umweltbundesamt
ENVIRONMENT AGENCY AUSTRIA

Austria's National Inventory Document 2025

Submission under the UNFCCC and under the Paris Agreement

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REPORT
REP-0964

VIENNA 2025

Since 23 December 2005 the Umweltbundesamt has been accredited as Inspection Body for emission inventories, Type A (ID No. 241), in accordance with EN ISO/IEC 17020 and the Austrian Accreditation Law (AkkG), by decree of Accreditation Austria (first decree, No. BMWA-92.715/0036-I/12/2005, issued by Accreditation Austria / Federal Ministry of Economics and Labour on 19 January 2006).

The accreditation scope of the IBE is listed on: akkreditierung-austria.gv.at/overview. The specific underlying standards for the results presented in this report are outlined in Chapter 1.5 of this report.

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The 'National Inventory Document' ('NID') as well as the 'Common Reporting Tables' ('CRT') are elements of the official 2025 submission of Austria under the UNFCCC and under the Paris Agreement as well as under the EU Governance Regulation (EU) 218/1999 in fulfilment of Article 26. It replaces the one designated as DRAFT submitted to the EU on March 15th 2025 and has undergone a complete and final quality control and layout/typesetting. The report meets the requirements of the MPGs of the ETF as stipulated in chapter II of annex to 18/CMA.1 on 'National inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases' of the MPGs.

This report is compiled and published as an inspection report in accordance with the Accreditation Law and the international standard ISO/IEC 17020, in fulfilment of and in compliance with the IPCC 2006 Guidelines, the IPCC 2019 Refinement, the 2006 GL Revised Supplement KP as well as the 2006 GL Supplement Wetlands (as included in the scope of accreditation regarding GHG emissions) as well as the UNFCCC Reporting Guidelines.

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PREFACE

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), Austria is required to produce and regularly update National Greenhouse Gas Inventories. Methodologies, content and format of this reporting obligation are prescribed by the IPCC (IPCC, 2006) and the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (Decision 18/CMA.1)

Developed country Parties to the Paris Agreement must submit their annual 'National Inventory Reports' (NIRs) – covering 'Common Reporting Tables' (CRT) as well as an 'National Inventory Document' (NID) – to the UNFCCC by 15 April each year. The first submission of the NIR under the Paris Agreement was done in December 2024 together with the submission of Austria's first Biennial Transparency Report.

The Austrian NID is submitted as a stand-alone report, and not as part of the BTR (Biennial Transparency Report). This is because developed country Parties to the Convention under the Paris Agreement have to submit their GHG inventories annually, even in years when a BTR is not due. Detailed requirements on definitions, national circumstances and institutional arrangements, methods, metrics and reporting guidance are stipulated in the MPG's – the Modalities, Procedures and Guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement' included in Annex to Decision 18/CMA.1 (FCCC/PA/CMA/2018/3/Add.2). The outline of the NID is set out in Annex V to Decision 5/CMA.3 (FCCC/PA/CMA/2021/10/Add.2).

First, there is an Executive Summary giving an overview of Austria's greenhouse gas inventory. Chapter 1 provides general information on the national circumstances, institutional arrangements and cross-cutting information. Chapter 2 summarizes the overall trends in emissions. Comprehensive information on the methodologies used for estimating emissions of Austria's greenhouse gas inventory is presented in the Sector Analysis Chapters 3–8. Chapter 9 reports on indirect carbon dioxide and nitrous oxide emissions. Chapter 10 gives an overview of recalculations, including improvements made and planned in response to the previous reviews.

The report also presents GHG data relevant under the Effort-sharing Regulation[1] (target period 2021–2030) covering greenhouse gas emissions for sectors not covered by the emissions trading system. It is submitted as final report[2] to the European Commission in fulfilment of Austria's obligations under Article 26 of Regulation (EU) No 218/1999 ('Governance Regulation')[3] governing reporting of greenhouse gas inventory data by Member States from 2023 onwards. The purpose of this

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[1] 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.

[2] First submission 2025 was done on 15th January 2025 providing inventory data for 2023 and information as stipulated in Art. 26 (3) in the EU Governance Regulation: 'Short-NID 2025'; Umweltbundesamt (2025a).

[3] 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, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

regulation is to monitor anthropogenic greenhouse gas emissions and to evaluate the progress towards meeting the Union greenhouse gas reduction commments in accordance with the Paris Agreement.

The CO_2-equivalent emissions presented in this report were calculated by applying the Global Warming Potentials ('GWPs') according to the 5th Assessment Report ('AR5') of the Intergovernmental Panel on Climate Change (IPCC). Austria thus fulfills the requirements of the Decision 18_CMA1 as well as the EU Governance Regulation 2018/1999[4] on GHG inventories applicable from 2023 onwards, which, by means of its Delegated Regulation 2020/1044[5] Article 2, requires the use of the GHG potentials listed in Annex 1 of this Regulation in accordance with AR5.

This is the 24th version of the national GHG inventory report submitted by Austria. It builds on the NID submitted 2024 (Umweltbundesamt, 2024b) and is consistent with the Common Reporting Tables submitted together with this report.

Data and information presented in this report replaces the information submitted in previous years.

Michael Anderl in his function as head of the Expert Team *National Emission Inventories* of the *Umweltbundesamt* is responsible for the preparation of Austria's National Greenhouse Gas Inventory as well as for the preparation of the NID.

Michael Anderl in his function as head of the *Inspection Body for Emission Inventories* is responsible for the content of this report and for the quality management system of the Austrian Greenhouse Gas Inventory. Katja Pazdernik acts as deputy head of the *Inspection Body for Emission Inventories.*

Project leader for the preparation of the Austrian GHG inventory is Stephan Poupa.

Specific responsibilities for the preparation of the Austrian GHG inventory are:

- Data management.................................... Stephan Poupa
- Fuel combustion stationary...................... Stephan Poupa ('Sector Coordinator')
- Fuel combustion mobile .... Gudrun Stranner ('Sector Coordinator')
- Fuel combustion residential..................... Wolfgang Schieder ('Sector Coordinator')
- Fugitive emissions .... Marion Gangl ('Sector Coordinator'')
- Industrial processes and Product Use .... Maria Purzner ('Sector Coordinator')
- Agriculture .... Simone Mayer ('Sector Coordinator')
- LULUCF... Peter Weiss ('Sector Coordinator')
- Waste.. Katja Pazdernik ('Sector Coordinator')

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4 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, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

5 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.

- Key Category Analysis .... Bradley Matthews
- Uncertainty Analysis.................................. Bradley Matthews

Project leader for the preparation of the NID is Katja Pazdernik.

Specific responsibilities for the NID 2025 have been as follows:

- Executive Summary ....Katja Pazdernik
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- Chapter 1.2, 1.3...Günther Schmidt, Manuela Wieser
- Chapters 1.5, 1.6 ....Bradley Matthews
- Chapter 2 ....all sector experts
- Chapters 3.1, 3.2, 3.4, 7.4.1 ....Stephan Poupa
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- Chapter 3.3 ....Marion Gangl, Katja Pazdernik, Jérôme Colson
- Chapter 4 ....Maria Purzner, Manuela Wieser, Jérôme Colson
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- Chapters 7.1–7.3, 7.5................................Katja Pazdernik, Michael Roll
- Chapter 7.4 ....Stephan Poupa, Simone Mayer
- Chapter 8 ....Katja Pazdernik
- Chapter 9 ....Katja Pazdernik
- Chapter 10 ....all sector experts

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EXECUTIVE SUMMARY

ES.1 BACKGROUND INFORMATION ON GHG INVENTORIES AND CLIMATE CHANGE

ES.1.1Background information on climate change

Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. It undergoes natural variability. Since industrialisation started some 150 years ago, mankind has been influencing the climate via the emission of greenhouse gases. In 1992, by adopting the United Nations Convention on Climate Change, the countries of the world came together to prevent harmful effects of climate change. However, the Convention did not include binding commitments to limit GHG emissions. To go this step further the Kyoto Protocol was adopted in 1997: It sets binding emission limits for 37 industrialized countries for the period 2008–2012. An agreement on a second Kyoto commitment period from 2013 to 2020 was achieved 2012 at the 18th Conference of the Parties in Doha (Qatar) (UNFCCC CMP.8). The agreed reduction for the EU is 20% compared to 1990 emissions, which is in line with the climate and energy package 2020 of the EU.

The decision to negotiate a new global agreement for the period after 2020 was made at the Conference of the Parties in Durban in 2011. In December 2015, this was adopted at the 21st Conference of the Parties in Paris. It entered into force on November 4, 2016, as more than 55 Parties covering at least 55% of global GHG emissions ratified it.

The Paris Agreement established the long-term 2°C target for the first time in an international treaty. It also calls for additional efforts to limit temperature increases to 1.5°C. In contrast to the Kyoto Protocol, this new agreement includes not only industrialized but also newly industrializing and developing countries in order to take account of the change in the global distribution of GHG emissions. Plans for emission reductions (Nationally Determined Contributions, NDCs) of the participating countries have been submitted to the UNFCCC.

ES.1.2 Background information on greenhouse gas inventories

To be able to evaluate the trend of greenhouse gas emissions, especially the progress in achieving the emission reduction goal, it is necessary to regularly compile an inventory of GHG emissions.

ES.2 SUMMARY OF TRENDS RELATED TO NATIONAL EMISSIONS AND REMOVALS

In 2023 Austria's total greenhouse gas (GHG) emissions (without Land Use, Land Use Change and Forestry – LULUCF) amounted to 68.7 Mt CO_2 equivalents (CO_2e). Compared to the 1990 base year[6], 2023 GHG emissions without LULUCF decreased by 13.7%. Compared to 2022 GHG emissions decreased by 6.6%.

The most important gas in the Austrian GHG balance remains carbon dioxide (CO_2) with a share of 83% in total 2023 emissions (without LULUCF). Emissions of CO_2 primarily result from combustion activities. Methane (CH_4), which mainly arises from livestock farming and waste disposal, contributes 10% (2023) to total national GHG emissions. Nitrous oxide (N_2O), with agricultural soils as the main source, contributes another 4.5% (2023). The remaining 2.6% are emissions of fluorinated compounds, which are mostly emitted from the use of these gases as substitutes for ozone depleting substances (ODS) in refrigeration equipment.

Table 1: Austria's greenhouse gas emissions by gas.

GHG emissions	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NF_3	Total
	CO_2 equivalents (kt)							
1990	62 191	11 763	4 117	2.0	1 063	485	NO,NA	**79 621**
1995	64 063	10 967	3 997	328	75	1 134	6.0	**80 570**
2000	66 204	9 655	4 160	688	80	592	9.8	**81 389**
2005	79 095	8 961	3 502	1 097	150	509	26	**93 341**
2010	72 000	8 349	3 217	1 455	71	346	3.9	**85 442**
2011	69 892	8 114	3 304	1 554	66	317	3.8	**83 251**
2012	67 260	7 977	3 270	1 604	46	321	8.0	**80 487**
2013	67 759	7 855	3 238	1 647	45	315	9.1	**80 868**
2014	64 159	7 694	3 312	1 669	48	324	9.9	**77 215**
2015	66 358	7 605	3 322	1 698	45	319	13	**79 359**
2016	67 219	7 539	3 405	1 700	46	405	5.7	**80 319**
2017	69 601	7 500	3 335	1 736	40	412	11	**82 635**
2018	66 567	7 292	3 293	1 847	30	398	15	**79 441**
2019	67 951	7 168	3 275	1 749	35	450	13	**80 641**
2020	62 180	7 082	3 223	1 699	27	454	14	**74 679**
2021	65 751	7 109	3 251	1 555	24	368	15	**78 073**
2022	61 454	7 005	3 148	1 506	24	362	16	**73 515**
2023	56 909	6 892	3 077	1 402	26	372	18	**68 696**

[6] Austria's base year under the UNFCCC is 1990. Under the EU Effort Sharing, the base year is 2005 (relates only to emissions not included in the EU Emissions Trading Scheme). Unless otherwise specified, references to the base year in this report refer always to 1990.

Note: Global warming potentials (GWPs) according to the 5th Assessment Report (IPCC 2013) (100 years time horizon): carbon dioxide (CO_2) = 1; methane (CH_4) = 28; nitrous oxide (N_2O) = 265; sulphur hexafluoride (SF_6) = 23 500; nitrogen trifluoride (NF_3) = 16 100; hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) consist of different substances, therefore GWPs have to be calculated individually depending on the substances

Over the period 1990–2023 CO_2 emissions decreased by 8.5%, mainly due to decreasing emissions from energy industries and the residential sector. During the same period CH_4 emissions decreased by 41%, mainly due to lower emissions from solid waste disposal sites, to a smaller extent also from enteric fermentation. N_2O emissions decreased by 25% due to lower emissions from the chemical industry (nitric acid production) and from agricultural soils. HFC emissions increased remarkably between 1990 and 2023 (from 2.0 to 1 402 kt CO_2e), whereas PFC and SF_6 emissions decreased by 98% and 23% respectively. NF_3 emissions amounted to 18 kt CO_2e in 2023 compared to zero emissions in 1990.

ES.3 OVERVIEW OF SOURCE AND SINK CATEGORY EMISSION ESTIMATES AND TRENDS

The dominant sector regarding GHG emissions in Austria is *Energy*, causing 65% of total national GHG emissions in 2023 (66% in 1990), followed by the sectors *Industrial Processes and Other Product Use* (23% in 2023) and *Agriculture* (11% in 2023).

Table 2: Austria's greenhouse gas emissions by sector.

GHG source and sink categories	1. Energy	2. IPPU	3. Agriculture	4. LULUCF	5. Waste	6. Other
	CO_2 equivalents (kt)					
1990	52 835	13 641	8 581	-13 756	4 565	NO*
1995	54 329	13 631	8 353	-18 397	4 257	NO
2000	55 459	14 454	8 013	-18 060	3 463	NO
2005	66 889	15 651	7 578	-15 228	3 223	NO
2010	59 453	15 965	7 574	-11 734	2 450	NO
2011	57 141	16 161	7 645	-11 027	2 303	NO
2012	54 997	15 731	7 584	-9 156	2 176	NO
2013	55 169	16 097	7 570	-5 020	2 032	NO
2014	51 439	16 171	7 699	-9 828	1 906	NO
2015	53 218	16 611	7 727	-4 085	1 803	NO
2016	54 441	16 322	7 843	-8 125	1 715	NO
2017	56 154	17 078	7 781	-4 430	1 623	NO
2018	54 708	15 502	7 683	1 831	1 548	NO
2019	55 093	16 474	7 579	6 002	1 495	NO
2020	50 142	15 524	7 568	-950	1 445	NO

GHG source and sink categories	1. Energy	2. IPPU	3. Agriculture	4. LULUCF	5. Waste	6. Other
	CO_2 equivalents (kt)					
2021	52 042	17 030	7 607	-3 362	1 394	NO
2022	48 434	16 170	7 573	-206	1 337	NO
2023	44 451	15 472	7 477	7 530	1 295	NO

**not occurring*

ES.4 OTHER INFORMATION

Overview of Emission Estimates and Trends of Indirect GHGs and SO_2

Emissions of indirect greenhouse gases decreased in the period from 1990 to 2023: NO_x by 50%, CO by 63%, NMVOC by 69%, and SO_2 by 86%. The most important emission source for NO_x, SO_2 and CO is *Energy* (fuel combustion). The most important emission sources for NMVOC are *Industrial Processes and Other Product Use and Agriculture.*

Table 3: Emissions of indirect GHGs and SO_2 1990–2023.

	NO_x	CO	NMVOC	SO_2
	[kt]			
1990	215	1 248	338	74
1995	198	972	252	47
2000	211	727	192	31
2005	246	624	163	26
2010	204	577	140	16
2011	196	560	134	15
2012	191	560	131	15
2013	192	563	128	14
2014	185	528	122	14
2015	182	539	120	14
2016	175	534	119	13
2017	165	525	118	13
2018	153	483	113	11
2019	144	496	112	11
2020	123	473	113	10
2021	122	536	114	11
2022	113	482	105	11
2023	107	465	103	10
1990–2023	-50%	-63%	-69%	-86%

ES.5 KEY CATEGORY ANALYSIS

A description of the key categories is provided in Chapter 1.4.

ES.6 IMPROVEMENTS INTRODUCED

A description of implemented and planned improvements (including recalculations) is provided in Chapter 10.3.

1 NATIONAL CIRCUMSTANCES, INSTITUTIONAL ARRANGEMENTS AND CROSS-CUTTING INFORMATION

1.1 Background information on GHG inventories and climate change

1.1.1 Background information on climate change

1.1.1.1 Global Warming

Temperature around the world has been rising since the Industrial Revolution. Scientific evidence makes clear that human activities are mostly responsible for the increase by emitting greenhouse gases like carbon dioxide, methane, nitrous oxide as well as various fluorinated and chlorinated gases (IPCC 2014).

The average global temperature on earth has increased by a little more than 1° Celsius since 1880, while two-thirds of the warming has occurred since 1975 (NASA, 2020).

According to the fifth assessment report of the IPCC 2014, temperature will rise by another 0.9–5.4°C in the 21st century, depending on the emission scenario.

The IPCC 2019 states that global warming from the pre-industrial period to the present will persist for centuries and will continue to cause further long-term changes in the climate system.

It will lead to changes in the hydrological cycle as well as to modification of the albedo (total reflectivity of the earth) and to significant changes of the atmospheric circulation. This will increase the risk of extreme weather events such as hurricanes, droughts and floods and others.

1.1.1.2 Climate Change in Austria

Since 1880, an approx. 2°C increase in the average air temperature in Austria has been recorded (APCC 2014), which is significantly higher than the global average. The effects of global warming in Austria are already visible today: rapid melting of glaciers, thawing of permafrost, an increasing number of hot days, longer vegetation periods, etc.

In 2015, regional climate projections for the near (2050) and distant future (2100) were made available for Austria (called ÖKS15), providing comprehensive, high-resolution and error-corrected information on climate change. All models consistently show significant increases in annual and seasonal mean temperatures throughout Austria, about +1.3°C to +1.4°C by 2050. By the end of the 21st century, with +4.0°C throughout Austria, RCP8.5 predicts a much more pronounced increase in temperature than RCP4.5 at +2.3°C.

Being aware of the need for further research to various topics related to climate change, Austria launched StartClim and the Austrian Climate Research Program (ACRP) in the last century and installed in 2011 the Climate Change Center Austria (CCCA). Furthermore a strategy to adapt to climate change in Austria was developed in 2012 and updated in 2017.

1.1.1.3 The Convention, its Protocols and the flexible mechanisms thereunder

In 1992 Austria signed the United Nations Framework Convention on Climate Change (UNFCCC) which sets an ultimate objective of stabilizing atmospheric concentrations of greenhouse gases at levels that would prevent "dangerous" human interference with the climate system. Such levels, which the Convention does not quantify, should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The UNFCCC covers all greenhouse gases not covered by the Montreal protocol[7]: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) as well as hydrogenated fluorocarbons (HFCs), perfluorinated halocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

Five years after adoption of the Climate Change Convention in 1997, governments took a further step forward and adopted the landmark Kyoto Protocol. Building on the Convention, the Kyoto Protocol broke new ground with its legally binding constraints on greenhouse gas emissions and its innovative 'mechanisms' aimed at cutting the cost of curbing emissions. Under the terms of the Protocol, the industrialised world – Parties listed in Annex I of the Convention and known as 'Annex I countries' – pledged to reduce their greenhouse (GHG) emissions by 5% below 1990 levels by the period 2008–2012. The European Union is also a Party to the Convention and the KP and agreed on a reduction target of 8% below 1990 levels during the five-year commitment period from 2008 to 2012. The EU and its Member States decided to achieve this goal jointly, for Austria an emission target of minus 13% was set.

The KP entered into force on 16 February 2005, triggered by Russia's ratification in November 2004 which fulfilled the requirement that at least 55 Parties to the Convention ratified (or approved, accepted, or acceded to) the Protocol, including Annex I Parties accounting for 55% of that group's carbon dioxide emissions in 1990: by April 2011, 190 Parties had ratified the KP, accounting for 63.7% of emissions of Annex I Parties.

The Protocol sets out three 'flexible mechanisms' to help countries meet their obligations to cut emissions.

- *Emission Trading*: Article 17 of the Kyoto Protocol allows Annex I Parties (basically, the industrialised nations) to purchase the rights to emit greenhouse gases (GHG) from other Annex I countries which have reduced their GHG emissions below their assigned amounts. Trading can be carried out by intergovernmental emission trading, or entity-source trading where assigned amounts are allocated to sub-national entities.
- *Joint Implementation*: Article 6 allows an Annex I Party to gain a credit (converted to Assigned Amounts) by investing in another Annex I country in a project which reduces GHG emissions.
- *Clean Development Mechanism*: Article 12 allows an Annex I country (or companies in an Annex I country) which funds projects in developing countries (non-Annex I Party) to get credits for certified emission reductions providing that "benefits" accrue for the host country.

Tradable emission permits tie the emissions to a fixed ceiling, the costs of emission reduction being as low as possible.

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[7] The Montreal Protocol sets the elimination of ozone-depleting substances as its final objective and covers chloro and bromo fluorocarbons.

The final assessment on compliance with the goals of the first commitment period of the KP was made 2016 in the true up process after finalization of the last review reports.

The so called Doha Amendment extends GHG mitigation obligations of the Kyoto Protocol until 2020, establishing a second commitment period. As of 28 October 2020, 147 Parties had deposited their instrument of acceptance, exceeding the threshold of 144 instruments of acceptance. The Doha Amendment entered into force on 31 December 2020.[8]

Independently of the setting into force of the Doha Amendment, the European Community has fixed its goal in the so called Effort Sharing Decision (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), with the goal of a 20% cut of emissions below the 1990 emission level by 2020. The ESD Directive also sets national emission targets for the member states, the Austrian target is −16% related to 2005 (not considering the sectors/sources regulated by the EU ETS).

Paris Agreement:

After negotiations on a global climate protection agreement failed in Copenhagen in 2009, the decision to negotiate a new global agreement for the period after 2020 was made at the Conference of the Parties in Durban in 2011. In December 2015, this was adopted at the 21st Conference of the Parties in Paris. It entered into force on November 4, 2016, as more than 55 Parties covering at least 55% of global GHG emissions ratified it.

The Paris Agreement established the long-term 2°C target for the first time in an international treaty. It also calls for additional efforts to limit temperature increases to 1.5°C. In contrast to the Kyoto Protocol, this new agreement includes not only industrialized but also newly industrializing and developing countries in order to take account of the change in the global distribution of GHG emissions. Plans for emission reductions (Nationally Determined Contributions, NDCs) of the participating countries have been submitted to the UNFCCC. From 2020, all Parties are required to submit increasingly ambitious climate change mitigation plans on a regular basis and to report transparently on progress to date from 2024. By the second half of the century, global decarbonization efforts are to result in "net zero emissions.

To meet the goal of the Paris Agreement, the emission reduction target of at least 40 % (relative to 1990) of the EU's 2030 climate and energy policy framework adopted in 2014 has been increased to a net emission reduction target of at least 55 % under the new EU Climate Law, adopted under the European Green Deal.

For 2050, the European Commission has set itself the goal to be climate-neutral, a legally binding target that it is also set out in the EU Climate Law. To achieve the ambitious targets of the Climate Law, the EU Commission presented in July 2021 a legislative 'Fit for 55' package, which includes proposals and amendments to a number of existing legal rules (such as the Effort Sharing Regulation, Emissions Trading Directive and the Energy Efficiency Directive).

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[8] https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment

1.1.2 Background information on greenhouse gas inventories

As a Party to the Convention, Austria is required to produce and regularly update National Greenhouse Gas Inventories. Furthermore Parties shall submit a National Inventory Document (NID) containing detailed and complete information on their inventories, in order to ensure the transparency of the inventory. This report presents the latest results from the Austrian greenhouse gas (GHG) inventory, documenting the annual national GHG emissions for the years 1990 to 2023.

The Environmental Control Act ('Umweltkontrollgesetz'; Federal Law Gazette 152/1998)[9] designated the Umweltbundesamt as the single national entity with overall responsibility for inventory preparation. Within the Umweltbundesamt, the Inspection Body for Emission Inventories (IBE) was established and entrusted with the preparation of and reporting on emission inventories; since 2005 the IBE is accredited according to EN ISO/IEC 17020. In 2011, 2016 and 2020 the re-accreditation was passed successfully. In between these re-accreditation audits several external audits were conducted by quality experts appointed by Accreditation Austria, last in June 2023.

For the purpose of Quality Assurance, resulting from increased requirements of transparency, consistency, comparability, completeness and accuracy of the national greenhouse gas inventory, the inventories have been annually reviewed by international experts managed by the Climate Secretariat in Bonn (expert review team ERT). To date, Austria's Greenhouse Gas Inventory was reviewed by three in-country reviews (2006, 2007[10] and 2013) and various centralized reviews in 2001 (during the trial period of the review process), 2003, 2004, 2005, 2007, 2008, 2009, 2010, 2011, 2012, 2014, 2015, 2016, 2018, 2020 (as a desk review[11]), 2022 and 2023. In 2017, 2019, 2021 and 2024 no UNFCCC Reviews were conducted[12].

The reports on Austria's inventory reviews can be found on the UNFCCC website, the recommendations from the latest UNFCCC review 2023[13] and their implementation are demonstrated in Table 345.

In addition, annual reviews were conducted for all EU MS inventories 2013–2020 according to Article 19 of the MMR (Monitoring Mechanism Regulation No 525/2013). In 2012 a technical review was done by EU experts, with the aim of supporting the determination of Member States' annual emission allocations under Decision No 406/2009/EC (Effort-Sharing Decision). In 2015 this 'ESD-Review' was conducted as a trial review as inventories were submitted delayed due to the technical problems with the UNFCCC CRF Reporter. Annual ESD reviews of the Austrian inventory were successfully passed in 2017, 2018, 2019, 2021, 2022 and 2023[14]. 'Comprehensive ESD-Reviews' were carried out in 2016 and 2020 with no technical corrections being necessary. The next comprehensive review under the Effort-Sharing Regulation (ESR) according to Article 38 Governance Regulation will be conducted in 2025 and will form the basis for the AEAs for the years 2026 to 2030.

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[9] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10011109

[10] In February 2007 the in-country review of the initial report of Austria (the Pre-commitment period review) took place, covering the review of the assigned amount, the national inventory system and the national registry.

[11] The review 2020 was originally organized as an in-country review, but had to be re-organised as a 'remote centralised review' given the of impacts of Covid-19.

[12] In these years, only initial checks of the greenhouse gas inventory of Austria took place.

[13] https://unfccc.int/sites/default/files/resource/arr2023_AUT.pdf

[14] For the first time conducted as an ESR-Review (Effort-Sharing Regulation, Article 38 Governance Regulation)

1.2 Description of national circumstances and institutional arrangements

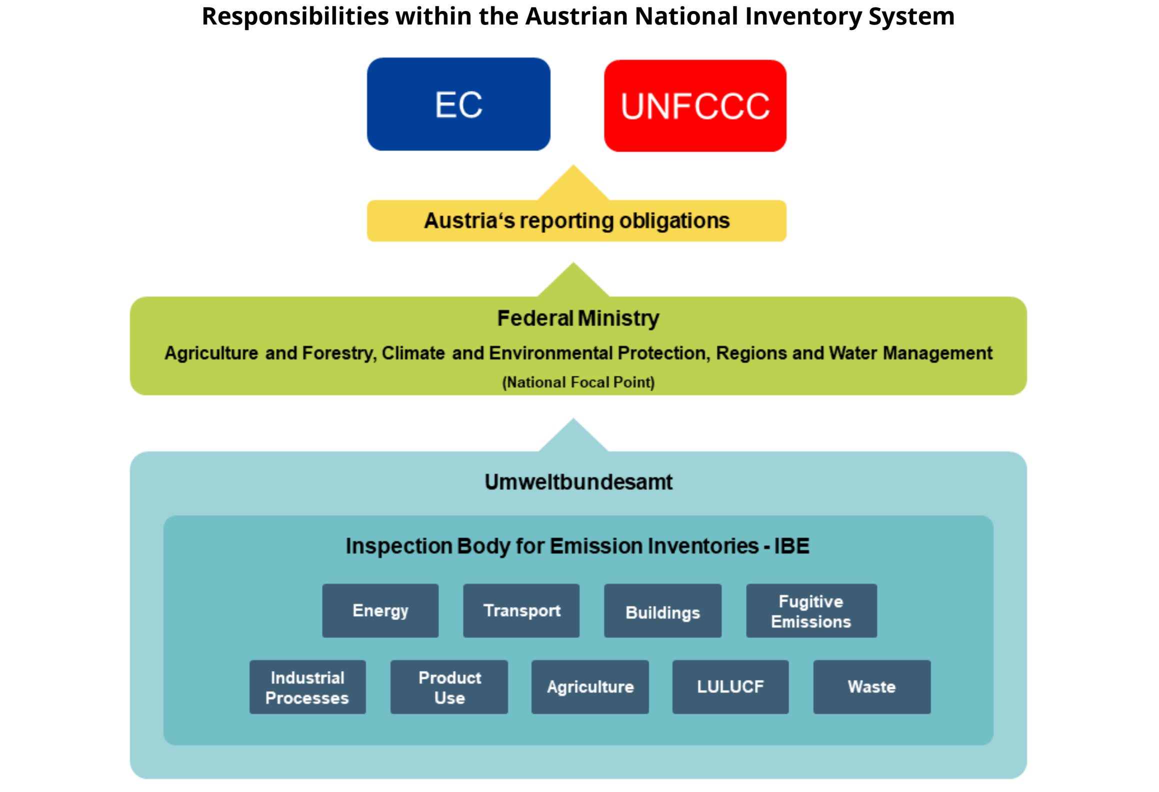
1.2.1 National entity or national focal point

Austria's reporting obligations to the UNFCCC, UNECE and EC are administered by the Federal Ministry of 'Climate Action, Environment, Energy, Mobility, Innovation and Technology' (BMK) – since 1st April 2025 named as 'Federal Ministry of Agriculture and Forestry, Climate and En-vironmental Protection, Regions and Water Management (BMLUK) – which constitutes Austria's national focal point. With the Environmental Control Act (Federal Law Gazette 152/1998), that entered into force on the 1st of January 1999, the Umweltbundesamt has been designated as single national entity with overall responsibility for inventory preparation. This law regulates responsibilities of environmental control in Austria and lists the tasks of the Umweltbundesamt. Furthermore, the Environmental Control Act establishes the Umweltbundesamt as a private limited company owned by the Republic of Austria. To assure that the Umweltbundesamt has the resources to fulfil all listed tasks, the financing is set up as a fixed amount of money annually allocated to the Umweltbundesamt. The Umweltbundesamt is free to manage this so called 'basic funding', provided that the tasks are fulfilled. Projects beyond the scope of the Environmental Control Act are financed on a project basis by the contracting entity, which may be national, EC authorities or private entities.

One task of the Umweltbundesamt is the preparation of technical expertise and the data basis for fulfilment of the obligations under the UNFCCC and the UNECE LRTAP Convention. For the Umweltbundesamt a national emission inventory that identifies and quantifies the sources of greenhouse gases and air pollutants in a consistent manner is of a high priority. Such an inventory provides a common means for comparing the relative contribution of different emission sources and hence can serve as an important basis for policies to reduce emissions.

Thus the Umweltbundesamt established the 'Inspection Body for Emission Inventories' (IBE, hereinafter also referred to as inspection body) which is entrusted with the preparation of emission inventories as assigned to the Umweltbundesamt.

Figure 1: Responsibilities within the Austrian National Inventory System (greenhouse gases).

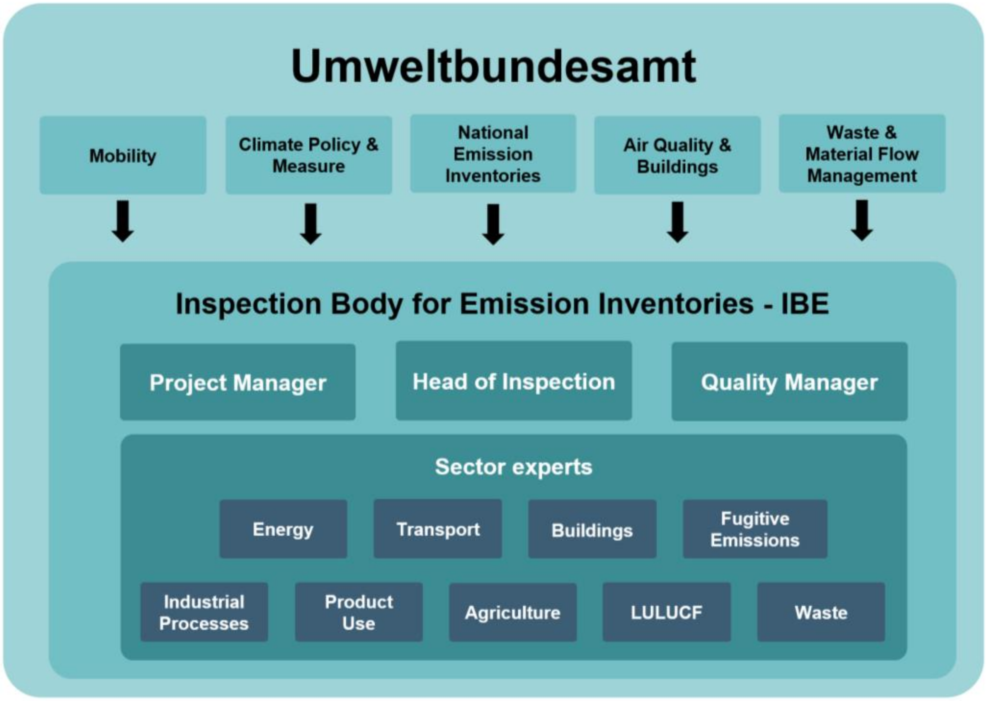


Source: Umweltbundesamt

The personnel of the IBE consists of staff from various organisational units of the Umweltbundesamt, who in the course of their inspection activity are assigned to the IBE and are in this context responsible to the head of the inspection body. They are free from any commercial, financial and other pressures that might influence their technical judgement, and no technical instructions from outside the IBE are given for the preparation of emission inventories (see Figure 2).

Figure 2: Structure of the Inspection Body for Emission Inventories.

Structure of the Inspection Body for Emission Inventories



Source: Umweltbundesamt

umweltbundesamt

The quality system is maintained and updated under the responsibility of a quality manager ('quality representative'), the inventory work is coordinated by a project manager. For these functions as well as for the head of inspection body deputies are appointed. Regarding the inventory work, specific responsibilities for the different emission source/sink categories ('Sector Experts') are defined. There are 9 sectors defined (Energy, Transport, Buildings, Fugitive Emissions, Industrial Processes, Product Use, Agriculture, LULUCF and Waste). At least two experts form a sector team and one of them is nominated as 'Sector Coordinator'. For more information on the QMS please refer to Chapter 1.5.

In addition, the Austrian emissions trading registry is managed by the Umweltbundesamt on behalf of the Federal Ministry of 'Climate Action, Environment, Energy, Mobility, Innovation and Technology'. This mandate was given to the Umweltbundesamt in the Registry Ordinance (Registerstellenverordnung) Federal Law Gazette II No. 208/2012. The Umweltbundesamt is responsible for the operational management of the registry and serves as a contact point for national and international authorities.

The Austrian emissions trading registry has been operational since 2005 and serves both as registry for the EU Emissions Trading Scheme and as the national registry for Austria.

Besides the Environmental Control Act there are some other legal and institutional arrangements in place as the main basis for the national system:

- The Austrian Emissions Certificate Trading Act15 that regulates monitoring and reporting in the context of the EU Emissions Trading Scheme (ETS) in Austria. The Umweltbundesamt takes the emission reports of the emissions trading scheme into account for the national greenhouse gas inventory in order to comply with requirements of the Regulation (EU) No 218/1999 ('Governance Regulation')16 and the Enhanced Transparency Framework und the Paris Agreement (UNFCCC). This is not only important for emissions from combustion of fuels, for which more detailed information is available in the ETS reports than is provided in the national energy balance, but also for emissions from industrial processes. First data from the EU ETS were available for the year 2005. Since then ETS data have been considered in the submissions.
- The Austrian statistical office (Statistik Austria) is required by contract with the BMK to annually prepare the national energy balance (the contracts also cover some quality aspects). The energy balance is prepared in line with the methodology of the Organisation for Economic Co-operation and Development (OECD) and is submitted annually to the International Energy Agency (IEA) (IEA/EUROSTAT Joint Questionnaire (JQ) Submission). The national energy balance is the most important data basis for the Austrian greenhouse gas and air pollutant inventory.
- According to national legislation (Bundesstatistikgesetz 200017), the Austrian statistical office has to prepare annual import/export statistics, production statistics and statistics on agricultural issues (livestock counts, etc.), providing an important data basis for calculating emissions from the sectors Industrial Processes, Product Use and Agriculture.
- In order to comply with the reporting obligations, the Umweltbundesamt has the possibility to obtain confidential data from the national statistical institute (of course these data have to be treated confidentially). The legal basis for this data exchange is the Bundesstatistikgesetz 200017 (federal statistics law), which allows the national statistical office to provide confidential data to authorities that have a legal obligation for the processing of these data.
- According to paragraph 38 (1) of the EG-K 201318 each licensee of an operating boiler with a thermal capacity of more than two megawatts (MW) is obliged to report the emissions to the competent authority. The Umweltbundesamt can request copies of these emission declarations. This data is used to verify the data from the national energy balance for the Energy sector.
- According to the old Landfill Ordinance (Deponieverordnung 1996)19 the operators of landfill sites had to report type and amount of waste deposited annually. These reports

[15] *„Emissionszertifikate-Gesetz 2011"*; Federal Law Gazette I No 118/2011.

[16] 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, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

[17] *„Bundesstatistikgesetz 2000"*; Federal Law Gazette I No 163/1999.

[18] *„Emissionsschutzgesetz für Kesselanlagen 2013"*; Federal Law Gazette I No 127/2013.

[19] *„Deponieverordnung";* Federal Law Gazette No 164/1996.

(collected in a central database run by Umweltbundesamt) still provide the main basis for calculating emissions from the sector Waste for the inventory years 1998–2007.

- Starting with the deposited waste of the year 2008 landfill operators have been – pursuant to the new Landfill Ordinance (Deponieverordnung 2008)[20] – obliged to submit their data annually and electronically via the portal http://edm.gv.at (Electronic Data Management – 'EDM'). Responsible for data collection and analysis is the BMK, since April 2025 named as BMLUK. The necessary data is requested by the Umweltbundesamt for the purpose of inventory preparation.
- Since 2004 there has been a reporting obligation to the BMK under the Austrian Fluorinated Compounds (FC) Ordinance[21] for users of FCs for the following applications: refrigeration and air-conditioning, foam blowing, semiconductor manufacture, electrical equipment, fire extinguishers and aerosols. This data is notified via EDM and used for estimating emissions from the consumption of fluorinated compounds (IPCC sector 2.F).

More information on the National Inventory System in Austria (NISA) is provided in Annex 4.1.

1.2.2 Inventory preparation process

In Austria, emissions of greenhouse gases are estimated together with emissions of air pollutants in a single database based on the CORINAIR (CORe INventory AIR)/SNAP (Selected Nomenclature for sources of Air Pollution) nomenclature. This nomenclature was designed by the ETC/AE (European Topic Centre on Air Emissions) to estimate not only emissions of greenhouse gases but all kind of air pollutants.

Within the inventory system specific responsibilities for the different emission source/sink categories ('Sector Experts') are defined. There are 9 sectors defined (Energy, Transport, Buildings, Fugitive Emissions, Industrial Processes, Product Use, Agriculture, LULUCF and Waste). At least two experts form a sector team and one of them is acting as 'Sector Coordinator'. Sector experts collect activity data, emission factors and all relevant information needed for finally estimating emissions. The sector experts are also responsible for the choice of methods, data processing and archiving and for contracting studies, if needed. Furthermore sector experts perform Quality Assurance and Quality Control (QA/QC) activities regarding their sector.

For the Austrian greenhouse gas inventory the main planning is performed once a year at the so called Management Review, which is conducted in two parts.

The first part comprises the annual sector talks (sectoral improvement planning), in which the sector team discusses all issues related to the respective sector with the head of the inspection body (HI), rates all issues according to their urgency and resource needs, and finally agrees on measures/activities. Furthermore the HI checks the implementation of the previously integrated improvements.

The second part is the actual management review meeting where the quality manager presents the 'IBE Management Review Report' on activities within and performance of the IBE in the last year to the HI. Based on this report, the HI reviews the QMS, and sets measures for the improvement of

[20] *„Deponieverordnung 2008"*; Federal Law Gazette II No 39/2008.

[21] *„Industriegas-Verordnung (HFKW-FKW-SF6-VO)";* Federal Law Gazette II No. 447/2002.

the effectiveness of the management system and its processes and improvements of the Inspection Body related to the fulfilment of EN ISO/IEC 17020. The report also includes the planning regarding internal audits, QA and verification activities as well as the training plan and resource planning.

Finally the report, and particularly planned improvements with high resource needs, are presented to the managing directors of the Umweltbundesamt, to obtain the necessary additional resources. Furthermore issues that need intervention by the managing directors or the ministry are discussed. On the basis of the decisions at the management review, the project manager and sector experts work out a detailed working plan including milestones, timelines and responsibilities.

Table 4 gives an overview on the tasks of inventory preparation together with a typical timeline.

Table 4: Overview Inventory related tasks.

Task	Description	Deadline
Management Review	Preparation of a report including evaluation of the fulfilment of the previous improvement plan and a plan for QMS and inventory improvement based on audit and review findings.	Summer
Kick-Off	Meeting of inventory team (HI, sector experts, project manager, quality manager and data manager of the inventory, report coordinators, cross-sector analyst and all deputies); definition of a working plan.	Autumn
Activity data collection	Collection of activity data, including contracting out studies.	November
Inventory preparation	Estimation of emissions for all sources, including collection of background data.	December
Compilation of national inventory	Updating the data base and conversion to the CRT reporter	December
Quality checks	Tier 1 and Tier 2 QA/QC activities	December
Final sectoral approval	Final approval of sectoral results by sector experts	December
Compilation of preliminary data and information22 (Short-NID)	Compilation of the inventory report 'Short NID' (Governance Regulation No 2018/1999)	January
Final approval Short-NID	Final approval of submission Short NID by the HI	January
EU Submission Short-NID	Submission of the Short NID to the EC (Governance Regulation No 2018/1999)	January 15
Preparation of NID	Compilation of the National Inventory Document	March
Final approval NID	Final approval of submission NID by the HI	March
EU Submission NID	Submission of the National Inventory Document to the EC (Governance Regulation No 2018/1999)	March 15
UNFCCC Submission NID	Submission of the National Inventory Document to the UNFCCC	April 15[23]
Publication of final report	Publication of the NID on the website https://www.umweltbundesamt.at/klima/treibhausgase/unfccc-berichtspflicht	April

[22] Including greenhouse gases and inventory information listed in Annex V to the EU Governance Regulation No 2018/1999.

[23] 2024 no April submission of the NIR to the UNFCCC was expected in accordance with CP.27 Decision 6 Para 6 and CMA.1 Decision 18 Para 3. Instead Parties shall submit their first biennial transparency report and national inventory report, if submitted as a stand-alone report, at the latest by 31 December 2024.

During the inventory preparation process, sector experts collect activity data, emission factors and all relevant information needed for finally estimating emissions. The sector experts are also responsible for the choice of methods, data processing and archiving and for service contracting of e.g. studies, if needed. As part of the quality management system the head of the 'Inspection Body for Emission Inventories' approves the methodological choices and the sectoral improvement plans. Sector experts also perform Quality Control (QC) and Quality Assurance (QA) activities regarding their sector. All data collected together with emission estimates are fed into a database (see below), where data sources are well documented for full reproducability of the inventory.

As mentioned above, the Austrian Inventory is based on the SNAP nomenclature, and has to be transformed according to the IPCC Guidelines into the UNFCCC Common Reporting Tables (CRT) to comply with the reporting obligations under the UNFCCC. In addition to the actual emission data, the background tables of the CRT are filled in by the sector experts, and finally QA/QC procedures as defined in the QA/QC plan are carried out before the data are submitted to the UNFCCC.

For the inventory management a reliable data management to fulfil the data collecting and reporting requirements is needed. As mentioned above, data are collected by the different sector experts and the reporting requirements grow rapidly and may change over time. Data management is carried out by using MS Excel™ spreadsheets in combination with Visual Basic™ macros, which is a very flexible system that can easily be adjusted to new requirements. The data are stored in a central network server which is backed up daily for the needs of data security. The inventory management as part of the QMS includes a control system for all documents and data, for records and their archives as well as documentation on QA/QC activities. This ensures the necessary documentation and archiving for full reproducability of the inventory and for the timely response to requests during the review process.

1.2.3 Archiving of information

Regulations for documentation and archiving are included in the QMS, and have to be complied with by the sector experts. For each sector the documentation includes:

Documentation of the methodology:

- Description (source/sink category, emissions, key source, completeness, uncertainty)
- Methodology
- Template for emission estimation
- Documentation of validation

Documentation of actual emission calculation:

- Methodology
- 'Logbook' (who did what and when)
- Calculation file
- References for activity data, emission factors and/or emissions, respectively
- Documentation of assumptions, sources of data and information, expert judgements etc. to allow full reproduction and understanding of choices made
- Recalculations
- Planned improvements

- QC activities

Documentation of expert judgements in line with the IPCC 2006 GL:

- Name of the expert and institution/department
- Date
- Basis of judgement (references to relevant studies etc.)
- Underlying assumptions

Relevant literature has to be archived and references to be stated in the internal documentation as well as in the NID.

1.2.4 Processes for official consideration and approval of inventory

In Austria the independent accreditated inspection body for emission inventories at the Umweltbundesamt is entrusted with the preparation and final approval of the inventory (see 1.2.1). The approved inventory is transmitted to the Austrian Federal Ministry of 'Climate Action, Environment, Energy, Mobility, Innovation and Technology' (BMK) – since 1st April 2025 named as 'Federal Ministry of Agriculture and Forestry, Climate and En-vironmental Protection, Regions and Water Management' (BMLUK) –, where the National Focal Point for the UNFCCC is established, which submits it to the UNFCCC Secretariat.

The annual schedule covering the entire process for inventory preparation, review and approval as well as for transmission to the UNFCCC is illustrated in Table 4.

As Austria is a small country, many of the experts regarding greenhouse gas inventories have been involved by some means or other e.g. in inventory preparation, in preparation of the uncertainty study, in national or regional task groups etc., such as:

- experts from federal provinces (some prepare a partly independent emission inventory for their federal province and compare their results with the disaggregated national inventory),
- data supplier, e.g. industrial facilities or association of industries
- further national experts in the relevant fields, e.g. from universities or consultants

The NID is published for public consideration at the website of the Umweltbundesamt. Any comment received from outside the IBE is included in an inventory improvement plan. Experts of the IBE then rate any comment according to relevance and decide on the follow-up process.

1.3 Brief general description of methodologies (including tiers used) and data sources used

The methods used for emissions calculation of individual categories are described in the relevant category chapters on methodological issues. A summary is provided in CRT table 3 Summary report for methods and emission factors used.

The main data sources of the Austrian GHG inventory are as follows:

- The main data supplier for the Austrian Emission Inventories is Statistik Austria, providing the underlying energy source data. The Austrian energy balances are based on several databases mainly prepared by the Federal Ministry of Economy, Family and Youth, „Bundeslastverteiler" and Statistik Austria. Their methodology follows the IEA and Eurostat conventions. The aggregated balances, for example transformation input and output or final energy use, are harmonised with the IEA tables as well as their sectoral breakdown which follows the NACE classification.
- Information about activity data and emissions of the industry sector is mostly obtained directly from individual plants, or in other cases from Associations of the Austrian Industries. Activity data for some sources are obtained from Statistik Austria which provides statistics on production data24.
- Operators of steam boilers with more than 50 MW report their emissions and their activity data directly to the Umweltbundesamt. Data from national and sometimes international studies are also used.
- Until 2008, operators of landfill sites reported their activity data directly to the Austrian Ministry of Environment or the Umweltbundesamt, where they were – after a check – in turn incorporated into a database on landfills. Emissions for the years 1998–2007 are calculated on basis of these data. Since 2009 landfill operators have to register and report their waste input directly at the portal of the Electronic Data Management. These data are evaluated by the responsible body at federal level (BMK, since April 2025 named as BMLUK) and are made available for emission calculation.
- Activity data needed for the calculation of non-energetic emissions are based on several statistics collected by Statistik Austria and national and international studies.

The following table presents the main data sources used for activity data:

Table 5: Main data sources for activity data.

Sector	Data Sources for Activity Data
Energy	• Energy Balance from Statistik Austria • EU ETS • Steam boiler database • Small scale combustion market data • Direct information from industry or associations of industry
Transport	• Energy Balance from Statistik Austria • Yearly new vehicle registrations from Statistik Austria • Yearly growth rates of transport performance on Austrian roads from Federal Ministry • ZBD: Zentrale Beguchtachtungsdatenbank (periodically updated specific mileage) • Yearly flight movements from Austro Control • Yearly FC of airport ground activities at Vienna International Airport

[24] „Industrie und Gewerbestatistik" published by STATISTIK AUSTRIA for the years until 1995; „Konjunkturstatistik im produzierenden Bereich" published by STATISTIK AUSTRIA for the years since 1997.

Sector	Data Sources for Activity Data
IPPU	• National production statistics • Import/export statistics • EU ETS • Direct information from industry or associations of industry • Short term statistics for trade and services • Austrian foreign trade statistics • Structural business statistics • Surveys at companies and associations
Agriculture	• National studies • National agricultural statistics obtained from Statistik Austria • INVEKOS Data from the Integrated Administration and Control System (IACS) • National fertilizer statistics, protein content and fat content of milk, obtained from Agrarmarkt Austria (AMA) • National statistics on cattle breeding obtained from Rinderzucht Austria • Distributing company (sales data)
LULUCF	• National forest inventory obtained from the Austrian Research Centre for Forests • National agricultural statistics and land use statistics obtained from Statistik Austria and from the IACS system • Wetland and settlement areas from the Real Estate Database
Waste	• Federal Waste Management Plan (Data sources: Database on landfills (1998–2007), Electronic Data Management (EDM) in environment and waste management) • EMREG-OW (Electronic Emission Register of Surface Water Bodies) • National Studies

Emission calculation and related inventory work (reporting, QA/QC, documentation and archiving etc.) is carried out by the sector experts of the Inspection Body for Emission Inventories (IBE).

In cases which exceed the IBE's resources, the IBE concludes service contracts with qualified institutions (particularly universities or research institutes).

The IBE is responsible for:

- choice of the contractor i.e. judging his/her expertise with regard to the technical and QMS requirements
- specifying the technical and QMS requirements in the service contract
- performing and documenting a detailed QC check of the results i.e. checking if the specified requirements were fulfilled
- implementation of the results into the emission inventory in line with the technical and QMS requirements particularly the requirement of full reproducibility of the emission inventory

Service contracts have e.g. entered into with:

- Technical University Graz (road and off-road transport)
- University of Natural Resources and Applied Life Sciences (agriculture)

However, the final assessment of fulfilment of the requirements is made by the IBE.

Detailed information on data sources for activity and emission data or emission factors used by sector can be found in the Chapters 3–8.

For large point sources the Umweltbundesamt preferably uses – after careful assessment of plausibility of this data – emission data that are reported by the 'operator' of the source because these data usually reflect the actual emissions better than data calculated using general emission factors, as the operator has the best information about the actual circumstances.If such data is not available, and for area sources, national emission factors are used or, if there are no national emission factors, international emission factors are used to estimate emissions. Where no applicable data is found, standard emission factors e.g. from the EMEP/EEA Guidebook are applied.

The main sources for emission factors are:

- National studies for country specific emission factors
- Plant-specific data reported by plant operators
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories[25]
- 2019 Refinement to the 2006 IPCC Guidelines[26]
- EMEP/EEA air pollutant emission inventory guidebooks[27]
- Handbook emission factors for road transport (HBEFA), Version 4.2 (INFRAS, 2022)
- National forest inventory obtained from the Austrian Research Centre for Forests
- Soil inventories by the Federal States and by the Austrian Federal Office and Research Centre for Forests
- Modelling of the forest soil C stock changes Austrian Research Centre for Forests

For key categories (see Chapter 1.4) the most accurate methods for the preparation of the greenhouse gas inventory should be used. Required methodological changes and planned improvements are described in the corresponding sector analysis chapters (Chapters 3–8).

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[25] https://www.ipcc-nggip.iges.or.jp/public/2006gl/?msclkid=f48edfa2badf11ec90525bf3c93873fc

[26] The 2019 Refinement does not revise the 2006 IPCC Guidelines, but updates, supplements and/or elaborates the 2006 IPCC Guidelines where gaps or out-of-date science have been identified. It does not replace the 2006 IPCC Guidelines, but should be used in conjunction with the 2006 IPCC Guidelines and, where indicated, with the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement).

[27] Prepared by the UNECE/EMEP Task Force on Emissions Inventories and Projections (TFEIP) and published by the European Environment Agency (EEA). Latest update: https://www.eea.europa.eu/publications/emep-eea-guidebook-2023.

1.3.1 EU Emissions Trading System (EU ETS)

The European Union Emissions Trading Scheme has been established by Directive 2003/87/EC of the European Parliament and of the Council[28] and amended by several legal acts[29]. From 2013 onwards, it is known as the European Union Emissions Trading System (EU ETS). It includes heavy energy-consuming installations in power generation and manufacturing. The activities covered are energy activities, the production and processing of ferrous metals, the mineral industry and some other production activities. From 2012 onwards, CO_2 emissions from aviation have also been included. For the trading period 2013–2020 the scope of the EU ETS has been further extended to include additional installations from the metal and chemical industry and compressor stations. For more detailed information on the included activities please refer to Annex I of the above mentioned directive.

Greenhouse gases covered under the EU ETS are CO_2 (since 2005), N_2O (since 2010) and PFC (since 2013).[30] Slightly more than one third of total Austrian GHG emissions currently result from installations under the EU-ETS (ca. 24 Mt CO_2eq in 2023).

Plant operators have to report their activity data and emissions annually for the GHG as mentioned above; for the first time they reported their emissions of 2005 in March 2006. The first trading period of the EU ETS ran from 2005–2007. The second trading period, which coincided with the 1st Kyoto commitment period, ran from 2008–2012. The third trading period, which coincides with the 2nd Kyoto commitment period, ran from 2013 to 2020. The fourth trading period started in 2021 and will run until 2030. Since 2012 aircraft operators have also been included into the scheme. They have to report their emissions concerning internal flights in the European Economic Area.

General rules for reporting and verification of emissions in the EU ETS are defined in EU Directive 2003/87/EC and specific rules can be found in Commission Regulation (EU) No 2018/2066[31]. In Austria, Member State specific regulations are defined in the Austrian Emissions Allowance Trading Act[32]. This ordinance also specifies that the Umweltbundesamt has to incorporate, as far as necessary, the verified emissions of the emissions trading scheme into the national greenhouse gas inventory. For a detailed description of the sectors covered and the incorporation of these emissions into the national inventory please refer to the chapters 3 Energy (CRT Sector 1) and 4 Industrial Processes and Product Use (CRT Sector 2).

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[28] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, OJ L 275/32.

[29] Directive 2004/101/EC, Directive 2008/101/EC, Regulatin (EC) No 219/2009, Directive 2009/29/EC, Decision No 1359/2013/EU, Regulation (EU) No 421/2014, Decision (EU) 2015/1814, Regulation (EU) 2017/2392, Directive (EU) 2018/410, Commission Delegated Decision (EU) 2020/1071, Commission Delegated Regulation (EU) 2021/1416 and Decision (EU) 2023/136.

[30] Austria unilaterally opted-in N_2O as of 2010. Since 2013 N_2O and PFCs have been included in the EU ETS at EU level.

[31] Commission Implementing Regulation (EU) 2018/2066 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012, amended by Commission Implementing Regulation (EU) 2020/2085, Commission Implementing Regulation (EU) 2022/388 and Commission Implementing Regulation (EU) 2022/1371.

[32] Emissionszertifikategesetz 2011, Federal Law Gazette I No. 118/2011, as amended.

An important feature of the emissions reported under the EU-ETS is that these emissions have to pass independent verification by an accredited verifier. The Austrian Federal Ministry for Sustainability and Tourism has to fulfil a quality control function, which is implemented by spot checks of emissions and verification reports that the Umweltbundesamt performs on behalf of the Ministry.

1.3.2 Electronic Data Management (EDM)

The electronic data management of the Federal Ministry of 'Climate Action, Environment, Energy, Mobility, Innovation and Technology' is an electronic recording and notification system (information network), implemented as an integrated e-government application. It allows enterprises and authorities to handle registration and notification obligations online in the areas of waste and environment (e.g. on Austrian Emissions Allowances, HFC or EMREG – Emission Register Surface Water). Data from this source are used for reporting in the sector *Wast*e (landfilled waste, biologically treated waste, organic freights in wastewater).

There are around 40 000 users registered, covering national and international waste owners (collectors, operators of treatment plants, waste producers) doing their reporting obligations according to national legislation, e.g. on landfilled amounts.

1.3.3 Other data (E-PRTR)

The Industrial Emissions Portal (the Portal, https://industry.eea.europa.eu/) is the EU-wide register containing key environmental data from industrial facilities in European Union Member States and in Iceland, Liechtenstein, Norway, Serbia, UK and Switzerland. The information contained in the Portal is reported annually and requested under the industrial emissions directive (IED), via the EU Registry on Industrial Sites (EU Registry) and the European Pollutant Release and Transfer Register (E-PRTR). This portal replaced the E-PRTR website in 2021. E-PRTR was implemented by Regulation (EC) No 166/2006 covering 91 pollutants from nine activity groups

Commission Implementing Decision (EU) 2019/1741(2) sets out the format and frequency of the annual reporting of data on releases of pollutants to air, water and land and on off-site waste transfers. Commission Implementing Decision (EU) 2022/142 requires operators reporting production volume for each facility concerned, and establishes the units and metrics to be used.

The E-PRTR Regulation has been superseded by the Industrial Emissions Portal Regulation (IEPR, (EU) 2024/1244) which sets additional reporting requirements and establishes the reporting unit at "installation" level (rather than facility level). The requirements of the new legislation will apply from 2028. Until then, the E-PRTR Regulation will continue to apply.

Umweltbundesamt implemented E-PRTR in Austria using an electronic system enabling the facilities and the authorities to fulfil the requirements of the E-PRTR Regulation online. In 2008, installations reported for the first time releases and transfers of pollutants and waste from 2007 under the E-PRTR, which is an annual reporting obligation. The plausibility of the reports is checked by the competent authorities and Umweltbundesamt. Umweltbundesamt also checks the data for consistency with other reporting obligations, across the years and across facilities with the same activity.

Since submission 2018 data from E-PRTR or its predecessor have been used in one source category (*NFR 2.B.10* for NMVOC). The main reason for not using E-PRTR data on a broader scale in the national inventory is that the E-PRTR reports contain only very little information other than emission data, whereby these emissions can either be reported as measured, calculated or estatimated emissions. Until now, the reporting thresholds are relatively high for some pollutants, so that many of the relevant facilities do not have to report.

Thus greenhouse gas emission data from the EU Emissions Trading System (see chapter 1.4.1), combined with the top-down approach of the national inventory has been considered to be more reliable and data of EPER/E-PRTR has not been used as a data source for point source data for the national GHG inventory, but for verification purposes – where possible.

1.4 Brief description of key categories

The identification of key categories is described in the IPCC 2006 GL (Volume 1, Chapter 4). It stipulates that a key category is one that is prioritised within the National System because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level of emissions or removals, the trend in emissions or removals, or both.

All notations, descriptions of identification and results for key categories included in this chapter are based on the IPCC 2006 GL. The identification includes all reported greenhouse gases CO_2, CH_4, N_2O, HFC, PFC, SF_6 and NF_3, and all IPCC categories.

Austria's key category analysis was performed by the Umweltbundesamt with data for greenhouse gas emissions from the 2025 submission and comprises a level assessment for the years 1990 and 2023 and a trend assessment for the emissions from 1990 to 2023. Following the IPCC 2006 GL, key categories were first identified for the inventory excluding LULUCF with a subsequent key category analysis repeated for the full inventory including LULUCF categories. The approach 1 method is based purely on emission/removal levels and trends. The approach 2 analysis additionally considers the respective category uncertainties. Consequently, and also due to the more detailed resolution of analysed categories and gases, the key categories described in the Austrian NID differ slightly from the ones in the corresponding CRT Table 7.

The detailed methodology for identifying the key categories is described in detail in Annex 1.

The key categories without LULUCF (determined by Approach 1 and Approach 2) comprise 66 866 kt CO_2e in the year 2023, which corresponds to 97.3% of Austria's total greenhouse gas emissions (without LULUCF). The key categories including LULUCF amounted to 73 668 kt CO_2e (96.6%) in 2023. The following tables present the results of the KCA approach 1 and approach 2 including LULUCF and excluding LULUCF by indicating the ranking of the different subcategories as well as emissions/removal data.

Table 6: Key categories excluding LULUCF.

		Approach 1			Approach 2					
IPCC Category	**GHG**	**LA 1990**	**LA 2023**	**TA 1990 – 2023**	**LA 1990**	**LA 2023**	**TA 1990 – 2023**	**1990 [kt CO_2-e units]**	**2023 [kt CO_2-e units]**	**Share 2023 [%]**
1.A.1.a. Public electricity and heat production - Biomass	N_2O						26	3	64	0.1
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	8	5	23	23			3294	3206	4.7
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	15		12				1229	147	0.2
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	45	15	14	26	10	6	286	1094	1.6
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	3		2			22	6247	NO	NO
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	37	30					437	327	0.5
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	11	8	17				1958	2252	3.3
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	31	42	29				506	155	0.2
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	24	16	18		25	33	650	1075	1.6
1.A.2.a. Iron and steel - Solid Fuels	CO_2	17	23	25				1107	632	0.9
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2		34	37				75	260	0.4
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	28	17	19		29	34	519	957	1.4
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2		33	43		27	27	125	278	0.4
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	20	14	28	28	24		943	1101	1.6
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	21		15				853	39	0.1
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	39		27				398	49	0.1
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	30	22	36				507	635	0.9
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	43		45				345	148	0.2
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	26	26					559	506	0.7
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	29	39	31				508	190	0.3
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2		25	20		17	11	67	554	0.8
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	27		24				535	128	0.2
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	47	11	9		21	18	252	1365	2
1.A.2.g.viii Other - Gaseous Fuels	CO_2	19	13	21	27	19	37	1014	1270	1.8
1.A.2.g.viii Other - Liquid Fuels	CO_2	25		22				610	137	0.2
1.A.3.b. Road transportation - Diesel Oil	CO_2	5	1	1	9	5	4	5358	14667	21.4
1.A.3.b. Road transportation - Diesel Oil	N_2O		38	41		22	15	11	191	0.3
1.A.3.b. Road transportation - Gasoline	CH_4						40	77	7	0
1.A.3.b. Road transportation - Gasoline	CO_2	1	3	6	7	9	10	7896	4625	6.7
1.A.3.b. Road transportation - Gasoline	N_2O				25		19	83	7	0
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	49		44				224	25	0
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	23	19	39				698	793	1.2
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	14	36	11				1420	216	0.3
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2			51				91	NO	NO

		Approach 1			Approach 2					
IPCC Category	**GHG**	**LA 1990**	**LA 2023**	**TA 1990 – 2023**	**LA 1990**	**LA 2023**	**TA 1990 – 2023**	**1990 [kt CO_2-e units]**	**2023 [kt CO_2-e units]**	**Share 2023 [%]**
1.A.4.b. Residential - Biomass	CH_4	46	37		13	16	43	264	196	0.3
1.A.4.b. Residential - Gaseous Fuels	CO_2	12	6	10	19	13	13	1856	2736	4
1.A.4.b. Residential - Liquid Fuels	CO_2	4	7	5	24		30	5633	2261	3.3
1.A.4.b. Residential - Solid Fuels	CH_4	50		40	15		8	224	2	0
1.A.4.b. Residential - Solid Fuels	CO_2	9		7			35	2511	27	0
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	16	20	32				1180	791	1.2
1.B.1.a. Coal mining and handling	CH_4	41		26	10		5	373	NO	NO
1.B.2.a. Oil	CH_4						38	92	43	0.1
1.B.2.b. Natural gas	CH_4	40	32		11	15		375	290	0.4
2.A.1. Cement production	CO_2	10	9	33	17			2033	1543	2.2
2.A.2. Lime production	CO_2	36	24	38	29			456	588	0.9
2.A.4.c. Non-metallurgical magnesium production	CO_2	33	29					481	339	0.5
2.B.1. Ammonia production	CO_2	35	27					467	447	0.7
2.B.2. Nitric acid production	N_2O	22		16			39	780	27	0
2.C.1. Iron and steel production	CO_2	2	2	3	12	18	28	6840	10188	14.8
2.C.3. Aluminium production	CO_2			47			32	150	5	0
2.C.3. Aluminium production	PFCs	18		13	5		3	1032	NO	NO
2.C.4. Magnesium production	SF_6	48		34				235	2	0
2.D. Non-energy products from fuels and solvent use	CO_2	42	41	46	14	20	16	349	162	0.2
2.F.1. Refrigeration and air-conditioning	HFCs		12	8		4	2	NO	1350	2
2.G.1. Electrical equipment	SF_6					26	20	11	51	0.1
2.G.2. SF_6 and PFCs from other product use	SF_6		31	35	22	11	7	124	306	0.4
3.A.1. Cattle	CH_4	6	4	42	3	2	23	4871	4024	5.9
3.A.4. Other livestock	CH_4						44	41	103	0.1
3.B.1. Cattle	CH_4	32	21	30	18	14	17	482	665	1
3.B.1. Cattle	N_2O	38	35	49	6	6	9	404	253	0.4
3.B.3. Swine	N_2O				16	23	21	111	57	0.1
3.B.4. Other livestock	N_2O						42	11	26	0
3.B.5. Indirect N_2O emissions	N_2O				8	7	36	123	117	0.2
3.D.1. Direct N_2O emissions from managed soils	N_2O	13	10		1	1	25	1606	1402	2
3.D.2. Indirect N_2O emissions from managed soils	N_2O	34	28		4	3	14	467	376	0.5
3.G. Liming	CO_2					28	31	46	95	0.1
5.A. Solid waste disposal	CH_4	7	18	4	2	8	1	4081	799	1.2
5.B. Biological treatment of solid waste	CH_4					30	24	15	77	0.1
5.B. Biological treatment of solid waste	N_2O						29	20	72	0.1
5.D. Wastewater treatment and discharge	CH_4	44	40	48	21		41	334	190	0.3
5.D. Wastewater treatment and discharge	N_2O		43	50	20	12	12	86	155	0.2
							∑	**77049**	**66866**	**97.3**

Table 7: Key categories including LULUCF.

		Approach 1			Approach 2					
IPCC Category	**GHG**	**LA 1990**	**LA 2023**	**TA 1990 – 2023**	**LA 1990**	**LA 2023**	**TA 1990 – 2023**	**1990 [kt CO2-e units]**	**2023 [kt CO2-e units]**	**Share 2023 [%]**
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	9	6	22				3294	3206	4.2
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	18		13				1229	147	0.2
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	52	17	20		15	16	286	1094	1.4
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	4		3				6247	NO	NO
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	42	36	45				437	327	0.4
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	14	9					1958	2252	3
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	35		30				506	155	0.2
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	28	18	34				650	1075	1.4
1.A.2.a. Iron and steel - Solid Fuels	CO_2	20	27	21				1107	632	0.8
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2		40	46				75	260	0.3
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	32	19	33				519	957	1.3
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2		39					125	278	0.4
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	23	16					943	1101	1.4
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	25		17				853	39	0.1
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	45		31				398	49	0.1
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	34	26					507	635	0.8
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	50		38				345	148	0.2
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	30	31	51				559	506	0.7
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	33	47	32				508	190	0.2
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2		29	27		26	20	67	554	0.7
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	31		26				535	128	0.2
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	54	13	16		31		252	1365	1.8
1.A.2.g.viii Other - Gaseous Fuels	CO_2	22	15			29		1014	1270	1.7
1.A.2.g.viii Other - Liquid Fuels	CO_2	29		25				610	137	0.2
1.A.3.b. Road transportation - Diesel Oil	CO_2	6	1	2	15	7	8	5358	14667	19.2
1.A.3.b. Road transportation - Diesel Oil	N_2O		46	44				11	191	0.3
1.A.3.b. Road transportation - Gasoline	CO_2	2	4	4	13	14	13	7896	4625	6.1
1.A.3.b. Road transportation - Gasoline	N_2O						23	83	7	0
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	56		40				224	25	0
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	27	22					698	793	1
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	17	44	11				1420	216	0.3
1.A.4.b. Residential - Biomass	CH_4	53	45		19	25	24	264	196	0.3
1.A.4.b. Residential - Gaseous Fuels	CO_2	15	7	23		19		1856	2736	3.6
1.A.4.b. Residential - Liquid Fuels	CO_2	5	8	5				5633	2261	3
1.A.4.b. Residential - Solid Fuels	CH_4			37	22		14	224	2	0

		Approach 1			Approach 2					
IPCC Category	**GHG**	**LA 1990**	**LA 2023**	**TA 1990 – 2023**	**LA 1990**	**LA 2023**	**TA 1990 – 2023**	**1990 [kt CO2-e units]**	**2023 [kt CO2-e units]**	**Share 2023 [%]**
1.A.4.b. Residential - Solid Fuels	CO_2	12		7				2511	27	0
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	19	23	24				1180	791	1
1.B.1.a. Coal mining and handling	CH_4	47		29	16		11	373	NO	NO
1.B.2.b. Natural gas	CH_4	46	38	50	17	21	22	375	290	0.4
2.A.1. Cement production	CO_2	13	10	19	24			2033	1543	2
2.A.2. Lime production	CO_2	41	28					456	588	0.8
2.A.4.c. Non-metallurgical magnesium production	CO_2	38	35	41				481	339	0.4
2.B.1. Ammonia production	CO_2	40	32					467	447	0.6
2.B.2. Nitric acid production	N_2O	26		18				780	27	0
2.C.1. Iron and steel production	CO_2	3	2	8	18	27		6840	10188	13.4
2.C.3. Aluminium production	CO_2			47				150	5	0
2.C.3. Aluminium production	PFCs	21		14	9		6	1032	NO	NO
2.C.4. Magnesium production	SF_6	55		35				235	2	0
2.D. Non-energy products from fuels and solvent use	CO_2	49		39	21	30	19	349	162	0.2
2.F.1. Refrigeration and air-conditioning	HFCs		14	12		5	5	NO	1350	1.8
2.G.2. SF_6 and PFCs from other product use	SF_6		37	49		16	18	124	306	0.4
3.A.1. Cattle	CH_4	7	5	10	6	3	10	4871	4024	5.3
3.B.1. Cattle	CH_4	37	25		25	20		482	665	0.9
3.B.1. Cattle	N_2O	44	42	42	11	11	12	404	253	0.3
3.B.3. Swine	N_2O				23		21	111	57	0.1
3.B.5. Indirect N_2O emissions	N_2O				14	12		123	117	0.2
3.D.1. Direct N_2O emissions from managed soils	N_2O	16	11	28	2	1	4	1606	1402	1.8
3.D.2. Indirect N_2O emissions from managed soils	N_2O	39	33	48	7	4	9	467	376	0.5
4. Land use, land-use change and forestry	N_2O		50		20	18		180	169	0.2
4.A.1. Forest land remaining forest land	CO_2	1	3	1	1	2	1	-10624	6763	8.9
4.A.2. Land converted to forest land	CO_2	11	12	15	3	8	7	-2959	-1402	-1.8
4.B.1. Cropland remaining cropland	CO_2		41			22		201	256	0.3
4.B.2. Land converted to cropland	CO_2		49			28		173	172	0.2
4.C.1. Grassland remaining grassland	CO_2	48	34			24		371	371	0.5
4.C.2. Land converted to grassland	CO_2	43	43	36	12	23	15	421	222	0.3
4.E.2. Land converted to settlements	CO_2	24	20	52	10	6	17	935	945	1.2
4.F.2. Land converted to other land	CO_2	36	30		8	9		502	520	0.7
4.G. Harvested wood products	CO_2	10	24	9	4	10	3	-3122	-678	-0.9
5.A. Solid waste disposal	CH_4	8	21	6	5	13	2	4081	799	1
5.D. Wastewater treatment and discharge	CH_4	51	48	43				334	190	0.2
5.D. Wastewater treatment and discharge	N_2O					17		86	155	0.2
							∑	**62720**	**73668**	**96.6**

The key category with the highest contribution to the national total emissions excl. LULUCF in 2023 is *1.A.3.b Road Transportation – diesel oil (CO_2)*, with a share of 21.4% in 2023. This category is also the most important category in terms of emission trends: Since 1990 emissions increased by 174%. This strong increase is mainly due to the increase of road performance. The second most important source of greenhouse gas emissions in Austria is *2.C.1 Iron and Steel Production (CO_2)*, with a contribution to national total emissions of 14.8% in 2023. The key category with the highest contribution to national removals is *4.A.2 Land converted to forest land (CO_2)*.

Comparison Approach 1 – Approach 2 KCA

The following categories have been identified as key additionally to the Approach 1 analysis:

Table 8: comparison results Approach 1 – Approach 2 KCA.

IPCC Code and Category	Greenhouse Gas
1.A.1.a. Public electricity and heat production - Biomass	N_2O
1.A.3.b. Road transportation - Gasoline	CH_4
1.A.3.b. Road transportation - Gasoline	N_2O
1.B.2.a. Oil	CH_4
2.G.1. Electrical equipment	SF_6
3.A.4. Other livestock	CH_4
3.B.3. Swine	N_2O
3.B.4. Other livestock	N_2O
3.B.5. Indirect N_2O emissions	N_2O
3.G. Liming	CO_2
5.B. Biological treatment of solid waste	CH_4
5.B. Biological treatment of solid waste	N_2O

1.5 Brief general description of QA/QC plan and implementation

For fulfilment of the reporting obligations the Umweltbundesamt, in particular the *Inspection Body for Emission Inventories*, operates a Quality Management System (QMS) based on the International Standard EN ISO/IEC 17020 *Conformity assessment — Requirements for the operation of various types of bodies performing inspection*.

Since 23 December 2005 the Umweltbundesamt has been accredited[33] as Inspection Body for emission inventories, Type A (ID No. 0241), in accordance with EN ISO/IEC 17020 and the Austrian Accreditation Law (AkkG)[34], by decree of Accreditation Austria (first decree, No. BMWA-92.715/0036-I/12/2005, issued by Accreditation Austria / Federal Ministry of Economics and Labour on 19 January 2006). The accreditation scope of the IBE can be found on akkreditierung-austria.gv.at/overview. Relevant for the underlying report are:

[33] For more information on the accreditation please refer to Annex 4.

[34] Federal Law Gazette I No 28/2012 (Akkreditierungsgesetz 2012).

- 2006 IPCC GL for National Greenhouse Gas Inventories
- 2006 GL Supplement Wetlands
- 2006 GL Revised Supplementary KP
- 2019 Refinement to the 2006 IPCC GL

The 2006 IPCC GL with its supplements is basically applied for all sectors. However, sectors *3 Agriculture, 5 Waste* and *1B Fugitive emissions* partly already apply the 2019 Refinement, as described in the chapters 3.3.3.2, 5.2, 5.3 and 7.5.2.1.1.

In addition to the elements of a QMS as described in the EN ISO 9000 series, the EN ISO/IEC 17020 focusses on the competence of the personnel, and ensures strict independence, impartiality and integrity. The implementation is audited by the Austrian Accreditation Body ('Akkreditierung Austria') regularly (about every 20 months). Every five years the accreditation has to be renewed in a more comprehensive audit. The accreditation of the IBE was awarded for the first time in 2005 and was renewed in 2011, 2016 and 2020.

Major elements of the QMS are the Quality Manual of the IBE and its quality and technical procedures ('**Austrian QA/QC Plan**').

1.5.1 Requirements of the EN ISO/IEC 17020 compared to the IPCC 2006 GL

The IPCC 2006 GL set out the major elements of a QA/QC system to be implemented by emission inventory compilers

- inventory agency responsible for coordinating QA/QC activities and definition of roles and responsibilities
- a QA/QC plan
- general QC procedures (Tier 1) and source category-specific QC procedures (Tier 2)
- QA and review procedures and verification activities
- QA/QC system interaction with uncertainty analysis (see chapter on uncertainties)
- reporting, documentation and archiving

Table 9: Overview of QA/QC aspects in different technical and quality standards.

IPCC 2006 GL	EMEP/EEA GB 2019[35]	EN ISO 9001[36]	EN ISO/IEC 17020[37]
Roles and Responsibilities	Roles and Responsibilities	X	X
QA/QC plan	QA/QC plan	X	X
QC procedures	QC procedures	X	X
QA procedures	QA procedures	X	X
QA/QC system interaction with uncertainty analysis	QA/QC system interaction with uncertainty analysis	-	-

[35] Requirements largely based on the 'Quality Assurance/Quality Control and Verification' chapter of the 2006 IPCC Guidelines (IPCC 2006).

[36] Basic international standard for quality management and quality assurance.

[37] contains additional requirements compared to ISO 9001.

IPCC 2006 GL	EMEP/EEA GB 2019[35]	EN ISO 9001[36]	EN ISO/IEC 17020[37]
Verification activities	Verification activities	(X)	(X)
Reporting, documenting and archiving procedures	Reporting, documenting and archiving procedures	X	X
-	Inventory management report[38]	Management review (report)	Management review (report)
-	-	Control of documents and records	Control of documents and records
-	-	Internal audits	Internal audits
-	-	-	Competence
-	-	-	independence, impartiality and integrity

The implementation of these elements in the Austrian QMS is described in the following chapters.

1.5.2 Quality policy and objectives

As stated in the Quality Manual of the IBE, the overall objective of the work of the IBE is to promote climate change mitigation and air quality control measures via a high quality emission inventory reporting under the relevant national, European and international frameworks and conventions.

To achieve this, the IBE is committed to strict impartiality and quality management. In this context, the term quality means:

- Fulfilment of requirements for emission inventories to provide a solid data basis for the political processes in the context of greenhouse gas and air pollutant emissions.
- Providing emission inventories that facilitate the definition and evaluation of measures, which needs a forward looking maintainance and improvement of the emission inventory. Therefore the IBE keeps its staff updated on the latest technical expertise, scientific findings and the latest developments by encouraging the participation of its staff in international technical and political processes and ensure the transfer of knowledge within the IBE.
- Compliance with the EN ISO/IEC 17020 standard by ensuring the implementation and continuous improvement of a QMS as described in the quality manual by the IBE and its personnel. The QMS procedures are designed to facilitate the preparation of the emission inventories in a professional and timely manner, particularly to enhance the transparency to allow full reproduction, and ensure correctness by applying quality checks and validation activities. One of the key managerial functions is raising the personnel's awareness for quality control.

[38] According to the EMEP/EEA Guidebook, it also is good practice to summarize lessons learned from previous inventory preparation cycles in an inventory management report.

Aim of the IBE is to provide a best-practise example by setting a high quality standard – even higher than specified in the requirements – so as to improve the quality of air emission reporting in the long term, and to encourage other countries to set up similar systems.

The **quality objectives** for emission inventories are above all the fulfilment of all relevant requirements in terms of content and format: 'TACCC': transparency, accuracy, completeness, comparability, consistency (as defined in the IPCC 2006 GL), and timeliness.

The QMS was primarily developed to meet the requirement of reporting greenhouse gas emissions under the Kyoto Protocol. For this reason the emphasis was originally placed on greenhouse gases, but by now all air pollutants are covered by the QMS as well.

1.5.3 Elements of the QA/QC Plan

Activities to be conducted by the personnel of the IBE are written down in quality and technical procedures that complement the Quality Manual. Such activities are:

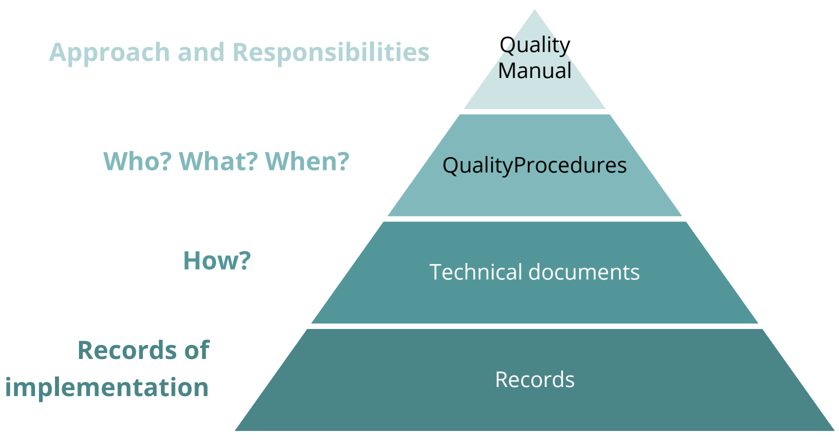
- QC activities
- Procedures for country specific methodologies
- Internal audits (QM specific)
- Procedures for service contracting
- Inventory improvement plan
- Documentation and archiving
- Treatment of confidential data
- Annual Management Review

Quality Manual

The Quality System is divided into three levels:

- Level 1: General (the actual 'Quality Manual' containing general information, description of QMS, general responsibilities etc.): https://www.umweltbundesamt.at/klima/emissionsinventur/emi-akkreditierung
- Level 2: Detailed description of activities to be conducted and checklists and forms to be filled in ('quality procedures' and 'technical documents').
- Level 3: Documentation of QC activities (filled in checklists, …)

Figure 3: Structure of the Austrian Quality Management System (QMS).



Source: Umweltbundesamt

1.5.4 QC Activities

The following four quality-check-steps are performed before finalization of the data submission:

1. Tier 2 (category specific): by the sector expert in the course of the inventory preparation
2. Tier 1 (general) / Step 1: QC by the sector expert after emissions have been estimated
3. Tier 1 (general) / Step 2: QC by the data manager in the course of the preparation of the overall inventory (electronic checks e.g. check for completeness and comparison with last years' inventory)
4. Tier 1 (general) / Step 3: QC of final submission by the sector expert

Where possible the checks (1), (2) and (4) are conducted by the sector expert that has not predominantly prepared the sectoral inventory in the particular year.

