	-104	-49%	-5	-5%
Bulgaria	-219	-56	-107	-2.3%	112	51%	-51	-92%
Croatia	89	138	143	3.0%	54	60%	4	3%
Cyprus	-134	-134	-134	-2.8%	0	0%	0	0%
Czechia	-13	-17	-21	-0.4%	-8	-66%	-5	-29%
Denmark	4,791	590	600	12.6%	-4,191	-87%	10	2%
Estonia	603	609	713	15.0%	110	18%	104	17%
Finland	4,522	5,774	6,439	135.4%	1,917	42%	665	12%
France	1,191	36	-66	-1.4%	-1,257	-106%	-102	-285%
Germany	10,988	7,872	7,875	165.6%	-3,113	-28%	3	0%
Greece	-808	-1,295	-1,509	-31.7%	-701	-87%	-214	-17%
Hungary	40	-40	-24	-0.5%	-64	-160%	16	40%
Ireland	-48	-101	-83	-1.8%	-35	-73%	18	18%
Italy	1,272	1,050	1,109	23.3%	-163	-13%	59	6%
Latvia	2,364	1,239	1,259	26.5%	-1,104	-47%	21	2%
Lithuania	358	-1,125	-1,248	-26.2%	-1,606	-448%	-123	-11%
Luxembourg	0	2	3	0.1%	3	168023%	0	6%
Malta	0	-1	-1	0.0%	-1	-1395%	0	0%
Netherlands	1,479	799	661	13.9%	-819	-55%	-138	-17%
Poland	1,105	-3,343	-3,316	-69.7%	-4,420	-400%	27	1%
Portugal	952	-1,914	-1,946	-40.9%	-2,897	-304%	-31	-2%
Romania	-577	-3,953	-3,701	-77.8%	-3,124	-542%	252	6%
Slovakia	-951	-698	-690	-14.5%	261	27%	7	1%
Slovenia	65	85	84	1.8%	19	29%	-1	-1%
Spain	-207	-4,416	-4,301	-90.5%	-4,094	-1979%	115	3%
Sweden	2,681	1,510	2,823	59.4%	142	5%	1,313	87%
EU-27	**29,739**	**2,776**	**4,755**	**100%**	**-24,985**	**-84%**	**1,979**	**71%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 6. 8 Trend of emissions (+)/removals (-) in subcategory 4B1 “Cropland remaining Cropland” in EU (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. 4). 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.

Overall, following the IPCC approach, the carbon pool living biomass is assumed in balance for annual crops, while carbon stock changes are reported for conversions among annual and woody crops. 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. 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 or as a net source.

With regard to carbon stock changes 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.

Applied tier 2 methods rely 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. 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).

6.3.6.3 Land converted to Cropland (CRT 4B2)

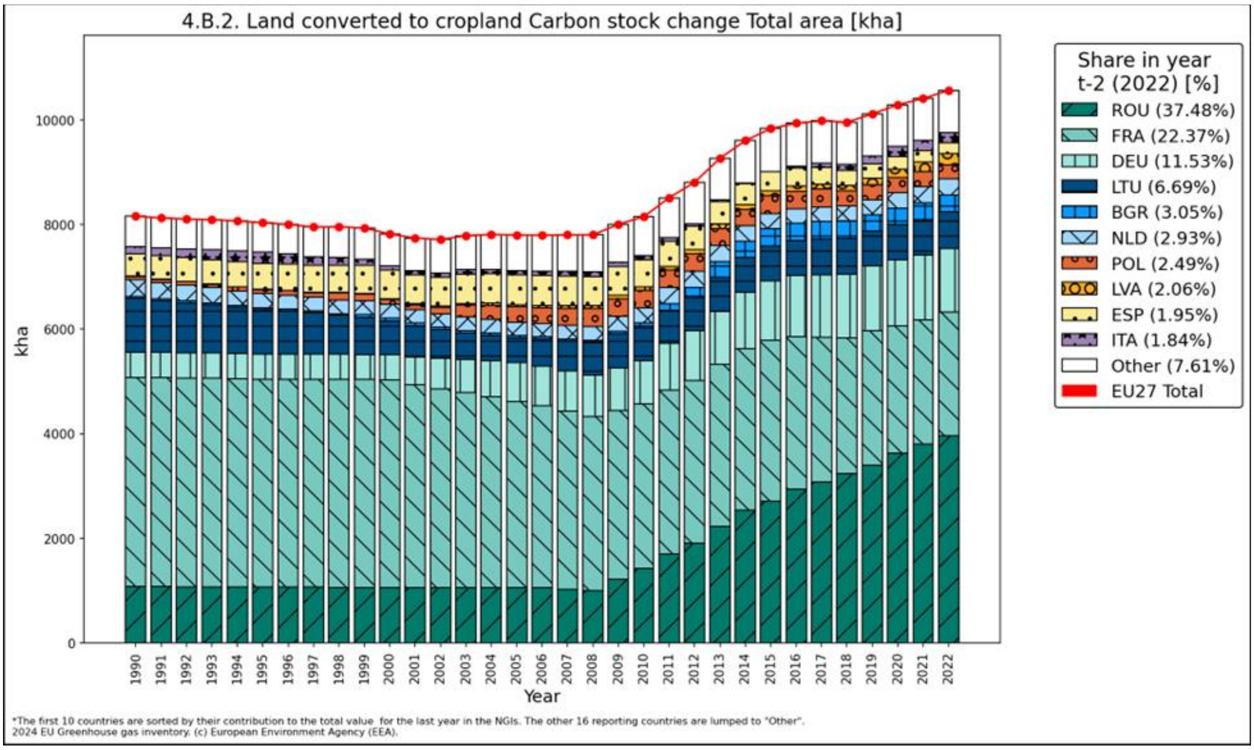
Overview of Land converted to Cropland category.

In terms of area, this subcategory represents 9% of the total cropland areas reported at the level of EU MS. 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 (Figure 6. 19).

Main conversions of lands to Cropland take place from areas of Grassland and Forest land. The trend in this subcategory is mainly driven by Romania, France and Germany, 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 (kha)



In terms of emissions, this subcategory is reported as a net source of emissions that for the current inventory year reaches 15 083 Kt CO_2. This represents a decrease of 56% as compared to 1990 (Table 6.13). The largest emissions are reported by France, which reports about 62 % of the total emissions in this subcategory; followed by Germany.

Nevertheless, some individual Member States report this subcategory as a carbon sink, as a result of removals from the living biomass carbon and the soil carbon pool when lands are converted to Croplands. With some few exceptions, all the other carbon pools are reported by the countries as a net source of emissions.

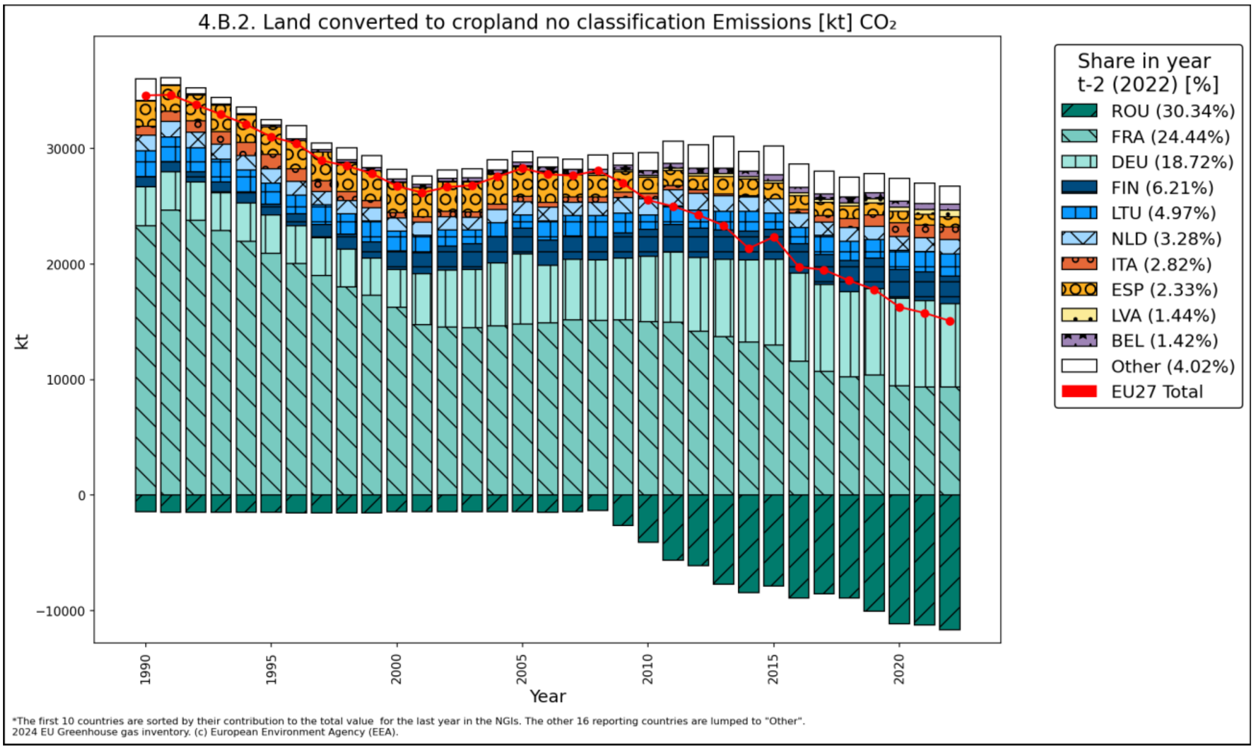
Table 6. 13 4B2 Land converted to Cropland: EU contributions to net CO_2 emissions (+)/ removals (-) (CRT table 4)

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	202	230	233	1.5%	31	15%	4	2%
Belgium	42	533	545	3.6%	503	1212%	11	2%
Bulgaria	48	476	408	2.7%	360	744%	-68	-14%
Croatia	26	123	120	0.8%	94	364%	-4	-3%
Cyprus	0	6	6	0.0%	6	2390%	0	-1%
Czechia	121	63	64	0.4%	-57	-47%	1	2%
Denmark	71	-11	-26	-0.2%	-97	-137%	-15	-140%
Estonia	NE,NO	130	132	0.9%	132	∞	2	1%
Finland	859	2,490	2,382	15.8%	1,523	177%	-108	-4%
France	23,306	9,352	9,378	62.2%	-13,928	-60%	27	0%
Germany	3,384	7,500	7,184	47.6%	3,800	112%	-316	-4%
Greece	52	17	20	0.1%	-32	-62%	3	16%
Hungary	30	154	154	1.0%	124	413%	0	0%
Ireland	NO	NO	NO	-	-	-	-	-
Italy	749	1,083	1,083	7.2%	334	45%	0	0%
Latvia	7	412	554	3.7%	547	8002%	142	35%
Lithuania	2,225	1,722	1,907	12.6%	-318	-14%	185	11%
Luxembourg	45	25	34	0.2%	-11	-24%	9	35%
Malta	-2	-1	-1	0.0%	1	47%	0	14%
Netherlands	1,398	1,220	1,258	8.3%	-141	-10%	37	3%
Poland	272	119	119	0.8%	-153	-56%	0	0%
Portugal	372	248	214	1.4%	-158	-42%	-33	-13%
Romania	-1,454	-11,220	-11,642	-77.2%	-10,188	-701%	-422	-4%
Slovakia	467	44	41	0.3%	-426	-91%	-3	-7%
Slovenia	197	59	61	0.4%	-137	-69%	1	2%
Spain	2,182	931	893	5.9%	-1,290	-59%	-39	-4%
Sweden	-7	56	-37	-0.2%	-29	-392%	-93	-166%
EU-27	**34,591**	**15,762**	**15,083**	**100%**	**-19,508**	**-56%**	**-678**	**-4%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

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.

Figure 6. 10 Trend of emissions (+)/ removals (-) in subcategory 4B2 "Land converted to Cropland" in EU (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.

6.3.7 Grassland (CRT 4C)

6.3.7.1 Overview of Grassland category (CRT 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, Grassland is reported as net source of emissions.

Based on individual submissions, for the current inventory year total Grassland covers 73 394 kha. This represents 17% of the total territory of EU. However, as for Cropland, these areas have constantly decreased, and nowadays these ecosystems cover 5% less area than in the base year.

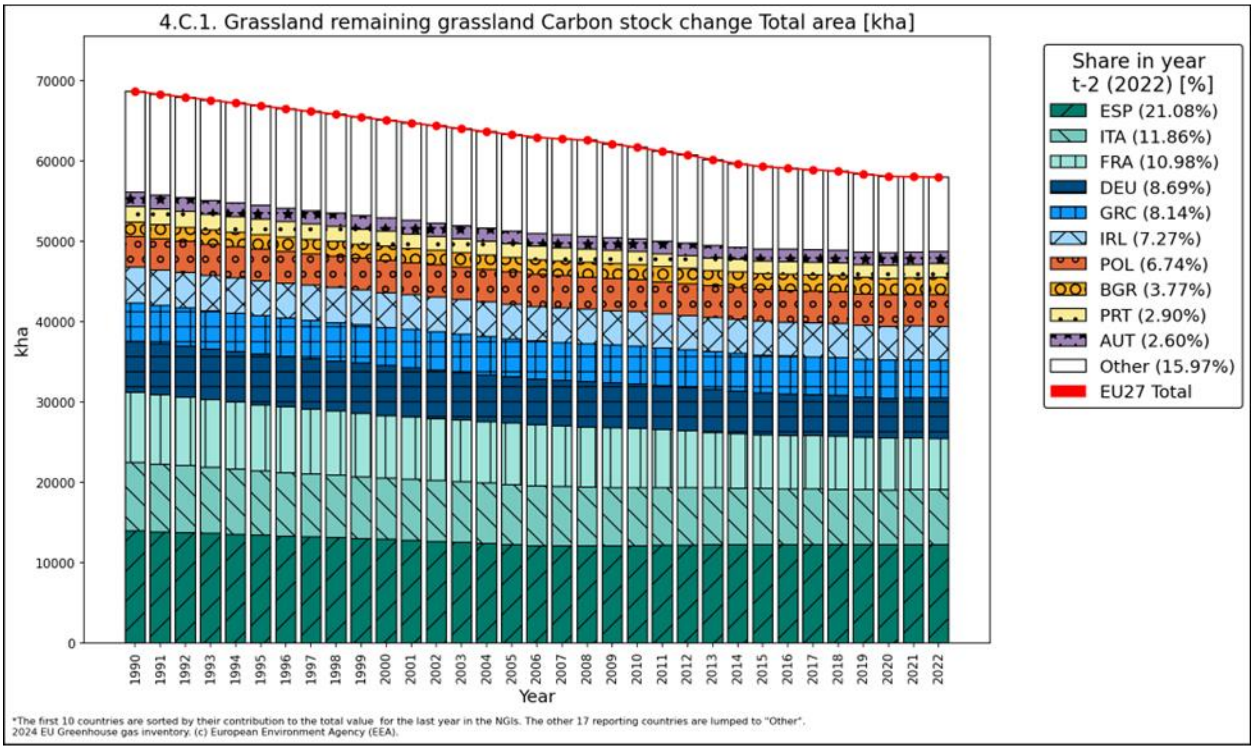
6.3.7.2 Grassland remaining Grassland (CRT 4.C1)

Overview of Grassland remaining Grassland category

Following the general trend of these lands, this subcategory has also constantly decreased since 1990, and in 2022 (Figure 6. 11).

Spain, France and Italy report together about 45% of the total area of Grassland remaining Grassland, while the 10 MS with the larger contribution account for about 85% of the total area.

Figure 6. 11 Trend of activity data in subcategory 4C1 "Grassland remaining Grassland" in EU (kha)



In terms of emissions, this subcategory has always resulted in a net source at the level of EU. In the current inventory year, the reported emissions reached 27 212 kt CO_2, which represents a decrease of 40% as compared with the year 1990 (Table 6.14).

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. 14 4C1 Grassland remaining Grassland: EU contributions to net CO_2 emissions (+)/removals (-) (CRT table 4)

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	304	304	304	1.1%	0	0%	0	0%
Belgium	29	218	209	0.8%	179	609%	-10	-4%
Bulgaria	115	80	78	0.3%	-36	-32%	-1	-2%
Croatia	2	2	2	0.0%	0	0%	0	0%
Cyprus	-23	-22	-22	-0.1%	2	7%	0	0%
Czechia	NO	-310	-311	-1.1%	-311	-∞	-1	0%
Denmark	2,129	1,822	1,799	6.6%	-329	-15%	-22	-1%
Estonia	-122	-99	-99	-0.4%	22	18%	0	0%
Finland	852	511	518	1.9%	-335	-39%	6	1%
France	-879	-1,130	-1,144	-4.2%	-266	-30%	-15	-1%
Germany	27,859	23,576	23,226	85.4%	-4,632	-17%	-350	-1%
Greece	0	0	0	0.0%	0	-100%	0	-100%
Hungary	25	-149	-122	-0.4%	-148	-583%	26	18%
Ireland	2,258	1,165	1,151	4.2%	-1,107	-49%	-14	-1%
Italy	5,432	1,457	2,157	7.9%	-3,275	-60%	700	48%
Latvia	935	273	490	1.8%	-445	-48%	217	80%
Lithuania	47	55	56	0.2%	9	19%	0	0%
Luxembourg	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Malta	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Netherlands	3,258	2,660	2,576	9.5%	-683	-21%	-84	-3%
Poland	1,306	660	643	2.4%	-662	-51%	-16	-2%
Portugal	2,334	-2,203	-2,317	-8.5%	-4,651	-199%	-114	-5%
Romania	-348	-1,366	-1,038	-3.8%	-690	-199%	328	24%
Slovakia	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Slovenia	195	-405	-377	-1.4%	-572	-294%	28	7%
Spain	-19	-38	-34	-0.1%	-15	-76%	4	10%
Sweden	-559	-538	-532	-2.0%	27	5%	6	1%
EU-27	**45,129**	**26,525**	**27,212**	**100%**	**-17,917**	**-40%**	**687**	**3%**

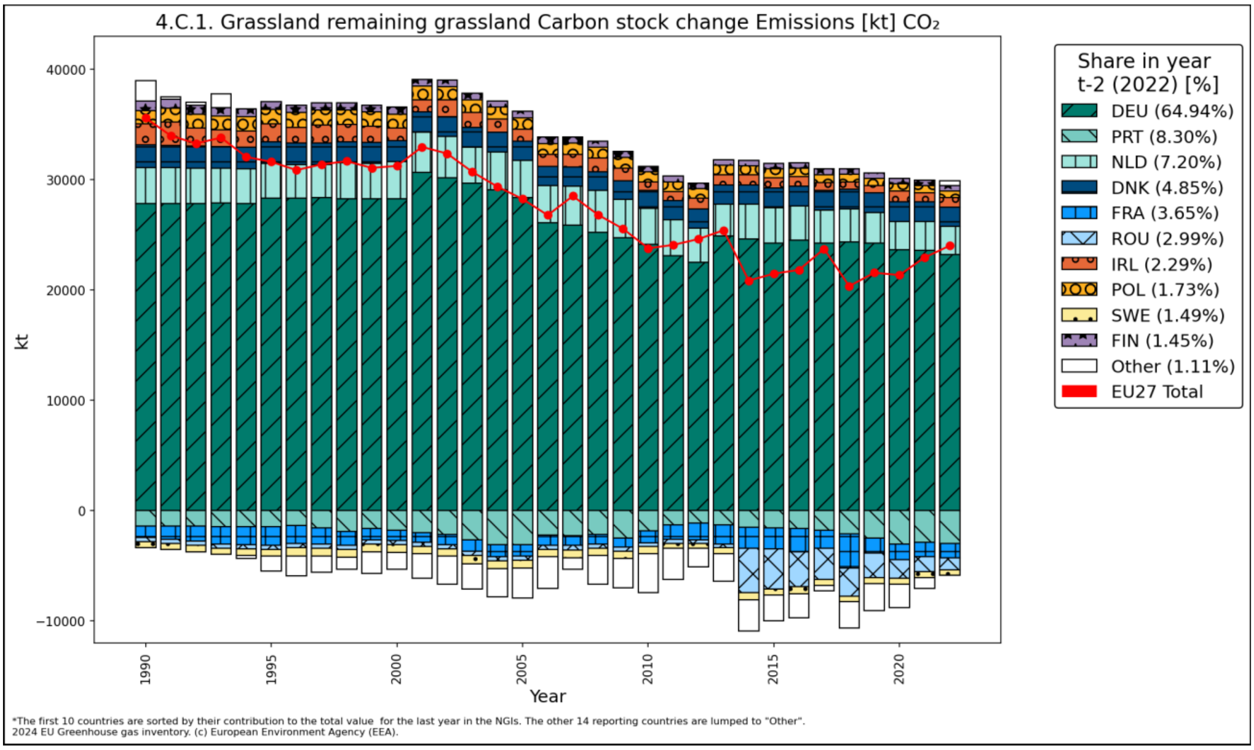
Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

The EU trend in emissions from this subcategory is largely affected by Germany, Italy, and Portugal (Table 6. 14). 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 Portugal that reports a significant carbon sink from woody vegetation and Romania that reports a carbon sink from mineral soils on grassland 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 (kt CO_2)



Methodological issues for Grassland remaining Grassland category

Despite different eco-regions and management approaches among the countries, Grassland definitions show a good match with the IPCC land use definition (Table 6. 5). 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 a 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 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. 14).

6.3.7.3 Land converted to Grassland (CRT 4C2)

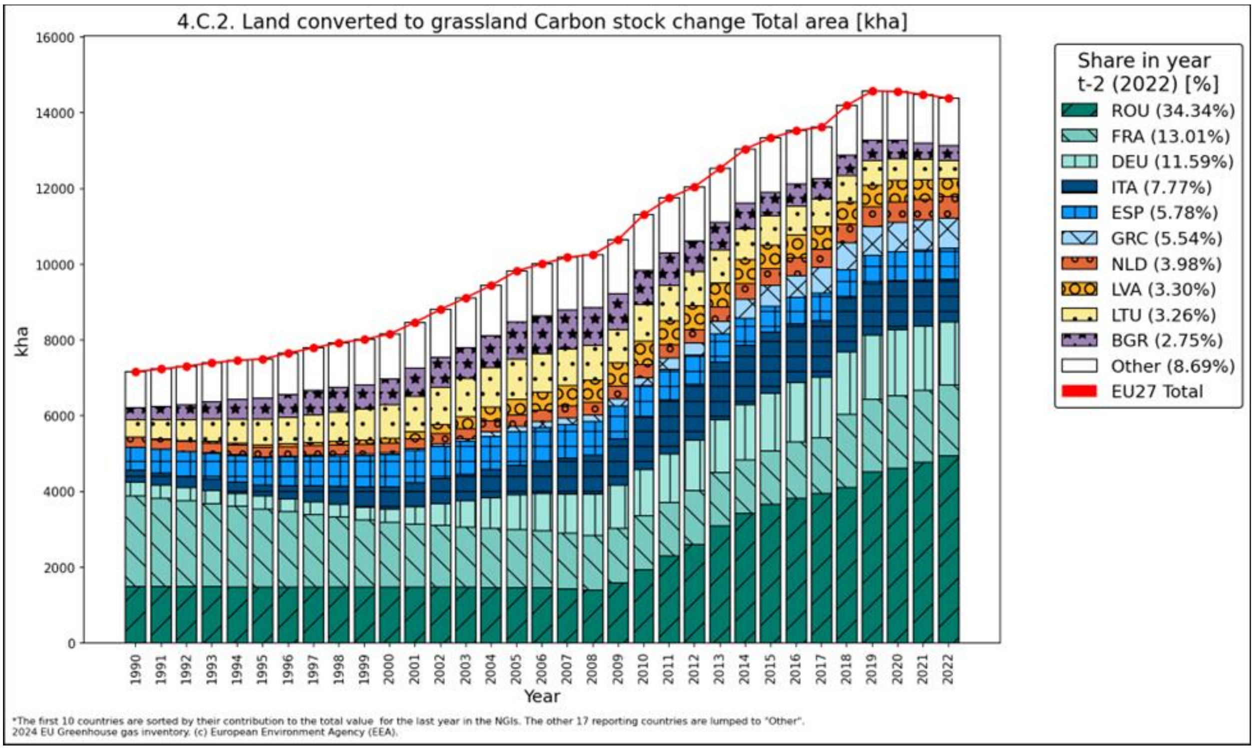
Overview of Land converted to Grassland category.

In terms of area, this subcategory represents 20% of the total grassland areas; however, the carbon sink reported offsets about 74% of the emissions resulting from grassland remaining grassland.

The area reported under this subcategory is about two times the area reported in 1990 under this category (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 and Germany, which together report about 60% of the total area converted to Grassland.

Figure 6. 13 Trend of activity data in subcategory 4C2 "Land converted to Grassland" in EU-27 (kha)



In terms of emissions, lands converted to Grassland represent in the current inventory year a total net sink of -11 595 kt CO_2, which corresponds to an increase of about 72% compared to the year 1990 (Table 6. 15).

The trend in GHG emissions for this subcategory is by far driven by Italy, and followed by Greece and Germany, in all cases, the net sink reported under this category is the result of carbon sequestration in mineral soils. By contrary, final net emissions, as reported for several countries, as for instance Latvia and Sweden, are associated with emissions from the conversion of Forest land, and to a lesser extent, from woody crops to Grassland.

Table 6. 15 4C2 Land converted to Grassland: EU contributions to the net CO_2 emissions (+)/removals (-) (CRT table 4)

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	393	141	140	-1.2%	-253	-64%	-1	-1%
Belgium	52	84	85	-0.7%	33	63%	2	2%
Bulgaria	-987	-704	-928	8.0%	59	6%	-224	-32%
Croatia	-10	-311	-304	2.6%	-294	-2959%	6	2%
Cyprus	0	2	2	0.0%	2	459%	0	0%
Czechia	-144	-185	-190	1.6%	-46	-32%	-5	-3%
Denmark	68	127	49	-0.4%	-19	-27%	-78	-61%
Estonia	0	-72	-73	0.6%	-72	-21414%	-1	-1%
Finland	168	251	249	-2.2%	82	49%	-1	0%
France	-4,152	419	447	-3.9%	4,599	111%	28	7%
Germany	67	-2,454	-2,031	17.5%	-2,098	-3137%	422	17%
Greece	0	-2,012	-2,041	17.6%	-2,041	#########	-29	-1%
Hungary	-4	209	41	-0.4%	45	1253%	-167	-80%
Ireland	3	10	9	-0.1%	7	229%	0	-4%
Italy	-1,124	-4,755	-4,335	37.4%	-3,211	-286%	420	9%
Latvia	8	1,009	964	-8.3%	956	11511%	-45	-4%
Lithuania	-614	-741	-669	5.8%	-55	-9%	72	10%
Luxembourg	-35	-28	-18	0.2%	17	49%	11	38%
Malta	-11	-3	-3	0.0%	8	73%	0	0%
Netherlands	-329	-137	-145	1.3%	184	56%	-8	-6%
Poland	-1,207	-997	-817	7.0%	391	32%	180	18%
Portugal	NO	-677	-610	5.3%	-610	-∞	67	10%
Romania	2,189	-517	-629	5.4%	-2,817	-129%	-112	-22%
Slovakia	-196	-55	-36	0.3%	160	81%	19	34%
Slovenia	-490	44	62	-0.5%	552	113%	18	41%
Spain	-786	-1,570	-1,630	14.1%	-845	-108%	-60	-4%
Sweden	403	193	815	-7.0%	412	102%	622	323%
EU-27	**-6,738**	**-12,731**	**-11,595**	**100%**	**-4,857**	**-72%**	**1,136**	**9%**

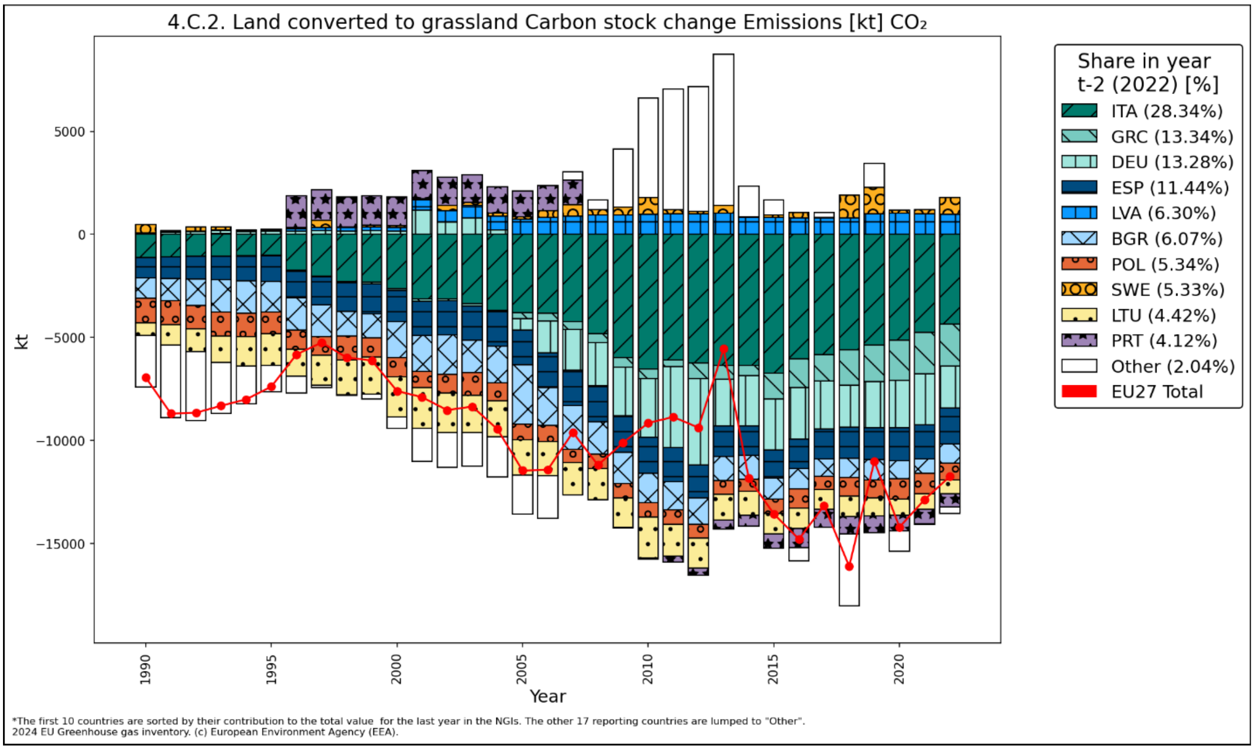
Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Major changes in the time series of emissions from Land converted to Grassland have been reported by France, Italy, and Romania, 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. 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.

The EU trend for this category reflects in the year 2013 the impact of the reporting of France that in 2021 has introduced a complete update of the methodology for land use change monitoring and for calculating carbon fluxes using a spatially explicit approach. This new method led to various recalculations, among others the area of deforestation, which is the main driver of the increase in the emissions for that year.

Figure 6. 14 Trend of emissions (+)/removals (-) in subcategory 4C2 "Land converted to Grassland" in EU 27 (kt CO_2)



Methodological issues for Land converted to Grassland category.

For estimating and reporting carbon stock 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.

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 occurs in managed grassland and as a result of the conversion to and from grasslands.

6.3.8 Category: Wetlands, Settlements and Other land (CRT Tables 4D, 4E, 4F)

6.3.8.1 Wetlands (CRT 4D)

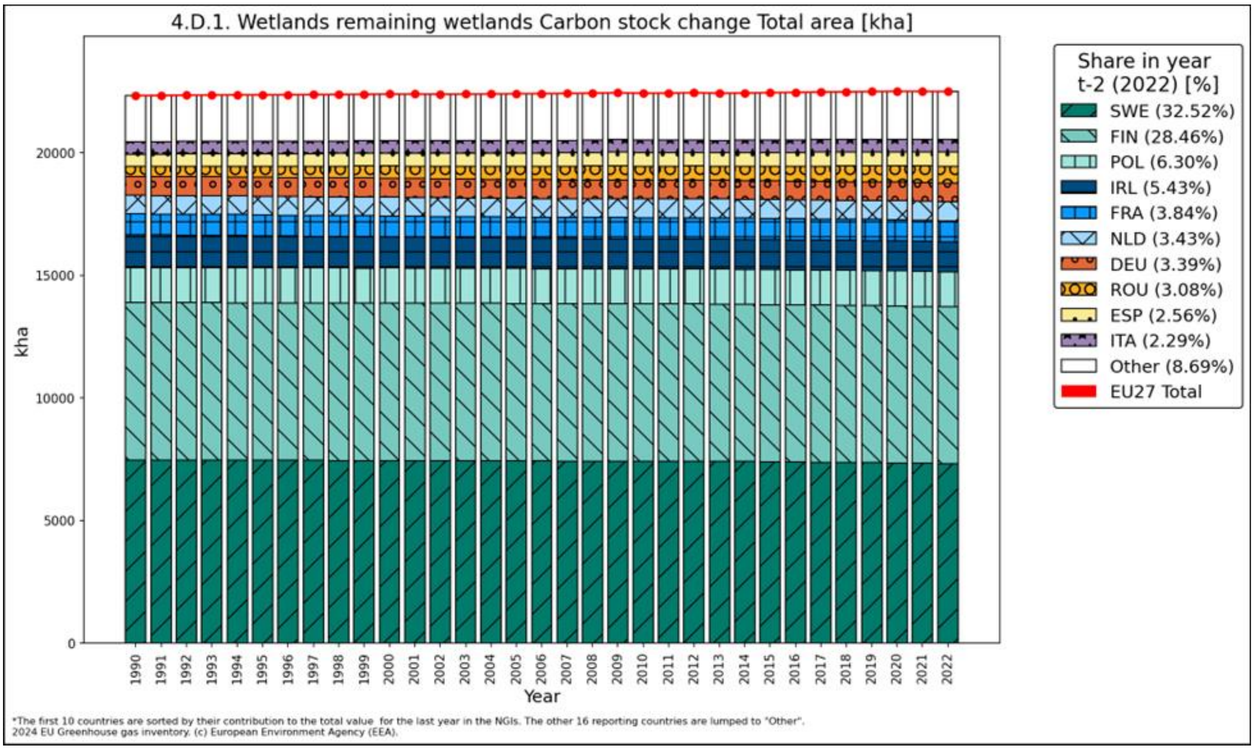
In terms of area, Wetlands represent 23 435 kha, which represents 6% of the total EU area. The category has shown a constant slight increase, resulting in about 2% more area in the reporting year, as compared to the base year.

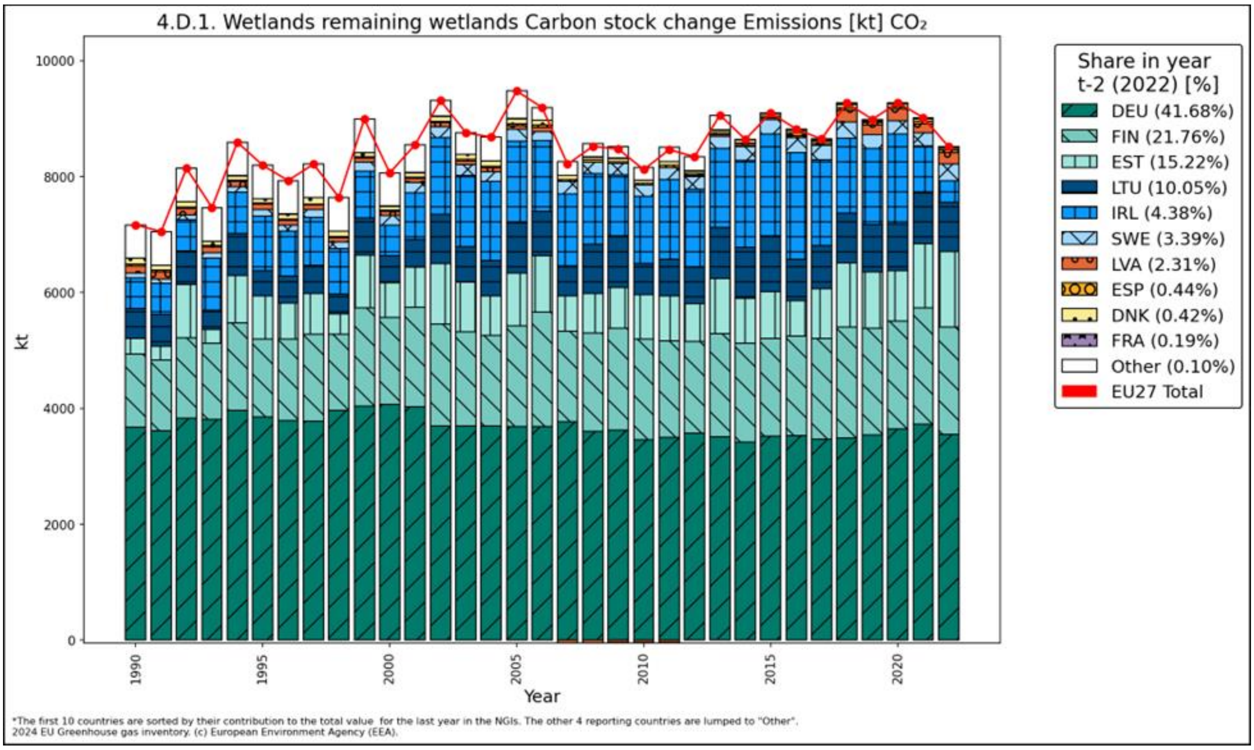
The trend in areas show a fairly constant area of Wetlands dominated by Sweden and Finland, and mainly for the dominant subcategory of Wetlands remaining Wetlands (Figure 6.15).

In terms of emissions, Wetlands remaining Wetlands reaches for this inventory year about 10 822 ktCO_2. Subcategories, 4D1 and 4D2, have been 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 in this category is indeed the occurrence of peat extraction areas, which even if affecting relatively small areas at country level has a big impact on the overall emissions from LULUCF. Within the EU, Germany, Finland, and Latvia are the main contributors of the emissions from Wetlands remaining wetlands (Table 6.16) .

Figure 6. 15 Trend of activity data and emissions (+)/removals (-) in subcategory 4D1 "Wetlands remaining Wetlands" in EU-27 (kha, Kt CO_2)





4.D.1. Wetlands remaining wetlands Carbon stock change Emissions [kt] CO_2
Share in year t-2 (2022) [%]
DEU (41.68%)
FIN (21.76%)
EST (15.22%)
LTU (10.05%)
IRL (4.38%)
SWE (3.39%)
LVA (2.31%)
ESP (0.44%)
DNK (0.42%)
FRA (0.19%)
Other (0.10%)
EU27 Total
kt
Year
*The first 10 countries are sorted by their contribution to the total value for the last year in the NGIs. The other 4 reporting countries are lumped to "Other".
2024 EU Greenhouse gas inventory. (c) European Environment Agency (EEA).

Table 6. 16 CO_2 Emissions and removals from 4.D.1 wetlands remaining wetlands contributions to the net CO_2 emissions (+)/removals (-) (CRT table 4)

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NA, NE, NO	NA, NE, NO	NA, NE, NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NE, NO	NE, NO	NE, NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NE, NO	NE, NO	NE, NO	-	-	-	-	-
Czechia	NA, NO	NA, NO	NA, NO	-	-	-	-	-
Denmark	100	43	36	0.3%	-64	-64%	-7	-16%
Estonia	267	1,110	1,297	12.0%	1,030	386%	187	17%
Finland	1,269	2,010	1,854	17.1%	585	46%	-156	-8%
France	NO	17	16	0.1%	16	∞	-1	-3%
Germany	3,671	3,725	3,551	32.8%	-120	-3%	-174	-5%
Greece	NE, NO	NE, NO	NE, NO	-	-	-	-	-
Hungary	195	60	73	0.7%	-122	-63%	13	21%
Ireland	1,780	1,587	1,143	10.6%	-637	-36%	-443	-28%
Italy	NE, NO	NE, NO	NE, NO	-	-	-	-	-
Latvia	986	1,399	1,658	15.3%	672	68%	259	19%
Lithuania	517	872	856	7.9%	339	66%	-16	-2%
Luxembourg	NA, NO	NA, NO	NA, NO	-	-	-	-	-
Malta	0	0	0	0.0%	0	-310%	0	0%
Netherlands	IE, NA, NO	IE, NA, NO	IE,NA,NO	-	-	-	-	-
Poland	578	12	12	0.1%	-566	-98%	0	0%
Portugal	NO	0	0	0.0%	0	∞	0	-8%
Romania	-3	NA, NO	NA, NO	-	3	100%	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NE, NO	NE, NO	NE, NO	-	-	-	-	-
Spain	31	37	37	0.3%	7	22%	0	0%
Sweden	75	220	289	2.7%	213	283%	69	31%
EU-27	**9,465**	**11,090**	**10,822**	**100%**	**1,356**	**14%**	**-268**	**-2%**

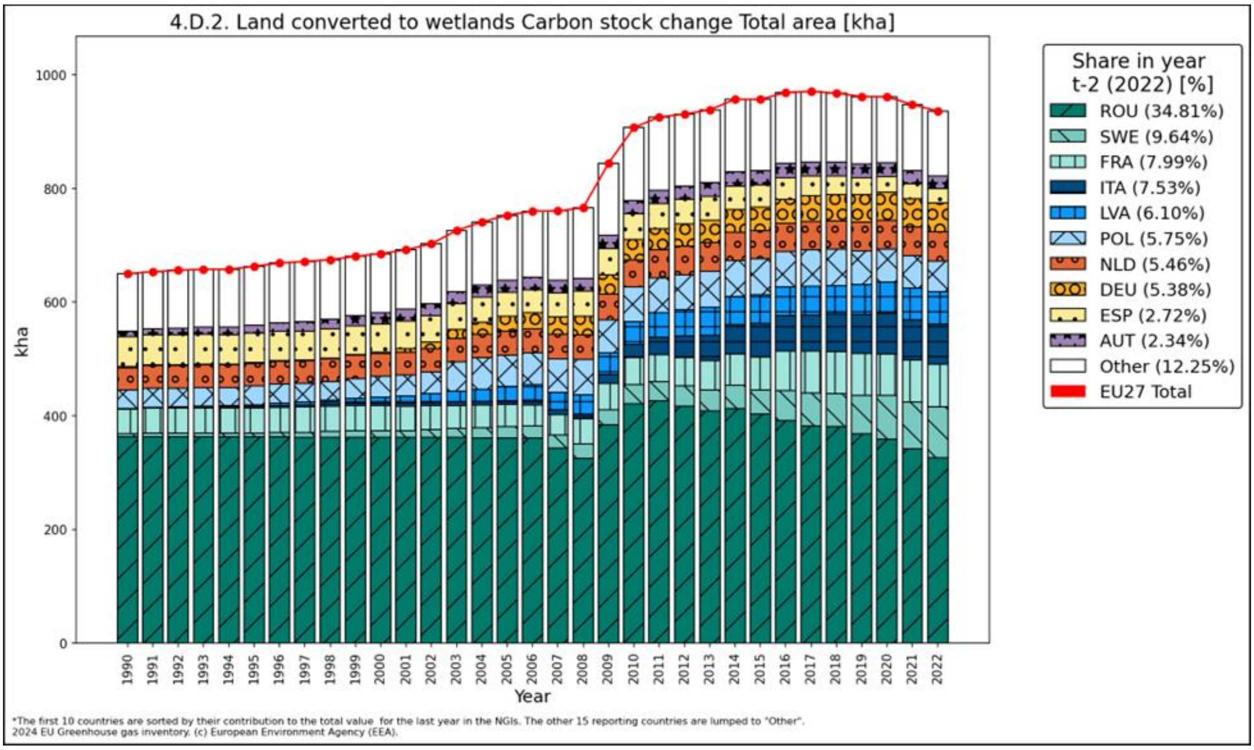
Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

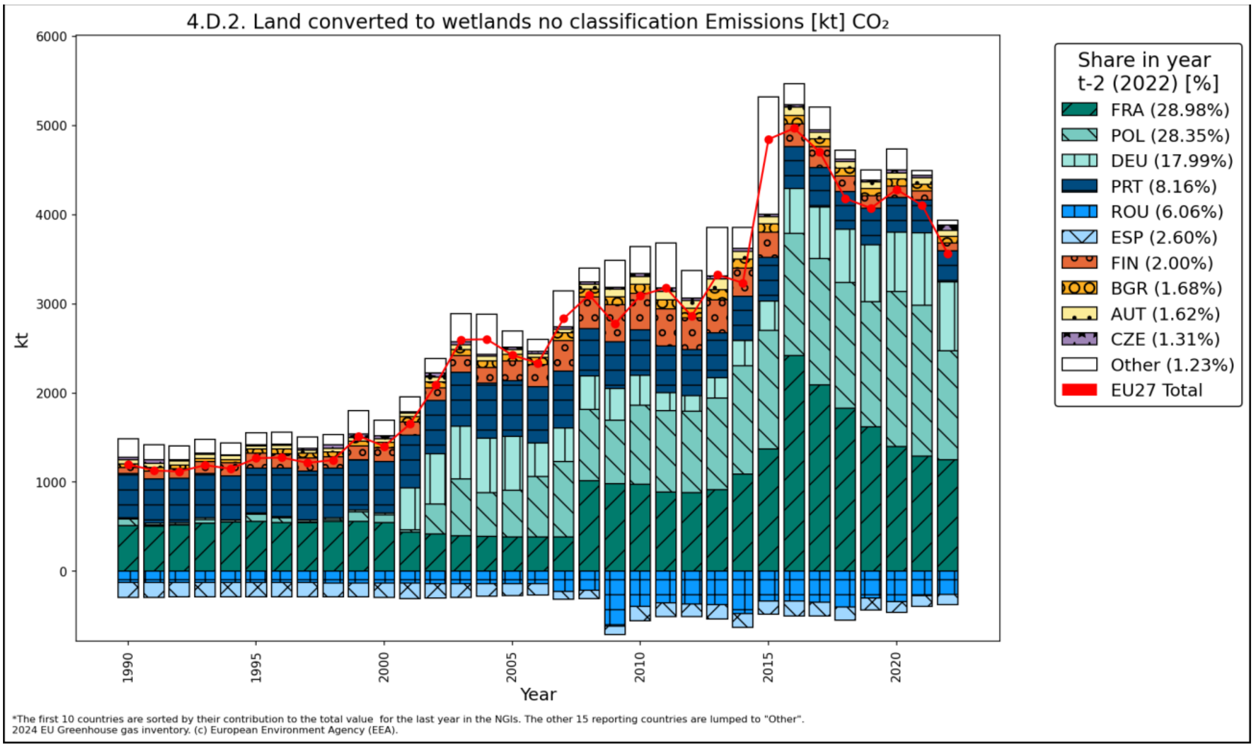
The other subcategory, Land converted to wetlands, represents only 4% of the wetlands area but results in about 25% of the final net emissions reported within the category. In terms of emissions this represents almost three times more than the reported emissions in the base year. The main driver is Poland that reports since 2001 a significant increase of land area in conversion to wetlands which, in particular, is done by clearing grassland.

The area of land converted to wetlands is dominated by Romania, Sweden and France. Overall, this area has increased as compared with 1990, mainly driven by new areas reported by Sweden, Italy and Latvia in the second half of the time series (Figure 6.18).

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. 18 Trend of activity data and emissions (+) / removals (-) in subcategory 4D2 "Lands converted to Wetlands" in EU (kha, Kt CO_2)





Emissions in this subcategory are mainly reported by Poland, France and Germany because of the loss of carbon from the living biomass existing in the lands that are converted to wetlands (Table 6.17).

Table 6. 17 CO_2 Emissions and removals from 4.D.2 land converted to wetlands contributions to the net CO_2 emissions (+)/removals (-) (CTF table 4)

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	48	70	70	2.0%	22	47%	0	0%
Belgium	11	-4	-4	-0.1%	-15	-140%	0	-7%
Bulgaria	40	76	72	2.0%	32	80%	-4	-5%
Croatia	77	12	12	0.3%	-65	-84%	1	4%
Cyprus	NO	0	0	0.0%	0	∞	0	0%
Czechia	24	26	57	1.6%	32	135%	30	114%
Denmark	0	-4	-2	-0.1%	-2	-3142%	2	44%
Estonia	6	10	8	0.2%	3	46%	-2	-17%
Finland	65	100	86	2.4%	21	32%	-14	-14%
France	516	1,293	1,249	35.1%	733	142%	-44	-3%
Germany	14	809	775	21.8%	761	5275%	-34	-4%
Greece	NO	2	1	0.0%	1	∞	-1	-62%
Hungary	3	-3	-3	-0.1%	-6	-198%	0	-6%
Ireland	IE,NO	10	10	0.3%	10	∞	0	-2%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	1	34	35	1.0%	34	5036%	1	4%
Lithuania	63	NA,NE,NO	NA,NE,NO	-	-63	-100%	-	-
Luxembourg	0	2	0	0.0%	0	43%	-2	-90%
Malta	0	NO	NO	-	0	100%	-	-
Netherlands	11	-44	-48	-1.4%	-59	-537%	-4	-9%
Poland	68	1,693	1,221	34.3%	1,153	1693%	-471	-28%
Portugal	501	370	352	9.9%	-149	-30%	-19	-5%
Romania	-121	-274	-261	-7.3%	-140	-116%	12	5%
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	40	42	44	1.2%	4	9%	2	4%
Spain	-169	-116	-112	-3.1%	56	33%	4	3%
Sweden	NA,NO	NA,NO	NA,NO	-	-	-	-	-
EU-27	**1,199**	**4,105**	**3,562**	**100%**	**2,363**	**197%**	**-543**	**-13%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Most of the unmanaged land reported in the EU is found in this category. This explains why countries with the largest share of areas do not always report the largest emissions. Also lack of IPCC methods prevents countries from reporting GHG fluxes in some cases.