QC activities are conducted according to QC checklists, which cover issues like:

- ✓ documentation of assumptions
- ✓ documentation of expert judgements
- ✓ clear explanation of recalculations
- ✓ provision of references
- ✓ plausibility of data
- ✓ consistency of data
- ✓ completeness
- ✓ correct transformation/transcription into CRT
- ✓ information on background tables
- ✓ consistency of data and information with information in inspection reports
- ✓ treatment of confidential data

Additionally, in the course of the NID preparation, the following four QC steps are performed:

1. Tier 2 (category specific) / Step 1: check of methodologies, assumptions and explanations by sector expert in the course of report preparation.
2. Tier 2 (category specific) / Step 2: check of methodologies, assumptions and explanations by the head of inspection body .
3. Tier 1 (general) / Step 1: final check of each sector chapter by the corresponding sector experts (in particular regarding consistency of values in the NID and the latest CRT tables).
4. Tier 1 (general) / Step 2: final check of consistency of figures in reporting format and report by a member of the IBE team (usually done by the report coordinator who checks at least 5 values per sector).

If CRT tables are updated during the preparation of the inventory, the data manager informs the whole team immediately to make sure that comparisons between CRT and NID data are done by sector experts with the latest data set.

1.5.5 QA Activities

The following QA activities are performed:

Validation of methodologies and calculation

New and improved methodologies are documented as a SOP (standard operating procedure) together with a template for calculating emissions, where needed. The SOP is checked for applicability and transparency and finally approved by the head of the inspection body. New and changed calculation files are validated before use.

Annual second party audits for every sector

Once a year the documentation of one emission source per sector is checked throughout the whole emission estimation and reporting process (i.e. archiving of underlying information, emission calculation, input into the data management system, documentation, information in the NID etc.) for transparency, reproducibility, clearness and completeness. This tool has proved to be very helpful in order to further improve the documentation and the implementation of QA/QC routines.

Second party audits for work performed by service contractors

The sector experts at the Umweltbundesamt are responsible for incorporation of results in the inventory database and additional QA/QC procudures (carried out as second party audit).

Accreditation audits (third party audits)

In the course of the accreditation process, conformity of the QMS with EN ISO/IEC 17020 is regularly monitored. Audits are performed every 20 months on average by the accreditation body (one and a half day audit). Every fifth year the accreditation has to be renewed in a more comprehensive audit. The audits aim to assess the QMS with regard to compliance with the underlying standard EN ISO/IEC 17020, to check its implementation in practice and to assure that measures and recommendations as set out in previous audits have been implemented accordingly.

Input data examination

Input data examinations refer to examinations of complex input data (i.e. collected and aggregated data, particularly statistics, or generally data provided by data collectors as the opposite to input data provided by one single facility). These examinations go beyond the scope of Tier 2 QC procedures performed during inventory preparation and are as far as possible conducted in close cooperation with the data suppliers.

The aim of the examinations is to assess:

- whether the requirements regarding independence and integrity are fulfilled
- the long term availability of the data
- the data collection and data management process
- QC of the data processing

Resulting areas of improvement are discussed with the data suppliers.

Since 2007 input data examinations have been conducted together with all main data suppliers :

- Statistik Austria regarding
  - energy balance in 2007
  - agricultural statistical data in 2009
  - import/export and production statistics in 2016
- the administrator of the landfill database in 2009
- the administrator of the electronic data management for landfills (EDM) in 2014

- the national forest inventory at the Austrian Federal Office and Research Centre for Forests (BFW) in 2016

It is planned to conduct follow-up examinations with these institutions only when substantial changes become apparent.

These input data examinations have proven a good basis for the cooperation with the data suppliers.

1.5.6 Error correction and continuous improvement

All issues regarding transparency, accuracy, completeness, consistency or comparability identified by experts from different backgrounds are incorporated in the inventory improvement plan. The sources of these findings are:

- UNFCCC Reviews
- Initial checks and comprehensive reviews according to Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action (article 37 para 4 and article 38 para 1 & 2)
- external experts (e.g. experts from federal provinces who prepare a partly independent emission inventory for their federal province compare their results with the disaggregated national inventory)
- stakeholders (e.g. industrial facilities or association of industries: the NID is communicated to every data supplier and Austrian experts involved in emission inventorying after submission)
- personnel of the IBE (head of inspection body, sector experts etc.).

These findings are documented including a plan to improve the inventory, a timeline and responsibilities. The improvement plan and fulfilment of planned improvements is monitored by the head of inspection body. Improvements that are relevant in terms of resources are presented in the annual Management Review to the managing directors, and if additional resources are needed, these are notified to the Federal Ministry.

1.5.7 Treatment of confidentiality issues

The IBE ensures confidential treatment of sensitive information obtained in the course of its inspection activities.

According to the Austrian Envirionmental Information Act[39] §4 (2) emissions data are generally publicly accessible and are explicitely not seen as confidential data, with the possibility to request confidentiality in justified exceptional cases. This is the case for emissions of fluorinated substances for semiconductors, where detailed emissions data could give clues regarding the setting up of industrial processes and therefore emissions are reported at a higher aggregated level.

[39] *„Umweltinformationsgesetz"* (UIG) Federal Law Gazette No 495/1993.

Generally, for transparency reasons, activity data is reported together with emissions data. Activity data, particularly that relates to less than three plant operators, in some cases has to be treated confidentially and is therefore not reported because this data is sensitive according to a plant operator.

Compliance with confidentiality provisions is organized and documented in the QM manual which contains specific quality system procedures. Staff of the inspection body is obliged to issue a written commitment stating their full compliance with all provisions.

- **Confidentiality of statistics**
  The strict confidentiality provisions concerning handling of sensitive data relating to individuals and organisations are regulated by the Austrian Federal Statistics Act 2000[40]. The Environmental Control Act[41] allows the Umweltbundesamt to request confidential statistical data, this data is then incorporated in the emission inventory. To protect the confidential data, only aggregated results are reported.
- **Security of data**
  Confidentiality of sensitive data used to calculate emission is a legal obligation: Ensuring confidentiality through technical and organisational measures (e.g. final QC whether confidential information is not visible in CRT tables) is obligatory for Umweltbundesamt and consequently also for the Inspection Body.
- **Trust of respondents**
  Individuals, associations and organizations providing information to the Inspection Body can be sure that the provided data are used exclusively for purposes of inspection activities. Data – either of official, private or of another nature – are treated confidentially and will not be passed on to third parties. In the course of inventory reviews, such data and information is exchanged with the review team only if needed for judging the conformity of emission calculation following the strict rules for confidentiality set up by the review process.

Also in case of voluntary reviews an absolute confidential treatment of data exchanged is ensured by strictly adhering to the rules of the QMS of the Inspection Body.

1.5.8 QMS activities and improvements 2024

Until 2024, in the IBE the emissions from private and commercial buildings were calculated by one single person. In 2024 we established a new inventory sector team 'Buildings' that is responsible for the calculation of the corresponding emissions and that is double staffed for security reasons. Another new member joined the inventory sector team AFOLU, so that currently Austria's inventory team consists of 25 members in total. The new sector experts have to undergo an initial inventory training, that lasts at least one year and ends, after careful consideration of feedback from the mentors, trainers and the trainee, with the official approval as sector experts.
In 2024 two of our experts participated in international inventory reviews, and two staff members passed the UNFCCC review sub-course B.1 'General guidance and cross-cutting issues'.

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[40] Federal Act on Federal Statistics (Federal Statistics Act 2000) No 163/1999.

[41] „*Umweltkontrollgesetz*" (UKG) Federal Law Gazette I No 152/1998.

1.6 General uncertainty assessment

The uncertainty calculation was performed applying approach 1 of the IPCC 2006 GL, for all sectors including and excluding LULUCF. As a result of the uncertainty analysis, the following tables show a total uncertainty of 4.8% for the base year 1990 and 4.7% for 2023 (excluding LULUCF), as well as a total uncertainty of 9.8% for the base year 1990 and of 5.5% for the year 2023 (including LULUCF). Further details can be found in the Annex 2. The uncertainty in the 1990-2023 trend is estimated at ±1.8 percentage points for the trend in national total emissions excluding LULUCF and ±11.5 percentage points for the trend in national total emissions and removals including LULUCF.

Table 10: Approach 1 Uncertainty calculation and reporting according IPCC 2006 GL for 1990 – excluding LULUCF.

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.1.a. Public electricity and heat production - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00012
1.A.1.a. Public electricity and heat production - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00154
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CH_4	2.00	50.00	50.04	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	2.00	0.20	2.01	0.00692	0.01297
1.A.1.a. Public electricity and heat production - Gaseous Fuels	N_2O	2.00	50.00	50.04	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00012	0.00003
1.A.1.a. Public electricity and heat production - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00001
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00421	0.06318
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00001	0.00005
1.A.1.a. Public electricity and heat production - Solid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	0.50	0.50	0.71	0.00308	0.00114
1.A.1.a. Public electricity and heat production - Solid Fuels	N_2O	0.50	50.00	50.00	0.00023	0.00017
1.A.1.b. Petroleum refining - Gaseous Fuels	CH_4	2.00	50.00	50.04	0.00000	0.00000
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	2.00	0.20	2.01	0.00012	0.00014
1.A.1.b. Petroleum refining - Gaseous Fuels	N_2O	2.00	50.00	50.04	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.1.b. Petroleum refining - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00030	0.00041
1.A.1.b. Petroleum refining - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CH_4	2.00	50.00	50.04	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	2.00	0.20	2.01	0.00016	0.00003
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	N_2O	2.00	50.00	50.04	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00167	0.00912
1.A.2.a. Iron and steel - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1.00	0.50	1.12	0.00024	0.00013
1.A.2.a. Iron and steel - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00002	0.00054
1.A.2.b. Non-ferrous metals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.b. Non-ferrous metals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00106	0.00722
1.A.2.c. Chemicals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00080	0.00346
1.A.2.c. Chemicals - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Biomass	N_2O	10.00	50.00	50.99	0.00009	0.00010
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00351	0.00956
1.A.2.d. Pulp, paper and print - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00014	0.00002
1.A.2.d. Pulp, paper and print - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00001	0.00001
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	1.00	0.50	1.12	0.00003	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00101	0.00318
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00002	0.00001
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00001
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00123	0.00202
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00005	0.00001
1.A.2.f. Non-metallic minerals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00023	0.01842
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00006	0.00001
1.A.2.f. Non-metallic minerals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	3.00	3.00	4.24	0.00018	0.00716
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	N_2O	3.00	30.00	30.15	0.00008	0.00004
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncer-tainty (1)	Emission factor / es-timation parameter uncertainty (1)	Combined uncertainty	Contribu-tion to vari-ance by cat-egory in year x	Uncertainty introduced into the trend in to-tal national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.2.g.viii Other - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00001
1.A.2.g.viii Other - Biomass	N_2O	10.00	50.00	50.99	0.00001	0.00013
1.A.2.g.viii Other - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.viii Other - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00406	0.01273
1.A.2.g.viii Other - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00007	0.00001
1.A.2.g.viii Other - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00000	0.00006
1.A.2.g.viii Other - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.b. Road transportation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.b. Road transportation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00009
1.A.3.b. Road transportation - Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00001
1.A.3.b. Road transportation - Diesel Oil	CO_2	3.00	3.00	4.24	0.08152	0.75385
1.A.3.b. Road transportation - Diesel Oil	N_2O	3.00	30.00	30.15	0.00002	0.00478
1.A.3.b. Road transportation - Gaseous Fuels	CH_4	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Gaseous Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00001
1.A.3.b. Road transportation - Gaseous Fuels	N_2O	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Gasoline	CH_4	3.00	30.00	30.15	0.00086	0.00051
1.A.3.b. Road transportation - Gasoline	CO_2	3.00	3.00	4.24	0.17701	0.06752
1.A.3.b. Road transportation - Gasoline	N_2O	3.00	70.00	70.06	0.00531	0.00322
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CH_4	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CO_2	3.00	3.00	4.24	0.00000	0.00000

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	N_2O	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00013
1.A.3.c. Railways - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.c. Railways - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CO_2	3.00	3.00	4.24	0.00008	0.00002
1.A.3.c. Railways - Liquid Fuels	N_2O	3.00	30.00	30.15	0.00004	0.00001
1.A.3.c. Railways - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CO_2	3.00	3.00	4.24	0.00000	0.00001
1.A.3.d. Domestic navigation - Gas/Diesel Oil	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.3.d. Domestic navigation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CH_4	2.00	50.00	50.04	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	2.00	0.20	2.01	0.00003	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	N_2O	2.00	50.00	50.04	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.3.e. Other transportation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.a. Commercial/institutional - Biomass	CH_4	10.00	50.00	50.99	0.00002	0.00001
1.A.4.a. Commercial/institutional - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00192	0.00497
1.A.4.a. Commercial/institutional - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.a. Commercial/institutional - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00001	0.00001
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00040	0.00005
1.A.4.a. Commercial/institutional - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00036	0.00018
1.A.4.a. Commercial/institutional - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.4.b. Residential - Biomass	CH_4	10.00	50.00	50.99	0.02850	0.00160
1.A.4.b. Residential - Biomass	N_2O	10.00	50.00	50.99	0.00157	0.00034
1.A.4.b. Residential - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00001	0.00000
1.A.4.b. Residential - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.01360	0.05907
1.A.4.b. Residential - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.b. Residential - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00019	0.00009
1.A.4.b. Residential - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00626	0.00188
1.A.4.b. Residential - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00013	0.00003
1.A.4.b. Residential - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.b. Residential - Peat	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.4.b. Residential - Peat	CO_2	10.00	15.00	18.03	0.00000	0.00000
1.A.4.b. Residential - Peat	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.b. Residential - Solid Fuels	CH_4	1.00	50.00	50.01	0.01972	0.01431
1.A.4.b. Residential - Solid Fuels	CO_2	1.00	0.50	1.12	0.00124	0.00018
1.A.4.b. Residential - Solid Fuels	N_2O	1.00	50.00	50.01	0.00004	0.00003
1.A.4.c. Agriculture/forestry/fishing - Biomass	CH_4	10.00	50.00	50.99	0.00046	0.00042
1.A.4.c. Agriculture/forestry/fishing - Biomass	N_2O	10.00	50.00	50.99	0.00001	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00000	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00002	0.00001
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00027	0.00020
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00184	0.00034
1.A.4.c. Agriculture/forestry/fishing - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CH_4	1.00	50.00	50.01	0.00001	0.00001
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.5. Other (not specified elsewhere) - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.B.1.a. Coal mining and handling	CH_4	5.00	50.00	50.25	0.05548	0.04088
1.B.2.a. Oil	CH_4	0.50	50.00	50.00	0.00335	0.00054
1.B.2.a. Oil	CO_2	0.50	0.50	0.71	0.00000	0.00000
1.B.2.b. Natural gas	CH_4	20.00	40.00	44.72	0.04430	0.01092
1.B.2.b. Natural gas	CO_2	20.00	0.20	20.00	0.00066	0.00069
2.A.1. Cement production	CO_2	5.00	2.00	5.39	0.01891	0.01880
2.A.2. Lime production	CO_2	10.00	2.00	10.20	0.00341	0.01094
2.A.3. Glass production	CO_2	5.00	2.00	5.39	0.00001	0.00001
2.A.4.a. Ceramics	CO_2	5.00	2.00	5.39	0.00006	0.00002
2.A.4.b. Other uses of soda ash	CO_2	30.00	2.00	30.07	0.00002	0.00002
2.A.4.c. Non-metallurgical magnesium production	CO_2	2.00	2.00	2.83	0.00029	0.00015
2.B.1. Ammonia production	CH_4	2.00	10.00	10.20	0.00000	0.00000
2.B.1. Ammonia production	CO_2	2.00	5.00	5.39	0.00100	0.00026
2.B.10. Other	CH_4	2.00	2.00	2.83	0.00000	0.00000
2.B.10. Other	CO_2	2.00	2.00	2.83	0.00002	0.00002
2.B.2. Nitric acid production	N_2O	2.00	2.00	2.83	0.00077	0.00026
2.B.5. Carbide production	CO_2	1.00	5.00	5.10	0.00001	0.00000
2.B.8. Petrochemical and carbon black production	CH_4	20.00	10.00	22.36	0.00007	0.00023
2.C.1. Iron and steel production	CH_4	2.00	20.00	20.10	0.00000	0.00000
2.C.1. Iron and steel production	CO_2	2.00	0.50	2.06	0.03137	0.13170
2.C.2. Ferroalloys production	CO_2	5.00	25.00	25.50	0.00004	0.00000
2.C.3. Aluminium production	CO_2	2.00	5.00	5.39	0.00010	0.00006
2.C.3. Aluminium production	PFCs	2.00	50.00	50.04	0.42092	0.31275
2.C.3. Aluminium production	SF_6	2.00	50.00	50.04	0.00008	0.00006
2.C.4. Magnesium production	SF_6	5.00	5.00	7.07	0.00044	0.00016
2.C.5. Lead production	CO_2	5.00	50.00	50.25	0.00001	0.00000
2.D. Non-energy products from fuels and solvent use	CO_2	20.00	30.00	36.06	0.02497	0.00606
2.E.1. Integrated circuit or semiconductor	HFCs	5.00	10.00	11.18	0.00000	0.00000

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
2.E.1. Integrated circuit or semiconductor	NF_3	5.00	10.00	11.18	0.00000	0.00001
2.E.1. Integrated circuit or semiconductor	PFCs	5.00	10.00	11.18	0.00002	0.00001
2.E.1. Integrated circuit or semiconductor	SF_6	5.00	10.00	11.18	0.00020	0.00009
2.F.1. Refrigeration and air-conditioning	HFCs	10.00	50.00	50.99	0.00000	0.77663
2.F.1. Refrigeration and air-conditioning	PFCs	10.00	50.00	50.99	0.00000	0.00000
2.F.2. Foam blowing agents	HFCs	20.00	100.00	101.98	0.00000	0.00034
2.F.3. Fire protection	HFCs	10.00	20.00	22.36	0.00000	0.00001
2.F.4. Aerosols	HFCs	20.00	10.00	22.36	0.00000	0.00008
2.F.5. Solvents	HFCs	0.00	0.00	0.00	0.00000	0.00000
2.G. Other product manufacture and use	CO_2	0.00	20.00	20.00	0.00000	0.00000
2.G. Other product manufacture and use	N_2O	0.00	20.00	20.00	0.00087	0.00023
2.G.1. Electrical equipment	SF_6	5.00	100.00	100.12	0.00020	0.00266
2.G.2. SF_6 and PFCs from other product use	SF_6	25.00	50.00	55.90	0.00763	0.03412
2.G.4 Other	HFCs	0.00	0.00	0.00	0.00000	0.00000
2.G.4 Other	PFCs	0.00	0.00	0.00	0.00000	0.00000
3.A.1. Cattle	CH_4	10.00	20.00	22.36	1.87130	0.51275
3.A.2. Sheep	CH_4	10.00	20.00	22.36	0.00053	0.00042
3.A.3. Swine	CH_4	10.00	20.00	22.36	0.00061	0.00013
3.A.4. Other livestock	CH_4	10.00	20.00	22.36	0.00013	0.00062
3.B.1. Cattle	CH_4	10.00	20.00	22.36	0.01834	0.01785
3.B.1. Cattle	N_2O	10.00	100.00	100.50	0.25941	0.01629
3.B.2. Sheep	CH_4	10.00	30.00	31.62	0.00000	0.00000
3.B.2. Sheep	N_2O	10.00	100.00	100.50	0.00010	0.00001
3.B.3. Swine	CH_4	10.00	20.00	22.36	0.00268	0.00054
3.B.3. Swine	N_2O	10.00	100.00	100.50	0.01951	0.00248
3.B.4. Other livestock	CH_4	10.00	30.00	31.62	0.00002	0.00002
3.B.4. Other livestock	N_2O	10.00	100.00	100.50	0.00021	0.00043
3.B.5. Indirect N_2O emissions	N_2O	5.00	200.00	200.06	0.09619	0.00074
3.D.1. Direct N_2O emissions from managed soils	N_2O	5.00	200.00	200.06	16.28236	0.01723
3.D.2. Indirect N_2O emissions from managed soils	N_2O	5.00	200.00	200.06	1.37976	0.00587
3.F. Field burning of agricultural residues	CH_4	100.00	40.00	107.70	0.00000	0.00000
3.F. Field burning of agricultural residues	N_2O	100.00	50.00	111.80	0.00000	0.00000
3.G. Liming	CO_2	5.00	50.00	50.25	0.00083	0.00130
3.H. Urea application	CO_2	5.00	50.00	50.25	0.00004	0.00019
3.I. Other carbon-containing fertilizers	CO_2	5.00	50.00	50.25	0.00037	0.00001
5.A. Solid waste disposal	CH_4	12.00	25.00	27.73	2.02039	0.75860
5.B. Biological treatment of solid waste	CH_4	20.00	50.00	53.85	0.00010	0.00237

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
5.B. Biological treatment of solid waste	N_2O	20.00	50.00	53.85	0.00019	0.00184
5.C. Incineration and open burning of waste	CH_4	0.00	7.00	7.00	0.00000	0.00000
5.C. Incineration and open burning of waste	CO_2	7.00	20.00	21.19	0.00006	0.00003
5.C. Incineration and open burning of waste	N_2O	0.00	7.00	7.00	0.00000	0.00000
5.D. Wastewater treatment and discharge	CH_4	15.00	16.00	21.93	0.00847	0.00295
5.D. Wastewater treatment and discharge	N_2O	15.00	100.00	101.12	0.01187	0.01194
Total					**22.96**	**3.77**
Total Uncertainties				**Uncertainty in total inventory %:**	**4.79**	**1.94**

Table 11: Approach 1 Uncertainty calculation and reporting according IPCC 2006 GL for 2023 – excluding LULUCF.

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.1.a. Public electricity and heat production - Biomass	CH_4	5.00	50.00	50.25	0.00017	0.00012
1.A.1.a. Public electricity and heat production - Biomass	N_2O	5.00	50.00	50.25	0.00222	0.00154
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	1.00	0.20	1.02	0.00227	0.00324
1.A.1.a. Public electricity and heat production - Gaseous Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00000	0.00003
1.A.1.a. Public electricity and heat production - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CH_4	5.00	50.00	50.25	0.00001	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.06338	0.03488
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	N_2O	5.00	50.00	50.25	0.00011	0.00005

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.1.a. Public electricity and heat production - Solid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	0.50	0.50	0.71	0.00000	0.00114
1.A.1.a. Public electricity and heat production - Solid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00017
1.A.1.b. Petroleum refining - Gaseous Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	1.00	0.20	1.02	0.00002	0.00003
1.A.1.b. Petroleum refining - Gaseous Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00054	0.00041
1.A.1.b. Petroleum refining - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	1.00	0.20	1.02	0.00001	0.00001
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00613	0.00912
1.A.2.a. Iron and steel - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1.00	0.50	1.12	0.00011	0.00013
1.A.2.a. Iron and steel - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00036	0.00054
1.A.2.b. Non-ferrous metals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.b. Non-ferrous metals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	N_2O	10.00	50.00	50.99	0.00001	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00486	0.00722
1.A.2.c. Chemicals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00532	0.00346
1.A.2.c. Chemicals - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00001	0.00000
1.A.2.c. Chemicals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Biomass	CH_4	10.00	50.00	50.99	0.00002	0.00000
1.A.2.d. Pulp, paper and print - Biomass	N_2O	10.00	50.00	50.99	0.00040	0.00010
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00643	0.00956
1.A.2.d. Pulp, paper and print - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00002
1.A.2.d. Pulp, paper and print - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00002	0.00001
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.e. Food processing, beverages and tobacco - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00214	0.00318
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00001	0.00001
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	N_2O	10.00	50.00	50.99	0.00001	0.00001
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00136	0.00202
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00001	0.00001
1.A.2.f. Non-metallic minerals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.02114	0.01842
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00003	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00001
1.A.2.f. Non-metallic minerals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncer-tainty (1)	Emission factor / es-timation parameter uncertainty (1)	Combined uncertainty	Contribu-tion to vari-ance by cat-egory in year x	Uncertainty introduced into the trend in to-tal national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	3.00	3.00	4.24	0.00711	0.00716
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	N_2O	3.00	30.00	30.15	0.00027	0.00004
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.2.g.viii Other - Biomass	CH_4	10.00	50.00	50.99	0.00002	0.00001
1.A.2.g.viii Other - Biomass	N_2O	10.00	50.00	50.99	0.00023	0.00013
1.A.2.g.viii Other - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.viii Other - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00856	0.01273
1.A.2.g.viii Other - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00001
1.A.2.g.viii Other - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00007	0.00006
1.A.2.g.viii Other - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.b. Road transportation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.b. Road transportation - Biomass	N_2O	5.00	50.00	50.25	0.00012	0.00009
1.A.3.b. Road transportation - Diesel Oil	CH_4	3.00	30.00	30.15	0.00003	0.00001

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.3.b. Road transportation - Diesel Oil	CO_2	3.00	3.00	4.24	0.82055	0.75385
1.A.3.b. Road transportation - Diesel Oil	N_2O	3.00	30.00	30.15	0.00701	0.00478
1.A.3.b. Road transportation - Gaseous Fuels	CH_4	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Gaseous Fuels	CO_2	3.00	3.00	4.24	0.00001	0.00001
1.A.3.b. Road transportation - Gaseous Fuels	N_2O	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Gasoline	CH_4	3.00	30.00	30.15	0.00001	0.00051
1.A.3.b. Road transportation - Gasoline	CO_2	3.00	3.00	4.24	0.08160	0.06752
1.A.3.b. Road transportation - Gasoline	N_2O	3.00	70.00	70.06	0.00005	0.00322
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CH_4	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	N_2O	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00015	0.00013
1.A.3.c. Railways - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.c. Railways - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CO_2	3.00	3.00	4.24	0.00002	0.00002
1.A.3.c. Railways - Liquid Fuels	N_2O	3.00	30.00	30.15	0.00000	0.00001
1.A.3.c. Railways - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CO_2	3.00	3.00	4.24	0.00001	0.00001
1.A.3.d. Domestic navigation - Gas/Diesel Oil	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.3.d. Domestic navigation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	1.00	0.20	1.02	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.3.e. Other transportation - Liquid Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.3.e. Other transportation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.a. Commercial/institutional - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00001
1.A.4.a. Commercial/institutional - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00334	0.00497
1.A.4.a. Commercial/institutional - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.a. Commercial/institutional - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00001
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00001	0.00005
1.A.4.a. Commercial/institutional - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00000	0.00018
1.A.4.a. Commercial/institutional - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.4.b. Residential - Biomass	CH_4	10.00	50.00	50.99	0.02119	0.00160
1.A.4.b. Residential - Biomass	N_2O	10.00	50.00	50.99	0.00303	0.00034
1.A.4.b. Residential - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00003	0.00000
1.A.4.b. Residential - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.03973	0.05907
1.A.4.b. Residential - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.b. Residential - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00001	0.00009
1.A.4.b. Residential - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00135	0.00188
1.A.4.b. Residential - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00002	0.00003
1.A.4.b. Residential - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.b. Residential - Peat	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.4.b. Residential - Peat	CO_2	10.00	15.00	18.03	0.00000	0.00000
1.A.4.b. Residential - Peat	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.b. Residential - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.01431
1.A.4.b. Residential - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00018
1.A.4.b. Residential - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00003
1.A.4.c. Agriculture/forestry/fishing - Biomass	CH_4	10.00	50.00	50.99	0.00181	0.00042
1.A.4.c. Agriculture/forestry/fishing - Biomass	N_2O	10.00	50.00	50.99	0.00005	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00000	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00001
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00017	0.00020
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00046	0.00034
1.A.4.c. Agriculture/forestry/fishing - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00001
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.B.1.a. Coal mining and handling	CH_4	5.00	50.00	50.25	0.00000	0.04088
1.B.2.a. Oil	CH_4	0.50	50.00	50.00	0.00096	0.00054
1.B.2.a. Oil	CO_2	0.50	0.50	0.71	0.00000	0.00000
1.B.2.b. Natural gas	CH_4	20.00	40.00	44.72	0.03575	0.01092
1.B.2.b. Natural gas	CO_2	20.00	0.20	20.00	0.00046	0.00069
2.A.1. Cement production	CO_2	1.00	2.00	2.24	0.00252	0.00078
2.A.2. Lime production	CO_2	5.00	2.00	5.39	0.00213	0.00275
2.A.3. Glass production	CO_2	1.00	2.00	2.24	0.00000	0.00000
2.A.4.a. Ceramics	CO_2	1.00	2.00	2.24	0.00000	0.00000
2.A.4.b. Other uses of soda ash	CO_2	30.00	2.00	30.07	0.00001	0.00002
2.A.4.c. Non-metallurgical magnesium production	CO_2	2.00	2.00	2.83	0.00019	0.00015
2.B.1. Ammonia production	CH_4	2.00	10.00	10.20	0.00000	0.00000
2.B.1. Ammonia production	CO_2	2.00	5.00	5.39	0.00123	0.00026
2.B.10. Other	CH_4	2.00	2.00	2.83	0.00000	0.00000
2.B.10. Other	CO_2	2.00	2.00	2.83	0.00002	0.00002
2.B.2. Nitric acid production	N_2O	2.00	2.00	2.83	0.00000	0.00026
2.B.5. Carbide production	CO_2	1.00	5.00	5.10	0.00001	0.00000
2.B.8. Petrochemical and carbon black production	CH_4	20.00	10.00	22.36	0.00019	0.00023
2.C.1. Iron and steel production	CH_4	0.50	20.00	20.01	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncer-tainty (1)	Emission factor / es-timation parameter uncertainty (1)	Combined uncertainty	Contribu-tion to vari-ance by cat-egory in year x	Uncertainty introduced into the trend in to-tal national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
2.C.1. Iron and steel production	CO_2	0.50	0.50	0.71	0.01100	0.00891
2.C.2. Ferroalloys production	CO_2	5.00	25.00	25.50	0.00004	0.00000
2.C.3. Aluminium production	CO_2	20.00	5.00	20.62	0.00000	0.00006
2.C.3. Aluminium production	PFCs	2.00	50.00	50.04	0.00000	0.31275
2.C.3. Aluminium production	SF_6	2.00	50.00	50.04	0.00000	0.00006
2.C.4. Magnesium production	SF_6	5.00	5.00	7.07	0.00000	0.00016
2.C.5. Lead production	CO_2	5.00	50.00	50.25	0.00002	0.00000
2.D. Non-energy products from fuels and solvent use	CO_2	20.00	30.00	36.06	0.00723	0.00606
2.E.1. Integrated circuit or semiconductor	HFCs	5.00	10.00	11.18	0.00000	0.00000
2.E.1. Integrated circuit or semiconductor	NF_3	5.00	10.00	11.18	0.00001	0.00001
2.E.1. Integrated circuit or semiconductor	PFCs	5.00	10.00	11.18	0.00002	0.00001
2.E.1. Integrated circuit or semiconductor	SF_6	5.00	10.00	11.18	0.00000	0.00009
2.F.1. Refrigeration and air-conditioning	HFCs	10.00	50.00	50.99	1.00466	0.77663
2.F.1. Refrigeration and air-conditioning	PFCs	10.00	50.00	50.99	0.00000	0.00000
2.F.2. Foam blowing agents	HFCs	20.00	100.00	101.98	0.00044	0.00034
2.F.3. Fire protection	HFCs	10.00	20.00	22.36	0.00001	0.00001
2.F.4. Aerosols	HFCs	20.00	10.00	22.36	0.00006	0.00008
2.F.5. Solvents	HFCs	0.00	0.00	0.00	0.00000	0.00000
2.G. Other product manufacture and use	CO_2	0.00	20.00	20.00	0.00000	0.00000
2.G. Other product manufacture and use	N_2O	0.00	20.00	20.00	0.00014	0.00023
2.G.1. Electrical equipment	SF_6	5.00	100.00	100.12	0.00542	0.00266
2.G.2. SF_6 and PFCs from other product use	SF_6	25.00	50.00	55.90	0.06215	0.03412
2.G.4 Other	HFCs	0.00	0.00	0.00	0.00000	0.00000
2.G.4 Other	PFCs	0.00	0.00	0.00	0.00000	0.00000
3.A.1. Cattle	CH_4	1.00	20.00	20.02	1.37564	0.00713
3.A.2. Sheep	CH_4	10.00	20.00	22.36	0.00117	0.00042
3.A.3. Swine	CH_4	4.00	20.00	20.40	0.00033	0.00003
3.A.4. Other livestock	CH_4	10.00	20.00	22.36	0.00112	0.00062
3.B.1. Cattle	CH_4	1.00	20.00	20.02	0.03756	0.00405
3.B.1. Cattle	N_2O	1.00	100.00	100.00	0.13569	0.01429
3.B.2. Sheep	CH_4	10.00	30.00	31.62	0.00000	0.00000
3.B.2. Sheep	N_2O	10.00	100.00	100.50	0.00019	0.00001
3.B.3. Swine	CH_4	4.00	20.00	20.40	0.00109	0.00021
3.B.3. Swine	N_2O	4.00	100.00	100.08	0.00680	0.00240
3.B.4. Other livestock	CH_4	10.00	30.00	31.62	0.00008	0.00002
3.B.4. Other livestock	N_2O	10.00	100.00	100.50	0.00145	0.00043
3.B.5. Indirect N_2O emissions	N_2O	5.00	200.00	200.06	0.11513	0.00074

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
3.D.1. Direct N_2O emissions from managed soils	N_2O	5.00	200.00	200.06	16.67338	0.01723
3.D.2. Indirect N_2O emissions from managed soils	N_2O	5.00	200.00	200.06	1.19824	0.00587
3.F. Field burning of agricultural residues	CH_4	100.00	40.00	107.70	0.00000	0.00000
3.F. Field burning of agricultural residues	N_2O	100.00	50.00	111.80	0.00000	0.00000
3.G. Liming	CO_2	5.00	50.00	50.25	0.00486	0.00130
3.H. Urea application	CO_2	5.00	50.00	50.25	0.00048	0.00019
3.I. Other carbon-containing fertilizers	CO_2	5.00	50.00	50.25	0.00026	0.00001
5.A. Solid waste disposal	CH_4	12.00	25.00	27.73	0.10414	0.75860
5.B. Biological treatment of solid waste	CH_4	20.00	50.00	53.85	0.00363	0.00237
5.B. Biological treatment of solid waste	N_2O	20.00	50.00	53.85	0.00321	0.00184
5.C. Incineration and open burning of waste	CH_4	0.00	7.00	7.00	0.00000	0.00000
5.C. Incineration and open burning of waste	CO_2	7.00	20.00	21.19	0.00000	0.00003
5.C. Incineration and open burning of waste	N_2O	0.00	7.00	7.00	0.00000	0.00000
5.D. Wastewater treatment and discharge	CH_4	5.00	16.00	16.76	0.00215	0.00068
5.D. Wastewater treatment and discharge	N_2O	5.00	100.00	100.12	0.05078	0.01043
Total					**21.97**	**3.06**
Total Uncertainties				**Uncertainty in total inventory %:**	**4.69**	**1.75**

Table 12: Approach 1 Uncertainty calculation and reporting according IPCC 2006 GL for 1990 – including LULUCF.

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.1.a. Public electricity and heat production - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00017
1.A.1.a. Public electricity and heat production - Biomass	N_2O	5.00	50.00	50.25	0.00001	0.00219
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CH_4	2.00	50.00	50.04	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	2.00	0.20	2.01	0.01011	0.01896
1.A.1.a. Public electricity and heat production - Gaseous Fuels	N_2O	2.00	50.00	50.04	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.1.a. Public electricity and heat production - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00017	0.00010
1.A.1.a. Public electricity and heat production - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00001
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00615	0.08529
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00001	0.00006
1.A.1.a. Public electricity and heat production - Solid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	0.50	0.50	0.71	0.00450	0.00301
1.A.1.a. Public electricity and heat production - Solid Fuels	N_2O	0.50	50.00	50.00	0.00034	0.00046
1.A.1.b. Petroleum refining - Gaseous Fuels	CH_4	2.00	50.00	50.04	0.00000	0.00000
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	2.00	0.20	2.01	0.00018	0.00020
1.A.1.b. Petroleum refining - Gaseous Fuels	N_2O	2.00	50.00	50.04	0.00000	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00044	0.00058
1.A.1.b. Petroleum refining - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CH_4	2.00	50.00	50.04	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	2.00	0.20	2.01	0.00024	0.00005
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	N_2O	2.00	50.00	50.04	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00244	0.01332
1.A.2.a. Iron and steel - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.a. Iron and steel - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1.00	0.50	1.12	0.00035	0.00021
1.A.2.a. Iron and steel - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00003	0.00078
1.A.2.b. Non-ferrous metals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	N_2O	10.00	50.00	50.99	0.00001	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00155	0.01055
1.A.2.c. Chemicals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00117	0.00448
1.A.2.c. Chemicals - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Biomass	CH_4	10.00	50.00	50.99	0.00001	0.00000
1.A.2.d. Pulp, paper and print - Biomass	N_2O	10.00	50.00	50.99	0.00013	0.00009
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00513	0.01397
1.A.2.d. Pulp, paper and print - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00021	0.00005
1.A.2.d. Pulp, paper and print - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00002	0.00002
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	1.00	0.50	1.12	0.00005	0.00001
1.A.2.d. Pulp, paper and print - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00148	0.00465
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00003	0.00001
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00001
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00180	0.00295
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00007	0.00003
1.A.2.f. Non-metallic minerals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00034	0.02592
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00008	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	3.00	3.00	4.24	0.00026	0.01012
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	N_2O	3.00	30.00	30.15	0.00012	0.00003
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.2.g.viii Other - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00001
1.A.2.g.viii Other - Biomass	N_2O	10.00	50.00	50.99	0.00001	0.00017
1.A.2.g.viii Other - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.viii Other - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00593	0.01860
1.A.2.g.viii Other - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00011	0.00003
1.A.2.g.viii Other - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00000	0.00008
1.A.2.g.viii Other - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	N_2O	3.00	30.00	30.15	0.00000	0.00000

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.3.a. Domestic aviation - Jet Kerosene	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.b. Road transportation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.b. Road transportation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00013
1.A.3.b. Road transportation - Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00001
1.A.3.b. Road transportation - Diesel Oil	CO_2	3.00	3.00	4.24	0.11912	1.04106
1.A.3.b. Road transportation - Diesel Oil	N_2O	3.00	30.00	30.15	0.00002	0.00675
1.A.3.b. Road transportation - Gaseous Fuels	CH_4	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Gaseous Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00001
1.A.3.b. Road transportation - Gaseous Fuels	N_2O	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Gasoline	CH_4	3.00	30.00	30.15	0.00126	0.00141
1.A.3.b. Road transportation - Gasoline	CO_2	3.00	3.00	4.24	0.25866	0.13091
1.A.3.b. Road transportation - Gasoline	N_2O	3.00	70.00	70.06	0.00776	0.00893
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CH_4	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	N_2O	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00018
1.A.3.c. Railways - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.c. Railways - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CO_2	3.00	3.00	4.24	0.00012	0.00005
1.A.3.c. Railways - Liquid Fuels	N_2O	3.00	30.00	30.15	0.00005	0.00004
1.A.3.c. Railways - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CO_2	3.00	3.00	4.24	0.00000	0.00002
1.A.3.d. Domestic navigation - Gas/Diesel Oil	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	N_2O	3.00	70.00	70.06	0.00000	0.00000

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.3.d. Domestic navigation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CH_4	2.00	50.00	50.04	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	2.00	0.20	2.01	0.00005	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	N_2O	2.00	50.00	50.04	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.3.e. Other transportation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.a. Commercial/institutional - Biomass	CH_4	10.00	50.00	50.99	0.00004	0.00003
1.A.4.a. Commercial/institutional - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00281	0.00726
1.A.4.a. Commercial/institutional - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.a. Commercial/institutional - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00001	0.00002
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00058	0.00014
1.A.4.a. Commercial/institutional - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00052	0.00048
1.A.4.a. Commercial/institutional - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.4.b. Residential - Biomass	CH_4	10.00	50.00	50.99	0.04165	0.00862
1.A.4.b. Residential - Biomass	N_2O	10.00	50.00	50.99	0.00229	0.00026
1.A.4.b. Residential - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00001	0.00000
1.A.4.b. Residential - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.01988	0.08631
1.A.4.b. Residential - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.b. Residential - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00028	0.00026
1.A.4.b. Residential - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00914	0.00340
1.A.4.b. Residential - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00018	0.00012
1.A.4.b. Residential - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.b. Residential - Peat	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.4.b. Residential - Peat	CO_2	10.00	15.00	18.03	0.00000	0.00000

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.4.b. Residential - Peat	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.b. Residential - Solid Fuels	CH_4	1.00	50.00	50.01	0.02882	0.03786
1.A.4.b. Residential - Solid Fuels	CO_2	1.00	0.50	1.12	0.00182	0.00048
1.A.4.b. Residential - Solid Fuels	N_2O	1.00	50.00	50.01	0.00006	0.00008
1.A.4.c. Agriculture/forestry/fishing - Biomass	CH_4	10.00	50.00	50.99	0.00068	0.00034
1.A.4.c. Agriculture/forestry/fishing - Biomass	N_2O	10.00	50.00	50.99	0.00001	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00000	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00002	0.00002
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00040	0.00031
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00269	0.00142
1.A.4.c. Agriculture/forestry/fishing - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CH_4	1.00	50.00	50.01	0.00001	0.00002
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.B.1.a. Coal mining and handling	CH_4	5.00	50.00	50.25	0.08107	0.10749
1.B.2.a. Oil	CH_4	0.50	50.00	50.00	0.00489	0.00236
1.B.2.a. Oil	CO_2	0.50	0.50	0.71	0.00000	0.00000
1.B.2.b. Natural gas	CH_4	20.00	40.00	44.72	0.06473	0.02312
1.B.2.b. Natural gas	CO_2	20.00	0.20	20.00	0.00096	0.00101
2.A.1. Cement production	CO_2	5.00	2.00	5.39	0.02764	0.02803
2.A.2. Lime production	CO_2	10.00	2.00	10.20	0.00499	0.01595
2.A.3. Glass production	CO_2	5.00	2.00	5.39	0.00001	0.00001
2.A.4.a. Ceramics	CO_2	5.00	2.00	5.39	0.00009	0.00003
2.A.4.b. Other uses of soda ash	CO_2	30.00	2.00	30.07	0.00003	0.00003

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
2.A.4.c. Non-metallurgical magnesium production	CO_2	2.00	2.00	2.83	0.00043	0.00026
2.B.1. Ammonia production	CH_4	2.00	10.00	10.20	0.00000	0.00000
2.B.1. Ammonia production	CO_2	2.00	5.00	5.39	0.00146	0.00042
2.B.10. Other	CH_4	2.00	2.00	2.83	0.00000	0.00000
2.B.10. Other	CO_2	2.00	2.00	2.83	0.00004	0.00002
2.B.2. Nitric acid production	N_2O	2.00	2.00	2.83	0.00112	0.00071
2.B.5. Carbide production	CO_2	1.00	5.00	5.10	0.00001	0.00000
2.B.8. Petrochemical and carbon black production	CH_4	20.00	10.00	22.36	0.00010	0.00033
2.C.1. Iron and steel production	CH_4	2.00	20.00	20.10	0.00000	0.00000
2.C.1. Iron and steel production	CO_2	2.00	0.50	2.06	0.04584	0.19169
2.C.2. Ferroalloys production	CO_2	5.00	25.00	25.50	0.00006	0.00001
2.C.3. Aluminium production	CO_2	2.00	5.00	5.39	0.00015	0.00017
2.C.3. Aluminium production	PFCs	2.00	50.00	50.04	0.61510	0.82226
2.C.3. Aluminium production	SF_6	2.00	50.00	50.04	0.00011	0.00015
2.C.4. Magnesium production	SF_6	5.00	5.00	7.07	0.00064	0.00042
2.C.5. Lead production	CO_2	5.00	50.00	50.25	0.00001	0.00000
2.D. Non-energy products from fuels and solvent use	CO_2	20.00	30.00	36.06	0.03649	0.01697
2.E.1. Integrated circuit or semiconductor	HFCs	5.00	10.00	11.18	0.00000	0.00000
2.E.1. Integrated circuit or semiconductor	NF_3	5.00	10.00	11.18	0.00000	0.00001
2.E.1. Integrated circuit or semiconductor	PFCs	5.00	10.00	11.18	0.00003	0.00001
2.E.1. Integrated circuit or semiconductor	SF_6	5.00	10.00	11.18	0.00029	0.00025
2.F.1. Refrigeration and air-conditioning	HFCs	10.00	50.00	50.99	0.00000	1.13490
2.F.1. Refrigeration and air-conditioning	PFCs	10.00	50.00	50.99	0.00000	0.00000
2.F.2. Foam blowing agents	HFCs	20.00	100.00	101.98	0.00000	0.00050
2.F.3. Fire protection	HFCs	10.00	20.00	22.36	0.00000	0.00002
2.F.4. Aerosols	HFCs	20.00	10.00	22.36	0.00000	0.00012
2.F.5. Solvents	HFCs	0.00	0.00	0.00	0.00000	0.00000
2.G. Other product manufacture and use	CO_2	0.00	20.00	20.00	0.00000	0.00000
2.G. Other product manufacture and use	N_2O	0.00	20.00	20.00	0.00127	0.00083
2.G.1. Electrical equipment	SF_6	5.00	100.00	100.12	0.00029	0.00330
2.G.2. SF_6 and PFCs from other product use	SF_6	25.00	50.00	55.90	0.01115	0.04223
2.G.4 Other	HFCs	0.00	0.00	0.00	0.00000	0.00000
2.G.4 Other	PFCs	0.00	0.00	0.00	0.00000	0.00000
3.A.1. Cattle	CH_4	10.00	20.00	22.36	2.73457	0.98607
3.A.2. Sheep	CH_4	10.00	20.00	22.36	0.00077	0.00052
3.A.3. Swine	CH_4	10.00	20.00	22.36	0.00089	0.00032
3.A.4. Other livestock	CH_4	10.00	20.00	22.36	0.00020	0.00077

IPCC category/Group	GHG	Activity data uncer-tainty (1)	Emission factor / es-timation parameter uncertainty (1)	Combined uncertainty	Contribu-tion to vari-ance by cat-egory in year x	Uncertainty introduced into the trend in to-tal national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
3.B.1. Cattle	CH_4	10.00	20.00	22.36	0.02680	0.02143
3.B.1. Cattle	N_2O	10.00	100.00	100.50	0.37908	0.10846
3.B.2. Sheep	CH_4	10.00	30.00	31.62	0.00000	0.00000
3.B.2. Sheep	N_2O	10.00	100.00	100.50	0.00015	0.00000
3.B.3. Swine	CH_4	10.00	20.00	22.36	0.00392	0.00153
3.B.3. Swine	N_2O	10.00	100.00	100.50	0.02850	0.01191
3.B.4. Other livestock	CH_4	10.00	30.00	31.62	0.00004	0.00002
3.B.4. Other livestock	N_2O	10.00	100.00	100.50	0.00030	0.00041
3.B.5. Indirect N_2O emissions	N_2O	5.00	200.00	200.06	0.14057	0.00655
3.D.1. Direct N_2O emissions from managed soils	N_2O	5.00	200.00	200.06	23.79376	1.94259
3.D.2. Indirect N_2O emissions from managed soils	N_2O	5.00	200.00	200.06	2.01628	0.25307
3.F. Field burning of agricultural residues	CH_4	100.00	40.00	107.70	0.00000	0.00000
3.F. Field burning of agricultural residues	N_2O	100.00	50.00	111.80	0.00000	0.00000
3.G. Liming	CO_2	5.00	50.00	50.25	0.00121	0.00114
3.H. Urea application	CO_2	5.00	50.00	50.25	0.00005	0.00022
3.I. Other carbon-containing fertilizers	CO_2	5.00	50.00	50.25	0.00055	0.00011
4. Land use, land-use change and forestry	CH_4	0.00	42.80	42.80	0.00059	0.00002
4. Land use, land-use change and forestry	N_2O	0.00	71.14	71.14	0.03788	0.00179
4.A.1. Forest land remaining forest land	CO_2	0.00	37.62	37.62	36.82817	118.90412
4.A.2. Land converted to forest land	CO_2	0.00	97.65	97.65	19.24624	9.00023
4.B.1. Cropland remaining cropland	CO_2	0.00	38.56	38.56	0.01387	0.00019
4.B.2. Land converted to cropland	CO_2	0.00	32.66	32.66	0.00739	0.00020
4.C.1. Grassland remaining grassland	CO_2	0.00	27.90	27.90	0.02471	0.00061
4.C.2. Land converted to grassland	CO_2	0.00	96.02	96.02	0.37675	0.14992
4.D.1. Wetlands remaining wetlands	CO_2	0.00	24.55	24.55	0.00006	0.00000
4.D.2. Land converted to wetlands	CO_2	0.00	69.27	69.27	0.00215	0.00036
4.E.1. Settlements remaining settlements	CO_2	0.00	0.00	0.00	0.00000	0.00000
4.E.2. Land converted to settlements	CO_2	0.00	46.26	46.26	0.43136	0.00933
4.F.2. Land converted to other land	CO_2	0.00	109.88	109.88	0.70005	0.01007
4.G. Harvested wood products	CO_2	0.00	49.02	49.02	5.39896	4.77700
5.A. Solid waste disposal	CH_4	12.00	25.00	27.73	2.95244	2.25766
5.B. Biological treatment of solid waste	CH_4	20.00	50.00	53.85	0.00014	0.00316
5.B. Biological treatment of solid waste	N_2O	20.00	50.00	53.85	0.00027	0.00234
5.C. Incineration and open burning of waste	CH_4	0.00	7.00	7.00	0.00000	0.00000
5.C. Incineration and open burning of waste	CO_2	7.00	20.00	21.19	0.00008	0.00008
5.C. Incineration and open burning of waste	N_2O	0.00	7.00	7.00	0.00000	0.00000
5.D. Wastewater treatment and discharge	CH_4	15.00	16.00	21.93	0.01238	0.00602

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
5.D. Wastewater treatment and discharge	N_2O	15.00	100.00	101.12	0.01735	0.00953
Total					**96.62**	**142.42**
Total Uncertainties				**Uncertainty in total inventory %:**	**9.83**	**11.93**

Table 13: Approach 1 Uncertainty calculation and reporting according IPCC 2006 GL for 2023 – including LULUCF.

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.1.a. Public electricity and heat production - Biomass	CH_4	5.00	50.00	50.25	0.00014	0.00017
1.A.1.a. Public electricity and heat production - Biomass	N_2O	5.00	50.00	50.25	0.00180	0.00219
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	1.00	0.20	1.02	0.00184	0.00474
1.A.1.a. Public electricity and heat production - Gaseous Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00000	0.00010
1.A.1.a. Public electricity and heat production - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CH_4	5.00	50.00	50.25	0.00001	0.00001
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.05148	0.04392
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	N_2O	5.00	50.00	50.25	0.00009	0.00006
1.A.1.a. Public electricity and heat production - Solid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	0.50	0.50	0.71	0.00000	0.00301
1.A.1.a. Public electricity and heat production - Solid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00046

IPCC category/Group	GHG	Activity data uncer-tainty (1)	Emission factor / es-timation parameter uncertainty (1)	Combined uncertainty	Contribu-tion to vari-ance by cat-egory in year x	Uncertainty introduced into the trend in to-tal national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.1.b. Petroleum refining - Gaseous Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	1.00	0.20	1.02	0.00002	0.00005
1.A.1.b. Petroleum refining - Gaseous Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00044	0.00058
1.A.1.b. Petroleum refining - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	1.00	0.20	1.02	0.00000	0.00001
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CH_4	0.50	50.00	50.00	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CO_2	0.50	0.50	0.71	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	N_2O	0.50	50.00	50.00	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00498	0.01332
1.A.2.a. Iron and steel - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1.00	0.50	1.12	0.00009	0.00021
1.A.2.a. Iron and steel - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00029	0.00078
1.A.2.b. Non-ferrous metals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	N_2O	10.00	50.00	50.99	0.00001	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00394	0.01055
1.A.2.c. Chemicals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00432	0.00448
1.A.2.c. Chemicals - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00001	0.00000
1.A.2.c. Chemicals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Biomass	CH_4	10.00	50.00	50.99	0.00001	0.00000
1.A.2.d. Pulp, paper and print - Biomass	N_2O	10.00	50.00	50.99	0.00033	0.00009
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00522	0.01397
1.A.2.d. Pulp, paper and print - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00005
1.A.2.d. Pulp, paper and print - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00002	0.00002
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00001
1.A.2.d. Pulp, paper and print - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00174	0.00465

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00001
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	N_2O	10.00	50.00	50.99	0.00001	0.00001
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00110	0.00295
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00001	0.00003
1.A.2.f. Non-metallic minerals - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.01717	0.02592
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00002	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	3.00	3.00	4.24	0.00577	0.01012
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	N_2O	3.00	30.00	30.15	0.00022	0.00003

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.2.g.viii Other - Biomass	CH_4	10.00	50.00	50.99	0.00001	0.00001
1.A.2.g.viii Other - Biomass	N_2O	10.00	50.00	50.99	0.00019	0.00017
1.A.2.g.viii Other - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.viii Other - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00696	0.01860
1.A.2.g.viii Other - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00003
1.A.2.g.viii Other - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00005	0.00008
1.A.2.g.viii Other - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.b. Road transportation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.b. Road transportation - Biomass	N_2O	5.00	50.00	50.25	0.00009	0.00013
1.A.3.b. Road transportation - Diesel Oil	CH_4	3.00	30.00	30.15	0.00003	0.00001
1.A.3.b. Road transportation - Diesel Oil	CO_2	3.00	3.00	4.24	0.66644	1.04106
1.A.3.b. Road transportation - Diesel Oil	N_2O	3.00	30.00	30.15	0.00569	0.00675
1.A.3.b. Road transportation - Gaseous Fuels	CH_4	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Gaseous Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00001
1.A.3.b. Road transportation - Gaseous Fuels	N_2O	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Gasoline	CH_4	3.00	30.00	30.15	0.00001	0.00141
1.A.3.b. Road transportation - Gasoline	CO_2	3.00	3.00	4.24	0.06628	0.13091
1.A.3.b. Road transportation - Gasoline	N_2O	3.00	70.00	70.06	0.00004	0.00893

IPCC category/Group	GHG	Activity data uncer-tainty (1)	Emission factor / es-timation parameter uncertainty (1)	Combined uncertainty	Contribu-tion to vari-ance by cat-egory in year x	Uncertainty introduced into the trend in to-tal national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CH_4	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	N_2O	3.00	50.00	50.09	0.00000	0.00000
1.A.3.b. Road transportation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00013	0.00018
1.A.3.c. Railways - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.c. Railways - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CO_2	3.00	3.00	4.24	0.00002	0.00005
1.A.3.c. Railways - Liquid Fuels	N_2O	3.00	30.00	30.15	0.00000	0.00004
1.A.3.c. Railways - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CO_2	3.00	3.00	4.24	0.00001	0.00002
1.A.3.d. Domestic navigation - Gas/Diesel Oil	N_2O	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.d. Domestic navigation - Gasoline	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.3.d. Domestic navigation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	1.00	0.20	1.02	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CH_4	3.00	30.00	30.15	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CO_2	3.00	3.00	4.24	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	N_2O	3.00	70.00	70.06	0.00000	0.00000
1.A.3.e. Other transportation - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.a. Commercial/institutional - Biomass	CH_4	10.00	50.00	50.99	0.00000	0.00003
1.A.4.a. Commercial/institutional - Biomass	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00271	0.00726

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
1.A.4.a. Commercial/institutional - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.a. Commercial/institutional - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00002
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00001	0.00014
1.A.4.a. Commercial/institutional - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CO_2	10.00	15.00	18.03	0.00000	0.00048
1.A.4.a. Commercial/institutional - Other Fossil Fuels	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.4.b. Residential - Biomass	CH_4	10.00	50.00	50.99	0.01721	0.00862
1.A.4.b. Residential - Biomass	N_2O	10.00	50.00	50.99	0.00246	0.00026
1.A.4.b. Residential - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00002	0.00000
1.A.4.b. Residential - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.03227	0.08631
1.A.4.b. Residential - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.b. Residential - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00001	0.00026
1.A.4.b. Residential - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00110	0.00340
1.A.4.b. Residential - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00002	0.00012
1.A.4.b. Residential - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.b. Residential - Peat	CH_4	10.00	50.00	50.99	0.00000	0.00000
1.A.4.b. Residential - Peat	CO_2	10.00	15.00	18.03	0.00000	0.00000
1.A.4.b. Residential - Peat	N_2O	10.00	50.00	50.99	0.00000	0.00000
1.A.4.b. Residential - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.03786
1.A.4.b. Residential - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00048
1.A.4.b. Residential - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00008
1.A.4.c. Agriculture/forestry/fishing - Biomass	CH_4	10.00	50.00	50.99	0.00147	0.00034
1.A.4.c. Agriculture/forestry/fishing - Biomass	N_2O	10.00	50.00	50.99	0.00004	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CO_2	5.00	0.20	5.00	0.00000	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00002
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00013	0.00031
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00037	0.00142

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		input data Note A	input data Note A			K^2 + L^2
1.A.4.c. Agriculture/forestry/fishing - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00002
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	CH_4	5.00	50.00	50.25	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	N_2O	5.00	50.00	50.25	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CH_4	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CO_2	1.00	0.50	1.12	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	N_2O	1.00	50.00	50.01	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Other Fossil Fuels	CO_2	5.00	15.00	15.81	0.00000	0.00000
1.B.1.a. Coal mining and handling	CH_4	5.00	50.00	50.25	0.00000	0.10749
1.B.2.a. Oil	CH_4	0.50	50.00	50.00	0.00078	0.00236
1.B.2.a. Oil	CO_2	0.50	0.50	0.71	0.00000	0.00000
1.B.2.b. Natural gas	CH_4	20.00	40.00	44.72	0.02904	0.02312
1.B.2.b. Natural gas	CO_2	20.00	0.20	20.00	0.00038	0.00101
2.A.1. Cement production	CO_2	1.00	2.00	2.24	0.00205	0.00170
2.A.2. Lime production	CO_2	5.00	2.00	5.39	0.00173	0.00399
2.A.3. Glass production	CO_2	1.00	2.00	2.24	0.00000	0.00000
2.A.4.a. Ceramics	CO_2	1.00	2.00	2.24	0.00000	0.00001
2.A.4.b. Other uses of soda ash	CO_2	30.00	2.00	30.07	0.00001	0.00003
2.A.4.c. Non-metallurgical magnesium production	CO_2	2.00	2.00	2.83	0.00016	0.00026
2.B.1. Ammonia production	CH_4	2.00	10.00	10.20	0.00000	0.00000
2.B.1. Ammonia production	CO_2	2.00	5.00	5.39	0.00100	0.00042
2.B.10. Other	CH_4	2.00	2.00	2.83	0.00000	0.00000
2.B.10. Other	CO_2	2.00	2.00	2.83	0.00002	0.00002
2.B.2. Nitric acid production	N_2O	2.00	2.00	2.83	0.00000	0.00071
2.B.5. Carbide production	CO_2	1.00	5.00	5.10	0.00000	0.00000
2.B.8. Petrochemical and carbon black production	CH_4	20.00	10.00	22.36	0.00015	0.00033
2.C.1. Iron and steel production	CH_4	0.50	20.00	20.01	0.00000	0.00000
2.C.1. Iron and steel production	CO_2	0.50	0.50	0.71	0.00893	0.01226
2.C.2. Ferroalloys production	CO_2	5.00	25.00	25.50	0.00003	0.00001
2.C.3. Aluminium production	CO_2	20.00	5.00	20.62	0.00000	0.00017
2.C.3. Aluminium production	PFCs	2.00	50.00	50.04	0.00000	0.82226
2.C.3. Aluminium production	SF_6	2.00	50.00	50.04	0.00000	0.00015

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		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
2.C.4. Magnesium production	SF_6	5.00	5.00	7.07	0.00000	0.00042
2.C.5. Lead production	CO_2	5.00	50.00	50.25	0.00001	0.00000
2.D. Non-energy products from fuels and solvent use	CO_2	20.00	30.00	36.06	0.00587	0.01697
2.E.1. Integrated circuit or semiconductor	HFCs	5.00	10.00	11.18	0.00000	0.00000
2.E.1. Integrated circuit or semiconductor	NF_3	5.00	10.00	11.18	0.00001	0.00001
2.E.1. Integrated circuit or semiconductor	PFCs	5.00	10.00	11.18	0.00001	0.00001
2.E.1. Integrated circuit or semiconductor	SF_6	5.00	10.00	11.18	0.00000	0.00025
2.F.1. Refrigeration and air-conditioning	HFCs	10.00	50.00	50.99	0.81597	1.13490
2.F.1. Refrigeration and air-conditioning	PFCs	10.00	50.00	50.99	0.00000	0.00000
2.F.2. Foam blowing agents	HFCs	20.00	100.00	101.98	0.00036	0.00050
2.F.3. Fire protection	HFCs	10.00	20.00	22.36	0.00001	0.00002
2.F.4. Aerosols	HFCs	20.00	10.00	22.36	0.00005	0.00012
2.F.5. Solvents	HFCs	0.00	0.00	0.00	0.00000	0.00000
2.G. Other product manufacture and use	CO_2	0.00	20.00	20.00	0.00000	0.00000
2.G. Other product manufacture and use	N_2O	0.00	20.00	20.00	0.00012	0.00083
2.G.1. Electrical equipment	SF_6	5.00	100.00	100.12	0.00440	0.00330
2.G.2. SF_6 and PFCs from other product use	SF_6	25.00	50.00	55.90	0.05048	0.04223
2.G.4 Other	HFCs	0.00	0.00	0.00	0.00000	0.00000
2.G.4 Other	PFCs	0.00	0.00	0.00	0.00000	0.00000
3.A.1. Cattle	CH_4	1.00	20.00	20.02	1.11727	0.24719
3.A.2. Sheep	CH_4	10.00	20.00	22.36	0.00095	0.00052
3.A.3. Swine	CH_4	4.00	20.00	20.40	0.00027	0.00018
3.A.4. Other livestock	CH_4	10.00	20.00	22.36	0.00091	0.00077
3.B.1. Cattle	CH_4	1.00	20.00	20.02	0.03051	0.00126
3.B.1. Cattle	N_2O	1.00	100.00	100.00	0.11020	0.10554
3.B.2. Sheep	CH_4	10.00	30.00	31.62	0.00000	0.00000
3.B.2. Sheep	N_2O	10.00	100.00	100.50	0.00015	0.00000
3.B.3. Swine	CH_4	4.00	20.00	20.40	0.00089	0.00105
3.B.3. Swine	N_2O	4.00	100.00	100.08	0.00552	0.01179
3.B.4. Other livestock	CH_4	10.00	30.00	31.62	0.00006	0.00002
3.B.4. Other livestock	N_2O	10.00	100.00	100.50	0.00118	0.00041
3.B.5. Indirect N_2O emissions	N_2O	5.00	200.00	200.06	0.09351	0.00655
3.D.1. Direct N_2O emissions from managed soils	N_2O	5.00	200.00	200.06	13.54193	1.94259
3.D.2. Indirect N_2O emissions from managed soils	N_2O	5.00	200.00	200.06	0.97320	0.25307
3.F. Field burning of agricultural residues	CH_4	100.00	40.00	107.70	0.00000	0.00000
3.F. Field burning of agricultural residues	N_2O	100.00	50.00	111.80	0.00000	0.00000
3.G. Liming	CO_2	5.00	50.00	50.25	0.00395	0.00114

IPCC category/Group	GHG	Activity data uncertainty (1)	Emission factor / estimation parameter uncertainty (1)	Combined uncertainty	Contribution to variance by category in year x	Uncertainty introduced into the trend in total national emissions
		%	%	%		%
		input data Note A	input data Note A			K^2 + L^2
3.H. Urea application	CO_2	5.00	50.00	50.25	0.00039	0.00022
3.I. Other carbon-containing fertilizers	CO_2	5.00	50.00	50.25	0.00021	0.00011
4. Land use, land-use change and forestry	CH_4	0.00	41.95	41.95	0.00042	0.00001
4. Land use, land-use change and forestry	N_2O	0.00	89.26	89.26	0.03933	0.00282
4.A.1. Forest land remaining forest land	CO_2	0.00	37.39	37.39	11.00620	117.42625
4.A.2. Land converted to forest land	CO_2	0.00	33.08	33.08	0.37005	1.03260
4.B.1. Cropland remaining cropland	CO_2	0.00	50.68	50.68	0.02902	0.00033
4.B.2. Land converted to cropland	CO_2	0.00	38.64	38.64	0.00764	0.00027
4.C.1. Grassland remaining grassland	CO_2	0.00	27.92	27.92	0.01847	0.00061
4.C.2. Land converted to grassland	CO_2	0.00	47.02	47.02	0.01869	0.03595
4.D.1. Wetlands remaining wetlands	CO_2	0.00	24.49	24.49	0.00004	0.00000
4.D.2. Land converted to wetlands	CO_2	0.00	47.21	47.21	0.00184	0.00017
4.E.1. Settlements remaining settlements	CO_2	0.00	0.00	0.00	0.00000	0.00000
4.E.2. Land converted to settlements	CO_2	0.00	71.73	71.73	0.79046	0.02244
4.F.2. Land converted to other land	CO_2	0.00	67.93	67.93	0.21496	0.00385
4.G. Harvested wood products	CO_2	0.00	49.01	49.01	0.18992	4.77479
5.A. Solid waste disposal	CH_4	12.00	25.00	27.73	0.08458	2.25766
5.B. Biological treatment of solid waste	CH_4	20.00	50.00	53.85	0.00295	0.00316
5.B. Biological treatment of solid waste	N_2O	20.00	50.00	53.85	0.00260	0.00234
5.C. Incineration and open burning of waste	CH_4	0.00	7.00	7.00	0.00000	0.00000
5.C. Incineration and open burning of waste	CO_2	7.00	20.00	21.19	0.00000	0.00008
5.C. Incineration and open burning of waste	N_2O	0.00	7.00	7.00	0.00000	0.00000
5.D. Wastewater treatment and discharge	CH_4	5.00	16.00	16.76	0.00174	0.00270
5.D. Wastewater treatment and discharge	N_2O	5.00	100.00	100.12	0.04124	0.00733
Total					**30.53**	**131.82**
Total Uncertainties				**Uncertainty in total inventory %:**	**5.53**	**11.48**

1.7 General assessment of completeness

1.7.1 Information on completeness

CRT 9 (Completeness) as well as the completeness information in the sectoral chapters include detailed information on the completeness of the Austrian GHG Inventory. An overview is provided in this chapter.

Sources and sinks

All sources and sinks included in the IPCC 2006 Guidelines are adressed.

Gases

Both direct GHGs as well as precursor gases are covered by the Austrian inventory.

Geographic coverage

The geographic coverage is complete. There is no part of the Austrian territory not covered by the inventory.

Notation keys

The sources and sinks not considered in the inventory but included in the IPCC 2006 Guidelines are clearly indicated, the reasons for such exclusion are explained. In addition, the notation keys presented below are used to fill in the blanks in all the CRT tables. Notation keys used in the NID are consistent with those reported in the CRT. Notation keys are used according to the UNFCCC reporting guidelines (FCCC/PA/CMA/2018/3/Add.2).

Allocations to categories may differ from Party to Party. The main reasons for different category allocations are different allocations in national statistics, insufficient information on the national statistics, national methods, and the impossibility to disaggregate emission declarations.

Austrian Completeness Analysis

In the Austrian QMS a transparency and completeness index is used to quantify the quality of the inventory, calculated as follows:

- *Transparency [%] = [1 – (number of IE/number of entries)]*100*
- *Completeness [%] = [1 – (number of NE/number of entries)]*100*

The total number of entries cover data records (emission/removal data) as well as notation keys ('IE', 'NE', 'NO', 'NA'). Then the respective shares of 'NE' and 'IE' in the total number of entries are determined.

The following Table 14 shows the results of this years' evaluation of transparency and completeness based on the CRT submitted 2025. The notation key 'IE' is reported across all categories. Explanations are provided in the respective sectoral chapters on 'Completeness' as well as in CRT Table 9. 'NE' is now only reported for CH_4 from abandoned oil wells (*1.B.2.a.vii*) and a minor source of N_2O from category *5.D.2.* No 'NE' is reported anymore in the sector LULUCF due to improvements in the reporting on wetlands.

Table 14: Transparency and completeness in UNFCCC submission 2025.

Sector	**Submission 2025**			
	IE	**NE**	**Transparency**	**Completeness**
1 Energy	48	1	*94%*	*100%*
2 IPPU	4	0	*99%*	*100%*
3 Agriculture	3	0	*96%*	*100%*
4 LULUCF	13	0	*97%*	*100%*
5 Waste	2	1	*97%*	*99%*
Total	**70**	**2**	**96%**	**100%**
Total number of estimates*			**1 837**	

* *including IE and NE, but also NO and NA*

The new inventory reporting via CRT requires a larger number of information to be completed compared to the CRF, due to e.g. more detailled reporting on fuels (category 1.A) and gases (F-gases), more sub-categories covered, e.g. under CRT 1.B. (fuel transformation, abandoned wells, gas post meter), CRT 3 (mules & asses, rabbits), CRT 4 (e.g. emissions and removals from drainage and rewetting and other management of organic and mineral soils) or more detailled reporting e.g. on CO_2 recovery/capture (sector 2) or on N_2O reporting under category 5.D.

1.7.2 Description of insignificant categories

Pursuant to Decision 18/CMA.1 each Party may use the notation key 'NE' (not estimated) when the estimates would be insignificant in terms of level according to the following considerations: emissions from a category should only be considered insignificant if the likely level of emissions is below 0.05 % of the national total GHG emissions, excluding LULUCF, or 500 kt CO_2e, whichever is lower. The total national aggregate of estimated emissions for all gases from categories considered insignificant shall remain below 0.1 % of the national total GHG emissions, excluding LULUCF.

CRT 9 gives an overview of sources and sinks whose emissions are currently not estimated (NE). In Austria emissions of the following gases and categories are currently reported as 'NE' due to reason of insignificance:

- direct N_2O emissions (i.e. from plants) from 5.D.2 Industrial wastewater are reported as 'NE' as annual emissions amount to only around 0.003 kt CO_2e as determined by a national study (UMWELTBUNDESAMT 2019).
- Indirect N_2O emissions from IPPU are not reported because they are well below the level of insignificance (~ 1 kt CO_2e).
- CH_4 emissions from abandoned oil wells (1.B.2.a.vi Other) are currently reported as 'NE' as investigations on potential CH_4 emissions from this category in Austria are not finalized yet.

1.7.3 Total aggregate emissions considered insignificant

In view of the information provided in chapter 1.7.2 the quantity of GHG emissions not being reported in the Austrian inventory amounts to significantly less than 0.1 % of the national total reported for 2023.

1.8 Metrics

Austria uses the 100-year time-horizon global warming potential (GWP) values from the Fifth IPCC Assessment Report to report aggregate emissions and removals of GHGs, expressed in CO_2e.

1.9 Summary of any flexibility applied

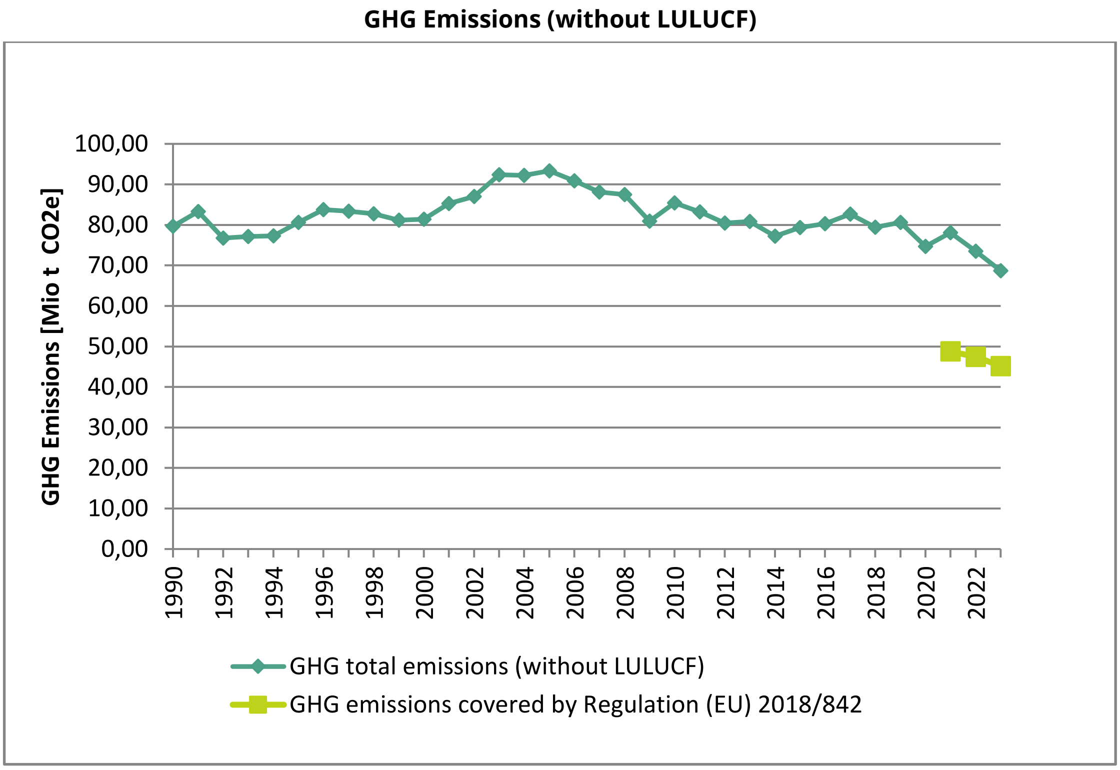
As an Annex I country, Austria does not make use of the flexibilities.

2 TRENDS IN GREENHOUSE GAS EMISSIONS AND REMOVALS

2.1 Description of emission and removal trends for aggregated GHG emissions and removals

In 2023 Austria's total greenhouse gas (GHG) emissions (without Land Use, Land Use Change and Forestry – LULUCF) amounted to 68.7 Mt CO_2 equivalents (CO_2e). Compared to the 1990 base year[42], 2023 GHG emissions without LULUCF decreased by 13.7%. Compared to 2022, GHG emissions decreased by 6.6%.

Figure 4: Trend in GHG emissions 1990–2023 without LULUCF.



Source: Umweltbundesamt

Greenhouse gas emissions covered by Regulation (EU) No. 2018/842 ('Effort Sharing Regulation') amounted to 44 251 886 t CO_2 equivalents in 2023, and were thus below the level of the annual emission allocation (AEA) for that year (see Table 15).

[42] Austria's base year under the UNFCCC is 1990. Under the EU Effort Sharing, the base year is 2005 (relates only to emissions not included in the EU Emissions Trading Scheme). Unless otherwise specified, references to the base year in this report refer always to 1990.

Table 15: GHG Emissions (covered by the ESR) and status of ESR-target achievement.

t CO_2-Äquivalent (AR5)	**2021**	**2022**	**2023**
Total GHG emissions without LULUCF	78 073 250	73 515 151	68 695 923
Total verified emissions from stationary installations under Directive 2003/87/EC2	28 703 349	26 626 258	24 413 630
Total ESR emissions43	49 345 981*	46 859 257*	44 251 886*
Annual Emission Allocations (AEA) pursuant to Article 4(3) of Regulation (EU) 2018/842, as amended 2023/85744	48 768 448	47 402 495	45 181 662
Difference between AEA and reported total ESR emissions	−577 533	+543 238	+929 776

* *Defined as: Total greenhouse gas emissions without LULUCF minus total verified emissions from stationary installations under Directive 2003/87/EC ('ETS emissions') minus CO_2 emissions from 1.A.3.a civil aviation.*

Table 15 shows that Austria's ESR emissions in 2023 are around one million t CO_2 equivalents below the level of the annual emission allocation (AEA) for that year.

Trend 2022–2023

The largest decreases in emissions between 2022 and 2023 took place in the sectors *Energy (CRT 1)* (−3 983 kt CO_2e; −8.2%) and *Industrial Processes and Product Use (CRT 2)* (−697 kt CO_2e; −4.3%).

The main reasons for the emissions decrease in sector *Energy (CRT 1)* were the lower consumption of natural gas in industrial production (category *1.A.2 Manufacturing Industries and Construction)*, the lower natural gas and gasoil consumption in category *1.A.4 Other Sectors* as well as a decrease in diesel sales (category *1.A.3 Transport)*.

The emissions decrease in *Industrial Processes and Product Use (CRT 2)* was mainly due to a decrease in production, in particular in the cement-, and iron and steel production. The main driver for this reduction was the increased energy costs resulting from the geopolitical situation.

Emissions from *Agriculture (CRT 3)* decreased slightly by 1.3% (−96 kt CO_2e) from 2022 to 2023, mainly due to falling emissions from mineral fertilizer application caused by high prices, as well as lower livestock numbers, in particular cattle.

Net removals from *LULUCF (CRT 4)* amounting to −206 kt CO_2e in 2022 turned to a net emission source in 2023 (+7 530 kt CO_2e). However, it should be noted that the annual variations of the LULUCF category (both positive and negative) are very high over the entire 1990-2023 time series (refer to section 2.2.4).

The declining emission trend of recent decades continues for the *Waste sector (CRT 5)* with a further decline by 3.2% (−42 kt CO_2e) 2022-2023 mainly due to the decreasing carbon content of waste deposited in preceding years.

The most important gas in the Austrian GHG balance remains carbon dioxide (CO_2) with a share of 83% of total 2023 emissions (without LULUCF). Emissions of CO_2 primarily result from combustion

[43] GHG emissions covered by Regulation (EU) 2018/842

[44] as included in Annex II of COMMISSION IMPLEMENTING DECISION (EU) 2023/1319 of 28 June 2023 amending Implementing Decision (EU) 2020/2126 to revise Member States' annual emission allocations for the period from 2023 to 2030.

activities. Methane (CH_4), which mainly arises from livestock farming and waste disposal, contributes 10% to total national GHG emissions. Nitrous oxide (N_2O), with agricultural soils as the main source, contributes another 4.5% in 2023. The remaining 2.6% are emissions of fluorinated compounds, which are mostly emitted from the use of these gases as substitutes for ozone depleting substances (ODS) in refrigeration equipment.

Table 16: Austria's anthropogenic greenhouse gas emissions (without LULUCF) by gas.

GHG emissions	**CO_2**	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF6**	**NF_3**	**Total**
	CO_2 equivalents (kt)							
1990	62 191	11 763	4 117	2.0	1 063	485	NO NA	**79 621**
1995	64 063	10 967	3 997	328	75	1 134	6.0	**80 570**
2000	66 204	9 655	4 160	688	80	592	9.8	**81 389**
2005	79 095	8 961	3 502	1 097	150	509	26	**93 341**
2010	72 000	8 349	3 217	1 455	71	346	3.9	**85 442**
2011	69 892	8 114	3 304	1 554	66	317	3.8	**83 251**
2012	67 260	7 977	3 270	1 604	46	321	8.0	**80 487**
2013	67 759	7 855	3 238	1 647	45	315	9.1	**80 868**
2014	64 159	7 694	3 312	1 669	48	324	9.9	**77 215**
2015	66 358	7 605	3 322	1 698	45	319	13	**79 359**
2016	67 219	7 539	3 405	1 700	46	405	5.7	**80 319**
2017	69 601	7 500	3 335	1 736	40	412	11	**82 635**
2018	66 567	7 292	3 293	1 847	30	398	15	**79 441**
2019	67 951	7 168	3 275	1 749	35	450	13	**80 641**
2020	62 180	7 082	3 223	1 699	27	454	14	**74 679**
2021	65 751	7 109	3 251	1 555	24	368	15	**78 073**
2022	61 454	7 005	3 148	1 506	24	362	16	**73 515**
2023	56 909	6 892	3 077	1 402	26	372	18	**68 696**

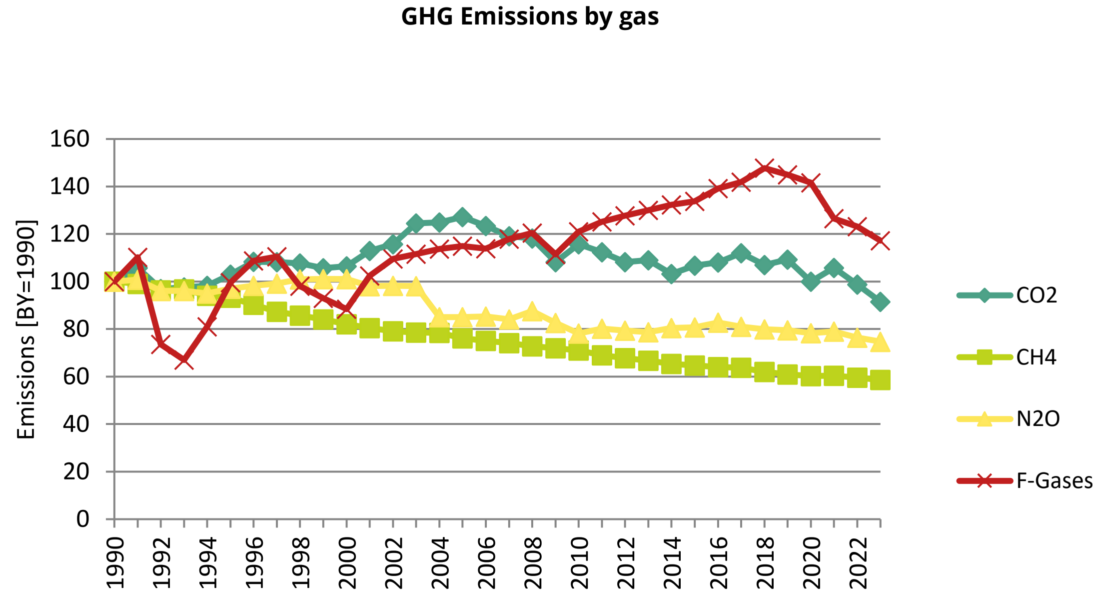
Note: Global warming potentials (GWPs) according to the 5th Assessment Report (IPCC 2013) (100 years time horizon): carbon dioxide (CO_2) = 1; methane (CH_4) = 28; nitrous oxide (N_2O) = 265; sulphur hexafluoride (SF_6) = 23 500; nitrogen trifluoride (NF_3) = 16 100; hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) consist of different substances, therefore GWPs have to be calculated individually depending on the substances

Table 17: Austria's greenhouse gas emissions by gas 1990 and 2023.

GHG	**1990**	**2023**	**Trend 1990–2023**	**1990**	**2023**
	CO_2 equivalent [kt]			**Share in national total [%]**	
Total	**79 621**	**68 696**	**–13.7%**	**100%**	**100%**
CO_2	62 191	56 909	-8.5%	78%	83%
CH_4	11 763	6 892	-41.4%	15%	10.0%
N_2O	4 117	3 077	-25.3%	5.2%	4.5%
F-gases	1 550	1 818	17.3%	1.9%	2.6%

Emissions without LULUCF

Figure 5: Trend in greenhouse gas emissions 1990–2023 by gas in index form (1990 = 100).