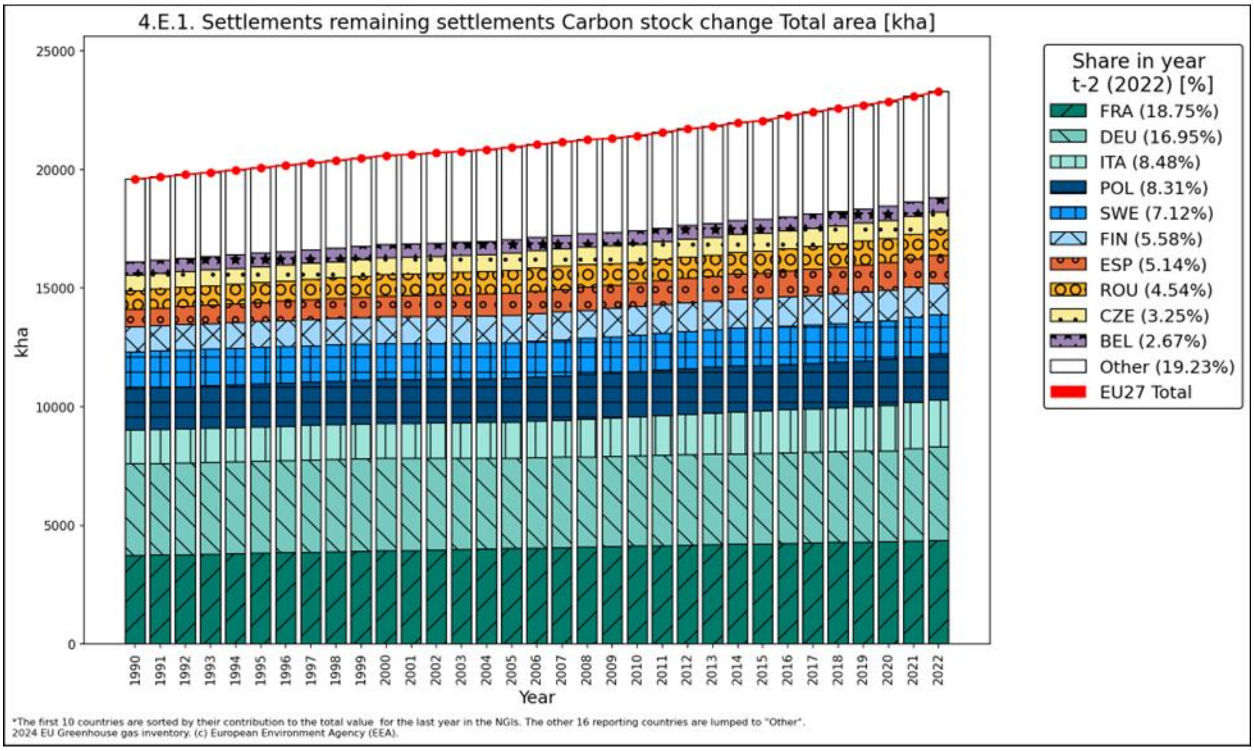
6.3.8.2 Settlements (CRT 4E)

In terms of area, this land use category represents 28 402 kha, which is 7% of the total reported area. For the year 2022, Settlements areas have resulted in an increase of 25% as compared with 1990.

In terms of emissions, this land use category is reported as a net source that reaches 25 799 kt CO_2 in 2022. Out of this, 93% are due to emissions resulting from Land converted to Settlement, which although in terms of area represents only 18% of the total category, results in significant emissions when forest, other woody lands, or high-carbon content soils are converted to urban areas.

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 CRT tables. Nevertheless, a few countries have reported this subcategory as a net source of GHG emissions due to disturbed soils or net removals due to accumulation of living biomass.

Figure 6.19 Trend of activity data and emissions (+)/removals (-) in subcategory 4E1 "Settlements remaining Settlements" in EU (kha, kt CO_2)



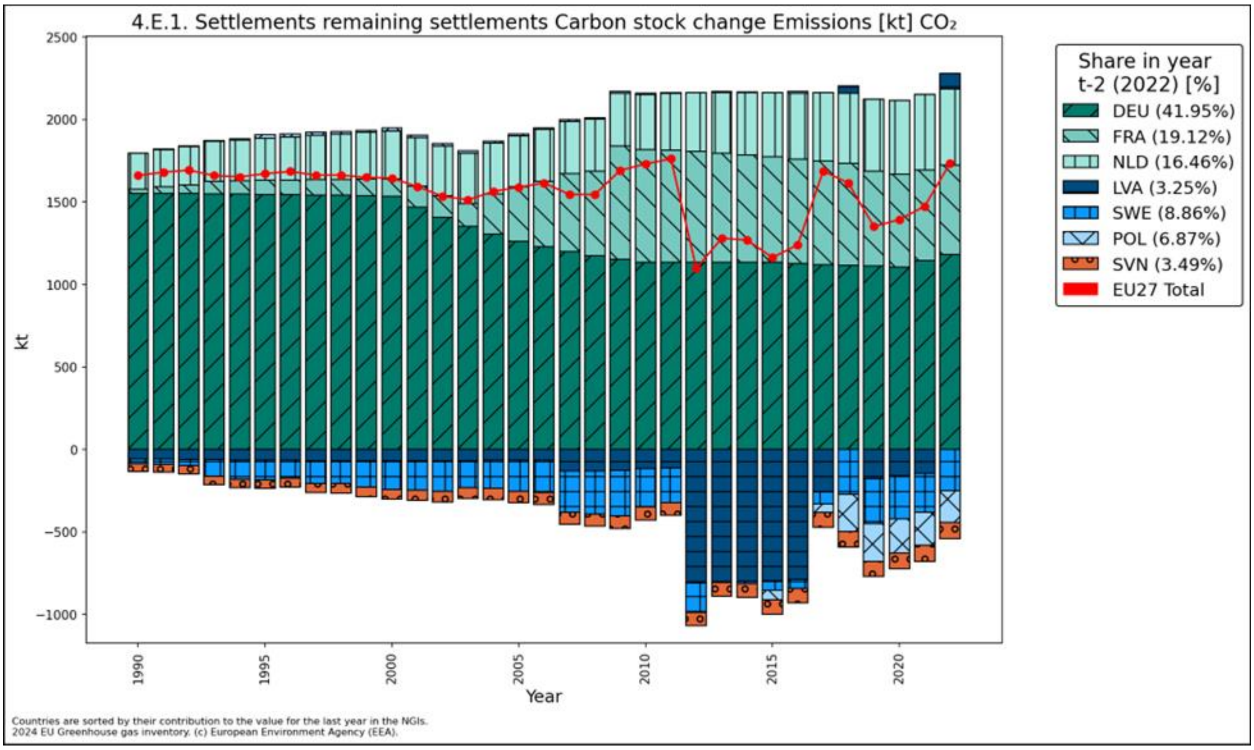
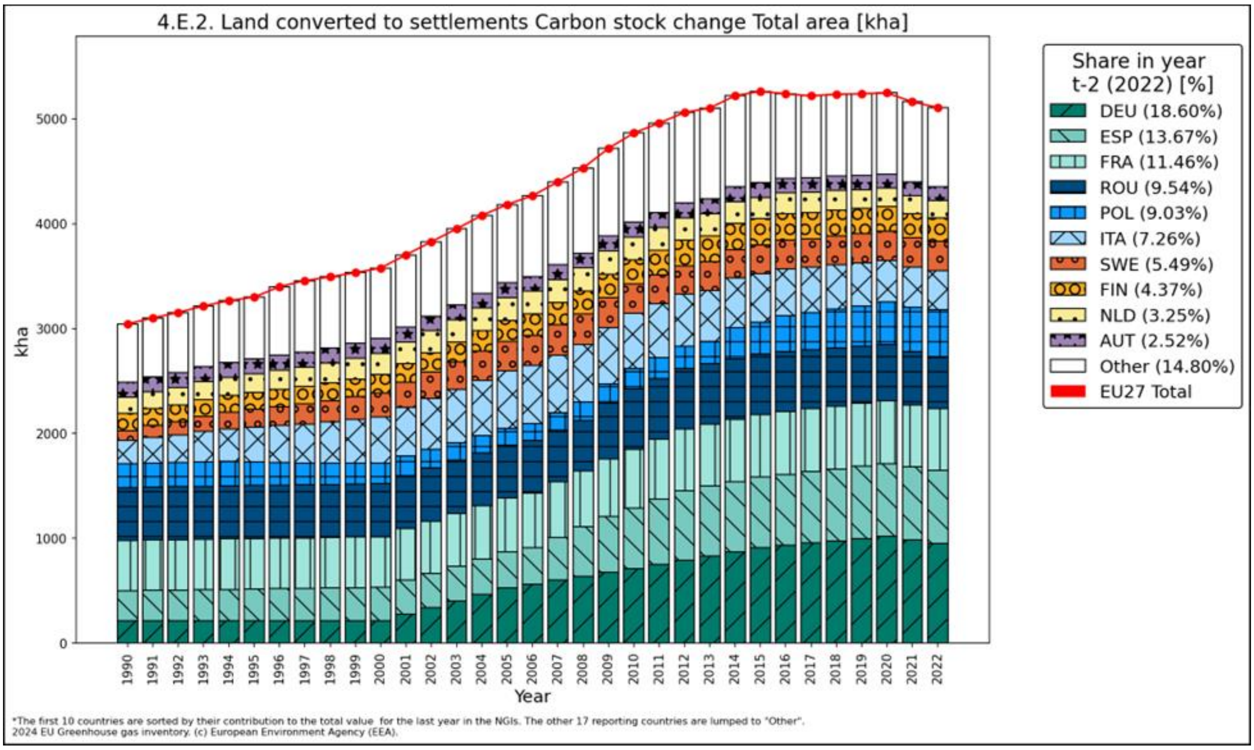
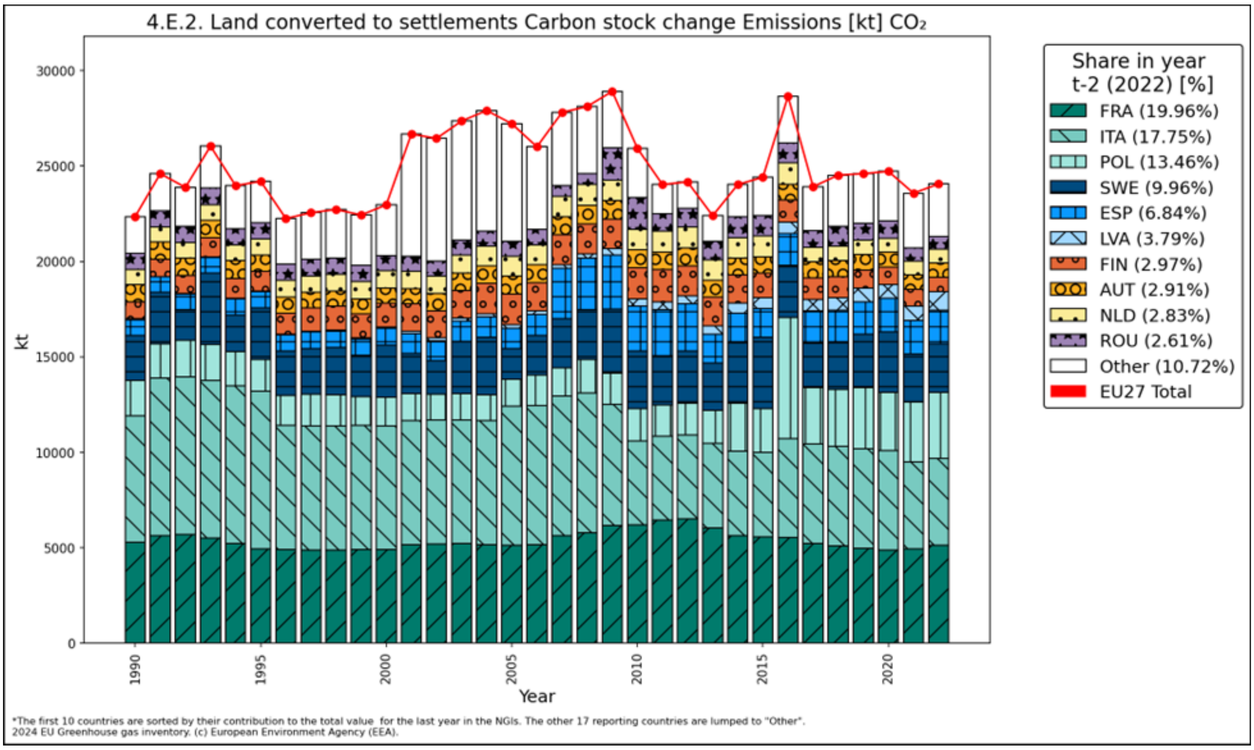


Figure 6.20 **Trend of activity data and emissions (+)/removals (-) in subcategory 4E2 "Land converted to Settlements" in EU-27 kha, kt CO_2)**





Regarding subcategory 4E2, annual emissions from Land converted to Settlements have increased by 8% since 1990 (Table 6.18). For the year 2022 this subcategory was reported as a net source of emissions, reaching 24 064 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. 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.

While conversions to Wetland or Other land may be caused by natural effects, a conversion to Settlement is 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. 18 4E2 Land converted to Settlements: EU-27 contributions to the net CO_2 emissions (+)/removals (-) (CRT table 4)

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	917	758	746	3.1%	-171	-19%	-12	-2%
Belgium	144	512	515	2.1%	371	258%	3	1%
Bulgaria	101	138	162	0.7%	61	60%	24	17%
Croatia	235	629	586	2.4%	350	149%	-43	-7%
Cyprus	0	4	3	0.0%	3	600%	0	-9%
Czechia	319	245	195	0.8%	-124	-39%	-50	-20%
Denmark	414	277	330	1.4%	-84	-20%	52	19%
Estonia	NE,NO	361	309	1.3%	309	∞	-53	-15%
Finland	858	857	762	3.2%	-96	-11%	-95	-11%
France	5,281	4,947	5,120	21.3%	-161	-3%	172	3%
Germany	-346	-817	-793	-3.3%	-447	-129%	24	3%
Greece	50	125	130	0.5%	80	161%	5	4%
Hungary	96	154	171	0.7%	76	79%	17	11%
Ireland	60	110	144	0.6%	84	139%	34	31%
Italy	6,640	4,550	4,553	18.9%	-2,086	-31%	3	0%
Latvia	81	766	973	4.0%	892	1101%	206	27%
Lithuania	5	638	512	2.1%	507	9853%	-125	-20%
Luxembourg	29	40	23	0.1%	-7	-23%	-17	-43%
Malta	2	2	2	0.0%	0	10%	0	0%
Netherlands	786	732	727	3.0%	-59	-7%	-5	-1%
Poland	1,851	3,131	3,453	14.3%	1,601	86%	322	10%
Portugal	271	96	106	0.4%	-165	-61%	10	11%
Romania	850	677	669	2.8%	-181	-21%	-8	-1%
Slovakia	97	86	80	0.3%	-16	-17%	-6	-7%
Slovenia	462	283	276	1.1%	-186	-40%	-7	-2%
Spain	801	1,744	1,755	7.3%	955	119%	11	1%
Sweden	2,354	2,533	2,555	10.6%	201	9%	23	1%
EU-27	**22,357**	**23,577**	**24,064**	**100%**	**1,707**	**8%**	**487**	**2%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period.
Abbreviations are explained in the Chapter 'Units and abbreviations'.

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. 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%).

6.3.8.3 Other land (CRT 4F)

The land use category Other land reached in this reporting year 9 258 Kha, which represents about 2% 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.

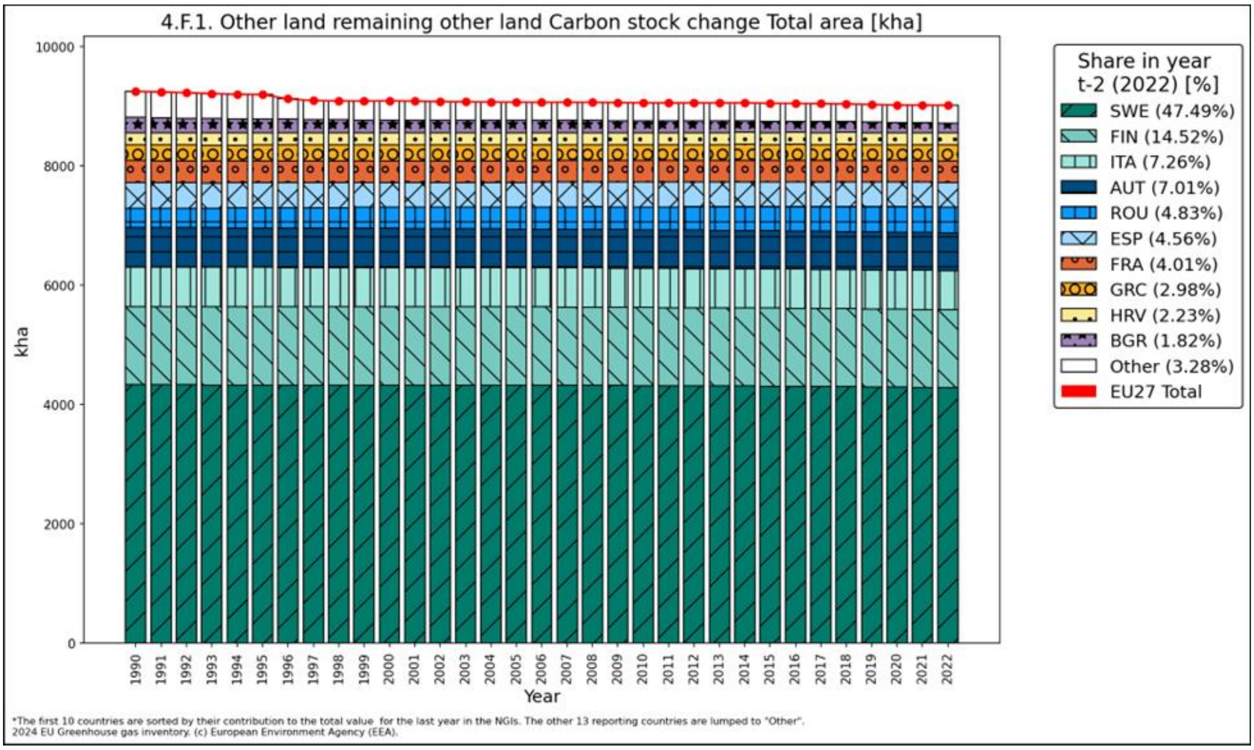
The largest areas under the category 4F1 are reported by Sweden (Figure 21), while new Other lands areas in the subcategory 4F2 are mainly reported by Poland, Romania and Slovakia (Figure 6.22).

In terms of emissions, the trend is driven by Austria, Netherlands, and France (Figure 6.22).

Definitions of Other land are close to each other among countries and overall match the IPCC general description (Table 6.8). In most 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.

In terms of emissions, Other land represents a small source of emissions of 1 132 Kt CO_2. Countries generally report emissions as a result of carbon oxidation from living biomass and soils when lands are converted to Other land.

Figure 6.21 Trend of activity data in subcategories 4F1 and 4F2 "Other land remaining Other Land" and "Land converted to Other land" in EU (kha)



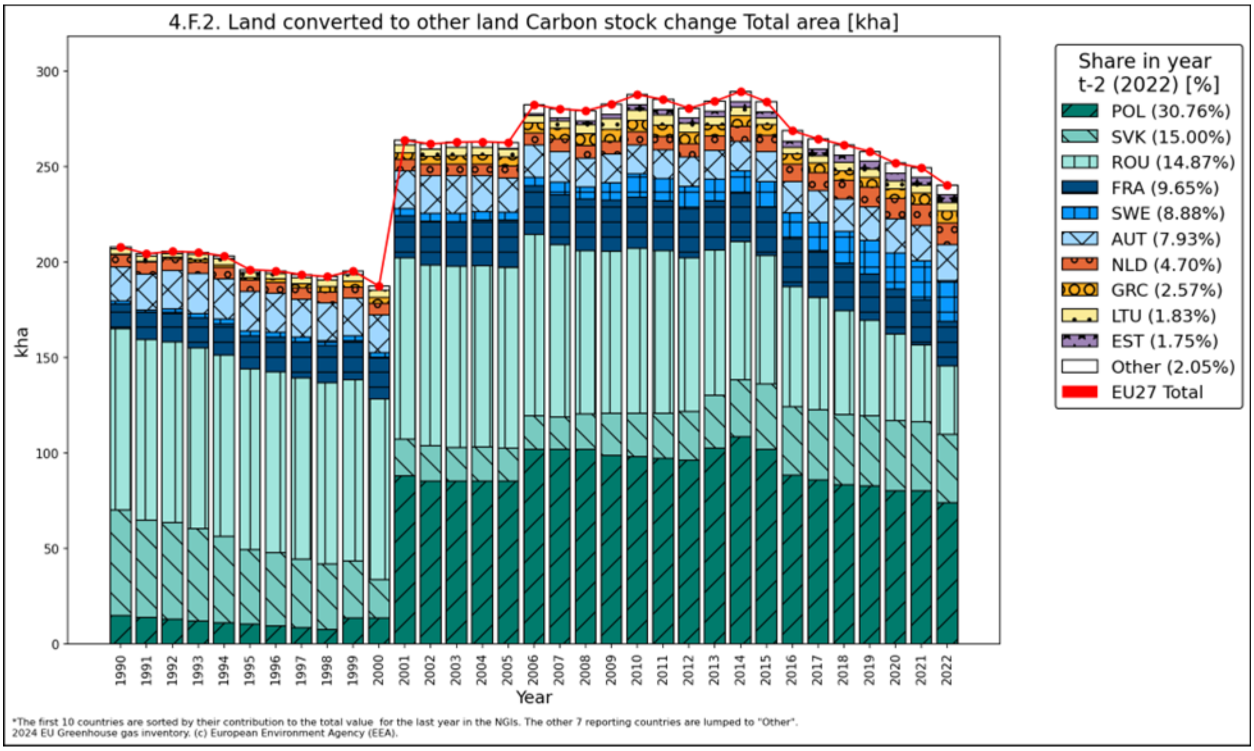
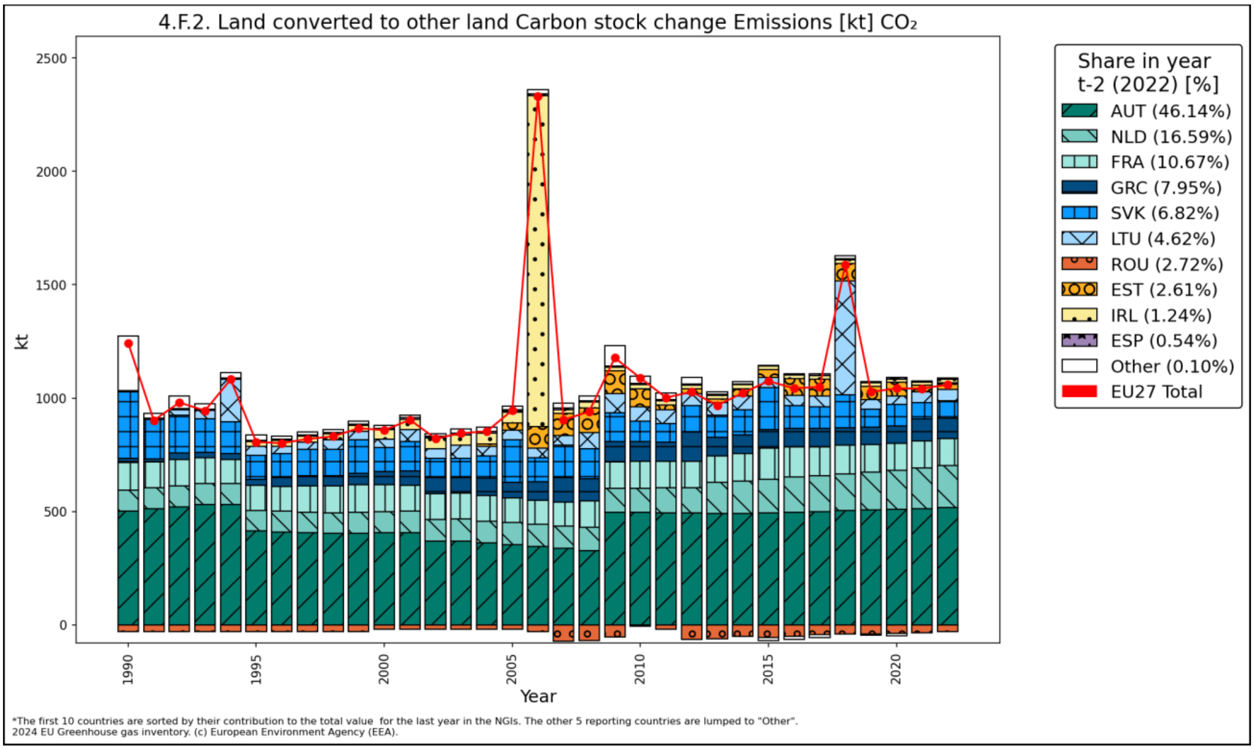


Figure 6.22 Trend of emissions (+)/removals (-) in subcategory 4F2, "Land converted to Other lands" in EU-27 (kt CO_2)



6.3.9 Harvested wood products (CRT 4.G)

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) arising from previous years production.

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 a net carbon sink of –39 739 kt CO_2 in the current inventory year (table 6.19 and 6.19a). Most of the countries reported this carbon pool as a net sink; however, some countries, and for certain years, reported this pool as a net source. The main contributors to the carbon sink are Sweden, Poland and Germany.

The methods and data sources for estimating carbon stock changes in HWPs are consistent with methodologies provided by 2006 IPCC GL. Individual inventories implement 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 and subsequently according to EU Regulations No 2018/841. This implies that only HWP from domestic harvested wood is reported as an inflow to the HWP pool,

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. 19 4Gs1 harvested wood products: EU-27 contributions to the net CO_2 emissions (+)/removals (-) (CRT table 4)

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	-3,122	-1,889	-2,110	5.4%	1,012	32%	-221	-12%
Belgium	-1,516	157	11	0.0%	1,527	101%	-146	-93%
Bulgaria	-583	-1,209	-970	2.5%	-387	-66%	239	20%
Croatia	-318	-656	-393	1.0%	-75	-24%	263	40%
Cyprus	2	20	20	-0.1%	18	846%	0	1%
Czechia	-1,680	-2,390	-1,946	4.9%	-266	-16%	444	19%
Denmark	-	-	-	-	-	-	-	-
Estonia	-156	-932	-642	1.6%	-485	-311%	291	31%
Finland	-2,952	-3,719	-3,251	8.3%	-299	-10%	468	13%
France	-5,401	-1,750	-1,086	2.8%	4,315	80%	664	38%
Germany	-1,330	-7,178	-3,984	10.1%	-2,654	-199%	3,194	44%
Greece	-349	28	28	-0.1%	377	108%	0	-1%
Hungary	-315	-933	-916	2.3%	-600	-191%	18	2%
Ireland	-413	-963	-866	2.2%	-453	-110%	97	10%
Italy	-	-	-	-	-	-	-	-
Latvia	-166	-2,603	-3,002	7.6%	-2,835	-1707%	-398	-15%
Lithuania	-242	-1,229	-1,467	3.7%	-1,226	-508%	-239	-19%
Luxembourg	2	-9	-4	0.0%	-6	-283%	5	58%
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	-69	125	130	-0.3%	199	290%	5	4%
Poland	-459	-5,384	-4,702	12.0%	-4,243	-924%	682	13%
Portugal	-2,127	-253	-270	0.7%	1,857	87%	-17	-7%
Romania	354	-3,300	-2,356	6.0%	-2,711	-765%	943	29%
Slovakia	-470	-382	-144	0.4%	327	69%	238	62%
Slovenia	-67	-195	-305	0.8%	-238	-355%	-110	-56%
Spain	-2,020	-2,488	-2,725	6.9%	-705	-35%	-237	-10%
Sweden	-5,007	-8,843	-8,392	21.3%	-3,385	-68%	452	5%
EU-27	**-28,404**	**-45,976**	**-39,341**	**100%**	**-10,937**	**-39%**	**6,635**	**14%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 6. 19a CRT 4 harvested wood products: EU Member States contributions to the net CO_2 emissions (+)/removals (-) (CRT table 4)

Member State	CO_2 Emissions in ktCO_2 equiv.			Share in EU Emissions in 2022	Change in 1990-2022		Change 2021-2022	
	1990	2021	2022		Kt CO_2 equiv.	%	Kt CO_2 equiv.	%
Denmark	-2	-56	-98	0	-96	4030	-42	75
Italy	-388	-361	-300	1	88	-23	61	-17
EU-27	-28,974	-46,393	-39,739	100	-10,944	38	6,654	-14

Note: Due to problems with data in the JSON files, Denmark and Italy are not included in the table above. The values here have been extracted from the CRT table 4.

6.3.10 Other sources of emissions: Tables 4(I)-4(IV)

6.3.10.1 Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (CRT Table 4(I))

Under CRT table 4(I) countries report 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.

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 80 kt CO_2 equivalents, which is about 8% less than in 1990.

Table 6. 20 4 LULUCF Direct nitrous oxide (N_2O) emissions from nitrogen (N) inputs to managed soils (kt CO_2 eq.)

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	-	-	-	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	-	-	-	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	-	-	-	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-
Finland	18	27	5	2.2%	-13	-71%	-21	-80%
France	-	-	-	-	-	-	-	-
Germany	NO	NO	NO	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	-	-	-	-	-	-	-	-
Ireland	IE	IE	IE	-	-	-	-	-
Italy	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Latvia	IE	IE	IE	-	-	-	-	-
Lithuania	NO	NO	NO	-	-	-	-	-
Luxembourg	-	-	-	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	NO	NO	NO	-	-	-	-	-
Poland	312	217	230	95.2%	-82	-26%	13	6%
Portugal	-	-	-	-	-	-	-	-
Romania	IE	IE	IE	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	NO	NO	NO	-	-	-	-	-
Sweden	44	27	6	2.6%	-37	-86%	-20	-77%
EU-27	**374**	**270**	**242**	**100%**	**-133**	**-35%**	**-28**	**-10%**

Note: Due to problems with the files not all notation keys have been uploaded. No values are missing.

Indirect N_2O emissions reported in table CRT 4(I) from atmospheric deposition of N volatilized soils from agricultural input of N and from N leaching/runoff from managed soils. Only six Member States report on these emissions in 2022 and it amounted to 633 ktCO_2e. The Member States that report these emissions are Germany, France, Latvia, Portugal, Slovakia and Sweden. Due to problems with the files these values have been collated manually from countries CRT 4(I).

6.3.10.2 Emissions and removals from drainage and rewetting and other management of organic and mineral soils (CRT Table 4(II))

Under CRT 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 CRT tables 4.A to 4.F).

For this year, total emissions from this source reached 22 779 kt CO_2 equivalent (tables 6.21, 6.22 and 6.23) that occurred mostly in organic soils and that are mainly reported by Finland, Germany, Ireland Sweden, Lithuania, and Latvia.

Table 6. 21 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	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	179	97	92	1.9%	-86	-48%	-4	-5%
Estonia	IE,NE,NO	IE,NE,NO	IE,NE,NO	-	-	-	-	-
Finland	IE,NA	IE,NA	IE,NA	-	-	-	-	-
France	224	224	224	4.7%	0	0%	0	0%
Germany	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Greece	NO	NO	NO	-	-	-	-	-
Hungary	196	64	76	1.6%	-120	-61%	13	20%
Ireland	1,197	1,055	1,053	22.1%	-144	-12%	-1	0%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	856	1,359	1,590	33.4%	734	86%	231	17%
Lithuania	1,848	1,500	1,527	32.0%	-321	-17%	28	2%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	E,NA,NE,NO	E,NA,NE,NO	E,NA,NE,NO	-	-	-	-	-
Poland	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	204	204	204	4.3%	0	0%	0	0%
Slovakia	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0	0	0	0.0%	0	22%	0	0%
Sweden	IE,NA	IE,NA	IE,NA	-	-	-	-	-
EU-27	**4,704**	**4,502**	**4,767**	**100%**	**63**	**1%**	**266**	**6%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 6. 22 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	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	NO	NO	NO	-	-	-	-	-
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	29	21	21	0.5%	-8	-28%	0	0%
Estonia	238	243	243	5.5%	5	2%	0	0%
Finland	1,451	1,729	1,728	39.2%	277	19%	0	0%
France	NO	NO	NO	-	-	-	-	-
Germany	586	611	612	13.9%	26	4%	1	0%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	0	0	0	0.0%	0	106%	0	0%
Ireland	166	244	241	5.5%	75	45%	-3	-1%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	483	512	508	11.5%	25	5%	-5	-1%
Lithuania	30	30	31	0.7%	0	1%	0	0%
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	1	1	1	0.0%	0	-5%	0	-1%
Poland	4	5	5	0.1%	1	36%	0	0%
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NO	NO	NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0	0	0	0.0%	0	22%	0	0%
Sweden	1,016	1,016	1,024	23.2%	8	1%	8	1%
EU-27	**4,004**	**4,414**	**4,415**	**100%**	**411**	**10%**	**1**	**0%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'

Table 6. 23 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	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	27	27	27	0.2%	0	0%	0	0%
Belgium	NO	NO	NO	-	-	-	-	-
Bulgaria	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Croatia	NO	NO	NO	-	-	-	-	-
Cyprus	NO	NO	NO	-	-	-	-	-
Czechia	NO	NO	NO	-	-	-	-	-
Denmark	294	306	311	2.3%	17	6%	6	2%
Estonia	72	75	75	0.6%	2	3%	0	0%
Finland	1,690	851	848	6.2%	-843	-50%	-3	0%
France	12	12	12	0.1%	0	0%	0	0%
Germany	6,184	6,441	6,463	47.5%	279	5%	22	0%
Greece	NO	NO	NO	-	-	-	-	-
Hungary	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Ireland	4,003	3,817	3,930	28.9%	-73	-2%	113	3%
Italy	NO	NO	NO	-	-	-	-	-
Latvia	495	849	877	6.4%	382	77%	28	3%
Lithuania	NA,NE,NO	NA,NE,NO	NA,NE,NO	-	-	-	-	-
Luxembourg	NO	NO	NO	-	-	-	-	-
Malta	0	NO	NO	-	0	-100%	-	-
Netherlands	598	595	593	4.4%	-5	-1%	-2	0%
Poland	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Portugal	NO	NO	NO	-	-	-	-	-
Romania	NA,NO	NA,NO	NA,NO	-	-	-	-	-
Slovakia	NO	NO	NO	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-
Spain	0	0	0	0.0%	0	22%	0	0%
Sweden	537	456	463	3.4%	-74	-14%	7	2%
EU-27	**13,911**	**13,427**	**13,597**	**100%**	**-313**	**-2%**	**170**	**1%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'

6.3.10.3 Direct nitrous oxide and indirect (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 (CRT Table 4(III))

Under CRT 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 4 208 kt CO_2 equivalent, which represent an increase of 14% as compared to 1990. Significant emissions under this category are reported by Poland, Germany and Italy (Table 6.24 and 6.24a) and in most of the cases they were estimated using IPCC methodologies and default emissions factors. Note that due to some problems with the JSON file, an additional table is added below with the countries missing in table 6.24.

Table 6. 24 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_2 eq.)

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	131	118	118	3.5%	-13	-10%	0	0%
Belgium	5	89	90	2.7%	85	1833%	1	1%
Bulgaria	53	86	86	2.6%	33	61%	0	0%
Croatia	44	156	149	4.5%	105	238%	-8	-5%
Cyprus	0	1	1	0.0%	1	6712%	0	-12%
Czechia	10	3	3	0.1%	-7	-71%	0	6%
Denmark	-	-	-	-	-	-	-	-
Estonia	0	21	21	0.6%	21	90878%	0	2%
Finland	27	26	25	0.7%	-2	-7%	-1	-5%
France	-	-	-	-	-	-	-	-
Germany	385	552	544	16.4%	159	41%	-8	-1%
Greece	1	14	14	0.4%	13	1097%	0	1%
Hungary	-	-	-	-	-	-	-	-
Ireland	8	159	152	4.6%	145	1910%	-6	-4%
Italy	-	-	-	-	-	-	-	-
Latvia	NA,NO	53	58	1.7%	58	∞	5	10%
Lithuania	-	-	-	-	-	-	-	-
Luxembourg	7	6	2	0.1%	-5	-69%	-4	-65%
Malta	0	1	1	0.0%	0	80%	0	-2%
Netherlands	-	-	-	-	-	-	-	-
Poland	1 544	1 816	1 826	54.9%	282	18%	10	1%
Portugal	-	-	-	-	-	-	-	-
Romania	195	66	69	2.1%	-126	-65%	3	4%
Slovakia	98	17	17	0.5%	-81	-83%	-1	-3%
Slovenia	-	-	-	-	-	-	-	-
Spain	219	158	153	4.6%	-66	-30%	-6	-4%
Sweden	-	-	-	-	-	-	-	-
EU-27	**2 725**	**3 341**	**3 327**	**100%**	**601**	**22%**	**-15**	**0%**

Table 6. 24a 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_2 eq.)

Member State	N_2O emissions in ktCO_2 equiv.			Share in EU Emissions in 2022	Change in 1990-2022		Change 2021-2022	
	1990	2021	2022		Kt CO_2 equiv.	%	Kt CO_2 equiv.	%
Denmark	38	17	17	0	-20	-54	1	4
Hungary	43	76	75	2	31	75	-1	-1
Italy	531	363	363	9	-168	-32	0	0
Lithuania	65	95	84	2	19	29	-11	-12
Netherlands	96	82	83	2	-13	-13	2	2

Portugal	116	156	149	4	29	29	-7	-4
Slovenia	63	35	35	1	-45	-45	-1	-2
Sweden	25	75	75	2	197	197	0	-1
EU-27	3 703	4 239	4 208	100	504	14	-32	-1

Indirect N_2O emissions reported in table 4(III) have been reported by 14 Member States in 2022 and amounts to 148 ktCO_2e. The 14 Member States are Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Spain, Estonia, Finland, Hungary, Italy, Lithuania, Luxembourg, Latvia and Slovenia, with Hungary reporting 38% of the total.

6.3.10.4 CO_2, CH_4 & N_2O emissions from Biomass Burning (CRT Table 4(IV))

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 CRT table 4(IV), 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 and Sweden in forest lands and Spain 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 2022 compared to 1990, reaching in this inventory year 12 572 kt CO_2 equivalent (Table 6.26 , Table 6.27 and Table 6.28). However, emissions from biomass burning do not show a clear trend since their occurrence is in many cases 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. 26 **CO_2 emissions from Biomass Burning (in kt CO_2)**

Member State	CO_2 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-
Belgium	IE,NO	7	NO	-	-	-	-7	-100%
Bulgaria	IE,NE,NO	IE,NE,NO	IE,NE,NO	-	-	-	-	-
Croatia	15	57	382	3.8%	367	2451%	325	575%
Cyprus	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Czechia	16	49	203	2.0%	187	1165%	154	313%
Denmark	IE,NA	IE,NA,NO	IE,NA,NO	-	-	-	-	-
Estonia	IE,NE,NO	IE,NE,NO	IE,NE,NO	-	-	-	-	-
Finland	0	0	0	0.0%	0	-74%	0	2096%
France	2,629	459	3,091	30.7%	462	18%	2,633	574%
Germany	IE,NO	IE,NO	IE,NO	-	-	-	-	-
Greece	IE,NO	0	0	0.0%	0	∞	0	-69%
Hungary	IE,NA,NO	IE,NA,NO	IE,NA,NO	-	-	-	-	-
Ireland	480	70	70	0.7%	-410	-85%	0	0%
Italy	5,072	2,283	1,906	19.0%	-3,166	-62%	-377	-17%
Latvia	23	64	29	0.3%	6	24%	-35	-55%
Lithuania	1	0	0	0.0%	-1	-68%	0	223%
Luxembourg	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	5	7	7	0.1%	2	47%	0	1%
Poland	107	18	23	0.2%	-83	-78%	5	28%
Portugal	11,389	3,278	3,408	33.9%	-7,981	-70%	130	4%
Romania	9	42	271	2.7%	261	2783%	228	539%
Slovakia	47	48	361	3.6%	314	672%	313	654%
Slovenia	15	1	109	1.1%	94	620%	108	10070%
Spain	546	149	192	1.9%	-354	-65%	43	29%
Sweden	-	-	-	-	-	-	-	-
EU-27	**20,355**	**6,533**	**10,053**	**100%**	**-10,302**	**-51%**	**3,520**	**54%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'

Table 6. 27 **CH_4 emissions from Biomass Burning (in kt CO_2 eq.)**

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	1	0	1	0.0%	0	42%	0	50%
Belgium	0	0	NO	-	0	-100%	0	-100%
Bulgaria	3	8	21	1.2%	18	681%	13	159%
Croatia	1	7	37	2.1%	36	2596%	31	469%
Cyprus	0	5	0	0.0%	0	745%	-5	-95%
Czechia	19	9	21	1.2%	1	6%	12	139%
Denmark	1	0	0	0.0%	-1	-98%	0	22%
Estonia	0	0	0	0.0%	0	-93%	0	-66%
Finland	3	1	1	0.0%	-3	-82%	0	-44%
France	618	479	587	33.2%	-31	-5%	108	22%
Germany	10	1	21	1.2%	11	112%	20	1986%
Greece	70	154	62	3.5%	-8	-12%	-92	-60%
Hungary	22	13	73	4.1%	51	227%	60	445%
Ireland	98	14	14	0.8%	-84	-86%	0	0%
Italy	720	489	358	20.3%	-362	-50%	-131	-27%
Latvia	28	16	12	0.7%	-16	-56%	-3	-21%
Lithuania	3	0	0	0.0%	-3	-88%	0	199%
Luxembourg	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	0	1	1	0.0%	0	49%	0	1%
Poland	55	8	27	1.5%	-28	-50%	20	255%
Portugal	818	249	259	14.7%	-558	-68%	10	4%
Romania	1	5	47	2.7%	46	5895%	42	799%
Slovakia	12	20	46	2.6%	33	268%	26	132%
Slovenia	1	0	9	0.5%	8	620%	9	10070%
Spain	351	111	169	9.5%	-183	-52%	58	52%
Sweden	2	2	2	0.1%	0	-14%	-1	-21%
EU-27	**2,839**	**1,593**	**1,769**	**100%**	**-1,070**	**-38%**	**176**	**11%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Table 6. 28 N_2O emissions from Biomass Burning (in kt CO_2 eq.)

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%
Austria	0	0	0	0.1%	0	38%	0	49%
Belgium	0	0	NO	-	0	-100%	0	-100%
Bulgaria	1	4	11	1.5%	10	681%	7	159%
Croatia	1	4	21	2.8%	20	2682%	17	427%
Cyprus	0	3	0	0.0%	0	745%	-3	-95%
Czechia	10	4	11	1.4%	1	6%	6	139%
Denmark	0	0	0	0.0%	0	-96%	0	22%
Estonia	0	0	0	0.0%	0	-89%	0	-64%
Finland	2	1	0	0.0%	-1	-82%	0	-44%
France	206	138	194	25.8%	-12	-6%	56	40%
Germany	5	1	11	1.5%	6	112%	10	1986%
Greece	5	10	3	0.4%	-2	-33%	-7	-69%
Hungary	14	7	41	5.4%	27	194%	33	453%
Ireland	22	3	3	0.4%	-19	-87%	0	0%
Italy	377	256	188	25.0%	-189	-50%	-69	-27%
Latvia	3	2	1	0.2%	-1	-54%	0	-20%
Lithuania	3	0	0	0.0%	-2	-89%	0	235%
Luxembourg	NE,NO	NE,NO	NE,NO	-	-	-	-	-
Malta	NO	NO	NO	-	-	-	-	-
Netherlands	0	0	0	0.0%	0	48%	0	1%
Poland	29	4	14	1.9%	-15	-50%	10	255%
Portugal	206	63	65	8.7%	-141	-68%	3	4%
Romania	0	3	33	4.4%	33	7919%	30	894%
Slovakia	7	10	24	3.2%	17	268%	14	132%
Slovenia	1	0	5	0.6%	4	620%	5	10070%
Spain	253	84	124	16.5%	-130	-51%	39	47%
Sweden	0	0	0	0.0%	0	-14%	0	-21%
EU-27	**1,145**	**599**	**750**	**100%**	**-395**	**-34%**	**152**	**25%**

Note: Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

6.4 Uncertainties

For the year 2022, LULUCF uncertainty was estimated in 52.7 % for the uncertainty of the level and 29.4 % for the uncertainty of the trend (0).

For more information on the uncertainty analysis please refer to chapter 1.6.

Table 6. 32 Level and trend uncertainty assessment of the annual EU emission/removal on LULUCF land subcategories and GHG sources.

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2021	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
4.A Forest Land	CO_2	-282 802	-245 053	-13.3%	22.3%	19.1%
4.A Forest Land	CH_4	1 307	1 292	-1.2%	82.1%	50.6%

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2021	Level uncertainty estimates based on MS uncertainty estimates	Trend uncertainty estimates based on MS uncertainty estimates
4.A Forest Land	N_2O	1 950	1 870	-4.1%	89.7%	7.1%
4.B Cropland	CO_2	60 166	15 474	-74.3%	206.5%	28.8%
4.B Cropland	CH_4	593	410	-30.8%	76.8%	16.5%
4.B Cropland	N_2O	1 919	1 069	-44.3%	93.4%	52.9%
4.C Grasland	CO_2	39 305	16 155	-58.9%	130.9%	23.5%
4.C Grasland	CH_4	3 562	2 869	-19.5%	169.8%	17.2%
4.C Grasland	N_2O	615	356	-42.2%	92.4%	36.0%
4.D Wetlands	CO_2	10 488	14 027	33.7%	58.7%	15.2%
4.D Wetlands	CH_4	7 589	8 065	6.3%	55.5%	3.8%
4.D Wetlands	N_2O	141	148	5.3%	66.6%	42.9%
4.E Settlements	CO_2	21 467	23 138	7.8%	46.5%	11.8%
4.E Settlements	CH_4	77	81	5.1%	75.9%	10.0%
4.E Settlements	N_2O	2 258	2 656	17.6%	96.9%	17.0%
4.F Other Land	CO_2	1 014	1 059	4.4%	76.4%	23.6%
4.F Other Land	CH_4	1	1	12.4%	100.0%	12.4%
4.F Other Land	N_2O	6	46	645.0%	85.5%	511.9%
4.G Harvested wood products	CO_2	-22 501	-29 060	29.1%	39.1%	23.8%
4.G Harvested wood products	CH_4	0	0	0.0%	0.0%	0.0%
4.G Harvested wood products	N_2O	0	0	0.0%	0.0%	0.0%
4.H Other	CO_2	0	30	Inf	30.4%	Inf
4.H Other	CH_4	0	244	Inf	100.0%	Inf
4.H Other	N_2O	0	0	0.0%	0.0%	0.0%
4.I	CO_2	0	0	0.0%	0.0%	0.0%
4.I	CH_4	0	0	0.0%	0.0%	0.0%
4.I	N_2O	18	5	-71.0%	202.9%	144.1%
4.II	CO_2	2 027	1 620	-20.1%	54.2%	9.0%
4.II	CH_4	1 984	1 159	-41.6%	91.0%	48.6%
4.II	N_2O	1 511	1 780	17.8%	112.3%	21.0%
4.III	CO_2	0	0	0.0%	0.0%	0.0%
4.III	CH_4	0	0	0.0%	0.0%	0.0%
4.III	N_2O	71	174	145.7%	95.6%	134.2%
4.IV	CO_2	15	382	2449.1%	66.9%	1637.3%
4.IV	CH_4	6	38	565.3%	94.9%	605.2%
4.IV	N_2O	3	22	641.0%	95.4%	677.3%
4. Indirect emissions (4.I & 4.III)	CO_2	0	0	0.0%	0.0%	0.0%
4. Indirect emissions (4.I & 4.III)	CH_4	0	0	0.0%	0.0%	0.0%
4. Indirect emissions (4.I & 4.III)	N_2O	306	375	22.4%	0.4%	1.0%
4 (where no subsector data were submitted)	*all*	*-70 549*	*-56 883*	-19.4%	*60.6%*	*38.7%*
Total - 4	**all**	**-217 454**	**-236 454**	**8.7%**	**52.7%**	**29.4%**

6.4.5 Category -specific quality assurance and quality control, and verification.

6.4.5.1 Quality Assurance and Quality Control

Information submitted under the LULUCF sector by EU MS is under a double QA/QC system. One implemented at country level, and another one, carried out in the context of the EU Regulations No 2018/841 and 2018/842. As LULUCF is concerned the QAQC checks are performed by the European Environment Agency, in collaboration with the countries, and European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM)

Under these Regulations, the checks focus on early versions of national GHG inventories that are submitted by member States to the European Commission 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 are received in March, which are also checked in terms of the implementation status of issues previously identified during the QA&QC check phase. The reasons for potential recalculations of the information submitted in January and March are also assessed.

Ultimately, the checks are mainly, but not only, intended to (i) identify and resolve calculation errors, (ii) to provide suggestions to address completeness issues, (iii) to identify the need for further information to amend the lack of transparency, (iv) to spot outliers on time-series that hamper the consistency, and, (v) to identify discrepancies among data included on the different sections of the submission. In all cases, QA/QC checks are implemented by interacting with national experts to get clarifications and to plan possible improvements.

As a result of the implementation of these QA/QC checks on LULUCF information, on average, a total of about 175 findings (i.e., potential issues) are communicated to the countries. Examples of issues include the use, and justifications of notations keys, potential inconsistencies in land representation, wrong reading of how to fill in the tables, inconsistent reporting of activity data among CRT tables, and between CRT tables and NIR, outliers in IEFs values for different categories, or lack of transparency in specific national circumstances that affected the EU trend.

6.4.5.2 Verification

Relatively little information on verification is included in national GHG inventories. From the EEA side, as part of the implementation of QAQC checks and verification procedures, the information on biomass burning included in CRT tables 4 (IV) is verified against data submitted, and estimated, as part of the EFFIS - European Forest Fire Information System[50].

In addition, information included in the FAOSTAT database, regarding harvested wood products, was also used to track the path of the carbon, and to assess consistency of the reporting across pools, whenever significant natural disturbances, causing important losses in the living biomass pools, were reported by member States (e.g. the impact of a windstorm in 1990 in Germany)

As regards activity data, the EEA is assessing how the information included in the LULUCF Instance – a Copernicus[51] product, including estimation of land use area, can be used to support the verification of the areas and trends of the land use categories reported by member States under the LULUCF chapter.

6.5 Category specific recalculations

Recalculations are described in chapter 10.1, including the explanations for significant changes (>500 kt CO_2eq) in categories.

[50] EFFIS - Welcome to EFFIS

[51] CLC+: a new generation Land Information System for Europe — Copernicus Land Monitoring Service

6.6 Category-specific planned improvement

Given that this is the first submission under the Paris Agreement, efforts have been devoted to ensuring compliance with reporting requirements, and to align the chapter to the outline included in the UNFCCC Decision 5/CMA.3

7 WASTE (CRT SECTOR 5)

This chapter starts with an overview on emission trends in CRT sector 5 Waste and covers greenhouse gas emissions, which are generated from the treatment and disposal of liquid and solid waste[52]. This sector covers the following sub-sectors:

- 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.