Source: Umweltbundesamt

CO_2

The main source of CO_2 emissions in Austria is fossil fuel combustion; within the fuel combustion sector transport is the most important sub-source.

CO_2 emissions in 2023 were 8.5% below the level 1990. In absolute figures, CO_2 emissions decreased from 62 191 to 56 909 kt during the period from 1990 to 2023 mainly due to lower CO_2 emissions from the stationary combustion in Other sectors, in particular the residential sector, as well as lower emissions from the public electricity and heat production.

CH_4

The main sources of CH_4 emissions in Austria are agriculture (enteric fermentation) and solid waste disposal on land (landfills).

CH_4 emissions decreased steadily during the period from 1990 to 2023 from 11 763 to 6 892 kt CO_2 equivalents. In 2023, CH_4 emissions were 41% below the level of 1990, mainly due to lower emissions from solid waste disposal sites.

N_2O

The main source of N_2O emissions is sector agriculture with a share of 73% (2023) in national total N_2O emissions. Agricultural soils contribute most to national N_2O emissions (58% in 2023). Other important sources of N_2O emissions are fuel combustion (18%) and manure management (15%).

N_2O emissions show a decreasing trend, resulting in 3 077 kt CO_2 equivalents in 2023 compared to 4 117 kt CO_2 equivalents in 1990 (−25%). The general decrease is mainly due to lower N_2O emissions from agricultural soils and chemical industry; the strong decrease 2003–2004 was also due to emission reduction measures in the chemical industry.

HFCs

HFC emissions increased remarkably during the period from 1990 to 2023 from 2.0 to 1 402 kt CO_2 equivalents. HFCs are used as substitutes for HCFCs (Hydro Chloro Fluoro Carbons; these are ozone depleting substances), the use of which has been banned for most applications.

PFCs

PFC emissions show an inverse trend of HFC emissions. PFC emissions decreased remarkably during the period from 1990 to 2023, from 1 063 to 26 kt CO_2 equivalents (−98%). In 1990 PFCs were mainly emitted as by-products of primary aluminium production, which closed down in Austria in 1992; Semiconductor manufacture is the main source of PFC emissions.

SF_6

SF_6 emissions in 1990 amounted to 485 kt CO_2 equivalents. Until 1996 emissions increased steadily as a result of increasing emissions from metal production and semiconductor manufacture reaching 1 213 kt CO_2 equivalents. In 2023 SF_6 emissions amounted to 372 kt CO_2 equivalents, which was 23% below the level of 1990. Current emissions mainly result from disposal of noise insulating windows.

NF_3

In 1990 no NF_3 was emitted in Austria. NF_3 emissions solely arise from semiconductor manufacture; NF_3 has been in use in Austria since 1994. In 2023, NF_3 emissions amounted to 18 kt CO_2 equivalents.

2.2 Description of emission and removal trends by sector and by gas

Table 18 presents a summary of Austria's anthropogenic greenhouse gas emissions by sector.

Table 18: Summary of Austria's anthropogenic greenhouse gas emissions by sector.

GHG source and sink categories	1. Energy	2. IPPU	3. Agriculture	4. LULUCF	5. Waste	6. Other
	CO_2 equivalents (kt)					
1990	52 835	13 641	8 581	-13 756	4 565	NO*
1995	54 329	13 631	8 353	-18 397	4 257	NO
2000	55 459	14 454	8 013	-18 060	3 463	NO
2005	66 889	15 651	7 578	-15 228	3 223	NO
2010	59 453	15 965	7 574	-11 734	2 450	NO

GHG source and sink categories	1. Energy	2. IPPU	3. Agriculture	4. LULUCF	5. Waste	6. Other
	CO_2 equivalents (kt)					
2011	57 141	16 161	7 645	-11 027	2 303	NO
2012	54 997	15 731	7 584	-9 156	2 176	NO
2013	55 169	16 097	7 570	-5 020	2 032	NO
2014	51 439	16 171	7 699	-9 828	1 906	NO
2015	53 218	16 611	7 727	-4 085	1 803	NO
2016	54 441	16 322	7 843	-8 125	1 715	NO
2017	56 154	17 078	7 781	-4 430	1 623	NO
2018	54 708	15 502	7 683	1 831	1 548	NO
2019	55 093	16 474	7 579	6 002	1 495	NO
2020	50 142	15 524	7 568	-950	1 445	NO
2021	52 042	17 030	7 607	-3 362	1 394	NO
2022	48 434	16 170	7 573	-206	1 337	NO
2023	44 451	15 472	7 477	7 530	1 295	NO

**not occurring*

The dominant sector (excluding LULUCF) causing most GHG emissions in Austria is *1 Energy*, causing 65% of the total national GHG emissions in 2023 (66% in 1990), followed by the sectors *2 Industrial Processes and Other Product Use* (23% in 2023) and *3 Agriculture* (11% in 2023).

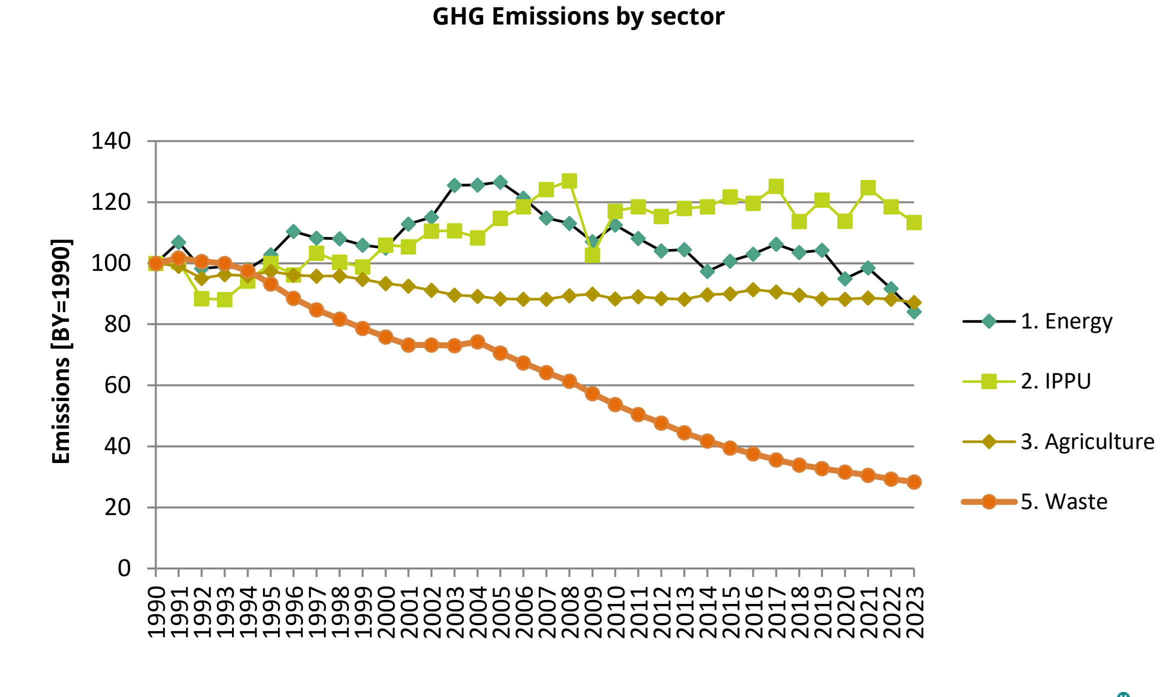
Table 19: Austria's greenhouse gas emissions (without LULUCF) for 1990 and 2023 expressed as aggregate levels and trends, as well as respective sector contributions.

GHG	1990	2023	Trend 1990–2023	1990	2023
	Emissions [kt CO_2e]			Share [%]	
Total	**79 621**	**68 696**	**-13.7%**	**100%**	**100%**
1 Energy	52 835	44 451	-15.9%	66%	65%
2 IPPU	13 641	15 472	13.4%	17%	23%
3 Agriculture	8 581	7 477	-12.9%	11%	11%
5 Waste	4 565	1 295	-71.6%	5.7%	1.9%

Total emissions without emissions from sector LULUCF

The only sector with 2023 GHG emissions above the level in 1990 is *2 Industrial Processes and Other Product Use* (+13%; +1 831 kt CO_2e). All other sectors show decreasing trends in GHG emissions: sector *5 Waste* (−72%; −3 269 kt CO_2e), sector *1 Energy* (–16%; −8 383 kt CO_2e) and sector *3 Agriculture* (−13%; −1 104 kt CO_2e).

Figure 6: Trend in greenhouse gas emissions 1990–2023 by sector in index form (1990 = 100).



Source: Umweltbundesamt

A more detailed description and interpretation of emissions trends per sector is given in the following sub-chapters.

2.2.1 Energy

In 2023, greenhouse gas emissions from sector *1 Energy* amounted to 44 451 kt CO_2 equivalents, which corresponds to 65% of total national emissions without LULUCF. Emissions from fuel combustion (*1.A*) contribute 99% of total Energy emissions, while fugitive emissions from fuels (*1.B*) are of minor importance.

The most important **sub-category** of *1.A Fuel Combustion Activities* is *1.A.3 Transport* with a share of 45% in 2023, followed by *1.A.2 Manufacturing Industries and Construction* (22%), *1.A.4 Other Sectors* (16%) and the sub-category *1.A.1 Energy Industries* (17%). The most important **greenhouse gas** is CO_2, contributing 97.3% to total sectoral GHG emissions, followed by CH_4 (1.5%) and N_2O (1.2%).

From **2022 to 2023**, emissions from sector *1.A Fuel Combustion Activities* decreased by 8.2% (−3 955 kt CO_2e). The main drivers of the trend were the categories *1.A.2 Manufacturing Industries and Construction* (−1 107 kt CO_2e) due to lower consumption of natural gas and *1.A.4 Other Sectors* (−1 042 kt CO_2e) due to lower gasoil (−24%) and natural gas (−6.0%) consumption.

Emissions of the category *1.A.4 Other Sectors* decreased by 13% mainly due to the replacement of fossil fuel heating systems. Heating degree days in 2023 were 3.1% lower than in 2022.

Emissions from *1.A.3 Transport* decreased by 4.4% (−924 kt CO_2e) between 2022 and 2023, which was mainly due to lower diesel sales (−5.1%).

From 1990 to 2023, the overall trend of greenhouse gas emissions of the *Energy* sector shows 16% lower emissions for 2023 compared to 1990 although emissions from *1.A.3.b Road transport* are 46% higher than in 1990. Year to year variations are mainly due to the following factors:

- Weather circumstances in the corresponding years (in particular cold or mild winters, and/or dry or wet summers) which affect the heating demand, and the availability of electricity from hydro and wind power plants
- Economic situation as reflected in the gross domestic product (GDP)
- Change in power generation (switch from coal to gas)
- national 'lockdowns' due to the COVID pandemic (2020–2021)

Trend 1990–2023 by sub-category

In 2023, emissions from sub-category ***1.A.1 Energy Industries*** were 48% below the level in 1990. Emissions from power plants have generally been decreasing since 2005, mainly because of the growing contribution of renewable energy sources, the substitution of solid and liquid fossil fuels by natural gas and biomass, as well as improvements in efficiency.

The share of biomass used as a fuel in this sector increased from 1.5% in 1990 to 33% in 2023. The contribution of hydro, wind and photovoltaic power plants to total public electricity production increased from 69% in 1990 to 86% in 2023. Electricity consumption has increased by 44% since 1990 and since 2002 the increase in consumption has largely been covered by electricity imports, with the exception of 2023, when a small net export of electricity occurred.

Energy related GHG emissions from ***1.A.2 Manufacturing Industries and Construction*** increased by 0.2% from 1990 to 2023. Emissions from *Off-road vehicles and other machinery (1.A.2.g.7)*, *Chemicals Industry (1.A.2.c)* and *Non-Ferrous Metals (1.A.2.b)* increased, while emissions from *Pulp, Paper and Print (1.A.2.d)*, *Other Manufacturing Industries (1.A.2.g.8)* and *Non-Metallic Minerals (1.A.2.f)* decreased since 1990. Fuel consumption increased by 35% in that period, mainly due to increased use of natural gas and biomass. As natural gas has a lower carbon content, and CO_2 emissions from biomass combustion are not accounted for under the UNFCCC reporting framework, the increase in GHG emissions from this category is significantly smaller (only 0.2%) compared to the increase in fuel consumption.

The category ***1.A.3 Transport*** showed an increase in GHG emissions since 1990 (+42%) mainly due to an increase of road performance (mileage) of diesel cars and freight transport. In addition to the increase of road performance **within** Austria, the amount of fuel sold in Austria but **used elsewhere** – an effect called "fuel export" mainly caused by a lower fuel tax compared to Austria's neighbouring countries – has increased considerably since 1990. Between 2005 and 2012 total GHG emissions decreased due to lower amounts of fuel sold together with an increased use of biofuels for blending and the gradual replacement with newer vehicles with lower specific fuel consumption. Since then, GHG emissions from transport have been **gradually increasing** with rising traffic volumes. In the pandemic year 2020 a sharp decrease of emissions was observed followed by an increase due to a slight economic recovery in 2021. Since then the GHG emissions show a decreasing trend. **From 2022 to 2023** emissions from sub-category *1.A.3.b Road Transportation* declined by 3.9% due to a drop in total diesel sales due to reduced milage of heavy duty vehicles on inland roads and abroad with Austrian fuel (fuel exports).

The variation in demand for heating and hot water generation due to climatic circumstances and the shift in the fuel mix are important drivers for emissions from the category ***1.A.4 Other Sectors***.

Emissions in 2023 were 49% lower than in 1990. This reduction is mainly attributable to the displacement of coal-fired heating systems and the progressive shift of heating oil towards natural gas, biomass, district heating and heat pumps, as well as the long-term decreasing trend in the number of heating degree-days. This development is supported by increased energy performance of buildings (thermal renovation, energy-efficient new buildings). Total fuel consumption of this sub-category has decreased by 24% since 1990.

Emissions from ***1.B Fugitive emissions*** decreased by 57% since 1990. This is mainly due to the progressive closure of coal mines up until 2006. There have been no coal-mining activities in Austria since 2007 (*1.B.1 Coal Mining and Handling*). Fugitive Emissions from *1.B.2 Oil and Natural gas* are also below the 1990 level (−28%) mainly because volumes of crude oil and crude gas produced have declined in recent years.

2.2.2 Industrial Processes and Other Product Use

In 2023, greenhouse gas emissions from *Industrial Processes and Product Use* amounted to 15 472 kt CO_2 equivalent, which corresponds to 23% of total national emissions.

The most important **categories** of this sector are the *metal industry* and *mineral industry*, generating 66% and 17% of total sectoral emissions, respectively. The most important **greenhouse gas** of this sector is CO_2 with a contribution of 87% to total sectoral emissions, followed by HFCs with 9.1% and SF_6 with 2.4%, the other GHGs contribute less than 0.5% each.

From 2022 to 2023, overall emissions from this sector decreased by 4.3% mainly due to a decrease in cement- (−16% of emissions) as well as iron and steel production (−2.2% of emissions).

The **overall trend** in GHG emissions from *Industrial Processes and Product Use* shows an increase of 13% from 1990 to 2023. Within this period, emissions were at minimum in 1993 then increased until peaking in 2008 followed by a significant dip in 2009. Since then, emissions fluctuated just around the mean of these two years. **Main drivers** for the trend in emissions from this sector were (i) the termination of primary aluminium production in 1993, (ii) the introduction of N_2O abatement technologies in the chemical industry in 2004 and in 2009 (which became fully operational in 2010), (iii) the impacts of the 2007-2008 financial crisis , (iv) increasing iron and steel production resulting in 49% higher GHG emissions in 2023 compared to 1990 and (iv) a strong increase of HFC emissions over the 1990-2018 period from 2 to 1 847 kt CO_2 equivalents.

Sub-category trends between 1990 and 2023

The largest increase in GHG emissions between 1990 and 2023 can be observed in the *metal industry* (+23%) due to an increase in GHG emissions from iron and steel production. In the categories *mineral industry* and *chemical industry*, GHG emissions declined over the same period by 18% and 54%, respectively. Emissions from *non-energy products from fuels and solvent use* dropped by 54%, due to legal measures controlling the solvent content of products and their use.

Emissions of *fluorinated gases* increased by 17% compared to 1990, driven by increasing emissions of HFCs (+327% since 1995) due to HFCs replacing Ozone Depleting Substances (ODSs) as cooling agents. The maximum was reached in 2018; since then emissions are decreasing.

2.2.3 Agriculture

In 2023, greenhouse gas emissions from *Agriculture* amounted to 7 477 kt CO_2 equivalent, which correspond to 11% of total national emissions.

The **most important categories** of this sector are *enteric fermentation* (57%) and *agricultural soils* (24%). *Agriculture* is the largest source of national N_2O and CH_4 emissions: in 2023, 73% (8.5 kt N_2O) of total N_2O emissions and 74% (182 kt CH_4) of total CH_4 emissions originated from this sector. Total GHG emissions from the sector *Agriculture* are dominated by CH_4, with a share of 68%, and N_2O, with a share of 30%. CO_2 emissions account for 2.0% of the emissions from this sector.

From 2022 to 2023 GHG emissions decreased slightly by 1.3%, mainly due to falling emissions from mineral fertilizer application (−7.4%). The reasons for this reduction are lower sales volumes due to the pandemic and the war in the Ukraine, which lead to higher energy and raw material prices also affecting the fertilizer market. Additionally, livestock numbers of cattle (−1.4%) fell in 2023 resulting in lower GHG emissions from enteric fermentation. Swine, sheep and goat numbers decreased as well (−5.0%, −2.2% and −2.1%, respectively).

The **overall trend** in GHG emissions from *Agriculture* shows a decrease of 12% from 1990 to 2023. The **main drivers** for this trend are decreasing livestock numbers of cattle and swine as well as lower amounts of N-fertilizers applied on agricultural soils.

2.2.4 LULUCF

In 2023, the LULUCF sector represented a significant net emission source. The *LULUCF* net emissions in 2023 amounted to 7 530 kt CO_2 equivalent, which correspond to 11% of national total GHG emissions (without LULUCF) in the same year.

With regard to the **overall trend**, the net removals from *LULUCF* significantly decreased across time since the 90-ies and even turned to a source of net emissions in single recent years (2018, 2019, 2023) with substantial annual variations over the observed period. According to a regression trend over the time series, the decrease of net removals between 1990 and 2023 is about 100%. The **main driver** for this trend is the biomass and soil carbon stock changes in *Forest land*. Fluctuations are due to weather conditions, which influence growth rates (e.g. very low increment in years of draughts) as well as decay in forest soils, biomass losses and salvage loggings due to natural disturbances (more wind throws and bark beetle infestations in recent years), timber demand and prices (e.g. very high harvest rates in 2007 and 2008).

The **most important category** is *Forest land (4.A)* with net emissions of 5 399 kt CO_2 equivalent in 2023.

The *LULUCF* sector and the *Forest land* category represent net GHG sources in single years, namely in 2018, 2019 and 2023. The net source values in these years are explained by high harvest rates due to natural disturbances, low increments as well as soil carbon stock losses due to weather conditions. The results of the most recent years are based on an update using intermediate NFI results for these years and an updated YASSO modelling run including also these NFI results for the most recent years. By that, the LULUCF results of the submission 2025, which is relevant for defining the LULUCF budget for the period 2026-2029, should be based on the most recent and representative results for the years 2021 to 2023.

Harvested Wood Products (4.G) is the only sink category in 2023 and contributed –678 kt CO_2 equivalent.

Together, CH_4 and N_2O emissions amounted to 207 kt CO_2 equivalent (including indirect emissions). Total net emissions arising from the other non-forest categories (excluding HWPs) amounted to 2809 kt CO_2 equivalent in 2023 (including indirect emissions).

2.2.5 Waste

In 2023, greenhouse gas emissions from the sector *Waste* amounted to 1 295 kt CO_2 equivalent, which correspond to 1.9% of total national emissions.

The most important category of *Waste* is *solid waste disposal*, which caused 62% of the emissions from this sector in 2023, followed by *waste water treatment and discharge* (27%) and *biological treatment of solid waste* (12%). The most important greenhouse gas is CH_4 with a share of 82% in emissions, mainly arising from *solid waste disposal*. N_2O accounts for 18% of GHG emissions from this sector.

From 2022 to 2023 GHG emissions continued to decrease (−3.2%) mainly due to the decreasing carbon content of waste deposited in preceding years.

The **overall trend** in GHG emissions from *Waste* is decreasing, with a decrease of 72% from 1990 to 2023. The **main driver** for this trend is the implementation of waste management policies: Waste separation, reuse and recycling activities have increased since 1990 and the amount of disposed waste has decreased correspondingly especially since 2004 when pre-treatment of waste became obligatory (although some exceptions were granted to some Austrian provinces). The legal basis for the reduced disposal of waste as well as the landfill gas recovery is the Landfill Ordinance. Since 2009 all waste with high organic content has to be pre-treated before deposition (without exceptions). Furthermore, methane recovery from landfills was implemented in the 1990s and continues since.

2.3 Emission trends for indirect greenhouse gases and SO_2

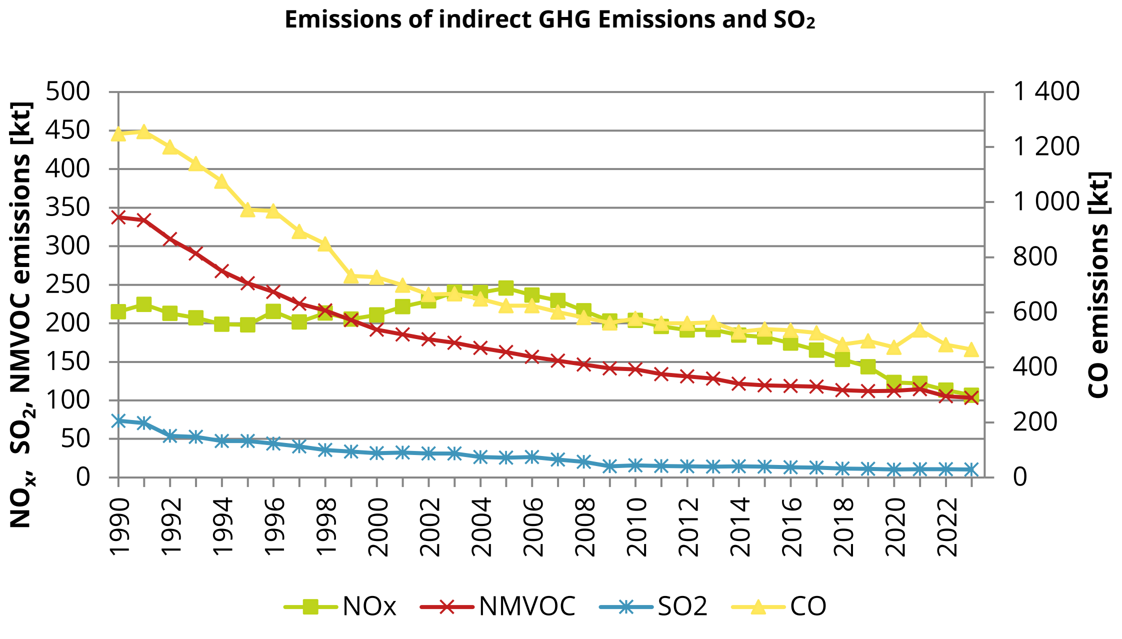
Emission estimates for NO_x, CO, NMVOC and SO_2 are also reported in the CRT. This chapter summarizes the trends for these gases.

A detailed description of the methodology used to estimate these emissions is provided in *Austria's Informative Inventory Report (IIR) 2025, Submission under the UNECE/CLRTAP Convention*, published in spring 2024 (UMWELTBUNDESAMT 2025b). Total emissions shown below are different from totals reported under UNECE/CLRTAP due to differences in the accounting of emissions from aviation and shipping.

Table 20: Total emissions and trends 1990–2023 of indirect GHGs and SO_2.

	NO_x	CO	NMVOC	SO_2
	[kt]			
1990	215	1 248	338	74
1995	198	972	252	47
2000	211	727	192	31
2005	246	624	163	26
2010	204	577	140	16
2011	196	560	134	15
2012	191	560	131	15
2013	192	563	128	14
2014	185	528	122	14
2015	182	539	120	14
2016	175	534	119	13
2017	165	525	118	13
2018	153	483	113	11
2019	144	496	112	11
2020	123	473	113	10
2021	122	536	114	11
2022	113	482	105	11
2023	107	465	103	10
1990–2023	**–50%**	**–63%**	**–69%**	**–86%**

Figure 7: Emissions of indirect GHGs and SO_2 1990–2023.



Source: Umweltbundesamt

The most important emission source for NO_x, SO_2 and CO is fuel combustion. The most important emission source for NMVOC is Sector *2 Industrial Processes*.

NO_x

NO_x emissions decreased from 215 to 107 kt during the period from 1990 to 2023. In 2023 NO_x emissions were 50% below the level of 1990. In 2023 about 90% of NO_x emissions in Austria originated from fossil fuel combustion (sector *1A Energy*), with the major part originating from *1.A.3.b Road transportation* (44% in national total NO_x emissions in 2023).

CO

CO emissions decreased from 1 248 to 465 kt during the period from 1990 to 2023. In 2023 CO emissions were 63% below the level of 1990. In the year 2023, 97% of total CO emissions in Austria originated from fuel combustion activities (sector *1A Energy*). The most important sub-source regarding CO emissions is *1.A.4 Other sectors* (48% in national total CO emissions) followed by *1.A.2 Manufacturing industries and construction* with 37% and *1.A.3.b Road Transport* with 10% share in national total CO emissions in 2023.

NMVOC

NMVOC emissions decreased from 338 to 103 kt during the period from 1990 to 2023. In 2023 NMVOC emissions were 69% below the level of 1990. The most important source of NMVOC emissions is sector *2 Industrial Processes*, contributing 37% to national total NMVOC emissions in 2023 (contribution of *2.D.3.1 Solvent Use* 33%), followed by *1.A. Fuel Combustion Activities* (29% contribution).

SO_2

SO_2 emissions decreased from 74 to 10 kt during the period 1990 to 2023. In 2023 SO_2 emissions were 86% below the level of 1990. Fuel combustion activities (*1.A*) contribute 94% to total emissions (2023).

3 ENERGY (CRT SECTOR 1)

3.1 Sector Overview

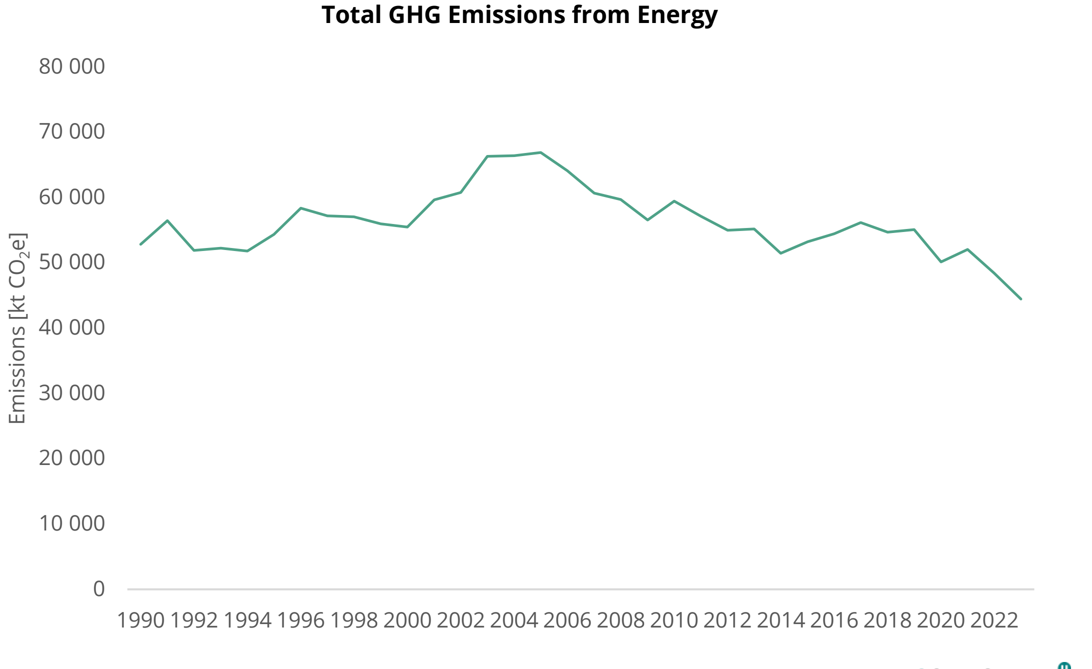
In the energy sector emissions originating from fuel combustion activities in road traffic, in the energy and manufacturing industry and in the commercial, agricultural and residential sector (Category *1.A*) as well as fugitive emissions from fuels (Category *1.B*) are considered. However, fugitive emissions make up only about 0.9% of total emissions from this sector.

Emissions from the energy sector are the main source of GHGs in Austria. In the year 2023, about 64.8% of national total GHGs emissions and 76% of national total CO_2 emissions from Austria arose from the energy sector.

Emission trends

Emissions from the energy sector decreased by 8% from 52.8 Mt CO_2 equivalents in 1990 to 44.5 Mt CO_2 equivalents in 2023, which is mainly caused by decreasing emissions from energy industries and the residential sector while emissions from the transport sector increased.

Figure 8: Trend of GHG emissions from 1990–2023 for Energy.



Source: Umweltbundesamt

Total emissions from energy mainly consist of CO_2 whereas CH_4 and N_2O emissions only make up about 1.5% and 1.2%, respectively. The increase in N_2O emissions is primarily due the increasing activity of transport. The decrease of CH_4 emissions mainly occurs in the residential sector due to a shift to more efficient biomass heating and in category *1.B.1.a Coal Mining and Handling* due to the closure of coalmines. The strong increase in CO_2 emissions from 2002 to 2003 is primarily due to increased coal consumption of power plants. Between 2005 and 2023, CO_2 emissions decreased by 34.0%. Between 2022 and 2023, emissions from public electricity and heat generation decreased by

20%; higher electricity generation from hydro power plants power plants offset lower power production from natural gas. Emissions from road transport decreased by 3.9% due to lower diesel fuel sales, whereas gasoline sales showed an increase. In 2023, emissions from households (*1.A.4.b.i*) fell by 13.3 %, which can be attributed to lower demand for heating due to warm weather conditions (heating degree days were 3.1 % lower than in 2022), but also to high fuel prices.

Table 21: Emissions of greenhouse gases and their trend from 1990–2023 from category 1.A Energy – fuel combustion.

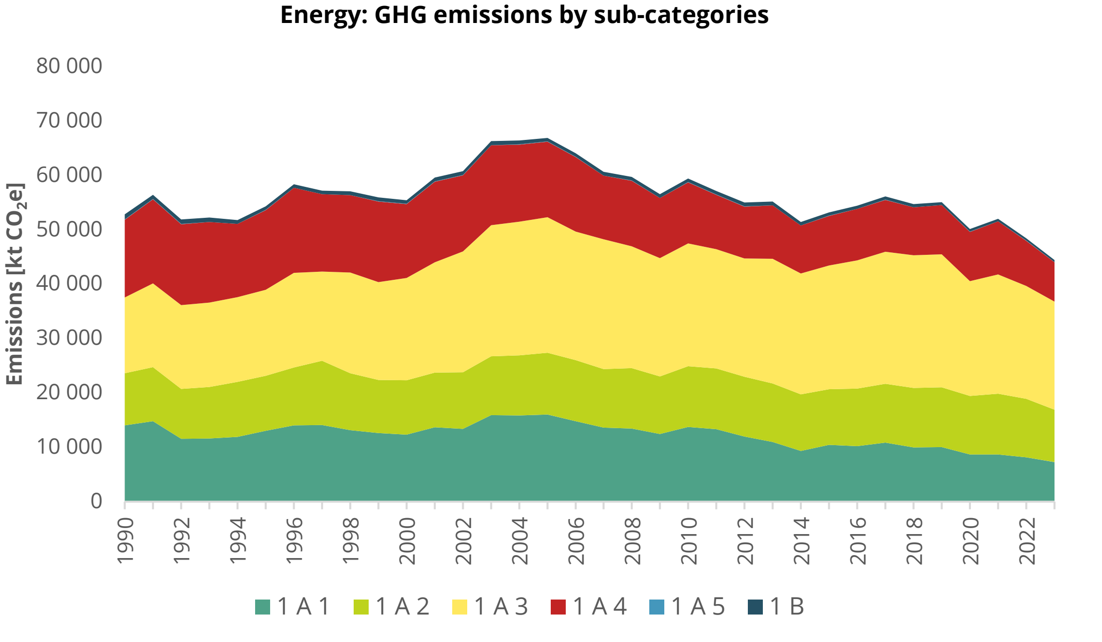
Year	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	kt CO_2 equivalent
1990	50 828	24.34	1.44	51 893
1995	52 649	20.97	1.59	53 657
2000	53 832	16.57	1.73	54 754
2005	65 309	14.70	1.96	66 239
2010	57 772	15.67	2.09	58 765
2011	55 507	14.45	2.08	56 463
2012	53 334	14.94	2.10	54 307
2013	53 502	15.10	2.12	54 487
2014	49 874	13.43	2.06	50 797
2015	51 650	13.81	2.11	52 595
2016	52 897	14.05	2.13	53 855
2017	54 560	14.28	2.17	55 535
2018	53 214	13.19	2.16	54 156
2019	53 623	13.13	2.18	54 567
2020	48 737	12.91	2.05	49 641
2021	50 587	14.72	2.17	51 575
2022	47 086	12.72	2.10	47 999
2023	43 159	12.26	2.05	44 044
1990–2023	**-15.1%**	**-49.6%**	**41.6%**	**-15.1%**

The most important sub categories regarding total emissions in 1990 were *Energy Industries* (*1.A.1*), *Transport* (*1.A.3*) and *Other Sectors* (*1.A.4*), mainly residential space heating.

While emissions from *Energy Industries* and *Other Sectors* are well below the level of 1990 (-48% and -49% respectively), emissions from *Transport* show higher emissions in 2023 compared to 1990 (+ 42%) mainly due to an increase of road performance (mileage) of cars (in particular diesel-powered), and freight transport.

Emissions from power plants have decreased since 2005, mainly because of the growing contribution of renewable energy sources, the substitution of solid and liquid fuels by natural gas and biomass, as well as improvements in efficiency. GHG emissions from the residential category have decreased since 1990 because of a change in the fuel mix. The decrease in GHG emissions from *1.B fugitive emissions from fuels* is primarily due to the the gradual closure of coal mines by 2006.

Figure 9: GHG emissions [kt CO_2e] 1990–2023 from sector Energy by sub-categories.



Source: Umweltbundesamt

Table 22: GHG emissions [kt CO_2e] 1990–2023 from sector Energy by sub-categories.

	1	1.A	1.A.1	1.A.2	1.A.3	1.A.4	1.A.5	1.B	1.B.1	1.B.2
1990	52 835	51 893	14 008	9 609	13 950	14 287	38	942	373	569
1995	54 329	53 657	13 059	10 065	15 846	14 652	35	671	41	630
2000	55 459	54 754	12 314	10 023	18 792	13 582	42	705	30	675
2005	66 889	66 239	16 025	11 363	24 930	13 883	38	650	0	650
2010	59 453	58 765	13 747	11 189	22 569	11 231	30	687	0	687
2011	57 141	56 463	13 354	11 153	21 919	10 011	28	678	0	678
2012	54 997	54 307	11 974	11 021	21 735	9 551	26	689	0	689
2013	55 169	54 487	10 973	10 766	22 914	9 810	25	682	0	682
2014	51 439	50 797	9 353	10 373	22 228	8 819	23	642	0	642
2015	53 218	52 595	10 458	10 248	22 705	9 162	22	623	0	623
2016	54 441	53 855	10 240	10 583	23 537	9 472	23	586	0	586
2017	56 154	55 535	10 852	10 816	24 267	9 573	28	619	0	619
2018	54 708	54 156	10 003	10 926	24 387	8 812	29	552	0	552
2019	55 093	54 567	10 035	10 994	24 439	9 071	29	525	0	525
2020	50 142	49 641	8 667	10 758	21 122	9 065	29	501	0	501
2021	52 042	51 575	8 686	11 172	21 916	9 773	29	467	0	467
2022	48 434	47 999	8 173	10 740	20 765	8 292	28	435	0	435
2023	44 451	44 044	7 292	9 633	19 842	7 250	28	407	0	407
1990–2023	**-15.9%**	**-15.1%**	**-47.9%**	**0.2%**	**42.2%**	**-49.3%**	**-27.2%**	**-56.8%**	**-100.0%**	**-28.5%**

3.2 Fuel Combustion Activities (CRT Category 1.A)

This chapter gives an overview of emissions and key sources of fuel combustion activities. It includes information on completeness, QA/QC, uncertainty, recalculations and planned improvements as well as on emissions, emission trends and methodologies applied (including emission factors). In addition, this chapter provides information on the sectoral/referential approach comparison and the feedstock/non-energy use of fuels.

3.2.1 Comparison of the Sectoral Approach with the Reference Approach

3.2.1.1 Comparison of CO_2 emissions

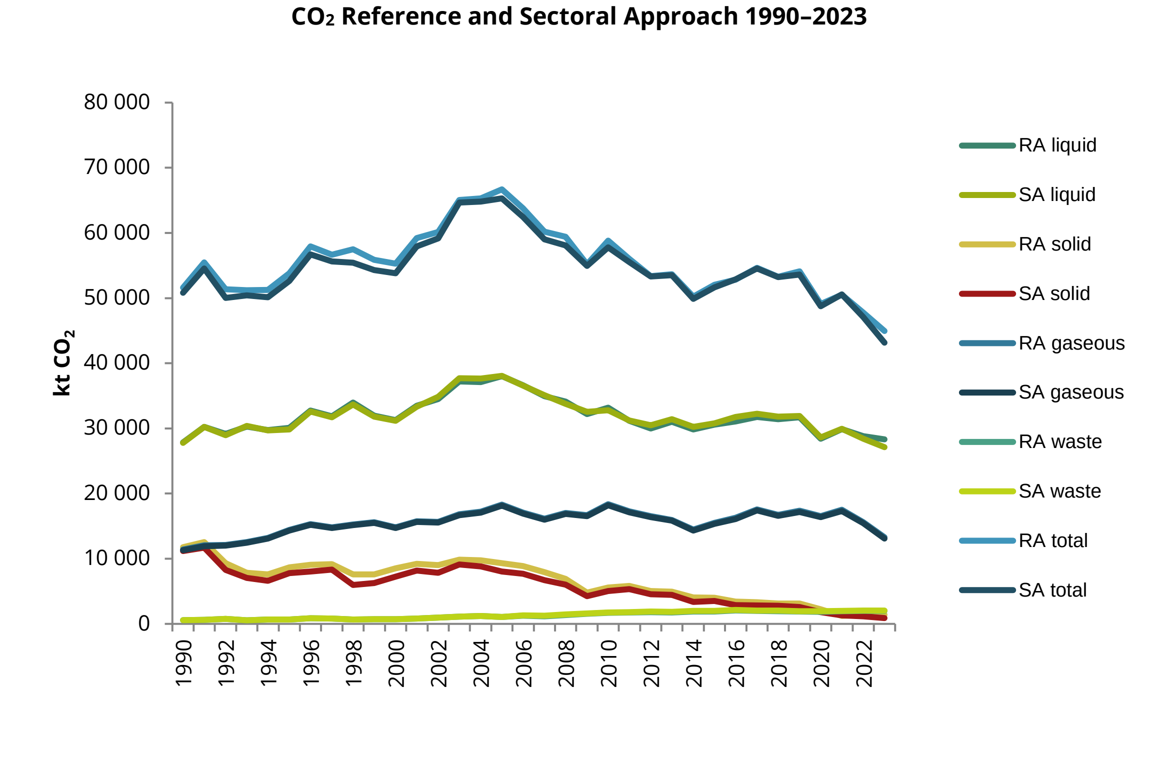
In the following, CO_2 emissions from the sectoral and reference approach are compared and explanations for the differences are provided.

The reference approach shows 0.6% higher CO_2 emissions in 2022 which is mainly due to solid and liquid fuels. The mean value of differences for all years 1990 to 2023 shows that the reference approach is 1.5% higher than the sectoral approach. The mean value for the more recent years 2010 to 2022 shows 0.8% higher CO_2 emissions from the reference approach (with a range of -0.11% to 4.15%) in 2023.

Since submission 2021, the reference approach considers energy balance data of pure fossil diesel and gasoline while in previous submissions blended biofuels were included in those fuel data. Furthermore, double counting of coal tar in the reference approach is removed and some double counting of liquid fuels is removed in the sectoral approach. In addition, the carbon content of waste non-biomass fraction in the reference approach is harmonized with the sectoral approach.

The following figure shows the results for the two approaches for the period 1990–2023. Solid fuels show the most significant deviation except for 2022 and 2023, were CO_2 emissions from liquid fuels are significantly higher in the reference approach because refinery losses are very high (which are not allocated to the sectoral approach).

Figure 10: CO_2 emissions of the Reference and Sectoral Approach 1990 to 2023.



Source: Umweltbundesamt

Table 23 presents CO_2 emissions of the sectoral and reference approach in tabular form.

Table 23: CO_2 emissions [kt] of sectoral and reference approach.

	Reference Approach					Sectoral Approach 1 A Fuel Combustion				
	Liquid	**Solid**	**Gaseous**	**Waste**	**Total**	**Liquid**	**Solid**	**Gaseous**	**Waste**	**Total**
1990	27 849	11 766	11 417	580	51 612	27 764	11 183	11 301	580	50 828
1995	30 081	8 653	14 404	690	53 829	29 862	7 779	14 317	690	52 649
2000	31 254	8 512	14 791	714	55 270	31 176	7 248	14 695	714	53 832
2005	38 023	9 318	18 293	1 059	66 693	38 066	8 013	18 156	1 073	65 309
2010	33 193	5 583	18 365	1 678	58 819	32 790	5 019	18 209	1 754	57 772
2011	31 185	5 828	17 288	1 738	56 039	31 217	5 331	17 144	1 815	55 507
2012	29 980	5 051	16 523	1 819	53 374	30 504	4 553	16 382	1 895	53 334
2013	30 998	4 938	15 954	1 757	53 647	31 399	4 450	15 821	1 832	53 502
2014	29 840	4 038	14 475	1 886	50 239	30 221	3 355	14 325	1 973	49 874
2015	30 564	4 018	15 522	1 919	52 024	30 771	3 497	15 369	2 011	51 650
2016	31 068	3 428	16 277	2 066	52 839	31 749	2 893	16 112	2 143	52 897
2017	31 775	3 322	17 569	1 995	54 662	32 261	2 826	17 407	2 066	54 560
2018	31 432	3 140	16 719	1 964	53 254	31 826	2 779	16 569	2 041	53 214
2019	31 727	3 139	17 349	1 879	54 094	31 913	2 577	17 180	1 953	53 623

	Reference Approach					Sectoral Approach 1 A Fuel Combustion				
	Liquid	Solid	Gaseous	Waste	Total	Liquid	Solid	Gaseous	Waste	Total
2020	28 402	2 260	16 546	1 870	49 078	28 620	1 803	16 382	1 932	48 737
2021	29 883	1 230	17 497	1 931	50 540	29 935	1 319	17 336	1 996	50 587
2022	28 816	1 365	15 619	1 985	47 785	28 410	1 165	15 463	2 047	47 086
2023	28 298	1 406	13 271	1 976	44 951	27 123	888	13 110	2 038	43 159

Table 24 presents the difference of CO_2 emissions in percent between reference and sectoral approach.

Table 24: Difference of CO_2 emissions by type of fuel in percent.

Year	Liquid	Solid	Gaseous	Waste	Total
1990	1.7%	4.0%	0.0%	3.1%	1.6%
1995	3.5%	9.3%	0.2%	4.3%	3.0%
2000	1.4%	15.0%	-1.0%	4.6%	1.9%
2005	1.4%	9.4%	-0.8%	-3.2%	1.3%
2010	2.3%	19.8%	-1.4%	-16.2%	1.4%
2011	1.3%	17.2%	-0.8%	-14.6%	1.0%
2012	-0.5%	19.9%	-0.8%	-18.5%	-0.1%
2013	-0.2%	20.5%	-0.9%	-21.3%	0.0%
2014	0.0%	28.8%	-0.9%	-26.6%	-0.2%
2015	0.4%	28.3%	-0.8%	-24.1%	0.2%
2016	-1.0%	35.9%	-0.7%	-25.6%	-0.6%
2017	-0.4%	34.5%	-0.8%	-22.2%	-0.2%
2018	-0.5%	32.4%	-0.8%	-24.0%	-0.4%
2019	0.0%	27.1%	-0.8%	-24.9%	-0.5%
2020	0.0%	35.1%	-0.8%	-20.3%	-0.4%
2021	0.4%	14.5%	-0.6%	-21.5%	-0.8%
2022	1.9%	38.2%	-0.7%	-20.2%	0.4%
2023	5.1%	46.2%	-0.8%	-23.0%	2.0%

Positive numbers indicate that CO_2 emissions from the reference approach are higher than emissions from the sectoral approach.

Explanation of differences

- *Solid fuels:* In the sectoral approach plant specific CO_2 emission factors are used for large coal boilers since 2005
  According to the IPCC 2006 Guidelines, the total coal consumption from **integrated steel plants** except the use for coke production must be reported in category *2.C.1*. The methodology of calculating *2.C.1* emissions includes higher uncertainty, because year specific carbon contents of the different fuel types are not available at the level of final use, and because total reported CO_2 emissions from integrated steel plants are calculated by means of

an **input/output mass balance**. Thus, the emissions reported under *1.A.2.a* covers the uncertainty of the approach for *2.C.1*. E.g. in 2023 about 10.1 Mt of solid fuels CO_2 from integrated iron plants are considered in *2.C.1* and 1.3 Mt CO_2 are considered in *1.A.2.a*.

- *Liquid Fuels:* The energy balance is mass-balanced but not carbon balanced. Fuel category *Other Oil* is an aggregation of several fuel types and therefore it is difficult to quantify a reliable carbon emission factor for the reference approach. The reference approach takes a share of feedstocks used for plastics and solvent production as non-carbon stored. In the sectoral approach, emissions from plastics waste incineration are reported as "other fuels", but in the reference approach, it is included in "liquid fuels". Emissions from solvent use are included in category *2.D.3* under subcategory *Solvent Use*. In the energy balance, significant amounts of crude oil losses were reported in the oil refinery for the year 2023, which is the reason for the higher deviation between the reference and the sectoral approach, as these losses are not taken into account in the sectoral approach.
- *Gaseous fuels*: The small difference is due to the methodological uncertainty of subtracting emissions from Non-Energy Use used for chemical processes.
- *Other fuels:* The sectoral approach considers industrial waste with sector/plant specific carbon contents since the year 2005 while the methodology for the reference approach uses a single emission factor of 75 t CO_2/TJ. Furthermore, the activity data for the MSW non-biomass-fraction has been taken from the national energy balance while for the sectoral approach a different fraction has been chosen.

At current, it is not possible to quantify the amount of solvents and plastic products, which are imported or exported by products, bulk or waste.

- In the sectoral approach, sector- or even plant-specific net calorific values are taken to calculate the energy consumption, whereas in the reference approach, average (country specific) calorific values are applied.

3.2.1.2 Comparison of energy consumption

Table 25 shows the energy consumption of the two approaches. For the reference approach, non-energy consumption according to the energy balance is subtracted. The comparison shown in Table 25 is equal to CRT table 1.A(c). Please note that positive numbers indicate that the RA shows higher energy consumption than the SA.

Table 25: Energy consumption of sectoral and reference approach in [PJ].

Year	Reference Approach excluding non energy use and reductants					Sectoral Approach				
	Liquid	Solid	Gaseous	Waste	Total	Liquid	Solid	Gaseous	Waste	Total
1990	374.7	118.0	204.0	8.1	704.8	368.4	113.5	204.0	7.8	693.7
1995	407.6	87.3	258.8	9.4	763.1	393.9	79.9	258.4	9.0	741.2
2000	423.2	85.9	262.5	10.5	782.1	417.2	74.7	265.3	10.0	767.2
2005	515.7	92.9	325.2	16.7	950.4	508.6	84.9	327.7	17.2	938.4
2010	449.6	64.4	324.2	25.0	863.2	439.4	53.7	328.7	29.8	851.6
2011	423.6	67.0	307.0	27.5	825.2	418.4	57.2	309.5	32.2	817.3
2012	406.1	58.7	293.5	26.7	785.0	408.1	49.0	295.7	32.8	785.5

Year	Reference Approach excluding non energy use and reductants					Sectoral Approach				
	Liquid	Solid	Gaseous	Waste	Total	Liquid	Solid	Gaseous	Waste	Total
2013	419.5	58.1	283.1	26.0	786.6	420.2	48.2	285.6	33.0	787.0
2014	404.2	46.5	256.3	26.2	733.1	404.3	36.1	258.6	35.8	734.7
2015	412.8	48.0	275.2	27.3	763.4	411.4	37.4	277.4	36.0	762.2
2016	419.2	42.3	288.9	29.3	779.7	423.3	31.1	290.8	39.4	784.6
2017	429.2	41.0	311.6	28.1	809.9	431.0	30.5	314.2	36.1	811.8
2018	424.0	39.5	296.6	26.9	787.0	426.0	29.9	299.1	35.4	790.4
2019	427.4	35.1	306.4	26.0	794.9	427.5	27.6	309.0	34.6	798.6
2020	383.0	26.0	292.1	27.3	728.5	383.2	19.3	294.6	34.3	731.4
2021	402.2	16.0	309.8	27.1	755.1	400.7	14.0	311.8	34.5	761.0
2022	388.2	17.0	276.1	28.4	709.8	381.0	12.3	278.1	35.6	707.1
2023	382.0	13.6	233.9	27.6	657.1	363.5	9.3	235.8	35.8	644.4

Table 26: Difference of energy consumption by type of fuel in percent.

Year	Liquid	Solid	Gaseous	Waste	Total
1990	1.7%	4.0%	0.0%	3.1%	1.6%
1995	3.5%	9.3%	0.2%	4.3%	3.0%
2000	1.4%	15.0%	-1.0%	4.6%	1.9%
2005	1.4%	9.4%	-0.8%	-3.2%	1.3%
2010	2.3%	19.8%	-1.4%	-16.2%	1.4%
2011	1.3%	17.2%	-0.8%	-14.6%	1.0%
2012	-0.5%	19.9%	-0.8%	-18.5%	-0.1%
2013	-0.2%	20.5%	-0.9%	-21.3%	0.0%
2014	0.0%	28.8%	-0.9%	-26.6%	-0.2%
2015	0.4%	28.3%	-0.8%	-24.1%	0.2%
2016	-1.0%	35.9%	-0.7%	-25.6%	-0.6%
2017	-0.4%	34.5%	-0.8%	-22.2%	-0.2%
2018	-0.5%	32.4%	-0.8%	-24.0%	-0.4%
2019	0.0%	27.1%	-0.8%	-24.9%	-0.5%
2020	0.0%	35.1%	-0.8%	-20.3%	-0.4%
2021	0.4%	14.5%	-0.6%	-21.5%	-0.8%
2022	1.9%	38.2%	-0.7%	-20.2%	0.4%
2023	5.1%	46.2%	-0.8%	-23.0%	2.0%

Energy consumption is different between the two approaches because

- Transformation and distribution losses are not considered in the sectoral approach.
- The sectoral approach uses sector-specific NCVs.
- The methodology of the approaches is not comparable at fuel type level.

Changed methodologies

Since submission 2021, the reference approach considers energy balance data of pure fossil diesel and gasoline while in previous submissions blended biofuels were included in those fuel data. Furthermore, double counting of coal tar in the reference approach has been removed and some double counting of liquid fuels is removed in the sectoral approach. In addition, the carbon content of waste non-biomass fraction in the reference approach has been harmonized with the sectoral approach.

Recalculations

Recalculations follow the revisions of the energy balance.

3.2.2 International bunker fuels

3.2.2.1 International aviation

In 2023, the share of international aviation in the total fuel consumption in the aviation sector in Austria represents 98.9% (defined on energy content). Greenhouse gas emissions and activity data from aviation assigned to international bunkers include the transport modes international airport traffic (LTO-cycles) and international cruise traffic for IFR-flights (International Flight Rules) as shown in the following Table 27.

Table 27: Greenhouse gas emissions and activity from international bunkers-aviation 1990–2023.

	CO_2 [kt]		CH_4 [kt]		N_2O [kt]		Activity [TJ]
	int. LTO	int. cruise	int. LTO	Int. cruise	int. LTO	int. cruise	int. LTO + int. cruise
Year	Kerosene						
1990	116	764	0.01	NA	0.005	0.02	12 097
1995	176	1 157	0.02	NA	0.008	0.04	18 315
2000	210	1 485	0.03	NA	0.010	0.05	23 296
2005	270	1 689	0.04	NA	0.012	0.05	26 927
2010	276	1 773	0.04	NA	0.012	0.06	28 159
2011	314	1 854	0.05	NA	0.014	0.06	29 793
2012	302	1 771	0.04	NA	0.014	0.06	28 477
2013	294	1 682	0.04	NA	0.013	0.05	27 141
2014	297	1 680	0.04	NA	0.013	0.05	27 177
2015	313	1 814	0.05	NA	0.013	0.06	29 243
2016	321	2 004	0.02	NA	0.009	0.06	31 957

	CO_2 [kt]		CH_4 [kt]		N_2O [kt]		Activity [TJ]
	int. LTO	int. cruise	int. LTO	Int. cruise	int. LTO	int. cruise	int. LTO + int. cruise
Year	Kerosene						
2017	310	1 936	0.01	NA	0.009	0.05	30 873
2018	338	2 192	0.02	NA	0.009	0.06	34 777
2019	381	2 525	0.02	NA	0.010	0.07	40 032
2020	148	896	0.01	NA	0.004	0.02	14 381
2021	173	1 055	0.01	NA	0.005	0.03	16 913
2022	279	1 688	0.01	NA	0.008	0.05	27 039
2023	360	2 274	0.02	NA	0.010	0.06	36 203
1990–2023	**209%**	**198%**	**25%**		**86%**	**153%**	**199%**

Methodological Issues

Emissions have been calculated using the methodology and emission factors as described in *1.A.3.a Civil Aviation*.

Recalculations

No recalculations are reported in this years' submission.

Planned Improvements

No category-specific improvements are planned.

3.2.2.2 International navigation

In 2023, the share of international navigation in the total fuel consumption in the navigation sector in Austria represented 29% (defined on energy content).

Methodological Issues

Since 2010, greenhouse gas emissions from water-borne navigation (inland navigation on the River Danube) have been reported separately for the national and the international share of navigation from 1990 onwards.

For this purpose Austria uses a bottom-up method to calculate the international fuel consumption in navigation which is based on freight transport activities on the River Danube. As domestic navigation on the River Danube is navigation between Danube harbours located within Austria, international navigation is navigation across national boundaries and transit navigation, expressed in:

tons x kilometers → (GWh/tkm*tkm; CO_2/tkm*tkm etc.)

As inland tkm on the Danube are used to calculate bottom-up domestic navigation, tkm from import, export and transit-activities on the Danube are used to calculate the international share of navigation on the Danube.

Statistical data (tkm) for freight activities (split up into inland, import, export and transit tkm) on the River Danube are obtained from (Via Donau, 2024). For detailed methodological issues concerning factors like kg diesel/tkm and emissions factors see the results of the model GEORG as described in *1.A.2 g.vii.*

Activity Data & Emission Factors

Activity data and implied emission factors from navigation assigned to international bunkers are presented in the following table.

Table 28: Emission factors and activity data for international bunkers-marine 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	619	74.2	4.8	33.3
1995	770	74.2	4.7	33.5
2000	905	74.2	4.5	33.9
2005	1 005	74.2	3.8	33.0
2010	882	74.2	2.6	27.5
2011	779	74.2	2.4	26.4
2012	794	74.2	2.3	25.8
2013	849	74.2	2.3	25.3
2014	785	74.4	2.2	24.8
2015	645	74.4	2.1	24.2
2016	704	74.4	2.1	23.7
2017	728	74.4	2.0	23.2
2018	530	74.4	2.0	22.9
2019	610	74.4	1.9	22.7
2020	572	74.4	1.9	22.4
2021	523	74.4	1.9	22.2
2022	434	74.4	1.9	21.9
2023	403	74.4	1.8	21.7

Recalculations

No recalculations are reported in this years' submission.

Planned Improvements

No category-specific improvements are planned.

3.2.3 Feedstocks and non-energy use of fuels

Non-energy use of fuels is considered in the national energy balance. This chapter presents explanations for the reported non-energy use together with information on where CO_2 emissions due to the manufacture, use and disposal of carbon containing products are considered.

Lubricants

manufacture: emissions are assumed to be included in total emissions from category *1.A.1.b* petroleum refinery.

use: VOC emissions from lubricants used in rolling mills are considered in category *2.C.1*. It is assumed that other uses of lubricants do not result in VOC or CO_2 emissions due to the low vapour pressure of lubricants.

CO_2 from lubricants which are used in engines are considered in category *2.D.1.*

disposal: In case that waste oil is used as fuel, emissions from incineration of lubricants (waste oil) are included in categories *1.A.1.a* and *1.A.2*. In case that energy is not recovered, incineration of waste oil is reported under category *5.C.*

Bitumen

manufacture: emissions from the production of bitumen are assumed to be included in total emissions of category *1.A.1.b* petroleum refinery.

use: GHG emissions from the use of bitumen for road paving and roofing are considered as not applicable/negligible.

disposal: CO_2 emissions from the disposal from bitumen are assumed to be negligible. Recycling is not considered.

Naphtha

manufacture: Naphta is produced in the oil refinery and transferred to a petrochemical plant. Residues from the petrochemical plants are transferred back to the oil refinery steam cracker.

use: Naphta is used for plastics production (e.g. ethylene).

Petroleum coke

In the IEA JQ (2024), non energy use is reported for the manufacture of electrodes.

manufacture: No information about emissions from manufacture of electrodes is currently available.

use: Emissions from the use of electrodes are considered in category *2.B.4* carbide production and *2.C* metal production.

Residual fuel oil

use: Considerable amounts of residual fuel are used in blast furnaces until the year 2015. Emissions are considered in *2.C.1*.

Coking coal, Bituminous coal, Coke oven coke, Coal Tar

manufacture: emissions from the production of coke are considered in category *1.A.2.a*.

use: CO_2 emissions from coal, coke and coal tar used in iron and steel industry are reported under *2.C*. The use of coal tar as a reductant in blast furnaces is considered under category *2.C.1* and is relevant for the years 2010–2014 only.

Natural Gas

use: emissions from the use of natural gas as a feedstock in ammonia production are accounted for in the industrial processes sector (category *2.B.1*).

Plastics waste

manufacture: Emissions from manufacture of plastics are considered in category *2.B.*

use: plastics waste is used as a reductant in blast furnaces since the year 2006. Emissions are considered in *2.C.1*.

disposal: Any emissions from waste disposal are considered in category 5.A. Waste incineration with energy use is considered in *1.A – other fossil fuels* and – to a minor degree – waste incineration without energy recovery is considered in category *5.C*.

Solvents

manufacture: emissions from the production of solvents are considered in sector *2.D.3*

use: Indirect CO_2 emissions from solvent use are considered in sector *2.D.3*. Incineration of waste solvents is considered under category *1.A – other fossil fuels.*

disposal: emissions from the disposal of solvents are considered in 5.A.

Paraffin wax

use: CO_2 emissions from paraffin wax use are considered in sector *2.D.2*.

Lubricants

use: CO_2 emissions from lubricants use are considered in sector *2.D.1*.

3.2.4 CO_2 capture from flue gases and subsequent CO_2 storage, if applicable

CO_2 capture from flue gases and CO_2 storage is not occurring in Austria.

3.2.5 Country-specific issues

With regard to country-specific issues, it can be referred to Chapter 3.2.9, where point source emissions as well as the CO_2 emission trading system (ETS) are considered.

3.2.6 Source Category Description

Transport (1.A.3)

In 2023, the most important source of GHGs was the category *1.A.3 Transport* with a share of 28.9% in total national GHG emissions. 18.4% of national GHG emissions were released by passenger cars, 2.5% by light duty vehicles, 7.5% by heavy-duty vehicles and 0.2% by mopeds and motorcycles. Austria's railway system is mainly driven by electricity, only 0.1% of overall GHGs originate from this category. Fuels used by ships on inland waterways have a share of 0.1% in total GHG emissions. Because Austria is a landlocked country, there is no occurrence of maritime activities. However, emissions from international transport at inland waterways are excluded from the national total and reported as marine bunkers. About 0.04% of national GHG arise from domestic aviation. Gas pipeline compressors contribute 0.1% to national GHG emissions.

Manufacturing Industries (1.A.2)

Combustion in *manufacturing industries and construction* was the second largest sub-category with a share of 14% in 2023 national total GHG emissions. This category also includes mobile machinery mainly used in the construction sector. Considerably large amounts of CO_2-emissions from non-energy fuel use, such as reducing agents used in iron and steel industries and natural gas used for ammonia production, are reported as emissions from industrial processes (CRT Category 2).

Energy Industries (1.A.1)

The third largest GHG source of the energy sector in 2023 with a share of 10.6% total GHG emissions was *energy industries*, where fossil fuels are used for electrical power and district heating production. In the year 2023, overall gross public electricity production of main producers was 60 951 GWh[45], of which 44 199 GWh (73%) were generated by hydro plants, 8 464 GWh (14%) by thermal power plants and 8 283 GWh (14%) by wind, solar and geothermal power plants. Industrial auto producers generated 13 509 GWh of electricity in the year 2023. There are no operating nuclear plants in Austria. Due to the importance of hydropower, the seasonal water situation in Austria has a high influence on the need for electric power generation by fossil fuels. In energy industries, biomass is mainly used by smaller district heating plants. The oil refining industry, which consists of only one plant in Austria, is also included in this category (sub-category *1.A.1.b Petroleum refining*). Crude oil input of the oil refinery was 8 Mt in 2022. Furthermore, this category includes emissions from other energy industries, which is mainly natural gas consumption of the oil/gas exploration sector and of gas refining industries (sub-category *1.A.1.c Manufacture of Solid Fuels and Other Energy Industries*).

Other Sectors (1.A.4)

Fossil fuels, mainly used for space and water heating in the commercial, agricultural and household sector (sub-category *1.A.4 Other Sectors* or "small combustion" sector), formed the fourth largest category within sector energy, with a share of 10.6% in 2023 total national GHG emissions. Emissions of this category are very dependent on the climatic circumstances and on the economic trend. E.g. a "cold winter" in combination with a low heating oil price may increase emissions from space heating significantly. In Austria a large share of solid biomass consumption is used for space

[45] Source: IEA Questionnaire December/2024 by STATISTIK AUSTRIA.

and water heating. Category *1.A.4* also includes emissions from mobile machinery mainly used in agriculture and forestry.

Military (1.A.5)

Category *1.A.5 Other* includes emissions from military air and road transport as well as from other mobile machinery. It contributes 0.04% to total GHG emissions in 2023.

3.2.7 Key Categories

The methodology and results of the key category analysis is presented in Chapter 1.4.

3.2.8 Completeness

Table 29 provides an overview of the IPCC categories included in this chapter and presents the transformation matrix from SNAP categories. It also provides information on the status of emission estimates of all subcategories. A "✓" indicates that emissions from this sub-category have been estimated. "NO" indicates that the Austrian energy balance does not quote any energy consumption for the relevant sector and fuel category.

Emissions of all sources of category *1.A Fuel Combustion* have been estimated; the status of emission estimates of this category is complete.

Table 29: Overview of subcategories of Category 1.A Fuel Combustion: transformation into SNAP Codes and status of estimation for the year 2023.

IPCC Category	SNAP	Status		
		CO_2	CH_4	N_2O
1.A.1.a Public Electricity and Heat Production	**0101 Public power 0102 District heating plants**			
1.A.1.a Liquid Fuels		✓	✓	✓
1.A.1.a Solid Fuels		✓	✓	✓
1.A.1.a Gaseous Fuels		✓	✓	✓
1.A.1.a Biomass		✓	✓	✓
1.A.1.a Other Fuels		✓	✓	✓
1.A.1.b Petroleum refining	**0103 Petroleum refining plants**			
1.A.1.b Liquid Fuels		✓	✓	✓
1.A.1.b Solid Fuels		NO	NO	NO
1.A.1.b Gaseous Fuels		✓	✓	✓
1.A.1.b Biomass		NO	NO	NO
1.A.1.b Other Fuels		NO	NO	NO
1.A.1.c Manufacture of Solid fuels and Other Energy Industries	**010503 Oil/Gas Extraction plants**			
1.A.1.c Liquid Fuels		✓	✓	✓

IPCC Category	SNAP	Status		
		CO_2	CH_4	N_2O
1.A.1.c Solid Fuels		IE(1)	IE(1)	IE(1)
1.A.1.c Gaseous Fuels		✓	✓	✓
1.A.1.c Biomass		NO	NO	NO
1.A.1.c Other Fuels		NO	NO	NO
1.A.2.a Iron and Steel	**0301 Comb. In boilers, gas turbines and stationary engines (Iron and Steel Industry) 030326 Processes with Contact-Other(Iron and Steel Industry)**			
1.A.2.a Liquid Fuels		✓	✓	✓
1.A.2.a Solid Fuels		✓	✓	✓
1.A.2.a Gaseous Fuels		✓	✓	✓
1.A.2.a Biomass		✓	✓	✓
1.A.2.a Other Fuels		NO	NO	NO
1.A.2.b Non-ferrous Metals	**0301 Comb. In boilers, gas turbines and stationary engines (Non-ferrous Metals Industry)**			
1.A.2.b Liquid Fuels		✓	✓	✓
1.A.2.b Solid Fuels		✓	✓	✓
1.A.2.b Gaseous Fuels		✓	✓	✓
1.A.2.b Biomass		✓	✓	✓
1.A.2.b Other Fuels		✓	✓	✓
1.A.2.c Chemicals	**0301 Comb. in boilers, gas turbines and stationary engines (Chemical Industry)**			
1.A.2.c Liquid Fuels		✓	✓	✓
1.A.2.c Solid Fuels		✓	✓	✓
1.A.2.c Gaseous Fuels		✓	✓	✓
1.A.2.c Biomass		✓	✓	✓
1.A.2.c Other Fuels		✓	✓	✓
1.A.2.d Pulp, Paper and Print	**0301 Comb. in boilers, gas turbines and stationary engines (Pulp, Paper and Print Industry)**			
1.A.2.d Liquid Fuels		✓	✓	✓
1.A.2.d Solid Fuels		✓	✓	✓
1.A.2.d Gaseous Fuels		✓	✓	✓
1.A.2.d Biomass		✓	✓	✓
1.A.2.d Other Fuels		✓	✓	✓
1.A.2.e Food Processing, Beverages and Tobacco	**0301 Comb. in boilers, gas turbines and stationary engines (Food Processing, Beverages and Tobacco Industry)**			
1.A.2.e Liquid Fuels		✓	✓	✓
1.A.2.e Solid Fuels		✓	✓	✓
1.A.2.e Gaseous Fuels		✓	✓	✓
1.A.2.e Biomass		✓	✓	✓

IPCC Category	SNAP	Status		
		CO_2	CH_4	N_2O
1.A.2.e Other Fuels		✓	✓	✓
1.A.2.f Non-Metallic Minerals	**030311 Cement** **030317 Glass** **030312 Lime** **030319 Bricks and Tiles** **030323 Magnesia production (dolomite treatment)**			
1.A.2.f Liquid Fuels		✓	✓	✓
1.A.2.f Solid Fuels		✓	✓	✓
1.A.2.f Gaseous Fuels		✓	✓	✓
1.A.2.f Biomass		✓	✓	✓
1.A.2.f Other Fuels		✓	✓	✓
1.A.2.g Other	**0301 Comb. in boilers, gas turbines and stationary engines** **0808 Other Mobile Sources and Machinery-Industry**			
1.A.2.g Liquid Fuels		✓	✓	✓
1.A.2.g Solid Fuels		✓	✓	✓
1.A.2.g Gaseous Fuels		✓	✓	✓
1.A.2.g Biomass		✓	✓	✓
1.A.2.g Other Fuels		✓	✓	✓
1.A.3.a Civil Aviation	**080501 Domestic airport traffic (LTO cycles – < 1 000 m)** **080503 Domestic cruise traffic (> 1 000 m)**			
1.A.3.a Aviation Gasoline		✓	✓	✓
1.A.3.a Jet Kerosene		✓	✓	✓
1.A.3.b Road Transportation	**0701 Passenger cars** **0702 Light duty vehicles < 3.5 t** **0703 Heavy duty vehicles > 3.5 t and buses** **0704 Mopeds and Motorcycles < 50 cm³** **0705 Motorcycles > 50 cm³** **0706 Gasoline evaporation from vehicles**			
1.A.3.b Gasoline		✓	✓	✓
1.A.3.b Diesel Oil		✓	✓	✓
1.A.3.b LPG		✓	✓	✓
1.A.3.b Gaseous Fuels		✓	✓	✓
1.A.3.b Biomass		✓	✓	✓
1.A.3.b Other Fuels		✓	IE(2)	IE(2)
1.A.3.c Railways	**0802 Other Mobile Sources and Machinery-Railways**			
1.A.3.c Liquid Fuels		✓	✓	✓
1.A.3.c Solid Fuels		✓	✓	✓
1.A.3.c Gaseous		NO	NO	NO
1.A.3.c Biomass		✓	✓	✓
1.A.3.c Other Fuels		✓	IE(2)	IE(2)
1.A.3.d Navigation	**0803 Other Mobile Sources and Machinery-Inland waterways**			

IPCC Category	SNAP	Status		
		CO_2	CH_4	N_2O
1.A.3.d Residual Oil		NO	NO	NO
1.A.3.d Gas/Diesel oil		✓	✓	✓
1.A.3.d Gasoline		✓	✓	✓
1.A.3.d Gaseous		NO	NO	NO
1.A.3.d Biomass		✓	✓	✓
1.A.3.d Other Fuels		✓	IE(2)	IE(2)
1.A.3.e.i Pipeline Transport	**010506 Pipeline Compressors**			
1.A.3.e.i Gaseous Fuels		✓	✓	✓
1.A.3.e.ii Other - Airport Ground activities	**0810 Other off-road (Airport Ground Activities)**			
1.A.3.e.ii Liquid Fuels		✓	✓	✓
1.A.3.e.ii Gaseous Fuels		✓	✓	✓
1.A.3.e.ii Other Fuels		✓	IE(2)	IE(2)
1.A.3.e.ii Biomass		✓	✓	✓
1.A.4.a Commercial/Institutional	**0201 Commercial and institutional plants**			
1.A.4.a Liquid Fuels		✓	✓	✓
1.A.4.a Solid Fuels		✓	✓	✓
1.A.4.a Gaseous Fuels		✓	✓	✓
1.A.4.a Biomass		✓	✓	✓
1.A.4.a Other Fuels		✓	✓	✓
1.A.4.b Residential	**0202 Residential plants** **0809 Other Mobile Sources and Machinery-Household and gardening**			
1.A.4.b Liquid Fuels		✓	✓	✓
1.A.4.b Solid Fuels		✓	✓	✓
1.A.4.b Gaseous Fuels		✓	✓	✓
1.A.4.b Biomass		✓	✓	✓
1.A.4.b Other Fuels		✓	IE(2)	IE(2)
1.A.4.b Peat		✓	✓	✓
1.A.4.c Agriculture/Forestry/Fisheries	**0203 Plants in agriculture, forestry and aquaculture** **0806 Other Mobile Sources and Machinery-Agriculture** **0807 Other Mobile Sources and Machinery-Forestry**			
1.A.4.c Liquid Fuels		✓	✓	✓
1.A.4.c Solid Fuels		✓	✓	✓
1.A.4.c Gaseous Fuels		✓	✓	✓
1.A.4.c Biomass		✓	✓	✓
1.A.4.c Other Fuels		✓	IE(2)	IE(2)
1.A.5 Other	**0801 Other Mobile Sources and Machinery-Military**			
1.A.5 Liquid Fuels		✓	✓	✓

IPCC Category	SNAP	Status		
		CO_2	CH_4	N_2O
1.A.5 Solid Fuels		NO	NO	NO
1.A.5 Gaseous Fuels		NO	NO	NO
1.A.5 Biomass		✓	✓	✓
1.A.5 Other Fuels		✓	IE[(2)]	IE[(2)]
Marine Bunkers	**080404 International sea traffic (international bunkers)**			
Gasoline		NO	NO	NO
Gas/Diesel oil		✓	✓	✓
Residual Fuel Oil		NO	NO	NO
Lubricants		NO	NO	NO
Coal		NO	NO	NO
Other Fuels		NO	NO	NO
Aviation Bunkers	**080502 International airport traffic (LTO cycles – < 1 000 m)** **080504 International cruise traffic (> 1 000 m)**			
Jet Kerosene		✓	✓	✓
Gasoline		NO	NO	NO
Multilateral Operations		NO	NO	NO

[(1)] *Emissions from coke ovens are included in 1.A.2.a iron and steel industries*

[(2)] *Other fuels include the share of fossil methanol in FAME (biodiesel). CH_4 and N_2O emissions of this share are reported under biomass.*

3.2.9 Methodology Overview

Stationary combustion

For stationary combustion the IPCC Tier 1 and Tier 2 methodologies have been applied. Activity data are taken either from national statistics or from the IEA/EUROSTAT joint questionnaires. Calorific values used for conversion of fuel activity data from [tonnes] and [cubic metres] into [Terajoule] are country specific. Country specific emission factors are fuel and technology dependent.

Mobile sources

For mobile sources either Tier 3 or country specific methods (Tier 2) have been applied, where technology dependent activity data are calculated by means of a bottom up model and adjusted to top down activity data. Bottom up activity data are calculated by means of vehicle-kilometres, vehicle stock statistics and operating condition dependant fuel consumption per vehicle kilometre. Bottom-up fuel consumption of civil aviation is calculated by aircraft specific LTO-cycle and cruise-kilometre consumption. Top down activity data are based on fuel sales taken from the national energy balance.

Table 30: Overview of applied 1.A Methodologies by source and gas.

	Method			Emission factor		
	CO_2	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
1 A 1 a liquid	T2	T1	T1	CS	D	D
1 A 1 a solid	T2	T1	T1	CS	D	D
1 A 1 a gaseous	T2	T1	T1	CS	D	D
1 A 1 a other	T2	T2	T1	CS	CS	D
1 A 1 a biomass	T1	T1,T2	T1	D	CS,D	D
1 A 1 b liquid	T2	T1	T1	CS	D	D
1 A 1 b gaseous	T2	T1	T1	CS	D	D
1 A 1 c 2 gaseous	T2	T1	T1	CS	D	D
1 A 1 c 3 gaseous	T2	T1	T1	CS	D	D
1 A 1 c 3 biomass	NA	T1	NA	NA	D	NA
1 A 2 a liquid	T2	T1	T1	CS	D	D
1 A 2 a solid	T2	T1	T1	CS	D	D
1 A 2 a gaseous	T2	T1	T1	CS	D	D
1 A 2 a biomass	T1	T2	T1	D	CS	D
1 A 2 b liquid	T2	T1	T1	CS	D	D
1 A 2 b solid	T2	T1	T1	CS	D	D
1 A 2 b gaseous	T2	T1	T1	CS	D	D
1 A 2 b other	T2	T2	T1	CS	CS	D
1 A 2 b biomass	T1	T2	T1	D	CS	D
1 A 2 c liquid	T2	T1	T1	CS	D	D
1 A 2 c solid	T2	T1	T1	CS	D	D
1 A 2 c gaseous	T2	T1	T1	CS	D	D
1 A 2 c other	T2	T2	T1	CS	CS	D
1 A 2 c biomass	T1	T1,T2	T1	D	CS,D	D
1 A 2 d liquid	T2	T1	T1	CS	D	D
1 A 2 d solid	T2	T1	T1	CS	D	D
1 A 2 d gaseous	T2	T1	T1	CS	D	D
1 A 2 d other	T2	T2	T1	CS	CS	D
1 A 2 d biomass	T1	T1,T2	T1	D	CS,D	D
1 A 2 e liquid	T2	T1	T1	CS	D	D
1 A 2 e solid	T2	T1	T1	CS	D	D
1 A 2 e gaseous	T2	T1	T1	CS	D	D
1 A 2 e other	T2	T2	T1	CS	CS	D
1 A 2 e biomass	T1	T1,T2	T1	D	CS,D	D
1 A 2 f liquid	T2	T1	T1	CS	D	D
1 A 2 f solid	T2	T1	T1	CS	D	D
1 A 2 f gaseous	T2	T1	T1	CS	D	D

	Method			Emission factor		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
1 A 2 f other	T2	T2	T1	CS	CS	D
1 A 2 f biomass	T1	T2	T1	D	CS	D
1 A 2 g 7 liquid	T3	T3	T3	CS	CS	CS
1 A 2 g 7 biomass	T1	T3	T3	D	CS	CS
1 A 2 g 8 liquid	T2	T1	T1	CS	D	D
1 A 2 g 8 solid	T2	T1	T1	CS	D	D
1 A 2 g 8 gaseous	T2	T1	T1	CS	D	D
1 A 2 g 8 other	T2	T2	T1	CS	CS	D
1 A 2 g 8 biomass	T1	T1,T2	T1	D	CS,D	D
1 A 3 a aviation gasoline	T2	T2	T2	CS	CS	CS
1 A 3 a jet kerosene	T3	T3	T3	D	CS	CS
1 A 3 b 1 gasoline	T2	T3	T3	CS	CS	CS
1 A 3 b 1 diesel oil	T2	T3	T3	CS	CS	CS
1 A 3 b 1 LPG	T2	T3	T3	CS	CS	CS
1 A 3 b 1 gaseous	T2	T3	T3	CS	CS	CS
1 A 3 b 1 biomass	T1	T3	T3	D	CS	CS
1 A 3 b 1 other	T2	-	-	D	-	-
1 A 3 b 2 gasoline	T2	T3	T3	CS	CS	CS
1 A 3 b 2 diesel oil	T2	T3	T3	CS	CS	CS
1 A 3 b 2 LPG	T2	T3	T3	CS	CS	CS
1 A 3 b 2 gaseous	T2	T3	T3	CS	CS	CS
1 A 3 b 2 biomass	T1	T3	T3	D	CS	CS
1 A 3 b 2 other	T2	-	-	D	-	-
1 A 3 b 3 gasoline	T2	T3	T3	CS	CS	CS
1 A 3 b 3 diesel oil	T2	T3	T3	CS	CS	CS
1 A 3 b 3 LPG	T2	T3	T3	CS	CS	CS
1 A 3 b 3 gaseous	T2	T3	T3	CS	CS	CS
1 A 3 b 3 biomass	T1	T3	T3	D	CS	CS
1 A 3 b 4 gasoline	T2	T3	T3	CS	CS	CS
1 A 3 b 4 biomass	T1	T3	T3	D	CS	CS
1 A 3 c liquid	T2	T3	T3	CS	CS	CS
1 A 3 c solid	T2	T3	T3	CS	CS	CS
1 A 3 c biomass	T1	T3	T3	D	CS	CS
1 A 3 c other	T2	-	-	D	-	-
1 A 3 d gas/diesel oil	T2	T3	T3	CS	CS	CS
1 A 3 d gasoline	T2	T3	T3	CS	CS	CS
1 A 3 d biomass	T1	T3	T3	D	CS	CS
1 A 3 d other	T2	-	-	D	-	-

	Method			Emission factor		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
1 A 3 e 1 gaseous	T2	T1	T1	CS	D	D
1 A 3 e 2 liquid	T2	T2	T2	CS	CS	CS
1 A 3 e 2 gaseous	T2	T2	T2	CS	CS	CS
1 A 3 e 2 other	T2	-	-	CS	-	-
1 A 4 a 1 liquid	T2	T1,T2	T1	CS	CS,D	D
1 A 4 a 1 solid	T2	T1	T1	CS	D	D
1 A 4 a 1 gaseous	T2	T1	T1	CS	D	D
1 A 4 a 1 other	T2	T2	T1	CS	CS	D
1 A 4 a 1 biomass	T1	T1,T2	T1	D	CS,D	D
1 A 4 b 1 liquid	T2	T1,T2	T1	CS	CS,D	D
1 A 4 b 1 solid	T2	T1	T1	CS	D	D
1 A 4 b 1 gaseous	T2	T1	T1	CS	D	D
1 A 4 b 1 peat	T1	T1	T1	D	D	D
1 A 4 b 1 biomass	T1	T1,T2	T1	D	CS,D	D
1 A 4 b 2 liquid	T2	T3	T3	CS	CS	CS
1 A 4 b 2 biomass	T1	T3	T3	D	CS	CS
1 A 4 b 2 other	T2	-	-	CS	-	-
1 A 4 c 1 liquid	T2	T1,T2	T1	CS	CS,D	D
1 A 4 c 1 solid	T2	T1	T1	CS	D	D
1 A 4 c 1 gaseous	T2	T1	T1	CS	D	D
1 A 4 c 1 biomass	T1	T2	T1	D	CS	D
1 A 4 c 2 gasoline	T3	T3	T3	CS	CS	CS
1 A 4 c 2 diesel oil	T3	T3	T3	CS	CS	CS
1 A 4 c 2 biomass	D	T3	T3	D	CS	CS
1 A 4 c 2 other	T2	-	-	D	-	-
1 A 5 b liquid	T2	T3	T3	CS	CS	CS
1 A 5 b biomass	T1	T3	T3	D	CS	CS
1 A 5 b other	T2	-	-	D	-	-

Consideration of point source emissions

For the following categories and pollutants, plant or boiler specific emission declarations are considered each year.

- 1.A.1.a Public Electricity and Heat Production (about 130 boilers): CO, SO_2, NO_x
- 1.A.1.b Petroleum Refining (1 plant): SO_2, NO_x, CO, VOC ("IE": reported under 1 B)
- 1.A.2.a Iron and Steel (2 integrated iron & steel plants): CO_2, CO, VOC, SO_2, NO_x
- 1.A.2.f Non-Metallic Minerals – Cement production (10 plants): CO_2, SO_2, NO_x, CO, VOC

To avoid double counting of point source emissions with area sources (data from the national energy balance), the consistency of reported activity by plant operators with activity data from energy statistics is checked. Reported data must not be greater than data from energy statistics for the respective category (the correspondence of a plant to the specific energy balance sector is determined by identical NACE or ISIC-Codes). Only consistent and complete point source data are used for inventory preparation. If point source data are not consistent, then data from the national energy balance are used.

Activity data and emissions of point source emissions declarations are checked by comparing implied emission factors against IPCC default values or by comparing emissions to those of a simple Tier 1 approach.