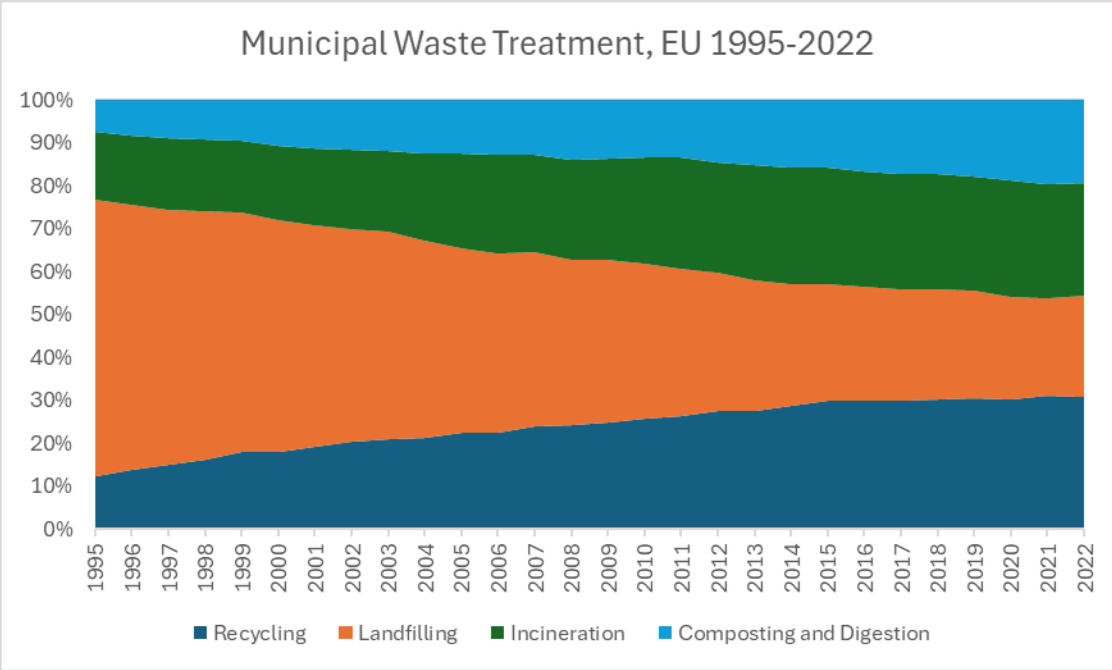
For each Union key category, overview tables are presented including the Member States' contributions to the key categories in terms of level and trend, and information on methodologies and emission factors.

Of the above, the first three categories mainly refer to possible routes for treatment and disposal of solid waste. The decrease of total GHG emissions in the waste sector is mainly driven by the development of the different waste treatment routes. Figure 1.1 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 by Eurostat [[env_wasmun__custom_14030714]. 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 2022 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.

[52] The EU Greenhouse gas inventory data in this report was compiled using the September 2024 release of the 'CRT reporting tool' developed by the UNFCCC Secretariat. However, due to remaining technical shortcomings in the UNFCCC ETF tools, there have been substantial difficulties in preparing and finalizing the EU GHG inventory tables, which are based on the aggregation of emissions and removals from Member States' GHG inventories. In addition, because of the ongoing improvements and additional releases of the ETF tools by the UNFCCC secretariat after the compilation of the EU GHG inventory, reported data may differ from actual inventory data in some cases. The EU will provide additional information on sector-specific issues affected by the ETF tool during the technical expert review. For more information, see also footnote 4 of the executive summary.

Figure 7.1 Sector 5 Waste: Development of municipal waste treatment in the EU (Data source: Eurostat)



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.

7.1 Overview of sector

Sector 5 Waste is the fourth largest sector in the EU, after energy CRT, agriculture and industrial processes, contributing 3.5 % to total GHG emissions including indirect CO_2 and with LULUCF in 2022. Total emissions from waste decreased by 41 % from 184 Mt in 1990 to 108 Mt in 2022 (Figure 1.4).

The strong decrease of emissions from the waste sector is mainly influenced by a strong decline of emissions in the waste sector from Germany, the Netherlands and Poland. Reductions from category 5.A solid waste disposal on land make up about 73 % of total emission reductions in the waste sector (between 1990 and 2022). 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 7.2 Sector 5 Waste: EU GHG emissions, 1990-2022

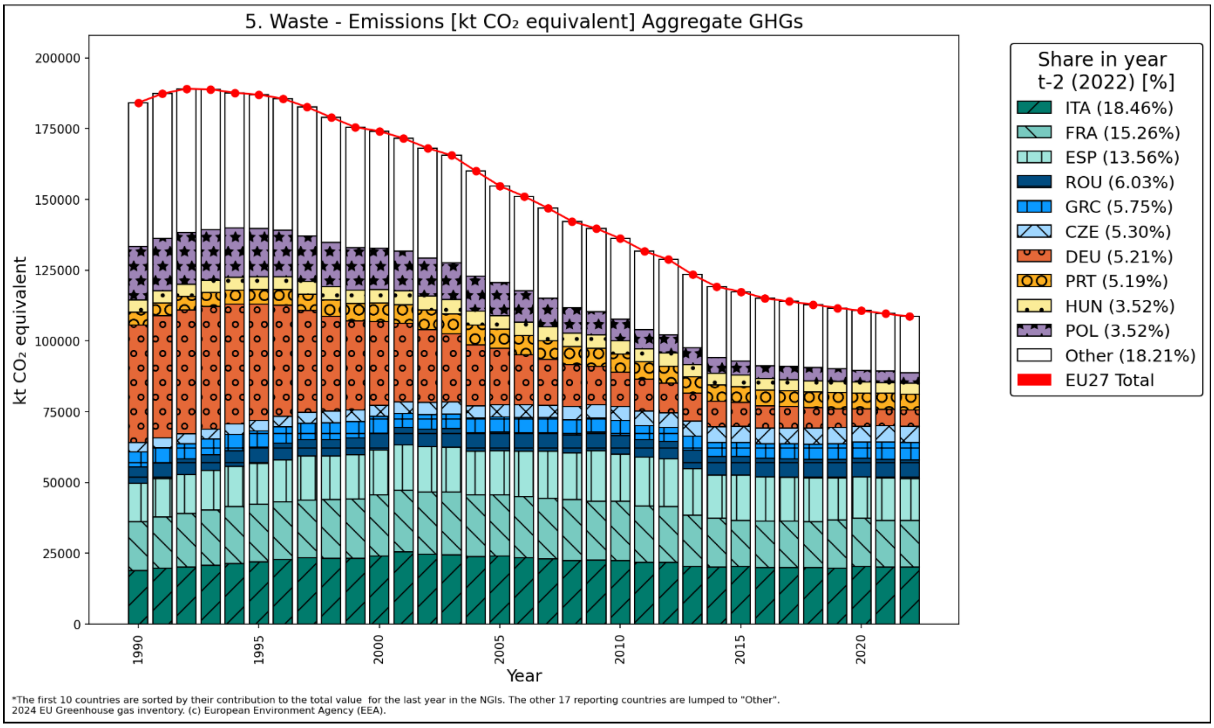


Table 1.1 shows that CH_4 emissions from 5A1 Managed Waste Disposal on Land had the greatest decrease of all waste-related emissions (- 36 %) between 1990 and 2022, but still accounts for 60 % of waste-related GHG emissions in the EU in 2022 as shown in Figure 1.4.

Table 6.1 Sector 5 Waste: Share of key source categories and all remaining categories in 2022 for EU

GREENHOUSE GAS SOURCE CATEGORIES	1990 (kt)	2022 (kt)	absolute change (Mt)	% change (in Mt)	share 2022
5.A.1 - Managed Waste Disposal Sites - CH4	102013	65244	-37	-36%	60%
5.D.2 - Industrial Wastewater - CH4	9469	5900	-4	-38%	5%
5.A.2 - Unmanaged Waste Disposal Sites - CH4	30130	9007	-21	-70%	8%
5.D.1 - Domestic Wastewater - CH4	26502	10200	-16	-62%	9%
5.D.1 - Domestic Wastewater - N2O	6508	7455	1	15%	7%
All other Waste categories	9470	10764	-2	-29%	6%
Total Waste	**184092**	**108570**	**-76**	**-41%**	**100%**

Note: Colors visualize decreases (green), increases (red) and the share in sectoral total emissions (yellow). "Other" is calculated by subtracting the presented categories from the sector total.

7.2 Source categories and methodological issues

CRT Sector 5 Waste is the smallest sector contributing 3,5% to total EU GHG emissions in 2022. The most important GHG from this sector is CH_4 (89 % of total GHG emissions), followed by N_2O (9 % of total GHG emissions). CO_2 emissions arising from waste incineration with energy recovery are allocated in category 1A1.

The emissions from the sector Waste decreased by 41 % from 184 Mt in 1990 to 109 Mt in 2022 (Table 1.1). In 2022, the emissions increased by 1 % compared to 2021.

Table 1.1 shows the key categories on an aggregated level, visualising, that CH_4 emissions from 5A1 – Managed Waste Disposal Sites had the highest share in 2022, and is the category showing the highest decrease since 1990. N_2O emissions have a rather small share but have been increasing in the last year as composting of waste is increasingly used as a way of treating waste.

The following chapters include information on emission levels and emission trends for all 27 countries (EU) for the EU key source categories and composting. 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.

The following table lists the key sources in the waste sector, and share of Member States using a higher Tier method to estimate these emissions. 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) or plant specific (PS).

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.

Table 6.2 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	2022		1990	2022	
5.A.1. Managed waste disposal sites: no classification (CH_4)	102013	65244	T	L	L	100%
5.A.2. Unmanaged waste disposal sites: no classification (CH_4)	30130	9007	T	L	L	100%
5.D.1. Domestic wastewater: no classification (CH_4)	26502	10200	T	L	L	44.4%
5.D.1. Domestic wastewater: no classification (N_2O)	6508	7455	T	0	L	32.0%
5.D.2. Industrial wastewater: no classification (CH_4)	9469	5900	0	L	L	45.0%

Note: 5.A.2/CH_4: 2 MSs (HRV and CYP) do not document the Tier level; 5.D.1/N_2O: 1 MS (IRL) do not document the Tier level; 5.D.2/N_2O: 2 MS (CYP and FRA) do not document the Tier level

For other source categories in the waste sector that are not identified as key sources, only information on total emissions is provided in chapter 1.2.3).

7.2.1 Solid waste disposal on land (CRT 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 (1990-2022) 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 2.4 % to total GHG emissions including indirect CO_2 and with LULUCF, in 2022.

Table 1.3 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 45 % between 1990 and 2022 in the EU. Fourteen EU countries reduced their emissions from this source. In the countries experiencing an increase, waste disposal changed from unmanaged to managed landfills during the time period 1990 and 2022 which leads to increasing CH_4 emissions from managed landfills. In 2022, CH_4 emissions from landfills decreased by 0.9 % compared to 2021.

Table 6.3 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	2022	1990	2022
Austria	4 081	846	4 081	846
Belgium	3 323	557	3 323	557
Bulgaria	2 100	2 162	2 100	2 162
Croatia	559	1 392	559	1 392
Cyprus	295	575	295	575
Czechia	2 008	3 725	2 008	3 725
Denmark	1 525	421	1 525	421
Estonia	239	191	239	191
Finland	4 847	1 384	4 847	1 384
France	12 457	11 384	12 457	11 384
Germany	37 191	2 375	37 191	2 375
Greece	2 512	4 514	2 512	4 514
Hungary	2 977	3 322	2 977	3 322
Ireland	1 476	634	1 476	634
Italy	13 671	15 565	13 671	15 565
Latvia	353	405	353	405
Lithuania	1 152	573	1 152	573
Luxembourg	103	44	103	44
Malta	46	169	46	169
Netherlands	15 321	2 027	15 321	2 027
Poland	13 313	825	13 313	825
Portugal	2 945	4 051	2 945	4 051
Romania	1 536	4 386	1 536	4 386
Slovakia	782	1 207	782	1 207
Slovenia	418	176	418	176
Spain	6 131	10 881	6 131	10 881
Sweden	3 847	509	3 847	509
EU-27	**135 207**	**74 298**	**135 207**	**74 298**

Note: The first two columns 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 (CRT Source Category 5A1)

Table 1.4 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 1.9 % of total EU GHG emissions including indirect CO_2, with LULUCF, in 2022. Between 1990 and 2022, CH_4 emissions from managed landfills declined by 36 % in the EU. In 2022, CH_4 emissions from managed landfills decreased by 0.2 % compared to 2021.

Table 6.4 5A1 Managed Waste Disposal on Land: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	4 081	898	846	1.3%	-3 235	-79%	-52	-6%	NA,T2	CS,D,NA
Belgium	3 323	585	557	0.9%	-2 767	-83%	-28	-5%	NA,T2	D,NA
Bulgaria	NO	1 233	1 238	1.9%	1 238	∞	5	0%	NA,T2	CS,D,NA
Croatia	529	1 312	1 392	2.1%	863	163%	80	6%	NA,T2	CS,NA
Cyprus	NO	159	181	0.3%	181	∞	22	14%	-	-
Czechia	2 008	3 725	3 725	5.7%	1 717	86%	0	0%	NA,T1	D,NA
Denmark	1 525	433	421	0.6%	-1 104	-72%	-12	-3%	CS,T2	CS,D
Estonia	NO	197	191	0.3%	191	∞	-6	-3%	NA,T2	D,NA
Finland	4 847	1 470	1 384	2.1%	-3 463	-71%	-86	-6%	NA,T2	CS,D,NA
France	12 457	11 035	11 384	17.4%	-1 073	-9%	349	3%	-	-
Germany	37 191	2 575	2 375	3.6%	-34 816	-94%	-200	-8%	NA,T2	CS,NA
Greece	90	2 946	3 104	4.8%	3 014	3363%	158	5%	NA,T2	CS,D,NA
Hungary	470	2 136	2 178	3.3%	1 708	364%	42	2%	NA,T2	D,NA
Ireland	NO	590	634	1.0%	634	∞	45	8%	M,T2	CS,D
Italy	7 153	13 632	13 602	20.8%	6 449	90%	-30	0%	NA,T2	CS,NA
Latvia	NO	248	293	0.4%	293	∞	46	18%	NA,T2	D,NA
Lithuania	766	490	457	0.7%	-309	-40%	-33	-7%	NA,T2	D,NA
Luxembourg	103	48	44	0.1%	-59	-57%	-4	-8%	NA,T1	D,NA
Malta	NO	161	163	0.2%	163	∞	2	1%	T2	M
Netherlands	15 321	2 185	2 027	3.1%	-13 294	-87%	-158	-7%	NA,T2	CS,NA
Poland	1 468	945	755	1.2%	-714	-49%	-191	-20%	NA,T2	CS,D,NA
Portugal	793	3 420	3 462	5.3%	2 669	336%	42	1%	T2	CS,D
Romania	NA,NO	2 536	2 658	4.1%	2 658	∞	121	5%	NA,T2	CS,D,NA
Slovakia	782	1 278	1 207	1.9%	425	54%	-71	-6%	T2	-
Slovenia	418	197	176	0.3%	-241	-58%	-21	-11%	T2	CS,D
Spain	4 843	10 409	10 283	15.8%	5 440	112%	-127	-1%	NA,T2	CS,D,NA,OTH
Sweden	3 847	549	509	0.8%	-3 337	-87%	-40	-7%	T2	CS,D
EU-27	**102 013**	**65 393**	**65 244**	**100%**	**-36 770**	**-36%**	**-149**	**0%**	**-**	**-**

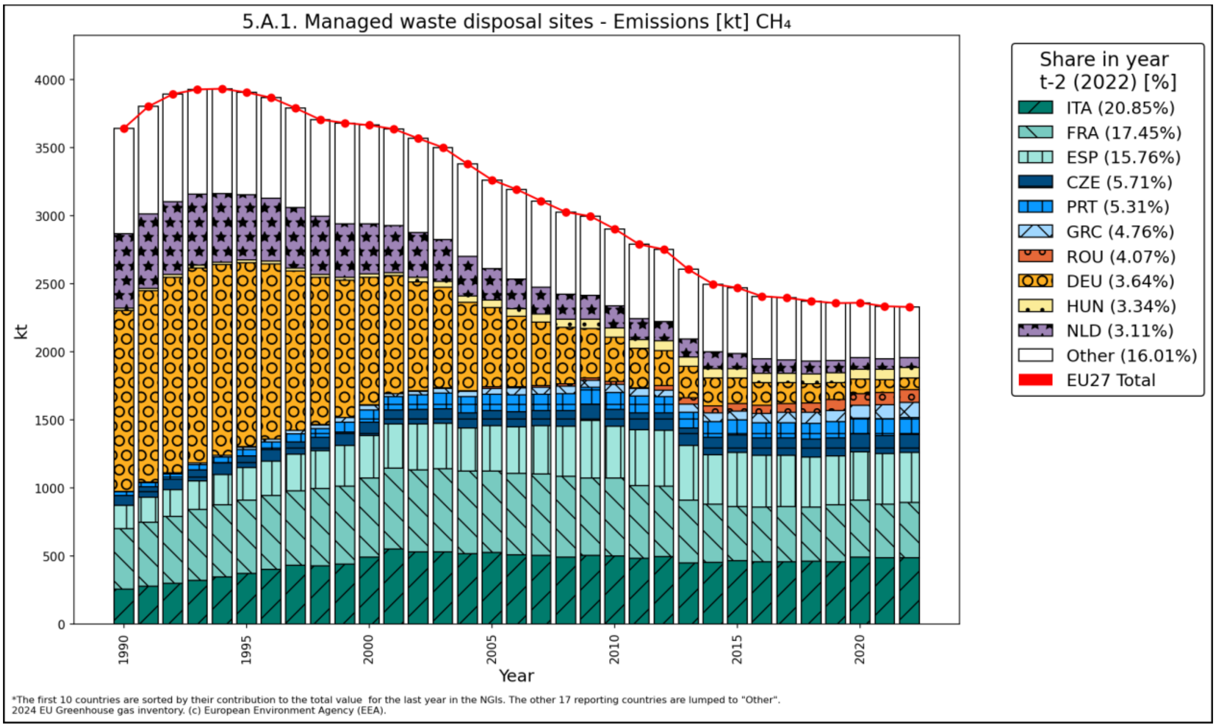
Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the 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 2022 by 36 %. *Figure 1.3* shows the trend of emissions indicating the countries contributing most to EU total.

The countries with highest emissions from this source in 2022 were France, Italy and Spain. These MS account for 54.1 % of EU CH_4 emissions from 5A1. The largest reductions in absolute terms between 1990 and 2022 were reported by Germany. 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 7.3 5A1 Managed waste disposal on land: CH_4 emissions (Trend in relevant countries)



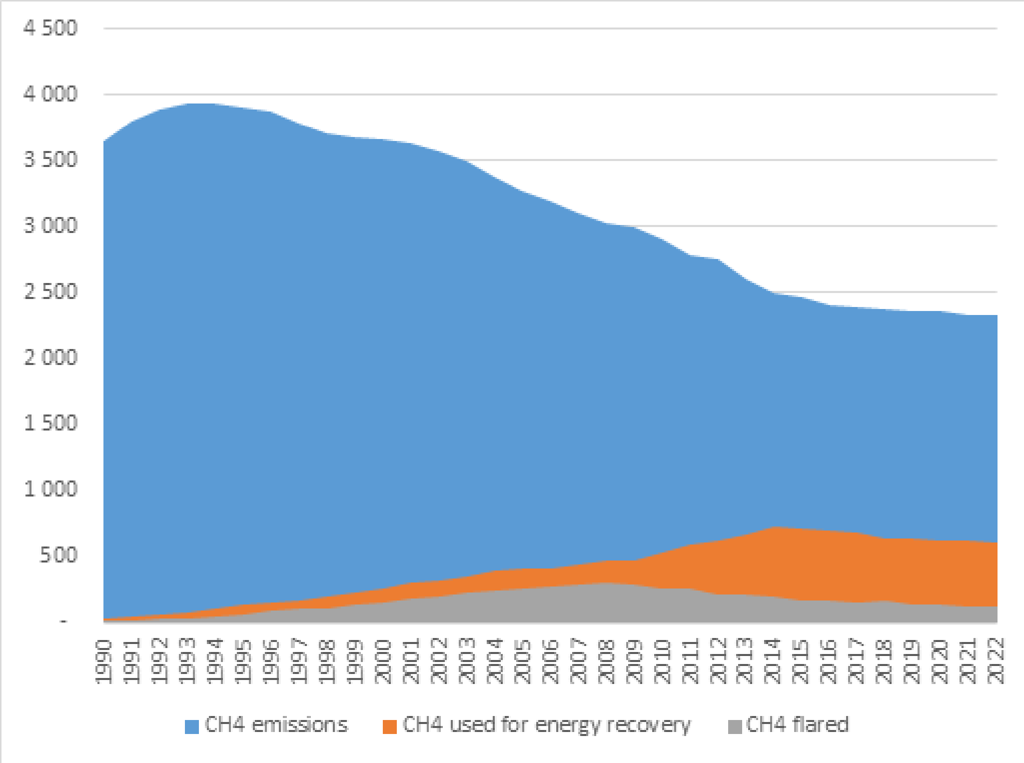
A main driving force of CH_4 emissions from managed waste disposal on land is the amount of waste, especially of biodegradable waste going to landfills. According to the CRT tables submitted in 2023, the amount of waste annually landfilled decreased by 41% between 1990 and 2021[53]. In addition, CH_4 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 since 1990.

Methane recovery and flaring

Besides lower quantities of organic carbon deposited on landfills, the major determining factor for the 0.9) in managed landfills (only 5A1) in 1990 to 22.1 % in 2022 (Figure 1.4). 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 potential to recover and use CH_4.

[53]. Due to inconsistencies in reporting of activity data by Member States in CRT tables, the activity data can currently not be summed up at EU level.

Figure 7.4 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



Source: CRT 2024, 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 1.9, varies among the countries and depends - amongst other - on the share of solid waste disposal sites where recovery installations exist.

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. 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 30 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 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.

Recent data on waste generation and waste disposal is available in most EU countries and is not estimated based on the per capita waste generation rate and a share of waste landfilled, but on direct measurements. 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.

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.

Sludge

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.

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.

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.

7.2.1.2 Unmanaged waste disposal sites (CRT Source Category 5A2)

CH_4 emissions from 5A2 Unmanaged Waste Disposal on Land account for 0.3 % of total EU GHG emissions including indirect CO_2, with LULUCF, in 2022. 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.

Table 6.5 5A2 Unmanaged Waste Disposal on Land: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	NO	NO	NO	-	-	-	-	-	NA	NA
Belgium	NO	NO	NO	-	-	-	-	-	NA	NA
Bulgaria	2 100	1 002	924	10.3%	-1 176	-56%	-79	-8%	T2	CS,D
Croatia	30	2	NO	-	-30	-100%	-2	-100%	NA	NA
Cyprus	295	412	394	4.4%	99	33%	-18	-4%	-	-
Czechia	NO	NO	NO	-	-	-	-	-	NA	NA
Denmark	NO	NO	NO	-	-	-	-	-	-	-
Estonia	NO	NO	NO	-	-	-	-	-	NA	NA
Finland	-	NO	NO	-	-	-	-	-	NA	NA
France	NO	NO	NO	-	-	-	-	-	-	-
Germany	NO	NO	NO	-	-	-	-	-	NA	NA
Greece	2 423	1 468	1 410	15.7%	-1 012	-42%	-58	-4%	T2	CS,D
Hungary	2 507	1 200	1 144	12.7%	-1 363	-54%	-56	-5%	T2	D
Ireland	1 476	NO	NO	-	-1 476	-100%	-	-	M,T2	CS,D
Italy	6 518	2 051	1 963	21.8%	-4 555	-70%	-88	-4%	T2	CS
Latvia	353	126	111	1.2%	-241	-68%	-14	-11%	T2	CS,D
Lithuania	386	127	116	1.3%	-270	-70%	-10	-8%	T2	D
Luxembourg	IE	IE	IE	-	-	-	-	-	NA	NA
Malta	46	7	6	0.1%	-41	-88%	-1	-14%	M	M
Netherlands	NO	NO	NO	-	-	-	-	-	NA	-
Poland	9 020	36	23	0.3%	-8 997	-100%	-14	-37%	T2	CS,D
Portugal	2 152	632	589	6.5%	-1 562	-73%	-43	-7%	-	-
Romania	1 536	1 817	1 728	19.2%	192	13%	-88	-5%	T2	CS,D
Slovakia	NO	NO	NO	-	-	-	-	-	-	-
Slovenia	NO	NO	NO	-	-	-	-	-	-	-
Spain	1 288	629	599	6.6%	-689	-54%	-30	-5%	T2	D
Sweden	NO	NO	NO	-	-	-	-	-	-	-
EU-27	**30 130**	**9 509**	**9 007**	**100%**	**-21 123**	**-70%**	**-501**	**-5%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data

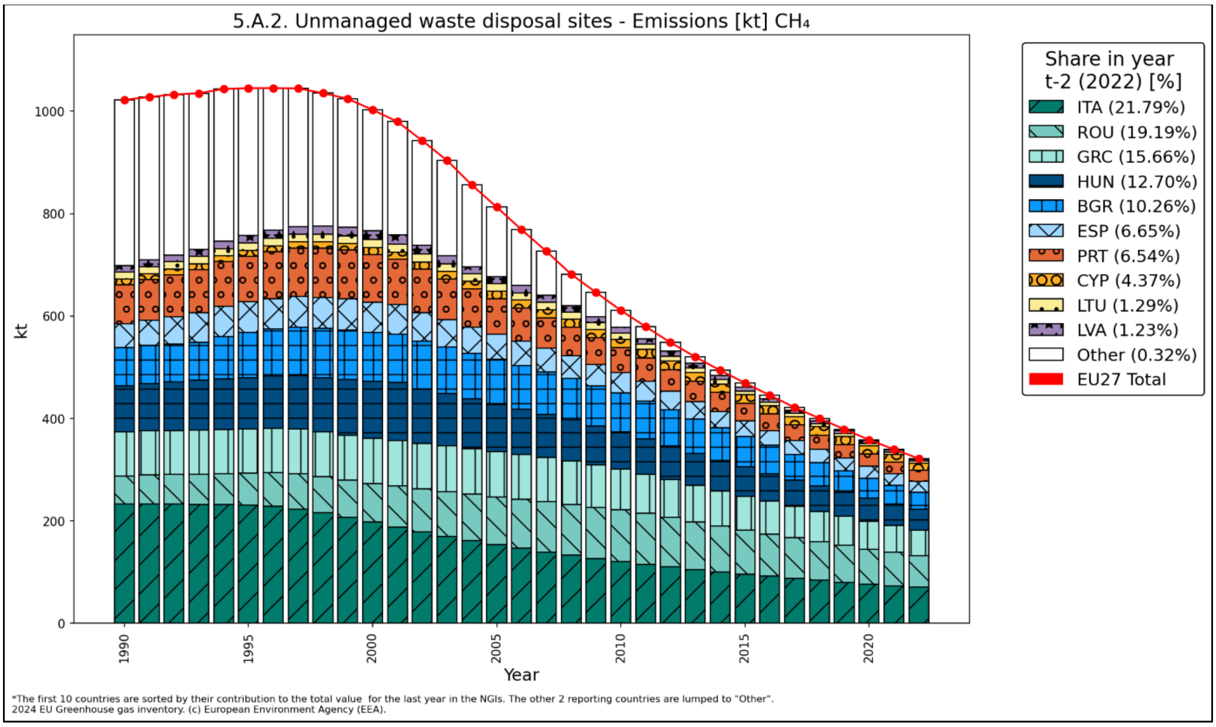
CH_4 emissions from unmanaged solid waste disposal sites decreased considerably. Between 1990 and 2022, CH_4 emissions from this source decreased by 70 % (Table 1.5). In 2022, CH_4 emissions from unmanaged landfills decreased by 5 % compared to 2021.