3.2.9.1 Consistency with the EU emission trading system (EU-ETS)

Currently the following industrial branches are fully covered by the national ETS:

- 1.A.1.b Oil refineries
- 1.A.2.a+2.C.1 Iron and steel manufacturing industries
- 1.A.2.f Non-metallic mineral industries (cement, glass, lime, bricks and tiles, other ceramic materials)

Combustion plants of other industrial branches (including power plants) are considered, if their thermal plant capacity exceeds 20 MW_{th} (excluding boilers < 3 MW, biomass-boilers and hazardous and municipal waste incineration boilers).

The following branches have a high coverage of ETS installations:

- 1.A.1.a Public electricity and heat production (about 80 %). Covers about 95% of fossil fuels (except waste)
- 1.A.2.d Pulp, paper and print (around 75 %)
- 1.A.2.c Chemicals (around 75 %)

Description of received ETS data

ETS data is submitted by means of a standard calculation sheet, which includes numerical data about multiple fuels, processes and material flows. Additionally, a written QA/QC report has to be submitted. National legislation (Emissionszertifikategesetz §7) allows the use of detailed ETS data for reasons of inventory compilation.

For fuel combustion and industrial processes, the following numerical data is reported:

- Activity data: mass or volume of fuel consumption/process input material
- Net calorific value of fuel
- Oxidation factor of fuel/conversion factor of process material
- CO_2 emission factor of fuel or process material
- Share of non-fossil CO_2 (biomass) in case of "non-traded fuels"

For sites with complex material flows (e.g. refineries, iron and steel plants, chemical plants), carbon mass balance data is reported alternatively:

- Activity data: mass or volume of material flow (may have a negative sign)
- Net calorific value of material
- Carbon content of material
- Direct CO_2 measurements

The ETS reports include data about "traded-fuels" (e.g. different types of coal and fuel oils, natural gas) as well as "non-traded fuels" (e.g. industrial wastes, biomass). For each of the "traded fuels", a national default NCV and a national default CO_2 emission factor may be selected for emission calculation. For "non-traded fuels" (industrial waste, mostly used in cement industry), plant operators have to make their own estimate of the carbon content and the NCV. However, carbon contents (t C/t waste) and oxidation factors of common waste fuels (tyres, waste oil, plastics waste) used in the cement industry are widely harmonized between different operators.

Methodology of ETS data consideration

ETS "bottom up" data since 2005 are used for calculation of emission data in categories *1.A.1*, *1.A.2, 1.A.3.e* and *1.A.4.a*. About 200 plants report 800 fuel and material flows yearly, which are considered in the inventory. From the year 2013 onwards, the scope of ETS has been expanded by natural gas compressors used in energy industries (CRT *1.A.1.c* and *1.A.3.e*), smaller steel-works (CRT *1.A.2.a* and *2.C*), magnesite sinter plants (CRT *1.A.2.f* and *2.A*) and chemical industries (CRT *1.A.2.c* and *2.B*).

- In accordance with STATISTIK AUSTRIA, each plant is allocated to a NACE category of the energy balance.
- In accordance with STATISTIK AUSTRIA, each reported fuel is allocated to a fuel type according to the energy statistics system. For "non-traded fuels", systematic errors of allocation have to be avoided as far as possible.
- ETS fuel masses/volumes and NCVs are used for activity data calculation. The remaining activity data is calculated by means of remaining fuel masses/volumes and averaged NCVs from the energy balance:
  $Activity_{category,\ fuel} = (Energy\_Balance\_Activity_{category,\ fuel} - \Sigma i(ETS\_Activity_{plant\ i,\ fuel})) \times Energy\_Balance\_NCV_{fuel} + \Sigma i(ETS\_Activity_{plant\ i,\ fuel} \times ETS\_NCV_{plant\ i,\ fuel})$.
- ETS CO_2 emissions are considered by fuel. The remaining CO_2 emissions are calculated by remaining activity data and "national default" emission factors:
  $CO_{2\,category,\ fuel} = (Energy\_Balance\_Activity_{category,\ fuel} - \Sigma i(ETS\_Activity_{plant\ i,\ fuel})) \times Energy\_Balance\_NCV_{fuel} \times Default\_EF_{fuel} + \Sigma i(ETS\_CO_{2\,plant\ i,\ fuel})$.

3.2.9.2 Choice of emission factors for stationary combustion

Emission factors for combustion plants are expressed as kg/GJ for CO_2 and as g/GJ for CH_4 and g/GJ for N_2O. Please note that emission factors sometimes are different for different sectors because of the different share of fuel combusted. E.g., the CO_2 emission factor for "hard coal" used in the energy industries is different from the factor used for manufacturing industry because different hard coal types with different origin are used; "hard coal" is actually a group of different hard coal types.

Emission factors may vary over time for the following reasons:

- The chemical characteristics of a fuel category varies, e.g. sulphur content in residual oil, carbon content of coal, CH_4 content of natural gas.
- The mix of fuels in the fuel category changes over time. If the different fuels of a fuel category have different calorific values and their share in the fuel category changes, the calorific value of the fuel category might change over time.
- The technical equipment of a combustion plant, which burns a specific fuel, changes over time.
- Changes in technologies (rather relevant for air pollutants such as NO_X, VOC or $PM_{2.5}$)

References for country specific CO_2 default emission factors are included in national studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, BMWA, 2003, Umweltbundesamt, 2001b, Umweltbundesamt, 2004a). Detailed figures are included in the relevant chapters.

CO_2 emission factors for stationary sources per fuel type

Natural Gas (fossil)

For all sources of natural gas combustion, a CO_2 emission factor of 55.4 t CO_2/TJ (Umweltbundesamt, 2001b) is applied for 1990–2018. For the year 2019 onwards, a factor of 55.6 t CO_2/TJ is applied.

In 2016, national gas supplier companies provided detailed data about natural gas composition and heating values for the years 2013–2015 and a CO_2 emission factor of 55.4 t/TJ and a net calorific value of 36.4 MJ/Nm^3 has been calculated. The emission factor is in line with the emission factor used so far for emission calculations and valid until the inventory year 2018.

The CO_2 emission factor and the calorific value have been used as default values for ETS reporting since 2016 and have been first published by the ministry of environment in January 2017. Updates are planned to be published every three years.

In the year 2020, an updated (slightly higher) natural gas CO_2 emission factor (55.6 t CO_2/TJ) has been published (Bundesministerium für Nachhaltigkeit und Tourismus, 2019), which is applied for the years 2019 to 2021. In the follow up report (Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie, 2022), the CO_2 emission factor to be applied from 2022 to 2024 remains unchanged.

Table 31 shows the typical composition of natural gas as reported by the main national natural gas supplier for 2021.

Table 31: Typical natural gas composition of Austrian main supplier 2021 (NCV = 36.68 MJ/Nm^3).

Component	% Volume
CH_4	95.64
C_2H_6	2.86
C_3H_8	0.34
n-C_4H_{10}	0.05
i-C_4H_{10}	0.06
n-C_5H_{12}	0.01

Component	% Volume
$i\text{-}C_5H_{12}$	0.01
C_6H_{14}+	0.02
CO_2	0.47
N_2	0.52
O_2	0.75

Liquid fuels (fossil)

Fuel oil: Depending on the sulphur content three fuel oil categories are considered in the inventory.

Gasoil, Diesel Oil, Liquefied Petroleum Gas (LPG): CO_2 emission factors are taken from (Bundesministerium für wirtschaftliche Angelegenheiten, 1996).

Refinery Gas: The CO_2 emission factor is based on plant specific measurements.

Solid fuels (fossil)

Coal: CO_2 emission factors are based on elemental analysis with the assumption that 100% of carbon is released as CO_2 (Bundesministerium für wirtschaftliche Angelegenheiten, 1996). Values originate from the study (HACKL, A. & MAUSCHITZ, G., 1996), where the EF are based on the elemental analysis for different coal types.

Peat (fossil)

A default emission factor of 106 t/TJ for peat is taken from the IPCC 2006 Guidelines.

Municipal Solid Waste, MSW (partly fossil)

For the years 1990 to 2004, the fossil carbon content for MSW is taken from (Umweltbundesamt, 2003a). A fraction analysis of the typical wet MSW for Vienna[46] was performed by the local waste authority MA 48 of Vienna in 1997/1998.

The fossil and non fossil carbon content of each fraction is taken from (ÖKOINSTITUT, 2002). This leads to a fossil share of 45% of the overall carbon content of 261 kg C/t $MSW_{wet\ matter}$. The CO_2 emission factor was converted into t CO_2/TJ by means of a net calorific heating value of 8.81 GJ/t. The calculated CO_2 emission factor for MSW is 48.88 t/TJ. The emissions factor has been applied for the years 1990 to 2004.

From the year 2005 onwards, an updated MSW CO_2 emission factor of 43.45 t CO_2/TJ is applied for the sum of renewable and non-renewable MSW. The updated emission factor is based on a new study (Umweltbundesamt and TU Vienna, 2019). Emission factors were derived from a methodology worked out by the Technical University of Vienna (TU Vienna, 2015) and available MSW fraction analyses. The methodology of TU Vienna uses CO_2 stack measurements as well as available input and output process measurement parameters of the plants. These plant specific measurements have been used to validate a methodology based on MSW fraction analysis (manual sorting of frac-

[46] Until 1998 incineration of MSW in Vienna took place only at the one plant where the analysis was performed; in 2003 73% of total MSW in Austria was combusted in this plant, the value was applied to total MSW combustion in Austria.

tions such as paper, kitchen and garden waste, packaging plastics, packaging glass, metals) to calculate the total carbon content and the fossil share of carbon. The resulting emission factor was derived from MSW sorting analysis of several years.

Activity data is taken from the energy balance, where the fossil (non renewable) part together with CO_2, N_2O and CH_4 emissions is allocated to *1.A.1.a-other fossil fuel*s and the biogenic (renewable) part together with CO_2 from biomass, N_2O and CH_4 emisions is allocated to *1.A.1.a-biomass*. The sum of both parts is consistent with the sum of renewable and non-renewable energy consumption as reported in the energy balance. However, the shares of the non-renewable (fossil) and renewable (biomass) parts of energy consumption used within the inventory are not consistent with the energy balance but are calculated by the heating values of the different MSW fractions as provided in the study (Umweltbundesamt and TU Vienna, 2019). The calculated share of the non-renewable part used for the inventory results to 52.1% while the calculated share of the energy balance lies between 56% and 65% (e.g. about 60.2% for the years 2021 to 2022, 65.3% for the year 2005, 62% for the year 1990). Because the selected CH_4 and N_2O emission factors for both parts are identical, the selected share does not affect total emissions of both parts.

Industrial Waste (partly fossil)

The main share of industrial waste is used in cement and chemical industry for the purpose of energy recovery. For cement industry emission factors are based on the studies (Hackl, Mauschitz, 1995, 1997, 2001, 2003, 2007) and (Mauschitz, 2004, 2009, 2010-2023) which include information about fractions and carbon contents. Details about emissions from cement industry are given in Chapter 3.2.11.2.

The fractions and the specific carbon contents of waste incinerated in hazardous waste incineration plants (rotation kilns), chemical industry, pulp and paper industry and wood products manufacturing industry are not reported within the ETS and therefore are unknown.

Until the submission 2019, a CO_2 emission factor of 104.17 t/TJ had been applied for those unknown waste fractions. Within (Umweltbundesamt and TU Vienna, 2019) the Technical University of Vienna (TU Vienna) presented an emission factor, which better reflects actual known dependencies of heating value, water content and carbon content of waste fuels. TU Vienna also carried out stack measurements and input analysis of a hazardous waste incineration plant, which shows that the factor represents a "conservative approach" (high certainty that under-estimation does not occur). The proposed CO_2 emission factor is 75 t/TJ and has been applied for the whole time series since 1990.

Sewage Sludge (non fossil)

Sewage sludge is incinerated in one waste incineration plant and a couple of public power plants. The default CO_2 emission factor of 112 t/TJ has been selected from the IPCC 2006 Guidelines.

Black Liquor (non fossil)

Black liquor is incinerated in pulp and paper industry and in wood products manufacturing industry. The default CO_2 emission factor of 95.3 t/TJ has been selected from the IPCC 2006 Guidelines.

Biogas, Sewage Sludge Gas, Landfill Gas (non fossil)

Biogas reported by (IEA/Eurostat JQ, 2024) is used for energy recovery in all subcategories of Category *1.A.* The default CO_2 emission factor of 54.6 t/TJ has been selected from the IPCC 2006 Guidelines.
Biogas is also fed into the public natural gas network or local biogas networks but reported separately in the energy balance. The biogas fed into the public gas network must meet special requirements with regard to purity and calorific value.
(see http://www.biogas-netzeinspeisung.at/rechtliche-planung/index.html).

3.2.9.3 CO_2 emissions reported by the EU-ETS

The following Table 32 shows certificated CO_2 emissions from the ETS (Umweltbundesamt, 2024d) and their allocation to IPCC categories. The allocation does not always follow the category reported by plant operators but is harmonized by means of reported NACE-codes and therefore harmonized with energy statistics. Minor process related emissions which could not be allocated to a specific category (e.g. carburisation material, pyrolisis material) have been allocated to category *1.A.2.g.8*

Table 32: 2005–2023 CO_2 emissions [kt] as reported under the EU-ETS.

	Category	2005	2010	2018	2019	2020	2021	2022	2023
Total ETS1)		33 373	30 855	28 345	29 482	26 982	28 662	26 603	24 386
1.A	FUEL COMBUSTION ACTIVITIES	20 760	17 836	15 593	15 745	14 112	14 072	12 812	11 174
1.A.1.a	Public Electricity and Heat Production	11 482	9 335	5 420	5 667	4 386	4 379	4 445	3 226
1.A.1.b	Petroleum refining	2 827	2 724	2 824	2 791	2 732	2 750	2 255	2 580
1.A.1.c	Manufacture of Solid fuels and Other Energy Industries	43	47	175	180	159	163	180	143
1.A.2.a	Iron and Steel	1 163	893	1 501	1 513	1 493	1 550	1 437	1 406
1.A.2.b	Non-ferrous Metals	0	0	50	50	51	52	50	46
1.A.2.c	Chemicals	665	654	1 109	1 187	1 112	1 065	954	851
1.A.2.d	Pulp, Paper and Print	2 245	2 044	1 474	1 417	1 377	1 378	1 094	875
1.A.2.e	Food Processing, Beverages and Tobacco	316	352	280	257	249	237	263	254
1.A.2.f	Non-metallic minerals	1 656	1 528	1 694	1 664	1 654	1 682	1 579	1 378
1.A.2.g.8	Other: Stationary	340	245	433	422	375	403	371	364
1.A.3.e	Pipeline compressors	0	0	587	547	475	378	152	24
1.A.4.a	Commercial/Institutional	22	15	47	49	48	36	31	28
2	INDUSTRIAL PROCESSES	12 613	13 020	12 752	13 738	12 870	14 590	13 792	13 213
2.A.1	Cement Production	1 797	1 622	1 827	1 771	1 821	1 889	1 832	1 543
2.A.2	Lime Production	579	574	511	544	521	585	548	521
2.A.3	Glass Production	35	40	38	41	39	36	35	35
2.A.4	Other Process Uses of Carbonates	438	395	470	397	388	453	417	387
2.B.1	Ammonia Production	0	0	358	521	491	501	419	447
2.B.10	Other Chemical Industry	0	0	114	122	124	121	122	90
2.C.1	Steel	9 764	10 388	9 431	10 339	9 482	11 002	10 414	10 188
2.C.3	Aluminium Production	0	0	4	4	4	5	4	4

[1)] *These data do not include N_2O emissions from nitric acid production.*

CO_2 emission factors reported within the ETS

Table 33 and Table 34 show the implied CO_2 emission factors reported within the ETS by fuel and SNAP category for the recent reported year. In some cases, rather small fuel consumption was reported for specific categories. This may lead to significant errors in implied emission factor calculation (e.g. diesel, gasoil) because within the ETS CO_2 emissions are rounded to the nearest ton whereas reported fuel consumption is not rounded.

Table 33: 2023 CO_2 implied emission factors calculated from ETS data. Coal, Petrol Coke, Waste and Natural Gas.

SNAP	102A Hard Coal	105A Brown Coal	107A Coke Oven Coke	110A Petrol Coke	115A Ind. Waste	301A Natural Gas
Weighted average	92.69	96.92	111.96	96.10	81.51	55.76
010101 Public Power plants >= 300 MWth	-	-	-	-	-	55.60
010102 Public Power plants >= 50 MWth < 300 MWth	-	-	-	-	106.20	55.60
010103 Public Power plants <= 50 MWth	-	-	-	-	-	-
010201 Public District Heating plants >= 300 MWth	-	-	-	-	-	55.60
010202 Public District Heating plants >= 50 MWth < 300 MWth	-	-	-	-	-	55.60
010203 Public District Heating plants < 50 MWth	-	-	-	-	-	55.60
010301 Refinery	-	-	-	129.93	-	55.60
010504 Other Energy Industries – Gas Turbines	-	-	-	-	-	55.60
010506 Pipeline Compressors	-	-	-	-	-	55.22
020103 Commercial plants < 50 MWth	-	-	-	-	64.52	55.60
0301 Industry – Steel	-	-	-	-	-	55.60
0301 Industry – Non ferrous metals	94.00	-	104.00	-	73.76	55.60
0301 Industry – Chemicals	95.52	-	-	-	95.78	55.60
0301 Industry – Pulp and Paper	93.20	-	-	-	115.08	55.60
0301 Industry – Food and Beverages	-	-	108.41	-	68.65	55.60
03010 Industry – Other	-	-	-	-	94.84	55.60
030311 Cement kilns	94.02	96.60	-	94.69	79.84	55.60
030312 Lime kilns	-	98.16	-	95.02	-	55.60
030317 Glass	128.42	-	104.00	-	-	55.60
030319 Bricks and Tiles	94.00	97.53	-	-	43.80	55.60
030323 Dolomite Treatment	-	-	-	96.53	70.00	55.60
030326 Integrated Iron & Steel works	92.67	-	112.06	-	80.80	57.26

Table 34: 2023 CO_2 implied emission factors calculated from ETS data. Oil products.

SNAP	203B light fuel oil	203D Heavy fuel oil	204A Gasoil	2050 Diesel	224A other liquid	303A LPG
Weighted average	77.75	79.64	74.97	72.76	69.03	67.44
010101 Public Power plants >= 300 MWth	-	-	75.00	73.70	-	-
010102 Public Power plants >= 50 MWth < 300 MWth	-	-	75.00	73.70	-	-
010103 Public Power plants <= 50 MWth	-	-	-	-	-	-
010201 Public District Heating plants >= 300 MWth	-	-	75.00	73.70	-	-
010202 Public District Heating plants >= 50 MWth < 300 MWth	77.00	80.32	75.00	73.70	-	-
010203 Public District Heating plants < 50 MWth	77.00	-	64.66	73.70	-	-
010301 Refinery	-	79.65	-	73.70	-	67.98
010504 Other Energy Industries – Gas Turbines	-	-	-	71.31	-	-
010506 Pipeline Compressors	-	-	-	67.18	-	-
020103 Commercial plants < 50 MWth	-	-	-	-	70.87	-
0301 Industry – Steel	-	-	-	73.70	-	-
0301 Industry – Non ferrous metals	-	-	-	73.70	-	-
0301 Industry – Chemicals	-	80.90	75.00	73.70	67.50	-
0301 Industry – Pulp and Paper	78.00	78.00	75.00	73.70	-	-
0301 Industry – Food and Beverages	-	-	75.00	73.70	-	-
03010 Industry – Other	-	-	75.00	73.70	-	64.00
030311 Cement kilns	78.00	78.00	74.91	-	-	-
030312 Lime kilns	-	-	75.00	73.70	-	-
030317 Glass	-	-	75.00	73.70	-	-
030319 Bricks and Tiles	78.00	78.00	75.00	73.70	-	-
030323 Dolomite Treatment	78.00	78.00	75.00	73.70	-	64.00
030326 Integrated Iron & Steel works	78.00	-	75.00	-	-	-

3.2.9.4 Choice of activity data for stationary sources

Activity data used for estimating emissions in the sectoral approach is taken from the energy balance as well as information on the last revision of the national energy balance.

The national energy balance is provided by Statistik Austria (Statistik Austria, 2024d, IEA/Eurostat JQ, 2024). The net calorific values (NCV) used for converting mass or volume units of the fuel quantities into energy units [TJ] are provided by Statistik Austria.

In the sectoral approach of Category *1.A*, only the fuel quantities that are combusted are relevant and thus considered for emission calculation. Quantities not considered are: non-energy and feed-stock use, international bunker fuels, transformation and distribution losses, transformations of fuels to other fuels like hard coal to coke oven coke and internal refinery processes which have been added to the transformation sector of the energy balance.

Potential emissions from non-energy and feedstock fuel use are considered in the corresponding IPCC categories as described in chapter 3.2.3.

3.2.10 Energy Industries (CRT Category 1.A.1)

3.2.10.1 1.A.1.a Public Electricity and Heat Production

Key Sources: CO_2 from *1.A.1.a* gaseous, liquid, solid and other fossil fuels

Category *1.A.1.a Public Electricity and Heat Production* covers emissions from fuel combustion in public power and heat plants. The share in total GHG emissions from sector *1.A* is 21.4% for the year 1990 and 10.3% for the year 2023. The increased CH_4 and N_2O emissions are mainly due to increased biomass combustion in plants smaller than 50 MW_{th}.

Methodology

For the years 1990 to 2004, the IPCC Tier 2 methodology is applied by using activity data from energy balance and national CO_2 default emission factors.

For the years 2005–2023, CO_2 emissions from plants having a total boiler capacity of >= 20 MW_{th} are taken from ETS reports and CO_2 emissions from plants < 20 MW_{th} are calculated by means of national default emission factors and the remaining fuel consumption of the energy balance. Coal consumption is fully covered by the ETS. The general methodology is described in chapter 3.2.1.2.

Emission factors

National CO_2 emission factors are taken from (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Umweltbundesamt, 2001a, Umweltbundesamt, 2002). The selected emissions factors for 2023 as well as the national default emission factors are listed in the following table. The CO_2 emission factor for municipal solid waste for the years 1990 to 2004 is taken from (Umweltbundesamt, 2003a) and for the years 2005 onwards it is taken from (Umweltbundesamt and TU Vienna, 2019). The CO_2 emission factor for industrial waste is also taken from (Umweltbundesamt and TU Vienna, 2019).

Table 35: Default emission factors of Category 1.A.1.a for the year 2023.

Fuel	Default CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Light Fuel Oil in plants ≥ 50 MWth	77.00	3.00	0.60
Heavy Fuel Oil in plants ≥ 50 MWth	80.00	3.00	0.60
Fuel Oil in plants ≤ 50 MWth	78.00	3.00	0.60
Gasoil	75.00	3.00	0.60
Diesel oil	75.00	3.00	0.60

Fuel	Default CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Liquified Petroleum Gas	64.00	1.00	0.10
Hard coal in power and CHP plants	95.00	1.00	1.50
Hard coal in district heating plants.	93.00	1.00	1.50
Lignite and brown coal in power and CHP plants ≥ 50 MWth	110.00	1.00	1.50
Lignite and brown coal in district heating plants ≥ 50 MWth	108.00	1.00	1.50
Lignite, brown coal and brown coal briquettes in plants < 50 MWth	97.00	1.00	1.50
Natural Gas	55.60	1.00	0.10
Fuel Wood	112.00[1)]	30.00	4.00
Wood Waste	112.00[1)]	10.00	4.00
Sewage Sludge	112.00[1)]	12.00	4.00
Biogas, Sewage Sludge Gas, Landfill Gas	54.60[1)]	1.00	0.10
Municipal Solid Waste 1990–2004: renewable and non-renewable	48.88	12.00	4.00
Municipal Solid Waste 2005 onwards: renewable and non-renewable	43.45	12.00	4.00
Municipal Solid Waste implied emission factor: non renewable	83.46	12.00	4.00
Municipal Solid Waste 2005 onwards: renewable	108.58[1)]	12.00	4.00
Industrial Waste	75.00	12.00	4.00

[1)] *Reported as CO_2 emissions from biomass.*

1.A.1.a – Biomass – implied emission factors for CO_2, N_2O and CH_4

Following a recommendation of the 2023 UNFCCC review, the fluctuations in the trends of *1.A.1.a biomass* CO_2, CH_4 and N_2O implied emission factors are explained in Annex 3.1.

Activity data

Total fuel consumption of Category *1.A.1.a* is taken from (IEA/Eurostat JQ, 2024, Statistik Austria, 2024d).

Fuel consumption in the public electricity sector varies strongly over time. The most important reason for this variation is the fact that in Austria up to 78% of yearly electricity production comes from hydropower. If production of electricity from hydropower is low, production from thermal power plants is high and vice versa.

The following Table 36 presents the gross electricity and heat production of public power and district heating plants. Increasing district heat production is mainly generated by new biomass (local) heat plants and by waste incineration. The share of combined heat and power plants (CHP generation) is increasing and leads to higher efficiency of energy generation. The year 2010 shows a historic maximum of about 19 TWh electricity production from fuel combustion. In the year 2012 electricity production from hydro plants reached a historic maximum of 47.2 TWh and contributed to 74% of total production. District heat production in 2023 was 7% lower than in 2022, mainly because of a lower heating demand (3.1% less heating degree days).

Table 36: Public gross electricity and heat production.

Year	Public gross electricity production [GWh]						Public Heat Production [TJ] by Combustible Fuels
	Total	**Hydro**[1)]	**Combustible Fuels**	**Geothermal**	**Solar**	**Wind**	
1990	43 403	30 111	13 292	0.000	0	0	24 427
1995	47 580	35 431	12 147	0.000	1	1	34 426
2000	52 810	41 131	11 609	0.000	3	67	42 197
2005	58 518	38 205	18 958	2.302	21	1 331	54 424
2010	61 571	40 500	18 916	1.398	89	2 064	70 415
2011	56 270	36 815	17 344	1.053	174	1 936	70 399
2012	64 030	47 204	14 025	0.677	337	2 463	74 061
2013	60 239	45 226	11 234	0.306	626	3 152	75 274
2014	57 742	44 270	8 840	0.384	785	3 846	69 707
2015	57 455	40 102	11 575	0.061	937	4 840	72 314
2016	60 429	42 482	11 617	0.021	1 096	5 235	74 159
2017	63 114	41 697	13 576	0.091	1 269	6 572	76 620
2018	60 631	40 745	12 400	0.239	1 455	6 030	74 087
2019	66 268	43 669	13 446	0.200	1 702	7 450	73 573
2020	64 721	44 888	10 997	0.073	2 043	6 792	73 971
2021	60 131	42 271	11 009	0.031	107	6 740	80 763
2022	58 089	38 872	11 791	0.002	179	7 242	72 838
2023	60 951	44 199	8 464	0.005	247	8 037	67 450

1) *including pumped storage*

As shown in Table 37 electricity supply increased by 11.3 TWh since 2000 of which approx. 80% has been supplied by additional imports until 2008. The year 2009 shows falling electricity consumption (supply) but an increase of production, mainly by hydropower. The year 2015 shows an historical maximum of net imports which contributed to 15% of total electricity supply. After a long period of net imports, a small amount of net exports was recorded for the first time in 2023.

Table 37: Electricity supply, gross production, imports, exports and net imports [GWh].

Year	Electricity [GWh]				
	Supply[1)]	**Gross production**[2)]	**Imports**	**Exports**	**Net Imports**[3)]
1990	46 489	50 294	6 839	7 298	-459
1995	50 979	56 225	7 287	9 757	-2 470
2000	55 750	61 257	13 824	15 192	-1 368
2005	62 948	66 833	20 355	17 732	2 623
2010	65 523	71 128	19 909	17 472	2 437
2011	65 702	65 813	24 977	16 777	8 199
2012	66 690	72 603	23 430	20 627	2 803

Year	Electricity [GWh]				
	Supply[1)]	Gross production[2)]	Imports	Exports	Net Imports[3)]
2013	67 048	68 357	24 960	17 689	7 270
2014	65 977	65 439	26 712	17 437	9 275
2015	67 021	65 299	29 389	19 328	10 062
2016	67 866	68 308	26 366	19 207	7 159
2017	69 029	71 324	29 362	22 817	6 546
2018	69 192	68 618	28 076	19 129	8 947
2019	69 332	74 234	26 047	22 918	3 129
2020	66 936	72 558	24 522	22 327	2 196
2021	70 108	70 887	26 436	18 893	7 543
2022	69 353	69 193	28 595	19 890	8 705
2023	67 089	74 459	21 550	21 622	-72

[1)] *Excluding own use and heat pumps, boilers and pumped storage use. Including losses*

[2)] *Public and autoproducer gross production*

[3)] *Negative values for net imports mean net imports*

Recalculations

Recalculations of activity data are following the revisions of the energy balance as described in Annex 3.

Sector specific QA/QC procedures

Large point source data are used for validation of energy consumption. Until the year 2007 the Umweltbundesamt operates a database to store boiler specific data, which is called „*Dampfkesseldatenbank“* (Umweltbundesamt, 2007) which includes fuel consumption, CO, NO_x, SO_x and dust emissions from boilers with a thermal capacity greater than 20 MW which data is used for the years 1990 to 2007. These data are used to generate a sectoral split of the categories *Public Power* and *District Heating* each into the two categories ≥ *300 MW* and ≥ *10 MW to 300 MW* of thermal capacity. Currently about 65 boilers between 10 and 950 MW_{th} are considered in this approach. Large point source activity data from 2005 onwards is considered from ETS reporting.

The remaining fuel consumption (= total consumption minus consumption of large point sources) is the activity data for boilers smaller than 10 MW_{th}.

3.2.10.2 1.A.1.b Petroleum Refining

Key Sources: CO_2 from 1.A.1.b gaseous and liquid fuels

Category *1.A.1.b Petroleum Refining* enfolds emissions from fuel combustion, flaring and thermal cracking of the only petroleum refining plant in Austria. Fugitive CH_4 emissions are included in category *1.B.2.a Fugitive Emissions from Fuels – Oil – Refining/storage*. Since 2003 the plant has been upgraded which increases CO_2 emissions from bitumen blowing and hydrogen production.

The share in total GHG emissions from sector *1.A* is 4.6% for the year 1990 and 5.9% for the year 2023. Crude oil input was 8 megatons in 1990 and 8 megatons in 2023.

Methodology

The IPCC Tier 2 methodology is used. For calculation of CO_2 emissions, plant specific emission factors are used. For calculation of N_2O and CH_4 emissions, the default emission factors from the IPCC 2006 Guidelines have been selected.

The carbon contents of *gaseous*, *liquid* and *solid* fuel types are reported by the plant operator. The fuel groups do not correspond with IPCC definitions, e.g. gaseous fuels include refinery gas which is, according to IPCC definition, a liquid fuel.

Table 38: Carbon content per fuel group for petroleum refining.

Fuel-type	Carbon Content [t CO_2/t fuel]	Associated IEA-Fuels
Gaseous	2.683	Natural Gas, Refinery Gas
Liquid	3.047	Residual Fuel Oil, Gas Oil, Diesel, Petroleum, Jet Gasoline, Other Oil Products, LPG
Solid	3.430	Petrol coke (FCC-coke)

For 1990 to 2001, CO_2 emissions are calculated by multiplying activity data from the energy balance by the emission factors in Table 38. CO_2 emissions 2002 to 2005 are reported by the Austrian Association of Mineral Oil Industries and are consistent with ETS 2005 data. From the year 2006 onwards, reported ETS data is used.

To be consistent with IPCC fuel group definition, total CO_2 emissions are disaggregated to the IEA fuel types (see column "Associated IEA-fuels") by using default emission factors for industrial boilers, subtracting the calculated CO_2 emissions from total CO_2 emissions, and associating remaining CO_2 emissions to refinery gas. The resulting IEF for refinery gas is presented in Table 39. The IEF fluctuations reflect changes in refinery gas composition.

Table 39: Implied emission factors for refinery gas.

Year(s)	t CO_2/TJ
1990	65.8
1995	82.3
2000	60.5
2001	54.0
2002–2023	64.0

For corresponding crude oil input data which may be used as an indicator over time series refer to description of category *1.B.2.a Oil*.

Table 40: Emission factors of Category 1.A.1.b.

Fuel	CO_2 [t/TJ]	N_2O [kg/TJ]	CH_4 [kg/TJ]
Residual Fuel Oil	80.00	0.60	3.00
Gas oil	75.00	0.60	3.00
Diesel	78.00	0.60	3.00
Other Oil Products	78.00	0.60	3.00
Petrol Coke	100.88	0.60	3.00
Refinery gas	64.00	0.10	1.00
LPG	64.00	0.10	1.00
Natural Gas	55.60	0.10	1.00

Activity data

Fuel consumption is taken from (IEA/Eurostat JQ, 2024) except for the years 1999 to 2005, where petrol coke is additionally counted in *other oil products* (1999: +63 kt, 2004: +59 kt) to obtain consistency with plant specific activity data reported in the *"Dampfkesseldatenbank"* (Umweltbundesamt, 2007).

Sector specific QA/QC procedures

A simple mass balanced input/output validation of energy balance data has been performed which shows a plausible and time series consistent correlation of the input and output material flows as shown in the following table. The last line shows the difference between input and output. Natural gas consumption is not considered in this approach.

Table 41: Refinery input/output mass balance.

Material flow [kt]	1990	1995	2000	2005	2010	2017	2018	2019	2020	2021	2022	2023
Total Input	**9 062**	**9 259**	**8 887**	**9 233**	**8 457**	8 948	9 576	9 952	8 871	8 832	6 502	8 977
Crude oil	7 952	8 619	8 240	8 743	7 719	8 064	8 970	9 124	8 168	8 243	5 617	8 022
NGL	41	43	107	78	134	37	18	16	14	11	11	10
Feedstocks	1 069	597	540	362	325	552	293	501	421	268	658	519
Biofuel (blending)	0	0	0	50	279	294	294	311	267	310	215	427
Total Output	**8 864**	**9 013**	**8 620**	**9 086**	**8 335**	8 791	9 460	9 842	8 706	8 676	6 377	8 666
Fuel oil	1 913	1 596	1 075	1 360	934	839	710	735	737	645	778	1 019
Gas oil	1 239	1 454	1 062	997	795	662	581	476	592	387	261	369
Diesel	1 531	1 920	2 662	2 931	2 741	3 319	3 472	3 703	3 202	3 329	1 883	2 942
Other Kerosene	31	8	1	1	3	15	26	15	13	9	27	26
Aviation kerosene	291	420	544	592	476	613	760	893	362	344	404	708
Aviation gasoline	0	0	0	0	0	1	1	1	1	1	1	1

Material flow [kt]	1990	1995	2000	2005	2010	2017	2018	2019	2020	2021	2022	2023
Motor gasoline	2 631	2 276	1 815	1 798	1 589	1 782	2 030	2 075	1 805	1 870	1 389	1 764
White spirit	0	5	0	0	70	0	0	0	0	0	0	0
Bitumen	269	254	343	366	292	306	369	395	424	440	236	400
Other petroleum products	7	29	15	87	172	27	21	23	45	46	26	42
Naphtha	475	621	710	472	720	804	1 028	1 006	1 051	1 087	822	790
LPG	47	60	34	107	87	102	111	137	117	150	106	138
Refinery gas	373	305	312	309	392	262	281	316	284	296	389	415
Petroleum Coke (FCC)	57	66	48	66	62	59	71	67	73	74	56	55
Input-Output	198	246	267	147	123	157	115	111	165	156	124	311

Recalculations

No recalculations have been carried out in this year's submission.

Planned improvements

No improvements are planned.

3.2.10.3 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries

Key Source: CO_2 from 1.A.1.c gaseous fuels

Category *1.A.1.c Manufacture of Solid Fuels and Other Energy Industries* enfolds emissions from fuel combustion in the oil and gas extraction sector (reported by companies as 'own use'), compressors used for natural gas storage tanks and fuel use of gas processing facilities ('gas refineries'). For 1990 to 1995 transformation losses/own use in gas works are included too. The share in sector *1.A* overall GHG emissions is 1% for the year 1990 and 0.4% for the year 2023.

Methodology

Calculation of CO_2 emissions are following a Tier 2 methodology and calculation of CH_4 and N_2O emissions are following a Tier 1 methodology.

For 2005 onwards, CO_2 emissions and activity data of natural gas storage compressors are taken from ETS data.

Emission factors

CO_2 emission factors are taken from studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996).

For calculation of N_2O and CH_4 emissions the default emission factors from the IPCC 2006 Guidelines have been selected.

Table 42: Emission factors of Category 1.A.1.c.

Fuel	CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Natural Gas	55.60	1.00	0.10
Heavy Fuel Oil	78.00	3.00	0.60

Activity data

Fuel consumption is taken from (IEA/Eurostat JQ, 2024).

Transformation losses in gas works are calculated by subtracting final energy use from transformation input. Since the energy balance (IEA/Eurostat JQ, 2024) does not report gas works gas, activity data is taken from the 'Austrian Energy Balance' (Statistik Austria, 2024d), which is structured differently but consistent with (IEA/Eurostat JQ, 2024).

Recalculations

Natural gas consumption of gas supply companies (reported as transformation input for district heating and already included in public district heating plants 1.A.1.a) has been moved from category *1.A.1.c* to category *1.A.2.g.viii* for the years from 2011 onwards (approx. 130 kt CO_2 from natural gas in 2022), as the offset quantity was previously deducted from category *1.A.2.g.viii*. This improved consistency with the energy balance at sector level.

3.2.10.4 1.A.1.c.iii Other energy industries – charcoal production

CH_4 emissions from Charcoal production are included in *1.A.1.c.iii Other energy industries – biomass.*

Methodology

Calculation of CH_4 emissions from charcoal production is following a Tier 2 methodology.

For the most recent years (2005 to latest inventory year) Austria uses the data from the National Energy Balance to calculate emissions from charcoal production

For the years 1990–2004 an average production amount of 1 000 t was assumed, as the National Energy Balance only provides data for this fuel category starting from 2005. Although the IEA Joint Questionnaire figures also do not show indigenous production for the years prior to 2001, it is unlikely that there was no traditional charcoal production based on wood as feedstock at all as charcoal is produced within small communities for many decades mainly to keep this old tradition in rural areas as a cultural heritage. Hence, it is reasonable to assume a constant charcoal production for the years before 2001. In Table 43 the activity data of charcoal production is presented.

Table 43: Activity data (charcoal produced) and CH_4 emissions for Fugitive Emissions from Solid Fuel Transformation 1990–2023.

Year	Charcoal production (in t)	Charcoal [TJ]	CH_4 emissions [kt]
1990	1 000	31	0.031
1995	1 000	31	0.031
2000	1 000	31	0.031
2005	1 101	34	0.034
2010	1 181	37	0.037
2011	1 130	35	0.035
2012	1 377	43	0.043
2013	1 269	38	0.038
2014	1 263	36	0.036
2015	1 447	41	0.041
2016	1 382	41	0.041
2017	1 222	35	0.035
2018	1 379	39	0.039
2019	1 425	40	0.041
2020	1 442	41	0.041
2021	1 463	42	0.042
2022	1 096	32	0.032
2023	1 034	30	0.030

For calculating the emissions, Austria is using a constant country specific NCV of 30 MJ/kg from its National Energy Balance. Due to the absence of measurements which are needed to derive a country specific emission factor, the default emission factor of the revised IPCC 1996 Guidelines (Table 1–14) has been applied for CH_4 (1 000 kg/TJ).

3.2.11 Manufacturing Industries and Construction (CRT Category 1.A.2)

3.2.11.1 1.A.2.a Iron and Steel

Key Sources: CO_2 from 1.A.2.a gaseous and solid fuels

Category *1.A.2.a Iron and Steel* enfolds emissions from fuel combustion in iron and steel industry. CO_2 emissions from ore reduction in blast furnaces are included in category *2.C.1.b Pig Iron*. The share in total GHG emissions from Sector *1.A* is 3.5% for the year 1990 and 3.9% for the year 2023.

Methodology

Two iron and steel production sites (the only operating blast furnaces in Austria) are considered as point sources. For 1990 to 2002, CO_2 emissions and fuel consumption from these two plants were reported by the plant operator. The reported fuel consumption of the two plants is subtracted from total fuel consumption for iron and steel production in Austria and the resulting fuel consumption is considered as area source. For the area sources an IPCC Tier 2 methodology was applied for all GHGs.

CO_2, NMVOC, CO, NO_x and SO_2 emissions are reported by the two Austrian iron and steel plants, together with their coal, fuel oil and natural gas fuel consumption. The emissions declaration includes emissions from natural gas consumption not included in the ETS.

The methodology of separating process CO_2 emissions from total integrated steel plants' CO_2 emissions is also explained in the methodology chapter of category *2.C.1*. 100% of natural gas consumption and a share of coke oven gas consumption are considered within category *1.A.2.a* while 100% of solid, liquid and other fuels and a share of coke oven gas are considered as reducing agents in blast furnaces and therefore CO_2 emissions are reported under category *2.C.1*. Activity data of natural gas is taken from plant operator emission reports and includes fuel consumption which is not considered under the ETS. CO_2 emissions from coke oven gas are calculated by subtracting emissions from reducing agents and emissions from natural gas from total CO_2 emissions. The methodology of calculating CO_2 emissions from reducing agents is partly a tier 1 method using default emission factors and reported consumption data as well as data from the energy balance while EU-ETS reporting is based on a detailed mass balance. The resulting methodological uncertainty between the two approaches is therefore fully reflected in the CO_2 emissions from coke oven gas which is the main reason of the fluctuating trend of *1.A.2.a solid fuels.*

The CO_2 emission factor for natural gas is taken from (Bundesministerium für wirtschaftliche Angelegenheiten, 1996). For coke oven coke, a default emission factor of 25.8 t C/TJ (94.6 t CO_2/TJ) has been selected.

CO_2 emissions of integrated steel plants 1990 to 2002 and 2005 onwards are reported by plant operators.

N_2O and CH_4 emissions are calculated by means of a Tier 1 methodology.

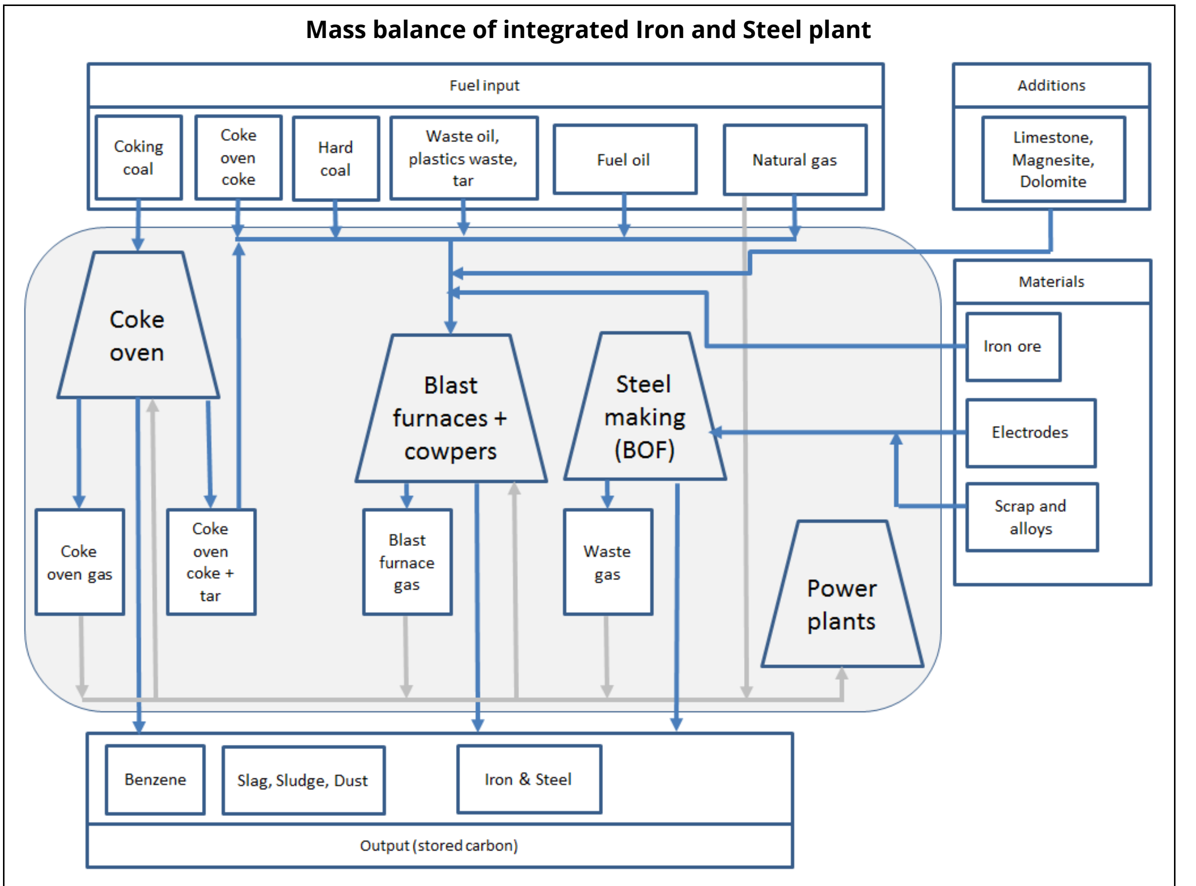
Point source CO_2 emissions 2003 and 2004

Since for the years 2003 and 2004 no point source CO_2 emissions have been reported by plant operators, the Umweltbundesamt performed calculations on the basis of 2000 to 2002 data by means of a simple approach: Activity data reported by plant operators are multiplied by national default emission factors. The resulting emissions are those from blast furnaces and autoproducer power plants. CO_2 emissions from coke ovens (2004: 285 kt) are estimated by means of coke oven output and an emission factor of 0.2 t CO_2/t coke which is equal to 5% transformation losses.

Mass balance of integrated iron and steel plant

The following Figure 11 shows a flow chart of a integrated iron and steel plant representing the mass balance which is used for reporting under the ETS. The grey shaded area illustrates the most important facilities and the interior fluxes between them, although the real conditions are even more complex. The outside parts of the figure shows the carbon containing inputs and outputs of fuels and materials as reported under the ETS. The fuel Input and the internal transformation processes between fuels (e.g. coke oven coke, blast furnace gas, coke oven gas, blast furnace gas, waste gas from basic oxygen furnaces) are reported in the energy balance. CO_2 emissions from reducing agents (coke oven coke, hard coal, fuel oil, waste oil, plastics waste, tar) which are used in the blast furnace as well as the net CO_2 emissions from carbon containing material input such as iron ore, scrap and electrodes as well as output material such as steel and pig iron are reported under CRT category *2.C.1.* CO_2 Emissions from natural gas and coke oven gas are reported under CRT category *1.A.2.a*.

Figure 11: Mass balance of integrated Iron and Steel plant.



Source: Umweltbundesamt

Emissions

The following table lists the results of the two approaches. Please note that process related CO_2 emissions from blast furnaces are reported under category *2.C.1*.

Table 44: Greenhouse gas emissions from Category 1.A.2.a by sub sources.

Year	other sources			integrated steel plants		
	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 [kt]	CH_4 [kt]	N_2O [kt]
1990	193	0.005	0.001	1 640	0.021	0.002
1995	293	0.009	0.001	1 045	0.015	0.002
2000	457	0.010	0.001	819	0.013	0.001
2005	366	0.010	0.001	1 478	0.022	0.002
2010	345	0.008	0.001	931	0.016	0.002
2011	345	0.007	0.001	1 101	0.019	0.002
2012	353	0.007	0.001	1 130	0.019	0.002

Year	other sources			integrated steel plants		
	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 [kt]	CH_4 [kt]	N_2O [kt]
2013	332	0.007	0.001	1 274	0.021	0.002
2014	307	0.006	0.001	1 189	0.020	0.002
2015	358	0.007	0.001	1 047	0.017	0.002
2016	396	0.008	0.001	1 181	0.018	0.002
2017	374	0.008	0.001	1 284	0.019	0.002
2018	366	0.008	0.001	1 406	0.021	0.002
2019	389	0.008	0.001	1 415	0.021	0.002
2020	395	0.008	0.001	1 408	0.020	0.002
2021	340	0.007	0.001	1 452	0.021	0.002
2022	483	0.010	0.001	1 290	0.018	0.002
2023	449	0.009	0.001	1 267	0.018	0.002

Emission factors

CO_2 emission factors are taken from studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Umweltbundesamt, 2002).

The selected and calculated emission factors for 2023 are presented in Table 45 and Table 46.

Activity data

Total fuel consumption is taken from (IEA/Eurostat JQ, 2024).

Point source activity data are reported by plant operators which are widely consistent with (IEA/Eurostat JQ, 2024).

Table 45: Emission factors of Category 1.A.2.a for area sources.

Fuel	CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Light Fuel Oil	78.00	3.00	0.60
Heavy Fuel Oil	78.00	3.00	0.60
Gas oil	75.00	3.00	0.60
Petroleum	78.00	3.00	0.60
LPG	64.00	1.00	0.10
Hard Coal	94.00	10.00	1.50
Lignite and brown coal	97.00	10.00	1.50
Coke	104.00	10.00	1.50
Natural Gas	55.60	1.00	0.10
Wood Waste	112.00[1)]	10.00	4.00

[1)] *Reported as CO_2 emissions from biomass.*

Table 46: Emission factors of Category 1.A.2.a for point sources.

Fuel	CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Coke Oven Coke	94.60	1.00	0.10
Natural Gas	55.60	0.10	0.10

Fugitive emissions and losses

An analysis of ETS data shows that the amount of carbon stored in slag, dust, sludge and steel was 66 kt CO_2 equivalents in 2023 (2022: 71 kt; 2021: 78 kt; 2020: 65 kt; 2019: 71 kt; 2018: 70 kt, 2017: 73 kt, 2016: 83 kt, 2015: 87 kt, 2014: 91 kt, 2013: 83 kt, 2012: 76 kt, 2011: 71 kt, 2010: 66 kt, 2009: 55 kt, 2008: 91 kt). This amount should be considered in the quantification of the difference between the sectoral and the reference approach.

Recalculations

Due to the revision of process-related CO_2 emissions from steel production (2.C.1) for 2022, 134 kt CO_2 from category *1.A.2.a* were shifted to category *2.C.1*.

3.2.11.2 1.A.2.b Non-Ferrous Metals

Key Source: CO_2 from 1.A.2.b gaseous fuels

Category *1.A.2.b Non-Ferrous Metals* enfolds emissions from fuel combustion in non ferrous metal industry. The share in total GHG emissions from sector *1.A* is 0.3% for the year 1990 and 0.6% for the year 2023.

Methodology

CO_2 emissions are calculated by means of a Tier 2 method while N_2O and CH_4 emissions are calculate by means of a Tier 1 method. From the year 2013 onwards, CO_2 ETS data are considered.

CO_2 emission factors are taken from studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Umweltbundesamt, 2002).

Emission factors for 2023 are presented in the following table.

Table 47: Emission factors of Category 1.A.2.b.

Fuel	CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Residual Fuel Oil	78.00	3.00	0.60
Gas oil	75.00	3.00	0.60
Petroleum	78.00	3.00	0.60
LPG	64.00	1.00	0.10
Hard Coal	94.00	10.00	1.50
Coke	104.00	10.00	1.50
Natural Gas	55.60	1.00	0.10
Industrial waste	75.17[1)]	12.00	4.00

[1)] *Implied emission factor*

Activity data

Fuel consumption is taken from (IEA/Eurostat JQ, 2024) and ETS.

Recalculations

Recalculations of activity data are following the revision of the energy balance as described in Annex 3.

3.2.11.3 1.A.2.c Chemicals

Key Sources: CO_2 from 1.A.2.c gaseous and other fuels

Category *1.A.2.c Chemicals* enfolds emissions from fuel combustion in chemical industry. The share in total GHG emissions from sector *1.A* is 1.6% for the year 1990 and 3% for the year 2023.

Methodology

CO_2 emissions are calculated by means of a Tier 2 method while N_2O and CH_4 emissions are calculated by means of a Tier 1 method. From the year 2013 onwards, CO_2 ETS data are considered.

CO_2 emissions from industrial waste: Table 48 shows the composition of the implied emissions factor for industrial waste. One plant with a capacity of 250 kt solid waste/year is considered with a NCV of 10 TJ/kt waste and a CO_2 emission factor of 75 t/TJ. From 2005 on ETS data is considered with plant specific emissions and energy consumption. The remaining energy use (other waste) is considered with a CO_2 emission factor of 37.50 t/TJ. 'Other waste' is considered as 50% waste gas (with a high share of hydrogen) and chemical reaction heat (which is not relevant for GHG emissions). Therefore, an emission factor of 50% of the default emission factor is selected.

Table 48: Composition of 1.A.2.c Chemical industries – industrial waste – CO_2 IEF for the years 2000 to 2023.

Year	Total energy use	Solid waste		ETS		Other waste		CO_2 IEF
	[TJ]	[TJ]	CO_2 EF	[TJ]	CO_2 IEF	[TJ]	CO_2 EF	[t/TJ]
2000	2 258	1 500	75.00	378[1)]	70.62	380	37.50	67.96
2005	1 431	1 052	75.00	378	70.62	0	37.50	73.84
2010	4 190	3 914	75.00	276	77.47	0	37.50	75.16
2011	3 690	3 479	75.00	210	75.10	0	37.50	75.01
2012	3 776	3 517	75.00	259	82.92	0	37.50	75.54
2013	2 858	2 441	75.00	417	83.31	0	37.50	76.21
2014	3 249	2 661	75.00	588	58.28	0	37.50	71.98
2015	3 057	2 466	75.00	591	61.86	0	37.50	72.46
2016	3 363	2 906	75.00	457	77.87	0	37.50	75.39
2017	3 023	2 638	75.00	385	71.98	0	37.50	74.62
2018	2 776	2 327	75.00	448	68.78	0	37.50	74.00
2019	2 479	1 920	75.00	559	65.50	0	37.50	72.86
2020	3 241	2 710	75.00	530	77.92	0	37.50	75.48
2021	3 017	2 600	75.00	418	86.18	0	37.50	76.55

Year	Total energy use	Solid waste		ETS		Other waste		CO_2 IEF
	[TJ]	[TJ]	CO_2 EF	[TJ]	CO_2 IEF	[TJ]	CO_2 EF	[t/TJ]
2022	4 100	3 684	75.00	416	76.82	0	37.50	75.18
2023	3 743	3 275	75.00	468	69.10	0	37.50	74.26

[1] *For 2000 to 2004 the value of 2005 has been selected.*

Emission factors

CO_2 emission factors are taken from studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Umweltbundesamt, 2002).

Table 49: Emission factors of Category 1.A.2.c for 2023.

Fuel	CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Residual Fuel Oil	78.00	3.00	0.60
Gas oil	75.00	3.00	0.60
LPG	64.00	1.00	0.10
Other liquid fuels (flaring)	67.50[3]	3.00	0.60
Hard Coal	94.00	10.00	1.50
Lignite, Brown Coal Briquettes	97.00	10.00	1.50
Coke	104.00	10.00	1.50
Natural Gas	55.60	1.00	0.10
Fuel Wood	112.00[1]	30.00	4.00
Wood Waste	112.00[1]	10.00	4.00
Black Liquor	95.30[1]	3.00	2.00
Biogas	54.60[1]	1.00	0.10
Industrial Waste	74.26[2]	12.00	4.00

[1] *Reported as CO_2 emissions from biomass;* [2] *For the years 1990 to 1999: 75 t/TJ;* [3] *IEF derived from ETS data*

Activity data

Fuel consumption is taken from (IEA/Eurostat JQ, 2024) as presented in Annex 3.4 and from the ETS.

Recalculations

Recalculations of activity data are following the revision of the energy balance as described in Annex 3.

3.2.11.4 1.A.2.d Pulp, Paper and Print

Key Source: CO_2 from 1.A.2.d gaseous, solid and liquid fuels

Category *1.A.2.d Pulp, Paper and Print* includes emissions from fuel combustion in pulp, paper and print industry. The share in total GHG emissions from sector *1.A* is 4.3% for the year 1990 and 2.8% for the year 2023.

Methodology

CO_2 emissions are calculated by means of a Tier 2 method while N_2O and CH_4 emissions are calculated by means of a Tier 1 method. For the years 2005 onwards, CO_2 emissions from ETS reports are considered.

CO_2 emissions from industrial waste: The following Table 50 shows the composition of the implied emissions factor 2000–2023 for industrial waste. From 2005 onwards, ETS data is considered with plant specific emissions and energy consumption. From 1990 to 2004, energy consumption of the energy balance is taken and considered with a CO_2 emission factor of 75 t/TJ. Table 50 shows fuel waste consumption as provided by energy statistics together with fuel waste consumption, CO_2 emissions and the calculated IEF from ETS.

Table 50: Composition of 1.A.2.d Pulp, Paper and Print – industrial waste – CO_2 IEF for the years 2000 to 2023.

Year	Total energy use (energy balance)	ETS		CO_2 IEF	CO_2
	[TJ]	[TJ]	CO2 IEF	[t/TJ]	[kt]
2000	0	–	–	75.00	–
2005	90	111	64.29	64.29	7.15
2010	166	79	100.85	100.85	7.93
2011	164	91	87.79	87.79	7.99
2012	81	60	116.27	116.27	6.98
2013	153	170	128.46	128.46	21.83
2014	258	180	129.09	129.09	23.20
2015	237	180	140.21	140.21	25.23
2016	268	151	134.22	134.22	20.21
2017	248	178	125.66	125.66	22.36
2018	212	289	73.69	73.69	21.29
2019	231	74	91.13	91.13	6.71
2020	205	94	99.33	99.33	9.38
2021	125	14	124.93	124.93	1.74
2022	988	18	118.37	118.37	2.14
2023	1 234	158	115.08	115.08	18.20

Emission factors

CO_2 emission factors are taken from studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Umweltbundesamt, 2002).

Emission factors for 2023 are presented in the following table.

Table 51: Emission factors of Category 1.A.2.d.

Fuel	CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Hard Coal	94.00	10.00	1.50
Lignite, Brown Coal Briquettes	97.00	10.00	1.50
Coke	104.00	10.00	1.50
Residual Fuel Oil	78.00	3.00	0.60
Diesel and Gasoil	75.00	3.00	0.60
Petroleum	78.00	3.00	0.60
LPG	64.00	1.00	0.10
Natural Gas	55.60	1.00	0.10
Fuel Wood and Sewage Sludge	112.00[1)]	30.00	4.00
Wood Waste	112.00[1)]	12.00	4.00
Black Liquor	95.30[1)]	3.00	2.00
Biogas and Landfill Gas	54.60[1)]	1.00	0.10
Industrial Waste	115.08	12.00	4.00

[1)] *Reported as CO_2 emissions from biomass*

Activity data

Fuel consumption is taken from (IEA/Eurostat JQ, 2024) as presented in Annex 3.4 and from the ETS.

Recalculations

Recalculations of activity data are following the revision of the energy balance as described in Annex 3.

3.2.11.5 1.A.2.e Food Processing, Beverages and Tobacco

Key Source: CO_2 from 1.A.2.e gaseous and liquid fuels

Category *1.A.2.e Food Processing, Beverages and Tobacco* enfold emissions from fuel combustion in food processing, beverages and tobacco industry. The share in total GHG emissions from sector *1.A* is 1.7% for the year 1990 and 1.8% for the year 2023.

Methodology

CO_2 emissions are calculated by means of a Tier 2 method while N_2O and CH_4 emissions are calculated by means of a Tier 1 method. For the years 2005 onwards, ETS data are considered.

Emission factors

CO_2 emission factors are taken from studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Umweltbundesamt, 2002).

Emission factors for 2023 are presented in the following table.

Table 52: Emission factors of Category 1.A.2.e.

Fuel	CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Residual Fuel Oil	78.00	3.00	0.60
Diesel and Gas oil	75.00	3.00	0.60
Petroleum	78.00	3.00	0.60
LPG	64.00	1.00	0.10
Hard Coal	94.00	10.00	1.50
Lignite, Brown Coal Briquettes	97.00	10.00	1.50
Coke	104.00	10.00	1.50
Natural Gas	55.60	1.00	0.10
Fuel Wood	112.00[1)]	30.00	4.00
Wood Waste	112.00[1)]	10.00	4.00
Biogas	54.60[1)]	1.00	0.10
Industrial Waste	75.00	12.00	4.00

[1)] *Reported as CO_2 emissions from biomass*

Activity data

Fuel consumption is taken from (IEA/Eurostat JQ, 2024) as presented in Annex 3.4 and from the ETS.

Recalculations

Recalculations of activity data are following the revision of the energy balance as described in Annex 3.

3.2.11.6 1.A.2.f Non-Metallic Minerals

Key Source: CO_2 from 1.A.2.f gaseous, solid, liquid and other fuels

Category *1.A.2.f Non-Metallic Minerals* enfolds emissions from fuel combustion in cement, lime, magnesia, glass and bricks & tiles industries. Fuel use of limekilns, which are operated by sugar industries, is reported under category *1.A.2.e food processing, Beverages and Tobacco*. The share in total GHG emissions from Sector *1.A* is 3.2% for the year 1990 and 3.2% for the year 2023.

Cement Clinker Production (NACE 26.51)

This category enfolds emissions from fuel combustion in cement clinker kilns. The yearly production capacity of the 9 Austrian plants is about 4.3 Mt cement clinker. Yearly clinker production is

80% to 90% of total capacity. Further information about yearly clinker production is provided in the methodology chapter of category *2.A.1 Cement production*. Between 2008 and 2014, clinker production was falling by 21% from 4 Mt to 3.1 Mt and has increased to 3.6 Mt in 2022. Clinker production decreased to 3.1 Mt in 2023.

Methodology

Information about CO_2 emissions due to fuel combustion for cement production is taken from four studies of the Austrian cement industry (Hackl, Mauschitz, 1995, 1997, 2001, 2003, 2007, Mauschitz, 2004, 2009, 2010-2023). The data presented in these studies include fuel consumption and emission data for emissions from combustion processes and from calcination processes (process specific emissions, see category *2.A.1*) separately. The studies cover the years 1988 to 2023.

For the studies mentioned above, CO_2 emissions from all cement production plants in Austria were investigated. The determination of the emission data took place by inspection of every single plant, recording and evaluation of plant specific records, and plant specific measurements and analysis carried out by independent scientific institutes. Using this data (single measurement data or half-hourly mean values from continuous measurements), yearly mean values for concentration of CO_2 in the waste gas flow were calculated. With the average flow of dry waste gas, the plant specific CO_2 emission mass stream and consequently the plant specific emission factors (normalized to ton clinker and/or ton cement) were calculated.

CO_2 emissions

CO_2 emissions for the years 1990 to 2003 are taken from industry (Hackl, Mauschitz, 1995, 1997, 2001, 2003, 2007, Mauschitz, 2004, 2009, 2010-2023).

For solid, liquid and gaseous fuels, CO_2 emissions are calculated by multiplying activity data by national default emission factors (for sources of emission factors see relating chapter). The remaining CO_2 emissions are allocated to industrial waste.

CO_2 emissions from 2004 onwards are taken from the ETS allocation plan survey and from ETS reports.

CH_4 and N_2O emissions are calculated by means of the IPCC Tier 1 methodology.

Activity data

Calculated thermal energy intake of cement kilns is between 3.45 GJ/t clinker in 1990 and 3.94 GJ/t clinker in 2023.

Hard Coal, Brown Coal, Petrol Coke and Industrial Waste

In (IEA/Eurostat JQ, 2024) the category *Non-metallic Mineral Products* enfolds fuel consumption of NACE Division 26. As within this NACE division, industrial branches other than cement industry do not use coal and industrial waste for fuel combustion but 100% of those fuels are allocated to the cement industry. The same is for petrol coke until 2001, but from 2002 onwards, a share of petrol coke is allocated to magnesia production from dolomite by using ETS data. The following Table 53 shows the amount, NVCs and CO_2 IEFs of industrial waste, which is used as a fuel in cement kilns. After 2005, the share of non-fossil waste has been taken from ETS data. The overall IEF is between 79.0 to 88.5 t CO_2/TJ, which is reasonable because most of the waste origins from oil products. From 1990 to 2004, the mass of fractions with 100% biomass is not explicitly known. The biogenic C-content of the diverse waste fractions is e.g.: 0% for waste oil and solvents, 3–24% for plastics, 27–30% for scrap tyres, 36–42% for high heat value fraction of MSW and 56% for paper reject. Examples of non-fossil waste fractions: glycerine, carcass meal, animal fat, sewage sludge, paper fibre residue and sawdust.

Table 53: Industrial waste used as fuel in cement kilns 1990–2023.

Year	solid waste [kt]					
	100% biomass	Fractions with fossil C-content	NCV[1)] [MJ/kg]	fossil[1)] CO_2 IEF [t/TJ]	biomass[1)] CO_2 IEF [t/TJ]	Fossil [+1)] biomass CO_2 IEF [t/TJ]
1990	–	59	22.07	51.30	–	–
1995	–	87	22.71	61.80	–	–
2000	–	170	20.94	55.42	–	–
2005	58	204	23.28	68.92	10.32	79.25
2010	129	227	22.19	65.23	18.59	83.82
2011	136	240	21.53	64.06	21.81	85.86
2012	152	263	20.92	63.23	25.30	88.52
2013	146	280	19.90	64.26	20.04	84.30
2014	143	302	21.01	63.50	20.32	83.82
2015	164	307	19.93	59.87	24.06	83.93
2016	158	333	20.73	60.28	20.41	80.70
2017	158	341	21.15	61.03	20.01	81.04
2018	182	366	20.59	60.54	21.42	81.96
2019	169	359	19.82	59.40	20.62	80.02
2020	177	319	19.61	58.79	21.83	80.63
2021	212	348	20.03	55.55	23.48	79.03
2022	224	355	19.18	55.54	25.91	81.45
2023	230	320	19.18	55.33	25.77	81.10

1) Of solid waste with fossil and non-fossil C-content.

Natural Gas and Fuel Oil

For the period 1990 to 2004 natural gas and fuel oil consumption is taken from (Hackl, Mauschitz, 1995, 1997, 2001, 2003, 2007, Mauschitz, 2004, 2009, 2010-2023) converted into the unit TJ by applying the calorific values reported in (IEA/Eurostat JQ, 2024).

Activity data 2005–2023

For the years 2005 onwards, ETS data are taken which covers 100% of cement plants.

Emission factors

CO_2 default emission factors are taken from studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Umweltbundesamt, 2002).

Recalculations

The recalculations of CO_2 emissions from 2017 to 2022 are due to a correction of the CO_2 emission factor for coke.

3.2.11.7 1.A.2.g Other Manufacturing Industries and Construction

Key Source: CO_2 from 1.A.2.g.vii diesel oil
CO_2 from 1.A.2.g.viii gaseous and liquid fuels

This category enfolds emissions due to fuel combustion of the industrial branches as specified in Table 54. The share in total GHG emissions from Sector *1.A* is 3.9% for the year 1990 and 6.6% for the year 2023.

Table 54: ISIC divisions considered in category 1.A.2.g.viii.

ISIC Division(s)	Name
13 and 14	Mining and Quarrying (Non fuel)
17, 18 and 19	Textile and Leather
20	Wood and Wood Products
25	Rubber and Plastic Products
28, 29, 30, 32 and 33	Machinery and Instruments
34 and 35	Transport Equipment
36	Furniture
37	Recycling
45	Construction

Methodology

CO_2 emissions are calculated by means of a Tier 2 method while N_2O and CH_4 emissions are calculated by means of a Tier 1 method. For the years 2005 onwards, CO_2 ETS data are considered.

Activity data

Fuel consumption is taken from (IEA/Eurostat JQ, 2024) as presented in Annex 3.4.

Since the energy balance (IEA/Eurostat JQ, 2024) does not report gas works gas the activity data is taken from the 'Austrian Energy Balance' (Statistik Austria, 2024d), which is in a different structure but consistent with (IEA/Eurostat JQ, 2024).

Emission factors

CO_2 emission factors are taken from studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Umweltbundesamt, 2002).

The emission factors for 2023 are presented in the following table.

Table 55: Emission factors 2023 of category 1.A.2.g.viii Other Manufacturing Industries and Construction.

Fuel	CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Hard Coal	94.00	10.00	1.50
Lignite and Brown Coal Briquettes	97.00	10.00	1.50
Coke	104.00	10.00	1.50
Residual Fuel Oil	78.00	3.00	0.60
Diesel and Gasoil	75.00	3.00	0.60
Petroleum	78.00	3.00	0.60
LPG and Gas Works gas	64.00	1.00	0.10
Natural Gas	55.60	1.00	0.10
Fuel Wood	112.00[1)]	30.00	4.00
Wood Waste	112.00[1)]	10.00	4.00
Biogas, Sewage Sludge Gas, Landfill gas	54.60[1)]	1.00	0.10
Industrial Waste – fossil (1990–2004)	75.00	12.00	4.00
Industrial Waste – IEF	74.33[2)]	12.00	4.00

[1)] Reported as CO_2 emissions from biomass; [2)] Implied emission factor

Recalculations

Natural gas consumption of gas supply companies (reported as transformation input for district heating and already included in public district heating plants 1.A.1.a) has been moved from category *1.A.1.c* to category *1.A.2.g.viii* for the years from 2011 onwards (approx. 130 kt CO_2 from natural gas in 2022), as the offset quantity was previously deducted from category *1.A.2.g.viii*. This improved consistency with the energy balance at sector level.

Other recalculations of activity data are following the revision of the energy balance as described in Annex 3.4.

1.A.2.g.vii Off-road vehicles and other machinery (industry)

Key Source: yes (diesel oil, CO_2)

In this chapter the methodology of estimating emissions from mobile sources of CRT *1.A.2.g.vii* is described. The share in total GHG emissions from CRT *1.A* is 0.5% for the year 1990 and 3.2% for the year 2023.

Methodological Issues

The used methodology corresponds to the requirements of the IPCC 2006 GL Tier 3 methodology.

Energy consumption and emissions of off-road traffic in Austria are calculated with the model GEORG (**G**razer **E**missionsmodell für **O**ff-**R**oad **G**eräte). This model was developed within a study about off-road emissions in Austria (Hausberger, 2000). The study was prepared to improve the poor data quality in this sector. The following categories were taken into account:

- 1.A.2.g.vii Industry
- 1.A.3.c Railways
- 1.A.3.d Navigation

- 1.A.4.b Household and Gardening
- 1.A.4.c Agriculture and Forestry
- 1.A.5 Military (ground activities)

Activities of mobile machinery in CRT *1.A.2.g.vii Industry* also contain commercially/institutionally used machinery. Austria does not report emissions from these machines separately under CRT *1.A.4.a.2* as the split into commercial/institutional and non-commercial/non-institutional use is not possible due to a lack of data.

Input data to the model are:

- Machinery stock data (obtained from data on licences, through inquiries and statistical extrapolation);
- Assumptions on drop-out rates of machinery (broken down machinery will be replaced);
- Operating time (obtained through inquiries), related to age of machinery.

From machinery stock data and drop-out rates an age structure of the off-road machinery was obtained by GEORG. Four categories of engine types were considered. Depending on the fuel consumption of the engine the ratio power of the engine was calculated. Emissions were calculated by multiplying an engine specific emission factor (expressed in g/kWh) by the average engine power, the operating time and the number of vehicles.

With this method national fuel consumption and national emissions are calculated (bottom-up). Calculated fuel consumption of off-road traffic is then summed up with total fuel consumption of inland road transport and is compared with total fuel sold in Austria according to the national energy balance. The difference is allocated to fuel export (for details concerning fuel export see CRT *1.A.3.b*). The emissions reported for Austria also include the emissions from the fuel exports assuming that the fuel export fleet (mainly travelling on highways) is similar to the Austrian fleet on highways.

Activity Data

Activity data, vehicle stock and specific fuel consumption for vehicles and machinery (e.g. leaders, diggers etc.) were taken from:

- Statistik Austria (national energy balance),
- Questionnaire to vehicle and machinery users (Hausberger, 2000),
- Interviews with experts and expert judgment validating the questionnaire results (Hausberger, 2000) and
- Information from vehicle and machinery manufacturers (Hausberger, 2000).

An allocation of pure biofuels in the off-road sector has not been performed due to lack of data.

Activities used for estimating emissions of CRT *1.A.2.g.vii* as well as the implied emission factors are presented below. Combustion of liquid fossil fuels is the only mobile source of CO_2 emissions from category CRT *1.A.2.g.vii.*

The increasing substitution of fossil fuels with biofuels can be observed from 2005 onwards.

Table 56: Implied emission factors and activities from industrial mobile off-road sources 1990–2023.

Year	Activity	Implied Emission Factors		
	TJ	CO_2 t/TJ	CH_4 kg/TJ	N_2O kg/TJ
1990	3 448	74.19	3.79	26.12
1995	3 448	74.2	3.8	26.1
2000	4 821	74.2	3.6	27.1
2005	7 426	74.2	3.1	29.8
2010	11 016	73.5	1.7	21.3
2011	15 324	70.3	0.7	12.6
2012	15 401	70.2	0.7	12.1
2013	15 960	70.1	0.6	11.4
2014	16 051	70.3	0.6	10.7
2015	15 722	70.1	0.5	10.4
2016	15 318	69.7	0.5	10.1
2017	15 713	70.2	0.4	9.6
2018	16 781	70.5	0.4	9.0
2019	17 913	70.5	0.3	8.5
2020	18 907	70.6	0.3	8.2
2021	18 078	70.6	0.3	8.0
2022	19 458	70.5	0.3	7.9
2023	20 056	70.5	0.2	7.7

Emission Factors

Based on a new study (Schwingshackl, et al., 2020) emission factors for a set of recently measured NRMM were updated as well as the implementation periods of the corresponding emission standards (so called "stages") were taken into account.

The following emission factors for different engine types (average motor capacity) depending on the year of construction and emission standards are used in the GEORG model. They represent emissions according to the engine power output and fuel consumption.

Table 57: Emission factors for diesel engines < 80 kW.

Emission Standard		Fuel	CO_2	CH_4	N_2O
	Years	[g/kwh]			
AG1	1990–1993	285.005	898.622	0.045	0.316
AG2	1994–2001	268.445	846.406	0.035	0.350
Stage 1	2002–2003	274.294	864.848	0.005	0.224
Stage 2	2004–2006	274.294	864.848	0.004	0.120
Stage 3a	2007–2011	274.294	864.848	0.002	0.084
Stage 3b	2012–2017	274.294	864.848	0.001	0.084
Stage 4 SCR	2014–2020	274.294	864.848	0.001	0.084
Stage 5	2020–2023	274.294	864.848	0.00002	0.084

Table 58: Emission factors for diesel engines > 80 kW.

Emission Standard	Years	Fuel	CO_2	CH_4	N_2O
		[g/kwh]			
AG1	1990–1993	277.543	875.092	0.038	0.316
AG2	1994–2001	263.231	829.968	0.029	0.350
Stage 1	2002–2003	258.120	813.852	0.005	0.224
Stage 2	2004–2006	268.550	846.740	0.003	0.120
Stage 3a	2007–2011	268.550	846.740	0.002	0.084
Stage 3b	2012–2017	268.550	846.740	0.001	0.084
Stage 4 SCR	2014–2020	268.550	846.740	0.001	0.084
Stage 5	2020–2023	268.550	846.740	0.00002	0.084

Table 59: Emission factors for 2-stroke-petrol engines.

Emission Standard	Years	Fuel	CO_2	CH_4	N_2O
		[g/kwh]			
AG1	1990–1993	739.000	2 330.067	2.503	0.015
AG2	1994–2001	671.650	2 117.712	1.761	0.015
Stage 1	2002–2003	653.150	2 059.382	1.663	0.015
Stage 2	2004–2006	500.000	1 576.500	0.510	0.014
Stage 3a	2007–2011	482.143	1 520.196	0.510	0.012
Stage 3b	2012–2023	482.143	1 520.196	0.510	0.012

Table 60: Emission factors for 4-stroke-petrol engines.

Emission Standard	Years	Fuel	CO_2	CH_4	N_2O
		[g/kwh]			
AG1	1990–1993	561.100	1 769.148	0.554	0.038
AG2	1994–2001	540.000	1 702.620	0.440	0.041
Stage 1	2002–2003	469.400	1 480.018	0.420	0.041
Stage 2	2004–2006	469.400	1 480.018	0.407	0.041
Stage 3a	2007–2011	456.361	1 438.907	0.375	0.030
Stage 3b	2012–2023	456.361	1 438.907	0.375	0.030

Recalculations

The stock of non-road mobile machinery (NRMM) in construction and industry has been revised from 2016 onwards according to the production index by the federal statistics office 'Statistik Austria'. For 2016 to 2021 this resulted in an average increase in energy consumption of 2.7% per year; for 2022 in a reduction of 3.1%.

For CRT 1.A.2.g.vii this results in the following recalculations (2022) for CO_2: -45 kt (-0.07% of national total and -3.1% of category *1.A.2.g.vii*), for CH_4: -81.6 kg (-1.7% of category 1.A.2.g.vii) and for N_2O: -4 742 kg (-3% of category 1.A.2.g.vii).

Planned Improvements

For 2025 a measurement campaign including four measurements on new machines of emission level V is planned. A further four measurements on old machines of emission level IV and/or V are intended to determine the ageing effect. The goal is to create updated emission factors for fuel consumption and all air pollutants in g/kWh used within the model GEORG for the submission 2026.

3.2.12 QA/QC of 1.A.1 and 1.A.2 stationary sources

For general QA/QC see Chapter 1.5.

In 2016 STATISTIK AUSTRIA provided an updated documentation for the national energy balance and a document which covers a more actual quantification of uncertainties.

Concerning activity data for sectors *1.A.1* and *1.A.2* there are specific regulations in the Austrian legislation:

- BGBI II No. 1997/331 Feuerungsanlagen-Verordnung,
- BGBI 1989/19 Luftreinhalteverordnung für Kesselanlagen,
- BGBI 1988/380 Luftreinhaltegesetz für Kesselanlagen,
- BGBl 150/2004 Emissionsschutzgesetz für Kesselanlagen – EG K,
- BGBl 84/2006 Emissionsschutzgesetz für Kesselanlagen – EG K,
- BGBI II No. 2007/292 Emissionserklärungsverordnung – EEV.

Additionally the following sector specific QA/QC procedures have been carried out:

- activity data check
  - Survey for the "National Emission Trading Allocation Plan" 1 (NAP1) 1990 to 2002 with almost complete data for 1998 to 2002,
  - 1.A.1.a: public report: fuel consumption and energy production by plant (1990),
  - discussion of activity data with Refinery (incl. methodology of CO_2 emission calculation) and Iron and Steel Industry,
  - check of gas consumption with data from E-Control,
  - check of oil consumption with data from Mineral Oil Association.
- indicators and analysis (activity data and CO_2 emissions)
  - Public "Kyoto Progress" Reports until 2007. Public "Climate Protection" Reports since 2008,
  - energy intensity indicators: Iron and Steel, Cement industry, Refinery, Households.
- external review
  - federal provinces air emission inventory,
  - check of methodology and CO2 emissions by WIFO.
- emission factors check

  - check of IEF (time series),
  - NAP1 survey: Country specific CO2 emission factors used in the inventory were widely accepted,
  - comparison with IPCC.
- time series consistency
  - plausibility checks of dips and jumps,
  - yearly published emission trends report,
  - repeated values.
- recalculations check of activity data (energy balance), implied emissions factors and emissions.
- Method Documentation with Standard Operation Procedure (SOP);
- "Quick-calculation" of 1.A activity,
- improvement list (external and internal findings);
- link to STATISTIK AUSTRIA, Industrial associations;
- calculation by spreadsheets
  - consistent use of energy balance data (central file),
  - documented sources,
  - use of units,
  - strictly defined interfaces between spreadsheets/calculation modules,
  - unique structure of sheets which do the same,
  - use of coding systems (SNAP, SPLIT, NAPFUE[47]),
  - record keeping, use of write protection,
  - unique use of formulas, special cases are documented/highlighted,
  - quick-control checks for data consistency through all steps of calculation.

3.2.13 Transport (CRT Category 1.A.3)

3.2.13.1 1.A.3.a Civil Aviation

Key Source: No

Kerosene and gasoline consumption are reported under CRT *1.A.3.a*, whereas airport ground handling activities are reported under CRT *1.A.3.e.2 Other (Airport Ground Activities)*. CRT *1.A.3.a Civil Aviation* covers domestic LTO (landing/take off) and domestic cruise.

For methodological reasons it is distinguished between flights according to

- Visual Flight Rules (VFR) which include all flights using aviation gasoline
- Instrumental Flight Rules (IFR) which cover all flights using kerosene

International LTO and international cruise is considered in CRT *1.D.1.a International Bunkers Aviation*. Military Aviation is allocated to CRT *1.A.5 Other.*

[47] Nomenclature for Air Pollution Fuels

Greenhouse gas emissions from domestic aviation are very low related to total emissions from the transport sector *1.A.3* and amounted to 0.3% in 1990 and 0.1% of GHG emissions of *1.A.3* in 2023.

Table 61: Greenhouse gas emissions from 1.A.3.a domestic Civil Aviation by subcategories 1990–2023.

Year	CO_2 [kt]			CH_4 [kt]			N_2O [kt]		
	dom. LTO (VFR)	dom. LTO (IFR)	dom. cruise (IFR)	dom. LTO (VFR)	dom. LTO (IFR)	dom. Cruise (IFR)	dom. LTO (VFR)	dom. LTO (IFR)	dom. Cruise (IFR)
	Gasoline	Kerosene	Kerosene	Gasoline	Kerosene	Kerosene	Gasoline	Kerosene	Kerosene
1990	7.8	9.3	21.3	0.000054	0.0020	NA	0.00022	0.00119	0.00069
1995	7.1	14.0	32.2	0.000049	0.0026	NA	0.00019	0.00182	0.00106
2000	6.3	19.3	41.6	0.000045	0.0048	NA	0.00018	0.00226	0.00132
2005	8.6	16.4	41.6	0.000062	0.0041	NA	0.00025	0.00202	0.00132
2010	9.1	19.4	34.9	0.000065	0.0048	NA	0.00026	0.00205	0.00111
2011	13.6	16.8	31.2	0.000097	0.0042	NA	0.00039	0.00162	0.00099
2012	7.9	16.9	29.7	0.000056	0.0042	NA	0.00023	0.00164	0.00094
2013	8.1	16.9	29.5	0.000058	0.0042	NA	0.00023	0.00157	0.00094
2014	7.4	15.4	27.0	0.000053	0.0038	NA	0.00021	0.00148	0.00086
2015	8.2	14.9	26.6	0.000059	0.0037	NA	0.00024	0.00133	0.00084
2016	10.2	14.8	22.5	0.000073	0.0009	NA	0.00029	0.00041	0.00062
2017	7.4	13.8	21.3	0.000053	0.0008	NA	0.00021	0.00038	0.00059
2018	7.1	16.1	22.8	0.000051	0.0013	NA	0.00020	0.00044	0.00063
2019	6.8	16.4	22.8	0.000049	0.0014	NA	0.00019	0.00045	0.00063
2020	5.7	7.7	9.9	0.000041	0.0009	NA	0.00016	0.00021	0.00027
2021	6.3	8.0	9.6	0.000045	0.0010	NA	0.00018	0.00022	0.00027
2022	5.4	10.4	13.9	0.000038	0.0010	NA	0.00015	0.00029	0.00038
2023	5.4	10.7	14.2	0.000039	0.0011	NA	0.00016	0.00030	0.00039
1990–2023	**-31%**	**16%**	**-33%**	**-28%**	**-45%**		**-28%**	**-75%**	**-43%**

Methodological Issues

The used methodology corresponds to the requirements of the IPCC 2006 GL Tier 3A (IFR flights) and Tier 1 (VFR flights) methodology.