Figure 1.10 shows the trend of emissions indicating the countries contributing most to EU total. In comparison to the rather drastic decrease of the amount of waste disposed on unmanaged landfills. CH_4 emissions from unmanaged landfills show only a moderate decrease during the time series because of the FOD approach.

Not all countries reported emissions from this source since all waste disposal sites in the countries are managed) or they are included elsewhere (see Table 1.4).

Italy, Romania, Greece and Bulgaria are responsible for about 60 % of the total EU emissions from unmanaged waste disposal sites in 2022 (see *Figure 1.5*). Poland and Italy show the larger absolute reductions between 1990 and 2022.

Figure 7.5 5A2 Waste disposal on unmanaged landfills: CH_4 emissions (Trend in relevant countries)



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.

In the unmanaged solid waste landfills, hardly any CH_4-recovery takes place. Only Ireland (1996-1998) and Latvia (2002-2017) report CH_4 recovery from unmanaged landfills for a few years in the time series.

For countries still using unmanaged landfills (Bulgaria, Croatia, Greece), solid waste disposal on unmanaged landfill sites is still practiced, but the amount of waste disposed is considerably decreasing since 1990. The highest reductions in the amount of waste disposed between 1990 and 2022 are found for Bulgaria and Greece. In countries which still dispose waste in unmanaged landfills in 2022, the relative decrease of waste disposed is higher than 88 % in comparison with 1990.

Methodological issues

CH_4 emissions from unmanaged solid waste disposal sites were reported in 13 EU countries in 1990. Only three of these EU countries still dispose MSW to unmanaged SWDS, although in small quantities, while in all other countries waste disposal from the past still cause emissions in 2022 (see Table 1.4). 100 % of all EU 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 three countries still disposing MSW are using an MCF value of 0.8, representing deep unmanaged landfills.

7.2.2 Biological treatment of solid waste (CRT Source Category 5B)

Source category 5B Biological treatment of solid waste includes CH_4 and N_2O emissions from subcategories 5B1 Composting and 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 total GHG emissions including indirect CO_2, with LULUCF, in 2022 and is not a quantitative the key source for EU.

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.

Table 1.6 provides total GHG and CH_4 and N_2O emissions by Member State from 5B Biological treatment of solid waste. Total emissions from this category increased considerably since 1990, and especially during the last years, due to landfill regulations. All countries report emissions from this category since 2011 except Malta.

Table 6.6 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	2022	1990	2022	1990	2022
Austria	35	149	20	72	15	77
Belgium	6	55	4	30	3	25
Bulgaria	NO	13	NO	5	NO	9
Croatia	NO	28	NO	9	NO	19
Cyprus	NO	19	NO	7	NO	12
Czechia	NE,IE	804	IE,NE	66	IE,NE	738
Denmark	43	569	13	45	30	524
Estonia	1	30	0	11	1	19
Finland	45	108	16	34	29	74
France	173	989	61	212	112	777
Germany	79	1 090	20	199	59	890
Greece	1	111	NO	6	1	105
Hungary	9	154	3	37	6	117
Ireland	NO	51	NO	17	NO	35
Italy	23	529	18	409	5	120
Latvia	29	62	11	18	19	44
Lithuania	0	99	0	20	0	79
Luxembourg	NE,IE,NO	34	NE,NO	4	IE,NO	30
Malta	NO	1	NO	NA,NE,NO	NO	1
Netherlands	11	200	6	71	5	129
Poland	22	364	8	129	14	235
Portugal	9	122	3	41	6	82
Romania	NE,NO	89	NE,NO	21	NE,NO	68
Slovakia	114	356	41	117	73	240
Slovenia	NA,NO	19	NA,NO	7	NA,NO	12
Spain	209	635	76	220	133	415
Sweden	13	98	5	21	8	77
EU-27	**823**	**6 780**	**305**	**1 827**	**519**	**4 953**

Note: Abbreviations explained in the Chapter 'Units and abbreviations'

Biological treatment of waste is not a quantitative key category for the European Union but because of the rapid increase of emissions from composting activities it can be considered as a qualitative key category. Therefore, source category 5B1 Composting is presented hereafter. Regarding 5B2 Anaerobic digestion, some additional information can be found in the chapter 1.2.3 dedicated to waste - non key categories.

7.2.2.1 Waste Composting (CRT Source Category 5B1)

Emission and Trends

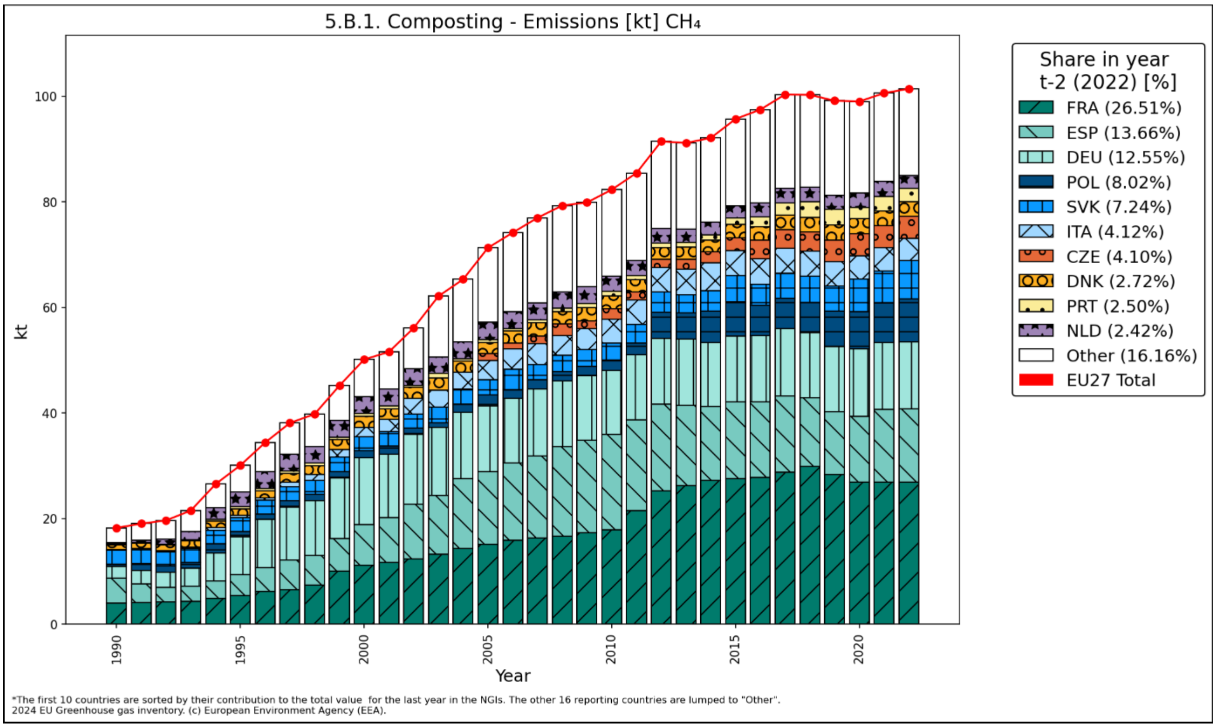
CH_4 emissions from 5B1 Composting account for 0.09 % of total EU GHG emissions including indirect CO_2, with LULUCF, in 2022. Between 1990 and 2022, CH_4 emissions from this source increased considerably of 456% (Table 1.7). Malta reports emissions from composting only in the period 1993 - 2006. All countries that practice composting feature an increasing emission trend from 1990 onwards.

Table 6.7: 5B1 Waste Composting: Countries contributions to CH_4 emissions and information on method applied and emission factor

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	15	56	55	1.9%	41	279%	-1	-2%	T2	CS
Belgium	3	25	25	0.9%	22	766%	0	-1%	NA,T1	CS,NA
Bulgaria	NO	8	8	0.3%	8	∞	1	10%	NA,T1	D,NA
Croatia	NO	13	16	0.6%	16	∞	3	21%	T1	D
Cyprus	NO	11	12	0.4%	12	∞	0	4%	-	-
Czechia	NE	117	117	4.1%	117	∞	0	0%	T1	D
Denmark	24	77	77	2.7%	53	220%	0	0%	NA,T1,T2	D,NA
Estonia	1	19	19	0.7%	19	2450%	0	1%	NA,T1	D,NA
Finland	29	59	60	2.1%	31	108%	0	1%	T1	D
France	111	752	753	26.5%	641	576%	0	0%	NA	NA
Germany	59	354	356	12.6%	297	500%	3	1%	NA,T2	CS,NA
Greece	NO	9	10	0.4%	10	∞	1	6%	D	D
Hungary	6	69	65	2.3%	59	1059%	-4	-6%	T1	D
Ireland	NO	24	29	1.0%	29	∞	5	20%	T1	D
Italy	5	124	117	4.1%	112	2167%	-7	-5%	D,NA	CS,NA
Latvia	19	33	32	1.1%	13	71%	-1	-4%	D,NA	D,NA
Lithuania	0	37	35	1.2%	35	15154%	-2	-7%	T1	D
Luxembourg	NO	9	7	0.3%	7	∞	-2	-19%	T1	D
Malta	NO	NE,NO	NE,NO	-	-	-	-	-	NA,T1	D,NA
Netherlands	5	80	69	2.4%	64	1337%	-11	-14%	NA,T1	CS,NA
Poland	14	211	228	8.0%	213	1500%	16	8%	T1	D
Portugal	6	77	71	2.5%	65	1161%	-6	-8%	T1	D
Romania	NE,NO	40	36	1.3%	36	∞	-4	-9%	NA,T1	D,NA
Slovakia	73	169	205	7.2%	133	183%	36	21%	T1	D
Slovenia	NA,NO	15	12	0.4%	12	∞	-3	-17%	NA,T1	D,NA
Spain	133	388	388	13.7%	254	191%	0	0%	NA,T1	D,NA
Sweden	8	38	37	1.3%	29	366%	-1	-4%	T1	D
EU-27	**510**	**2 816**	**2 840**	**100%**	**2 329**	**456%**	**23**	**1%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Figure 7.6 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). 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.

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 varies between 0.8 and 11.4 g CH_4/kg waste treated. Most countries apply the default EF for CH_4 emissions (see Table 1.10). 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.

Further methodological information for all countries is provided in the Annex of this submission

7.2.1 Incineration and open burning of waste (CRT 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 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 1.2.3 dedicated to waste- non key categories.

7.2.2 Wastewater treatment and discharge (CRT 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[54].

The subcategory 5D1 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 0.8 % of total EU GHG emissions including indirect CO_2, with LULUCF, in 2022.

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.

Table 1.8 shows total GHG, CH_4 and N_2O emissions by Member State from 5D Wastewater Handling. Between 1990 and 2022, total emissions from wastewater handling decreased by 45 % in EU. All countries except for France and Ireland decreased their emissions from wastewater treatment and discharge between 1990 and 2022. Due to the increasing connexion rate of the population to wastewater treatment plant CH_4 emission decreased considerably by 124 % between 1990 and 2022, while N_2O emissions increased moderately by 8 %.

[54] 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 6.8 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	2022	1990	2022	1990	2022
Austria	223	177	86	152	137	24
Belgium	1 165	348	123	102	1 042	246
Bulgaria	3 138	621	176	113	2 961	508
Croatia	719	508	59	89	660	419
Cyprus	140	72	10	15	130	57
Czechia	1 291	1 067	208	173	1 083	894
Denmark	368	211	301	127	67	84
Estonia	161	92	34	31	126	62
Finland	315	234	68	62	247	173
France	2 222	2 435	909	571	1 313	1 864
Germany	4 250	2 165	544	1 179	3 706	987
Greece	2 871	1 612	249	255	2 622	1 357
Hungary	1 142	333	131	75	1 011	258
Ireland	135	156	67	98	68	59
Italy	4 703	3 776	1 120	1 108	3 584	2 668
Latvia	423	122	47	32	376	90
Lithuania	497	146	23	8	474	139
Luxembourg	13	6	5	4	8	2
Malta	28	16	9	7	19	9
Netherlands	962	710	541	496	421	214
Poland	5 372	2 365	643	720	4 729	1 645
Portugal	1 451	1 387	294	796	1 157	591
Romania	4 098	2 069	383	373	3 715	1 696
Slovakia	481	352	75	85	406	267
Slovenia	350	171	35	33	315	138
Spain	6 569	2 485	767	797	5 802	1 688
Sweden	242	221	201	185	42	36
EU-27	**43 329**	**23 856**	**7 109**	**7 683**	**36 220**	**16 172**

Abbreviations explained in the Chapter 'Units and abbreviations'.

7.2.2.1 Domestic wastewater (CRT Source Category 5D1)

CH_4 emissions

CH_4 emissions from 5D1 Domestic Wastewater account for 0.33 % of total EU GHG emissions including indirect CO_2, with LULUCF in 2022.

Table 6.9 5D1 Domestic and commercial wastewater: Countries' contributions to CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	136	21	21	0.2%	-115	-85%	0	-1%	T2	CS,D
Belgium	1 042	256	246	2.4%	-796	-76%	-10	-4%	CR,T1	CR,D
Bulgaria	473	279	271	2.7%	-202	-43%	-8	-3%	T2	D
Croatia	551	321	318	3.1%	-233	-42%	-3	-1%	T1	D
Cyprus	103	23	24	0.2%	-79	-77%	0	2%	T1	D
Czechia	677	377	377	3.7%	-300	-44%	0	0%	T1	D
Denmark	67	87	84	0.8%	17	26%	-3	-3%	CS	CS
Estonia	126	57	57	0.6%	-69	-55%	0	0%	T1	D
Finland	218	154	153	1.5%	-65	-30%	-1	0%	CS,T2	CS,D
France	1 245	1 778	1 778	17.4%	533	43%	-1	0%	-	-
Germany	3 695	920	932	9.1%	-2 764	-75%	11	1%	CS,D	CS,D
Greece	1 703	170	169	1.7%	-1 534	-90%	-2	-1%	D	D
Hungary	859	228	230	2.3%	-629	-73%	2	1%	T1	D
Ireland	68	60	59	0.6%	-10	-14%	-1	-2%	T1,T2	CS,D
Italy	1 881	1 108	1 097	10.8%	-784	-42%	-11	-1%	T1	D
Latvia	222	91	86	0.8%	-136	-61%	-4	-5%	T2	CS
Lithuania	474	132	139	1.4%	-335	-71%	7	5%	T1,T2	D
Luxembourg	8	2	2	0.0%	-7	-77%	0	-13%	T1	CS
Malta	19	8	9	0.1%	-10	-53%	1	11%	D	CS
Netherlands	163	131	130	1.3%	-33	-20%	-1	0%	T1,T2	D
Poland	4 028	1 352	1 340	13.1%	-2 688	-67%	-12	-1%	T1,T2	CS,D
Portugal	963	536	536	5.3%	-427	-44%	0	0%	T2	CS,D
Romania	3 292	1 444	1 359	13.3%	-1 933	-59%	-85	-6%	D	D
Slovakia	370	268	263	2.6%	-107	-29%	-5	-2%	T2	D
Slovenia	207	145	131	1.3%	-76	-37%	-14	-9%	T1	CS,D
Spain	3 876	360	364	3.6%	-3 513	-91%	3	1%	T2	D
Sweden	35	28	28	0.3%	-7	-21%	0	1%	T2	CS
EU-27	**26 502**	**10 335**	**10 200**	**100%**	**-16 302**	**-62%**	**-135**	**-1%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

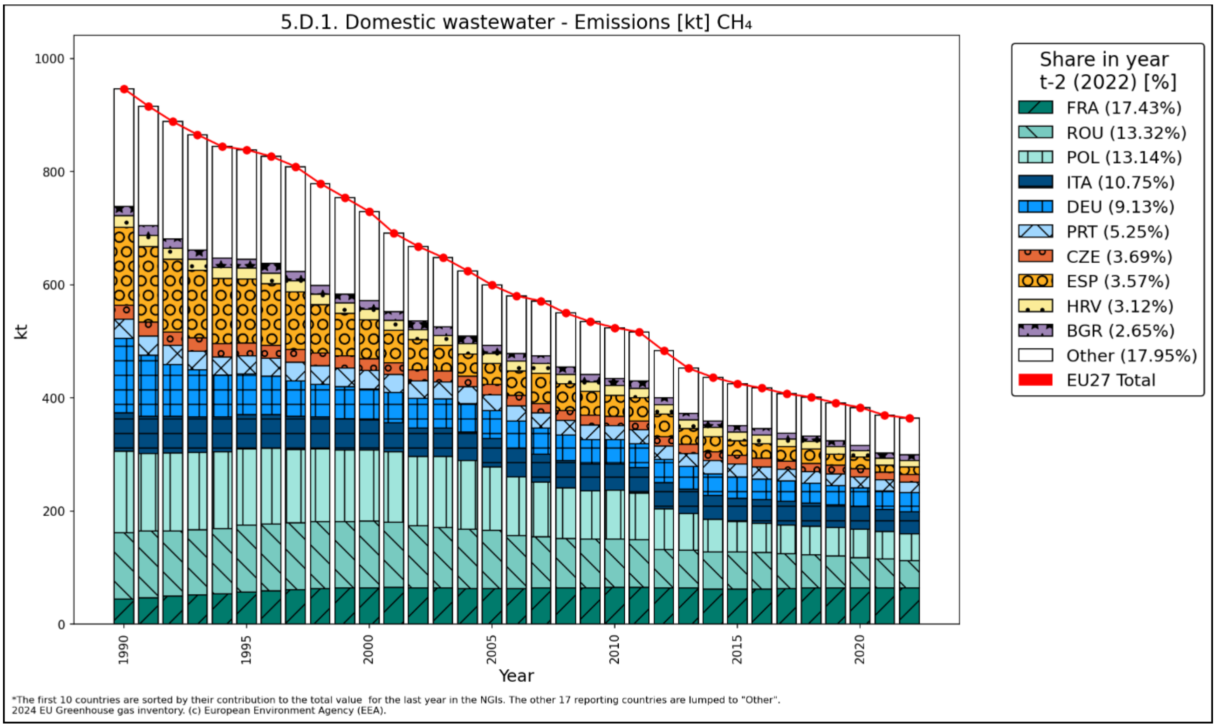
Trends in Emissions and Activity Data for CH_4 emissions from domestic wastewater

Figure 1.16 shows the trend of emissions indicating the countries contributing most to EU total.

CH_4 emissions from domestic wastewater treatment and discharge decreased considerably between 1990 and 2022 by 62 %. In 2022, CH_4 emissions decreased by 1 % in comparison to 2021.

Whereas France shows significant emission increases (+ 43 %) between 1990 and 2022, contributing to 17,4 % of EU emissions from source 5D1 in 2022. Although France increased its emissions, the trend of EU emissions is dominated by the large emission reductions in Spain, Poland and Germany which have large decreases in absolute terms between 1990 and 2022 are reported by Spain, Germany and Poland, contributing together to only 23.6 % of EU emissions from source 5D1 in 2022.

Figure 7.75D1 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. Key drivers for the large emission reduction are the following:

- 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 on anaerobic wastewater and sludge treatment systems

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.

An important remark in the interpretation of data on CH_4 recovery that are reported in the EU's CRT tables (and the countries CRT tables) for wastewater treatment (5D) is that, not all countries are reporting data related to CH_4 recovery, (for energy use of flaring) in CRT 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.

Moreover, it must be highlighet that some of the EU member states started to implement the 2019 refinement to the 2006 IPCC GB.

N_2O emissions

N_2O emissions from 5D1 Domestic Wastewater account for 0.24 % of total EU GHG emissions including indirect CO_2, with LULUCF, in 2022.

Table 6.10 5D1 Domestic and commercial wastewater: Countries' contributions to N_2O emissions

Member State	N_2O Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	85	150	151	2.0%	66	77%	1	1%	CS,D	CS,D
Belgium	123	106	102	1.4%	-21	-17%	-4	-4%	D	D
Bulgaria	176	120	113	1.5%	-64	-36%	-7	-6%	T1	D
Croatia	59	88	89	1.2%	29	49%	1	1%	T1	D
Cyprus	10	15	15	0.2%	5	55%	0	2%	T1	D
Czechia	208	173	173	2.3%	-35	-17%	0	0%	T1	CS,D
Denmark	92	116	112	1.5%	20	22%	-4	-4%	CS	CS
Estonia	34	31	31	0.4%	-4	-10%	0	0%	T1	D
Finland	49	55	52	0.7%	3	6%	-3	-6%	CS,T1	D
France	878	548	546	7.3%	-332	-38%	-2	0%	-	-
Germany	516	1 140	1 155	15.5%	639	124%	15	1%	CS,D	CS,D
Greece	244	251	248	3.3%	4	2%	-3	-1%	D	CS
Hungary	131	75	75	1.0%	-57	-43%	0	-1%	CS	D
Ireland	67	96	98	1.3%	31	46%	2	2%	-	-
Italy	1 059	1 065	1 063	14.3%	4	0%	-2	0%	T1	D
Latvia	45	33	32	0.4%	-13	-28%	-1	-2%	D	D
Lithuania	23	7	8	0.1%	-16	-67%	1	11%	T1,T2	D
Luxembourg	5	4	4	0.1%	0	-8%	0	-4%	T1	D
Malta	9	6	7	0.1%	-3	-28%	0	2%	D	D
Netherlands	374	429	423	5.7%	49	13%	-5	-1%	T2	D
Poland	643	722	720	9.7%	77	12%	-2	0%	T1	D
Portugal	240	757	776	10.4%	536	223%	20	3%	D	CS,D
Romania	383	380	373	5.0%	-11	-3%	-8	-2%	D	D
Slovakia	66	79	83	1.1%	17	25%	3	4%	T2	D
Slovenia	35	33	33	0.4%	-2	-6%	0	0%	T1	D
Spain	767	874	797	10.7%	29	4%	-78	-9%	D	D
Sweden	185	178	178	2.4%	-7	-4%	0	0%	T1	CS,D
EU-27	**6 508**	**7 531**	**7 455**	**100%**	**947**	**15%**	**-76**	**-1%**	**-**	**-**

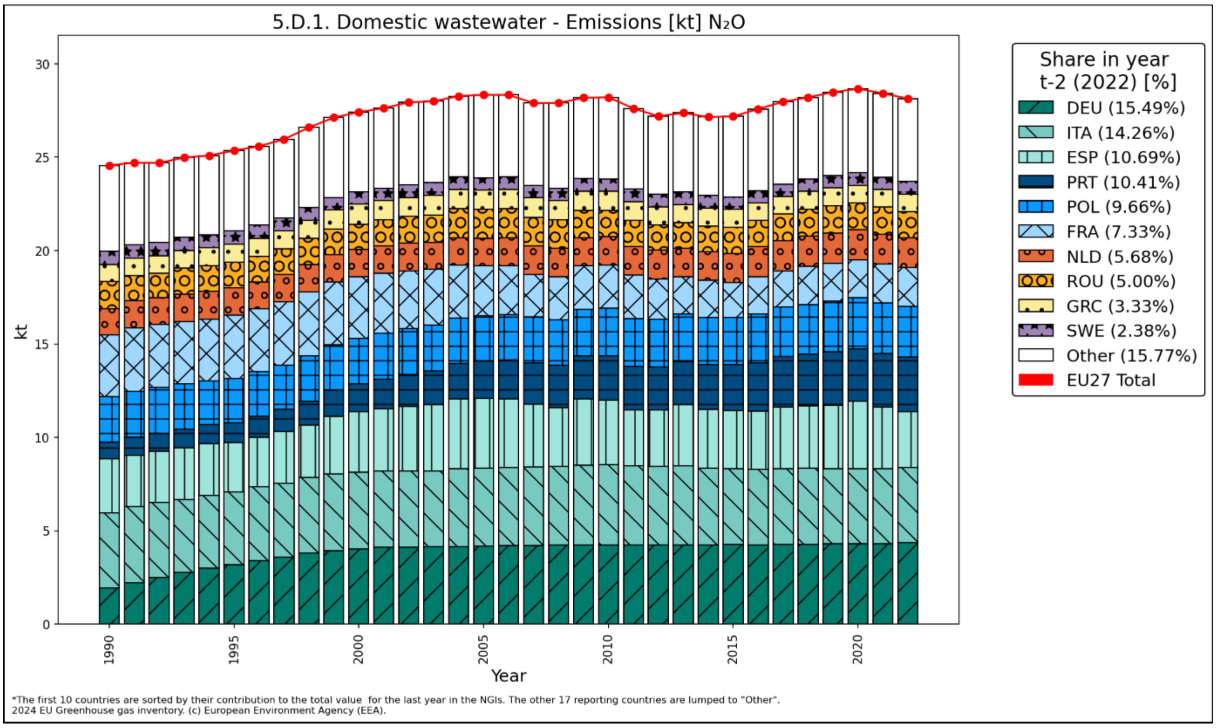
Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Trends in Emissions and Activity Data for N_2O emissions

N_2O emissions from domestic wastewater treatment and discharge increased moderately between 1990 and 2022 by 15 % (Table 1.10). *Figure 1.9* shows the trend of emissions indicating the countries contributing most to EU total. The countries contributing most to the observed increase between 1990 and 2022 are Germany, Portugal and Poland whereas France presents an important decrease in absolute value. In 2022, N_2O emissions decreased by 1 % in comparison to 2021 because of the important increase in absolute value observed for Portugal and Germany.