IFR – Instrument Flight Rules

Until the submission 2020 Austria has used two different methodologies for calculating emissions of IFR flights:

- Tier 3B: For the years 1990–1999 a country-specific methodology was applied. The calculations were based on a study (Kalivoda, Kudrna, 2002). This methodology was consistent with the very detailed IPCC 2006 GL Tier 3B methodology (advanced version based on the MEET model (Kalivoda, Kudrna, 1997). For emission calculation air traffic movement data[48]

[48] This data is also used for the split between domestic and international aviation.

(flight distance and destination per aircraft type) and aircraft/engine performances data were used.

- Tier 3A: For the years from 2000 onwards the IPCC 2006 GL Tier 3A methodology has been applied for IFR national LTO, IFR international LTO, IFR national cruise and IFR international cruise. Tier 3A takes into account average fuel consumption and emission data for LTO phases and various flight lengths, for an array of representative aircraft categories.

Based on a recommendation of the 2020 UNFCCC inventory review, Austria improved time series consistency by using the Tier 3A methodology as described above for the years from 2000 onwards and a trend extrapolation (as described in the IPCC 2006 GL volume 1 chapter 5.3.3) for 1990-1999.

Due to the lack of consistent data Austria was not able to use overlap or surrogate techniques. While the total amount of kerosene used in each year during the period 1990-1999 is out of question (Kalivoda, Kudrna, 2002), for the trend extrapolation it was necessary to determine the yearly ratios of kerosene used for domestic LTO, domestic cruise, international LTO and international cruise based on average shares of kerosene consumption over the three years 2000, 2001 and 2002. As a result four fixed average ratios were used for determing the new kerosene consumption and emissions for the years 1990-1999 for domestic LTO and domestic cruise as well as international LTO and international cruise.

VFR – Visual Flight Rules

The IPCC 2006 GL simple methodology (Tier 1 – fuel-based methodology) is applied.

Activity Data

IFR flights

Bottom up Methodology – fuel consumed

Based on the number of flight movements (AUSTROCONTROL, 2024), per aircraft type and airport (national and international) departing Austria, the distances for each airport pair and the specific fuel consumption per aircraft type and distance class, FC (kerosene) and emissions are calculated bottom-up.

For the inventory years 2000–2015 flight movements were obtained from special analyses by Statistik Austria (Statistik Austria, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016). In addition, domestic flight movements were compared with a second data source for flight movements, provided by Austro Control (AUSTROCONTROL, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016) and reconciled to meet these number of flight movements. Distances between airport pairs have been extracted based on IATA codes from single queries on the internet.[49]

Beginning with the inventory year 2016 flight movements have only been taken from Austrocontrol (AUSTROCONTROL, 2024), as they seemed to be more representative compared with international data. Since then distances between departure and arrival aerodromes have been calculated by an automatic distance generator using following formula:

[49] www.world-airport-codes.com

$$D = r * \arccos(\sin(\pi*\varphi(A)/180) * \sin(\pi*\varphi(B)/180) * \cos(\pi*\varphi(A)/180) * \cos(\pi*\varphi(B)/180) * \cos(\pi*(\lambda(A)-\lambda(B))/180))$$

D … Distance between aerodromes
r … Average radius of the earth (6371 km)
φ(A) … Geographical latitude of departure aerodrome A
φ(B) … Geographical latitude of arrival aerodrome B
λ(A) … Geographical longitude of departure aerodrome A
λ(B) … Geographical longitude of arrival aerodrome B

Therefore, each aerodrome being reported in the flight movements needs to be integrated in the calculation model with its geographical degree of latitude and longitude.

The specific fuel consumption per distance class is provided in the spreadsheet accompanying the EMEP/EEA 2023 Guidebook (Annex 5) (EEA 2023) for a wide range of aircraft types. Compared to the previous spreadsheet many new aircraft types have been added, other existing ones have been deleted as they obviously have not been considered relevant. Austria implemented the new emission factor spreadsheet (EEA 2023) in its 2025 submission for the inventory year 2023.

Still there are officially reported flight movements with aircraft types which are not listed in the spreadsheet. Following, an **allocation of unknown aircrafts** to listed aircraft types according to the spreadsheet has to be yearly undertaken based on research about engine type, number of engines, production series etc. If the unknown aircraft cannot be allocated, the aircraft is being labelled as UNKNOWN. The specific fuel consumption and emission factors are separately calculated on the basis of the national and international LTO and cruise averages of each year. This means the calculation distinguishes between:

- Unknown aircraft type for national flights – LTO
- Unknown aircraft type for national flights – cruise
- Unknown aircraft type for international flights – LTO
- Unknown aircraft type for international flights – cruise

For $LTO_{unknown}$ the equation is:

$$FC/LTO = Sum\ FC\_LTO_{unknown} / Sum\ flights\ movements_{unknown}$$

For $Cruise_{unknown}$ the equation is:

$$FC/km = (Sum\ FC\_cruise_{unknown} / sum\ nm\ cruise_{unknown}) * 125$$

125 nm (nautical miles) is the shortest distance class. For the other distance classes >125 nm the values are being extrapolated.

Top down Methodology – fuel sold

The calculated bottom up result for total kerosene consumption is being compared to the total fuel sold reported by the national energy balance (Statistik Austria, 2024d).

- For the inventory years 2000–2015 the delta was fully allocated to international cruise, as the data reconciliation of domestic flight movements (see above) had already resulted in increased numbers in line with Austrocontrol.
- Since the inventory year 2016 any delta between the bottom up result and the official amount of kerosene sold has been allocated to domestic LTO, international LTO, national cruise and international cruise depending on their relative shares in total kerosene consumption.

The following table shows the fuel consumption for IFR flights and the numbers of national LTO (IFR).

Table 62: Fuel consumption for IFR flights and number of IFR LTO cycles, 1990–2023.

Year	Activity		
	Dom. LTO (IFR) Kerosene [kt]	Dom. Cruise (IFR) Kerosene [kt]	Dom. LTO (IFR) [no. of flights]
1990	2.9	6.8	-
1995	4.5	10.2	-
2000	6.1	13.2	22 611
2005	5.2	13.2	20 179
2010	6.2	11.1	20 532
2011	5.3	9.9	16 185
2012	5.4	9.4	16 405
2013	5.4	9.4	15 741
2014	4.9	8.6	14 776
2015	4.7	8.4	13 282
2016	4.7	7.2	15 515
2017	4.4	6.8	14 781
2018	5.1	7.2	19 735
2019	5.2	7.3	19 679
2020	2.4	3.1	14 196
2021	2.5	3.1	12 917
2022	3.3	4.4	13 294
2023	3.4	4.5	11 088
1990–2023	**16%**	**-33%**	**-51%**[50]

VFR flights

Fuel consumption for VFR flights were directly obtained from the national energy balance, as total fuel consumption for this flight mode is represented by the total amount of aviation gasoline sold in Austria.

Table 63: Fuel consumption for VFR flights, 1990–2023.

Year	Activity
	Dom. LTO (VFR) Gasoline [kt]
1990	2.49
1995	2.24
2000	2.04

[50] Trend 2000 - onwards

Year	Activity
	Dom. LTO (VFR) Gasoline [kt]
2005	2.79
2010	2.92
2011	4.40
2012	2.54
2013	2.61
2014	2.38
2015	2.65
2016	3.28
2017	2.39
2018	2.30
2019	2.20
2020	1.83
2021	2.03
2022	1.73
2023	1.75
1990–2023	**-30%**

Emission Factors

Austria updated its aviation calculation tool according to the new emission factor spreadsheet accompanying the EMEP/EEA 2023 Guidebook (EEA 2023) for the 2025 submission **for the current inventory year 2023**. Regarding GHG emissions the new spreadsheet factors of EEA 2023 are relevant for total FC (and CO_2) and CH_4 emissions (influence of HC emissions). The CO_2 emission factor remains unchanged compared to the emission factor inlcuded in EEA 2016 with 3.15 kg/kg fuel. Also, the assumptions regarding CH_4 (10% of HC_LTO) and N_2O emission factors are the same as in previous years.

The emission factors are not applied for historical years, as they represent the latest state of the art fuel-burning and emission standards of aircraft types and have no age-related differentiation.

The following tables give an overview of the emission factors used for IFR and VFR flights.

Table 64: Comparison of emission factors for 1.A.3.a Civil Aviation – IFR flights.

	Inventory years 1990–2015	Inventory years 2016–2023
IFR – CO_2	3.15 kg/kg fuel	3.15 kg/kg fuel
IFR – CH_4	9.6% of HC_LTO	10.0% of HC_LTO
IFR – N_2O	0.1 kg/LTO 0.1 kg/t fuel for cruise	2.0 kg/TJ fuel

Table 65: Comparison of emission factors for 1.A.3.a Civil Aviation – VFR flights.

	Inventory years 1990–2015	Inventory years 2016–2023
VFR – CO_2	3.15 kg/kg fuel	70.000 kg/TJ fuel
VFR – CH_4	0.5 kg/TJ fuel	0.5 kg/TJ fuel
VFR – N_2O	2.0 kg/TJ fuel	2.0 kg/TJ fuel

CO_2 (Tier 1)

CO_2 emissions for IFR flights are calculated with the factor provided by the emission factor spreadsheet accompanying the EMEP/EEA 2023 Guidebook 2023 (EEA 2023). Sustainable aviation fuel has not been registered in the national energy balance yet. Hence, the factor used is 100% fossil and amounts to 3.15 kg/kg fuel.

CH_4 (Tier 1)

CH_4 emission factors are not included in the spreadsheet accompanying the EMEP/EEA 2023 Guidebook (Annex 5) (EEA 2023). According to the IPCC 2006 Guidelines, the Tier 1 approach assumes that all aircrafts have the same emission factors for CH_4 based on the rate of fuel consumption.

CH_4 emissions for all flights (IFR-LTO) can be estimated with the Tier 1 default value of 0.5 kg/TJ fuel (IPCC 2006) or 10% of total VOC (HC) emissions (IPCC 2006, Chapter Mobile Combustion, Table 3.6.5). For inventory years 1990–2015 a percentage of 9.6% of HC_LTO, for inventory years 2016–2019 10% of total VOC (HC) has been used.

HC emission factors were not included in the old CORINAIR 1996 emission factor spreadsheet for all aircraft types. Therefore, HC emissions for inventory years 1990–2015 were reported based on a calculation with HC IEFs from (Kalivoda, Kudrna, 2002). For inventory years 2016 onwards HC emissions are not reported based on the (Kalivoda, Kudrna, 2002) study any more, but based on the HC emission factors which are part of the emission factors spreadsheet (EEA 2023) for the different aircraft types.

According to the IPCC 2006 Guidelines, CH_4 emissions are assumed to be negligible in the cruise mode[51]. Therefore CH_4 emissions for domestic and international cruise are reported as 'NA'.

N_2O (Tier 1)

According to the IPCC Guidelines (IPCC 2006), the Tier 1 approach assumes that all aircrafts have the same emission factors for N_2O based on the rate of fuel consumption.

N_2O emissions for all flights are estimated with the Tier 1 default value of 2.0 kg N_2O/TJ fuel ((IPCC 2006) (Chapter Mobile Combustion, Table 3.6.5).

[51] This is assumed to be valid for domestic and international cruise mode.

Quality Assurance and Quality Control (QA/QC)

Validation of new emission factors and aircraft type allocation of IFR flights

The results for the inventory year 2022 of the 2024 submission based on the old aircraft types and emission factors were compared with the results of this years' (2025) submission calculated with the new set of available aircraft types and emission factors.

Table 66 shows that only minor changes in fuel consumption in LTO and cruise are associated with this methodological change. There is an increase of emissions of more than 5% compared to the calculation based on EEA 2016 for HC_LTO (international/national). A decrease in emissions of more than 5% can be seen for HC_Cruise (national).

Table 66: Relative changes of fuel consumption and HC emissions in LTO and cruise calculated

	International flights	National flights
Sum Fuel_LTO [kg]	99.2	102.4
Sum Fuel_Cruise [kg]	100.0	101.6
Sum HC_LTO [kg]	109.6	117.3
Sum HC_Cruise [kg]	95.6	86.5
Sum No. of flights	100.0	100.0
Summe No. of nautical miles	100.0	100.0

To understand the reason of these changes the impact of the updated allocation of not listed aircraft types to those in EEA 2023 has been evaluated. With the new spreadsheet the accuracy of the emission calculation has been increased remarkably. The majority of aircraft types (62%) can now be matched with an aircraft-specific emission factor. Even more important is the number, how much of the total nautical miles of flights departing Austria can be calculated with aircraft-specific emission factors directly originating from the EMEP/EEA spreadsheet: 98% of all nautical miles can now be assigned to an aircraft-specific original EF from the 2023 EMEP/EEA Guidebook, compared to only 78% in previous calculations.

Table 67: Analysis of availabilty of aircraft types in EEA 2023 vs. EEA 2016

Aircraft types [no.]	EEA 2023	EEA 2016
Availability	283	234
Departing Austria in 2022	295	
Automatically assigned	182 (62%)	84 (28%)
Assigned to „Equivalence type"	68 (23%)	191 (65%)
Assigned to „Unknown"	45 (15%)	20 (7%)

Table 68: Analysis of nautical mile coverage with original aircraft types in EEA 2023 vs. EEA 2016

	EEA 2023			**EEA 2016**		
	EF category					
	Original/aircraft-specific	Equivalence type	Unknown	Original/aircraft-specific	Equivalence type	Unknown
Total air miles	98%	2%	0%	78%	22%	0%

Moreover, the five most important aircraft types regarding their shares in total nautical miles of flights departing Austria for 2022 and their specific emission factors in EEA 2016 and EEA 2023 have been analysed. This new knowledge is mainly relevant for international flight movements, as national flights only account for 1.3 % of total kerosene consumption of all IFR flights on average over the past five years.

The following aircraft types cover around 60% of the air miles or number of flights in both the EEA 2016 and 2023 datatset. In Table 69, they are sorted in descending order by air miles. The percentages refer only to the distribution within the first five most common aircraft types. The different ranking between the results according to EEA 2023 versus EEA 2016 is due to the different allocation of unknown aircraft types to those five types.

Table 69: Most important aircraft types departing Austria regarding air miles

EEA 2023		**EEA 2016**	
Aircraft type	**Share in nautical miles**	**Aircraft type**	**Share in nautical miles**
A320	51%	A320	50%
B738	16%	B738	14%
E195	13%	A321	14%
B772	12%	E195	12%
A321	8%	B772	11%

The aircraft-specific emission factors of these five aircraft types show the following deviations between EEA 2023 and EEA 2016 which are in line with the relative changes of total HC emissions

Table 70: Relative change in emission factors based on the five main aircraft types departing Austria

		FUEL BURNT KG	**CO_2 (3.15 for Jet Kerosene)**	**HC**
A320	0_EFA_LTO-2	1.2%	1.2%	3.2%
	0_EFA_CCD	2.2%	2.2%	-3.8%
B738	0_EFA_LTO-2	-5.5%	-5.5%	23.1%
	0_EFA_CCD	0.5%	0.5%	8.7%
E195	0_EFA_LTO-2	1.3%	1.3%	3.5%
	0_EFA_CCD	7.9%	7.9%	-6.0%
B772	0_EFA_LTO-2	-8.9%	-8.9%	447.3%
	0_EFA_CCD	6.4%	6.4%	124.0%

		FUEL BURNT KG	CO_2 (3.15 for Jet Kerosene)	HC
A321	0_EFA_LTO-2	4.9%	4.9%	2.7%
	0_EFA_CCD	1.5%	1.5%	-35.7%

The changes that have a relevant impact on total emissions are discussed below (international/national). The basis of the comparison is again the flight movement data from Austria for 2023 as considered in the 2024 submission.

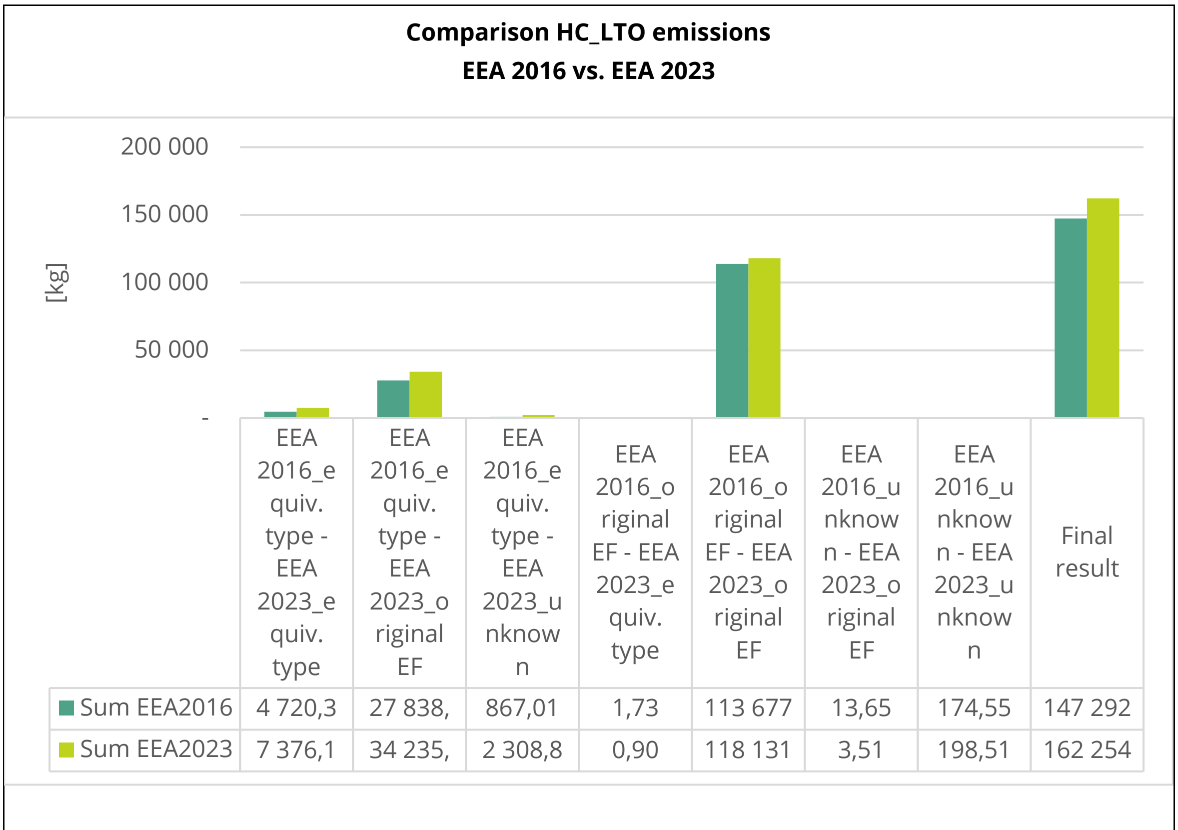
HC_LTO (internation/national)

Due to the new emission factors there is an increase of 9.6% in HC_LTO emissions in international and an increase of 17.3% in domestic air traffic. The increase is due to the higher emission factors (see table above) and on the other hand to the updated aircraft type allocation.

With the emission factor dataset in EEA 2016, many aircraft types were assigned to so-called "equivalence types". With the dataset in EEA 2023, many of these types could be assigned to unique types with existing emission factors, a so-called "original EF". The current assignment of flights to original EF types, which were previously mapped using an equivalence type, led to an increase in HC_LTO emissions (see next figure, 2nd pair of bars).

The 5th pair of bars undermines the above described fact that the aircraft-specific emission factors were increased for HC_LTO emissions.

Figure 12: Comparison of HC_LTO emissions calculated with EEA 2023 vs. EEA 2016



Source: Umweltbundesamt

Harmonization of CRF/CRT and IEA data

In 2013 the ERT detected inconsistencies of fuel consumption data of domestic aviation and domestic navigation between the CRF tables and the IEA data (ICR 2013). In response to that it was explained that Austria uses a bottom-up approach to estimate fuel consumption whilst IEA relies on top-down approach based on fuel consumption statistics reported by Statistics Austria.

After having discussed this issue with Statistics Austria an Explanatory Note (30/09/2013) has been compiled by Statistics Austria declaring that a regular adoption of inventory data for the split between national and international fuel consumption in civil aviation and navigation in the national statistics will be adopted in the future, as far as the data can be submitted in time (early November).

As part of the regular QA/QC, the energy split between national and international aviation is provided to Statistics Austria for the IEA statistics based on the bottom-up model used to calculate the annual emission inventory.

Comparison IEA (military jet kerosene data)

In 2014, the ERT noted a significant difference in jet kerosene consumption (civil aviation) between IEA data and CRF Table 1.C. In response to the draft ARR 2014, Austria explained that the IEA value also includes military jet kerosene data and that this is the reason for the difference.

Completeness

In response to a question raised by the ERT (ICR, 2013) and based on a recommendation made by the UNFCCC in the course of the 2020 Review, fuel consumption and emissions of mobile sources used for aircraft handling at Austrian airports are now reported under*1.A.3.e.2*.

Recalculations

There are no sector-specific recalculations.

Planned improvements

No sector-specific improvements are planned.

3.2.13.2 1.A.3.b Road Transport

Key Source: Yes (diesel oil CO_2/N_2O and gasoline CO_2/CH_4/N_2O)

Emissions from road transportation are covered in this category. It includes emissions from passenger cars, light duty vehicles, heavy duty vehicles and busses, mopeds and motorcycles.

Road transport showed an increase in GHG emissions since 1990 (+46%) mainly due to an increase of road performance (mileage) of diesel cars and freight transport. In addition to the increase of road performance **within** Austria, the amount of fuel sold in Austria but **used elsewhere** – an effect called "fuel export" mainly caused by a lower fuel tax compared to Austria's neighbouring countries – has increased considerably since 1990. Between 2005 and 2012 total GHG emissions decreased due to lower amounts of fuel sold together with an increased use of biofuels for blending and the gradual replacement with newer vehicles with lower specific fuel consumption. Since then, GHG emissions from transport have been **gradually increasing** with rising traffic volumes. In the pandemic year 2020 a sharp decrease of emissions was observed followed by an increase due to a slight economic recovery in 2021. Since then the GHG emissions show a decreasing trend. **From 2022 to 2023** emissions from sub-category *1.A.3.b Road Transportation* declined by 3.9% due to a drop in total diesel sales due to reduced milage of heavy duty vehicles on inland roads and abroad with Austrian fuel (fuel exports).

In 2023, the main share of traffic-related greenhouse gas emissions was caused by diesel-powered passenger cars (41.2%) and heavy commercial vehicles (25.8%), followed by gasoline-powered passenger cars (22.5%) and light commercial vehicles (8.7%). Compared to 2022, emissions have decreased by 3.9% (approximately 0.8 million tons of CO_2 equivalent).

In the following table total GHG emissions (in CO_2e) are disaggregated by means of road transportation. Inland emissions and those from fuel export are shown separately in the two relevant vehicle categories passenger cars and heavy duty vehicles and must be added to get the total emissions for each vehicle category. The phenomenon of fuel export is explained in the subchapter Methodological Issues.

Table 71: Greenhouse gas emissions from 1.A.3.b Road Transport differentiated by means of transportation 1990–2023.

Year	**Passenger cars**		**light duty vehicles**	**heavy duty vehicles**		**mopeds & motorcycles**
	inland	**fuel export**	**inland**	**inland**	**fuel export**	**inland**
	CO_2e [kt]					
1990	8 812	222	1 024	2 509	819	70
1995	9 935	-251	1 178	3 148	1 264	84
2000	10 896	-805	1 339	3 669	2 971	111
2005	11 448	2 740	1 435	4 014	4 492	126
2010	11 046	2 333	1 348	3 586	3 363	143
2011	11 136	2 077	1 366	3 673	2 681	148
2012	11 008	1 985	1 358	3 672	2 842	153
2013	11 166	1 782	1 378	3 675	3 904	159
2014	11 342	1 677	1 399	3 560	3 329	163
2015	11 528	1 962	1 426	3 554	3 256	168
2016	11 888	2 150	1 488	3 954	3 094	173
2017	12 125	2 232	1 534	4 183	3 145	176
2018	12 289	2 116	1 547	4 302	3 132	174
2019	12 383	1 759	1 594	4 345	3 388	173
2020	10 139	1 251	1 609	4 199	3 149	158
2021	10 832	1 073	1 734	4 522	3 071	150
2022	11 455	709	1 761	4 509	1 832	148
2023	11 347	1 281	1 724	4 229	896	146
1990–2023	**29%**	**476%**	**68%**	**69%**	**9%**	**109%**

Methodological Issues

The used methodology for estimating CO_2 emissions conforms to the requirements of the IPCC 2006 GL: Tier 2 for CO_2 and Tier 3 for CH_4 und N_2O. Details on EFs are given below.

Mobile road combustion is differentiated into the categories Passenger Cars, Light Duty Vehicles, Heavy Duty Vehicles and Buses, Mopeds and Motorcycles. In order to apply the IPCC 2006 GL methodology a split of the fuel consumption of different vehicle categories is needed.

Bottom up Methodology – fuel consumed

Energy consumption and emissions of the different vehicle categories are calculated by multiplying the yearly road performance per vehicle category (km/vehicle and year) by the specific energy use (g/km) and by the emission factors in g/km in the Model NEMO. NEMO combines a detailed calculation of the vehicle fleet composition and simulation of emission factors on a vehicle level.

NEMO calculates the percentages of different vehicle layers on the overall traffic volume as a function of year and considered road type based on data on vehicle stock, composition of new registrations and vehicle usage. The simulation of the emissions of the different vehicle layers is based on the correlation of the specific engine emission behaviour (emissions in grams per kilowatt-hour engine work) with the cycle average engine power in a normalised format. The calculation of the required engine power is based on average speed and additional kinematic parameters for the description of the cycle dynamics for a given road section.

Based on a recommendation made by the UNFCCC during the 2020 Review, Austria collected fuel consumption data of mobile sources used for aircraft handling at Austrian airports. On the basis of specific information from Vienna's International Airport an estimate for all Austrian airports was carried out. Emissions are now reported separately under CRT *1.A.3.e.2 Other*. Fuel and emissions from this source were previously included in CRT source category *1.A.3.b Road Transport.* For more information see chapter 3.2.13.6.

Top down Methodology – fuel sold

NEMO models the fuel consumption and emissions from road transport in a bottom-up approach. The results are then added to the modelled fuel consumption of off-road traffic. This sum is compared with the national total based on 'fuel sold' (obtained from the national energy balance). The gap is allocated to fuel export (fuel that is sold in Austria but consumed abroad). Total emissions reported in the CRT category 1.A.3.b Road Transport also include emissions from fuel export.

Fuel export

Since the end of the nineties an increasing discrepancy between the total Austrian fuel sales and the computed domestic fuel consumption became apparent. Between 2003 and 2007 this gap accounts for roughly 30% of the total fuel sales. A possible explanation of this discrepancy is the „fuel export in the vehicle tank" – due to the relatively low fuel prices in Austria (in comparison to the neighbouring countries). Meaning that to a greater extent fuel is filled up in Austria and consumed abroad. This assumption is underpinned by two national studies (Molitor, et al., 2004, Molitor, et al., 2009).

It is assumed that the fuel export fleet (mainly travelling on highways) is similar to the Austrian fleet on highways, which means that no different efficiency rates are assumed for the fuel export fleet. It is assumed that fuel export is assigned to three vehicles groups: gasoline PC, diesel PC and diesel trucks.

Gasoline fuel export is calculated from the inland gasoline consumption and the difference to the total sales of gasoline in Austria. The difference is being assigned to the gasoline fuel export in cars. Fuel consumption of diesel fuel export with cars is being calibrated in proportion to the diesel share of the foreign car fleet based on the relation between FC of gasoline cars in fuel export and FC of gasoline cars in inland. After having calculated the diesel export in cars the diesel export of trucks can be estimated by total diesel sales minus diesel FC inland minus diesel export in cars (Schwingshackl, et al., 2015)[52].

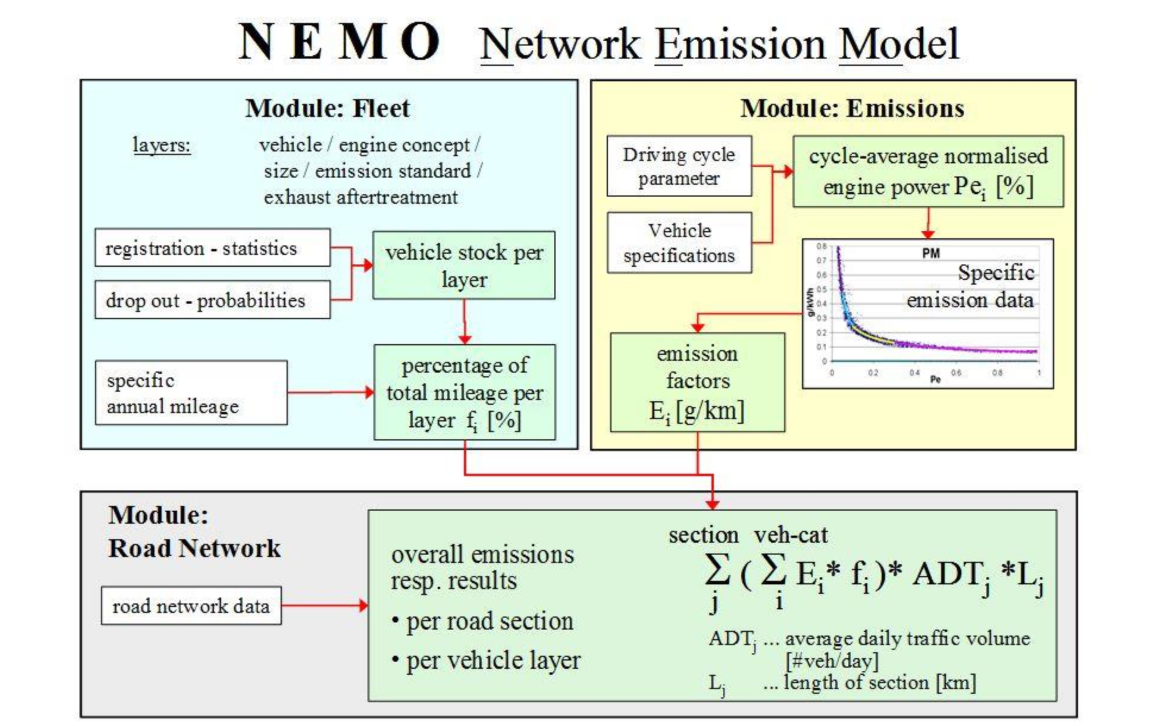
NEMO – Network Emission Model

From the submission in 2015 onwards calculations are based on the model NEMO – Network Emission Model (Dippold, et al., 2012); (Schwingshackl, et al., 2015, Hausberger, et al., 2015, Dippold, 2016, Schwingshackl, Hausberger, 2024). NEMO combines a detailed calculation of the fleet composition with the simulation of energy consumption and emission output on a vehicle level. It is fully capable to depict the upcoming variety of possible combinations of propulsion systems (internal combustion engine, hybrid, plug-in-hybrid, electric propulsion, fuel cell …) and alternative fuels (CNG, biogas, FAME, Ethanol, GTL, BTL, H_2 …).

In addition, NEMO has been designed to be also suitable for all main application fields of simulation of energy consumption and emission output on a road-section based model approach. As there does not yet exist a complete road network for Austria on a highly resolved spatial level, the old methodology based on a categorisation of the traffic activity into "urban", "rural" and "motorway" has been currently also applied in NEMO. The model calculates vehicle mileages, passenger-km, ton-km, fuel consumption, all exhaust gas emissions, evaporative emissions and suspended TSP, PM_{10}, $PM_{2.5}$, PM_1 and $PM_{0.1}$ exhaust and non-exhaust emissions of road traffic. Figure 13 shows a schematic picture of the methodology of NEMO.

[52] Page 22

Figure 13: Schematic picture of the NEMO model.



Source: (Schwingshackl, et al., 2015, Hausberger, et al., 2015) umweltbundesamt

Module: Fleet

The composition of the vehicle fleet in NEMO is being simulated based on annual Austrian **registration statistics per vehicle category and propulsion system** as well as age-dependent survival (drop-out) probabilities. Vehicle technologies (exhaust standards or “EURO classes”) are assigned to vehicle registrations based on the year of registration.

For **passenger cars (PC), light duty vehicles (LDV), buses and motorcycles** the specific mileage per year is obtained from the periodical inspection database (ZBD - annual inspection of traffic and operational safety according to §57a of the 1967 Motor Vehicle Act (KFG)) is used. As this data is only representative for the Austrian vehicle stock, for passenger cars it is only used to determine the ratio between the propulsion categories. For **vehicles >=3.5 tons and heavy duty vehicles (HDV)** mileage data from 2008 onwards is calculate based on yearly growth rates according to the final results of the automatic traffic counting stations and toll data on the high-level road network (ASFINAG, 2024) as well as from automatic traffic counting stations of the counties (AUSTRIATECH, 2024).

The total annual road performance (mileage driven per year) of the vehicle categories should be recorded as precisely as possible by national statistics. For many years this specific data was not available. Therefore, traffic volumes up to 2007 were taken from the Austrian National Transport Model “VMOe 2025+ Verkehrs-Mengenmodell-Österreich (Austrian Transport Model commissioned by the Federal Ministry of Transport, Innovation and Technology (BMVIT), not published).

Module: Road Network

NEMO also models the **road performance** and emissions per vehicle size, age and motor type based on dynamic vehicle specific drop out- and road performance functions for different road network types. Starting point for the road network files currently used in the inventory for the three road categories "urban", "rural" and "motorway" are the mileage distributions stored in HBEFA for Austria according to different traffic situations. Within the road categories the average speed is a product of x different driving patterns per vehicle category (dependant on y road types in each of the three road categories with specific inclinations, speed limits, actual traffic flows, average measured speeds, etc.). The resulting average speeds for Austrian "urban", "rural" and "motorway" road category weighted by traffic volume in the attachment can be found in the following table.

Table 72: Resulting average speeds per vehicle category in NEMO (based on HBEFA 4.2 traffic situations).

	Speed [km/h] per road category		
Vehicle category	**urban**	**rural**	**motorway**
Passenger Car	32.6	71.2	116.3
Light Duty Vehicle	32.6	71.2	116.2
Heavy Duty Vehicle-Road Truck	29.5	63.5	79.9
Heavy Duty Vehicle-Tow Truck	29.5	63.5	79.9
Coach	29.5	64.3	90.5
Urban Bus	23.7	49.8	-
Motorcycle-2 cylinders	33.7	68.3	-
Motorcycle-4 cylinders	33.7	68.3	-
Moped	33.7	48.8	-

Model input

1. Module: Fleet. Yearly vehicle registrations (STATAT) and an algorithm for drop-out probabilities form the vehicle stock of each vehicle category split into layers according to the propulsion system (SI, CI,..), cylinder capacity classes or vehicle mass;
2. Module: Fleet. Yearly specific mileages of PCs, LDVs, mopeds and motorcycles (ZBD - annual "sticker check" in accordance with §57a KFG);
3. Module: Fleet. Yearly growth rates of kilometres driven by PCs and HDVs separated for the federal street network (motorways) and the federal county network (urban, rural) (AUSTRIATECH);
4. Module: Emissions. Emission factors of the vehicles according to the year of first registration and the layers from 1);
5. Module: Road network. Yearly absolute number of vehicle kilometres (trucks and busses) on Austrian motorways (ASFINAG)
6. Number of passengers per vehicle and tons payload per vehicle;
7. Optional either/or
   - total gasoline and diesel consumption of the area under consideration,
   - average km per vehicle and year.

Model output

1. Km driven per vehicle and year,
2. Total fuel consumption of road traffic,
3. Total vehicle mileages,
4. Total passenger-km and ton-km,
5. Specific emission values for the vehicle fleets [g/km], [g/tkm], [g/pkm],
6. Total emissions (evaporative emissions and suspended TSP, PM_{10}, $PM_{2.5}$, PM_1 and $PM_{0.1}$ exhaust and non-exhaust emissions, CO, HC, NO_x, CO_2, SO_2 and several unregulated pollutants among them CH_4 and N_2O) of road traffic.

The calculation is done according to the following method for each year

1. Assessment of the vehicle stock split into layers according to the propulsion system (SI, CI,..), cylinder capacity classes (or vehicle mass for HDV) and year of first registration using the vehicle survival probabilities and the vehicle stock of the year before.

$$stock_{Jg_i,\text{year i}} = stock_{Jg_i,\text{year i}-1} \times \text{survival probability}_{Jg_i}$$

2. Assessment of the km per vehicle for each vehicle layer using age and size dependent functions of the average mileage driven. If option switched on, iterative adaptation of the km per vehicle to meet the total fuel consumption targets.

3. Calculation of the total mileage of each emission category (e.g. passenger car diesel, EURO 3)

$$\text{total mileage}_{E_i} = \sum_{Jg=\text{start.}}^{\text{end}} (\text{stock}_{Jg,\text{year i}} \times \text{km/vehicle}_{Jg_i,\text{year i}})$$

4. Calculation of the total fuel consumption and emissions of each emission category

$$\text{Emission}_{E_i} = \text{total mileage}_{E_i} \times \text{emission factor}_{K_j,E_i}$$

5. Calculation of the total fuel consumption and emissions of each vehicle category

$$\text{Emission}_{\text{veh.category}} = \sum_{E_i=1}^{end} \text{Emission}_{E_i}$$

6. Calculation of the total passenger-km and ton-km

$$\text{transport volumes}_{\text{veh.category}} = \sum_{E_i=1}^{end} (\text{vehicle mileage}_{E_i} \times \text{loading}_{E_i})$$

7. Summation over all vehicle categories with

Jg_i Index for a vehicle layer (defined size class, propulsion type, year of first registration)

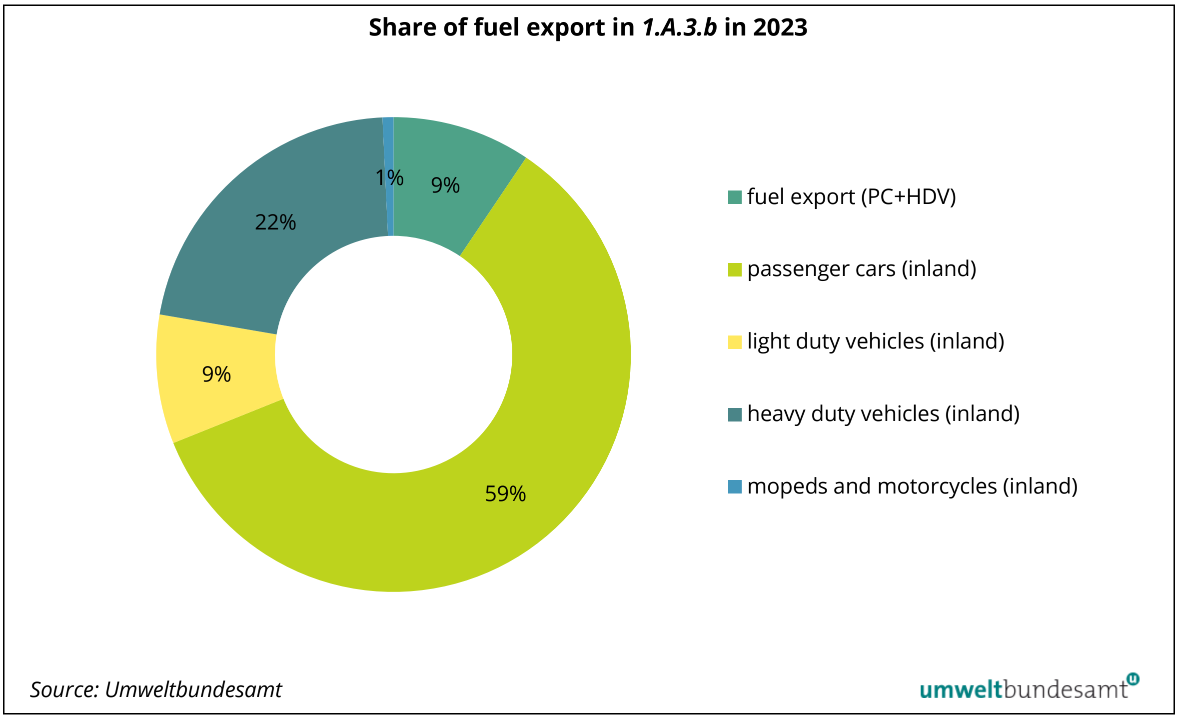
E_i Index for vehicles within a emission category (defined size class, propulsion type and exhaust certification level)

Activity Data

From 2022 to 2023 fuel consumption of road transport in TJ (gasoline, diesel and alternative fuels including liquid biomass) decreased by 2.9%. Specific consumption per average vehicle kilometer and vehicle category improved for all vehicle categories except motorcycles and mopeds.

In 2023, the total share of fuel export in CRT *1.A.3.b* amounted to 11% or 2 177 kt CO_2 equivalents of which 59% are attributed to passenger road transport and 41% to road freight transport.

Figure 14: Share of fuel export in 1.A.3.b Road Transport in 2023.



The general equal **distribution of pure biofuels** to relevant vehicle categories was changed in the calculations of the 2016 submission. The allocation has been done based on expert judgement and was implemented in the model NEMO according to the road performance of each vehicle category:

- biodiesel B100 is assigned to HDV to 100%
- vegetable oil is assigned to HDV to 100%[53]
- bioethanol (E85) is assigned to PC to 100%
- hydrotreated vegetable oil (HVO) to road trucks and heavy trucks to 100%

The allocation of alternative fuels like liquefied petroleum gas (LPG) and compressed natural gas (CNG) is assumed in the model as follows:

- LPG is assigned to PC and LDV (LPG consumption according to the number of fleet); the rest compared to the energy balance is assigned to gasoline trucks HDV (only otto-motorised) .
- Natural gas (CNG) is distributed to passenger cars, HDV and LDV (only otto-motorised) according to their road performance.

[53] An allocation to agriculture is not possible at the moment, because of the technical model framework.

Biofuels

Since 2005 biogenic fuel (biodiesel, bioethanol, plant oil) has been used in the Austrian road transport sector. Biodiesel and bioethanol are mainly used for blending fossil fuels, whereas plant oil is distributed in pure form. The following data is used as direct input data in the calculation models based on NEMO and GEORG (see 1.A.2.g.7).

During the 2023 calendar year, the substitution target of 5.68 % (in terms of the energy content) required by the Austrian Fuel Ordinance (KVO) was met (7.36 %). The value has risen significantly compared to previous years (Aichmayer, et al., 2025). 2005, the first year of blending biofuels, the substitution amounted to only 0.8% (Salchenegger, 2006).

The table below shows total absolute numbers of biofuels used in Austria for mobile sources reported in the national biofuel register elNa (electronic sustainability certificates). The reduction of **direct CO_2 emission** achieved through the use of biofuels in the transport sector in 2023 amounted to 1.6 million tonnes – emissions that count towards the Austrian National Greenhouse gas targets.

Table 73: Use of biofuels in absolute figures 2005–2023.

Year	Pure [t]					Blended [t]
	Biofuels	Biogas	Vegetable oil	HVO	Biodiesel+HVO	Bioethanol
2005	17 000	-	-	-	75 000	-
2006	42 500	-	10 000	-	288 000	-
2007	71 228	-	17 981	-	298 828	20 391
2008	102 000	0.1	19 276	-	304 291	84 910
2009	115 906	1	17 784	-	405 909	99 424
2010	74 984	2	17 393	-	427 000	105 883
2011	85 093	6	16 731	-	422 072	102 755
2012	58 160	9	16 823	-	440 938	105 378
2013	62 694	15	17 842	-	443 389	88 842
2014	143 125	463	16 028	-	474 692	87 688
2015	158 267	350	15 988	-	528 944	89 557
2016	65 280	344	15 595	-	495 764	86 912
2017	31 052	214	15 561	-	459 032	85 226
2018	62 914	306	263	-	462 396	88 206
2019	58 019	349	135	483	448 328	86 311
2020	34 451	278	107	91	390 273	82 030
2021	25 012	213	149	1 133	416 461	75 520
2022	28 349	527	209	132	391 503	78 766
2023	28 153	335	119	29 199	417 406	139 165

Emission Factors

CO_2 emissions are calculated on the basis of tons of fuel. In NEMO a country-specific CO_2 EF is applied assuming a carbon content of 86% for diesel and gasoline resulting in a value of 3.153 kg/kg fossil fuel.

As responded to the ERT's questions during the 2016, 2020 and 2022 UNFCCC Reviews the high CO_2 IEF for gasoline (75.94 t/TJ in 2022) is above the upper IPCC default values (73.00 t/TJ) due to the application of the comparatively low NCV from the national energy balance, which is 41.5 TJ/kt Gasoline for the year 2022. The application of the IPCC default NCV (44.3 TJ/kt) would increase activity data and thus reduce the CO_2-IEF and bring it into the range. Austria therefore does not assume that emissions from Gasoline are over-estimated.

As responded to the ERT's question during the UNFCCC Review 2016 on an update on the progress of separate reporting of CH_4 and N_2O emissions associated with biomass (also raised in ARR 2014 para 30) it should be noted that Austria has implemented this improvement in its submission 2018.

CH_4 and N_2O EFs used in NEMO are based on a representative number of vehicles and engines measured in real-world driving situations taken from the "Handbook of Emission Factors" (HBEFA) (Keller, Hausberger, 1998) and on ARTEMIS measurements (basically for passenger cars, light duty vehicles and motorcycles) which are taken into account in HBEFA. As planned in the last NID emission factors have been updated in the 2023 submission according to the HBEFA version V4.2 (Notter, et al., 2022) published in February 2022 and replacing version V4.1 (Matzer, et al., 2019).

Software updates

Besides other general updates in HBEFA V4.2, it contains a detailed mapping of the emission development of diesel vehicles with and without a software update in addition to the emission factors for diesel PCs with EA 189 engines, which have already been integrated in HBEFA V4.1. There the effect of the mandatory software update of VW vehicles with the EA189 engine ("Diesel Gate") on the average EURO 5 emission factor has been analysed in several measurement series.

The development of the emission factors and temperature dependencies for the additional software update vehicle layers can be read in a study by TU Graz (Dippold, Hausberger, 2021) and is also integrated in HBEFA V4.2.

Ambient temperature influence

Ambient temperature influences on NOx emission factors have been checked, but there have been no changes compared to HBEFA V4.1. Therefore, it is still valid to say that the lower the ambient temperature, the worse NO_x exhaust-aftertreatment systems work.

Moreover, specific yearly CO_2 emission and fuel consumption factors per vehicle kilometre of newly registered passenger cars and light duty vehicles have been implemented according to the national CO_2 monitoring data for the Austrian fleet (Schodl, Böhnke, 2025a, Schodl, Böhnke, 2025b).

Cold-start emissions

The cold-start emission module has been checked and there have been no changes compared to HBEFA V4.1.

Cold-start emissions according to IPCC 2006 GL are calculated as separate emissions in addition to the emissions that would be expected if all vehicles were only operated with hot engines and warmed-up catalysts. Cold-start emissions are only allocated for urban and rural driving, as the number of starts in highway conditions seems to be relatively limited. Cold-start emissions are calculated in NEMO for each vehicle category and each pollutant as follows:

Additional impact per start [g / km] =
cold-start surcharge [g / start] / average trip length per cold start [km / start]

The cold start influence is in NEMO included in the calculation of fuel consumption and emissions of CO_2, NO_x, CO, hydrocarbons and PM. For N_2O and NH_3 no cold start emission factors were found in the literature. Thus, the cold-start influence on the greenhouse effects of N_2O emissions could not be taken into account.

The values used for cold-start surcharges come from:

- *PC and LDV*: cold-start model (updated in HBEFA V4.1)
- *HDV*: cold-start study commissioned by Umweltbundesamt (REXEIS et al. 2013)
- *2-wheelers*: derived from cold-start emissions of PC gasoline

Relative factors on top of commercial fuels incl. blending of biofuels (=reference fuels)

All emission factors of alternative and pure biofuels used in NEMO are considered in the model by relative factors compared to commercial fuels. This allows to include any other fuels in the NEMO calculations.

The following table provides the used relative factors compared to the reference fuels. The reference fuels are blended gasoline and blended diesel, because these fuels are commercially launched by fuelling stations on the market. The relative factors are multiplied with the EFs (in g/km) of every EURO-class and vehicle category per year. The relative factors are kept constant for the whole time series, but the final EFs change over time, because the basic EFs per EURO class improve as a consequence of the vehicles' advanced exhaust gas technologies. The relative factors are derived from literature research (e.g. EMEP Guidebook) or exhaust measurements.

Table 74: Relative factors used for bioethanol E85, LPG, CNG and biogas.

Gasoline	blended gasoline	bioethanol E85	LPG	CNG	biogas
FC	1.00	1.00	1.00	0.84	0.84
NOx	1.00	1.51	1.22	0.67	0.67
HC	1.00	1.37	0.85	0.44	0.44
CO	1.00	0.88	1.25	0.70	0.70
PM exhaust	1.00	1.00	1.00	0.71	0.71
Nox_raw	1.00	1.51	1.22	0.67	0.67
N2O	1.00	0.64	1.00	0.34	0.34
NO2	1.00	1.51	1.22	1.11	1.11
NH3	1.00	1.00	1.00	0.68	0.68
CH4	1.00	1.94	1.00	2.94	2.94
Benzol	1.00	1.00	1.00	1.00	1.00
C22H12	1.00	1.00	0.03	1.00	1.00

Gasoline	blended gasoline	bioethanol E85	LPG	CNG	biogas
C20H12 (k)	1.00	1.00	0.04	1.00	1.00
C20H12 (b)	1.00	1.00	0.00	1.00	1.00
C20H12 (a)	1.00	1.00	0.03	1.00	1.00

Table 75: Relative factors used for biodiesel, plant oil and diesel B20.

diesel	blended diesel	biodiesel (RME[54])	plant oil	diesel B20
FC	1.00	1.00	1.00	1.00
NOx	1.00	1.20	1.20	1.04
HC	1.00	1.00	1.00	1.00
CO	1.00	0.74	0.74	0.95
PM exhaust	1.00	0.61	0.61	0.92
NOx_raw	1.00	1.20	1.20	1.04
N2O	1.00	1.20	1.20	1.04
NO2	1.00	1.00	1.00	1.00
NH3	1.00	1.00	1.00	1.00
CH4	1.00	1.15	1.15	1.03
Benzol	1.00	1.00	1.00	1.00
C22H12	1.00	1.00	1.00	1.00
C20H12 (k)	1.00	1.00	1.00	1.00
C20H12 (b)	1.00	1.00	1.00	1.00
C20H12 (a)	1.00	1.00	1.00	1.00

Implied emission factors for the different means of road transportation are listed in the following tables. In contrast to the CRT tables, Activity data shown in Table 76 to Table 79 include all energy sources (i.e. fossil and bio fuels) used in each vehicle category in order to show the increasing substitution of fossil fuels with biofuels from 2005 onwards. For this reason data provided in these tables do not correspond to the IEFs given in the CRT where they are separately shown for each energy source (e.g. IEF for fossil diesel, fossil gasoline, biomass etc.).

Table 76: Implied emission factors of passenger cars 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	117 059	75.9	21.4	2.7
1995	126 028	75.7	12.7	3.1
2000	132 382	75.3	6.7	2.7

[54] rapeseed oil methyl ester.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
2005	188 291	74.6	4.1	2.2
2010	186 417	71.2	2.7	1.9
2011	184 301	71.1	2.5	1.9
2012	181 672	70.9	2.4	1.9
2013	180 344	71.2	2.4	2.0
2014	182 126	70.9	2.3	2.0
2015	189 429	70.6	2.4	2.1
2016	195 390	71.2	2.6	2.2
2017	198 958	71.5	2.8	2.4
2018	200 392	71.1	3.0	2.5
2019	196 272	71.3	3.1	2.5
2020	158 211	71.2	3.2	2.7
2021	165 130	71.3	3.3	2.7
2022	168 331	71.4	3.3	2.7
2023	177 108	70.5	3.3	2.7

Table 77: Implied emission factors of light duty vehicles 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	13 637	74.7	7.0	0.9
1995	15 764	74.4	3.6	0.8
2000	17 937	74.3	1.8	1.3
2005	19 394	73.6	1.0	1.6
2010	19 032	70.3	0.7	1.8
2011	19 299	70.3	0.7	1.8
2012	19 214	70.1	0.8	1.9
2013	19 429	70.3	0.9	2.1
2014	19 763	70.2	1.1	2.2
2015	20 252	69.8	1.3	2.4
2016	20 967	70.3	1.5	2.5
2017	21 471	70.7	1.8	2.7
2018	21 642	70.6	2.2	2.9
2019	22 228	70.8	2.5	3.1
2020	22 396	70.9	2.8	3.4
2021	24 158	70.8	3.3	3.5

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
2022	24 514	70.8	3.5	3.5
2023	24 160	70.3	3.6	3.6

Table 78: Implied emission factors of heavy duty vehicles 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	44 660	74.3	2.8	0.7
1995	59 249	74.2	2.0	0.7
2000	89 277	74.2	1.1	0.6
2005	115 509	73.5	0.7	0.5
2010	98 436	70.1	0.4	1.8
2011	89 996	70.0	0.4	2.1
2012	92 430	69.9	0.3	2.3
2013	107 183	70.0	0.3	2.5
2014	97 569	69.9	0.3	2.8
2015	96 955	69.4	0.3	3.0
2016	99 713	69.9	0.2	2.8
2017	103 075	70.3	0.2	2.8
2018	104 530	70.3	0.2	2.9
2019	108 467	70.5	0.2	2.9
2020	103 033	70.6	0.2	2.9
2021	106 590	70.5	0.1	2.9
2022	88 978	70.5	0.2	3.0
2023	72 346	70.0	0.2	3.2

Table 79: Implied emission factors of mopeds and motorcycles 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	836	76.3	254.0	1.3
1995	1 024	76.3	185.7	1.2
2000	1 372	76.3	142.8	1.2
2005	1 570	76.3	120.9	1.2
2010	1 892	72.8	92.9	1.2
2011	1 954	72.8	88.5	1.2

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
2012	2 031	72.6	83.7	1.2
2013	2 099	73.0	79.0	1.2
2014	2 177	72.5	74.4	1.2
2015	2 243	72.5	70.7	1.2
2016	2 288	73.4	67.9	1.2
2017	2 337	73.4	64.8	1.2
2018	2 348	72.4	57.1	1.2
2019	2 323	72.4	61.7	1.2
2020	2 132	72.0	60.0	1.2
2021	2 015	72.4	57.1	1.3
2022	1 990	72.8	52.2	1.3
2023	2 016	70.9	49.0	1.3

Taking into account the carbon part of biofuels (and the associated CO_2 emissions)

According to the 2006 IPCC GLs (volume 2, chapter 3, section 'CO_2 emissions from biofuels' in page 3.17) "*it is important to assess the biofuel origin so as to identify and separate fossil from biogenic feed-stocks*". In other words, a part of the carbon of biofuels (and the associated CO_2 emissions) may have a fossil origin. In Austria this is the case. Consequently, the CO_2 from fossil methanol in the production of biodiesel (FAME[55]) has been accounted for the time series 2005–2019 resulting in increased emissions for every vehicle sub-category, where blended or pure biodiesel is used.

Calculations were done based on (Sempos, 2018) who published together with a group of experts an accorded point of view among EU MS to agree on a common understanding and define possible ways how to estimate the associated CO_2 emissions to the fossil carbon content in biofuels. The following default values were taken.

Table 80: Values used for the fossil carbon content in biofuels (Sempos, 2018).

C fossil part – origin from methanol [%]	Carbon content – bio and fossil [% kg/kg]	CO_2-EF for fossil FAME [kt CO_2/kt FAME]
5.4	76.5	0.1515

The fossil part in the production of ETBE[56] has been accounted for the whole time series, as we know that 53% of ETBE are produced from fossil sources (Isobuten) and 47% from bioethanol. The fossil part is being reported as fossil gasoline by the companies.

[55] Fatty Acid Methyl Ester.

[56] Ethyl Tert-Butyl Ether.

HVO[57] in contrast is produced through the hydro-treatment of the triglyceride-containing feed-stocks (vegetable oil or animal fat). All carbon can be considered of biogenic origin (no fossil part).

Quality Assurance and Quality Control (QA/QC)

Quality management for input data of *1.A.3.b Road Transport* is implemented by carrying out the following checklist after receipt of input data:

- ✓ Are the correct values used (check for transcription errors)?
- ✓ Check of plausibility of input data (time-series order of magnitude)!
- ✓ Is the data set complete for the whole time series?
- ✓ Check of calculation units!
- ✓ Check of plausibility of results (time-series order of magnitude)!
- ✓ Are all references clearly made?
- ✓ Are all assumptions documented?

Uncertainty Assessment

Uncertainty estimates are based on (Winiwarter, Rypdal, 2001) and on (Hausberger, 2005):

- The uncertainty of activity data (total fuel sold) for road transport is considered to be low (3%), and also the uncertainty of CO_2 emission factors is estimated to be 3%.
- N_2O emission factors are determined in vehicle emission tests, mostly carried out on test benches. Therefore emission factors are prone to uncertainties for the following reasons:
  - test driving cycles cannot fully reflect real driving behaviour,
  - uncertainties of test equipment and emission measurement equipment,
  - emission factor varies over time because of chemical characteristics of the fuels,
  - the influence of aging and maintenance of the vehicle stock.

Due to these reasons the uncertainty for the N_2O emission factor is relatively high; it is estimated to be –70 and +170% (lognorm) for gasoline and ±30% (norm) for diesel.

Recalculations

Update/Improvement of activity data

Revision of the energy balance

Update of natural gas and liquefied petroleum gas consumption for the years 2021 and 2022 due to revisions in the current national energy balance by the federal statistics office 'Statistik Austria'.

Update of correction factor (CF) for real-world fuel consumption PC (passenger cars)

The real-world consumption correction factors - when switching from NEDC (New European Driving Cycle) to WLTP (Worldwide harmonized Light vehicles Test Procedure) standard values - have been updated in the NEMO emissions calculation model for PC. The revision resulted in minor ad-

[57] Hydro Vegetable Oil.

justments for 2019 and 2020 and a update from 2021 onwards based on the national CO2 monitoring data and data from the new version V5.1 of the Handbook of emission factors (HBEFA) (not published yet).

- CO_2-CF for gasoline PC from 2021 onwards = 20%
- CO_2-CF for diesel PC from 2021 onwards = 18%

Methodological changes

Assumptions of **specific mileage for inland/domestic** road transport activity

Starting with the submission 2020 growth rates of the automatic permanent counting stations on the high-level road network were no longer used to annually extrapolate specific mileage from the previous year's level. Instead, data from the central annual "sticker check" (ZBD; in accordance with §57a KFG) have been used for all inland road transport (Austrian and foreign vehicles being operated on the Austrian road network).

Although comparisons with the mileage resulting from the replaced method showed similar results for 2020, an increasing gap in mileage became obvious between the two methods from the pandemic year 2020 onwards. The mileage of foreign vehicles in Austria is obviously growing faster than that of domestic vehicles in Austria. Conversely, this means that by giving priority to the information from the ZBD (only for vehicles registered in Austria), the total mileage on the Austrian road network was systematically underestimated in the recent submissions and too high fuel quantities were attributed to fuel exports.

The finding for this submission and for the future is that it is not permissible to use the specific mileage according to the ZBD for all motor vehicle traffic on Austria's roads.

The method has been changed now back to the previous approach and means a shift in fuel consumption and emissions from fuel exports to domestic consumption for the whole time-series. Total fuel sales have not been revised.

The changes in car mileage represent the largest difference compared to the previous year's inventory and methodically correctly shift energy consumption and emissions from fuel export to inland. The overall changes in CO_2 emissions amounts to +0.03 kt in 1990 (+0.0001% of national total and -0.0002% of 1.A.3) and +46.43 kt in 2022 (0.08% of national total and 0.23% of 1.A.3). CH_4 and N_2O have also changed. CH_4: 1990: +15.39 kg; 2022: +14.06 kg (0.01% of national total and 1.9% of 1.A.3). N_2O: 1990: +0.85 kg; 2022: +24.11 kg (+0.2% of national total and +3.06% of 1.A.3).

Planned improvements

The implementation of emission factors for emission standard (e.g. EURO 7) are planned with the next update of HBEFA.

3.2.13.3 1.A.3.c Railways

Key Source: No

In this category emissions from diesel railcars and steam engines are considered.

Methodological Issues

The used methodology corresponds to the requirements of the IPCC 2006 GL Tier 2 methodology. The applied methodology is described in the subchapter on mobile sources of CRT *1.A.2.g.vii*.

Activity Data & Emission Factors

Activities used for estimating the emissions and the implied emission factors of CRT *1.A.3.c* are presented below. In the following table the activity data includes all energy sources (including hard coal). The increasing substitution of fossil fuels with biofuels can be observed from 2005 onwards. Details concerning emission factors for mobile off-road sources are described in the subchapter on mobile sources of CRT*1.A.2.g.vii*.

Table 81: Implied emission factors and activity data for 1.A.3.c Railways 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	2 380	74.8	3.8	25.3
1995	1 987	74.8	3.7	25.6
2000	1 815	74.5	3.5	26.5
2005	2 187	73.6	3.2	26.1
2010	2 026	70.3	2.3	22.0
2011	1 714	70.3	2.1	21.0
2012	1 763	70.1	2.0	20.1
2013	1 510	70.4	1.8	18.9
2014	1 637	70.2	1.6	17.6
2015	1 245	69.8	1.6	16.9
2016	1 254	70.3	1.6	16.6
2017	1 368	70.7	1.5	16.0
2018	1 307	70.7	1.5	15.7
2019	1 307	70.9	1.5	15.3
2020	1 149	70.9	1.5	15.0
2021	1 140	70.8	1.4	14.7
2022	1 136	70.9	1.4	14.4
2023	1 042	70.4	1.4	14.2

Recalculations

No category-specific recalculations have been made.

Planned improvements

No category-specific improvements are planned.

3.2.13.4 1.A.3.d Navigation

Key Source: No

This sector includes emissions from gas/diesel oil and gasoline fuelled ships used by vessels and ships of all flags that depart and arrive per trip within Austria. The main sources are the river Danube and some other smaller rivers and lakes.

Methodological Issues

The used methodology conforms to the requirements of the IPCC 2006 GL Tier 2 methodology.

Austria uses the bottom-up model GEORG (Hausberger, 2000) to calculate the national fuel consumption of navigation which is made up of freight transport activities on the River Danube and passenger transport on rivers and lakes in Austria. Passenger transport is conducted with passenger ships, private motor boats and sailing boats. The inland navigation fleet (stock) was obtained from registration statistics from provincial governments , the average yearly operating time as well as the average fuel consumption per hour from questionnaires to fleet operators and/or manufacturers' data.

Statistical data (Tkm) for freight activities on the River Danube are obtained from (Via Donau, 2024). Additionally, fuel consumption for working boats is taken into account in the national fuel consumption of navigation. For detailed methodological issues of the model GEORG see CRT *1.A.2 g.vii.*

Since the **submission 2011**, building on data used in the model GEORG (see CRT *1.A.2.g.vii*), domestic navigation has been calculated following the bottom-up approach – the assumption being that domestic navigation is navigation between harbours located in Austria using the transport, expressed in

tons x kilometer → (GWh/tkm*tkm; CO_2/tkm*tkm etc.)

The applied methodology for estimating emissions of international navigation is described in subchapter 3.2.2.1 International bunker fuels.

Activity Data & Emission Factors

Activity data is updated yearly for freight activities on the River Danube and is obtained from (Via Donau, 2024). Emission factors were last updated in a study within the submission 2021 (Schwingshackl, et al., 2020) which resulted in

- Updated fuel consumption factors (in g/tkm) of Danube freight shipping. According to studies of real fuel consumption (including empty runs, including secondary consumers) current consumption in the upper Danube region amounts to 8.5 g/tkm.
- Updated activities of passenger shipping (Danube, other rivers and lakes), which reflects the trend towards significantly higher activities than assumed before.

Activities used for estimating the emissions and the implied emission factors of CRT *1.A.3.*are presented below. In the following table the activity data includes all energy sources. The increasing substitution of fossil fuels with biofuels can be observed from 2005 onwards. Details concerning emission factors for mobile off-road sources are described in the subchapter on mobile sources of *1.A.2.g.vii*.

Table 82: Implied emission factors and activity data for 1.A.3.d Domestic Navigation 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	374	74.9	93.9	22.3
1995	459	74.7	74.4	24.7
2000	564	74.6	55.2	27.1
2005	741	74.0	36.6	26.7
2010	782	70.3	26.4	24.5
2011	838	70.3	23.4	24.3
2012	768	70.2	23.7	23.5
2013	814	70.4	21.2	23.1
2014	909	70.2	18.1	22.7
2015	936	69.8	16.6	22.1
2016	974	70.3	15.2	21.7
2017	1 025	70.6	13.9	21.5
2018	1 061	70.5	12.9	21.1
2019	1 183	70.7	11.3	20.9
2020	331	70.3	31.6	16.0
2021	501	70.6	20.9	18.2
2022	972	70.7	11.7	20.4
2023	987	70.0	11.2	20.5

Quality Assurance and Quality Control (QA/QC)

Harmonization CRF/CRT and IEA data

In 2013 the ERT detected inconsistencies of fuel consumption data of domestic aviation and domestic navigation between the CRF tables and the IEA data (ICR 2013). In response to that it was explained that Austria uses a bottom-up approach to estimate fuel consumption whilst IEA relies on top-down approach based on fuel consumption statistics reported by Statistics Austria.

After having discussed this issue with Statistics Austria an Explanatory Note (30/09/2013) has been compiled by Statistics Austria declaring that a regular adoption of inventory data for the split between national and international fuel consumption in civil aviation and navigation in the national statistics will be adopted in the future, as far as the data can be submitted in time (early November).

As part of regular QA/QC the energy split between national and international navigation is provided to Statistics Austria for the IEA statistics based on the bottom up model used to calculate the annual emission inventory.

Completeness

In response to a question raised by the ERT (ICR 2013) Austria explained that emissions of ground activities at domestic harbours are also included, even if they are not separately reported under *1.A.3.e.2 Other.* All registered road vehicles – including those in ports - are taken into account in the emission calculation of *1.A.3.b*. Fuel consumption and emissions of any other port handling equipment are included in the overall calculation. This is ensured because Austria reports emissions from **total fuel sold** from the national energy balance (see chapter on *1.A.3.b. Road Transport – Top down Methodology – Fuel sold*).

Recalculations

In the GEORG shipping module rounding adjustments were made to the operation hours of occasional shipping from 2019 onwards, resulting in minor changes.

For source category *1.A.3.d*, year 2022, this resulted in the following recalculations: CO_2 of -216 kg (-0.0003% of category *1.A.4.c.2*).). CH_4 and N_2O have also changed. CH_4: -0.4 kg. N_2O: +3.5 kg.

Planned improvements

No category-specific improvements are planned.

1.A.3.e Other Transportation

Key Source: Yes (CO_2: gaseous)

3.2.13.5 1.A.3.e.i Other Transportation – Pipeline Compressors

Category *1.A.3.e Other Transportation* enfolds emissions from pipeline transport by gas turbine driven compressors. The share in GHG emissions from sector *1.A* is 0.4% for the year 1990 and 0.1% for the year 2023. The increase of emissions is mainly caused by the increase of natural gas transfer through Austria. Since 2020 emissions have decreased due to the substitution of gas turbines with electric motors.

Methodology

The IPCC Tier 2 methodology is applied for CO_2 and a Tier 1 methodology is applied for CH_4 and N_2O.

Activity data

Activity data (fuel consumption) is taken from (IEA JQ 2024) as presented in Annex 3.4.

Emission factors

The CO_2 emission factor for natural gas is taken from a national study (BMWA 1996).

N_2O and CH_4 emission factors are default values from the IPCC 2006 Guidelines.

Table 83: Emission factors of Category 1.A.3.e.

Fuel	CO_2 [t/TJ]	CH_4 [kg/TJ]	N_2O [kg/TJ]
Natural Gas	55.60	1.00	0.10

Recalculations

Activity data for 2019 to 2022 was revised slightly by using the (slightly higher) ETS natural gas consumption instead of the data provided in the national energy balance.

3.2.13.6 1.A.3.e.ii Other – Airport Ground Activities

This sector includes emissions from airport ground activities at all Austrian airports. Freight and car traffic to and from the airport is excluded and part of CRT *1.A.3.b*.

Methodological Issues

The used methodology conforms to the requirements of the IPCC 2006 GL Tier 3 methodology. Country-specific technology-based emission factors (IEFs taken from CRT *1.A.3.b*) are available.

Based on a recommendation made by the UNFCCC during the 2020 Review, Austria collected fuel consumption data of mobile sources used for aircraft handling from Vienna's International Airport. Based on this information emissions for aircraft handling on all Austrian airports were estimated and are now reported separately under CRT *1.A.3.e.2*. Emissions from this source were previously part of CRT *1.A.3.b.*

The share between the biggest airport VIE (Vienna) and the other five Austrian airports (GRZ, INN, KLU, LNZ, SZG) was calculated on the basis of the most recent evaluation of FC and CO_2 emissions from all Austrian airports for 2010 (Mathä, Ellinger, 2011). With the help of absolut FC numbers at VIE airport in 2019 (Ellinger, KRACHER, 2021) and the share for the sum of the other Austrian airports in 2010 the total activity data for CRT *1.A.3.e.2* was calculated for 2019. Second, a constant fuel consumption factor per flight movement was calculated and multiplied with yearly IFR flight movements (with departure airport in Austria) to create the FC time series for 1990 - 2020. Third, for the calculation of emissions time series, the activity data of each fuel type have been multiplied with yearly fuel type specific IEFs for road trucks (RT) and passenger cars (PC) taken from CRT *1.A.3.b*:

- HDV-RT Gasoline Size I
- HDV-RT Diesel Size II
- PC CNG Average

Activity Data & Emission Factors

Activities include liquid fuels (diesel, gasoline and biofuels) and gaseous fuels (CNG). The quantities of liquid and gaseous fuels used at airports represent only tiny proportion of total national fuel sales.

Due to the minor dimension of CRT *1.A.3.e.2* IEFs for all years and air pollutant are not being displayed separately.

Recalculations

No category specific recalculations have been carried out.

Planned improvements

No category-specific improvements are currently planned.

3.2.14 Other Sectors (CRT Category 1.A.4)

Category *1.A.4 Other Sectors* enfolds emissions from stationary fuel combustion in the small combustion sector. It also includes emissions from mobile sources in households and gardening including snow cats and skidoos as well as from agriculture and forestry.

The share in total GHG emissions from sector *1.A* is 28% for the year 1990 and 16% for the year 2023.

3.2.14.1 1.A.4 Other Sectors – Stationary Combustion

Key Source: CO_2 from liquid (*1.A.4.a, 1.A.4.b, 1.A.4.c*), solid (*1.A.4.b*), gaseous (*1.A.4.a, 1.a.4.b*); CH_4 from biomass and solid fuels (*1.A.4.b*)

Category *1.A.4 Other Sectors – Stationary Combustion* includes emissions from stationary fuel combustion in the small combustion sector. Emissions from public district heating plants are included in category *1.A.1.a Public Electricity and Heat Production*. Emissions of district heat generation delivered to third parties by industry are included in *1.A.2 Manufacturing Industries and Construction*.

3.2.14.1.1 Methodology

For calculation of CO_2 emissions from fossil fuels and CH_4 emissions from solid biomass (fuel wood and wood waste), the IPCC Tier 2 methodology is applied. For calculation of CH_4 emissions from liquid, solid and gaseous fuels, other biomass (biogas, sewage sludge gas and landfill gas, charcoal), peat and other fuels and for calculation of N_2O emissions from all fuel types, the Tier 1 methodology is applied.

Total fuel consumption for each of the sub categories of *1.A.4 Other Sectors – Stationary Combustion* is taken from (International Energy Agency, 2024) and the national energy balance (Statistik Austria, 2024d). This approach provides the most detailed data over time series, while both data sources are different in structure but consistent. From the view of energy statistics compilers this sector is sometimes the residual of gross inland fuel consumption because fuel consumption data of energy industries and manufacturing industry is collected each year in more detail and therefore of higher quality. However, in case of the Austrian energy balance fuel consumption of the small combustion sector is modelled over time series in consideration of heating degree days, micro census data and service industries survey panel.

Information about type of heating is derived from an energy demand model for space heating based on heating market surveys and on federal provinces data validated by micro census surveys and calibrated according to the energy statistics supplier. A clear distinction between 'real' public district heating or micro heating networks which serve several buildings under the same ownership cannot always be made by the interviewed person or interviewers.

The energy demand model for space heating, consists of five consecutive modules:

- **Building and dwelling stock:** by building type, year of construction, type of residence (number of buildings and dwellings, net floor area, useful area, number of residents) (Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft, Oktober

2024, Österreichisches Statistisches Zentralamt, 1973, Österreichisches Statistisches Zentralamt, 1982, Österreichisches Statistisches Zentralamt, 1992b, Statistik Austria, 2004, Statistik Austria, 2013b,

- **Heating type by energy carrier:** by categories of module 'building and dwelling stock' and energy carrier including heat pumps, district heating, solar thermal and electric heating (number of buildings and dwellings, net floor area, useful area, number of residents) (Statistik Austria, 2019, Statistik Austria, 2021b, Statistik Austria, 2023c)
- **Heating type by technology:** by categories of module 'building and dwelling stock', type of application (as main or auxiliary heating) and twenty-two technology and fuel dependent subcategories (number of buildings and dwellings, net floor area, useful area, residents) (Amt der Burgenländischen Landesregierung, 2021, Amt der Steiermärkischen Landesregierung, 2021, Amt der Vorarlberger Landesregierung, 2021, e7 Energie Markt Analyse GmbH, November 2009, e7 Energie Markt Analyse GmbH, 2017, e7 Energie Markt Analyse GmbH, März 2017, Land Salzburg, 2021)
- **Building energy performance:** by categories of module 'building and dwelling stock' based on type of energy-efficient building renovation, year of construction and residents (space heating demand, hot water demand) (Austrian Energy Agency, 2015, Bundesministerium für Wissenschaft, Forschung und Wirtschaft, 2014)
- **Final energy demand by technology:** by categories of module 'heating type by technology' based on results of module 'building energy performance' considering heating degree days (Geosphere Austria, Statistik Austria, 2024) and calibrated according to the energy statistics supplier to maintain consistency with fuel demand reported in (International Energy Agency, 2024) and (Statistik Austria, 2024d)

There are twenty-two technology and fuel dependent main subcategories (heating types) for category *1.A.4 Other Sectors – Stationary Combustion* as presented in the following table.

Table 84: Heating types of category 1.A.4. Other Sectors – Stationary Combustion

No.	Heating type	Fuel
#1	Fuel oil boilers	Light fuel oil, medium fuel oil, heavy fuel oil, diesel, petroleum, other petroleum products
#2	Gas oil stoves	Gas oil
#3	Vapourizing burners	Gas oil
#4	Yellow burners	Gas oil
#5	Blue burners with conventional technology	Gas oil
#6	Blue burners with low temperature or condensing technology	Gas oil
#7	Natural gas convectors	Natural gas
#8	Atmospheric burners	Natural gas, biogas, sewage sludge gas and landfill gas
#9	Forced-draft natural gas burners	Natural gas, biogas, sewage sludge gas and landfill gas
#10	LPG stoves	Liquefied petroleum gases
#11	LPG boilers	Liquefied petroleum gases
#12	Wood stoves and cooking stoves	Fuel wood
#13	Tiled wood stoves and masonry heaters	Fuel wood

No.	Heating type	Fuel
#14	Mixed-fuel wood boilers	Fuel wood
#15	Natural-draft wood boilers	Fuel wood
#16	Forced-draft wood boilers	Fuel wood
#17	Wood chips boilers with conventional technology	Wood waste
#18	Wood chips boilers with oxygen sensor emission control	Wood waste
#19	Pellet stoves	Wood waste
#20	Pellet boilers	Wood waste
#21	Coal stoves	Hard coal and Hard coal briquettes, lignite and brown coal, brown coal briquettes, coke, peat
#22	Coal boilers	Hard coal and Hard coal briquettes, lignite and brown coal, brown coal briquettes, coke, peat, industrial waste

In addition, the whole fuel consumption of charcoal is assumed to be combusted in devices similar to *#12 Wood stoves and cooking stoves* and calculated separately. For each technology a fuel dependent emission factor is applied.

3.2.14.1.2 Activity Data

Total fuel consumption for each of the sub categories of *1.A.4* is taken from (International Energy Agency, 2024) and (Statistik Austria, 2024d) as presented in Annex 3.4 (further details also given in section *Methodology* above).

Fuel Consumption by Fuel Group

Total fuel consumption of *1.A.4.a.1*, *1.A.4.b.1* and *1.A.4.c.1* is divided into 6 fuel groups (liquid, solid, gaseous, biomass, peat and other) (see Table 85, Table 86 and Table 87).

Table 85: Fuel consumption from 1.A.4.a.1 Commercial/Institutional: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	1.A.4.a.1						
Fuel group	**Total**	**Liquid**	**Solid**	**Gaseous**	**Biomass**	**Peat**	**Other**
Year	**[PJ]**						
1990	35.39	18.66	0.96	12.60	2.06	NO	1.11
1995	50.64	17.64	0.64	29.29	2.55	NO	0.52
2000	47.43	17.84	1.10	23.67	4.26	NO	0.56
2005	54.73	26.86	0.71	23.16	2.92	NO	1.07
2010	31.09	9.49	0.22	17.19	4.13	NO	0.06
2011	27.33	8.83	0.15	14.99	3.32	NO	0.05
2012	25.11	6.05	0.00	16.39	2.66	NO	NO
2013	25.78	5.87	0.01	17.01	2.82	NO	0.07

CRT	1.A.4.a.1						
Fuel group	**Total**	**Liquid**	**Solid**	**Gaseous**	**Biomass**	**Peat**	**Other**
Year	**[PJ]**						
2014	22.72	6.01	0.00	14.27	2.36	NO	0.08
2015	24.11	5.95	0.00	15.12	2.96	NO	0.08
2016	22.56	5.60	NO	14.37	2.49	NO	0.09
2017	26.63	7.73	NO	15.10	3.73	NO	0.08
2018	25.97	6.71	NO	15.43	3.74	NO	0.09
2019	26.52	6.25	NO	16.11	4.07	NO	0.10
2020	25.13	6.00	NO	15.15	3.97	NO	0.01
2021	29.70	7.80	NO	17.45	4.45	NO	0.01
2022	23.72	6.59	NO	13.02	4.11	NO	0.01
2023	20.26	2.90	NO	14.27	3.09	NO	0.01
1990–2023	**-43%**	**-84%**	**-100%**	**+13%**	**+50%**	**NO**	**-100%**
2022–2023	**-15%**	**-56%**	**NO**	**+9.6%**	**-25%**	**NO**	**-6.5%**

NO…not occurring

Table 86: Fuel consumption from 1.A.4.b.1 Residential: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	1.A.4.b.1						
Fuel group	**Total**	**Liquid**	**Solid**	**Gaseous**	**Biomass**	**Peat**	**Other**
Year	**[PJ]**						
1990	191.02	72.50	26.62	33.50	58.40	0.0044	NO
1995	200.23	75.59	17.56	44.28	62.80	0.0044	NO
2000	190.62	72.60	9.05	48.90	60.07	0.0044	NO
2005	192.43	63.88	3.97	65.71	58.86	0.0044	NO
2010	199.34	55.88	2.61	65.47	75.38	0.0044	NO
2011	179.92	48.34	1.69	58.18	71.71	0.0044	NO
2012	180.81	44.01	1.77	59.22	75.81	0.0044	NO
2013	186.20	47.32	1.35	59.83	77.69	0.0044	NO
2014	163.15	41.46	1.11	52.40	68.18	0.0044	NO
2015	173.62	43.18	0.91	56.97	72.55	0.0044	NO
2016	181.09	42.84	0.87	62.82	74.56	NO	NO
2017	180.66	43.35	0.96	61.50	74.85	NO	NO
2018	164.63	38.58	0.82	56.28	68.95	NO	NO
2019	169.63	38.84	0.83	59.49	70.46	NO	NO
2020	171.20	39.80	0.58	60.05	70.78	NO	NO
2021	192.97	41.64	0.41	65.05	85.88	NO	NO
2022	162.69	35.68	0.35	54.19	72.46	NO	NO

CRT				1.A.4.b.1			
Fuel group	**Total**	**Liquid**	**Solid**	**Gaseous**	**Biomass**	**Peat**	**Other**
Year				**[PJ]**			
2023	148.43	28.96	0.29	49.22	69.97	NO	NO
1990–2023	**-22%**	**-60%**	**-99%**	**+47%**	**+20%**	**-100%**	**NO**
2022–2023	**-8.8%**	**-19%**	**-18%**	**-9.2%**	**-3.4%**	**NO**	**NO**

NO...not occurring

Table 87: Fuel consumption from 1.A.4.c.1 Agriculture/Forestry/Fishing: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT				1.A.4.c.1			
Fuel group	**Total**	**Liquid**	**Solid**	**Gaseous**	**Biomass**	**Peat**	**Other**
Year				**[PJ]**			
1990	10.26	5.34	0.55	0.37	4.01	NO	NO
1995	7.68	2.30	0.39	0.49	4.49	NO	NO
2000	8.46	2.79	0.18	0.54	4.95	NO	NO
2005	8.11	1.47	0.12	0.77	5.75	NO	NO
2010	7.80	0.53	0.06	0.84	6.37	NO	NO
2011	7.30	0.42	0.04	0.72	6.13	NO	NO
2012	7.56	0.42	0.04	0.46	6.64	NO	NO
2013	8.34	0.53	0.03	0.51	7.28	NO	NO
2014	7.84	0.56	0.02	0.56	6.70	NO	NO
2015	8.02	0.50	0.02	0.62	6.88	NO	NO
2016	8.41	0.60	0.02	0.74	7.05	NO	NO
2017	8.68	0.28	0.03	1.01	7.37	NO	NO
2018	7.86	0.25	0.02	0.90	6.68	NO	NO
2019	7.48	0.16	0.02	1.09	6.21	NO	NO
2020	7.35	0.17	0.02	0.91	6.26	NO	NO
2021	8.58	0.18	0.01	0.97	7.42	NO	NO
2022	8.00	0.14	0.01	0.85	7.01	NO	NO
2023	7.42	0.13	0.01	0.47	6.81	NO	NO
1990–2023	**-28%**	**-97%**	**-99%**	**+28%**	**+70%**	**NO**	**NO**
2022–2023	**-7.3%**	**-6.3%**	**-23%**	**-45%**	**-2.8%**	**NO**	**NO**

NO...not occurring

Fuel Consumption by Fuel

Fuel consumption of liquid fuels, solid fuels and biomass fuels is further subdivided (from *1.A.4.a.1* see Table 88, Table 89 and Table 90, from *1.A.4.b.1* see Table 91, Table 92 and Table 93, from *1.A.4.c.1* see Table 94, Table 95 and

Table 96). All fuel consumption of biogas, sewage sludge gas and landfill gas is assigned to *1.A.4.a.1*. Gaseous fuel consumption applies to natural gas only. All fuel consumption of peat (fuel group) is occuring in *1.A.4.b.1* and is peat (fuel) only. Other fuel consumption is industrial waste only.

3.2.14.1.2.1.1 1.A.4.a.1 Commercial/Institutional: Stationary Combustion

Table 88: Share of liquid fuel consumption from 1.A.4.a.1 Commercial/Institutional: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	1.A.4.a.1							
Fuel group	**Liquid**							
Fuel	**Total**	**Light fuel oil**	**Medium fuel oil**	**Heavy fuel oil**	**Diesel**	**Petroleum and other petroleum products**	**Gas oil**	**Liquefied petroleum gases**
Year	**[% TJ]**							
1990	100.0	48.3	24.0	8.7	NO	5.1	5.9	8.0
1995	100.0	44.2	13.1	2.6	0.1	1.5	22.3	16.1
2000	100.0	19.8	8.2	0.8	0.0	1.5	63.4	6.3
2005	100.0	12.5	NO	NO	0.0	NO	75.6	11.8
2010	100.0	2.3	NO	NO	0.0	NO	68.5	29.2
2011	100.0	8.4	NO	NO	0.0	NO	65.8	25.9
2012	100.0	7.2	NO	NO	0.0	NO	89.9	2.9
2013	100.0	8.3	NO	NO	0.0	NO	88.8	2.8
2014	100.0	10.4	NO	NO	0.0	NO	87.4	2.2
2015	100.0	9.3	NO	NO	0.0	NO	88.3	2.4
2016	100.0	20.1	NO	NO	0.0	NO	77.7	2.2
2017	100.0	7.8	NO	NO	0.0	NO	88.1	4.1
2018	100.0	5.0	NO	NO	0.0	NO	90.7	4.3
2019	100.0	0.4	NO	NO	0.0	NO	94.5	5.1
2020	100.0	0.2	NO	NO	0.0	NO	94.7	5.2
2021	100.0	0.1	NO	NO	NO	NO	95.4	4.6
2022	100.0	0.1	NO	NO	NO	NO	95.7	4.2
2023	100.0	0.1	NO	NO	NO	NO	96.1	3.8

NO…not occurring

Table 89: Share of solid fuel consumption from 1.A.4.a.1 Commercial/Institutional: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	1.A.4.a.1				
Fuel group	**Solid**				
Fuel	**Total**	**Hard coal and hard coal briquettes**	**Lignite and brown coal**	**Brown coal briquettes**	**Coke**
Year	**[% TJ]**				
1990	100.0	33.5	10.4	16.5	39.6
1995	100.0	34.4	8.1	19.2	38.3
2000	100.0	23.3	3.4	59.1	14.2
2005	100.0	38.5	1.4	45.1	14.9
2010	100.0	6.2	2.8	70.9	20.2
2011	100.0	7.8	1.5	65.1	25.5
2012	100.0	NO	NO	NO	100.0
2013	100.0	94.8	NO	NO	5.2
2014	100.0	NO	NO	NO	100.0
2015	100.0	NO	NO	NO	100.0
2016	NO	NO	NO	NO	NO
2017	NO	NO	NO	NO	NO
2018	NO	NO	NO	NO	NO
2019	NO	NO	NO	NO	NO
2020	NO	NO	NO	NO	NO
2021	NO	NO	NO	NO	NO
2022	NO	NO	NO	NO	NO
2023	NO	NO	NO	NO	NO

NO…not occurring

Table 90: Share of biomass fuel consumption from 1.A.4.a.1 Commercial/Institutional: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	1.A.4.a.1				
Fuel group	**Biomass**				
Fuel	**Total**	**Fuel wood**	**Wood waste**	**Biogas, sewage sludge gas and landfill gas**	**Charcoal**
Year	**[% TJ]**				
1990	100.0	64.6	30.9	NO	4.5
1995	100.0	45.8	23.6	25.8	4.9
2000	100.0	8.1	77.1	11.9	2.9
2005	100.0	20.2	61.4	13.5	4.9
2010	100.0	14.7	71.0	10.7	3.6
2011	100.0	15.4	67.7	12.7	4.2

CRT			1.A.4.a.1		
Fuel group			**Biomass**		
Fuel	**Total**	**Fuel wood**	**Wood waste**	**Biogas, sewage sludge gas and landfill gas**	**Charcoal**
Year			**[% TJ]**		
2012	100.0	6.8	71.9	15.3	6.0
2013	100.0	6.7	75.2	12.7	5.4
2014	100.0	5.5	69.2	19.2	6.1
2015	100.0	3.2	74.9	15.8	6.0
2016	100.0	3.8	65.8	22.9	7.5
2017	100.0	5.7	74.6	15.5	4.3
2018	100.0	5.1	77.2	12.8	4.8
2019	100.0	5.2	78.9	11.5	4.4
2020	100.0	5.2	78.2	12.0	4.6
2021	100.0	5.4	79.6	10.9	4.1
2022	100.0	4.5	67.8	24.2	3.5
2023	100.0	1.4	61.3	33.0	4.3

NO…not occurring

3.2.14.1.2.1.2 1.A.4.b.1 Residential: Stationary Combustion

Table 91: Share of liquid fuel consumption from 1.A.4.b.1 Residential: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT					1.A.4.b.1			
Fuel group					**Liquid**			
Fuel	**Total**	**Light fuel oil**	**Medium fuel oil**	**Heavy fuel oil**	**Diesel**	**Petroleum and other petro-leum products**	**Gas oil**	**Liquefied petroleum gases**
Year					**[% TJ]**			
1990	100.0	26.6	NO	NO	NO	0.9	71.4	1.0
1995	100.0	10.4	NO	NO	NO	0.0	88.0	1.6
2000	100.0	13.3	NO	NO	NO	NO	83.5	3.2
2005	100.0	7.3	NO	NO	NO	NO	89.6	3.1
2010	100.0	2.2	NO	NO	NO	NO	95.0	2.7
2011	100.0	1.1	NO	NO	NO	NO	96.7	2.3
2012	100.0	0.6	NO	NO	NO	NO	96.8	2.6
2013	100.0	0.4	NO	NO	NO	NO	96.9	2.7
2014	100.0	NO	NO	NO	NO	NO	97.4	2.6
2015	100.0	NO	NO	NO	NO	NO	97.5	2.5
2016	100.0	NO	NO	NO	NO	NO	97.4	2.6

CRT	1.A.4.b.1							
Fuel group	**Liquid**							
Fuel	**Total**	**Light fuel oil**	**Medium fuel oil**	**Heavy fuel oil**	**Diesel**	**Petroleum and other petro-leum products**	**Gas oil**	**Liquefied petroleum gases**
Year	**[% TJ]**							
2017	100.0	NO	NO	NO	NO	NO	97.0	3.0
2018	100.0	NO	NO	NO	NO	NO	96.8	3.2
2019	100.0	NO	NO	NO	NO	NO	96.8	3.2
2020	100.0	NO	NO	NO	NO	NO	96.8	3.2
2021	100.0	NO	NO	NO	NO	NO	96.7	3.3
2022	100.0	NO	NO	NO	NO	NO	97.0	3.0
2023	100.0	NO	NO	NO	NO	NO	96.3	3.7

NO...not occurring

Table 92: Share of solid fuel consumption from 1.A.4.b.1 Residential: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	1.A.4.b.1				
Fuel group	**Solid**				
Fuel	**Total**	**Hard coal and hard coal briquettes**	**Lignite and brown coal**	**Brown coal briquettes**	**Coke**
Year	**[% TJ]**				
1990	100.0	18.5	8.5	15.5	57.5
1995	100.0	21.8	6.2	16.0	56.0
2000	100.0	22.4	6.6	14.9	56.1
2005	100.0	28.2	3.8	15.7	52.3
2010	100.0	25.3	3.7	16.0	55.0
2011	100.0	25.8	2.5	16.0	55.7
2012	100.0	26.5	2.2	17.3	54.0
2013	100.0	28.2	3.5	21.6	46.7
2014	100.0	28.6	2.8	21.6	47.0
2015	100.0	29.4	4.1	21.5	45.0
2016	100.0	28.8	3.1	20.5	47.7
2017	100.0	37.2	3.9	26.1	32.8
2018	100.0	39.8	3.7	29.3	27.2
2019	100.0	37.7	3.9	23.1	35.3
2020	100.0	19.6	5.2	32.8	42.4
2021	100.0	18.9	3.0	57.0	21.1
2022	100.0	20.4	3.2	44.7	31.6
2023	100.0	24.0	2.9	34.7	38.3

Table 93: Share of biomass fuel consumption from 1.A.4.b.1 Residential: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT			**1.A.4.b.1**		
Fuel group			**Biomass**		
Fuel	**Total**	**Fuel wood**	**Wood waste**	**Biogas, sewage sludge gas and landfill gas**	**Charcoal**
Year			**[% TJ]**		
1990	100.0	98.5	1.3	NO	0.2
1995	100.0	97.5	2.2	IE[1], NO[2]	0.2
2000	100.0	92.2	7.5	IE[1], NO[2]	0.3
2005	100.0	90.1	9.5	IE[1], NO[2]	0.4
2010	100.0	85.5	14.2	IE[1], NO[2]	0.3
2011	100.0	83.5	16.3	IE[1], NO[2]	0.3
2012	100.0	82.6	17.1	IE[1], NO[2]	0.3
2013	100.0	81.8	18.0	IE[1], NO[2]	0.3
2014	100.0	80.7	19.0	IE[1], NO[2]	0.3
2015	100.0	78.4	21.2	IE[1], NO[2]	0.4
2016	100.0	78.2	21.5	IE[1], NO[2]	0.4
2017	100.0	77.9	21.8	IE[1], NO[2]	0.3
2018	100.0	77.1	22.5	IE[1], NO[2]	0.4
2019	100.0	76.4	23.2	IE[1], NO[2]	0.4
2020	100.0	76.2	23.4	IE[1], NO[2]	0.4
2021	100.0	74.1	25.5	IE[1], NO[2]	0.3
2022	100.0	70.1	29.6	IE[1], NO[2]	0.3
2023	100.0	70.5	29.2	IE[1], NO[2]	0.3

IE…included elsewhere

NO…not occuring

[1] Biogas included elsewhere in category 1.A.4.a.1

[2] Sewage sludge gas and landfill gas not occurring in category 1.A.4.b.1

3.2.14.1.2.1.3 1.A.4.c.1 Agriculture/Forestry/Fishing: Stationary Combustion

Table 94: Share of liquid fuel consumption from 1.A.4.c.1 Agriculture/Forestry/Fishing: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	**1.A.4.c.1**							
Fuel group	**Liquid**							
Fuel	**Total**	**Light fuel oil**	**Medium fuel oil**	**Heavy fuel oil**	**Diesel**	**Petroleum and other petroleum products**	**Gas oil**	**Liquefied petroleum gases**
Year	**[% TJ]**							
1990	100.0	97.8	NO	NO	NO	NO	0.8	1.4
1995	100.0	92.3	NO	NO	NO	NO	2.3	5.4
2000	100.0	89.9	NO	NO	NO	NO	1.6	8.6
2005	100.0	82.2	NO	NO	NO	NO	4.0	13.8
2010	100.0	61.1	NO	NO	NO	NO	9.7	29.2
2011	100.0	62.9	NO	NO	NO	NO	10.6	26.5
2012	100.0	61.9	NO	NO	NO	NO	10.7	27.4
2013	100.0	66.8	NO	NO	NO	NO	8.3	24.9
2014	100.0	72.9	NO	NO	NO	NO	6.9	20.2
2015	100.0	69.6	NO	NO	NO	NO	8.0	22.4
2016	100.0	74.7	NO	NO	NO	NO	6.6	18.8
2017	100.0	35.8	NO	NO	NO	NO	15.1	49.1
2018	100.0	NO	NO	NO	NO	NO	48.6	51.4
2019	100.0	NO	NO	NO	NO	NO	20.6	79.4
2020	100.0	NO	NO	NO	NO	NO	21.0	79.0
2021	100.0	NO	NO	NO	NO	NO	21.6	78.4
2022	100.0	NO	NO	NO	NO	NO	22.8	77.2
2023	100.0	NO	NO	NO	NO	NO	19.6	80.4

NO...not occurring

Table 95: Share of solid fuel consumption from 1.A.4.c.1 Agriculture/Forestry/Fishing: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT			**1.A.4.c.1**		
Fuel group			**Solid**		
Fuel	**Total**	**Hard coal and hard coal bri-quettes**	**Lignite and brown coal**	**Brown coal briquettes**	**Coke**
Year			**[% TJ]**		
1990	100.0	5.1	NO	30.0	64.8
1995	100.0	14.2	NO	28.3	57.5
2000	100.0	NO	NO	33.7	66.3
2005	100.0	6.7	NO	54.9	38.4
2010	100.0	8.2	NO	32.8	59.0
2011	100.0	8.8	NO	32.3	58.9
2012	100.0	8.6	NO	34.7	56.8
2013	100.0	8.7	NO	42.8	48.5
2014	100.0	8.1	NO	42.9	49.0
2015	100.0	9.8	NO	43.1	47.2
2016	100.0	8.9	NO	41.0	50.0
2017	100.0	9.3	NO	64.4	26.3
2018	100.0	9.8	NO	69.3	21.0
2019	100.0	13.1	NO	48.2	38.7
2020	100.0	4.9	NO	58.9	36.2
2021	100.0	2.2	NO	81.9	15.9
2022	100.0	1.8	NO	71.7	26.5
2023	100.0	6.3	NO	59.4	34.3

NO…not occurring

Table 96: Share of biomass fuel consumption from 1.A.4.c.1 Agriculture/Forestry/Fishing: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT			**1.A.4.c.1**		
Fuel group			**Biomass**		
Fuel	**Total**	**Fuel wood**	**Wood waste**	**Biogas, sewage sludge gas and landfill gas**	**Charcoal**
Year			**[% TJ]**		
1990	100.0	90.5	9.5	NO	NO
1995	100.0	86.0	14.0	IE[1)], NO[2)]	NO
2000	100.0	70.5	29.5	IE[1)], NO[2)]	NO
2005	100.0	70.6	29.4	IE[1)], NO[2)]	NO
2010	100.0	63.8	36.2	IE[1)], NO[2)]	NO

CRT			1.A.4.c.1		
Fuel group			**Biomass**		
Fuel	**Total**	**Fuel wood**	**Wood waste**	**Biogas, sewage sludge gas and landfill gas**	**Charcoal**
Year			**[% TJ]**		
2011	100.0	61.5	38.5	IE[1], NO[2]	NO
2012	100.0	59.4	40.6	IE[1], NO[2]	NO
2013	100.0	55.0	45.0	IE[1], NO[2]	NO
2014	100.0	51.7	48.3	IE[1], NO[2]	NO
2015	100.0	52.2	47.8	IE[1], NO[2]	NO
2016	100.0	52.1	47.9	IE[1], NO[2]	NO
2017	100.0	49.9	50.1	IE[1], NO[2]	NO
2018	100.0	50.1	49.9	IE[1], NO[2]	NO
2019	100.0	54.7	45.3	IE[1], NO[2]	NO
2020	100.0	54.3	45.7	IE[1], NO[2]	NO
2021	100.0	54.1	45.9	IE[1], NO[2]	NO
2022	100.0	45.7	54.3	IE[1], NO[2]	NO
2023	100.0	45.7	54.3	IE[1], NO[2]	NO

IE…included elsewhere

NO…not occuring

[1] Biogas included elsewhere in category 1.A.4.a.1

[2] Sewage sludge gas and landfill gas not occurring in category 1.A.4.c.1

Fuel Consumption by Heating Type

The fuel consumption reported in (International Energy Agency, 2024) and (Statistik Austria, 2024d) is assigned to twenty-two heating types (see section *Methodology* above).

If occuring, all fuel consumption of light fuel oil, medium fuel oil, heavy fuel oil, diesel, and petroleum and other petroleum products is assigned to heating type *#1 Fuel oil boilers*. Fuel consumption of gas oil is assigned to 5 different heating types *(#2 Gas oil stoves*, *#3 Vapourizing burners*, *#4 Yellow burners*, *#5 Blue burners with conventional technology*, *#6 Blue burners with low temperature or condensing technology*). Fuel consumption of liquefied petroleum gas is assigned to 2 different heating types *(#10 LPG stoves*, *#11 LPG boilers*) (from *1.A.4.a.1* see Table 97, from *1.A.4.b.1* see Table 100).

If occuring, all fuel consumption of hard coal and hard coal briquettes, lignite and brown coal, brown coal briquettes and coke is assigned to two different types of heating *(#21 Coal stoves*, *#22 Coal boilers)* with the same share (from *1.A.4.a.1* see Table 98, from *1.A.4.b.1* see Table 101).

Fuel consumption of natural gas is assigned to three different heating types *(#7 Natural gas convectors*, *#8 Atmospheric burners*, *#9 Forced-draft natural gas burners*) (from *1.A.4.a.1* see Table 98, from *1.A.4.b.1* see Table 101).

If occuring, fuel consumption of biogas, sewage sludge gas and landfill gas is assigned to two different heatiny types (#8 Atmospheric burners, #9 Forced-draft natural gas burners) (from *1.A.4.a.1* see Table 98, from *1.A.4.b.1* see Table 101).

Fuel consumption of fuel wood (log wood) is assigned to five different heating types *(#12 Wood stoves and cooking stoves*, *#13 Tiled wood stoves and masonry heaters*, *#14 Mixed-fuel wood boilers*, *#15 Natural-draft wood boilers*, *#16 Forced-draft wood boilers*). Fuel consumption of wood waste (wood chips, pellets and other biomass) is assigned to 4 different heating types (*#17 Wood chips boilers with conventional technology*, *#18 Wood chips boilers with oxygen sensor emission control*, *#19 Pellet stoves*, *#20 Pellet boilers*) (from *1.A.4.a.1* see Table 99, from *1.A.4.b.1* see Table 102). In addition, the whole fuel consumption of charcoal is assumed to be combusted in devices similar to central heating and calculated separately.

If occuring, all fuel consumption of industrial waste is assigned to heating type *#22 Coal boilers*.

3.2.14.1.2.1.4 1.A.4.a.1 Commercial/Institutional: Stationary Combustion

The fuel consumption from category *1.A.4.a.1* reported in (International Energy Agency, 2024) and (Statistik Austria, 2024d) is assigned to twenty-two heating types derived from an energy demand model for space heating based on heating market surveys and federal provinces data and calibrated according to the energy statistics supplier (see section *Methodology* above).

Table 97: Percentual liquid fuel consumption by type of heating from 1.A.4.a.1 Commercial/Institutional: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	**1.A.4.a.1**							
Fuel group	**Liquid**							
Fuel	**Other liquid fuels**	**Gas oil**					**Liquefied petroleum gases**	
Heating type No.	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#10**	**#11**
Year	**[% TJ]**	**[%TJ]**					**[%TJ]**	
1990	100.0	10.2	2.3	78.4	1.7	7.4	86.8	13.2
1995	100.0	9.7	1.7	68.7	4.8	15.1	84.7	15.3
2000	100.0	8.9	1.2	56.9	9.1	23.9	81.9	18.1
2005	100.0	8.3	1.0	52.6	9.6	28.5	76.2	23.8
2010	100.0	7.8	0.7	49.3	6.8	35.3	73.1	26.9
2011	100.0	7.7	0.6	48.2	6.0	37.4	72.3	27.7
2012	100.0	7.6	0.5	47.0	5.1	39.7	71.7	28.3
2013	100.0	7.5	0.4	45.7	4.1	42.3	71.1	28.9
2014	100.0	7.4	0.3	44.1	2.9	45.4	70.1	29.9
2015	100.0	7.3	0.1	42.3	1.4	49.0	69.7	30.3
2016	100.0	6.6	0.1	41.7	1.3	50.3	68.2	31.8
2017	100.0	5.9	0.1	41.0	1.1	51.9	66.5	33.5
2018	100.0	5.2	0.1	40.3	1.0	53.5	64.4	35.6

CRT	1.A.4.a.1							
Fuel group	Liquid							
Fuel	Other liquid fuels	Gas oil					Liquefied petro-leum gases	
Heating type No.	#1	#2	#3	#4	#5	#6	#10	#11
Year	[% TJ]	[%TJ]					[%TJ]	
2019	100.0	4.3	0.1	39.5	0.8	55.3	62.1	37.9
2020	100.0	3.4	0.1	38.9	0.6	57.0	59.6	40.4
2021	100.0	2.3	0.1	38.2	0.4	59.0	57.0	43.0
2022	100.0	1.8	0.1	37.2	0.4	60.5	54.2	45.8
2023	100.0	0.6	0.1	36.4	0.4	62.5	53.8	46.2

Table 98: Percentual solid, gaseous and biomass fuel consumption by type of heating from 1.A.4.a.1 Commercial/Institutional: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	1.A.4.a.1						
Fuel group	Solid		Gaseous			Biomass	
Fuel	All solid fuels		Natural gas			Biogas, sewage sludge gas and landfill gas	
Heating type No.	#21	#22	#7	#8	#9	#8	#9
Year	[% TJ]		[%TJ]			[%TJ]	
1990	81.5	18.5	27.1	59.3	13.6	NO	NO
1995	81.5	18.5	19.9	58.1	22.1	72.5	27.5
2000	86.4	13.6	14.7	53.9	31.5	63.1	36.9
2005	89.9	10.1	14.8	49.5	35.7	58.1	41.9
2010	77.5	22.5	15.4	47.7	36.9	56.4	43.6
2011	76.8	23.2	15.8	47.4	36.8	56.3	43.7
2012	69.3	30.7	15.7	47.4	36.8	56.3	43.7
2013	95.3	4.7	15.8	47.5	36.7	56.4	43.6
2014	99.4	0.6	16.5	47.2	36.3	56.5	43.5
2015	99.5	0.5	16.3	47.6	36.1	56.9	43.1
2016	NO	NO	15.6	47.7	36.7	56.5	43.5
2017	NO	NO	14.9	47.6	37.4	56.0	44.0
2018	NO	NO	14.4	47.3	38.3	55.3	44.7
2019	NO	NO	13.6	47.1	39.3	54.5	45.5
2020	NO	NO	12.8	46.9	40.3	53.8	46.2
2021	NO	NO	11.8	46.7	41.5	53.0	47.0
2022	NO	NO	12.3	45.6	42.1	52.0	48.0
2023	NO	NO	8.0	47.0	45.0	51.1	48.9

NO...not occurring

Table 99: Percentual biomass fuel consumption by type of heating from 1.A.4.a.1 Commercial/Institutional: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023 (continued).

CRT	1.A.4.a.1								
Fuel group	**Biomass**								
Fuel	**Fuel wood**					**Wood waste**			
Heating type No.	**#12**	**#13**	**#14**	**#15**	**#16**	**#17**	**#18**	**#19**	**#20**
Year	**[%TJ]**					**[%TJ]**			
1990	1.6	65.0	32.6	NO	0.9	89.8	10.0	NO	0.2
1995	1.6	60.6	34.7	NO	3.2	40.2	13.7	0.9	45.2
2000	2.0	55.3	36.2	NO	6.5	19.3	12.1	2.9	65.7
2005	2.0	70.1	21.5	0.2	6.2	10.9	14.4	5.0	69.7
2010	2.4	83.5	10.9	0.1	3.1	13.4	43.3	3.1	40.3
2011	2.8	85.9	8.7	0.1	2.5	10.6	40.3	3.4	45.6
2012	2.8	88.7	6.6	0.1	1.9	11.3	50.0	2.7	35.9
2013	2.8	91.5	4.4	0.0	1.3	9.1	45.8	3.2	41.9
2014	3.6	93.6	2.2	0.0	0.6	6.5	36.8	3.9	52.7
2015	3.4	96.6	NO	NO	NO	8.5	53.6	2.7	35.2
2016	3.2	96.8	NO	NO	NO	5.5	37.4	4.0	53.1
2017	3.2	96.8	NO	NO	NO	4.5	33.6	4.3	57.6
2018	3.6	96.4	NO	NO	NO	5.3	42.2	3.6	49.0
2019	3.5	96.5	NO	NO	NO	4.9	42.5	3.5	49.1
2020	3.4	96.6	NO	NO	NO	4.5	43.0	3.4	49.0
2021	3.0	97.0	NO	NO	NO	4.2	44.0	3.3	48.5
2022	3.4	96.6	NO	NO	NO	3.8	43.8	3.0	49.4
2023	NO	100.0	NO	NO	NO	3.6	43.5	3.6	49.3

NO…not occurring

3.2.14.1.2.1.5 1.A.4.b.1 Residential: Stationary Combustion

Energy consumption from category *1.A.4.b.1* by type of fuel and by type of heating is derived from an energy demand model for space heating based on heating market surveys and federal provinces data validated with a statistical evaluation of micro census data 1990, 1992, 1999/2000, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020 and 2022 (Österreichisches Statistisches Zentralamt, 1990, Österreichisches Statistisches Zentralamt, 1992a, Statistik Austria, 2002, Statistik Austria, 2019, Statistik Austria, 2021a, Statistik Austria, 2021b, Statistik Austria, 2023b). The calculated shares are used to subdivide total final energy consumption to the several technologies. For the years in between the shares are interpolated. Because the newest census data is always reconsidered to improve previous years' census data evaluation this implies a periodic recalculation in time series. The energy demand model is calibrated according to the energy statistics supplier (see section *Methodology* above).

Table 100: Percentual liquid fuel consumption by type of heating from 1.A.4.b.1 Residential: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	**1.A.4.b.1**							
Fuel group	**Liquid**							
Fuel	**Other liquid fuels**	**Gas oil**					**Liquefied petroleum gases**	
Heating type No.	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#10**	**#11**
Year	**[%TJ]**	**[%TJ]**					**[%TJ]**	
1990	100.0	15.0	12.3	64.2	1.4	7.1	24.5	75.5
1995	100.0	12.7	10.6	57.2	3.7	15.9	16.0	84.0
2000	100.0	10.4	8.1	51.3	7.4	22.8	11.6	88.4
2005	100.0	4.4	7.3	51.9	8.4	28.1	9.8	90.2
2010	100.0	2.8	5.8	48.8	6.1	36.4	14.0	86.0
2011	100.0	2.7	5.4	47.5	5.5	38.9	16.6	83.4
2012	100.0	2.8	4.9	46.3	4.7	41.3	15.8	84.2
2013	100.0	2.8	4.3	44.7	3.9	44.2	15.4	84.6
2014	NO	2.9	3.7	43.0	2.9	47.6	19.1	80.9
2015	NO	2.8	2.9	40.9	1.7	51.7	19.1	80.9
2016	NO	2.6	2.6	40.6	1.5	52.7	17.1	82.9
2017	NO	2.4	2.2	40.2	1.3	53.8	16.0	84.0
2018	NO	2.4	1.8	39.8	1.1	54.8	19.3	80.7
2019	NO	2.4	1.4	39.4	0.9	55.8	21.0	79.0
2020	NO	2.3	1.0	39.1	0.7	56.8	20.7	79.3
2021	NO	2.1	0.6	38.9	0.5	57.9	19.2	80.8
2022	NO	2.1	0.6	37.8	0.5	59.0	21.4	78.6
2023	NO	1.0	0.6	37.2	0.5	60.8	3.7	96.3

NO…not occurring

Table 101: Percentual solid, gaseous and biomass fuel consumption by type of heating from 1.A.4.b.1 Residential: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023.

CRT	**1.A.4.b.1**						
Fuel group	**Solid**		**Gaseous**			**Biomass**	
Fuel	**All solid fuels**		**Natural gas**			**Biogas, sewage sludge gas and landfill gas**	
Heating type No.	**#21**	**#22**	**#7**	**#8**	**#9**	**#8**	**#9**
Year	**[%TJ]**		**[%TJ]**			**[%TJ]**	
1990	30.0	70.0	39.1	53.7	7.2	NO	NO
1995	26.6	73.4	31.9	55.4	12.8	IE[1)], NO[2)]	IE[1)], NO[2)]
2000	23.2	76.8	24.7	55.3	20.0	IE[1)], NO[2)]	IE[1)], NO[2)]

CRT	1.A.4.b.1						
Fuel group	**Solid**		**Gaseous**			**Biomass**	
Fuel	**All solid fuels**		**Natural gas**			**Biogas, sewage sludge gas and landfill gas**	
Heating type No.	**#21**	**#22**	**#7**	**#8**	**#9**	**#8**	**#9**
Year	**[%TJ]**		**[%TJ]**			**[%TJ]**	
2005	18.2	81.8	16.6	56.1	27.3	IE[1], NO[2]	IE[1], NO[2]
2010	17.7	82.3	14.9	51.7	33.4	IE[1], NO[2]	IE[1], NO[2]
2011	24.1	75.9	15.6	50.1	34.4	IE[1], NO[2]	IE[1], NO[2]
2012	24.1	75.9	13.5	50.0	36.5	IE[1], NO[2]	IE[1], NO[2]
2013	24.2	75.8	11.7	49.6	38.7	IE[1], NO[2]	IE[1], NO[2]
2014	22.2	77.8	12.6	47.7	39.7	IE[1], NO[2]	IE[1], NO[2]
2015	19.8	80.2	12.0	47.3	40.7	IE[1], NO[2]	IE[1], NO[2]
2016	22.0	78.0	11.5	46.6	41.9	IE[1], NO[2]	IE[1], NO[2]
2017	24.0	76.0	11.2	45.6	43.3	IE[1], NO[2]	IE[1], NO[2]
2018	26.0	74.0	12.1	43.6	44.2	IE[1], NO[2]	IE[1], NO[2]
2019	28.0	72.0	12.5	42.0	45.4	IE[1], NO[2]	IE[1], NO[2]
2020	33.2	66.8	11.3	41.3	47.4	IE[1], NO[2]	IE[1], NO[2]
2021	39.6	60.4	9.3	40.8	49.9	IE[1], NO[2]	IE[1], NO[2]
2022	42.5	57.5	9.5	39.7	50.7	IE[1], NO[2]	IE[1], NO[2]
2023	44.2	55.8	0.2	42.7	57.0	IE[1], NO[2]	IE[1], NO[2]

IE…included elsewhere

NO…not occuring

[1]Biogas included elsewhere in category 1.A.4.a.1

[2]Sewage sludge gas and landfill gas not occurring in category 1.A.4.b.1

Table 102: Percentual biomass fuel consumption by type of heating from 1.A.4.b.1 Residential: Stationary Combustion 1990, 1995, 2000, 2005 and 2010–2023 (continued).

CRT	1.A.4.b.1								
Fuel group	**Biomass**								
Fuel	**Fuel wood**					**Wood waste**			
Heating type No.	**#12**	**#13**	**#14**	**#15**	**#16**	**#17**	**#18**	**#19**	**#20**
Year	**[%TJ]**					**[%TJ]**			
1990	22.6	8.7	66.6	NO	2.1	89.9	10.1	NO	NO
1995	19.5	8.2	64.9	NO	7.5	39.2	13.6	NO	47.2
2000	16.3	8.1	61.4	NO	14.3	23.7	18.0	NO	58.3
2005	9.5	7.1	60.3	0.9	22.2	23.3	38.2	1.7	36.8
2010	9.1	8.5	53.0	3.6	25.8	8.3	29.1	3.0	59.5
2011	8.8	8.4	52.1	4.0	26.8	6.5	25.8	3.6	64.2

CRT	1.A.4.b.1								
Fuel group	Biomass								
Fuel	Fuel wood					Wood waste			
Heating type No.	#12	#13	#14	#15	#16	#17	#18	#19	#20
Year	[%TJ]					[%TJ]			
2012	9.3	8.9	50.3	4.3	27.2	4.9	22.3	3.6	69.2
2013	9.7	9.4	48.8	4.5	27.5	6.6	33.4	2.8	57.2
2014	10.1	9.6	47.6	4.8	27.9	5.9	33.0	2.8	58.2
2015	10.5	9.9	46.3	5.0	28.3	3.7	22.7	3.5	70.1
2016	10.6	9.9	45.2	5.3	29.0	3.5	22.9	3.7	69.9
2017	10.8	9.8	44.0	5.7	29.8	4.1	29.2	3.6	63.1
2018	11.4	10.1	42.3	6.0	30.2	2.4	18.3	4.5	74.8
2019	12.1	10.4	40.4	6.3	30.7	1.6	12.6	5.3	80.5
2020	11.2	9.2	39.9	7.0	32.7	1.3	11.1	5.4	82.2
2021	10.5	8.1	38.8	7.8	34.8	1.9	18.4	5.1	74.6
2022	9.8	7.0	38.9	8.4	35.8	2.4	24.2	4.4	69.1
2023	8.7	6.6	38.9	9.1	36.7	2.6	28.4	4.7	64.2

NO...not occurring

3.2.14.1.2.1.6 1.A.4.c.1 Agriculture/Forestry/Fishing: Stationary Combustion

The fuel consumption reported in (International Energy Agency, 2024) and (Statistik Austria, 2024d) for category *1.A.4.c.1* is predominantly assigned to implied emission factors derived from category *1.A.4.a.1* assuming similar structure of heating types in both categories (see section *Fuel Consumption by Heating Type* above).

Fuel Consumption by Subcategory of Heating Type

The following table shows biomass share of wood stoves and cooking stoves stock from 2001 which are considered with lower CH_4 emissions than equipment installed before 2001. The selected factors are derived from the energy demand model for space heating (see section *Methodology* above).

Table 103: Share of new and conventional wood stoves and cooking stoves stock 2005 and 2010–2023.

Heating type No.	#12			
Subcategory	Wood stoves and cooking stoves (new)		Wood stoves and cooking stoves (conventional)	
CRT	1.A.4.a.1	1.A.4.b.1	1.A.4.a.1	1.A.4.b.1
Year	[% TJ]		[%TJ]	
2005	11.3	7.9	88.7	92.1
2010	20.6	12.7	79.4	87.3
2011	22.5	14.3	77.5	85.7
2012	24.2	16.6	75.8	83.4

Heating type No.	#12			
Subcategory	Wood stoves and cooking stoves (new)		Wood stoves and cooking stoves (conventional)	
CRT	1.A.4.a.1	1.A.4.b.1	1.A.4.a.1	1.A.4.b.1
Year	[% TJ]		[%TJ]	
2013	26.1	19.0	73.9	81.0
2014	28.1	21.6	71.9	78.4
2015	30.1	24.7	69.9	75.3
2016	31.3	26.4	68.7	73.6
2017	32.7	28.5	67.3	71.5
2018	34.3	29.0	65.7	71.0
2019	35.9	29.7	64.1	70.3
2020	37.7	30.6	62.3	69.4
2021	39.0	31.7	61.0	68.3
2022	41.0	31.9	59.0	68.1
2023	42.3	32.4	57.7	67.6

The following table shows biomass share of mixed-fuel wood boilers stock with (comparatively) advanced technology which are considered with (slightly) lower CH_4 emissions than conventional equipment. The selected factors are derived from the energy demand model for space heating (see section *Methodology* above).

Table 104: Share of advanced and conventional mixed-fuel wood boilers stock 1990, 1995, 2000, 2005 and 2010–2023.

Heating type No.	#14			
Subcategory	Mixed-fuel wood boilers (advanced)		Mixed-fuel wood boilers (conventional)	
CRT	1.A.4.a.1	1.A.4.b.1	1.A.4.a.1	1.A.4.b.1
Year	[% TJ]		[% TJ]	
1990	2.1	2.9	97.9	97.1
1995	8.8	13.6	91.2	86.4
2000	11.9	18.7	88.1	81.3
2005	14.4	19.9	85.6	80.1
2010	13.8	19.9	86.2	80.1
2011	13.7	19.8	86.3	80.2
2012	13.6	19.8	86.4	80.2
2013	13.6	19.8	86.4	80.2
2014	13.5	19.7	86.5	80.3
2015	13.4	19.7	86.6	80.3
2016	13.4	19.3	86.6	80.7
2017	13.3	18.9	86.7	81.1

Heating type No.	#14			
Subcategory	Mixed-fuel wood boilers (advanced)		Mixed-fuel wood boilers (conventional)	
CRT	1.A.4.a.1	1.A.4.b.1	1.A.4.a.1	1.A.4.b.1
Year	[% TJ]		[% TJ]	
2018	13.2	18.3	86.8	81.7
2019	13.1	17.8	86.9	82.2
2020	13.1	17.1	86.9	82.9
2021	13.0	16.4	87.0	83.6
2022	13.0	15.9	87.0	84.1
2023	12.9	15.3	87.1	84.7

3.2.14.1.3 Emission Factors

CO_2 emission factors are taken from studies (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Bundesministerium für wirtschaftliche Angelegenheiten, 1999), elementary analysis of natural gas ((Umweltbundesamt, 2002), until 2018), newly recommended CO_2 emission factor for natural gas ((Bundesministerium für Nachhaltigkeit und Tourismus, 2019), starting from 2019), and the IPCC Guidelines 1996 (IPCC – Intergovernmental Panel on Climate Change, 1996) whereas N_2O emission factors from the IPCC Guidelines 2006 (IPCC, 2006) are used. CO_2 and N_2O emission factors are identical for the different heating types burning the same fuels. The studies also provide CH_4 respectively VOC and C_{org} emission factors for different fuels and heating types.

The C_{org} (Organic Carbon) emission factors provided in (Bundesministerium für wirtschaftliche Angelegenheiten, 1999) are converted into VOC emission factors with the formula VOC = 1.3 * C_{org}. The factor of 1.3 is an expert judgement by Umweltbundesamt as no factor was available from literature. It is based on analytical data of the composition of VOC emissions from the combustion of fuel wood for residential heating.

In some cases only VOC emission factors are provided in the studies, CH_4 emission factors are determined assuming that a certain percentage of VOC emissions is released as NMVOC as listed in Table 105. The split follows closely (Stanzel, et al., 1995).

Table 105: Share of CH_4 and NMVOC in VOC for small combustion devices.

Pollutant		CH_4	NMVOC	VOC
Fuel group	Fuel		[% VOC]	
Liquid	Light fuel oil, Medium fuel oil, Heavy fuel oil	25.0	75.0	100.0
	Petroleum, Gas oil	20.0	80.0	100.0
	Liquefied petroleum gases	80.0	20.0	100.0
Solid	All solid fuels	25.0	75.0	100.0
Gaseous	Natural gas	80.0	20.0	100.0
Biomass	All biomass fuels	25.0	75.0	100.0

From 2001 on new wood stove and cooking stove subtypes are considered which have lower VOC emissions and thus lower CH_4 emissions than conventional wood stoves and cooking stoves. In addition, mixed-fuel wood boilers stock with (comparatively) advanced technology are considered with (slightly) lower CH_4 emissions than conventional equipment.

The selected emission factors for 2023 are presented in the following table.

Table 106: Emission factors of category 1.A.4 heating types for the year 2023.

CRT		1.A.4	1.A.4.a.1	1.A.4.b.1	1.A.4.c.1	1.A.4
Pollutant		**CO_2**		**CH_4**		**N_2O**
Fuel	**Heating type No.**	**[t/TJ]**		**[kg/TJ]**		**[kg/TJ]**
Light fuel oil	#1	77.00	10.00	10.00	10.00	0.60
Medium fuel oil	#1	78.00	10.00	10.00	10.00	0.60
Heavy fuel oil	#1	78.00	10.00	10.00	10.00	0.60
Diesel	#1	75.00	10.00	10.00	10.00	0.60
Petroleum	#1	78.00	10.00	10.00	10.00	0.60
Other petroleum products	#1	64.00	10.00	10.00	10.00	0.60
Gas oil	#2, #3, #4, #5, #6	75.00	3.00	3.00	3.00	0.60
Natural gas	#7, #8, #9	55.60	5.00	5.00	5.00	0.10
Biogas, sewage sludge gas and landfill gas	#8, #9	54.60[1)]	5.00	5.00	5.00	0.10
Liquefied petroleum gases	#10, #11	64.00	5.00	5.00	5.00	0.10
Fuel wood	#12	112.00[1)]	175.89[2)]	186.20[2)]	300.00	4.00
	#13	112.00[1)]	115.61	115.61	300.00	4.00
	#14	112.00[1)]	145.62[3)]	146.32[3)]	300.00	4.00
	#15	112.00[1)]	121.42	121.42	300.00	4.00
	#16	112.00[1)]	112.74	112.74	300.00	4.00
Wood waste	#17	112.00[1)]	150.00	150.00	300.00	4.00
	#18	112.00[1)]	27.06	27.06	300.00	4.00
	#19	112.00[1)]	19.84	19.84	300.00	4.00
	#20	112.00[1)]	11.27	11.27	300.00	4.00
Hard coal and hard coal briquettes	#21, #22	93.00	10.00	300.00	300.00	1.50
Lignite and brown coal	#21, #22	108.00	10.00	300.00	300.00	1.50
Brown coal briquettes	#21, #22	97.00	10.00	300.00	300.00	1.50
Coke	#21, #22	92.00	10.00	300.00	300.00	1.50
Peat	#21, #22	106.00	10.00	10.00	10.00	1.40
Industrial waste *(fossil)*	#22	64.52[4)]	12.00	12.00	12.00	4.00
Industrial waste *(biogenic)*	#22	50.00[1)]	12.00	12.00	12.00	4.00
Charcoal	–	112.00[1)]	200.00	200.00	200.00	1.00

[1)] *Reported as CO_2 emissions from biomass*

[2)]Implied emission factor based on CH_4 emission factors of new and conventional wood stoves and cooking stoves stock (see Table 107) weighted with fuel consumption by subcategory of heating type (see Table 103)

[3)]Implied emission factor based on CH_4 emission factors of advanced and conventional mixed-fuel boilers stock (see Table 108) weighted with fuel consumption by subcategory of heating type (see Table 104)

[4)]Implied emission factor based on fossil fraction of industrial waste

Because no measurements are available, CH_4 emission factors for new wood stoves and cooking stoves (Table 107) are derived from conventional devices emission factors with the ratio of conventional and new devices NMVOC emission factors (Bundesministerium für wirtschaftliche Angelegenheiten, 1999, Lang, et al., 2003)):

$$EF(CH_4)_{new} = EF(CH_4)_{conventional} * EF(NMVOC)_{new} / EF(NMVOC)_{conventional}$$

Table 107: CH_4 emission factors of category 1.A.4 for conventional and new wood stoves and cooking stoves.

Pollutant			**CH_4**	
CRT			**1.A.4.a.1**	**1.A.4.b.1**
Fuel	**Heating type No.**	**Subcategory**	**[kg/TJ]**	
Fuel wood	#12	Wood stoves and cooking stoves (new)	115.61	115.61
		Wood stoves and cooking stoves (conventional)	220.00	220.00

Because no measurements are available, CH_4 emission factors for advanced mixed-fuel boilers (Table 108) are derived from conventional devices emission factors with the ratio of conventional and advanced devices NMVOC emission factors ((Bundesministerium für wirtschaftliche Angelegenheiten, 1999, Lang, et al., 2003)):

$$EF(CH_4)_{advacned} = EF(CH_4)_{conventional} * EF(NMVOC)_{advanced} / EF(NMVOC)_{conventional}$$

Table 108: CH_4 emission factors of category 1.A.4 for conventional and advanced mixed-fuel boilers.

Pollutant			**CH_4**	
CRT			**1.A.4.a.1**	**1.A.4.b.1**
Fuel	**Heating type No.**	**Subcategory**	**[kg/TJ]**	
Fuel wood	#14	Mixed-fuel wood boilers (advanced)	121.42	121.42
		Mixed-fuel wood boilers (conventional)	150.00	150.00

3.2.14.1.4 Recalculations

For 1990 to 2022, there are minor changes in greenhouse gas emissions of categories *1.A.4.a.1 Commercial/Institutional: Stationary Combustion* and *1.A.4.b.1 Residential: Stationary Combustion* because of updated heating stock data and reallocated shares of combustion technologies per energy carrier (updated energy demand model for space heating).

In particular, the following shares with an effect on certain implied emission factors have been revised:

- Share of new and conventional wood stoves and cooking stoves stock 2001–2022 (CH_4) (see Table 103)
- Share of advanced and conventional mixed-fuel wood boilers stock 1990–2022 (CH_4) (see Table 104)

Changes in total fuel consumption are based on the revisions of the energy balance. Please refer to chapter 3.2.17 below.

3.2.14.1.5 Planned Improvements

In order to improve the inventory on accurate heating type information a ongoing service-contract for an updated market survey of heating type stock, age distribution, final energy demand and type of heating use by CRT category has been awarded. In order to determine the user-related impact on emissions from biomass (and coal), data is collected on national conditions within an onging household survey. It is planned to implement the both survey results into the inventory of submission 2026.

No further category-specific improvements are planned.

3.2.14.2 1.A.4 Other sectors – mobile sources

1.A.4.a.2 Commercial/institutional

Currently there is neither a statistical basis nor any new study on NRMM (Non-Road Mobile Machinery) which would enable Austria to report emissions from mobile sources of *1.A.4.a.ii Commercial/institutional* separately. Commercial and institutional NRMM are reported as IE and included in CRT *1.A.2.g.7 Industry* and CRT *1.A.4.c.2 Agriculture and Forestry*.

1.A.4.b.2 Residential – Off-road vehicles and other machinery

In addition to NRMM used in household and gardening this category contains ski slope machineries and snow vehicles.

Methodological Issues

The used methodology conforms to the requirements of the IPCC 2006 GL Tier 3 methodology and is described in the subchapter on mobile sources of CRT *1.A.2.g.vii*.

Activity Data & Emission Factors

Activities used for estimating the emissions and the implied emission factors of CRT *1.A.4.b.ii* are presented below. In the following table the activity data includes all energy sources. The increasing substitution of fossil fuels with biofuels can be observed from 2005 onwards. Details concerning emission factors for mobile off-road sources are described in the subchapter on mobile sources of *1.A.2.g.vii*.

Table 109: Emission factors and activity data for mobile sources of 1.A.4.b.ii Residential 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	2 286	75.5	185.4	10.6
1995	2 286	75.5	174.2	11.1
2000	2 173	75.5	146.4	11.9

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
2005	2 071	75.2	121.4	11.3
2010	1 870	71.7	67.1	8.9
2011	1 842	71.6	58.8	8.2
2012	1 807	71.4	52.5	7.6
2013	1 773	71.7	49.4	7.0
2014	1 739	71.3	47.6	6.5
2015	1 689	71.1	46.0	6.0
2016	1 631	71.7	44.6	5.7
2017	1 583	71.9	43.0	5.4
2018	1 547	71.4	41.2	5.2
2019	1 510	71.5	39.9	5.0
2020	1 481	71.3	39.0	4.9
2021	1 459	71.4	38.1	4.9
2022	1 442	71.5	37.8	4.9
2023	1 433	70.4	37.9	4.9

Recalculations

No category-specific recalculations have been made.

Planned improvements

No category-specific improvements are planned.

1.A.4.c.2 Agriculture and Forestry – Off-road vehicles and other machinery

In this category emissions from NRMM used in agriculture and forestry (mainly tractors) are considered.

Methodological Issues

The used methodology conforms to the requirements of the IPCC 2006 GL Tier 3 methodology. The general methodology applied is described in the subchapter on mobile sources of CRT *1.A.2.g.vii*.

Activity Data & Emission Factors

Activities used for estimating the emissions and the implied emission factors of CRT *1.A.4.c* are presented below. In the following table the activity data includes all energy sources. The increasing substitution of fossil fuels with biofuels can be observed from 2005 onwards. Activities of mobile machinery in CRT *1.A.4.c.ii* also contain commercially/institutionally used machinery. They could not be split into commercial/institutional and non-commercial/non-institutional use due to a lack of data.

Table 110: Emission factors and activity data for mobile sources of 1.A.4.c.ii Agriculture and Forestry 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	10 366	74.2	17.4	24.5
1995	10 106	74.2	15.6	25.4
2000	10 610	74.2	13.5	27.3
2005	11 434	73.6	12.2	25.2
2010	10 901	70.4	8.2	19.8
2011	11 818	70.3	7.1	18.7
2012	10 909	70.2	6.7	17.6
2013	10 560	70.4	6.1	16.6
2014	11 667	70.2	5.2	15.7
2015	10 793	69.8	5.2	14.9
2016	11 611	70.3	4.6	14.1
2017	10 775	70.7	4.8	13.3
2018	10 872	70.6	4.9	12.6
2019	11 455	70.7	4.6	12.1
2020	11 592	70.7	4.1	11.6
2021	11 307	70.6	4.4	11.1
2022	11 222	70.6	4.5	10.8
2023	11 193	70.1	4.4	10.6

Recalculations

For tractors, the shares of electric vehicles were set at lower values in 2022 and 2023 compared to the initial model specification as no start of the mass market can be observed in this field apart from research and prototype vehicles.

For CRT *1.A.4.c.2* and the year 2022, this results in recalculations of: **CO_2** of +0.06 kt (+0.0001 % of national total and +0.01% of category *1.A.4.c.2*). CH_4 and N_2O have also changed. **CH_4**: +0.01 kg. **N_2O**: +4.3 kg.

Planned improvements

No category-specific improvements are currently planned.

3.2.15 Other (CRT Category 1.A.5)

In this category emissions of NRMM used for military transport (off-road and aviation) are reported.

1.A.5.b Mobile combustion – Military

Key Source: No

Military Off-Road (ground operations)

Methodological Issues

The used methodology corresponds to the requirements of the IPCC 2006 GL Tier 3 methodology for road transport. The applied methodology is described in the subchapter on mobile sources of CRT *1.A.2.g.vii.*

Activity Data

Emission estimates for military activities were taken from (Hausberger, 2000). Information on the fleet composition was taken from official data presented in the internet as for reasons of confidentiality no other data was available. In 2023, our efforts to improve inventory data quality in this area were successful.

For the 2024 submission the Austrian Ministry made some key data available like diesel consumption and vehicle fleet for the year 2021. For the model GEORG this vehicles fleet was grouped into two groups: <130 kW and >130 kW with an average nominal power of 95 kW (<130kW) and 422 kW (>130kW). Activities of 142 h/year (<130kW) and 29 h/year (>130kW) were assumed. Further assumptions were that a) the vehicle fleet remains constant due to long service life (confirmed by expert assessment) and b) the split of new registrations is 40% for <130 kW and 60% for >130 kW nominal power vehicles over the entire time series.

With these assumptions the model result was calibrated with the operating hours in 2021 to meet the diesel consumption of 2021. For time series consistency surrogate data (the statistical time series of the number of military personell) was used to scale the operating hours over the time series and calculate the new amounts of diesel consumption per year.

Emission Factors

For tanks and other special ground military vehicles the emission factors for diesel engines > 130 kW were used (for these vehicles a power of 300 kW was assumed). Details concerning emission factors for mobile off-road sources are described in the subchapter on mobile sources of *1.A.2.g.7.*

Military Aviation

Methodological Issues

The used methodology corresponds to the requirements of the IPCC 2006 GL Tier 1 (simple) methodology for aviation with country specific emission factors. The methodology is based on hours of operation and average fuel consumption per hour for the years 1990-1998 with a linear trend extrapolation for the years from 1998 onwards. The calculation of emissions from military aviation does not distinguish between LTO and cruise.

Activity Data

For the years 1990–1998 fuel consumption for military flights was reported once by the Austrian Ministry of Defence and used in the course of the general flight study to calculate emissions from military aviation (Kalivoda, Kudrna, 2002).

In response to a recommendation of the UNFCCC Review 2020 on Austria's methodology for estimating emissions from military aviation 2000–2018, data on kerosene consumption was re-evaluated.

However, even after several official attempts, no data was provided from the Austrian Ministry of Defence. Therefore, the historical number of aircrafts (fighter jets, airplanes, helicopters) was compared with available current data found on the Internet on the number of operating military aircraft assuming constant flight hours.[58]

Starting with the year 2009, fuel consumption was interpolated until the year 2020. The latest inventory year is being updated yearly via this source (last update in autumn 2024 for the 2025 submission). According to the trend shown in the table below fuel consumption is declining from 2009 onwards.

Table 111: Military aircraft stock 2008, 2020 and 2023

	Helicopters	Fighter jets and airplanes	Total number ofmilitary aircraft
2008	78	96	174
2020	64 (prev. 82)	43	107 (prev. 125)
2022	60	43	103
2023	64	43	107
Trend 2008–2023	**-18%**	**-55%**	**-39%**

As no aircraft data prior to 2008 could be found (Pötscher, 2008), the subsequent revision of activity data refers to the years 2009–2019 only; for the years 1999–2008 the previously applied method (linear extrapolation) has been retained, while for the years 1990–1998 the results of the flight study have been used directly as in previous submissions.

Emission Factors

Country specific IEFs (t/t fuel) taken from a national flight study (Kalivoda, Kudrna, 2002) and based on fuel consumption and emissions in the year 2000 have been used to estimate GHG emissions from military flights.

Table 112: Emission factors used for military flights.

	Amount in 2000 [t]	IEF [t/t]
Fuel	13 613	–
CO_2	42 880	3.1500
N_2O	2.69	0.0002
CH_4	1.41	0.0001

[58] https://de.wikipedia.org/wiki/Luftstreitkr%C3%A4fte_(Bundesheer); 14.11.2024

Overall activities and emissions

Activities used for estimating the emissions of the total CRT *1.A.5.b* are presented below (activity data includes all energy sources). The increasing substitution of fossil fuels with biofuels can be observed from 2005 onwards.

Table 113: Emission factors and activity data for 1.A.5.b Military 1990–2023.

Year	Activity	Implied Emission Factors		
		CO_2	CH_4	N_2O
	TJ	t/TJ	kg/TJ	kg/TJ
1990	512	72.9	2.5	7.1
1995	469	72.9	2.5	7.0
2000	566	72.8	2.4	6.1
2005	513	72.8	2.4	5.7
2010	401	72.6	2.4	5.6
2011	376	72.6	2.4	5.5
2012	355	72.6	2.4	5.5
2013	335	72.6	2.4	5.5
2014	317	72.5	2.3	5.5
2015	298	72.5	2.3	5.5
2016	314	72.6	2.3	5.4
2017	373	72.6	2.3	5.2
2018	392	72.6	2.3	5.2
2019	392	72.5	2.3	5.1
2020	393	72.5	2.3	5.1
2021	392	72.5	2.3	5.0
2022	384	72.6	2.3	5.0
2023	377	72.6	2.3	5.0

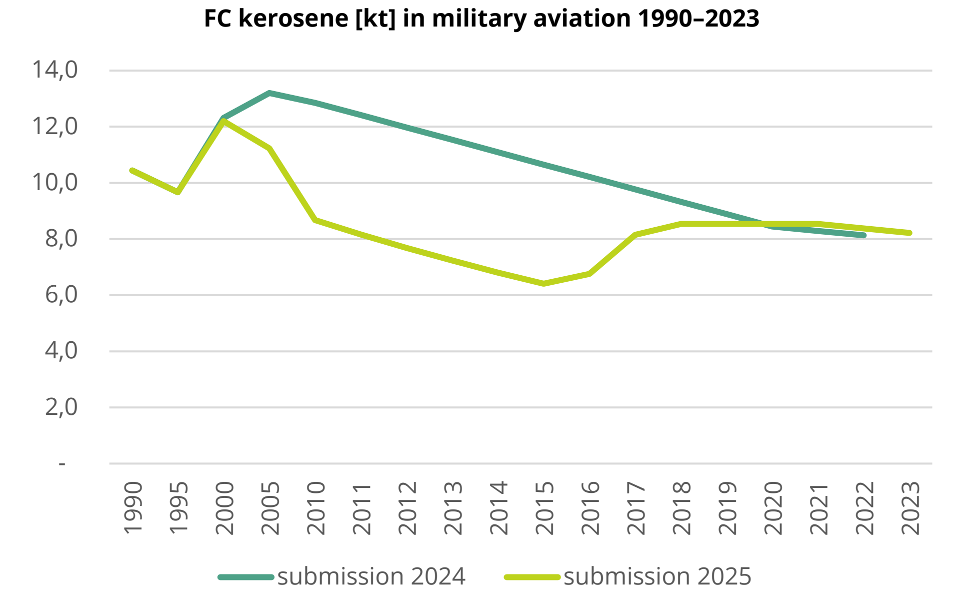
Recalculations

Emissions from military ground operations have been revised for the whole time series due to an update of military personnel numbers (year 2020). This update 2020 affected other years too as the average of values of the last five years were extrapolated to complete the time series. The personnel numbers are used to scale the deployment times per device and are currently around 28 hours of deployment time per year for around 850 devices. Retrospective minor changes occur across the entire time series, as the update affected the base year for the time series creation.

The kerosene consumption of military air traffic was updated using actual data for the years 2016, 2017 and 2018 as reported by the Austrian Ministry of Defense. This was done in response to the UNFCCC Review 2023. In previous submissions linear interpolation was necessary. Consequently, the time-series back to 1999 also changed noticeably.

In the submission 2025 kerosene fuel consumption is 12.5 kt for 1999 compared to 12.1 kt in the previous submission (+0.3 kt); for 2022 it is 8.4 kt compared to 8.1 kt in the previous submission (+0.2 kt). The following Figure 15 shows the revision over the time series.

Figure 15: Comparison of fuel consumption (FC) kerosene for military aviation – current vs previous submission.



Source: Umweltbundesamt

The overall changes in **CO_2** emissions amounts to -0.03 kt in 1990 (-0.0001% of national total and -0.09% of *1.A.5.b*) and +0.8 kt in 2022 (0.001% of national total and 2.9% of *1.A.5.b*). CH_4 and N_2O have also changed. **CH_4**: 1990: -1.6 kg; 2022: 25.8 kg (0.00001% of national total and 2.9% of *1.A.5.b).* **N_2O**: 1990: -11.6 kg; 2022: +49.5 kg (0.0004% of national total and 2.6% of *1.A.5.b).*

Planned Improvements

No category-specific improvements are planned.

3.2.16 Uncertainty Assessment

As the overall fuel balance for Austria is expected to be considerably more accurate than source specific information (Statistik Austria, pers. communication), also assessment of uncertainties was performed on the level of the overall energy balance. It was not possible, however, to strictly use this straightforward approach because dealing with all fuel related activities at the same time would make it difficult to provide separation of major source categories; as domestic combustion, industry and power plant would fall in the same category with traffic.

For these reasons, an arbitrary split was drawn between energy use in large sources (covering CRT sectors *1.A.1*, refineries as they are included in *1.B.2*, and energy in iron and steel production covered in *2.C.1*), transport sources (IPCC sector *1.A.3*, but including transport related machinery in *1.A.2*, manufacturing industry, and *1.A.4*, other sectors like agriculture, forestry and households) and small sources (covering all other combustion sources, specifically the rest of manufacturing industry, *1.A.2*, as well as other sectors, *1.A.4*. Also *1.A.5*, "other" is included which basically covers military energy consumption including transport). Activity uncertainty was assessed separately by fuel for fossil solids (fuel code 102–110), biomass and waste fuels (fuel code 111–118), liquid fuels (fuel codes 203–224 except for black liquor, code 215 which is treated separately) and gaseous fuels (fuel codes above 300). Uncertainty factors have been maintained from previous studies (WINIWARTER, W. & ORTHOFER, R, 2000, CHARLES et al., 1998) and are listed in Table 114. For transport, the respective factors are new and have been taken from an assessment of the overall transport GHG emissions (Hausberger, 2005).

Table 114: Uncertainty parameters for fuel combustion activities.

	Fossil solid	Biomass & waste	liquid	Black liquor	Gas
large sources	0.5	5.0*	0.5	–	1.0*
small sources	1.0	10	1.0	10.0	5.0
transport	–	5.0*	3.0	–	–

* *improved expert quess*

Uncertainty factors presented account for the generally high quality level of Austrian fuel statistics, which is based on physical measurements (weighing, flow-metering), but data reported in statistics are derived from the respective heat content of fuels. Transformation requires analysis or measurement of the heat content in the fuel. Biomass, waste and black liquor, which are not contained in detail by trade statistics, exhibit a much larger uncertainty.

Emission factors in fuel combustion are also considered to be well-known. CO_2 emissions can be derived from stoichiometry. Carbon content of fuels (within gaseous/liquid/solid fuels, respectively) is largely proportional to its heat content. Thus we estimate uncertainty of the emission factor – separately for solid, liquid and gaseous fuels – at 0.2% to 0.5%. Within these respective fuel classes we consider uncertainty correlated.

Even more interesting is the case of methane. A considerable number of seemingly independent emission factors for different emission situation are available. At closer inspection, however, it appears that data presented by (Stanzel, et al., 1995) and used in OLI actually derive from HC measurements. The fraction of CH_4 in total HC combustion exhaust has been estimated by (Orthofer, 1991) at 75% in gaseous fuels, 20% in solid fuels and 25% in liquid fuels. As this percentage is what drives overall uncertainty for methane emission factors, we again have to treat gaseous, liquid and solid fuels as dependent (correlated) parameters. As an indicator of overall uncertainty we may refer to (CHARLES et al., 1998) who reported 50% for methane from combustion sources. For the transport Sector we use 30% for methane.

For nitrous oxide, emission measurements have been performed by (VITOVEC, 1991) and resulting uncertainty has been estimated at 20%. This figure has previously been used for Austria, but is not sustainable any more considering the fact that emission factors originally used for an Austrian inventory by (Orthofer et al., 1995a) are now more than 20 years old and refer to a considerably different combustion regime. We now apply 50% as taken from (MONNI, S. & SYRI, S., 2003) or (RAMIREZ et al., 2006), a figure which we understand to also include uncertainty due to limited knowledge on the fraction of fluidized bed combustion in the installation park. Emission factors used in OLI originally derive from the GEMIS modelling system, again just one source. Thus they again need to be considered correlated within each fuel class (solid, liquid and gaseous).

3.2.17 Recalculations

This chapter presents the recalculation difference of emissions from fuel combustion activities and its sub categories with respect to the previous submission.

The whole time series of recalculations is included in Annex 7 to the NID.

3.2.17.1 Revision of energy balance

The federal statistics office 'Statistik Austria' revised the energy balance (mainly for the year 2022) with the following **main implications** for energy consumption as used in the inventory and the corresponding CO_2 emissions:

- Natural gas 2022: Gross inland consumption was not revised. The transformation input was revised downwards by 3.7 PJ (−170 kt CO_2 for *1.A.1.a* and −38 kt CO_2 for *1.A.2*) and shifted to final energy consumption. The final energy consumption of *1.A.4.a* and *1.A.4.b* was revised downwards by 0.2 PJ (−13 kt CO_2) and final energy consumption of manufacturing industries was revised upwards by +4.0 PJ (+220 kt CO_2 for *1.A.2*)
- Gas oil 2022: Gross inland consumption was not revised. Around 0.4 PJ (31 kt CO_2) were shifted from the commercial/institutional (*1.A.4.a*) and the residential sector (*1.A.4.b*) to public power and district heating plants (*1.A.1.a*).
- Liquefied natural gas 2022: Around 0.5 PJ (32 kt CO_2) were shifted from manufacturing industries to "non-energy consumption".
- Solid biomass 2022: Final energy consumption was corrected by +5.0 PJ, most of which was allocated to *1.A.4.b*.

Methodological changes

- Natural gas consumption of gas supply companies (reported as transformation input for district heating and already included in public district heating plants *1.A.1.a*) was moved from sector *1.A.1.c* to sector *1.A.2.g* since the year 2011 (approx. 130 kt CO2 from natural gas in 2022), as the offset quantity had previously been deducted from this sector. This improved consistency with the energy balance at the sector level.
- The revision of process-related CO_2 emissions from steel production (2.C.1) for 2022 shifted 134 kt CO*2* from sector *1.A.2.a* to sector *2.C.1*.

3.2.17.2 CO_2 recalculations 1.A

Table 115 shows the recalculations of CO_2 emissions for the subcategories of sector *1.A Fuel Combustion.* Recalculations of CO_2 emissions for 2022 are mainly due to the revision of energy statistics, the shift of natural gas from 1.A.1 to 1.A.2 and the shift of 1.A.2 to 2.C.1 as explained above.

Table 115: Recalculation difference of CO_2 emissions in [kt] for Category 1.A Fuel Combustion with respect to previous submission.

Year	1.A	1.A.1	1.A.2	1.A.3	1.A.4	1.A.5
1990	-	-	-	0.0	-	-0.0
1995	-	-	-	0.0	-	-0.0
2000	-0.3	-	-	0.0	-	-0.4
2005	-6.2	-1.4	1.4	0.0	-	-6.2
2010	-12.8	-0.4	0.4	0.4	-	-13.2
2011	-13.0	-54.7	54.7	0.5	-	-13.4
2012	-13.1	-0.7	28.6	0.5	-27.9	-13.5
2013	-13.0	-33.5	33.5	0.5	-	-13.6
2014	-12.9	-33.7	33.7	0.6	-	-13.5
2015	-12.7	-44.8	44.8	0.7	0.0	-13.4
2016	-10.3	-47.6	67.8	-19.6	-	-10.9
2017	-4.7	-51.0	92.3	-40.9	-	-5.1
2018	-1.8	-51.5	91.6	-39.4	-	-2.5
2019	-0.2	-134.6	174.7	-39.1	0.0	-1.1
2020	0.5	-132.5	167.5	-34.8	0.1	0.3
2021	-13.1	-222.6	278.5	-10.1	-59.7	0.8
2022	-174.4	-303.8	123.4	46.4	-41.2	0.8

3.2.17.3 CH_4 recalculations 1.A

Table 116 shows the recalculations of CH_4 emissions for the subcategories of sector *1.A Fuel Combustion*.

Table 116: Recalculation difference of CH_4 emissions in [kt] for Category 1.A Fuel Combustion with respect to previous submission.

Year	1.A	1.A.1	1.A.2	1.A.3	1.A.4	1.A.5
1990	0.015	-	-	0.015	-0.000	-0.000
1995	0.013	-	-	0.013	0.000	-0.000
2000	0.007	-	-	0.007	0.001	-0.000
2005	0.007	-0.000	0.000	0.007	-0.000	-0.000
2010	0.007	-0.000	0.000	0.007	-0.000	-0.000
2011	0.006	-0.001	0.001	0.007	0.000	-0.000
2012	0.004	-0.000	0.001	0.007	-0.002	-0.000
2013	0.007	-0.001	0.001	0.007	0.000	-0.000
2014	0.007	-0.001	0.001	0.007	0.000	-0.000
2015	0.008	-0.001	0.001	0.007	0.000	-0.000
2016	0.008	-0.001	0.001	0.008	0.000	-0.000
2017	0.007	-0.001	0.001	0.007	0.000	-0.000

Year	1.A	1.A.1	1.A.2	1.A.3	1.A.4	1.A.5
2018	0.011	-0.001	0.001	0.011	0.000	-0.000
2019	0.017	-0.002	0.002	0.015	0.002	-0.000
2020	0.008	-0.002	0.008	0.001	0.002	0.000
2021	-0.019	-0.004	0.010	0.008	-0.033	0.000
2022	0.398	0.000	-0.003	0.014	0.386	0.000

3.2.17.4 N_2O recalculations 1.A

Table 117 shows the recalculations of N_2O emissions for the subcategories of sector *1.A Fuel Combustion.*

Table 117: Recalculation difference of N_2O emissions in [kt] for Category 1.A Fuel Combustion with respect to previous submission.

Year	1.A	1.A.1	1.A.2	1.A.3	1.A.4	1.A.5
1990	0.001	-	-	0.001	-	-0.000
1995	0.002	-	-	0.002	-	-0.000
2000	0.002	-	-	0.002	-	-0.000
2005	0.003	-0.000	0.000	0.004	-	-0.000
2010	0.004	-0.000	0.000	0.005	-	-0.001
2011	0.004	-0.000	0.000	0.005	-	-0.001
2012	0.005	-0.000	0.000	0.005	-0.000	-0.001
2013	0.005	-0.000	0.000	0.006	-	-0.001
2014	0.005	-0.000	0.000	0.006	-	-0.001
2015	0.006	-0.000	0.000	0.007	0.000	-0.001
2016	0.009	-0.000	0.002	0.008	-	-0.001
2017	0.012	-0.000	0.004	0.009	-	-0.000
2018	0.018	-0.000	0.004	0.015	-	-0.000
2019	0.024	-0.000	0.005	0.020	0.000	-0.000
2020	0.008	-0.000	0.006	0.002	0.000	0.000
2021	0.014	-0.000	0.004	0.013	-0.003	0.000
2022	0.036	0.002	-0.007	0.024	0.017	0.000

3.2.17.5 GHG recalculations [kt CO_2e] 1.A

Table 118 shows the recalculations in [kt CO_2 equivalent] for the subcategories of sector *1.A Fuel Combustion.*

Table 118: Recalculation difference of GHG emissions in [kt CO_2e] for Category 1.A Fuel Combustion with respect to previous submission.

Year	1.A	1.A.1	1.A.2	1.A.3	1.A.4	1.A.5
1990	0.74	-	-	0.78	-0.00	-0.04
1995	0.99	-	-	1.02	0.00	-0.04
2000	0.48	-	-	0.86	0.01	-0.39
2005	-4.80	-1.37	1.37	1.58	-0.00	-6.38
2010	-10.96	-0.42	0.42	2.55	-0.00	-13.51
2011	-11.20	-54.77	54.77	2.53	0.00	-13.73
2012	-11.24	-0.68	28.63	2.67	-28.01	-13.86
2013	-10.96	-33.59	33.59	2.92	0.01	-13.89
2014	-10.78	-33.73	33.73	3.05	0.01	-13.84
2015	-10.26	-44.82	44.82	3.44	0.01	-13.71
2016	-6.63	-47.67	68.59	-16.39	0.01	-11.17
2017	-0.05	-51.03	93.70	-37.49	0.01	-5.24
2018	5.00	-51.54	92.89	-33.79	0.01	-2.57
2019	9.25	-134.78	176.42	-31.31	0.06	-1.15
2020	3.61	-132.70	169.90	-34.08	0.13	0.35
2021	-8.61	-222.87	280.14	-5.09	-61.61	0.81
2022	-150.10	-303.08	120.70	55.57	-24.10	0.81

3.2.18 Planned Improvements

No improvements are planned.

3.3 Fugitive Emissions (CRT Category 1.B)

Fugitive emissions are intentional or unintentional releases of GHG, which arise during the extraction, processing and delivery of fossil fuels (coal, oil and natural gas) to the point of final use. The fugitive emissions are reported in CRT Category *1.B,* whereas emissions from fuel combustion during these processes are reported under CRT Category *1.A*.

3.3.1 Emission Trends

In 2023, 0.59% of national total emissions arose from IPCC category *1.B Fugitive Emissions*. Figure 16 presents GHG emissions arising from this category and the trend from 1990 to 2023.

Figure 16: Greenhouse gas emissions from Category 1.B Fugitive Emissions.

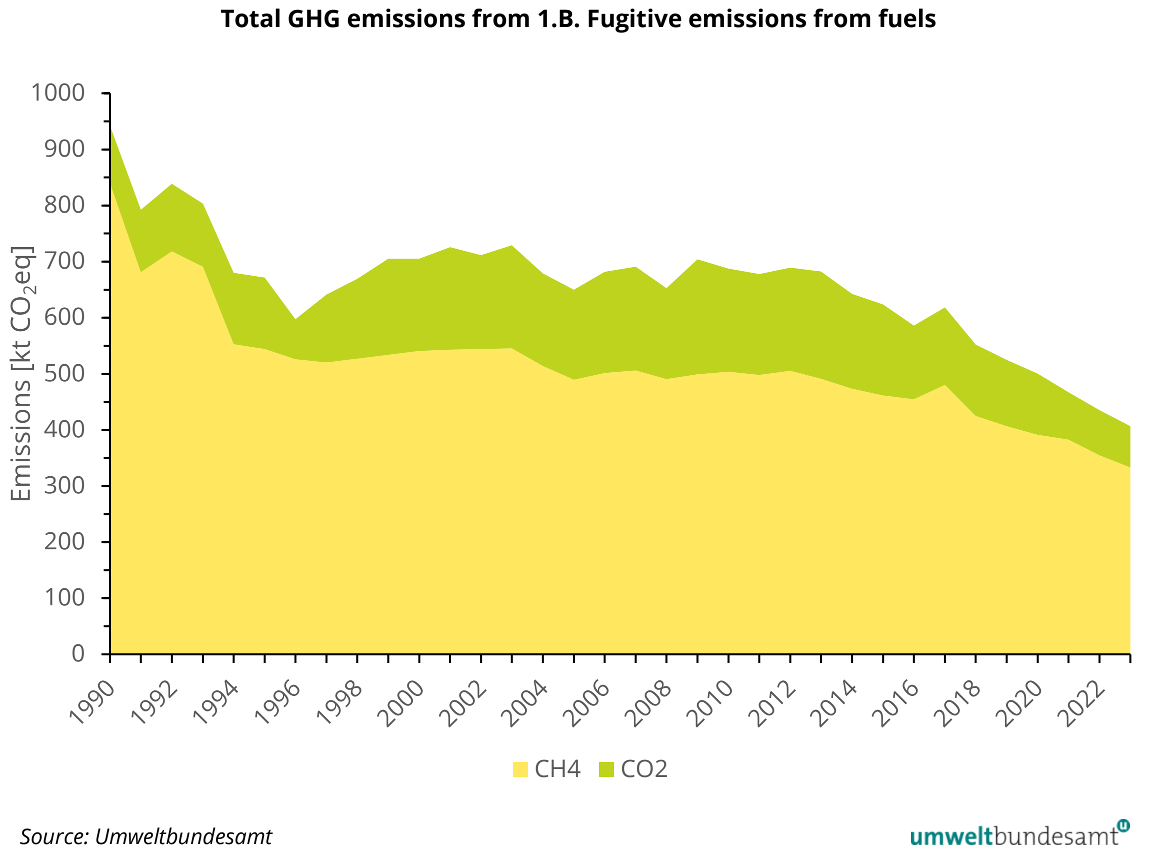


Table 119: Greenhouse gas emissions from Category 1.B Fugitive Emissions.

	GHG emissions [kt CO_2e]		
	Total	**CO_2**	**CH_4**
1990	942.23	102.20	840.03
1995	671.47	127.25	544.22
2000	705.36	164.75	540.61
2005	649.86	160.12	489.74
2010	687.42	183.63	503.79
2011	677.75	179.64	498.11
2012	689.16	183.64	505.52
2013	682.16	190.99	491.17
2014	642.41	168.75	473.66
2015	623.41	161.75	461.66
2016	586.00	131.29	454.71
2017	618.68	138.30	480.38
2018	552.24	127.29	424.95
2019	525.11	118.28	406.82

	GHG emissions [kt CO_2e]		
	Total	**CO_2**	**CH_4**
2020	500.52	109.28	391.24
2021	467.26	84.29	382.98
2022	435.00	80.28	354.72
2023	406.89	73.84	333.05
1990-2023	**-57%**	**-28%**	**-60%**

3.3.2 Completeness

Table 120 gives an overview of the IPCC categories included in this chapter and presents the transformation matrix from SNAP categories. It also provides information on the status of emission estimates of all subcategories. A "✓" indicates that emissions from this sub-category have been estimated.

As can be seen in the table, emissions from solid fuel transformation (charcoal production, coke oven coke production) are included in the sector *Energy*. Emissions from the production of coke oven coke are reported under sub category *1.A.2.a Iron and Steel*, because the only solid fuel transformation for production of coke oven coke in Austria is occurring in one coking plant as part of an integrated iron and steel site.

Furthermore, CO_2 emissions from oil and gas exploration, oil and gas production and gas processing are reported together under gas production (as oil and gas are extracted together at most sites), except CO_2 emissions from sour gas processing, which is reported separately under *1.B.2.b.3 Processing*. CH_4 emissions from oil exploration *(1.B.2.a.1)* and production *(1.B.2.a.2)*, previously included in *1.B.2.b.2*, are now reported under *1.B.2.a.2*.

Table 120: Overview of subcategories of Category 1.B Fugitive Emissions: transformation into SNAP Codes and status of estimation for the year 2023.

IPCC Category	SNAP	Status	
		CO_2	**CH_4**
1.B.1.a Coal Mining and Handling			
i Underground Mines			
1 Mining activities	050102 Underground mining	NA	NO
2 Post-mining activities	050103_X55 Underground mines – Post mining activities	NA	NO
3 Abandoned underground mines	050102_X53 Underground mines – Abandoned mines	NA	NA[1)]
4 Flaring of drained methane or conversion of methane to CO2		NO	NO
ii Surface Mines			
1 Mining activities	050101 Open cast mining	NA	NO
2 Post-mining activities	050103_X54 Surface mines – Postmining activities	NA	NO

IPCC Category	SNAP	Status	
		CO_2	CH_4
1.B.1.b Fuel transformation		**IE**	**IE**
i Charcoal and Biochar production			IE[2)]
ii Coke Production		IE[3)]	IE[3)]
1.B.2.a Oil			
i Exploration	050201 Extraction, 1st treatment and loading of liquid fossil fuels	IE[4)]	IE[4)]
ii Production and Upgrading		IE[4)]	✓
iii Transport	050601_X50 Oil pipelines	✓	✓
iv Refining/Storage	0401 Processes in Petroleum Industries	NA[5)]	✓
v Distribution of Oil Products	050502 Transport and depots 050503 Service stations	NA	NA[6)]
1.B.2.b Natural Gas			
i Exploration	050302 Extraction, 1st treatment and loading of gaseous fossil fuels - Land-based activities (other than desulfuration)	IE[4)]	IE[4)]
ii Production and Gathering		✓[4)]	✓[4)]
iii Processing	050301 Extraction, 1st treatment and loading of gaseous fossil fuels - Land-based desulfura-tion	✓	NA
iv Transmission and Storage	050601_X51 Transmission fugitive & venting 050601_X52 Storage	✓	✓
v Distribution	050603 Distribution networks	✓	✓
vi Other			
1 Gas post-meter	050603_X56 Post-meter	✓	✓
1.B.2.c Venting/Flaring		**IE[7)]**	**IE[7)]**
1.B.2.d Other		**NA[8)]**	**NA[8)]**

1) *According to an expert judgement all abandoned underground mines in Austria are flooded*

2) *CH_4 emissions from charcoal production are reported under 1.A.1.c.iii – biomass*

3) *The production of coke oven coke is included in 1.A.2.a Iron and Steel*

4) *included in 1.B.2.b.2 are: 1.B.2.a.1 Oil Exploration, 1.B.2.a.2 Oil Production and Upgrading, 1.B.2.b.1 Natural Gas Exploration and 1.B.2.b.3 Natural Gas Processing, except emissions from processing of sour gas*

5) *CO_2 emissions due to combustion are included in 1.A.1.b Petroleum Refining, fugitive CO_2 emissions are assumed to be negligible*

6) *also includes storage in storage tanks and refinery dispatch station – only NMVOC emissions are estimated as CH_4 emissions are assumed to be negligible*

7) *CO_2 emissions from venting and flaring are included in 1.A.1.b Petroleum refining. CH_4 emissions from venting and flaring are included in 1.B.2.a.iv. Refining/Storage*

8) *fugitive emissions from geo thermal energy are assumed to be negligible*

3.3.3 Methodological Issues

Category *1.B.1.a* Fugitive Emissions from Fuels – Coal Mining covers methane emissions from one brown coal surface mine and underground mines, and is calculated applying a Tier 1 methodology. Fugitive Emissions from oil and gas (*1.B.2.a* and *1.B.2.b*) are calculated using an IPCC Tier 1 methodology except *1.B.2.b.4* (Transmission and Storage) and *1.B.2.b.5* (Distribution) which are calculated applying a Tier 2 methodology, or are reported by the Association of the Austrian Petroleum Industry.

3.3.3.1 1.B.1 Solid fuels

1.B.1.a Fugitive Emissions from Fuels – Coal Mining

Key category: yes (CH_4; LA 1990)

1.B.1.a.i Underground mines

Emissions: CH_4

This category addresses methane emissions from mining and post-mining seam gas activities of brown coal underground mines. CH_4 emissions from mining as well as seam gas from post-mining activities decreased by 97% from 1990 to 1995 due to lower mining activities until it was stopped in 1995.

Mining

Emissions from underground mines (*1.B.1.a.i.1 Mining*) are calculated by multiplying the amount of coal produced (= activity data) with the IPCC 2006 Guidelines average default emission factor of 18 m^3 CH_4/t and using the conversion factor of 0.67×10^{-6} kt/m^3. Activity data are taken from the national energy balance.

Post mining seam gas emissions

Post-mining methane emissions from underground mining (*1.B.1.a.i.2*) are calculated – according to the IPCC 2006 Guidelines – by multiplication of the underground coal production with the average default emission factor of 2.5 m^3 CH_4/t and the conversion factor of 0.67×10^{-6} kt/m^3.

Table 121: Activity data (brown coal produced) and CH_4 emissions from mining and post mining activities for Fugitive Emissions from underground mines since 1990.

Year	Coal Mined [t]	CH_4 emissions from mining [kt]	CH_4 emissions from post-mining seam gas emissions [kt]
1990	870 403	10.50	1.46
1991	422 350	5.09	0.71
1992	478 095	5.77	0.80
1993	396 549	4.78	0.66
1994	82 625	1.00	0.14
1995	26 713	0.32	0.04
1996 onwards	NO	NO	NO

1.B.1.a.ii Surface mines

Emissions: CH_4

This category addresses methane emissions from one brown coal surface mine. CH_4 emissions from this category decreased by almost 30% from 1990 to 1999 due to lower mining activities. Before coal mining was stopped in 2007 emissions decreased sharply between 2003 and 2004 (80%), see Table 122.