Key drivers for the emission reduction are the development of centralized wastewater treatment plants with nitrogen abatement technologies.

Figure 7.8 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 environments.

For the calculation of N_2O emissions from domestic wastewater no different tier levels are provided in the IPCC 2006 Guidelines but the 2019 Refinement introduces a more complex methodology. Some countries apply the 2006 IPCC GB, some apply the 2019 refinement and, according to Table 1.13 some apply a country specific methodology and/or emission factors.

Further methodological information for all countries is provided in the Annex III of this submission.

7.2.2.2 Industrial wastewater (CRT Source Category 5D2)

CH_4 emissions from 5D2 Industrial Wastewater account for 0.19 % of total EU GHG emissions including indirect CO_2, with LULUCF in 2022.

Table 6.11 5D2 Industrial wastewater: Countries' contributions to CH_4 emissions

Member State	CH_4 Emissions in kt CO2 equiv.			Share in EU-27 Emissions in 2022	Change 1990-2022		Change 2021-2022		Method	Emission factor Information
	1990	2021	2022		kt CO2 equiv.	%	kt CO2 equiv.	%		
Austria	1	4	4	0.1%	3	272%	0	-4%	CS	CS,D
Belgium	IE	IE	IE	-	-	-	-	-	NA	NA
Bulgaria	2 488	216	237	4.0%	-2 251	-90%	21	10%	T2	D
Croatia	108	122	101	1.7%	-7	-6%	-20	-17%	T1	D
Cyprus	27	33	33	0.6%	6	22%	0	0%	-	D
Czechia	406	517	517	8.8%	111	27%	0	0%	CS,T1	CS,D
Denmark	IE	IE	IE	-	-	-	-	-	CS	CS
Estonia	NO	2	4	0.1%	4	∞	3	157%	T1	D
Finland	30	22	20	0.3%	-10	-34%	-2	-9%	CS,T2	CS,D
France	68	84	86	1.5%	18	27%	2	2%	-	-
Germany	10	54	55	0.9%	44	428%	1	2%	CS,T2	CS
Greece	919	1 176	1 188	20.1%	269	29%	12	1%	CS,D	CS,D
Hungary	152	28	28	0.5%	-123	-81%	0	0%	T1	D
Ireland	IE	IE	IE	-	-	-	-	-	NA	NA
Italy	1 703	1 567	1 571	26.6%	-131	-8%	4	0%	T1	D
Latvia	154	4	3	0.1%	-150	-98%	0	-7%	T1	PS
Lithuania	IE	IE	IE	-	-	-	-	-	NA	NA
Luxembourg	NO	NO	NO	-	-	-	-	-	NA	NA
Malta	IE	IE	IE	-	-	-	-	-	NA	NA
Netherlands	8	12	11	0.2%	3	41%	0	-2%	T2	CS
Poland	702	308	305	5.2%	-397	-57%	-3	-1%	T1	CS,D
Portugal	194	53	55	0.9%	-139	-72%	2	4%	T2	CS,D
Romania	424	257	337	5.7%	-87	-20%	80	31%	D	D
Slovakia	36	5	4	0.1%	-32	-88%	-1	-18%	T1	D
Slovenia	108	7	7	0.1%	-101	-94%	0	-2%	T1	CS,D
Spain	1 925	1 372	1 324	22.4%	-601	-31%	-47	-3%	T1	CS,D
Sweden	7	6	8	0.1%	2	23%	2	33%	T2	CS
EU-27	**9 469**	**5 848**	**5 900**	**100%**	**-3 569**	**-38%**	**52**	**1%**	**-**	**-**

Note: Presented methods and emission factor information refer to the last inventory year. Highlighted cells mark the three Member States with highest share in the EU sector total (yellow), highest decrease (green) and highest increase (red) in the respective period. Abbreviations are explained in the Chapter 'Units and abbreviations'.

Abbreviations explained in the Chapter 'Units and abbreviations'.

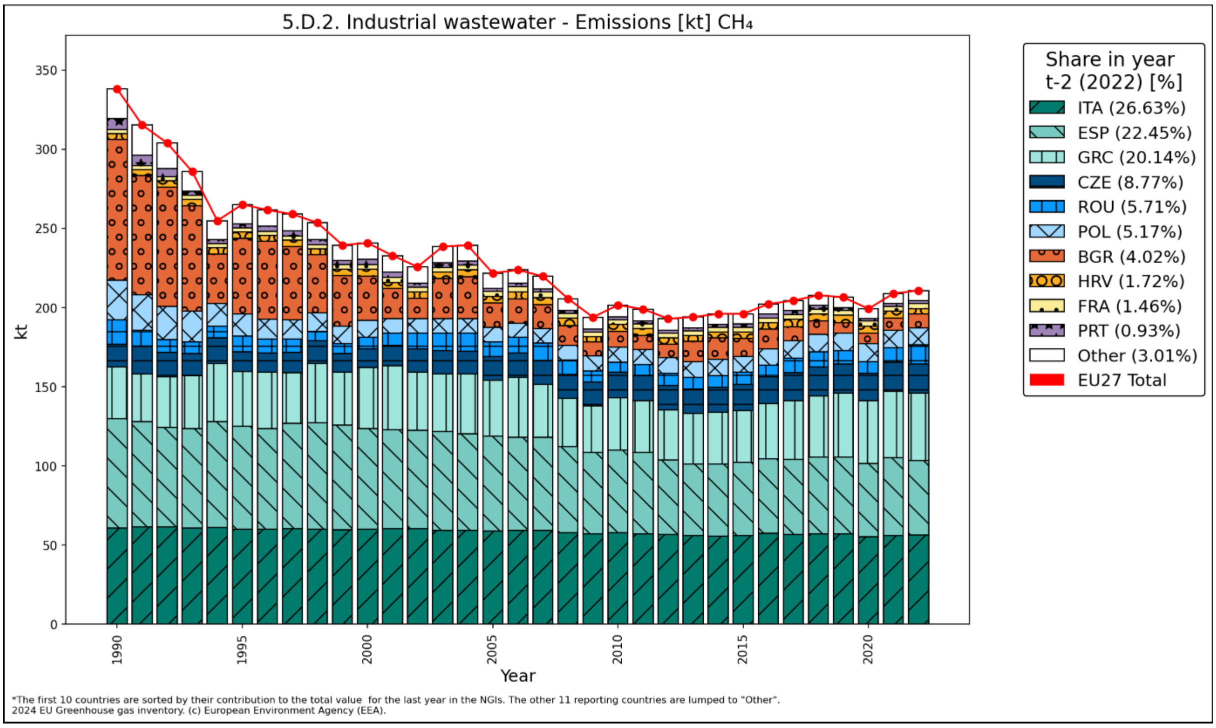
Trends in Emissions and Activity Data

CH_4 emissions from industrial wastewater treatment and discharge decreased by 38 % between 1990 and 2022. In 2022, CH_4 emissions from 5D2 Industrial Wastewater increased of 1 % in comparison to 2021 (see Table 1.11). *Figure 1.10* shows the trend of emissions indicating the countries contributing most to EU total.

The emission trends in this sector are mainly influenced by the strong decrease in Bulgaria.

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.

Figure 7.95D2 Industrial wastewater: CH_4 emissions (Trend in relevant countries)



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.

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.

7.2.3 Waste – non-key categories

Table 6.12 Aggregated GHG emission from non-key categories in the waste sector

EU-27	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 5. Waste in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
5.A.3 Uncategorized waste disposal sites: no classification (CH_4)	3 063.2	75.8	47.4	0.04%	-3 016	-98%	-28.4	-37%

EU-27	Aggregated GHG emissions in kt CO_2 equ.			Share in sector 5. Waste in 2022	Change 1990-2022		Change 2021-2022	
	1990	2021	2022		kt CO_2 equ.	%	kt CO_2 equ.	%
5.B.1 Composting: no classification (N_2O)	304.7	1 747.8	1 739.5	1.59%	1 435	471%	-8.3	0%
5.B.1 Composting: no classification (CH_4)	510.3	2816.3	2839.7	2.62	2 329	465%	23.42	0.8
5.B.2 Anaerobic digestion at biogas facilities: no classification (CH_4)	8.2	2 000.1	2 113.2	1.93%	2 105	25773%	113.2	6%
5.B.2 Anaerobic digestion at biogas facilities: no classification (N_2O)	0.0	83.7	87.7	0.08%	88	100%	4.0	5%
5.C.1 Waste incineration: no classification (CH_4)	16.0	10.1	12.4	0.01%	-4	-23%	2.3	23%
5.C.1 Waste incineration: no classification (CO_2)	3 713.1	2 807.4	2 515.3	2.30%	-1 198	-32%	-292.1	-10%
5.C.1 Waste incineration: no classification (N_2O)	194.5	117.3	117.5	0.11%	-77	-40%	0.2	0%
5.C.2 Open burning of waste: no classification (CH_4)	412.7	574.3	547.7	0.50%	135	33%	-26.6	-5%
5.C.2 Open burning of waste: no classification (CO_2)	83.4	31.8	30.1	0.03%	-53	-64%	-1.7	-5%
5.C.2 Open burning of waste: no classification (N_2O)	240.7	359.5	360.0	0.33%	119	50%	0.4	0%
5.D.2 Industrial wastewater: no classification (N_2O)	464.2	181.6	185.8	0.17%	-278	-60%	4.3	2%
5.D.3 Other: no classification (CH_4)	249.8	78.5	72.4	0.07%	-177	-71%	-6.1	-8%
5.D.3 Other: no classification (N_2O)	136.4	45.5	42.8	0.04%	-94	-69%	-2.7	-6%
5.E Other: no classification (CH_4)	56.3	9.2	9.2	0.01%	-47	-84%	0.0	0%
5.E Other: no classification (CO_2)	16.5	13.6	14.8	0.01%	-2	-10%	1.3	9%
5.E Other: no classification (N_2O)	0.0	28.8	28.1	0.03%	28	100%	-0.7	-2%

7.3 EU uncertainty estimates

Table 1.13 shows the total EU 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 the category 5E (CO_2 and CH_4), followed by N_2O from 5D. Regarding the uncertainty on trend, N_2O and CH_4 from 5B show the highest uncertainty estimates. For a description of the Tier 1 uncertainty analysis carried out for the EU, see Chapter 1.6.

Table 6.13 Sector 5 -Waste: EU uncertainty estimates

Source category	Gas	Emissions Base Year	Emissions 2022	Emission trends Base Year-2021	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	135 207	74 298	-45.0%	42.8%	9.4%
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	385	4 538	1078.6%	58.6%	424.3%
5.B Biological treatment of solid waste	N2O	229	1 607	601.9%	72.8%	227.4%
5.C Waste Incineration	CO2	3 672	2 545	-30.7%	22.0%	5.2%
5.C Waste Incineration	CH4	186	171	-7.9%	35.9%	5.1%
5.C Waste Incineration	N2O	226	136	-39.7%	31.6%	10.8%
5.D Wastewater treatment and discharge	CO2	0	0	0.0%	0.0%	0.0%
5.D Wastewater treatment and discharge	CH4	36 220	16 172	-55.4%	52.9%	11.5%
5.D Wastewater treatment and discharge	N2O	7 109	7 683	8.1%	304.4%	76.0%
5.E Other	CO2	16	15	-9.8%	500.4%	49.3%
5.E Other	CH4	7	9	19.8%	351.7%	79.3%
5.E Other	N2O	0	28	Inf	20.1%	Inf
5 (where no subsector data were submitted	all	836	1 366	63.5%	91.9%	130.9%
Total - 5	**all**	**184 092**	**108 570**	**-41.0%**	**38.5%**	**7.9%**

***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-NID 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

In 2024, the reporting has been amended to be in line with the new CRT reporting tables, as well as the NID outline. Descriptions of categories have been aligned accordingly. Information across sectors has been streamlined to provide a harmonised approach across the whole NID. Any recommendations for improvement of earlier UNFCCC reviews have been continuously followed up and implemented.

Improvements planned for the next reporting are continuing the efforts to ensure consistency between CRT/JSON files and NID, and the provision of sufficient information to meet transparency requirements.

8 OTHER

Sector Other is not an EU key category (see Annex 1.1) and does not include any emissions in 2024

9 INDIRECT CO_2 AND N_2O 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 a fraction of this carbon is initially emitted as CH_4, CO or NMVOC.

Total indirect CO_2 emissions at EU level are based on emission sources reported by those Member States estimating and reporting indirect CO_2, and consistent with the methodological guidance provided in the 2006 IPCC Guidelines.

Indirect CO_2 emissions from solvent use, road paving with asphalt and asphalt roofing are generally reported under CRT category 2D3 ,'non-energy products from fuels and solvent use according to UNFCCC Reporting Guidelines. For other sources of indirect CO_2, emissions are reported in CRT Table 6.

Indirect CO_2 only includes fossil carbon and excludes biogenic sources and combustion-fuels where IPCC default CO_2 emission factors (i.e. full oxidation with factor equal to 1) are assumed.

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.

In addition to agriculture, 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.

As with indirect CO_2, indirect N_2O emissions at EU level are fully consistent with estimation methods used by Member States.

The EU GHG national total includes indirect CO_2 if these emissions have been reported by Member States. Both national totals, including and excluding indirect CO_2, are reported in the CRT tables. Indirect N_2O emissions reported in Summary 1 are not included in national GHG totals.

This chapter refers to the indirect emissions that are reported in Table 6 of the EU CRT tables. As mentioned above, indirect emissions are also 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 CRT 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 by EU Member States. Twelve countries provided values for indirect CO_2 emissions. The highest shares of the EU total of indirect CO_2 emissions are reported by France (23.4 %) and Italy (20.1 %). Seven countries reported indirect N_2O emissions for the year 2022, with Romania and Italy accounting together for almost 82 % of the total EU indirect N_2O emissions.

Indirect CO_2 is not an EU key category.

Table 9.1 Indirect CO_2 and N_2O emission for the EU in 2022

Countries	indirect CO_2 [kt CO_2 equ.]	Share in EU-27 [%]	indirect N_2O [kt CO_2 equ.]	Share in EU-27 [%]
Austria	IE,NA,NE,NO	-	NA,NE,NO	-
Belgium	NE	-	NE	-
Bulgaria	NE,NO	-	NE,NO	-
Croatia	NA,NO	-	NA,NO	-
Cyprus	6	0.2%	NE,NO	-
Czechia	611	16.9%	0.71	5.2%
Denmark	286	7.9%	0.75	5.6%
Estonia	IE,NE,NO	-	IE,NE,NO	-
Finland	51	1.4%	0.43	3.2%
France	848	23.4%	-	-
Germany	NE	-	IE,NE	-
Greece	NE,NO	-	NE,NO	-
Hungary	NE	-	NE	-
Ireland	IE,NA,NE	-	NA,NE,NO	-
Italy	728	20.1%	3.12	23.1%
Latvia	11	0.3%	IE,NA,NO	-
Lithuania	38	1.1%	NO	-
Luxembourg	NA,NE,NO	-	NA,NE,NO	-
Malta	NA,NE,NO	-	0.04	0.3%
Netherlands	457	12.6%	NE,NO	-
Poland	419	11.6%	NA	-
Portugal	127	3.5%	NA,NE,NO	-
Romania	NE,NO	-	7.93	58.6%
Slovakia	40	1.1%	NE,NO	-
Slovenia	NA,NE	-	NA,NE	-
Spain	NA,NE	-	NA,NE	-
Sweden	NE,NO	-	0.55	4.0%
EU-27	**3 624**	**100%**	**14**	**100%**

The methodologies for the estimation of indirect emissions in EU countries are consistent 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. CZE, DNM) explicitly mention that the precursor gases emissions (CO, NO_X 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 (e.g. in the IPPU category 2.D.3).

9.3 Uncertainties and time-series consistency

Indirect CO_2 emissions have decreased since 1990 in all countries but Poland (+63%), Lithuania (+12%) and Portugal (+37%). The highest percentage decrease has been reported by Denmark (-77 %), while in absolute terms Czechia had the biggest share in the EU reduction, decreasing its indirect CO_2 emissions by 1.3 Mt. The main reason for the decrease in indirect CO_2 emissions is the decrease of the precursor gases emissions. Since 1990, indirect N_2O emissions decreased in all seven reporting countries.

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) to the UNFCCC under CRT 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 of the Climate Change Committee of the European Commission. 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.

10 RECALCULATIONS AND IMPROVEMENTS

10.1 Main recalculations

Table 10.1 provides an overview for the largest recalculations (>+/- 500 kt CO_2 equiv.) in the year 1990 and 2021 for the EU-27 Member States, together with explanations for these as provided in the NIRs of Member States.

Recalculations presented are calculated from countries submissions (CRT tables) used for the EU submission in May 2023 and MS submissions received until 30 October 2024.

Table 8.1 Main recalculations by source category for 1990 (>+/-500 kt CO_2 eq.)

Category	MS	1990		2021		Main Explanations
		kt CO_2 eq.	%	kt CO_2 eq.	%	
1.A.1. Energy industries	DEU	109.89	0.0%	713.56	0.3%	Energy balance update
1.A.2. Manufacturing industries and construction	DEU	-1 192.32	-0.6%	-1 517.59	-1.2%	Re-allocation and EF updates after revision of the fuel uses.
1.A.2. Manufacturing industries and construction	ESP	-321.56	-0.7%	-1 139.99	-2.4%	The recalculation of the fuel balance for the entire period of the National Inventory has produced changes in sector 1A2, in terms of consumption, due to the contribution of information received from the balance.
1.A.2. Manufacturing industries and construction	FRK	-558.11	-0.9%	-1 117.11	-2.5%	CO_2 emissions from natural gas consumption in the chemical industry were re-allocated from the the energy to the IPPU sector.
1.A.2. Manufacturing industries and construction	ITA	1.05	0.0%	697.24	1.3%	Energy balance update
1.A.2. Manufacturing industries and construction	NLD	-5 612.97	-15.8%	-7 413.87	-26.6%	CO_2 emissions from natural gas consumption in the chemical industry were re-allocated from the the energy to the IPPU sector.
1.A.2. Manufacturing industries and construction	SWE	-7.45	-0.1%	-952.52	-15.1%	Revision of AD in 1A2g due to revision in energy balances.
1.A.3. Transport	DEU	79.78	0.0%	-2 385.74	-1.6%	Recalculations based on revised emission factors and methodological adjustments and improvements. Comprehensive revision of the energy balances 2003 to 2020 was carried out with corresponding impacts on the emissions reported for these years.
1.A.4. Other sectors	BEL	0.09	0.0%	-910.57	-3.6%	Reallocation of machinery emissions to 1.A.5, revision of the geographical spreading of total energy consumption for the model.
1.A.4. Other sectors	DEU	1 061.46	0.5%	3 114.07	2.5%	Revision of energy volume of petrol fuels.
1.A.4. Other sectors	ITA	620.12	0.8%	-975.88	-1.2%	Energy balance update
1.A.4. Other sectors	ITA	620.12	0.8%	-975.88	-1.2%	Energy balance update
2.B. Chemical industry	FRK	1 368.13	4.0%	543.37	7.7%	CO_2 emissions from natural gas consumption in the chemical industry were re-allocated from the the energy to the IPPU sector.
2.B. Chemical industry	NLD	5 712.15	37.1%	7 443.06	138.2%	CO_2 emissions from the combustion of process waste gases in the chemical industry were re-allocated from the the energy to the IPPU sector.
2.D. Non-energy products from fuels and solvent use	ITA	-1 311.23	-78.0%	-695.08	-69.2%	Following different UNFCCC review recommendations, from this year's submission, Italy has reported CO_2 emissions from the oxidation of NMVOCs from solvent use as indirect CO_2 emissions.
2.F. Product uses as ODS substitutes	ITA	0.00	0.0%	-5 976.65	-38.9%	Commercial, industrial and transport refrigeration have undergone major changes summarized below: 1) new estimation of the container emissions, not considered in previous submissions. 2) availability of refrigerants consumptions by subsectors and consequently possibility to estimate separately commercial, industrial, and transport refrigeration 3) availability of refrigerants consumption split between first charge and service 4) updating of lifetimes emission factors (industrial refrigeration). 5) update of end-of-life charge and end-of-life gas recovery rates.

Category	MS	1990		2021		Main Explanations
		kt CO_2 eq.	%	kt CO_2 eq.	%	
2.F. Product uses as ODS substitutes	PRT	0.00	0.0%	-1 198.05	-37.6%	Recalculations occurred are mostly due to the disaggregation between residential AC (households) and non-residential AC (commerce, services and industry), the revision of the fluids considered in this category, updated fluid's penetration rate throughout the whole time series, for the 3 emission stages: assembly, operation and disposal, revision of the number of residential AC equipment.
3.D. Agricultural soils	CZE	611.58	13.3%	396.46	12.7%	Implementation of the 2019 IPCC Guidelines
3.D. Agricultural soils	DEU	-1 171.71	-5.8%	-2 135.78	-12.9%	Implementation of a Tier 3 method to estimate N from leaching.
3.D. Agricultural soils	SVK	-622.76	-31.4%	-432.96	-39.8%	Implementation of the 2019 IPCC Guidelines
4.A. Forest land	AUT	4.57	0.0%	-1 029.23	9.9%	The forest land results for the years 2020 to 2022 are extrapolated using the results of the last NFI 2016/21and relative harvest indices based on the harvest statistics for these years. By introduction of a new reported year, the derived relative harvest indices for the years since 2020 and the biomass losses due to harvest have changed accordingly
4.A. Forest land	BGR	-1 609.76	10.9%	-330.25	4.1%	Introduction of new approach in calculating the soil organic carbon stock in lands under different land use and management, to address an error in calculating the CSC in soil pool of LUC categories.
4.A. Forest land	CZE	-249.48	3.5%	-1 843.96	-16.8%	The emission estimates were recalculated for the entire category of 4.A Forest land and reporting period. This was required due to rectifications in the harvest input and proportions related to harvest residues, and secondarily due to the related revisions in disturbance matrices used for CBM-CFS3 model. Finally, changes in activity data for prescribed burning affected non-CO_2 emissions (N_2O, CH_4). These improvements affected the estimates in all carbon pools and non-CO_2 emissions in category 4.A. The overall effect of the implemented revisions was 14 % for the reporting period, as the estimated emissions for 4.A Forest land decreased relative those in the previous NIR submission.
4.A. Forest land	DEU	-1 359.42	7.5%	2 724.89	-6.6%	Recalculation is mainly due to change in emission factor in mineral soils based on YASSO15 modelling.
4.A. Forest land	ESP	9.56	0.0%	-1 963.34	4.9%	Uopdated NFI data on the living biomass pool from some provinces involving recalculations for the eriod 2004-2021.
4.A. Forest land	EST	-1 373.73	30.8%	-1 759.82	-125.6%	Emissions from living biomass and DOM have changed compared to the previous submission, because of new methodologies for estimating C stock changes in living biomass and dead wood on Forest land remaining forest land and land converted to forest land areas. In addition, the EFs for mineral soils have been updated, which has resulted in higher C sequestration in mineral soils.
4.A. Forest land	FIN	2 659.20	-8.4%	3 338.73	-40.1%	Recalculations on tree biomass including gains, losses and stocks as well as recalculation of area of forest land. These changes impacted the full timeseries.
4.A. Forest land	FRK	-4 542.08	12.6%	-6 693.12	24.1%	Recalculations of activity data impacting the full timeseries as well as updated NFI data impacting 2020 and 2021.
4.A. Forest land	ITA	-160.56	0.9%	-673.64	2.4%	The recalculation is due to the update of the 2021 harvest data, updated with the data collected by the National Forestry System.