Mining

Emissions from brown coal surface mines (*1.B.1.a.ii.1 Mining*) are calculated by multiplying the amount of brown coal produced (= activity data) by the IPCC 2006 Guidelines average default emission factor of 1.2 m^3 CH_4/t coal and using the conversion factor of 0.67x10-6 kt/m^3. Activity data are taken from the national energy balance and statistical year books (WKÖ, 2005, WKÖ, 2006).

Table 122: Activity data (brown coal produced) and CH_4 emissions from mining and post mining activities for Fugitive Emissions from surface mines since 1990.

Year	Coal Mined [t]	CH_4 emissions from mining [kt]	CH_4 emissions from post-mining seam gas emissions [kt]
1990	1 577 307	1.27	0.11
1995	1 270 718	1.02	0.09
2000	1 248 869	1.00	0.08
2001	1 205 618	0.97	0.08
2002	1 411 819	1.14	0.09
2003	1 152 383	0.93	0.08
2004	235 397	0.19	0.02
2005	6 168	0.00	0.00
2006	6 677	0.01	0.00
2007 onwards	NO	NO	NO

3.3.3.2 1.B.2 Oil and natural gas

3.3.3.2.1 1.B.2.a Fugitive Emissions from Fuels – Oil

Emissions: CH_4, CO_2

Key Source: No

In this category, fugitive emissions from oil refining (CH_4), oil production (CH_4) as well as crude oil transport (CO_2, CH_4) are reported. CH_4 emissions of *1.B.2.a.2 Oil Production* also cover oil exploration. CO_2 emissions of oil production are included in category *1.B.2.b.2 Gas Production.* CO_2 emissions from the refinery resulting from combustion processes (including flaring) are included in *1.A.1.b Petroleum Refining*.

CH_4 emissions contribute 99.99% to GHG emissions from *1.B.2.a*. In 2023 fugitive CH_4 and CO_2 emissions from oil contributed 0.06% to total greenhouse gas emissions in Austria.

3.3.3.2.1.1 Oil Production

The amount of oil produced is reported annually by the Association of the Austrian Petroleum Industry (FVMI, 13 Nov. 2024), see Table 123. CH_4 emissions from oil production are calculated applying a IPCC Tier 1 method with an aggregate production-based emission factor of 0.0026 t CH_4/t oil produced (The oil industry international exploration & production forum, 1994).

Table 123: Activity data (oil produced) and emissions for Fugitive Emissions from Fuels – Oil Production, 1990-2023.

	Production	
Year	**Oil produced [kt]**	**CH_4 [kt]**
1990	1 149	2.99
1995	1 035	2.69
2000	971	2.52
2005	855	2.22
2010	876	2.28
2011	854	2.22
2012	837	2.18
2013	846	2.20
2014	883	2.30
2015	848	2.20
2016	753	1.96
2017	705	1.83
2018	664	1.73
2019	627	1.63
2020	595	1.55
2021	560	1.46
2022	521	1.35
2023	468	1.22
1990-2023	**-59%**	**-59%**

3.3.3.2.1.2 Oil Transport

Both CH_4 and CO_2 emissions from transport are calculated by using the IPCC Tier 1 methodology, applying the emission factors from Table 4.2.4 of the IPCC 2006 Guidelines (IPCC, 2006).

To calculate CH_4 emissions from this source, the default emission factor of the IPCC 2006 Guidelines of 5.4×10^{-06} kt CH_4 per 1 000 m^3 oil transported by pipeline is used. For the calculation of CO_2 emissions, the IPCC 2006 default emission factor of 4.9×10^{-07} kt CO_2 per 1 000 m^3 oil transported in pipelines is applied.

The amount of transported crude oil in pipelines (= activity data) is reported annually by the Association of the Austrian Petroleum Industry (FVMI, 13 Nov. 2024).

3.3.3.2.1.3 Refining

Methane emissions from refining are calculated using the IPCC Tier 1 methodology.

For the calculation an emission factor of 31.66 g CH_4/t crude oil input is used. It is in the range of default emission factors in the IPCC Guidelines between 2.6×10^{-6} and 41.0×10^{-6} kt per 10^3 m^3 oil refined. The conversion from kt per 10^3 m^3 to g per t was calculated with a density for crude oil of 840 kg/m^3. This emission factor is assumed to be conservative since crude oil is being transported by pipeline and, therefore, it is stored for a short period only, which reduces the potential to release fugitive CH_4 emissions compared to the processes represented by the IPCC default emission factors. Further, high standards for the recovery of fugitive CH_4 emissions in accordance with the Austrian Best Available Technology regulations are implemented.

Emissions are then calculated by multiplying the amount of crude oil input (= activity data, taken from the national energy balance) by this converted emission factor of 31.66 g CH_4 /t crude oil.

Table 124: Activity data (Crude Oil Refined) and emissions for Fugitive Emissions from Fuels – Oil Transport and Refining, 1990–2023.

Year	Crude Oil Refined [kt]	Transport CH_4 [kt]	Refining CH_4 [kt]
1990	7 952	0.051	0.252
1995	8 619	0.055	0.273
2000	8 240	0.055	0.261
2005	8 743	0.057	0.277
2010	7 719	0.053	0.244
2011	8 170	0.057	0.259
2012	8 349	0.058	0.264
2013	8 584	0.059	0.272
2014	8 435	0.059	0.267
2015	8 853	0.060	0.280
2016	8 184	0.057	0.259
2017	8 064	0.057	0.255
2018	8 970	0.062	0.284
2019	9 124	0.064	0.289
2020	8 168	0.055	0.259
2021	8 243	0.053	0.261
2022	5 617	0.037	0.178
2023	8 022	0.051	0.254
1990-2023	**+0.9%**	**+0.7%**	**+0.9%**

3.3.3.2.2 1.B.2.b Fugitive Emissions from Fuels – Natural Gas

Emissions: CH_4, CO_2

Key Source: yes (CH_4)

In this category CO_2 emissions from sour gas processing, as well as CH_4 and CO_2 emissions from gas storage, gas exploration, production, processing as well as gas transmission (i.e. transport in pipelines >6 bar MOP[59]) and distribution (i.e. distribution to end consumer in pipelines <6 bar MOP) are covered. Moreover, CH_4 and CO_2 from natural-gas appliances (gas post-meter) and natural-gas-powered vehicles are reported from submission 2025 onwards.

In 2023 fugitive CH_4 and CO_2 emissions from *1.B.2.b natural gas* contributed 0.5% to total greenhouse gas emissions in Austria.

CH_4 emissions from *1.B.2.b* contribute 80% to total GHG emissions from this category (2023), with *1.B.2.b.6* gas post-meter being the main sub-category (58% share in CH_4 from *1.B.2.b* in 2023). CH_4 emissions from *1.B.2.b* decreased by 22% between 1990 and 2023, mainly due to decreased gas amounts produced (*1.B.2.b.2*) and decreased emissions from distribution (*1.B.2.b.5*). Although the natural gas distribution network has almost tripled in length since 1990, CH_4 emissions from this source have decreased by 44% during this period due to replacement of old pipelines made of cast iron (with high emission factors) by pipelines made of plastics (with low emission factors, see Table 128). Due to the introduction of flash gas utilization in various drying installations at storage sites, CH_4 emissions from storage decreased by 27% between 1990 and 2023, although the storage capacity and volume increased by 183% within the same period of time.

CO_2 emissions from *1.B.2.b* contributes 20% to total GHG emissions from this category (2023), and mainly arise from combined oil and gas production and sour gas processing; the general trend is decreasing due to declining oil and gas production. The exceptional low CO_2 emissions in 1996 in natural gas processing (land based desulfuration, see Table 129) was due to a break in processing during the implementation of pollution control measures. The drop of 36% of raw gas throughput in 2016 was due to the failure of one sour gas tube in one plant. Natural gas transmission and distribution are only minor sources of CO_2 emissions.

According to information from the Austrian Oil and Gas Association, flaring at the only refinery in Austria does not take place on a regular basis but is usually limited to unplanned shutdowns or emergency cases as a safety system. Therefore, CO_2 emissions from this source are very low. As described in chapter 3.2.10.2 *1.A.1.b Petroleum Refining* fugitive CH_4 emissions from category *1.B.2.a Fugitive Emissions from Fuels – Oil – Refining/storage* are reported in category *1.A.1.b* which includes emissions from fuel combustion, flaring and thermal cracking. The installation is included in the EU ETS. According to the Commission Regulation (EU) No 601/2012, Annex IV, emissions from flaring are included in the reported ETS emission data. The emission factors and caloric value of flared gas are based on analysis and the activity data are measured.

It has to be noted that there is only one refinery in Austria and separate reporting of emissions from flaring could enable drawing conclusions about the operating conditions in this refinery and this would cause a confidentiality issue. ETS data gained for inventory purpose is in general consid-

[59] Maximum Operating Pressure.

ered confidential, and emissions are only reported in aggregated form as provided by the operators. Thus 'IE' [60] is used for the reporting of emissions from flaring together with all other components from this source.

There are several legal bases that consider the protection of personal and company-related data:

- The protection of confidentiality is e.g. one of the fundamental principles of national statistical agencies (NSA), committing them[61] "to safeguarding information that plainly reveals the operations, belongings, attitudes or any other characteristics of individual respondents".
- The Federal Statistics Act[62] prohibits the evaluation and publication of data in a manner that allows conclusions on characteristics of persons or individual operators.
- Confidential transfer of emissions data e.g. is regulated in the Commission Implementing Regulation (EU) 2018/2066[63], ensuring that "data is only accessible to the party for which it was intended and that no data can be read, written or updated by unauthorised parties".
- Also the Comission Delegated Regulation (EU) 2019/1122[64] regulates in Art. 80 the confidential treatment of "all information held in the EUTL and the Union Registry".

As we use plant specific data of individual operators provided by the Austrian statistical agency ('Statistik Austria') and the Union Registry, we also comply with the related specifications regarding confidentiality and the corresponding principles.

3.3.3.2.2.1 Gas Exploration & Production (1.B.2.b.1 & 1.B.2.b.2)

CO_2 emissions of *1.B.2.a.1 Oil Exploration*, *1.B.2.a.2 Oil Production, 1.B.2.b.2 Natural Gas Production* and *1.B.2.b.3 Natural Gas Processing* (except CO_2 emissions from processing of sour gas), are all included in category *1.B.2.b.2 Natural Gas Production*. CH_4 emissions from *1.B.2.b.2 Natural Gas Production* also covers *1.B.2.b.1 Natural Gas Exploration* and *1.B.2.b.3 Natural Gas Processing* (other than desulfuration). The amount of natural gas produced and the related CO_2 emissions from combined oil and gas production are reported annually by the Association of the Austrian Petroleum Industry (FVMI, 13 Nov. 2024), see Table 125.

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60 The UNFCCC Reporting GL (Ar. 37) state that "Where 'IE' is used in an inventory, the Annex I Party should indicate, in the CRF completeness table, where in the inventory the emissions or removals for the displaced source/sink category have been included, and the Annex I Party should explain such a deviation from the inclusion under the expected category, especially if it is due to confidentiality".

61 http://unstats.un.org/unsd/methods/statorg/

62 BGBl. I Nr. 163/1999: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10006095

63 COMMISSION IMPLEMENTING REGULATION (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council" \\umweltbundesamt.at\Projekte\20000\20690_QS-Inventur\Intern\2_Basisnorm, Gesetze u. Leitfäden\Gesetze, RL, GL, GB, etc. (fachlich)\Regulation_EU_2018-2066_engl.pdf

64 COMMISSION DELEGATED REGULATION (EU) 2019/1122 of 12 March 2019 supplementing Directive 2003/87/EC of the European Parliament and of the Council as regards the functioning of the Union Registry" \\umweltbundesamt.at\Projekte\20000\20690_QS-Inventur\Intern\2_Basisnorm, Gesetze u. Leitfäden\Gesetze, RL, GL, GB, etc. (fachlich)\Regulation (EU) 2019-1122_UnionRegistry_EU-ETS_engl.pdf

Activity data on natural gas produced is reported by the Association of the Austrian Petroleum Industry as a total of natural gas and oil gas. Since those two components have a different density an intermediate step to convert data from m^3 to tonnes was introduced based on assumptions on the composition of raw gas, derived from the annual reports of the Austrian Petroleum Industry (FVMI, 2000-2023). For the calculation of CH_4 emissions from natural gas production, an emission factor of 0.0026 t CH_4/t gas produced (The oil industry international exploration & production forum, 1994) was applied.

Table 125: Activity data (natural gas produced) and emissions for Fugitive Emissions from Fuels – Gas Production 1990–2023.

		Production		
Year	**Natural Gas produced [Mio m^3]**	**CH_4 [kt]**	**CO_2 [kt]**	**IEF CO_2 [kg/1 000 m^3]**
1990	1 288	2.78	43.00	33
1995	1 482	3.20	38.00	26
2000	1 805	3.88	72.00	40
2005	1 637	3.58	76.86	47
2010	1 816	3.96	91.35	50
2011	1 684	3.64	91.35	54
2012	1 807	3.90	91.35	51
2013	1 467	3.18	102.69	70
2014	1 247	2.72	89.46	72
2015	1 166	2.53	89.46	77
2016	1 253	2.69	84.00	67
2017	1 742	3.70	71.00	41
2018	969	2.09	64.00	66
2019	891	1.93	58.00	65
2020	743	1.62	50.00	67
2021	655	1.45	40.00	61
2022	607	1.35	38.00	63
2023	545	1.20	33.57	62
1990-2023	**-58%**	**-57%**	**-22%**	

3.3.3.2.2.2 Natural Gas Processing (1.B.2.b.3)

Activity data and CO_2 emissions from the processing of natural gas (reported under *1.B.2.b.2*) as well as sour gas processing *(1.B.2.b.3)* are reported by the Association of the Austrian Petroleum Industry (FVMI, 13 Nov. 2024), the latter calculated from sour gas composition.

3.3.3.2.2.3 Transmission & Storage and Distribution (1.B.2.b.4 & 1.B.2.b.5)

Detailed information on fugitive emissions from natural gas transmission, storage and distribution in Austria was surveyed in the framework of a 'Life Cycle Inventory' set up for the years 1999, 2010 and 2021 by contract to Forschung Burgenland (Wartha, 2024). In these national studies, emissions (measurements) and other relevant data (on installations, processed quantities, gas composition) were collected by survey among the Austrian gas network operators. Emission factors were investigated by literature review in order to finally estimate fugitive emissions from the gas supply network in Austria. The study was originally conducted in 2005 and updated in 2011 and 2024 to reflect already implemented technical measures and to take into account the newest scientific knowledge.

Natural gas emissions were thus calculated applying a Tier 2 approach.

Fugitive CH_4 emissions from ***gas transmission*** *(1.B.2.b.4)*, i.e. from the transport of natural gas in pipelines under high pressure, covering long-distance pipelines as well as other high pressure pipelines >6 bar MOP, mainly result from compressors, connections, pneumatic aggregates, venting and accidental releases. Fugitive emissions due to diffusion through pipeline material are small because in Austria the material used is nearly 100% insulated steel.

For inventory purpose, country-specific implied emission factors were calculated based on the results of the national studies (Wartha, 2005, Wartha, 2011, Wartha, 2024) and related to the total length of the pipeline system of the respective years:

- 488 kg CH_4/km.a for 1999
- 382 kg CH_4/km.a for 2009
- 305 kg CH_4/km.a for 2021

For the other years the IEF were determined by interpolation. From 2022 onwards the reports from IMEO (OGMP 2.0) were directly used for the inventory reporting (United Nations Environment Programme, 2023). These account for 87% of total emissions from this sub-category (2023). For those operators not participating in this reporting programme, an adapted EF of 40 kg CH_4/km.a was applied based on (Wartha, 2024). The decreasing emission factors over the time can be explained by technical improvements such as recompression to reduce volumes vented, smart plug, the exchange of gas-pneumatic to electric valves as well as improved Leak Detection and Repair (LDAR). It was assumed that the technical improvements to reduce fugitive emissions from gas transmission were made continuously, thus linear interpolation was done to derive emission factors for 2000–2008 and 2010-2020.

Information on annual pipeline length is provided annually by the Austrian Association of Gas- and District Heating Supply Companies (FGW, 16 Dec. 2024).

Fugitive CH_4 emissions from **gas storage** *(1.B.2.b.4)* mainly result from storage sensors, compressors, separators and venting. As the information on these emissions is limited to the years 1999, 2009 and 2021 (WARTHA 2005, WARTHA 2011, WARTHA 2024) and no detailed information could be collected for the other years, implied emission factors were developed based on the bottom-up results compiled in the national studies, and related to the mean values of the annual amount of gas injection and withdrawal for the respective years:

- 410 kg CH_4/Mio. m^3 gas stored for 1999
- 296 kg CH_4/ Mio. m^3 gas stored for 2009
- 105 kg CH_4/ Mio. m^3 gas stored for 2021

The decreasing IEF over time is attributable to technical improvements such as the exchange of valves, the reduction of gas release to the atmosphere during tests as well as the installation of flashgas recovery in drying plants.

Activity data is taken from the Austrian Energy Regulator E-Control (E-CONTROL, 2024b).

Table 126: Activity data and emissions for 1.B.2.b.4 Fugitive Emissions from Fuels – Natural Gas Transmission and Storage 1990–2023.

Year	Natural Gas Transmission (Pipelines Fugitive & Venting)			Natural Gas Storage	
	Pipelines	CH_4 Emissions	CO_2 Emissions	Natural Gas Stored	CH_4 Emissions
	[km]	[kt]	[kt]	[Mio. m^3]	[kt]
1990	3 628	1.77	0.09	1 500	0.61
1995	5 972	2.91	0.15	1 820	0.75
2000	5 966	2.85	0.15	1 665	0.66
2005	6 290	2.67	0.15	1 828	0.62
2010	6 798	2.55	0.17	3 070	0.86
2011	6 983	2.57	0.17	3 850	1.01
2012	7 109	2.58	0.17	4 449	1.10
2013	7 177	2.55	0.18	5 747	1.33
2014	7 227	2.53	0.18	5 334	1.15
2015	7 242	2.48	0.18	5 317	1.06
2016	7 231	2.43	0.18	5 519	1.01
2017	7 250	2.39	0.18	6 745	1.13
2018	7 248	2.35	0.18	6 168	0.94
2019	7 231	2.30	0.18	4 669	0.64
2020	7 230	2.25	0.18	5 100	0.61
2021	7 203	2.20	0.18	6 668	0.70
2022	7 196	1.60	0.18	6 714	0.70
2023	7 232	1.62	0.18	4 251	0.45
1990-2023	**+99%**	**-8.5%**	**+99%**	**+183%**	**-27%**

The natural **gas distribution** *(1.B.2.b.5)* system consists of pipelines working under medium and low pressure (<6 bar MOP) supplying the end-consumer. Fugitive emissions from natural gas distribution mainly result from diffusion through the pipelines and emission factors largely depend on the pipeline material (see Table 127). Small emission sources are also connections to dwellings, pressure regulating valves and accidental releases.

Specific distribution pipeline lengths separated by material are provided annually by the Austrian Association of Gas- and District Heating Supply Companies (FGW, 16 Dec. 2024), which are then multiplied with material-specific emissions factors taken from (Wartha, 2024) and presented in Table 127. Emissions from connections to dwellings were considered by applying an EF of 0.11 kg CH_4 gas per connection (based on measurements by the Austrian Association of Gas- and District Heating Supply Companies, and referred to in (Wartha, 2024). The number of connections are obtained from (FGW, 16 Dec. 2024) and available on an annual basis. Information on other relevant sources (in particular pressure regulators and vented gas) cannot be gathered on an annual basis. These data were thus taken directly from the surveys (Wartha, 2005, Wartha, 2011, Wartha, 2024), and inter-/extrapolation was done to create a time series. In 2023 these sources contribute 15% to the total emissions from natural gas distribution in Austria.

Table 127: Emission factors applied for the gas distribution network (2023).

Gas distribution network **Material**	**Emission factors [kg CH_4/km and year]**
Insulated steel	17
Plastics (HDPE PVC)	12
Ductile cast iron	422
Grey cast iron	203

The material specific emission factors are lower than in previous inventories as the findings from the last two national studies (Wartha, 2011, Wartha, 2024) were considered. For cast iron pipes, study results resulted in a significant reduction over time, which can be explained by increased inspection activities and consequently faster detection and repair of leaks.

Table 128 gives an overview of the development of the structure of the gas distribution network in Austria since 1990.

Table 128: Structure of the gas distribution network.

Year	**Length of gas distribution network**				
	Insulated steel	**Plastics (HDPE PVC)**	**Ductile cast iron**	**Grey cast iron**	**Total**
	[km]	**[km]**	**[km]**	**[km]**	**[km]**
1990	2 881	6 368	2 213	210	11 672
1995	3 384	12 270	1 925	183	17 762
2000	3 746	18 501	1 720	118	24 086
2005	3 566	21 778	1 522	89	26 955
2010	3 532	23 645	1 516	18	28 711
2011	3 523	23 935	1 531	13	29 002
2012	3 499	24 196	1 515	9	29 220
2013	3 488	24 494	1 489	5	29 476
2014	3 488	24 850	1 467	3	29 808
2015	3 454	25 131	1 462	2	30 048

Year	Length of gas distribution network				
	Insulated steel	Plastics (HDPE PVC)	Ductile cast iron	Grey cast iron	Total
	[km]	[km]	[km]	[km]	[km]
2016	3 452	25 307	1 436	2	30 197
2017	3 537	25 541	1 411	2	30 490
2018	3 394	25 289	1 389	1	30 073
2019	3 377	25 521	1 364	1	30 263
2020	3 359	25 855	1 339	0	30 553
2021	3 349	25 917	1 311	0	30 577
2022	3 325	26 050	1 283	0	30 658
2023	3 325	26 064	1 254	0	30 644
1990-2023	**+15%**	**+309%**	**-43%**	**-100%**	**+163%**

Table 129: Activity data and emissions for 1.B.2.b.5 Natural Gas Distribution and 1.B.2.b.3 Sour Gas Processing 1990–2023.

Year	Natural Gas Distribution			Sour Gas Processing	
	Gas network	CH_4 Emissions	CO_2 Emissions	Crude gas throughput	CO_2 Emissions
	[km][65]	[kt]	[kt]	[1 000 m³]	[kt]
1990	11 672	2.02	0.03	248 090	59
1995	17 778	1.88	0.03	405 638	89
2000	24 099	1.78	0.03	358 357	93
2005	26 958	1.69	0.02	338 349	83
2010	28 733	1.62	0.02	397 132	92
2011	29 023	1.60	0.02	375 168	88
2012	29 260	1.56	0.02	375 420	92
2013	29 496	1.51	0.02	335 874	88
2014	29 826	1.47	0.02	307 475	79
2015	30 067	1.44	0.02	279 102	72
2016	30 215	1.40	0.02	179 474	47
2017	30 507	1.36	0.02	252 837	67
2018	30 089	1.31	0.02	237 622	63
2019	30 279	1.28	0.02	227 559	60
2020	30 569	1.24	0.02	219 605	59
2021	30 591	1.20	0.02	159 693	44
2022	30 670	1.17	0.02	151 733	42

[65] Including "other material" not further defined in the statistics.

Year	Natural Gas Distribution			Sour Gas Processing	
	Gas network	CH_4 Emissions	CO_2 Emissions	Crude gas throughput	CO_2 Emissions
	[km][65]	[kt]	[kt]	[1 000 m³]	[kt]
2023	30 655	1.13	0.02	140 793	40
1990-2023	**+163%**	**-44%**	**-43%**	**-43%**	**-32%**

3.3.3.2.2.4 Post-meter emissions (1.B.2.b.6)

This category covers fugitive emissions from gas end-users, in particular leaks from natural gas appliances and – to a far lesser extent (0.003 % of emissions from this sub-category) – emissions from natural gas powered vehicles.

For appliances, emissions factors from the IPCC Refinement (IPCC 2019) were taken:

- 3.2 kg CH_4/appliance
- 32 g CO_2/appliance

For natural gas-fuelled vehicles, the emission factors amount to 0.3 kg/car for CH_4 and 0.003 kg/car for CO_2 (IPCC 2019). Leakages at industrial plants and power stations are included in Sector *1.A* and are therefore not considered under *1.B.2.b.6*.

The number of natural gas-fuelled vehicles was taken from NEMO (refer to chapter 3.2.13.2 on road transport). Concerning fugitive emissions from appliances in commercial and residential sector, the number of meter points was provided by the Austrian Association of Gas- und District Heating Supply Companies (FGW, 16 Dec. 2024). Data on the exact number of appliances in Austria is not available, so the number of appliances was assumed to be equal to 1.5 times the number of meter points. This is based on the consideration that in Austria there are households with 2 appliances (gas stove and gas heater) or 1 appliance (gas stove or gas heater) per meter point, thus the mean value was used for calculation. Detailled country specific data is currently not available.

Table 130: Activity data and emissions for 1.B.2.b.6 Fugitive Emissions from Fuels – Natural Gas Post-meter Emissions, 1990-2023.

Year	Natural gas-fueled vehicles	Meter points	CH_4 Emissions	CO_2 Emissions
	no.	No.	[kt]	[kt]
1990	0	1 291 600	6.20	0.062
1995	0	1 291 600	6.20	0.062
2000	0	1 291 600	6.20	0.062
2005	10	1 326 292	6.37	0.064
2010	627	1 339 558	6.43	0.064
2011	721	1 337 551	6.42	0.064
2012	819	1 338 079	6.42	0.064
2013	881	1 341 502	6.44	0.064
2014	919	1 339 792	6.43	0.064

Year	Natural gas-fueled vehicles	Meter points	CH_4 Emissions	CO_2 Emissions
	no.	No.	[kt]	[kt]
2015	935	1 339 864	6.43	0.064
2016	901	1 339 076	6.43	0.064
2017	872	1 338 081	6.42	0.064
2018	852	1 336 563	6.42	0.064
2019	808	1 335 371	6.41	0.064
2020	797	1 331 074	6.39	0.064
2021	756	1 324 774	6.36	0.064
2022	722	1 307 880	6.28	0.063
2023	653	1 243 874	5.97	0.060
1990-2023		**-3.7%**	**-3.7%**	**-3.7%**

3.3.4 Category-specific QA/QC

3.3.4.1 1.B.1 – Coal Mining

An external expert was consulted and confirmed the correctness of the methodology to estimate historical emissions from *1.B.1 Coal mining*.

3.3.4.2 1.B.2. – Oil and natural gas

Before using the outcome of the study on 'Life Cycle Inventory Gasbereitstellung Österreich 2021' (Wartha, 2024) for inventory purpose, QA checks were made to ensure that the data quality is appropriate. These QA checks included consultations with the study author, the Association of Gas- and District Heating Supply and representatives from the Austrian gas network. Methodological changes compared to the preceding studies were carefully checked and adjustments were made to historical results to ensure time series consistency, in particular regarding consideration of measurement results (as conducted e.g. at Austrian storage probes) or use of EF. After QA checks and consultations were finished and the quality of the data was approved, the data was used for the calculation of the national GHG emissions following the internal QA/QC requirements.

For post-meter emissions from appliances, the results were compared with the figures published in a German study (Böttcher, 2022). The number of meter points taken as a starting point for further calculations in this study is 10 times higher than the Austrian figures. Considering the population of both countries, activity data is considered realistic.

3.3.5 Uncertainty Assessment

For *1.B.2.b* Natural Gas – CH_4 an uncertainty estimate was made that was calculated from the combination of estimated uncertainties on sub-category level.

Gas production: Data on natural gas production is taken from the annual reports of the Austrian Petroleum Industry. The associated uncertainty is assumed to be low (5%). The uncertainty of the EF is estimated to be 50%.

T*ransmission*: Pipeline length (medium and high pressure) is provided by the Austrian Association of Gas- and District Heating Supply Companies (FGW) that collects these numbers directly from the operators. The associated uncertainty is assumed to be low (5%). The uncertainty of the country-specific EF is estimated to be 8%, which is slightly lower than assumed in previous submissions (10% in submission 2024). This is due to improvements in the data collection and compilation made in the course of a national study (Wartha, 2024), such as the use of data from the IMEO Reporting (OGMP 2.0) delivering high quality measurement-based CH_4 emissions data.

Storage: The amount of natural gas injected and withdrawn from the storage sites is well known (uncertainty 5%). For the uncertainty of the country-specific EF the same assumption as for transmission was applied (uncertainty 8%), taken into account several improvements implemented in the LCI, such as use of measurement data at Austrian storage tanks or the consideration of flash gas utilization.

Distribution: The length of distribution pipelines is provided by the Austrian Association of Gas- and District Heating Supply Companies (FGW). The uncertainty is considered to be low (5%). Emission factors are material specific and from international literature. The associated uncertainty is assumed to be 10%.

Post-meter emissions: The number of meter points is provided by the Austrian Association of Gas- and District Heating Supply Companies (FGW). The exact number of appliances in Austria is not known and thus needs to be estimated. The uncerainty of the AD is estimated to be 30%. The EF as well as its uncertainty is taken from the IPCC 2019 Refinement (60%)

This leads to the combined uncertainty (using the Tier 1 approach, with weights for the contribution to total source emissions) of 20% for AD, 40% for EF, resulting in a total uncertainty of emissions of 44%.

3.3.6 Recalculations

1.B.2.a.2 Oil production

In previous submissions, emissions from *oil exploration* (*1.B.2.a.1*) and *oil production* (*1.B.2.a.2)* were included in *1.B.2.b.2 Natural gas production* as there is a combined production of oil and gas (incl. oil gas) in Austria. From this years' submission onwards however, oil production, including oil exploration, is reported separately under *1.B.2.a.2*. This is thus a partly shift in emissions from *1.B.2.b.2* to *1.B.2.a.2* done in response to the UNFCCC Review 2023 (UNFCCC, 2024)

1.B.2.b.2 Natural gas production

The revision of the whole emission time series in this years' submission is due to separate reporting of oil and gas production data, as mentioned above, done in response to the UNFCCC Review 2023 (UNFCCC, 2024). Moreover, for this years' submission activity data (gas produced) was taken from the (more complete) Mineral Oil Report (FVMI[66]), leading to higher emissions for 2022 (+8 *kt CO_2e).*

1.B.2.b.4 Natural gas transmission and storage

Emissions of CH_4 were revised over the whole time series due to the consideration of new study results on fugitive emissions from gas transmission, storage and distribution in Austria, conducted by Forschung Burgenland based on a survey among Austrian gas companies (Wartha, 2024). Moreover, verified emissions data on gas transmission became available from the IMEO reporting within the scope of OGMP 2.0 from 2022[67] onwards. Also CO_2 emissions from gas storage were reported for the first time based on the study results. Overall, emissions were revised by −52 *kt CO_2e* in this subsector for 2022, −33 *kt CO_2e* of which can be attributed to gas transmission and −19 *kt CO_2e* to gas storage.

1.B.2.b.5 Natural gas distribution

Emissions were updated over the whole time series (2022: −7.4 kt CO_2e) based on the new study on fugitive emissions from the Austrian gas network, covering gas transmission, storage and distribution (Wartha, 2024).

1.B.2.b.6.1 Natural gas post-meter

This sub-category was reported for the first time in this years' submission based on the IPCC 2019 Refinement, covering emissions from natural-gas appliances and natural-gas-powered vehicles (gas post meter). This resulted in +176 *kt CO_2e* for 2022 and to a similar extent for the rest of the time series. (see Annex 7)

3.3.7 Planned improvements

As soon as verified emissions data from the future reporting under the EU Regulation on the reduction of methane emissions in the energy sector (Regulation (EU) 2024/1787, 'Methane Regulation', in force since August 4th 2024) is available, the data will be taken into consideration for GHG inventory reporting on *1.B.2 Oil and Gas*.

3.4 CO_2 transport and storage (Category 1.C)

CO_2 transport and CO_2 storage is not occurring in Austria.

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[66] FVMI – Fachverband der Mineralölindustrie (2023): Branchenreport Mineralöl 2023/2024 – Schwerpunkte. Kennzahlen. Positionen

[67] UNEP – United Nations Environment Programme (2023): An Eye on Methane. The road to radical transparency: International Methane Emissions Observatory 2023. Nairobi.

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRT SECTOR 2)

4.1 Sector Overview

This chapter includes information on and descriptions of methodologies used for estimating greenhouse gas emissions as well as references for activity data and emission factors reported under IPCC Sector *2 Industrial Processes and Product Use (IPPU)* for the period from 1990 to 2023.

Emissions from this category comprise emissions from the following sub categories: *Mineral Industry*, *Chemical Industry*, *Metal Industry*, *Non-energy products from fuels and solvent use*, *Electronic Industry*, *Product uses as substitutes for ODS* and *Other product manufacture and use*.

Only process related emissions are considered in this sector; emissions due to fuel combustion in manufacturing industries are reported in IPCC Category *1.A.2 Fuel Combustion – Manufacturing Industries and Construction* (see Chapter 3). Not all sub sectors for which emissions due to combustion are reported in 1.A.2 additionally emit process specific emissions that would be reported in IPCC Category 2. For the categories *pulp and paper* as well as *food and drink industry* for example the additional (process related) emissions are of biogenic origin, which is why – in line with the guidelines – they are not accounted for.

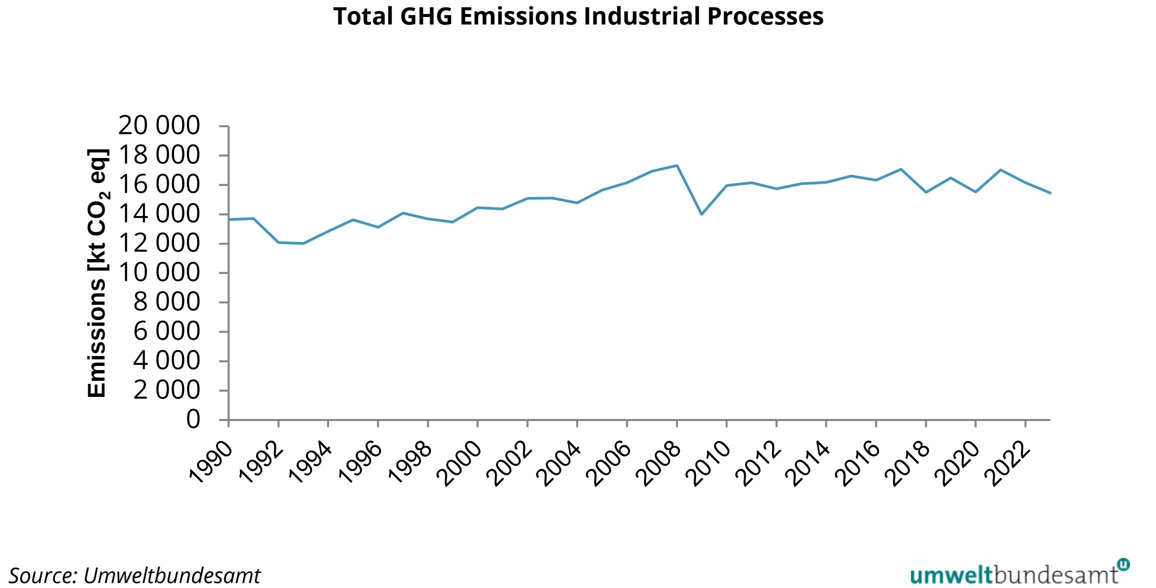
An overview on categories relevant in Austria as well as the status of emission reporting is presented in Table 136

4.1.1 Emission Trends

In 2023, greenhouse gas emissions from Sector *2 Industrial Processes and Product Use* amounted to 15 472 kt CO_2 equivalent, compared to 13 641 kt CO_2 equivalent in 1990. These emissions constituted 23% of Austria's total greenhouse gas emissions (excluding LULUCF) in 2023 and 17% of total emissions in 1990.

Greenhouse gas emissions from this sector show a long term increasing trend until 2008, and remain quite stable with minor fluctuations after the economic crisis in 2009, with the metal industry being the dominat sub-sector. The minimum in 1992/1993 resulted from the termination of primary aluminium production in Austria. In the following years, emissions increased due to extended activities in the iron and steel industry. The trend 2008–2010 is characterised by the effects of the economic crisis, followed by its recovery. The dip in 2018 is due to revision works at a blast furnace, the one in 2020 due to the Covid pandemic and its effects on production (reduced demand due to production stops in all major customer segments). Increased energy costs damped production and emissions in 2022. From 2022 to 2023 emissions again decreased by 6% due to reduced production, in particular of cement-, as well as iron and steel.

Figure 17: GHG emissions from Sector 2 Industrial Processes and Product Use 1990–2023.



Source: Umweltbundesamt

The following table presents greenhouse gas emissions from the IPPU sector as well as their share in total greenhouse gas emissions in 1990 and in 2023.

Table 131: GHG emissions from Sector 2 Industrial Processes and Product Use by gas.

GHG	Emissions [kt CO_2e]		Trend	Percent of total	
	1990	2023	1990–2023	1990	2023
Total	**13 641**	**15 472**	**13%**	**100%**	**100%**
CO_2	11 147	13 526	21%	81.7%	87.5%
CH_4	47	60	27%	0.3%	0.4%
N_2O	897	68	-92%	6.6%	0.4%
HFCs	2	1 402	68 534%	0.0%	9.1%
PFCs	1 063	26	-98%	7.8%	0.2%
SF_6	485	372	-23%	3.6%	2.4%
NF_3	0	18	NA	0.0%	0.12%

Carbon dioxide constitutes the most important greenhouse gas of the IPPU sector, contributing 87.5% of emissions to this sector in 2023, followed by HFCs with 9.1%, SF_6 with 2.4%, CH_4 with 0.4%, N_2O with 0.4%, and PFCs with 0.2% and finally NF_3 with 0.1%.

Table 132: Emissions from IPCC Sector 2 Industrial Processes and Product Use by gas from 1990 to 2023 and overall trend.

	Emissions [kt CO_2e]							
	Total	**CO_2**	**CH_4**	**N_2O**	**HFC**	**PFC**	**SF_6**	**NF_3**
1990	**13 641**	11 147	47	897	2	1 063	485	NO/NA
1995	**13 631**	11 191	47	850	328	75	1 134	6
2000	**14 454**	12 105	48	931	688	80	592	10
2005	**15 651**	13 519	49	301	1 097	150	509	26
2010	**15 965**	13 930	58	101	1 455	71	346	4
2015	**16 611**	14 399	59	79	1 698	45	319	13
2020	**15 524**	13 182	59	88	1 699	27	454	14
2021	**17 030**	14 929	58	81	1 555	24	368	15
2022	**16 170**	14 137	60	64	1 506	24	362	16
2023	**15 472**	13 526	60	68	1 402	26	372	18
1990-2023	**+13%**	**+21%**	**+27%**	**-92%**	**+68 534%**	**-98%**	**-23%**	

Concerning sub-categories of the sector, 66% of GHG emissions (expressed in CO_2 equivalent) originate from *Metal Industry* (mainly *Iron and Steel Production*) and 17% from *Mineral Industry*. 9.1% originate from *Product Uses as Substitutes for ODS*, and 4.3% from *Chemical Industry* (mainly *Ammonia Production*).

CO_2 emissions

As can be seen in in Figure 18, CO_2 emissions from the *Industrial Processes and Product Use* sector showed a strong increase in the period from 1999 to 2008, mainly due to increasing emissions from metal production. The effect of the economic crisis is strongly visible in 2009. In 2023, CO_2 emissions from industrial processes amounted to 13 526 kt, making up 87% of total emissions from *Industrial Processes and Product Use.* Emissions increased by 21% compared to 1990 levels.

CH_4 emissions

Only 0.4% of IPPU emissions are CH_4 emissions. They arise from *Chemical Industry (Production of Ethylene, Urea, Fertilizers and Ammonia)* and *Metal Industry (Steel Production).* As can be seen in Figure 18, CH_4 emissions from industrial processes remained quite stable until 2005. The increase in 2006 can be attributed to an increase in ethylene production capacity. In the following years, emissions remained at similar levels and in 2023 were 27% above 1990 levels.

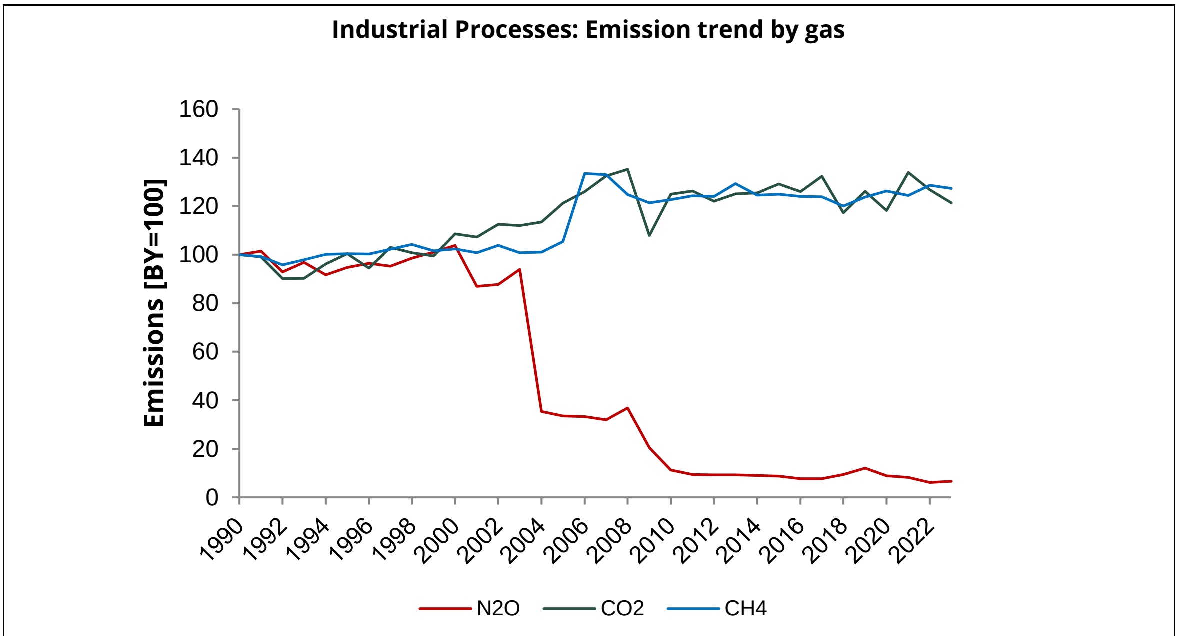
N_2O emissions

N_2O emissions mainly arise from *Nitric Acid Production (Chemical Industry)* which in Austria takes place at one site with two (and for some years three) plants. Emissions also arise from the use of N_2O as an anaesthetic and as cream propellant. As can be seen in Figure 18, N_2O emissions remained quite stable until 2000. The decreases since then are due to the introduction of emission control measures in the main emitting process nitric acid production:

- 2001: installation of a new catalyst
- 2004: installation of a N_2O decomposition facility
- 2009 (May): installation of a second catalyst in the nitric acid plant
- 2010: full operation of the second catalyst
- 2011: further optimisation of the production process as well as slightly reduced production

In 2023, N_2O emissions from *Industrial Processes* were 92% below the level of 1990, and now only contribute 0.4% of the sectoral emissions.

Figure 18: CO_2, CH_4 and N_2O emissions from Industrial Processes 1990–2023 (base year = 100).



Source: Umweltbundesamt

HFC emissions

As can be seen in Figure 19, HFC emissions increased remarkably during the period from 2 kt CO_2 equivalents in 1990 to 1 402 kt CO_2 equivalents in 2023 due to the use of these gases as substitutes for ozone depleting substances. HFC emissions mainly arise from the subcategory *Refrigeration and Air Conditioning*. Other important (sub-) categories include *Foam Blowing Agents and Electronics Industry*.

Because of the significant second step of the phase-down according to the EU F-gas regulation HFC emissions peak 2018 and have been decreasing since then.

PFC emissions

As can also be seen in Figure 19, PFC emissions decreased remarkably during the period from 1990 to 1993 – from 1 063 kt CO_2 equivalents to 57 kt CO_2 equivalents – due to the termination of primary aluminium production in 1992 which was the major source for PFC emissions. From 1993 onwards, PFC emissions solely arise from semiconductor manufacture, where a strong increase in production capacity was partly counterbalanced by emission reduction measures.

In 2023, PFC emissions amounted to 26 kt CO_2 equivalents, which is 98% below the level of 1990.

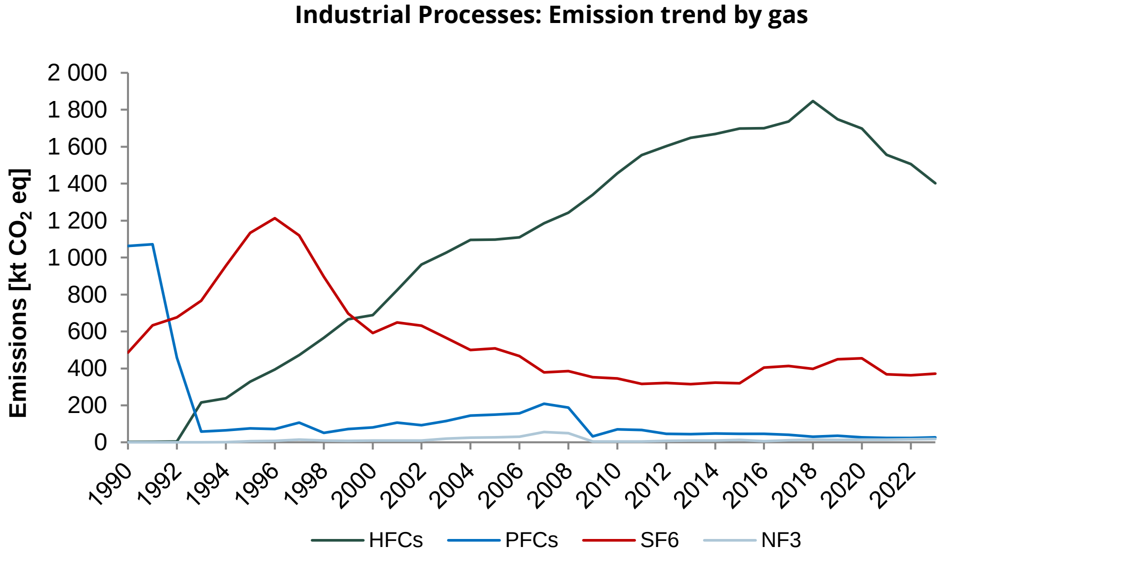
SF_6 emissions

As depicted in Figure 19, SF_6 emissions increased at the beginning of the reporting period and reached a maximum in 1996 as a result of increasing emissions from metal production and semiconductor manufacture, which decreased in the subsequent years. Current emissions mainly result from disposal of noise insulating windows. In 2023, SF_6 emissions amounted to 372 kt CO_2 equivalents corresponding to a reduction of 23% compared to the 1990 level.

NF_3 emissions

NF_3 emissions solely arise from semiconductor manufacture. NF_3 was first introduced to the Austrian market in 1994. In 2023, NF_3 emissions amounted to 18 kt CO_2 equivalents.

Figure 19: HFC, PFC, SF_6 and NF_3 emissions from Industrial Processes 1990–2023.



Source: Umweltbundesamt

Emission trends by sources

The main sources of greenhouse gas emissions in the industrial processes sector are *Metal Industry* and *Mineral Industry*, causing 66% and 17% respectively, of the emissions from this sector in 2023 (see Table 133).

Emissions from processes in *Iron and Steel Production* are the most important single source of the industry sector. It is also one of the ten most important sources regarding Austria's total greenhouse gas emissions (see below and Chapter 4.4.1).

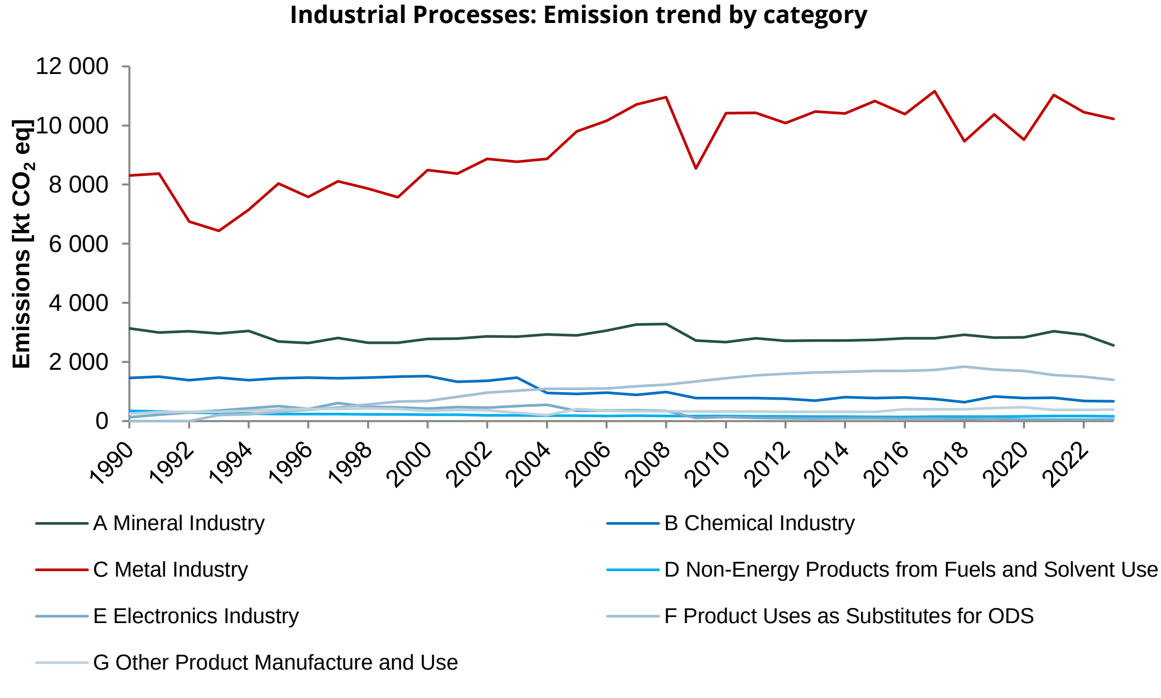
Table 133: Greenhouse gas emissions from IPCC Sector 2 Industrial Processes and Product Use by Category, their share and trend for 1990 and 2023.

	Emissions [kt CO_2e]		Share [%]		Trend 1990–2023
	1990	2023	1990	2023	
2 Industrial Processes	13 641	15 472	100%	100%	*13%*
A Mineral Industry	3 138	2 561	23%	17%	*-18%*

B Chemical Industry	1 464	670	11%	4.3%	*-54%*
C Metal Industry	8 304	10 223	61%	66%	*23%*
D Non-Energy Products from Fuels and Solvent Use	349	162	3%	1.0%	*-54%*
E Electronics Industry	133	58	1%	0.4%	*-56%*
F Product Uses as Substitutes for ODS	0-	1 400	-	9.1%	*NA*
G Other Product Manufacture and Use	253	398	1.9%	2.6%	*57%*

Figure 20 and Table 134 present greenhouse gas emissions from IPCC Sector *2 Industrial Processes and Product Use* by category for the years 1990 to 2023.

Figure 20: Greenhouse gas emissions from IPCC Sector 2 Industrial Processes and Product Use per category 1990–2023.



Source: Umweltbundesamt

Table 134: Greenhouse gas emissions from IPCC Sector 2 Industrial Processes (total and per category),1990–2023.

Year	**GHG emissions [kt CO_2e]**							
	2.A	**2.B**	**2.C**	**2.D**	**2.E**	**2.F**	**2.G**	**2 total**
1990	3 138	1 464	8 304	349	133	NO	253	**13 641**
1995	2 692	1 448	8 033	234	512	319	394	**13 631**
2000	2 775	1 523	8 489	217	420	684	346	**14 454**
2005	2 903	922	9 800	182	342	1 092	410	**15 651**
2010	2 673	778	10 420	171	144	1 454	325	**15 965**

Year	GHG emissions [kt CO_2e]							
	2.A	2.B	2.C	2.D	2.E	2.F	2.G	2 total
2011	2 797	782	10 430	167	113	1 552	320	**16 161**
2012	2 715	756	10 085	158	97	1 602	317	**15 731**
2013	2 730	694	10 470	155	86	1 646	316	**16 097**
2014	2 730	808	10 409	150	93	1 668	313	**16 171**
2015	2 753	779	10 825	144	102	1 696	311	**16 611**
2016	2 797	799	10 388	146	88	1 698	406	**16 322**
2017	2 807	741	11 159	151	87	1 732	400	**17 078**
2018	2 917	640	9 470	153	78	1 843	400	**15 502**
2019	2 825	837	10 376	153	85	1 746	452	**16 474**
2020	2 837	779	9 518	159	57	1 696	478	**15 524**
2021	3 040	785	11 039	170	53	1 553	390	**17 030**
2022	2 917	679	10 449	178	55	1 504	388	**16 170**
2023	2 561	670	10 223	162	58	1 400	398	**15 472**

2.A Mineral Industry

Greenhouse gas emissions from this category remained quite stable over the period, with an overall decrease of 18% from 1990 to 2023, and effects of the economic crisis 2009 clearly visible. The dominating sub category in total emissions and trend is *Cement Production,* other important subcategories are *Lime Production* with increasing and *Other Process Uses of Carbonates: Non-metallurgical Magnesium* with decreasing emissions over the considered period*.* Only CO_2 emissions arise from this category.

2.B Chemical Industry

For the source category *Chemical Industry*, greenhouse gas emissions remained quite stable over the period from 1990 to 2003, with nitric acid production as the main emission source (53% in 1990). Due to the implementation of emission reduction measures, ammonia production is now the main emitter, contributing 76% to total emissions from this category in 2023. Another 19% are contributed by emissions from the sub category “Other”, which mainly comprises of CO_2 emissions from organic chemical industry production. Minor sources in 2023 include nitric acid, carbide and ethylene production.

In 2023, emissions were 54% below the level of 1990.

2.C Metal Industry

Greenhouse gas emissions from *Metal Industry* fluctuated over the reporting period, which is mainly a result of a drop in PFC emissions from primary aluminium production which was terminated in 1992 and a strong increase in CO_2 emissions from *Iron and Steel Production* (+49%) over the whole time series*.* Dips in the time series relate to the economic crisis in 2009, a makeover at the iron & steel plant in 2018, the pandemic in 2020 and high energy prices due to the geopolitical situation in 2022 and the subsequent tense economical situation and increased inflation in 2023.

From 1990 to 2023 emissions increased by 23%. The main source of this category is CO_2 emissions from *Iron and Steel P*roduction.

2.D Non-energy products from fuels and solvent use

Emissions from non-energy products from fuels and solvent use are 54% below 1990 level. This is due to several legal measures (see chapter 4.4.1) that resulted in a decrease of emissions due to a lower solvent content of solvents in products e.g. paints as well as use of alternatives to solvents, implemented abatement measures and decreased use of lubricants.

2.E Electronic Industry

Emissions from this sector are solely attributed to semiconductor manufacturing, and contain HFC, PFC, SF_6 and NF_3 emissions. Emissions in 2023 are 54% lower compared to 1990, which is due to abatement measures taken by the companies.

2.F Product uses as substitutes for ODS

Emissions from products used as substitutes for ozone depleting substances (ODS) contribute 9.1% to the total emissions of the IPPU sector in 2023. HFCs as substitutes for ODS were introduced in the early 1990 and their use in the expanding refrigeration- air conditioning- and heat pumps- (RACHP) sector and with it emissions from use increased strongly since then.

Because of the significant second step of the phase-down according to the EU F-gas regulation HFC emissions peak 2018 and have been decreasing since then.

2.G Other product manufacture and use

Emissions from this sector contain emissions from the use of electrical equipment, as well as other product manufacture and use (use in tyres, shoes, soundproof windows, research etc.). Emissions in this sector are now 57% higher than in 1990, because high amounts of SF_6 are being released during the disposal of sound proof windows that were produced in the 1990ies.

2.H Other

No GHG emissions are reported in this category.

4.1.2 Methodology

In some categories, emission and production data were reported directly by industry or associations of industries and thus represent plant specific data and for some (e.g. *2.B.1 Ammonia Production*) very detailed methodologies trying to reflect the actual production process is applied.

Detailed information on the methodologies can be found in the corresponding subchapters.

Emission data reported under the European Emission Trading System

Verified CO_2 emissions reported under the EU ETS are available for the years 2005–2023, this data is used for emissions reporting of *2.A.1 Cement Production, 2.A.2 Lime Production, 2.A.3 Glass Production, 2.A.4.a Ceramics, 2.A.4.c Non Metallurgical Magnesia Production, 2.A.4.d Other Process Uses of Carbonates , 2.C.1 Iron and Steel production*. With the extension of the ETS in 2014, data for additional categories became available: *2.B.10 Chemical Industry – Other* and *2.C.3 (Secondary) Aluminium Production.* Special attention was given to time-series consistency. Furthermore, background data for emission calculations under the ETS were used for further QA/QC checks.

4.1.3 Uncertainty Assessment

In this year's submissions uncertainty estimates for all key sources based on the IPCC GL, on the uncertainty study by (Winiwarter, et al., 2007) and on estimates by Umweltbundesamt are provided (see Table 135, for explanations see the respective subchapters).

Table 135: Uncertainty assessment of 2023 estimates for key sources of Sector 2 Industrial Processes and Product Use.

IPCC Category	Source Categories	Uncertainty [%]		
		Activity data	Emission factor	Combined Uncertainty
2.A.1	Cement Production – CO2	1.0	2.0	2.2
2.A.2	Lime Production – CO2	5.0	2.0	5.4
2.A.4.c	Non-metallurgical Magnesium– CO2	2.0	2.0	2.8
2.B.1	Ammonia Production – CO2	2.0	5.0	5.4
2.B.2	Nitric Acid Production – N2O	2.0	2.0	2.8
2.C.1	Iron and Steel Production – CO2	0.5	0.5	0.7
2.C.3	Aluminium Production – CO2	20.0	5.0	20.6
2.C.3	Aluminium Production – F-Gases	20.0	50.0	54
2.C.4	Magnesium Production – Mg Foundries – SF6	5.0	5.0	7.1
2.D	Non-Energy Products from Fuels and Solvent Use – CO2	20	30.0	36
2.F.1	Refrigeration and Air Conditioning Equipment – HFC	10	50.0	51.0
2.G.1	Electrical equipment – SF6	5.0	100.0	100.1
2.G.2	SF6 from other product use – SF6	25.0	50.0	55.9

4.1.4 Quality Assurance and Quality Control (QA/QC)

For the Austrian Inventory an internal quality management system has been established. The QC procedures defined in the QMS correspond to general QC Tier 1 procedures. For further information see Chapter 1.2.3.

Concerning measurement and documentation of emission data within the EU ETS (Emission Trading System; former Emission Trading Scheme), Commission Decision 2004/156/EC established guidelines for monitoring and reporting of greenhouse gas emissions. This decision provided general guidelines on emission reporting and verification as well as sector specific guidelines on the methodologies to account for process specific CO_2 emissions. These include guidance on calculations and measurements at different level of detail similar to the different Tier methods in the IPCC guidelines. The original Commission Decision was replaced by Commission Decision 2007/589/EC and, most recently, Commission Regulation (EU) No 601/2012.

In Austria, the EU ETS is implemented by specific national regulations: the Austrian Emissions Allowance Trading Act[68] and the Ordinance regarding Monitoring and Reporting of Greenhouse Gas Emissions[69].

Furthermore most of the plants that report emission data – this includes plants that are not obliged to participate in the EU ETS – have quality management systems in place according to the ISO 9000 series or similar systems.

Consideration of additional sources/processes

2.G.4.a Fireworks

CO_2 emissions from fireworks are estimated for the first time in this years' submission (+0.05 kt CO_2 in 2022).

Allocation of emissions between subcategories

2.B.1 Ammonia Production / 2.D.3.d other - Urea used as a catalyst

Updated urea amounts used in road traffic for 2005 onwards led to a redistribution of minor amounts between these two categories (+/−1.25 kt CO_2 in 2022).

Methodological improvements

2.A.4.b Other uses of soda ash

As up-to-date input data for the previously applied methodology for estimating soda ash use is not available, a new methodology was applied for the whole time series. Emissive uses are now estimated directly (previously an indirect approach was applied where non-emissive uses were subtracted from total use). The main source is use in tungsten production, and here tungsten production and a CS value for soda use in tungsten production is used for estimating soda ash use. This results in recalculations of the whole time series (−1.07 kt CO_2 in 2022).

2.C.3.a Aluminium Production

For transparency reasons official data for aluminium production is now used as AD (previously confidential data was used and reported as "C"). The methodology for CO_2 emissions was reassessed, and the general level of emissions was verified. The change in methodology resulted in minor recalculations over the whole time series (−0.4 kt CO_2 in 2022).

2.D.3.a Solvent use

The methodology for estimating emissions from *Solvent Use* was reassessed for industrial and commercial applications and data on domestic use was updated. This resulted in recalculations of the time series from 1996 onwards, with higher emissions for the years 2000 − 2022 (+6.39 kt CO_2 of *2.D.3.1* emissions in 2022).

2.F Refrigeration and Air Conditioning

Compared to last year, several major improvements in Category *2.F* were implemented (details are given below). The total effect of all recalculations over the time series 1990-2022 is −0.3% of total F-

[68] *Emissionszertifikategesetz 2011*, Federal Law Gazette I No. 118/2011, as amended.

[69] Überwachungs-, Berichterstattungs- und Prüfungsverordnung, Federal Law Gazette II No. 339/2007, as amended.

Gas emissions reported now compared to last year's submission. The overall trend and the peak of F-Gases in 2018 remained the same. For the years before 2018, emissions reported now are lower than estimated last year, which is mainly due to the re-assessment of total imports and the allocation to sub sectors as well as the implementation of an updated emission factor for commercial refrigeration. Emissions from 2020 onwards are higher, which is mainly due to the revision of lifetime of refrigeration equipment leading to a shift of emissions from decommissioning to later years.

A short description of the recalculations is given below for each sub-category. Additionally, the total consumption of F-gases and the allocation to sub sectors was re-assessed, which affected input data for commercial and industrial refrigeration (input data for these two sub-categories are residual amounts not consumed by the other categories for which consumption is estimated bottom up).

2.F.1.a Commercial Refrigeration and 2.F.1.c Industrial Refrigeration

Emission factors and lifetime of equipment applied were updated based on actual data from about 1000 units in commercial and industrial refrigeration. The data showed that the applied emission factor for commercial refrigeration other than supermarkets previously was overestimated, and it was changed from 15% for all years to 7.5% in 2020 (interpolated in years in between). This results in lower emissions especially for recent years, but − as a result on the methodology which has refrigerant consumption as the main input parameter − on the other hand increases the stock as less amounts are needed for refilling, so more amounts are left for new installations. Also the updating of the second relevant parameter - lifetime of equipment - had an increasing effect on stock: data showed that the lifetime of equipment was previously underestimated (14 years was changed to 20 years for commercial and from 10 to 20 years for industrial refrigeration). Also, this resulted in a delay of emissions from decommissioning. Overall, the update of the two parameters roughly counterbalanced each other for ex-post emissions.

Also, emissions from commercial refrigeration other than supermarkets are now calculated based on emissions from every refrigerant separately (previously refrigerants were grouped according their GWP), as expected, the deviation of the two approaches is small (about 1%).

The implemented improvements concerning total refrigerant consumption described above, and the improvements made for MACs described below lowered the amounts of refrigerants attributed to the industrial and commercial sector, particularly for the 2010s.

For 2022, emissions from commercial refrigeration are now 18.95 kt CO_2e higher than in the last submission, and those from industrial refrigeration 18.49 kt CO_2e higher.

2.F.1.e Mobile Air Conditioning

In the course of the QA/QC plan an in-depth re-assessment of the methodology for this source category was made, leading to several improvements which resulted in an increase of emissions from this subcategory (+51.72 kt CO_2e for 2022):

- The applied default value for emissions from busses (15%) was updated using data from a sample of about 1 000 buses, which had an average of 25% leakage per year.
- The assumption on average filling of MACs was revised (previously emissions from MACs were calculated based on the assumption that the average filling is only 70% of the nomi-

nal filling, which would imply that about half of the MAC units, which need a minimum filling of about 60% to work properly, would not work during their lifetime; now the average filling is assumed to be 90% of the nominal filling and stock). As this increased emissions, this also resulted in an increase of F-Gas need for refilling, which reduces the residual amount assigned to commercial and industrial refrigeration.

Update of activity or emissions data

2.C.1.a Steel

The approach of disaggregation of total emissions from iron and steel production in Austria to Energy and IPPU was corrected for 2022 (one carbon flow was incorrectly transferred to the calculation file), resulting in +134.45 kt CO_2 in *2.C.1.a* in 2022. Additionally one rounded value of 2014 was replaced with the actual value.

2.E Electronics Industry

Reported data was corrected by the producer from 2020 onwards (−0.68 kt CO_2e in 2022).

2.F.1.d Transport refrigeration

For this year's submission, additional data reported for 2020 was incorporated also affecting 2021 and 2022 emissions (+0.69 kt CO_2e in 2022).

2.F.1.f Stationary Air Conditioning

Data was recalculated for 2020 as shares of the different refrigerant used in the different appliances was updated (−0.36 kg CO_2e in 2022).

2.F.3 Fire Protection

Amounts previously reported as refilling (= emissions) in 2022 actually corresponded to new fillings and this was corrected (−1.23 kt CO_2e in 2022).

2.F.4.b Aerosols

The methodology from technical aerosols was reviewed in the course of the QA/QC plan, leading to the correction of a transcription error (+0.13 kt CO_2e in 2022).

2.G.1 Other product manufacture and use - Electrical Equipment

The emission factor for 2022 was corrected (was 2%, should be 1% like in other years; −2.76 kt CO_2e in 2022).

4.1.5 Completeness

Table 136 gives an overview of the IPCC categories included in this chapter and presents the transformation matrix from SNAP categories. It also provides information on the status of emission estimates of all subcategories. A "✓" indicates that emissions from this sub-category have been estimated.

Table 136: Overview of subcategories of Sector 2 Industrial Processes and Product Use: transformation into SNAP Codes and status of estimation.

	IPCC Category		SNAP	Status		
				CO_2	CH_4	N_2O
2.A	**MINERAL PRODUCTS**					
2.A.1	Cement Production	040612	Cement (decarbonising)	✓	NA	NA
2.A.2	Lime Production	040614	Lime (decarbonising)	✓	NA	NA
		040618_X4T	Limestone and dolomite use – carbide			
		040618_X4U	Limestone and dolomite use – PCC			
		040618_X4V	Limestone and dolomite use - desulfurization			
2.A.3	Glass Production	040613	Glass (decarbonizing)	✓	NA	NA
2.A.4	Other Process Uses of Carbonates					
	2.A.4.a Ceramics	040617	Bricks and Tiles (decarbonizing)	✓	NA	NA
	2.A.4.b Other uses of soda ash	040619	Soda ash production and use	✓	NA	NA
	2.A.4.c Non Metallurgical Magnesia Production	040617	Magnesia sinter production	✓	NA	NA
2.B	**CHEMICAL INDUSTRY**					
2.B.1	Ammonia Production	040403	Ammonia	✓	✓	NA
2.B.2	Nitric Acid Production	040402	Nitric acid	NA[1)]	NA	✓
2.B.3	Adipic Acid Production	040521	Adipic acid	NO	NA	NO
2.B.4	Caprolactam, Glyoxal and Glyoxylic Acid Production			NO	NA	NO
2.B.5	Carbide Production					
	2.B.5.a Silicon Carbide			NO	NO	NO
	2.B.5.b Calcium Carbide	040412	Calcium carbide production	✓	NA	NA
2.B.6	Titanium Dioxide Production			NO	NA	NA
2.B.7	Soda Ash Production	040619	Soda ash production and use	NO	NA	NA
2.B.8	Petrochemical and Carbon Black Production					
	2.B.8.a Methanol			NO	NO	NO
	2.B.8.b Ethylene	040501	Ethylene production	IE	✓	NA
	2.B.8.c Ethylene Dichloride and Vinyl Chloride Monomer			NO	NO	NO
	2.B.8.d Ethylene Oxide			NO	NO	NO
	2.B.8.e Acrylonitrite			NO	NO	NO
	2.B.8.f Carbon Black			NO	NO	NO
2.B.9	Fluorochemical Production			NO (F-gases)		

	IPCC Category		SNAP	Status		
				CO_2	CH_4	N_2O
2.B.10.b	Other					
	2.B.10.b.i Other chemical bulk production	040407	NPK fertilisers	✓	✓	NA
		040408	Urea			
		040527_X4S	CO2 from Chemical Products			
	2.B.10.b.ii CO2 from Nitric Acid Production	040402	Nitric acid	✓	NA	NA
2.C	**METAL INDUSTRY**					
2.C.1	Iron and Steel Production					
	2.C.1.a Steel	040206	Basic oxygen furnace steel plant	✓	NA[2)]	NA
	2.C.1.b Pig Iron	040202	Blast furnace charging	IE[3)]	✓	NA
	2.C.1.c Direct Reduced Iron			NO	NO	NO
	2.C.1.d Sinter	040209	Sinter and pelletizing plant	IE[3)]	IE[4)]	NA
	2.C.1.e Pellet			NO	NO	NA
	2.C.1.f Other: Electric Furnace Steel	040207	Electric furnace steel plant	✓	NA	NA
2.C.2	Ferroalloys Production	040302	Ferro alloys	✓	NA	NA
2.C.3	Aluminium Production	040301	Aluminium Production	✓	NA	NA
2.C.3	Aluminium Production – By-product emissions and Al Foundries			✓[5)] (PFC, SF_6)		
2.C.4	Magnesium Production – Mg Foundries			✓ (SF_6)		
2.C.5	Lead Production	030307	Secondary Lead production	✓	NA	NA
2.C.6	Zinc Production			NO	NO	NO
2.D	**Non-Energy Products from Fuels and Solvent Use**					
2.D.1	Lubricant Use			✓	NA	NA
2.D.2	Paraffin Wax Use			✓	NA	NA
2.D.3	Other (Solvent Use)					
	2.D.3.a Solvent use	0601-0604	Solvent and other product use	✓	NA	NA
	2.D.3.b Road paving with asphalt	040611	Road paving with asphalt	NA	NA	NA
	2.D.3.c Asphalt roofing	040610	Roof covering with asphalt materials	NA	NA	NA
2.E	**Electronics Industry**			**✓ (F-gases)**		
2.F	**Product Uses as Substitutes for ODS**					
2.F.1	Refrigeration and Air Conditioning	060502	Refrigeration and air conditioning equipments	✓ (F-gases)		
2.F.2	Foam Blowing Agents	060504	Foam blowing (except 060304)	✓ (F-gases)		
2.F.3	Fire Protection	060505	Fire extinguishers	✓ (F-gases)		

	IPCC Category		SNAP	Status		
				CO_2	CH_4	N_2O
2.F.4	Aerosols	060506	Aerosol cans	✓ (F-gases)		
2.F.5	Solvents		Solvents	✓ (F-gases)		
2.F.6	Other applications			✓ (F-gases)		
2.G	**Other Product Manufacture and Use**					
2.G.1	Electrical Equipment			✓ (F-gases)		
2.G.2	SF6 and PFCs from Other Product Use			✓ (F-gases)		
2.G.3	N2O from Product Uses	0605		NA	NA	✓
2.G.4	Other		Fireworks	✓	NA	NA
			ORC	✓ (F-gases)		
2.H	**Other**					
2.H.1	Pulp and Paper Industry			NA	NA	NA
2.H.2	Food and Beverages Industry			NA[6)]	NA	NA

[1)] *CO_2 emissions from nitric acid production are included in the new category "2.B.10.i CO_2 from Nitric Acid Production*

[2)] *reported as "NA" as no default EF is provided in the IPCC 2006 GL*

[3)] *Emissions are included in category 2.C.1.a.*

[4)] *Emissions are included in category 2.C.1.b.*

[5)] *Primary aluminium production was terminated in 1992.*

[6)] *CO_2 emissions from this source are of biogenic origin.*

4.2 Mineral Products (CRT Category 2.A)

4.2.1 Cement Production (2.A.1)

4.2.1.1 Source Category Description

Emissions: CO_2

Key Source: Yes (CO_2)

In this category, only process specific CO_2 emissions are reported; emissions from combustion are reported in the energy sector (category *1.A.2.f*).

CO_2 emissions from *2.A.1 Cement production* are a key category because of their contribution to the level of the greenhouse gas inventory in 1990 and in 2023. In 2023, they contributed 2.2% to total greenhouse gas emissions in Austria (without LULUCF).

Process specific CO_2 is emitted during the production of clinker (calcination process) when carbonates (mainly $CaCO_3$) are heated in a cement kiln up to temperatures of about 1 300°C. During this process, calcium carbonate is converted into lime (CaO – Calcium Oxide) and CO_2.

Table 137 presents process-related CO_2 emissions from cement production for the period from 1990 to 2023. To increase transparency (in response to a question in the course of the UNFCCC review 2012), data on raw meal used was incorporated into the table.

Table 137: CO_2 emissions from decarbonising in cement production, clinker production, raw meal used and implied emission factor, 1990–2023.

Year	**Clinker [t]**	**Raw meal used [t]**	**Process specific CO_2 emissions [kt]**	**IEF [kg CO_2/t Clinker]**
1990	3 693 539	5 832 777	2 033	551
1995	2 929 973	4 671 693	1 631	557
2000	3 052 974	4 890 919	1 712	561
2005	3 221 167	5 148 317	1 797	558
2010	3 097 043	4 854 280	1 622	524
2011	3 175 642	4 947 150	1 666	525
2012	3 206 055	4 942 334	1 673	522
2013	3 156 286	4 858 175	1 656	525
2014	3 143 495	4 842 710	1 639	521
2015	3 256 561	5 033 733	1 701	522
2016	3 299 974	5 093 970	1 729	524
2017	3 313 459	5 057 751	1 710	516
2018	3 551 969	5 421 197	1 827	514
2019	3 422 866	5 264 330	1 771	517
2020	3 522 299	5 404 367	1 821	517
2021	3 662 612	5 623 758	1 889	516
2022	3 560 071	5 433 926	1 832	514
2023	3 075 996	4 726 459	1 543	501
1990-2023	**-16.7%**		**-24.1%**	**-8.9%**

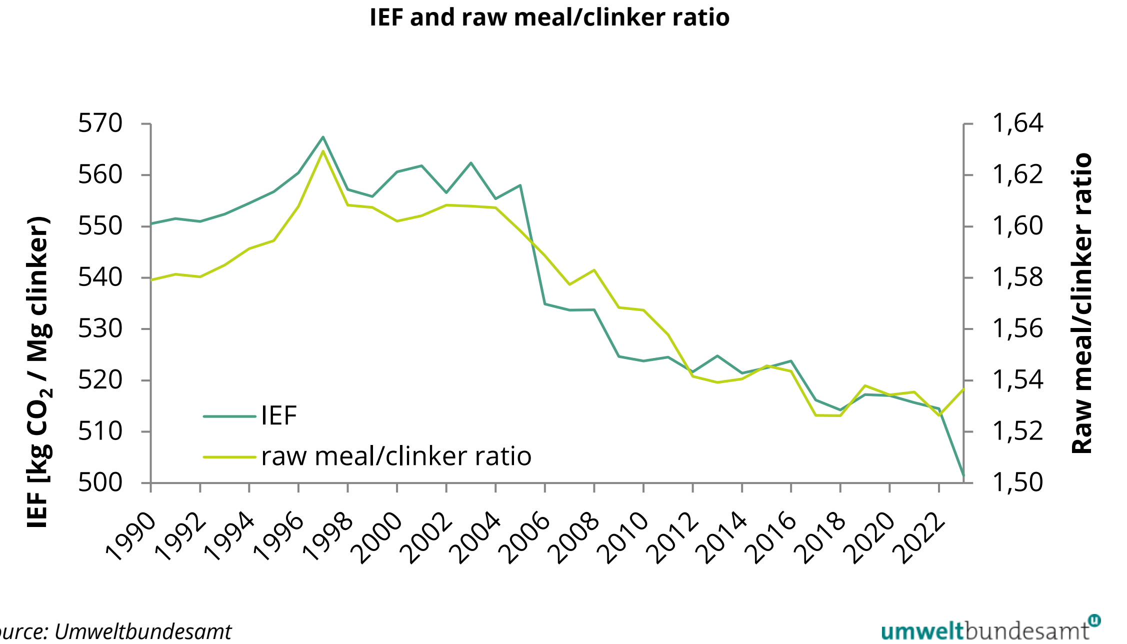
CO_2 emissions mainly follow production figures: they remained quite constant from 1990 to 1994 and dropped afterwards due to an economic downturn in the cement industry and the shutdown of one clinker oven. After 1995, emissions as well as production of clinker increased slowly, following cement demand, with minor fluctuations only. The trend from 2008 onwards is a result of the economic crisis followed by a (slow) recovery in the cement industry.

The overall emission trend from 1990 to 2023 is minus 8.9%. Production decreased by 16.7% during that period.

As process specific emissions are considered only, the IEF solely depends on the raw materials used (carbonate contents of fresh materials but also of secondary raw materials such as clay substitute, brick chips, and recycled gypsum) – smaller fluctuations of the IEF are also a result of opening/closing or shifting of production between plants that operate under different conditions (such as differing use of secondary materials). Currently, nine plants operate in Austria.

As can be seen in Figure 21, the IEF largely follows the trend of the raw meal/clinker ratio as it is a result of the raw materials used.

Figure 21: Time series of the implied emission factor (IEF) for cement production and ratio of raw meal used to clinker produced.



Source: Umweltbundesamt

In an effort to enhance transparency, information on the composition of raw material and its calcium carbonate and magnesium carbonate was collected. In 2011, the average $CaCO_3$ content was 76.3% and the average $MgCO_3$ content was 3.1%. In 2012, the values were 75.0% and 3.7%, respectively; in 2013, 74.9% and 3.8%, respectively. In 2014, the average $CaCO_3$ content was 74.8% and the average $MgCO_3$ content was 3.7% in the plants in operation.

It has to be noted that from 2005 onwards, emissions are calculated for each plant in line with the requirements of the EU ETS. Total carbonate contents of the raw meal are determined for each plant individually. However, the specific shares of $CaCO_3$ and $MgCO_3$ are not determined under this approach as this is not required for the determination of process emissions. Contents of various carbonates cannot be measured individually, but are calculated based on estimates in the individual plants. The procedures in the individual plants may differ and the percentages given above were calculated without weighing the percentages reported by the plant operators.

4.2.1.2 Methodological Issues

Until 2004, CO_2 emissions from cement production were estimated using a country specific method similar to the IPCC Tier 2 methodology. CO_2 emissions from raw meal calcination (decarbonising) were calculated based on the raw meal composition:

$$M_{(CO2\ calc)} = \sum_k (m_{(raw\ meal)})_k \cdot (x_{(MeCO3)k} \cdot M)$$

Where:	*mmass stream [kg/a]*	*Mmolecular weight CO2/molecular weight Me-carbonate*
	xmass portion	*MeCa, Mg*
	kfor the kth cement plant	

Based on raw meal data and plant specific production data, total emissions from this source were calculated. With this methodology, no cement kiln dust (CKD) correction factor has to be considered.

Activity data (clinker production) as well as emission data were taken from studies on emissions from the Austrian cement production industry (Hackl, Mauschitz, 1995, 1997, 2001, 2003, 2007, Hackl, Mauschitz, 1995, 1997, 2001, 2003, 2007) (Mauschitz, 2004, 2009, 2010-2023). The studies cover the years 1988 to 2003. In these studies process-specific CO_2 emissions and CO_2 emissions due to combustion are presented separately. In the course of these studies all cement production plants in Austria were investigated. The determination of the emission data took place by inspection of every single plant, recording and evaluation of plant specific records and also plant specific measurements and analysis carried out by independent scientific institutes.

Activity data and emissions for 2004–2023 conform to verified CO_2 emissions data of the EU ETS. A summary of the data is also published in annual reports (Mauschitz, 2004, 2009, 2010-2023) . The methodology for these emission calculations is the same as in the years before.

4.2.1.3 Category-specific QA/QC

Raw material analysis was carried out by independent scientific institutes. Clinker production data was compared with publications from the Association of the Austrian Cement Industry to ensure completeness.

During various reviews, the Austrian IEF has been considered high compared to other Parties and the IPCC default value. A possible explanation can be found in (Hackl, Mauschitz, 1995, 1997, 2001, 2003, 2007), where the authors apply both methods, based on clinker and on raw meal, to calculate CO_2 emissions and find that if CO_2 emissions are calculated from clinker instead of raw meal, this leads to 4% lower emissions.

For 2005–2023, verified CO_2 emissions (total of all plants) were checked against national emissions taken from the studies – no deviations were identified.

4.2.1.4 Uncertainty Assessment

As the applied methodology is based on plant specific data, the uncertainty of activity data is assumed to be low: it was assumed 5% for the base year and 1% for the recent year as now this data is verified under the EU ETS scheme. According to the IPCC 2006 GL the uncertainty of the CO_2 emission factor for Tier 2 is 1–2%. In the Austrian method, the uncertainty basically derives from the raw meal composition as the uncertainty for the stochiometric emission factor is negligible;

thus, the uncertainty of the emission factor is assumed to be 2%. This results in a combined uncertainty of 2.2%.

4.2.1.5 Recalculations

No recalculations have been carried out since the last submission.

4.2.2 Lime Production (2.A.2)

4.2.2.1 Source Category Description

Emissions: CO_2

Key Source: Yes (CO_2)

CO_2 emissions from lime production are a key category because of their contribution to the total inventory's level in 1990 and in 2023, as well as because of their contribution in terms of their trend. In 2023, emissions from this category contributed 0.9% to the total amount of greenhouse gas emissions in Austria.

In this category all processes using limestone or lime in Austria (both directly marketed and process use only) leading to CO_2 emissions or CO_2 removals are reported:

- Lime production in all lime kilns in Austria
- Lime production for calcium carbide production
- Lime production for PCC (precipitated calcium carbonate) production as well as CO2 recovery from PCC use in sugar and pulp and paper industry
- Limestone use for desuphurisation

CO_2 is emitted during the calcination step of lime production. Calcium carbonate ($CaCO_3$) in limestone and calcium/magnesium carbonates in dolomite rock ($CaCO_3$•$MgCO_3$) are decomposed to form CO_2 and quicklime (CaO) or dolomite quicklime (CaO•MgO) respectively.

Table 138 presents activity data for this category (lime produced) as well as CO_2 emissions from lime production for the period from 1990 to 2023.

Table 138: CO_2 emissions, activity data and implied emission factors for lime production 1990–2023.