Category	MS	1990		2021		Main Explanations
		kt CO_2 eq.	%	kt CO_2 eq.	%	
4.A. Forest land	LTU	0.00	0.0%	623.61	-9.6%	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.
4.A. Forest land	POL	0.00	0.0%	585.13	-2.6%	Updated information from the NFI for 2022 required a recalculation of 2020 and 2021.
4.A. Forest land	ROU	2 160.35	-7.3%	898.70	-3.1%	Updated information on activity data and emission factors following a comparison of carbon stock changes between two NFIs and the estmation based on gain loss method. Overall this resulted in CO_2 removals deceased by 14% over the timeseries.
4.A. Forest land	SVN	0.00	0.0%	2 762.23	-93.9%	Recalculations were conducted for the period 2018-2021 for the forest land remaining forest due to updated emission factors for living biomass and dead wood, derived from recent estimates from the NFI 2020-2023.
4.A. Forest land	SWE	-5 000.52	10.7%	-2 417.16	6.7%	The pools dead organic matter and soil organic carbon on mineral soils on Forest land remaining Forest land have been recalculated for the whole time series from 1990 to 2022 due to the introduction of more re-inventoried sample plots. Also updated information from the NFI is used to update estimates on area and the biomass pool for the years 2018-2022.
4.B. Cropland	BGR	602.72	-78.5%	197.29	73.6%	Recalculations in soil pool of CL remaining CL and a correction of technical error in calculating the emission factor for biomass in pCL converted to aCL.
4.B. Cropland	DNM	-305.45	-5.7%	-2 132.71	-77.3%	A new map of organic soils representing the area in 2022 has been included in the time series, thus resulting in a time series based on three points in time: 1975, 2010 and 2022, showing a considerable decrease in the area of organic soils, especially from 2010 to 2022.
4.B. Cropland	FRK	633.61	2.5%	2 355.71	31.1%	Recalculations of activity data impacting the full timeseries. Also updated soil carbon stock and flux values have been updated.
4.B. Cropland	ITA	300.08	16.7%	1 122.61	100.6%	The 2019 IPCC Refinement SOCref and F-factors have been used to estimate the carbon stock changes in mineral soil, resulting a significant recalculation of the CO_2 estimates from/to this pool, in both cropland remaining cropland and land converted to cropland, for the whole time series. In addition, an error related to the attribution of the SOCref to the volcanic soils (about 5% of the national territory) has been fixes, with a small revision of the whole time series. Finally, activity data have been updated for the last reporting years, i.e., woody crops area for the 2020 and 2021 reporting years and the 2021 areas subject to the above described management practices. These updates influenced the estimates for cropland remaining cropland subcategory: the first regards the biomass carbon pool, the latter the soil organic carbon pool.
4.B. Cropland	POL	-353.46	-20.2%	-4 920.95	-287.7%	Recalculation due to update of emission factor for organic soils.
4.B. Cropland	SVK	440.28	-52.4%	519.51	-44.6%	Recalculation due to change in the relative stock change factors Flu and Fmg used for calculating carbon stock changes in mineral soils.
4.C. Grassland	DEU	-1 195.95	-4.0%	-3 922.14	-15.1%	Recalculations due to introduction of regionalised emission factors for biomass of annual herbaceous arable and grassland plants.

Category	MS	1990		2021		Main Explanations
		kt CO_2 eq.	%	kt CO_2 eq.	%	
4.C. Grassland	FRK	2 145.35	-31.1%	905.12	-67.3%	Recalculations of activity data impacting the full timeseries. Also updated soil carbon stock and flux values have been updated.
4.C. Grassland	IRL	-3 355.73	-46.1%	-4 597.36	-64.7%	Significant recalculations have been undertaken as a result of recent research in relation to organic soils in Ireland. This research has allowed for the allocation of organic soils to both nutrient poor and nutrient status. It has also allowed for the use of country specific emission factors in conjunction with the use of default emission factors from the 2013 Wetlands Supplement where appropriate.
4.C. Grassland	ITA	-279.35	-5.4%	518.88	-14.6%	Recalculation due to the 2019 IPCC Refinement SOCref and F-factors have been implemented to estimate the carbon stock changes in mineral soil, resulting a recalculation of the CO_2 estimates from/to this pool, for the whole time series. In addition, an error fixing in the disaggregation of the area of land converted to grassland into managed grazing land, natural grazing land and other wooded land influenced both living biomass and carbon stock changes in the mineral soil under land converted to grassland from 2006 onward.
4.C. Grassland	NLD	-1 017.49	-24.4%	-81.40	-2.9%	Further improvement of the Tier 3 method for estimating carbon stock changes due to land management of mineral soils in the remaining category for Cropland and Grassland have resulted in recalculations of this pool for the whole time series.
4.C. Grassland	SWE	-33.19	29.4%	-580.96	-226.8%	The pools dead organic matter and soil organic carbon on mineral soils on Grassland remaining Grassland have been recalculated for the whole time series from 1990 to 2022 due to the introduction of more re-inventoried sample plots. Also emissions from organic soils as well as carbon pool changes for land-use change categories have been recalculated due to updated activity data from the NFI.
4.D. Wetlands	FRK	235.08	78.9%	858.16	165.6%	Recalculations of activity data impacting the full timeseries. Also updated soil carbon stock and flux values have been updated.
4.D. Wetlands	IRL	2 293.27	120.1%	1 998.38	96.0%	Significant recalculations have been undertaken on the basis of a reclassification of wetland subcategories and recently published research and national land cover map developments. These have a significant impact on the both the level and trend in emissions and removals.
4.E. Settlements	DEU	53.05	4.1%	-1 058.16	-65.3%	Recalculations due to introductions of new land use subcategrories such as rainways and increse in area of organic soils.
4.E. Settlements	FRK	490.73	9.7%	932.82	19.5%	Recalculations of activity data impacting the full timeseries.
4.E. Settlements	POL	196.82	6.4%	735.38	19.1%	Recalculation due to update of emission factor for organic soils.
4.E. Settlements	SWE	-26.55	-1.1%	555.98	30.8%	Recalculations of emissions factors for land converted to settlements following updates of the pools dead organic matter and soil organic carbon on mineral soils on Forest land remaining Forest land and updates of activity data from the NFI.
4.G. Harvested wood products	DEU	0.00	0.0%	1 473.62	-17.0%	Recalculations were done due to implementation of improved activity data in the FAO database.
4.G. Harvested wood products	ESP	0.00	0.0%	-1 011.44	68.5%	New activity data for the years 2020 and 2021 have been incorporated in the inventory.
4.G. Harvested wood products	ITA	0.00	0.0%	1 674.81	-82.3%	Recalculation due to the revision of FAOSTAT time series for wood-based panels, for the years 2017-2021, and for paper&paperboard for 2021.

Category	MS	1990		2021		Main Explanations
		kt CO_2 eq.	%	kt CO_2 eq.	%	
4.G. Harvested wood products	LVA	0.00	0.0%	-565.33	27.7%	Recalculations were done due to implementation of improved activity data for 2019-2021.
4.G. Harvested wood products	POL	0.00	0.0%	-507.07	10.4%	Recalculation due to update in HWP production data.
5.A. Solid waste disposal	ESP	0.00	0.0%	660.72	6.4%	Recalculation due to error correction and completion of the landfills database
5.A. Solid waste disposal	FRK	-685.50	-5.2%	-1 220.12	-10.0%	Recalculation due to error correction regarding industrial waste (COD for C&D waste) when implementing the 2019 Refinement and improvement of the estimate of CH_4 recovery (2012-2021)
5.A. Solid waste disposal	POL	-1 308.15	-8.9%	-245.82	-18.9%	Recalculation due to implementation of the 2019 refinement, exclusion of mining and carrying waste from industrial waste and change in the estimation of MSW historical values and change in allocation
5.D. Waste water treatment and discharge	DEU	311.02	7.9%	1 225.50	134.3%	Due to the newly derived and changed N_2O and CH_4 emission factor for direct emission from waste water treatment plants, emissions are increasing significantly. At the same time, emissions for indirect emissions fall slightly due to the adjusted methodology.
5.D. Waste water treatment and discharge	POL	2 220.47	70.5%	-377.63	-13.7%	Recalculation due to application of new MCF for latrines (from the 2019 refinements) and update of the dry matter content of WWTP sludge

10.2 Implications for emission levels

Table 10.1 provides the differences in total GHG emissions (including indirect emissions) between the latest submission and the previous submission in absolute and relative terms for the EU. The table shows that due to recalculations, total 1990 GHG emissions with indirect CO_2 including LULUCF have decreased in the latest submission compared to the previous submission by 9 187 kt (0.2 %). EU GHG emissions for 2021 decreased by 25 703 kt (0.8%) due to recalculations.

Table 8.2 Overview of recalculations of EU total GHG emissions (difference between latest submission and previous submission in kt CO_2 equivalents)

Recalculations		1990	1995	2000	2005	2010	2015	2020	2021
Total CO_2 equivalent emissions, including indirect CO_2, without LULUCF	kt	- 528	- 2 597	- 490	508	- 10 475	- 5 635	- 17 685	- 14 742
	%	0.0%	-0.1%	0.0%	0.0%	-0.3%	-0.1%	-0.5%	-0.4%
Total CO_2 equivalent emissions, including indirect CO_2, with LULUCF	kt	- 9 187	- 3 833	- 7 159	- 5 657	- 9 212	- 7 812	- 17 482	- 25 703
	%	-0.2%	-0.1%	-0.2%	-0.1%	-0.2%	-0.2%	-0.6%	-0.8%

Table 10.2 provides an overview of recalculations for the key categories for 1990 and 2021 (see Section 1.4 for information on identification of key categories). The table shows that the largest recalculations in absolute terms were made in the key categories 1.A.2 Manufacturing Industries-CO_2 and 2.B Chemical Industry-CO_2, followed by key categories of the LULUCF sector – especially 4.A Forest Land, 4.C Grassland and 4.D Wetlands).

Table 8.3 Recalculations for EU key source categories 1990 and 2020 (difference between latest submission and previous submission in kt of CO_2 equivalents and in percentage)

Greenhouse Gas Source Categories	Gas	Recalculations 1990		Recalculations 2021	
		kt CO_2 equivalent	%	kt CO_2 equivalent	%
1.A.1. Energy industries	CO2	145	0.0%	484	0.1%
1.A.2. Manufacturing industrie	CO2	-7683	-1.1%	-10789	-2.5%
1.A.3. Transport	CO2	-405	-0.1%	-2933	-0.4%
1.A.3. Transport	CH4	-10	-0.2%	-77	-5.8%
1.A.3. Transport	N2O	-24	-0.4%	23	0.3%
1.A.4. Other sectors	CO2	1233	0.2%	-123	0.0%
1.A.4. Other sectors	CH4	3	0.0%	104	0.5%
1.A.5. Other	CO2	372	1.7%	-229	-3.3%
1.B.1. Solid fuels	CH4	-7	0.0%	-25	-0.1%
1.B.2. Oil and natural gas and	CH4	261	0.4%	54	0.3%
1.B.2. Oil and natural gas and	CO2	47	0.3%	23	0.2%
2.A. Mineral industry	CO2	17	0.0%	31	0.0%
2.B. Chemical industry	CO2	6929	13.5%	7932	17.4%
2.B. Chemical industry	N2O	168	0.2%	33	0.8%
2.B. Chemical industry	Unspecified mix of HFCs and PFCs	0	0.0%	-29	-63.4%
2.C. Metal industry	CO2	-47	0.0%	-93	-0.1%
2.F. Product uses as ODS subs	HFCs	0	0.0%	-7123	-10.3%
3.A. Enteric fermentation	CH4	239	0.1%	449	0.2%
3.B. Manure management	CH4	185	0.3%	474	1.1%
3.B. Manure management	N2O	90	0.4%	-340	-1.9%
3.D. Agricultural soils	N2O	-1886	-1.3%	-2802	-2.4%
3.G. Liming	CO2	0	0.0%	-43	-0.8%
4.A. Forest land	CO2	-8173	2.4%	-5010	1.7%
4.B. Cropland	CO2	767	1.2%	-2118	-10.3%
4.C. Grassland	CO2	-4622	-10.7%	-8145	-37.1%
4.D. Wetlands	CH4	2377	42.7%	2458	41.1%
4.D. Wetlands	CO2	200	1.9%	112	0.7%
4.E. Settlements	CO2	769	3.3%	971	4.0%
4.G. Harvested wood products	CO2	-128	0.4%	998	-2.1%
5.A. Solid waste disposal	CH4	-1867	-1.4%	-473	-0.6%
5.D. Waste water treatment an	CH4	2048	6.0%	-890	-5.2%
5.D. Waste water treatment an	N2O	-272	-3.7%	1515	24.3%

Note: Many of these source categories are presented in a more aggregated than the EU key source categories identified in Section 1.5.

Table 10.3 and Table 10.4 give an overview of absolute and relative changes of Member States' emissions due to recalculations for 1990 and 2021. Recalculations of more than 500 kt of CO_2 equivalents were made by 14 countries in 1990, and 17 countries in 2021. For the EU this resulted in a relative change of -0.2 % in 1990 emissions and -0.8 % in 2021. In 1990, the highest recalculations was made by Sweden, and in 2021 by France. On country level, the highest recalculations in relative terms were made by Sweden, followed by Slovenia and Estonia. In all these countries, substantial recalculation have been carried out for the category 4.A Forest Land, influencing significantly the total recalculations.

Table 8.4 Contribution of countries to EU recalculations of total GHG emissions, including indirect CO_2, with LULUCF for 1990–2021 (difference between latest submission and previous submission kt of CO_2 equivalents)

	1990	1995	2000	2005	2010	2015	2020	2021
Austria	558	467	345	334	417	376	-505	-850
Belgium	0	-5	-12	-8	-124	221	85	-725
Bulgaria	-1 636	-898	-215	65	-159	-371	-294	-402
Croatia	56	142	130	52	99	166	16	29
Cyprus	-75	-103	-83	-73	-74	-61	-56	-19
Czechia	335	-669	-273	-92	-197	-146	-1 248	-1 381
Denmark	-81	146	181	-42	-109	-935	-2 088	-2 504
Estonia	-1 543	-1 625	1 197	-181	797	1 622	-1 332	-2 109
Finland	2 707	2 841	3 167	3 516	3 489	3 464	3 589	2 734
France	-964	-3 150	-3 992	-2 790	3 406	-224	-2 575	-5 165
Germany	-3 779	3 994	-3 889	3 121	-3 239	5 829	2 432	-2 143
Greece	-21	-18	18	-22	65	87	604	978
Hungary	138	110	87	306	12	-116	-265	-458
Ireland	-1 410	-925	-1 795	-1 797	-2 080	-2 453	-2 200	-3 065
Italy	738	1 378	2 675	3 273	906	-1 150	-873	-3 624
Latvia	-2	-2	-1	59	148	214	-35	-184
Lithuania	-118	-128	-144	-145	-173	-107	389	491
Luxembourg	1	-20	-1	1	-7	-3	5	-10
Malta	-2	-5	-4	-8	6	24	-26	-35
Netherlands	-801	-932	-494	-254	78	516	-145	-506
Poland	1 042	-1 013	-1 208	-1 886	-3 955	-5 442	-4 829	-4 390
Portugal	-601	-638	-301	-612	-733	-650	-509	-222
Romania	1 887	2 593	2 668	1 339	318	1 706	868	1 215
Slovakia	69	375	325	434	581	438	459	382
Slovenia	13	3	-37	-59	-62	-295	2 697	2 749
Spain	-430	-350	-140	-2 656	-1 878	-2 237	-3 958	-3 335
Sweden	-5 269	-5 398	-5 364	-7 534	-6 744	-8 282	-7 689	-3 154
EU27	**-9 187**	**-3 833**	**-7 159**	**-5 657**	**-9 212**	**-7 812**	**-17 482**	**-25 703**

Note: Red marked are all Member State recalculations > +/- 500 kt CO_2 equivalents

Table 8.5 Contribution of Member States to EU recalculations of total GHG, including indirect CO_2, without LULUCF for 1990–2022 (difference between latest submission and previous submission kt of CO_2 equivalents)

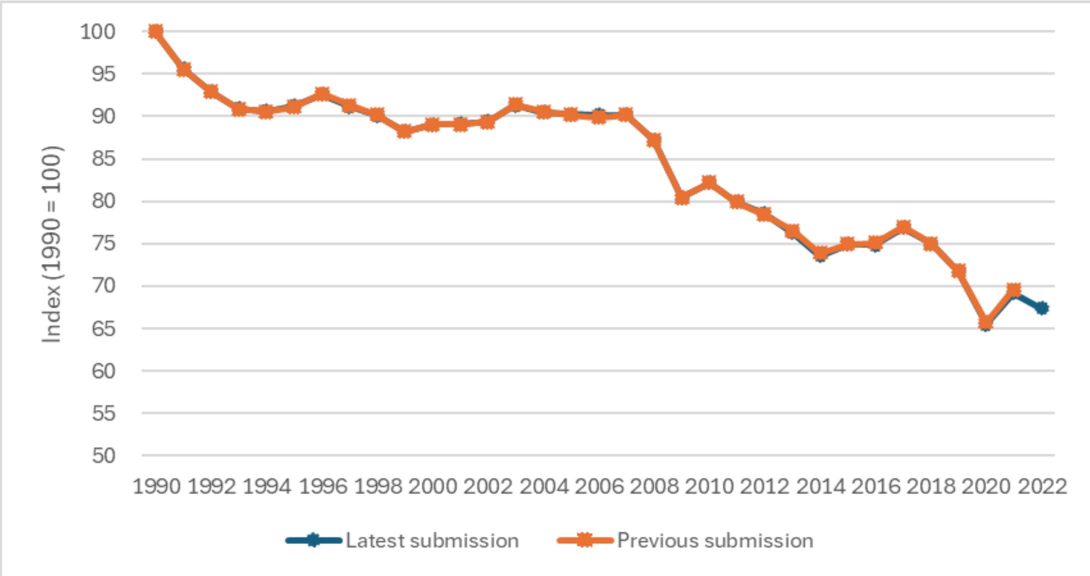
	1990	1995	2000	2005	2010	2015	2020	2021
Austria	0.8%	0.8%	0.5%	0.4%	0.6%	0.5%	-0.7%	-1.3%
Belgium	0.0%	0.0%	0.0%	0.0%	-0.1%	0.2%	0.1%	-0.7%
Bulgaria	-2.0%	-1.6%	-0.5%	0.1%	-0.3%	-0.7%	-0.8%	-0.9%
Croatia	0.2%	1.0%	0.7%	0.2%	0.5%	0.9%	0.1%	0.2%
Cyprus	-1.4%	-1.5%	-1.0%	-0.8%	-0.8%	-0.8%	-0.7%	-0.2%
Czechia	0.2%	-0.4%	-0.2%	-0.1%	-0.1%	-0.1%	-1.0%	-1.1%
Denmark	-0.1%	0.2%	0.2%	-0.1%	-0.2%	-1.9%	-4.5%	-5.4%
Estonia	-4.2%	-9.7%	9.4%	-1.1%	5.1%	9.4%	-9.6%	-13.6%
Finland	6.0%	6.0%	6.9%	8.5%	7.0%	9.0%	9.3%	5.7%
France	-0.2%	-0.6%	-0.8%	-0.6%	0.7%	-0.1%	-0.7%	-1.3%
Germany	-0.3%	0.4%	-0.4%	0.3%	-0.3%	0.7%	0.3%	-0.3%
Greece	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.9%	1.4%
Hungary	0.2%	0.2%	0.1%	0.4%	0.0%	-0.2%	-0.5%	-0.8%
Ireland	-2.3%	-1.4%	-2.3%	-2.3%	-3.0%	-3.6%	-3.3%	-4.4%
Italy	0.1%	0.3%	0.5%	0.6%	0.2%	-0.3%	-0.2%	-0.9%
Latvia	0.0%	0.1%	0.1%	1.2%	1.5%	2.0%	-0.3%	-1.4%
Lithuania	-0.3%	-0.7%	-1.4%	-0.8%	-1.7%	-0.9%	2.9%	3.5%
Luxembourg	0.0%	-0.2%	0.0%	0.0%	-0.1%	0.0%	0.1%	-0.1%
Malta	-0.1%	-0.2%	-0.2%	-0.3%	0.2%	1.2%	-1.2%	-1.6%
Netherlands	-0.3%	-0.4%	-0.2%	-0.1%	0.0%	0.3%	-0.1%	-0.3%
Poland	0.2%	-0.2%	-0.3%	-0.5%	-1.1%	-1.5%	-1.4%	-1.2%
Portugal	-0.9%	-1.1%	-0.4%	-0.7%	-1.2%	-1.0%	-1.0%	-0.4%
Romania	0.8%	1.6%	2.4%	1.1%	0.4%	2.6%	1.4%	1.8%
Slovakia	0.1%	0.9%	0.8%	0.9%	1.4%	1.2%	1.6%	1.1%
Slovenia	0.1%	0.0%	-0.3%	-0.4%	-0.5%	-1.7%	21.0%	21.1%
Spain	-0.2%	-0.1%	0.0%	-0.7%	-0.6%	-0.8%	-1.7%	-1.4%
Sweden	-21.0%	-17.6%	-26.6%	-32.5%	-47.9%	-115.9%	-156.1%	-51.6%
EU27	**-0.2%**	**-0.1%**	**-0.2%**	**-0.1%**	**-0.2%**	**-0.2%**	**-0.6%**	**-0.8%**

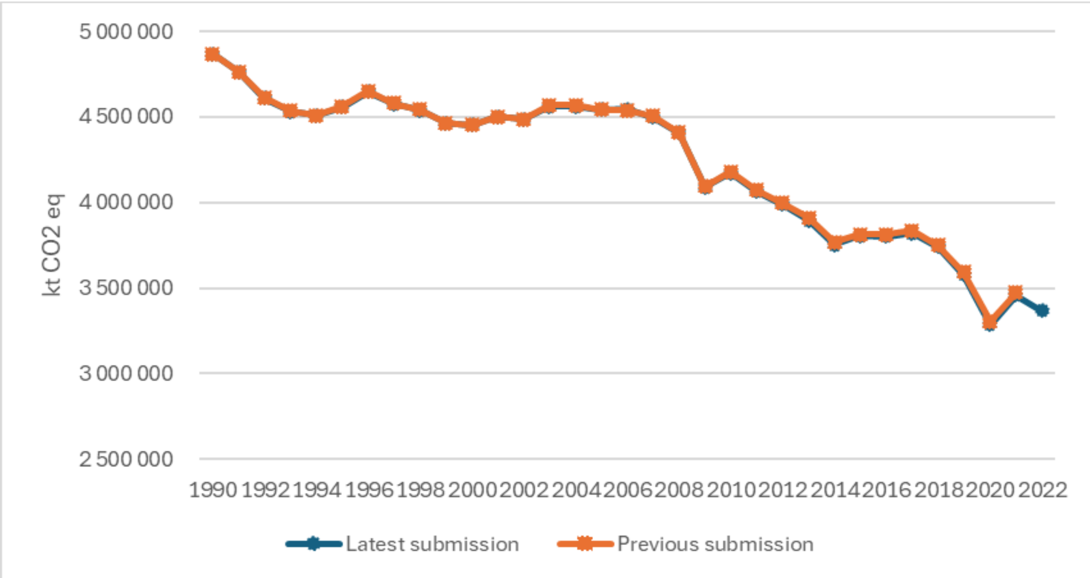
Note: Red marked are all Member State recalculations > +/- 1%

10.3 Implications for emission trends, including time series consistency

Figure 10.2 shows that the overall emission trend has only marginally changed due to recalculations caused by methodoligcal changes. The indexes are therefore largely overlapping. In the previous submission total GHG emissions (with indirect CO_2 and including LULUCF) of the EU decreased by 30.4%, and in the latest submission it decreased by 30.8% between 1990 and 2021.

Figure 10.1: Comparison of EU GHG emission trends 1990–2020 (with indirect CO_2 and including LULUCF) of the latest and the previous submission, as index and in absolute values





10.4 Recalculations, including in response to the review process, and planned improvements to the inventory

In 2024, the reporting has been amended to be in line with the new CRT reporting tables, as well as the NID outline. Descriptions of categories have been aligned accordingly. The report has been updated following the latest information available in Member State submissions.

Any recommendations for improvement of earlier UNFCCC reviews have been continuously followed up and implemented.

The improvements made can be summarised as follows:

- Amendment of layout for figures to display emission trends in sectors
- Increased transparency in tables displaying Member State's emissions by highlighting main contributing countries

- Streamlining and harmonizing of information provided in sectoral chapters

Improvements planned for the next reporting cycle are:

- Include new key categories in the NID giving detailed information like for other key categories
- Continue efforts to ensure consistency between CRT/JSON files and NID
- Continue efforts in harmonising the sectoral chapters and the content provided
- Continue the regular QA/QC activities and correct any possible inconsistencies detected

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12 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
CRT	common reporting tables
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
ETF	Enhanced Transparency Framework

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
MPG	Modalities, Procedures and guidelines
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
NID	national inventory document
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:

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				
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				