Year	Lime Produced [t]	CO_2 [kt]	IEF (not considering CO_2 recovery) [kg CO_2/t lime produced]
1990	672 436	456	678
1995	678 313	452	666
2000	830 632	556	669
2005	940 085	618	658
2010	912 285	604	662
2011	967 750	637	658
2012	911 180	598	657

Year	Lime Produced [t]	CO_2 [kt]	IEF (not considering CO_2 recovery) [kg CO_2/t lime produced]
2013	928 397	615	663
2014	940 300	616	655
2015	922 436	609	660
2016	928 417	609	656
2017	920 128	608	661
2018	897 581	573	638
2019	918 281	608	662
2020	867 384	579	668
2021	993 542	653	658
2022	958 549	624	651
2023	905 665	588	649
1990-2023	**35%**	**+29%**	

CO_2 emissions from this category have been increasing since 1990, with a pronounced dip due to the economic crisis in 2009. In the year 2023, emissions were 29% higher than in 1990 (see Table 138).

4.2.2.2 Methodological Issues

Lime produced at lime kilns

Emissions were estimated using a country specific method based on detailed production data.

Activity data for the whole time series and emission data until 2004 were reported by the *Association of the Stone & Ceramic Industry.* For 2005–2023, verified CO_2 emissions reported under the ETS were used for the inventory: some plants calculate emissions based on raw material data, most calculate emissions from lime produced; thus the activity data reported under the ETS for some plants is production volumes, others report the amount of raw materials used. For the calculation of an overall IEF, the overall value of Austrian lime production as reported by the *Association of the Stone & Ceramic Industry* is used.

Also reported emissions for the years before 2005 are based on detailed data of each of the seven lime production plants in Austria, including production volumes and the respective CaO and MgO contents of lime produced in the respective plant.

The IEF depends on the quality ($CaCO_3$/$MgCO_3$ content) of the limestone used; it ranges between 0.73 and 0.77 tonnes CO_2 per tonne lime produced – which corresponds to the default range for purity of high calcium lime of 93–98%.

Lime production for calcium carbide production

Calcium carbide production as well as the plant specific emission factor for the lime production step (0.7153 t CO_2/t carbide) is reported by the only producer in Austria.

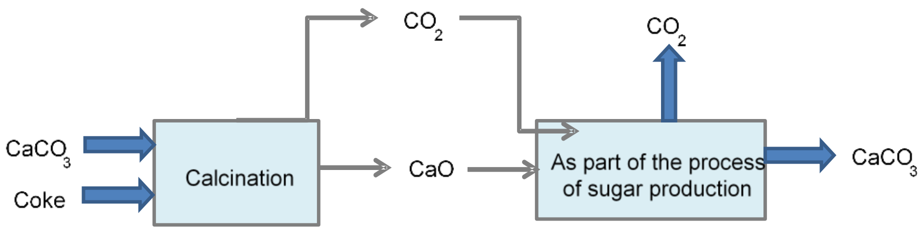
Lime production for PCC (precipitated calcium carbonate) production as well as CO_2 recovery from PCC use

Lime used for sugar purification

In Austria, two sugar processing plants are in operation, owned by the same company and integrated in the EU ETS. In these plants, limestone is converted into lime, using coke as fuel to maximise the amount of CO_2 available for the internal process. Both lime and CO_2 produced in the decarbonising step are fed into the raw sugar solution (this takes place in the sugar purification unit, see Figure 22). At this point, the lime re-reacts with CO_2 forming a limestone sediment which binds impurities in the raw sugar solution. Surplus CO_2 leaves the system. The sediment, the by-product of the sugar purification step, is known as 'Carbokalk'. It also contains the bound impurities (organic substances and minerals) and is used as a fertilizer (Wasner, 2009).

Figure 22: Purification step in the sugar production: lime production (calcination) and reaction of CO_2 and lime back to limestone (sediment).

Limestone and CO_2 in the sugar purification



Source: Umweltbundesamt

The majority of CO_2 originating from lime is contained in the sediment. However, following the recommendation by the Expert Review Team, mass balance data were obtained from the producer. Based on this mass balance, it was found that part of the CO_2 originating from limestone does not end up in the sediment but is emitted, and an emission factor of 2.07 kg CO_2 per t $CaCO_3$ input was calculated.

Lime used for production of PCC

Until 2019 PCC (precipitated calcium carbonate) was produced at one site in Austria. The process is basically the same as in sugar purification explained above (limestone calcination and subsequent precipitation using i.a. the CO_2 emitted in the calcination step), only that the precipitation step takes place under definded conditions to produce calcium carbonate with the desired physical parameters concerining particle size, crystal structure, surface area, purty, opacity etc.

For the years 2005 to 2023 CO_2 emissions data was available from the EU ETS, for the years before the value of 2005 was used. For CO_2 recovered data was only available for the years 2017 and 2018, for 2019 the data was not complete as the production was terminated in this year. Therefore the share of recovered data 2017 and 2018 was used for calculating CO_2 recovered for the other years.

Lime use and PCC production in pulp and paper industry

In the EU-ETS scheme, several pulp and paper production sites report process emissions from limestone use and recovery from PCC production respectively (this data and information is independantly verified). As data is only available for recent years, production capacities for the different plants have been used to prepare time series of emissions and removals.

Limestone use for desulphurisation

Activity data for limestone used for desulphurization were taken from a national report on desulphurization technologies in Austria (Windsperger, Hintermeier, 2002). The time series was constructed with the help of plant specific SO_2 emission declarations from the Austrian steam boiler database.

For calculation of CO_2 emissions, the IPCC default emission factors of 440 kg CO_2/t limestone and 477 kg CO_2/t dolomite were used. From 2005 onwards, ETS background data provided more detailed information on the actual carbon content of the limestone and dolomite used. Therefore, the IEFs from 2005 onwards are slightly different to the IPCC default values.

4.2.2.3 Category-specific QA/QC

The emission values for 2005 onwards are verified under the EU ETS. IEFs are compared with IPCC default values. The *Association of the Stone & Ceramic Industry* reported total CO_2 emissions, which were compared to ETS data.

For limestone use for desulfurisation it was checked whether data cover all industrial activities of this type in Austria.

4.2.2.4 Uncertainty Assessment

As emissions from lime klins cover about 95% of total emissions from this category, the uncertainty assessment was made for this main sub category only:

The uncertainty of the emission factor derives basically from the raw-material composition and is assumed to be 2%. Uncertainties for activity data are considered to be low as they are based on verified plant specific data of all Austrian plants, we assumed 5%. This leads to a combined uncertainty of 5.39%.

4.2.2.5 Recalculations

No recalculations have been carried out since the last submission.

4.2.3 Glass Production (2.A.3)

4.2.3.1 Source Category Description

Emissions: CO_2

Key Source: no

In this category CO_2 emissions from decarbonising of soda, limestone, dolomite and other carbonates used for glass production is considered. This category contributed 0.05% to total greenhouse gas emissions in Austria (without LULUCF).

4.2.3.2 Methodological Issues

Emissions are calculated based on the input of carbonates and a CO_2 emission factor for the different types of carbonates.

For years 2002 to 2004 input data on carbonates (limestone, dolomite and soda) was reported by the *Association of Glass Industry*. The factor of tonne carbonate used/ tonne glass for 2002 (the only year were both glass production and carbonate input was available) was also applied for 1990–2001. For the calculation of CO_2 emissions the IPCC 2006 default emission factors of 414.92 kg CO_2/t soda ash, 439.71 kg CO_2/t limestone and 477.32 kg CO_2/t dolomite were applied for the years 1990 to 2004.

Since 2005 verified CO_2 emissions and activity data reported under the ETS is used for the inventory.

Table 139 presents activity data and CO_2 emissions from this category for the period from 1990 to 2023.

Table 139: CO_2 emissions and carbonate use in glass production 1990–2023.

Year	**Glass Prod. [t]**	**CO_2 emissions [kt]**
1990	398 515	39
1995	435 094	42
2000	375 348	36
2005	417 685	35
2010	498 156	40
2011	474 222	36
2012	472 040	37
2013	487 359	39
2014	496 782	37
2015	497 368	40
2016	480 781	38
2017	501 881	38
2018	487 341	38
2019	525 624	41

Year	Glass Prod. [t]	CO_2 emissions [kt]
2020	503 490	39
2021	509 577	36
2022	545 652	35
2023	516 466	35
1990-2023	**+30%**	**-10%**

4.2.3.3 Category-specific QA/QC

The country-specific EFs for limestone, dolomite and soda ash have been compared with the IPCC default values. They deviate from the IPCC default values less than 1%.

4.2.3.4 Uncertainty assessment

The uncertainty of recent activity data is assumed to be 1%. The uncertainty of the emission factor is estimated to be about 2%. This leads to a combined uncertainty of 2.2%.

4.2.3.5 Recalculations

No recalculations have been carried out since the last submission.

4.2.4 Other Process Uses of Carbonates (2.A.4)

In this category ceramics (bricks), magnesia sinter production and soda ash use are addressed.

4.2.4.1 Ceramics (2.A.4.a)

Source Category Description

Emissions: CO_2

Key Source: No

This category includes CO_2 emissions from the production of bricks where CO_2 is generated through decomposition of the carbonate content of the raw materials.

Table 140 presents CO_2 emissions from bricks production for the period from 1990 to 2023. CO_2 emissions from bricks production showed a maximum in 1995/1996 due to a peak in brick production. In 2023, emissions from this category contributed 0.07% to total greenhouse gas emissions in Austria and were 59% lower than in 1990.

Methodological Issues

Activity data for the production of bricks was taken from national statistics (STATISTIK AUSTRIA), for 1996 the value of 1995 was used due to lack of data. Since 2006 the volumes sold of the short-term statistics are directly provided by the Statistik Austria on annual basis.

Emission values for the years 1998–2001 were reported by the *Association of the Stone & Ceramic Industry*. The reported CO_2 emission data is based on data of the different brick production sites in Austria, also considering the carbonate contents of raw materials used for bricks production at the respective plants. From the IEF for 1998, emissions of the years prior to 1998 were calculated and the IEF of 2001 was used to calculate emissions of 2002 to 2004.

For 2005–2023, verified CO_2 emissions reported under the ETS were used for the inventory (2006 IPCC GL, Tier 3). This data covers all brick production sites in Austria.

Table 140 presents activity data for production of bricks and CO_2 emissions for this category for the period from 1990 to 2023.

Table 140: Activity data and CO_2 emissions for bricks production 1990–2023.

Year	**Bricks** [m³]	**CO_2 emissions** [kt]	**IEF** [kg CO_2/m³]
1990	2 230 000	116	52
1995	2 848 716	149	52
2000	1 954 855	116	59
2005	2 170 069	128	59
2010	1 796 823	81	45
2011	2 381 604	99	41
2012	1 753 748	93	53
2013	1 677 076	80	48
2014	1 619 485	94	58
2015	1 672 425	91	55
2016	1 794 495	91	51
2017	1 713 349	95	55
2018	1 754 768	105	60
2019	1 980 878	104	53
2020	1 804 105	106	59
2021	2 040 411	96	47
2022	1 932 886	100	52
2023	1 142 362	48	42
1990-2023	**-49%**	**-59%**	**-20%**

The increasing IEF between 1998 and 2001 is due to a switch in porous material used in brick production. Previously mainly sawdust was used, whereas nowadays residual fibre material from paper industry is used. Furthermore, $CaCO_3$ is added for moisture compensation.

Generally, fluctuations in the IEF occur because of different brick types produced. High and low density bricks have different properties, and different raw materials with different carbon contents are used. The higher the density of the particular brick, the more CO_2 is emitted during production. For example, in 2010 and 2011, raw material (loam) with lower carbon content was used (verified by chemical analysis: loss on ignition), resulting in a lower average implied emission factor for these two years.

Uncertainty Assessment

The uncertainty of activity data is assumed to be low (1%).The uncertainty of the emission factor is estimated to be about 2%. This leads to a combined uncertainty of 2.2%

Recalculations

No recalculations have been performed since the last submission.

4.2.4.2 Other Uses of Soda Ash (2.A.4.b)

Source Category Description

Emissions: CO_2

Key Source: No

In this category CO_2 emissions from soda ash use in metallurgy and other industries is considered, CO_2 emissions from soda ash used in glass production are reported in *2.A.7.c Glass production*.

Soda ash was produced in Austria until 2005. However, als it was produced by the Solvay process which is CO_2-neutral (except for coke used for calcination of limestone which is accounted for as fuel in the energy sector subcategory *1.A.2.c*), the category 2.*B.7 Soda ash production* is reported as "NO" for all years.

In 2023, CO_2 emissions from soda ash use contributed 0.01% to total GHG emissions in Austria. The following table presents CO_2 emissions from this category.

Table 141: Activity data and CO_2 emissions for soda ash use 1990–2023.

Year	Soda ash used [t]	CO_2 emissions [kt]
1990	30 284	13
1995	18 769	8
2000	39 447	16
2005	36 029	15
2010	28 635	12
2011	35 000	15
2012	23 000	10
2013	21 000	9
2014	24 157	10
2015	25 426	11
2016	27 585	11

Year	Soda ash used [t]	CO_2 emissions [kt]
2017	24 835	10
2018	22 690	9
2019	21 623	9
2020	21 720	9
2021	22 278	9
2022	22 060	9
2023	21 114	9
1990-2023	**-30%**	**-30%**

Methodological Issues

Emissions were estimated using the methodology and the default emission factor of the IPCC Guidelines 2006 Tier 2 (415 kg CO_2/t soda ash).

The only Austrian producer Solvay Österreich GmbH provided data for 1990 and from 2008–2013 for solvent use. Activity data for the years in between was interpolated, for the years 2014ff the value of 2013 was used. From this total amount, the amount used in glass production that is already considered in category *2.A.3* was subtracted. Also Soda used for the production of detergents is subtracted as it is a non-emissive use. From the remaining soda ash use CO_2 emissions are calculated using the IPCC default EF.

Uncertainty Assessment

The uncertainty of activity data is assumed to be 30%. The uncertainty of the emission factor is estimated to be 2%. This leads to a combined uncertainty of 30.1%.

Recalculations

As up-to-date input data for the previously applied methodology for estimating soda ash use is not available, a new methodology was applied for the whole time series. Emissive uses are now estimated directly (previously an indirect approach was applied where non-emissive uses were subtracted from total use). The main source is use in tungsten production, and here tungsten production and a CS value for soda use in tungsten production is used for estimating soda ash use. This results in recalculations of the whole time series (−1.07 kt CO_2 in 2022).

4.2.4.3 Non-metallurgical magnesium production (2.A.4.c)

Emissions: CO_2

Key Source: Yes (CO_2)

This category includes CO_2 emissions from the production of magnesia sinter. CO_2 emissions from magnesia sinter production are a key category due to their contribution to total emissions in 1990 and in 2023. In 2023, this category contributed 0.5% to the total amount of greenhouse gas emissions in Austria.

During production of magnesia sinter, CO_2 is generated in the calcination step, when magnesite ($MgCO_3$) is sintered at high temperatures in a kiln to produce MgO. Magnesia sinter is processed to refractory materials such as bricks.

Table 142 presents CO_2 emissions from production of magnesia sinter for the period from 1990 to 2023. CO_2 emissions from magnesia sinter plants vary over the period from 1990 to 2023, with an overall decreasing trend. Fluctuations in CO_2 emissions from this category are explained by:

- Varying implied emission factors that reflect different qualities of sinter produced and proportions of sinter/caustic sinter production.
- Varying production figures. For example, magnesia sinter production showed a distinct dip in 2009 due to the economic crisis.

Methodological Issues

No IPCC methodology is available for this source.

Emission values and activity data were directly reported by the only company in Austria sintering magnesia. For 2005–2023, verified CO_2 emissions, reported under the ETS, were used for verification of the reported emissions. Emissions are calculated according to "calculation method B: alkali oxides" in Annex II of the EU ETS monitoring and reporting guidelines[70]. The composition of the oxides is measured using X-ray fluorescence analysis.

Table 142 presents activity data and CO_2 emissions from this category for the period from 1990 to 2023.

Table 142: CO_2 emissions from magnesia sinter production 1990–2023.

Year	Magnesite [t]	CO_2 Emissions [kt]	IEF [kg CO_2/t magnesite]
1990	966 066	481	498
1995	753 575	410	544
2000	699 707	339	485
2005	638 749	310	485
2010	627 612	314	500
2011	710 573	345	486
2012	625 259	305	488
2013	669 414	330	494
2014	676 263	334	494
2015	609 517	301	494
2016	643 350	318	495
2017	684 322	345	504
2018	744 227	365	490
2019	615 710	293	475
2020	579 845	282	487

[70] Commission Decision 2004/156/EC of 29 January 2004 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council.

Year	Magnesite [t]	CO_2 Emissions [kt]	IEF [kg CO_2/t magnesite]
2021	724 655	357	492
2022	657 396	317	482
2023	693 562	339	489
1990-2023	**-28%**	**-30%**	**-1.8%**

Source specific QA/QC

The calculation is based on a recognised European standard method. Order of magnitude and time-series checks are performed. The operator is contacted in case of inconsistencies. The operator reported total CO_2 emissions, which were compared with EU ETS data and found to accord.

Uncertainty Assessment

The uncertainty of the emission factor equals the uncertainty of raw material composition which is estimated to be about 2%. The uncertainty of activity data is assumed to be low (2%) as there is only one plant in Austria and data is obtained from this plant. This leads to a combined uncertainty of 2.8%.

Recalculations

No recalculations have been carried out since the last submission.

4.3 Chemical Industry (CRT Category 2.B)

4.3.1 Ammonia Production (2.B.1)

4.3.1.1 Source Category Description

Emissions: CO_2 and CH_4

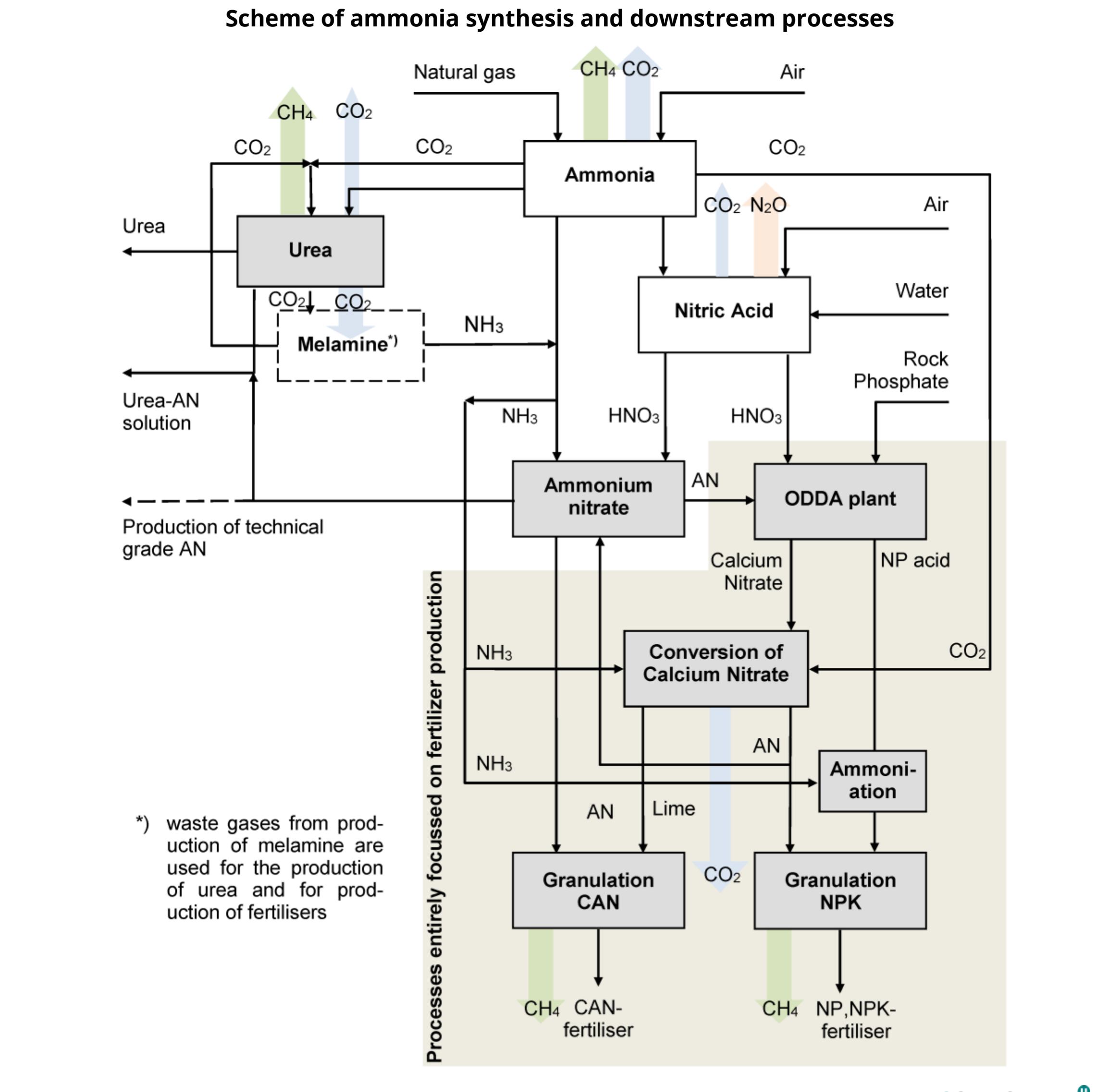
Key source: Yes (CO_2)

Ammonia production is a key category due to its contribution of sectoral CO_2 emissions to total greenhouse gas emissions in Austria in 1990 and in 2023. In 2023, this category contributed 0.7% to Austria's total greenhouse gas emissions.

Ammonia (NH_3) is produced by catalytic steam reforming of natural gas or other light hydrocarbons (e.g. liquefied petroleum gas, naphtha) – in Austria, natural gas is used. In this process, the feedstock is reformed with steam in a heated primary reformer and subsequently with air in a second reformer in order to produce the synthesis gas. CO_2 is produced by stoichiometric conversion and is mainly emitted during the primary reforming step (Umweltbundesamt, 2001d) .

Ammonia is produced at one plant in Austria. The process chart below (Figure 23) shows the scheme of ammonia synthesis and downstream processes at the integrated plant: the main production lines (ammonia, urea, melamine, nitric acid, different types of fertilisers and intermediate products), flows of main raw materials and intermediate products as well as relevant emissions.

Figure 23: Scheme of ammonia synthesis and downstream processes at Austria's integrated ammonia plant. Note: Grey coloring highlights those processes related to fertilizer production.



Source: Umweltbundesamt

Approximately half of the methane introduced in the synthesis is CH_4 that is generated in the so called methanator: small amounts of CO and CO_2, remaining in the synthesis gas, are harmful for the ammonia synthesis catalyst and have to be removed by conversion to CH_4 in the methanator. The other half consists of recycled methane that has not been converted in the reforming step. Only a small part of the methane is actually emitted as leakage during start-ups of the ammonia production, the main part is used as a fuel in the primary reformer.

Table 144 presents CO_2 and CH_4 emissions from ammonia production as well as ammonia production figures and natural gas input for the period from 1990 to 2023.

Emissions vary during the period, following closely the trend in ammonia production. In 2023, CO_2 emissions are 4% lower than in 1990. The interannual change 2013/2014 is due to lower production because of technical problems at the plant. In 2018 production was lower due to a turnaround at the plant.

4.3.1.2 Methodological Issues

Activity data (ammonia production and natural gas input) for the whole time series and CH_4 emission data from 1994 onwards were reported directly to the Umweltbundesamt by the only ammonia producer in Austria and thus represent plant specific data. The composition of the synthesis gas is measured regularly.

CH_4 emissions are calculated from the measured synthesis gas composition and the number and duration of start-ups. The implied emission factor for CH_4 that was calculated from activity and emission data from 1994 was applied to calculate emissions of the years 1990 to 1993 as no emission data was available for these years.

CH_4 emission factors of ammonia plants largely depend on the number of shutdowns and start-ups during the year. Especially a start up after a turn around with exchange of catalyst in some of the reactors of the plant needs a prolonged start up procedure resulting in an increase of the IEF.

CO_2 emissions are calculated as follows:

1. Carbon input is calculated from natural gas input – following the tier 2 method of the IPCC guidelines – with an emission factor of 55.4 t/TJ. Natural gas is the only carbon input for the ammonia synthesis and its downstream processes. Plant-specific natural gas data are available for the whole time series.
2. Subtraction of carbon that is accounted for elsewhere or stored to avoid double counting of emissions (the total of these is reported as recovery):
   a. Fugitive CH4 emissions during start-ups of the ammonia production reported in 2.B.1
   b. CO2 and CH4 emissions from fertilizer production (downstream process). These emissions are reported under CRT category 2.B.10.ii, further explanation see chapter 4.3.7.
   c. CO2 and CH4 emissions from urea production (downstream process). These emissions are reported under CRT category 2.B.10.ii, further explanation see chapter 4.3.7.
   d. CO2 emissions from nitric acid production (downstream process). These emissions are reported under CRT category 2.B.10.i CO2 from Nitric Acid Production, further explanation see chapter 4.3.5.
   e. CO2 emissions from urea use reported in Sector Agriculture (see chapter 5.7)
   f. CO2 emissions from urea use reported in 2.D.3 Other "Urea used as a catalyst" (Adblue)
   g. Carbon stored in melamine71:
3. the remainder carbon is accounted for as CO2 emissions from ammonia production.

[71] see description on melamine below.

Melamine

Melamine is primarily used to produce melamine resin, which, when combined with formaldehyde, produces a very durable thermoset plastic. Melamine is fire resistant and heat tolerant and has a highly stable structure. It is mainly used for wood based panels, but also everyday objects such as kitchenware. The life time of these products is assumed to be 10 to 30 years, as for other plastics.

The first step is the production of urea from ammonia:

$$2\ NH_3 + CO_2 \rightarrow H_2NCONH_2$$

The second step is the produciton of melamine from urea:

$$6\ H_2NCONH_2 \rightarrow C_3H_6N_6 + 6\ NH_3 + 3\ CO_2$$

So for every molecule of melamine, six molecules of CO_2 are needed, and only three molecules of CO_2 are emitted (see formulas above), so for every molecule of melamine, three CO_2 molecules are stored in the product, or – relating to urea used for the process - half of the carbon content of the urea (i.e. three C out of six) used as feedstock in step two is securely bound within the molecular structure.

According to the IPCC Guidelines no account should be taken for intermediate binding of CO_2 in downstream manufacturing processing and products. The rationale behind this guideance is that all emissions should be accounted for, and consideration of intermediate binding might result in an underestimation, if these amounts are not accounted for elsewhere, particularly as end of life emissions.

So even though the binding of carbon in melamine cannot be considered as long-time (which rather refers to several decades or centuries), the carbon stored in melamine is subtracted to avoid double counting of emissions, as the carbon in melamine is accounted for at the end of life as fossil carbon content of waste, and accounted for under the waste sector either as disposal (until 2004/2008 under *5.A*), or in the energy sector under *1.A Other Fossil Fuels*.

The Austrian approach of accounting for carbon stored in melamin is reported analoguesly to the approach used for plastics:

Plastics	Melamine
Production: fossil fuels used for production of plastics is accounted for as non-energy use of fuels, and thus accounted as carbon stored.	**Production:** fossil carbon used for melamine production is subtracted from carbon emissions, it is accounted for as carbon stored in melamine.
As carbon is bound within the molecular structure, no emissions during **use** occur.	
End of life emissions are being accounted for as fossil carbon content of waste, and accounted for under the waste sector either as disposal (until 2004/2008 under *5.A*), or in the energy sector under *1.A Other Fossil Fuels*.	

During the 2006 in-country review, the Austrian approach was explained to the ERT and accepted to be in line with the IPCC guidelines.

Table 143: CO_2 emissions from urea use .

	CO_2 emissions from urea use in selective catalytic reduction (SCR) in the transport sector	**CO_2 emissions from application of urea to soils in the agriculture sector**
Reported in category	**2.D.3 Other**	**3.H Urea application**
Year	**[kt]**	**[kt]**
1990	NO	4.4
1995	NO	7.9
2000	NO	8.4
2005	0.4	11.8
2010	15.9	19.6
2011	16.1	18.4
2012	17.7	21.7
2013	22.9	21.5
2014	24.3	25.4
2015	26.2	26.5
2016	27.0	31.3
2017	30.1	30.0
2018	34.6	23.9
2019	39.4	19.2
2020	40.1	17.0
2021	45.2	15.7
2022	43.4	18.2
2023	41.0	25.3
1990-2023		**+474%**

Table 144 shows relevant parameters for the calculation of CO_2 emissions from ammonia production. The trend of the resulting CO_2 IEF (with respect to ammonia) decreases over time, when the fluctuations caused by the included melamine production are taken in account.

Table 144: Activity data, emissions and implied emission factor for ammonia production 1990–2023.

Year	**Ammonia produced [t]**	**Natural gas input [TJ]**	**CO_2 Recovery72 [kt]**	**CO_2 Emissions [kt]**	**CH_4 Emissions [t]**	**CO_2 IEF [t/t ammonia]**
1990	461 000	10 193	97	467	62	1 014
1995	473 000	10 516	74	509	61	1 075
2000	482 333	10 548	94	491	60	1 017
2005	478 427	10 719	132	462	94	965

[72] CO_2 emissions reported in other categories or bound in melamine.

Year	Ammonia produced [t]	Natural gas input [TJ]	CO_2 Recovery72 [kt]	CO_2 Emissions [kt]	CH_4 Emissions [t]	CO_2 IEF [t/t ammonia]
2010	495 353	11 248	148	476	70	960
2011	502 461	11 347	134	495	77	984
2012	479 475	10 881	132	471	76	982
2013	435 244	9 840	122	423	225	972
2014	537 000	11 973	137	526	86	979
2015	519 860	11 562	139	502	91	965
2016	551 118	12 093	148	522	69	947
2017	507 689	11 071	146	468	91	921
2018	405 103	8 922	137	358	89	883
2019	552 973	12 091	152	521	67	942
2020	515 843	11 454	146	491	70	951
2021	527 858	11 614	145	501	48	949
2022	457 935	9 941	133	419	48	916
2023	496 117	10 559	140	447	78	900
1990-2023	**+7.6%**	**+3,6%**		**+4.4%**	**+25%**	

4.3.1.3 Category-specific QA/QC

The emission factor for natural gas is consistent with the emission factor used in fuel combustion. Natural gas input from the energy balance was checked for plausibility with ammonia production figures using the conversion factor 0.451 t natural gas per tonne ammonia. This factor is plant specific and derived from natural gas input and ammonia output.

4.3.1.4 Uncertainty assessment

As activity data are obtained from the only ammonia plant in Austria, uncertainty is rated as very low (2%). Also the emission factor and other conversion factors are considered to have low uncertainties. Thus, the quality of emission estimates is rated as "high" (5% uncertainty). This leads to a combined uncertainty of 5.4%.

4.3.1.5 Recalculations

Updated urea amounts used in road traffic for 2005 onwards led to a redistribution of minor amounts between categories *2.B.10.ii Urea Production* and *2.B.1 Ammonia Production* (+/−1.25 kt CO_2 in 2022)

4.3.2 Nitric Acid Production (2.B.2)

4.3.2.1 Source Category Description

Emission: N_2O, CO_2

Key Source: Yes (N_2O)

N_2O emissions from nitric acid production are a key source due to their contribution to total greenhouse gas emissions in Austria in 1990 and in terms of their trend. In 2023, this source contributed 0.04% to the total amount of greenhouse gas emissions in Austria, whereas in 1990 the contribution was 0.98%.

In line with the IPCC 2006 Guidelines, N_2O emissions from nitric acid production are reported in category *2.B.2*. As in the CRT only N_2O emission can be reported in this category, the CO_2 emissions are reported in *2.B.10.i CO_2 from nitric acid production*.

Nitric acid (HNO_3) is manufactured from ammonia (NH_3). In a first step, NH_3 reacts with air to NO and NO_2 and is then transformed with water to HNO_3.

Ammonia used as feedstock (gaseous or liquid) in the nitric acid plant always contains small amounts of methane, which is dissolved in ammonia. In Austria there is only one producer of nitric acid which operates two different dual pressure plants at one site. So called weak nitric acid is produced with a concentration of 59.6% HNO_3 by oxidation of ammonia produced at the same location (Umweltbundesamt, 2001d). There is no production of concentrated nitric acid in Austria. Nitric acid is mainly used for the production of fertilisers.

Table 145 presents N_2O and CO_2 emissions from production of nitric acid for the period from 1990 to 2023.

N_2O emissions follow the trend of nitric acid production for the period 1990 to 2000 with only minor fluctuations. The interannual change 2013/2014 is due to lower production because of technical problems at the plant. In 2018 production was lower due to a turnaround at the plant.

The increasing IEF between 1993 and 1994 is due to the closing down of part of a production facility that contributed to total emissions with lower specific N_2O emissions per produced unit of HNO_3. In 2007 and 2008 the IEF slightly increased again due to changes in the combustion system of one plant.

The decrease of the IEF is due to the introduction of emission reduction measures:

- 2001: installation of a new catalyst (IEF decreased from an average of 5.7 kg N2O/t nitric acid to approx. 5.0 kg N2O/t nitric acid)
- 2004: installation of a N2O decomposition facility[73] called Uhde process (Envinox® process) for the combined removal of N2O and NOx from the tail gas of nitric acid plants. The IEF decreased from an average of 5.0 kg N2O/t nitric acid, to approx. 1.6 kg N2O/t nitric acid.
- May 2009: installation of a second catalyst in the nitric acid plant
- 2010: full operation of the second catalyst

[73] This facility is documented as example in BAT Reference Document LVIC-AAF, section 3.4.7 (EUROPEAN COMMISSION 2007)

- 2011 further optimisation of the production process as well as slightly reduced activities

The increase of the IEF (increase of N_2O emissions despite lower activities) in 2012 can be attributed to a combination of various reasons with the last option being the predominant one:

- Reduced activity of the catalyst over time
- Reduced activity of the catalyst at lower productivity
- Emissions dependent on which of the two plants was in operation as their N2O emissions differ

In 2023, N_2O emissions were 3% above the emissions of 1990.

CO_2 emissions also varied over the period from 1990–2023, closely following the trend of nitric acid production until 1999. Specific emissions decreased since 2000 due to process optimisation (see implied emission factors in Table 145).

4.3.2.2 Methodological Issues

Following the IPCC Guidelines and monitoring and reporting guidelines[74] for the European Emission Trading System (ETS), plant specific measurement data was collected.

Activity and N_2O emission data was obtained directly from the plant operator. From 1998 onwards, emissions are measured continuously using a calibrated concentration monitor and volumetric flow meter. The monitoring method remained unchanged over time. Based on the analysed emission data of 1998 and due to the fact that the production technology has not changed between 1990 and 1998, emission factors per tonne of product were calculated for the technologies used (nitric acid has been produced at one site in five types of plants with different technologies over the years – with some of the plants closed or refurbished; currently two are in operation). With these estimates of plant specific emission factors and the production volume of the individual plants, the total emissions of N_2O per year were calculated.

Activity and emission data of CO_2 emissions from the years 1994 onwards have been reported directly to Umweltbundesamt by the plant operator and thus represent plant specific data. CO_2 emissions are measured discontinuously in the exhaust gas flow. The implied emission factor that was calculated from activity and CO_2 emission data from 1994 was applied to calculate CO_2 emissions of the years 1990 to 1993 as no CO_2 emission data was available for these years. Since 2008 the nitric acid plant is part of the EU ETS, and emissions reported are verified emissions. As in category *2.B.2 Nitric Acid Production* only N_2O emission are to be reported, a specific category was included under "Chemical Industry – Other" to report CO_2 emissions from Nitric Acid production.

[74] Commission Decision2007/587/EC of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council.

Table 145: Activity data, emissions and implied emission factors for N_2O and CO_2 from nitric acid production 1990–2023.

Year	Nitric acid produced [t]	N_2O emissions [t]	CO_2 emissions [kt]	N_2O IEF [kg/t]	CO_2 IEF [kg/t]
1990	529 998	2 942	0.41	5.55	0.78
1995	484 016	2 765	0.37	5.71	0.76
2000	533 715	3 070	0.37	5.75	0.69
2005	557 870	884	0.41	1.59	0.74
2010	547 699	205	0.40	0.37	0.73
2011	542 289	154	0.40	0.28	0.74
2012	534 641	170	0.39	0.32	0.74
2013	475 254	161	0.34	0.34	0.72
2014	552 041	159	0.40	0.29	0.73
2015	562 426	157	0.40	0.28	0.72
2016	567 507	120	0.41	0.21	0.72
2017	500 958	129	0.36	0.26	0.72
2018	429 840	189	0.32	0.44	0.73
2019	575 262	272	0.42	0.47	0.72
2020	556 936	176	0.40	0.32	0.71
2021	519 516	156	0.39	0.30	0.74
2022	460 341	86	0.34	0.19	0.73
2023	464 623	103	0.43	0.22	0.92
1990-2023	**-12%**	**-97%**	**+3.0%**		

4.3.2.3 Category-specific QA/QC

Measurements are done by an accredited testing body with internationally recognized standard methods. In the Austrian Ordinance regarding Monitoring and Reporting of Greenhouse Gas Emissions[75], the requirements for laboratories carrying out the analysis are described in § 15 and in Annex 2, section 5 the methods for determination of the flue gas are described.

Furthermore at Austrian plants, continuous measurements of N_2O and NO_x are state-of-the-art technology and the emission values are forwarded online to the local authority.

Order of magnitude and time-series checks are performed and the operator is contacted in case of inconsistencies.

Further QA/QC checks:

- Comparison with BAT

Modern M/H-type plant complies with BAT

[75] Überwachungs-, Berichterstattungs- und Prüfungsverordnung, Federal Law Gazette II No. 339/2007, as amended.

For older L/M-type plants no BAT conclusions have been drawn

- Comparison with international studies: (ENTEC UK Limited, 2006) page 15 and (ECOFYS et al., 2009)

4.3.2.4 Uncertainty assessment

An uncertainty of 2% was considered for the EF as N_2O emissions are continuously measured. The uncertainty of activity data is assumed to be low (2%) as it is collected from the only plant in Austria. This results in a combined uncertainty of 2.8%.

4.3.2.5 Recalculations

No recalculations have been carried out since the last submission.

4.3.3 Calcium Carbide Production (2.B.5.b)

4.3.3.1 Source Category Description

Emission: CO_2

Key Source: No

In this category the production of calcium carbide by reducing lime with carbon as well as production of acetylene from calcium carbide is considered – both processes lead to emissions of CO_2. Emissions from the preceding lime production step are reported in category 2.A.2 Lime production.

This category is a minor source of CO_2 emissions in Austria. In 2023, it contributed 0.05% of- national total emissions.

For calcium carbid production quick lime is heated mixed with coke in an electric arc funace:

$$CaO + 3\,C \rightarrow CaC_2 + CO$$

$$CO + \tfrac{1}{2}\,O_2 \rightarrow CO_2$$

Some of the produced carbid is used for production of acetylene, which is needed for welding:

$$CaC_2 + 2\,H_2O \rightarrow Ca(OH)_2 + C_2H_2$$

4.3.3.2 Methodological Issues

Activity data (carbid production as well as cabid used for acetylene production) were directly reported by the plant operator of the only carbide production plant in Austria.

Emissions from carbide production were estimated using a country specific methodology.

The country specific emission factor was derived from a carbon balance of the process for 2020, accounting for the following carbon input/outputs and parameters:

Carbon input to the process was derived from coke and electrode use and purity of the materials

Carbon outputs:

- Stochimetrical CaC_2-carbon in product, considering the purity of the produced calcium carbide
- Elementary carbon in product
- Elementary carbon in waste from flue gas treatment

Balancing input with the outputs leaves carbon which is emitted as CO_2; from these emissions an EF related to carbide production is calculated: 0.589 t CO_2/ t of technical carbide.

It has to be noted, that the emission factor is low compared to the IPCC default value, as the IPCC default value considers excess coke is used for the generation of heat needed for the process, whereas in Austria an electric arc furnace is used.

Emissions from acetylene production are calculatied using the IPCC default valule of 1.1 t CO_2/ t of carbide used.

Table 146: Activity data and CO_2 emissions from calcium carbide and subsequent acetylene production 1990–2023 reported in CRT Category 2.B.5.b.

Year	Calcium Carbide [t]	CO_2 Emissions [kt]
1990	28 951	38
1995	20 236	32
2000	37 130	43
2005	27 677	38
2010	33 041	37
2011	38 155	44
2012	37 606	43
2013	37 159	43
2014	36 022	42
2015	40 639	46
2016	36 752	43
2017	33 361	41
2018	37 078	43
2019	35 545	42
2020	34 979	40
2021	36 322	44
2022	38 860	43
2023	29 057	33
1990-2023	**+0.4%**	**-14%**

4.3.3.3 Uncertainty Assessment

The uncertainty of the emission factor is estimated with about 5% and the uncertainty of activity data with 1% (default uncertainty from the IPPC 2006 Guidelines). This leads to a combined uncertainty of 5.4%.

4.3.3.4 Recalculations

No recalculations have been carried out since the last submission.

4.3.4 Chemical Industry – Ethylene (2.B.8.b)

4.3.4.1 Source Category Description

Emission: CH_4

Key Source: No

Ethylene is produced by steam cracking of petrochemical feedstock (naphta). This production process leads to fugitive methane emissions. This category is a minor source of CH_4 emissions in Austria (1.50 kt CH_4 in 2023). In Austria, there is only one plant, which produces ethylene. This plant is located on the same general site as the refinery. According to information from the plant operator, no other products for which a guidance is provided in the IPCC 2006 Guidelines are produced at this site. Emissions from combustion including flaring are reported under *1.A.2.c*. All the GHG emissions of the plant have been verified under the EU-ETS.

4.3.4.2 Methodological Issues

Emissions were estimated using the IPCC default methodology.

Activity data are equal to the capacity of the only ethylene producing plant in Austria and amount to 350 000 t ethylene per year until 2005. In 2006, the capacity of the ethylene plant was expanded to 500 000 t. The IPCC default emission factor of 3 kg CH_4/t ethylene produced was used to calculate the emissions that amount to 1 050 tonnes CH_4 until 2005 and 1 500 tonnes CH_4 from 2006 onwards.

Depending on the further use of steam cracking by-products, this process may be a source of substantive CO_2 emissions. At the Austrian ethylene plant, all by-products are returned to the refinery, because this plant is located on the refinery site. Somehow it can be seen as a sub process of the refinery, but this ethylene plant does not belong to the same company as the refinery.

As the refinery and its related emissions are covered under sector 1, all CO_2 emissions related to by-products of ethylene production are reported in this sector. Hence, "IE" is reported under CO_2 emissions from category *2.B.8.b Ethylene*.

4.3.4.3 QA/QC

It was checked in 2021 that the production capacity used is still valid.

4.3.4.4 Uncertainty Assessment

The uncertainty for *2.B.8* activity data is assumed to be 20%. The uncertainty of the emission factor is estimated to be about 10%. This leads to a combined uncertainty of 22.4%.

4.3.4.5 Recalculations/Planned Improvements

No recalculations were required for this year's submission. For next year's submission it is planned to reassess the EF used.

4.3.5 Chemical Industry – Other: CO_2 from Nitric Acid Production (2.B.10.b.ii)

Emission: CO_2

Key Source: No

As in category *2.B.2 Nitric Acid Production* only N_2O emission are to be reported, this category was incerted under "Chemical Industry – Other" to report CO_2 emissions from Nitric Acid production. For further details, please refer to chapter 4.3.2.

4.3.6 Chemical Industry – Other: Production of bulk chemicals (2.B.10.b.i)

4.3.6.1 Source Category Description

Emission: CO_2

Key Source: No

The production of formaldehyde, maleic anhydride and phthalic anhydride involves process emissions of CO_2. Total CO_2 emissions from these processes amounted to 110kt in 2023.

4.3.6.2 Methodological Issues

Detailed information on process emissions for the years 2013 onwards are available as these processes were included in the ETS in 2013. For the years prior 2013, the emission factors obtained in 2013 were used and applied to activity data obtained from industry.

4.3.6.3 Uncertainty Assessment

The uncertainty for *2.B.10* activity data is assumed to be 2%.The uncertainty of the emission factor is estimated to be about 2%. This leads to a combined uncertainty of 2.8%

4.3.6.4 Recalculations

No recalculations have been carried out since the last submission.

4.3.7 Chemical Industry – Other: Production of Fertilizers and Urea (2.B.10.b.i)

4.3.7.1 Source Category Description

Emission: CH_4, CO_2

Key Source: No

This category includes CH_4 and CO_2 emissions from the production of urea and from the production of fertilizers (NPK as well as calcium ammonium nitrate). There is only one producer of urea in Austria; it is also the main producer of fertilizers in Austria, both processes are downstream processes of ammonia production at that plant (see Figure 23).

This category is a minor GHG emission source in Austria: in 2023, total emissions from this category contributed 0.04% to national total emissions. They remained quite constant over the reporting period, basically following the trend of fertilizer production as CO_2 from fertilizer production is the main emission source of this category. In 2023, overall emissions from this category were 5% lower than in 1990.

4.3.7.2 Methodological Issues

No IPCC methodology is available for these sources.

Data for urea production were directly reported by the Austrian producer of urea and thus represent plant-specific data. Urea is a downstream manufacturing process of ammonia production. The input gases for urea production are NH_3 and CO_2; the latter is a by-product of ammonia production. In urea production, CO_2 is emitted at start-ups of the process and emissions are calculated from the number and duration of start-ups. The ammonia stream entering the process contains a small amount of non-reacted CH_4 that is released when NH_3 reacts to urea. These CH_4 emissions are calculated from the ammonia input into the urea production process and the methane content of the ammonia stream.

Urea production

CH_4 emissions from the production of urea were reported for the years 2002–2023. For earlier years, no emission data is available; therefore the implied emission factor for the year 2002 was used for all years. CO_2 emissions are reported by the operator since 1995. The IEF from this year was applied to calculate emissions for previous years.

Fertilizer production

Activity data for fertilizer production for 1990 to 1994 were taken from national statistics (STATISTIK AUSTRIA), for 1995 to 2023, production data were reported directly by the main producer of fertilizers in Austria.

Emission data for CO_2 emissions from the production of fertilizers for 1992 to 2023 were directly reported by industry and thus represent plant–specific data. The average implied emission factor of the years 1992–2003 was applied to the years 1990 and 1991. CO_2 emissions from fertilizer production were calculated by the plant operator using a mass-balance approach.

CH_4 emissions from the production of fertilizers were reported for the years 2002–2023; these data became available due to a measurement programme for CH_4 at the plant starting in 2002. For earlier years, no data is available; therefore the implied emission factor for the year 2002 was used for these years.

Table 147 presents activity data, emissions and implied emission factors for CH_4 and CO_2 emissions from *Fertilizer Production* and *Urea Production* for the period from 1990 to 2023.

Table 147: Activity data, emissions and implied emission factors for CO_2 and CH_4 from NPK fertilizer production and urea production, 1990–2023.

Year	Urea Production				Fertilizer Production			
	Urea production [t]	CO_2 [kt]	CH_4 [t]	IEF CO_2 [kg CO_2/t urea]	Fertilizer production [t]	CO_2 [kt]	CH_4 [t]	IEF CO_2 [kg CO_2/t fertilizer]
1990	282 000	0.27	152	0.97	1 388 621	30	184	22
1995	393 000	0.40	212	1.02	916 265	20	121	21
2000	390 185	0.22	210	0.57	1 022 983	21	135	20
2005	416 407	0.21	224	0.50	1 043 916	24	149	23
2010	419 997	0.49	226	1.16	1 051 087	26	140	25
2011	426 861	0.26	230	0.60	1 058 249	26	138	24
2012	421 659	0.22	227	0.53	1 034 833	28	137	27
2013	351 921	0.46	189	1.32	890 501	19	106	21
2014	433 364	0.20	233	0.46	1 046 152	22	126	21
2015	434 587	0.20	234	0.46	1 044 451	22	125	21
2016	446 020	0.22	240	0.50	1 065 611	24	128	22
2017	420 106	0.40	226	0.95	949 667	24	113	25
2018	351 697	0.19	189	0.55	796 968	22	96	28
2019	448 535	0.22	241	0.50	1 093 985	26	130	24
2020	438 127	0.16	202	0.37	1 022 319	22	197	22
2021	456 800	0.11	236	0.25	990 179	22	159	23
2022	379 313	0.10	242	0.25	844 568	16	175	19
2023	414 139	0.11	185	0.27	874 960	20	126	22
1990-2023	**+47%**	**-59%**	**+22%**		**-37%**	**-35%**	**-31%**	

4.3.7.3 Uncertainty Assessment

The uncertainty for *2.B.10* activity data is assumed to be 2%. The uncertainty of the emission factor is estimated to be about 2%. This leads to a combined uncertainty of 2.8%.

4.3.7.4 Recalculations

No recalculations have been carried out since the last submission.

4.4 Metal Production (CRT Category 2.C)

4.4.1 Iron and Steel (2.C.1)

4.4.1.1 Source Category Description

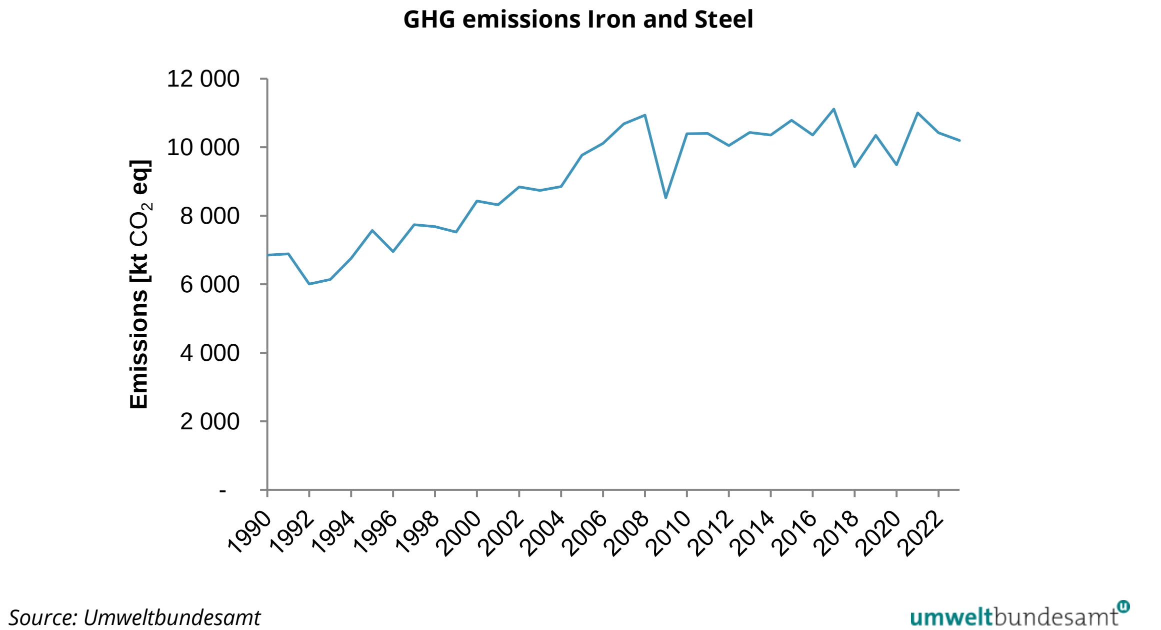
Emissions: CO_2
Key Category: Yes (CO_2)

CO_2 emissions from iron and steel production are an important key category of the Austrian greenhouse gas inventory because of their contribution to the total emission level for 1990 and for 2023 and in terms of their trend. In the year 2023, total emissions from production of iron and steel contributed 14.9% to total greenhouse gas emissions in Austria (see Chapter 1.5). In Austria, iron and steel production is concentrated at two integrated sites operated by the same company. It is the only company operating blast furnaces in Austria. Additionally there are companies operating electric arc furnaces, contributing approx. 10% to total steel production in Austria. Figure 24 presents total CO_2 emissions from the production of iron and steel for the period from 1990 to 2023.

The main driver behind CO_2 emissions from Iron and Steel Production is the production of iron and steel. The dip in 2009 was due to the economic downturn in 2009, the one in 2018 due to a shut down for upgrading of a blast furnace. The dips in 2020 and 2022 are due to lower production as a result of the economic effects of the covid pandemic 2020, and due to high energy prices caused by the geopolitical situation in 2022 that are only slowly diminishing again in 2023. In 2023, CO_2 emissions were 49% above the level of 1990.

Also minor CH_4 emissions arise from this sector, the contribution to total GHG emissions from iron and steel production in Austria is 0.05%.

Figure 24: GHG emissions from iron and steel production



Source: Umweltbundesamt

4.4.1.2 Methodological Issues

CO_2 emissions from integrated iron and steel plants

Process specific CO_2 emissions result from the use of reducing agents in pig iron production (in blast furnaces) and in steel production (lowering of the carbon content of pig iron).

Total CO_2 emissions from the two integrated iron and steel plants in Austria are reported in the ETS scheme since 2005, where they are also independently verified. They are calculated based on analysis of the carbon content and measurements of all relevant inputs such as coke, coal, natural gas, heating oil, plastics used as a substitute fuel, ore, limestone, scrap and additives, as well as outputs in iron and steel products and the carbon contained in coal tar, benzene, slag, dust and sludges. Detailed information on carbon contents, fluxes, and process volumes used for the calculation of emissions from this sector are not displayed here due to the confidentiality of this information.

According to the IPCC 2006 Guidelines, all emissions from iron and steel production should be reported under category *2.C.1*, irrespective of their role as reducing agent or fuel. However, as there is on site power generation taking place at the iron and steel production site, and also a coke oven is operated there, a carbon balance is applied to calculate CO_2 emissions that theoretically are attributable to iron and steel production itself and which are reported in *2.C.1.a*. The remainder of the verified total is then attributed to the energy sector as it is related to on site power plants and the coke oven operation. The carbon balance is based on the detailed ETS data on carbon inputs and outputs, but considers different system boundaries (only process directly related to iron and steel production and not the overall iron and steel production site). For this approach the ETS data is complemented with data taken from the national energy balance and data directly reported from the plant operator. As the detailed ETS data is only available since 2005, correlation techniques had to be used for the years 1990–2004. It has to be noted, that total CO_2 emissions for all years were calculated by the company on a detailed level (IPCC T3), the correlation techniques only add uncertainty to the split not to total emissions. Emissions of category *2.C.1.b* (pig iron) are reported as "IE", they are included in *2.C.1.a (steel)* as a further disaggregation is not feasible.

CH_4 emissions from integrated iron and steel plants

CH_4 emissions from sinter and coke production were calculated using plant specific EFs based on measurements. In 2003 and 2008 abatement measures were implemented, resulting in lower EFs.

CO_2 emissions from electric arc furnace steel production

Emissions were estimated using a country specific methodology.

CO_2 emissions for the year 2003 have been reported by each electric steel site in Austria. The IEF calculated for this year (52 kg/t steel) was also used to calculate emissions for earlier years and for 2004. For 2005–2020, verified CO_2 emissions, reported under the ETS, were used for the inventory.

The plant operators calculate emissions on the basis of the Austrian Monitoring, Reporting and Verification Ordinance[3]. The important part is §8(3) which defines the mass balance approach as the methodology to be used. Annex 2, (5) provides the relevant Tiers for this approach and the formula regarding carbon content.

[3] Überwachungs-, Berichterstattungs- und Prüfungs-Verordnung, Federal Law Gazette II No. 339/2007, as amended

The CO_2 emissions and production data are based on data of each of the three electric arc furnace plants in Austria. All CO_2 emissions from electric arc furnaces are allocated in *2.C.1* according to IPCC guidelines. There are no fuel related emissions.

The IEF depends on

- the raw material (carbon content of the used scrap)
- the production process (different processes with more or less input of electrical power and different additions of surcharges)

The increase of the IEF in 2005 is due to a change in the production process in one plant in Austria. The average IEF for the years 2005 to 2023 (approx. 0.066 kt CO_2 per kt steel) is in the range of the IPCC default value of 0.08.

Table 148 presents iron, steel and electric steel production and CO_2 emissions from this category.

Table 148: Activity data and emissions for CO_2 and CH_4 from steel production 1990–2023.

Year	Iron and Steel Production				Electric Steel Production		Total
	Iron [kt]	Steel [kt]	CO_2 [kt]	CH_4 [t]	Electric Steel [kt]	CO_2 [kt]	CO_2 eq [kt]
1990	3 444	3 921	6 821	231	370	20	6 847
1995	3 888	4 538	7 540	242	454	24	7 571
2000	4 320	5 183	8 391	263	541	29	8 427
2005	5 458	6 408	9 718	251	622	45	9 771
2010	5 644	6 570	10 341	123	637	47	10 391
2011	5 822	6 786	10 347	142	689	49	10 400
2012	5 751	6 746	9 999	140	674	46	10 049
2013	6 144	7 290	10 386	147	664	40	10 430
2014	6 015	7 185	10 318	144	691	39	10 361
2015	5 795	7 020	10 750	147	667	37	10 791
2016	5 634	6 766	10 315	143	672	36	10 356
2017	6 326	7 412	11 069	148	723	40	11 113
2018	5 263	6 176	9 390	141	721	41	9 435
2019	5 741	6 882	10 300	139	710	39	10 343
2020	5 286	6 187	9 448	150	680	34	9 486
2021	6 131	7 195	10 962	146	687	40	11 006
2022	5 803	6 834	10 375	192	675	39	10 420
2023	5 618	6 578	10 147	247	660	40	10 195
1990-2023	**+63%**	**+68%**	**+49%**	**+7.0%**	**+78%**	**+106%**	**+49%**

4.4.1.3 Category-specific QA/QC

Coke input from the energy balance is compared with coke input reported by the operator. Pig iron and steel production figures are compared with international published data (International Iron and Steel Institute, 2004) to ensure completeness. For 2005–2023, detailed information on the carbon mass balance applied by the company to calculate total emissions from pig iron and basic oxygen furnace steel were available from the EU ETS. Thus it was possible to validate CO_2 emissions with this background data.

The annual emission reports of the plant covered by the above mentioned ordinance regarding monitoring, reporting and verification of GHG emissions are checked by independent verifiers before submitting to the competent authority. On behalf of the Federal Ministry of Agriculture, Forestry, Environment and Water Management, the Umweltbundesamt conducts spot checks of the annual emissions and verification reports, time series consistency and consistency with monitoring plans.

In addition, the data included in the annual emission reports were checked regarding completeness and plausibility and they were also compared with national and international statistics (Statistic Austria and World Steel association[76]).

4.4.1.4 Uncertainty Assessment

The iron and steel industry is related to the energy sector, as the major share of CO_2 emissions results from the use of fossil fuel as reducing agent and for combustion. Thus, the same uncertainty values as for solid fuel combustion in large point sources have been applied, namely 0.5% for activity data and 0.5% for emission factor; this leads to an overall uncertainty for CO_2 emissions of 0.7% (Winiwarter, 2007).

4.4.1.5 Recalculations

2.C.1.a Steel

The approach of disaggregation of total emissions from iron and steel production in Austria to Energy and IPPU was corrected for 2022 (one carbon flow was incorrectly transferred to the calculation file), resulting in +134.45 kt CO_2 in *2.C.1.a* in 2022. Additionally one rounded value of 2014 was replaced with the actual value.

4.4.2 Ferroalloys Production (2.C.2)

4.4.2.1 Source Category Description

Emissions: CO_2

Key source: No

Ferroalloy production involves a metallurgical reduction process which results in CO_2 emissions.

This category is a minor source of CO_2 emissions in Austria: in 2023, emissions from this source contributed 0.02% to national total emissions.

[76] World Steel Association statistics archive, https://www.worldsteel.org/steel-by-topic/statistics.html

4.4.2.2 Methodological Issues

Emissions were estimated using the IPCC Tier 1b methodology.

Only one company produces ferroalloys in Austria. Activity data of ferro-molybdenum, ferro-vanadium and ferro-nickel production from 1995 to 2010 were taken from publications of the *British Geological Survey* (British Geological Survey, 2001-2012). As no data were available for 1990–1994, the value from 1995 was taken as a proxy for these years. For 2011, data was directly obtained from industry (personal communication) due to the late publication of the relevant report by the British Geological Survey. Similarly, data for 2012 to 2022 were obtained via personal communication from the British Geological Survey (British Geological Survey, 2012-2024) , as the report had not been published at the time of emission calculation and the producer does not directly pass on information to the Umweltbundesamt. The identical value reported for 2018 and 2019 was confirmed by the British Geological Survey as the company's data.

The emission factor for ferro-nickel of 1.36 t CO_2/t product was taken from (Sjardin, 2003) and applied to all ferroalloys as no specific emission factors for ferro-molybdenum and ferro-vanadium were available. Investigations were carried out in order to find adequate emission factors for ferro-molybdenum and ferro-vanadium. However, other countries where the production of ferroalloys is relevant are using country/plant specific emission factors. Therefore the emission factor used at present (based on a company specific report) was maintained.

Table 149: Activity data and emissions from ferroalloys production 1990–2023.

Year	Ferroalloys production [kt]	CO_2 emissions [kt]
1990	15.3	20.8
1995	15.3	20.8
2000	13.9	18.9
2005	13.8	18.7
2010	14.5	19.7
2011	14.5	19.7
2012	14.5	19.7
2013	14.5	19.7
2014	14.5	19.7
2015	14.5	19.7
2016	14.5	19.7
2017	14.5	19.7
2018	13.5	18.4
2019	13.5	18.4
2020	12.5	17.0
2021	12.5	17.0
2022	12.5	17.0
2023	12.0	16.3
1990-2023	**-22%**	**-22%**

4.4.2.3 Uncertainty Assessment

The uncertainty of activity data is assumed to be 5%.The uncertainty of the emission factor is estimated to be about 25%. This leads to a combined uncertainty of 25.5%.

4.4.2.4 Recalculations

No recalculations have been carried out since the last submission.

4.4.3 Aluminium Production (2.C.3)

4.4.3.1 Source Category Description

Emissions: PFCs, SF_6 and CO_2

Key Source: Yes (PFCs, SF_6 and CO_2)

This category includes emissions of CO_2, PFCs and SF_6 from aluminium production and is now a minor source of GHG in Austria: in 2023, emissions from this source amounted to 0.01% of the national total.

It is a key category for PFC emissions because of the contribution to the total level of greenhouse gas emissions in 1990; and a key source for both SF_6 and CO_2 emissions in terms of emission trends.

Primary aluminium production in Austria was terminated in 1992. Two PFCs, tetrafluoromethane (CF_4) and hexafluoroethane (C_2F_6) are emitted from the process of primary aluminium smelting. They are formed during the phenomenon known as the anode effect (AE). CO_2 emissions arise from the consumption of the anode in the production process.

During secondary aluminium production CO_2 emissions occur, arising from organic impurities of aluminium scrap.

Until 1999 SF_6 was used in aluminium casting as a fire quencher, and again in minor amounts for special applications (not on a regular basis) from 2006–2019.

Table 150 presents CO_2 and PFC emissions from primary aluminium production for the period from 1990 to 1992 and the SF_6 and CO_2 emissions from secondary aluminium production.

Table 150: CO_2 and PFC emissions from primary aluminium production from 1990 to 1992 as well as SF_6 and CO_2 emissions from secondary aluminium production from 1990 until 2023.

	Primary aluminium production		Secondary aluminium production	
Year	**CO_2 emissions [kt]**	**PFC emissions [t]**	**CO_2 emissions [kt]**	**SF_6 emissions [kg]**
1990	150	148	0.63	600.0
1995	NO	NO	0.63	600.0
2000	NO	NO	1.99	0.0
2005	NO	NO	1.40	0.0
2010	NO	NO	3.92	12.0

	Primary aluminium production		Secondary aluminium production	
Year	**CO_2 emissions [kt]**	**PFC emissions [t]**	**CO_2 emissions [kt]**	**SF_6 emissions [kg]**
2011	NO	NO	4.66	6.8
2012	NO	NO	6.97	3.0
2013	NO	NO	5.94	1.5
2014	NO	NO	6.69	12.0
2015	NO	NO	7.63	1.5
2016	NO	NO	5.18	3.0
2017	NO	NO	5.15	3.0
2018	NO	NO	5.72	4.2
2019	NO	NO	5.42	0.3
2020	NO	NO	4.63	NO
2021	NO	NO	5.80	NO
2022	NO	NO	4.91	NO
2023	NO	NO	4.61	NO
1990–2023	**-100%**	**-100%**	**+635%**	**-100%**

4.4.3.2 Methodological Issues

For **primary aluminium production** CO_2 emissions were calculated by applying the IPCC default emission factor of 1.7 t CO_2/t aluminium produced taken from the IPCC 2006 Guidelines.

PFC emissions were estimated using the IPCC Tier 3b methodology. The specific CF_4 emissions (and C_2F_6 emissions respectively) of the anode effect were calculated by applying the following formula (BARBER 1996), (GIBBS & JACOBS 1996), (TABERAUX 1996):

$$\text{kg } CF_4/t_{Al} = (1.7 \text{ x AE/pot/day x F x } AE_{min})/CE$$

Where: *AE/pot/day = frequency of occurrence of the anode effect (dependent on type of oxide supply (1,2/day)*

t_{Al} = effective production capacity per year [t] *CE = current efficiency (85%)*

AE_{min} = anode effect duration in minutes (5 min) *1.7 = constant resulting from Faraday's law*

F = fraction of CF_4 in the anode gas (13%)

In Austria so called "Søderberg" anodes were used. The technology applied was head to head HSS. The frequency of the anode effect (AE/pot/day) was about 1.2 per day. The duration of the anode effect (AE_{min}) was in the range of 4 to 6 minutes. The average fraction of CF_4 formed in percent of the anode gas (F) can be determined as a function of the duration of the anode effect. International values are about 10% after two minutes, 12% after three minutes and after that there is only a marginal increase. Therefore for Austrian aluminium production a CF_4 fraction in the anode gas of 13% was assumed.

Because C_2F_6 is formed only during the first minute of the anode effect, the rate of C_2F_6 is the higher the shorter the duration of the anode effect is. For the aluminium production in Austria the rate of C_2F_6 is about 8% and the current efficiency (CE) about 85.4%.

Activity data were taken from national statistics (88 021 t for 1990 and 1991, and 35 000 t in 1992).

By inserting these data into the formula mentioned above an emission factor of 1.56 kg CF_4/t aluminium was calculated. The resulting emission factor for C_2F_6 was 0.1248 kg per tonne of aluminium produced.

For **secondary aluminium production**, process related CO_2 emissions from one ETS installation for the years 2013 onwards are reported, arising from organic impurities of aluminium scrap. These emissions are upscaled to total secondary aluminium production in Austria using the average IEF for reported years of the ETS installation correlated to production capacity, and the time series of secondary aluminium production obtained from national statistics from 2008 onwards and from industry reprensentatives for earlier years.

In secondary aluminium smelting works (**aluminium casting**) inert gases are used to remove, prior to casting, hydrogen as well as alkaline and alkaline earth metals and solids from smelt to prevent porosity in the cast pieces (aluminium cleaning). Until 2000 inert gases with SF_6 concentrations of 1–2.5% were used, it is assumed that all SF_6 is emitted during use.

From the (formerly) six secondary aluminium smelters only one started the use of SF_6 as cleaning gas again from 2006 onwards until 2019 when the plant was closed. For these recent years an EF of 1.5% of SF_6 consumed was applied. This EF is based on measurements in a German aluminium plant that have shown significant destruction of SF_6 (decomposition into sulphur and fluorine) during the process (Schwarz W., Gschrey B., 2009).

4.4.3.3 Uncertainty Assessment

AD uncertainty is assumed to be 20%.

The uncertainty for the PFC emission factors ("Søderberg" process) is between 30–80% according to the IPCC. Activity data do not influence the uncertainty of emissions to that extent, because PFCs are formed during the anode effect that is associated with the EF. Assuming a mean value for the emission factor, the uncertainty of the PFC EF is assumed to be 50%. This leads to a combined uncertainty for PFC emissions of 54%.

Uncertainty of CO_2 EF is assumed to be 5% (it is based on detailed ETS data, but related to capacity and not actual production), which results in an uncertainty of 21% % for CO_2 emissions.

4.4.3.4 Recalculations

For transparency reasons official data for aluminium production is now used as AD (previously confidential data was used and reported as "C"). The methodology for CO_2 emissions was reassessed, and the general level of emissions was verified. The change in methodology resulted in minor recalculations over the whole time series (−0.4 kt CO_2 in 2022).

4.4.4 Magnesium Production – Magnesium Foundries (2.C.4)

4.4.4.1 Source Category Description

Emissions: SF_6

Key Source: Yes (SF_6)

This category includes emissions of SF_6 from magnesium foundries. This source is a key category due to its trend in emissions.

In 2023, SF_6 emissions from magnesium foundries contributed 0.003% to the total amount of greenhouse gas emissions in Austria, whereas the contribution was 0.3% in 1990.

Molten magnesium spontaneously burns in the presence of atmospheric oxygen. Therefore, in magnesium casting SF_6 is used in small amounts in blends with carrier gases as a protective cover gas to prevent oxidation and ignition and to quench fires of molten magnesium. It has been a common assumption that the SF_6 in magnesium cover gas will not be destroyed but more or less completely emitted. Recent studies showed that SF_6 undergoes destruction to some degree. Industry introduced alternative cover gases in the last years.

Table 151 presents SF_6 emissions from magnesium for the period from 1990 to 2023.

As can be seen in the table below, SF_6 emissions have been fluctuating during the period, but the overall trend has been decreasing SF_6 emissions; from 1990 to 2023 they decreased by 99%. This decreasing trend is explained by technological advances (rebuilt magnesium foundry) and the replacement of SF_6 by other substances ($N/CO_2/SO_2$; SO_2/N_2) used as a cover gas; since 2008 the use of SF_6 per foundry is limited to 850 kg per year in Europe[77]. Currently, only one magnesium foundry uses SF_6 as a cover gas for one particular magnesium alloy that is produced irregularly.

Table 151: SF_6 emissions from magnesium foundries 1990–2023.

Year	SF_6 emissions [t] from magnesium production
1990	10.00
1995	17.94
2000	1.55
2005	0.20
2010	0.00
2011	0.00
2012	0.19
2013	0.39
2014	0.67
2015	0.10
2016	0.10
2017	0.67
2018	0.24

[77] Regulation (EC) No 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases.

Year	SF_6 emissions [t] from magnesium production
2019	0.14
2020	0.20
2021	0.20
2022	0.10
2023	0.10
1990–2023	**-99%**

4.4.4.2 Methodological Issues

Emissions were estimated following the IPCC methodology using annual consumption data of SF_6.

Information about the amount of SF_6 used was obtained directly from the magnesium producer in Austria and thus represents plant-specific data. Actual emissions of SF_6 equal potential emissions and correspond to the annual consumption of SF_6 for magnesium casting. During the last ten years, two magnesium casting companies existed in Austria which at some point used SF_6 as fire-extinguishing cover gas. One company changed to a N_2/CO_2/SO_2-system. The other company changed to fluorinated ketone (Novec) as an alternative cover gas, but continued the use of SF_6 to quench fires.

4.4.4.3 Category-specific QA/QC

The IEFs for magnesium casting (based on the amount of magnesium cast) are below the value of 1.0 kg SF_6 emissions cited in the IPCC 2006 Guidelines (p. 4.66).

4.4.4.4 Uncertainty Assessment

According to the IPCC 2006 Guidelines the uncertainty associated with plant SF_6 use data is assumed to be 5%, the EF uncertainty is also estimated to be 5%, resulting in an overall uncertainty of 7%.

4.4.4.5 Recalculations

No recalculations have been carried out since the last submission.

4.4.5 Lead production (2.C.5)

4.4.5.1 Source Category Description

Emission: CO_2

Key Source: No

Primary lead production existed in Austria until 1993. CO_2 emissions originate from the use of coke as reducing agent. These emissions are reported in Sector 1, because this coke use is included in the energy balance together with the energetic use of coke.

In the secondary lead production CO_2 emissions are caused by the content of substances in the secondary raw material. The secondary lead production from 1990 until 2023 has a fluctuation range of ± app.20%.

This category is a minor source of CO_2 emissions in Austria: in 2023, emissions from this source contributed less than 0.01% to national total CO_2 emissions.

4.4.5.2 Methodological Issues

Activity data until 2016 are taken from the Montanhandbuch (BMWFW, 2017), which provides annual data of the Austrian secondary lead production. The CO_2 emissions of secondary lead production are calculated with the IPCC default emission factor of 0.2 t CO_2/t lead produced. For the years 2018–2020 production figures are available in kt only – they were on a constant level of 27 kt. For 2021, 2022, and 2023 no data was available, thus the value of 2020 was used as proxy for subsequent years. Activity data until 2016 are taken from the Montanhandbuch (BMWFW, 2017), which provides annual data of the Austrian secondary lead production. The CO_2 emissions of secondary lead production are calculated with the IPCC default emission factor of 0.2 t CO_2/t lead produced. For the years 2018–2020 production figures are available in kt only – they were on a constant level of 27 kt. For 2021, 2022, and 2023 no data was available, thus the value of 2020 was used as proxy for subsequent years.

Table 152: Activity data and CO_2 emissions from secondary lead production 1990–2023.

Year	Secondary lead production [t]	CO_2 Emissions [kt]
1990	23 511	4.7
1995	21 869	4.4
2000	21 977	4.4
2005	24 357	4.9
2010	25 499	5.1
2011	26 208	5.2
2012	24 504	4.9
2013	24 971	5.0
2014	25 136	5.0
2015	24 399	4.9
2016	25 000	5.0
2017	26 000	5.2
2018	27 000	5.4
2019	27 000	5.4
2020	27 000	5.4
2021	27 000	5.4
2022	27 000	5.4
2023	27 000	5.4
1990-2023		**+15%**

4.4.5.3 Uncertainty Assessment

The uncertainty of the emission factor is assumed to be 50% (IPCC default value) and the uncertainty of activity data to 5%. This leads to a combined uncertainty of 50.25%.

4.4.5.4 Recalculations

No recalculations have been carried out since the last submission.

4.5 Non-Energy Products from Fuels and Solvent Use (CRT Category 2.D)

4.5.1 Source Category Description

Emissions: CO_2 (some of those are emitted indirectly)

Key category: Yes (CO_2)

This chapter entails CO_2 emissions from non-energy products from fuels and indirect CO_2 emissions from solvent use in Austria. The direct emissions arise from lubricant use and from paraffin waxes, indirect emissions are calculated from NMVOC emissions from solvent use.

In the year 2023, 0.2% of total GHG emissions in Austria (162 kt CO_2 equivalents) originated from category *2.D Non-Energy Products from Fuels and Solvent Use*. The overall trend in greenhouse gas emissions in this sector shows decreasing emissions, with a decrease of 54% from 1990 to 2023, due to legal measures related to solvent use.

Figure 25: Emissions from Sector 2.D, Non-Energy Products from Fuels and Solvent Use, 1990–2023.

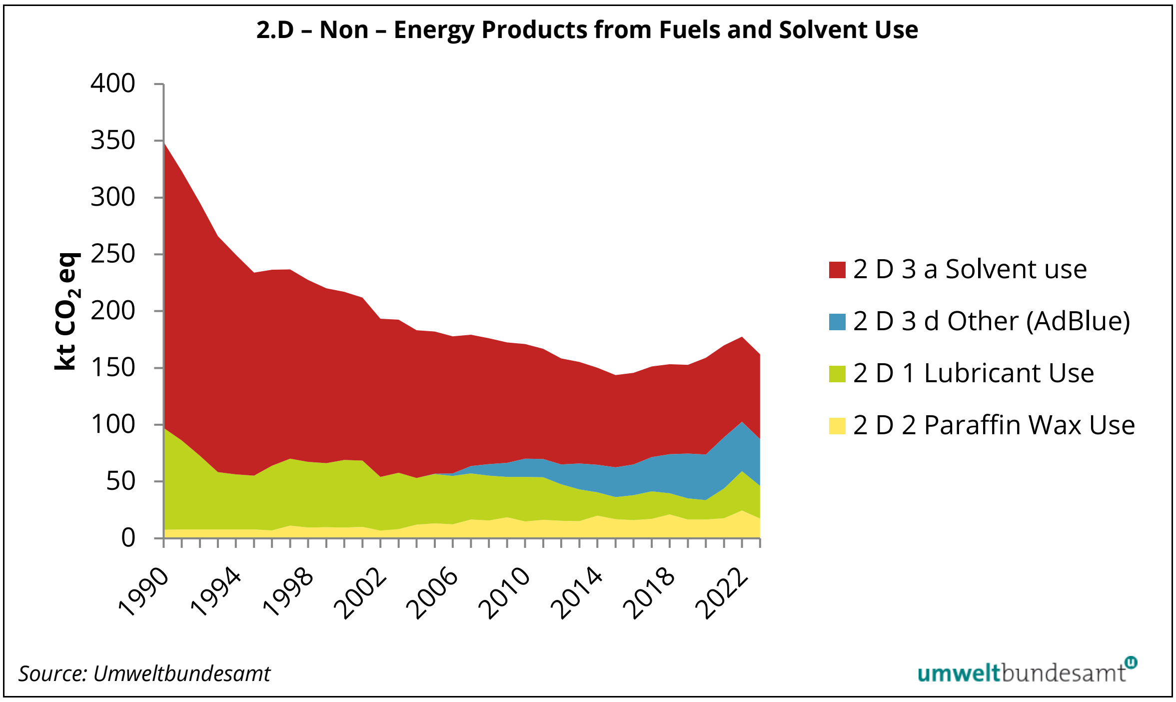


Table 153 presents the trend in total greenhouse gas emissions by subcategories.

Table 153: Total greenhouse gas emissions and trend from 1990–2023, in kt CO_2eq.

	2.D.1	**2.D.2**	**2.D.3.a**	**2.D.3.d**
Year	**Lubricant Use**	**Paraffin Wax Use**	**Solvent use**	**Other (AdBlue)**
1990	89.5	7.7	251.8	NO
1995	47.2	8.0	178.8	NO
2000	59.5	9.5	148.0	NO
2005	43.4	13.1	125.3	0.4
2010	39.3	14.9	101.1	15.9
2011	37.5	16.2	97.1	16.1
2012	32.1	15.4	93.3	17.7
2013	27.9	15.2	89.3	22.9
2014	20.6	19.9	85.5	24.3
2015	19.5	16.9	81.3	26.2
2016	22.0	16.1	80.7	27.0
2017	24.3	17.1	79.9	30.1
2018	18.6	21.0	79.0	34.6
2019	18.5	16.6	78.2	39.4
2020	17.1	16.6	85.2	40.1
2021	26.0	17.8	81.0	45.2
2022	34.7	24.4	75.2	43.4
2023	28.8	17.5	74.6	41.0
1990-2023	**-68%**	**+128%**	**-70%**	

4.5.2 Methodological issues

4.5.2.1 Lubricant Use (2.D.1)

Emission calculation follows the methodology of the IPCC 2006 Guidelines: The amount of lubricants used in Austria was taken from the Energy Balance (total final non energy use consumption).

Lubricants used for 2-stroke engines were not reported separately due to lack of data. As a rough estimate of the amount of lubricants used in the 431 million km driven by 2 stroke engines per year amount to only 1 kt CO_2, these emissions are considered to be taken into account by using an ODU factor of 0.2 for the total lubricant use of Austria.

Lubricant Use was estimated according to the IPCC Tier 1 method described in the Guidelines:

$$CO_2 \text{ emissions} = LC * CC_{Lubricant} * ODU_{Lubricant} * 44/12$$

Where:
LC = total lubricant consumption in TJ (taken from the Austrian Energy Balance)
$CC_{Lubricant}$= default value of carbon content of lubricants (20 t C/TJ)
$ODU_{Lubricant}$ = ODU factor (0.2), based on default composition of oil and grease)
44/12 = mass ratio of CO_2/C

4.5.2.2 Paraffin Wax Use (2.D.2)

Paraffin waxes are used in applications such as: candles, corrugated boxes, paper coating, board sizing, food production, wax polishes, surfactants and many others. Emissions from the use of waxes derive primarily when the waxes or derivates of paraffins are combusted during use (e.g. candles) when they are incinerated with or without heat recovery or in wastewater treatment. In the cases of incineration and wastewater treatment, the emissions should be reported in the energy or waste sectors respectively. It is also assumed that boxes and papers, as well as food production are accounted for in the respective sectors.

Activity data for paraffin wax use is taken from the import and export statistics of candles and wax products, as well as the production statistics of candles. Production statistics on candles are only available for the past 8 years, for the years before the average of available data was used for the rest of the reporting period. As statistical data on the imports and exports was only available until 1995, the years before were correlated with population growth.

The amount of candles used in Austria was then converted into TJ, using a Net Calorific Value of 40.2 TJ/kt, from this CO_2 emissions were calculated according to the IPCC Guidelines Tier 1 method:

$$CO_2\ Emissions = PW * CC_{wax} * ODU_{wax} * 44/12$$

Where: *PW = total wax consumption in TJ*
CC_{wax} = carbon content of paraffin wax (default, 20 t C/TJ)
ODU_{wax} = ODU factor for paraffin wax, fraction (0.2)
44/12 = mass ratio of CO2/C

4.5.2.3 Other: Solvent Use (2.D.3.a)

Solvents are chemical compounds, which are used to dissolve substances as paint, glues, ink, rubber, plastic, pesticides or for cleaning purposes (degreasing). After application of these substances or other procedures of solvent use most of the solvents are released into air. Because solvents consist mainly of NMVOC, solvent use is a major source for anthropogenic NMVOC emissions in Austria. Once released into the atmosphere NMVOCs react with reactive molecules (mainly HO-radicals) or high energetic light to finally form CO_2.

Please refer to Austria's IIR (Umweltbundesamt, 2024a) for a detailed description of the methodologies used. For the calculation of CO_2, the default conversion factor of 2.2 t CO_2/t NMVOC (taken from the IPCC 2006 GL) was applied.

4.5.2.4 Other: Urea used as a catalyst (2.D.3.d)

This contains emissions of the additive 'AdBlue' which is used in transportation. 'AdBlue' is the generic name of a 32.5% urea-water solution used to reduce NO_x emissions in SCR catalytic convertors used in road- and off-road transportation. During that process, CO_2 emissions occur that are taken into consideration in this sector. 'AdBlue' has been in use since 2004 for heavy vehicles, and since 2014 for passenger cars. In literature, the 'AdBlue' consumption is usually given as a volumetric ratio of the fuel consumption (litres of 'AdBlue' equivalent to litres of diesel). Common values for this are, for example, 3–5% for EURO IV vehicles and 4-6% for Euro V SNF. For the inventory a more detailed approach is used which considers the specific operating condition of the SCR exhaust gas after-treatment system in any driving condition (Rexeis, et al., 2013).

4.5.3 Uncertainty Assessment

For the subcategory 2.D uncertainty for the emission factors is estimated to be 30%, and for activity data 20%. This results in an combined uncertainty of 36%.

4.5.4 Recalculations

2.D.3.a Other: Solvent Use

The methodology for estimating emissions from *Solvent Use* was reassessed for industrial and commercial applications, and data on domestic use was updated. This resulted in recalculations of the time series from 1996 onwards, with higher emissions for the years 2000 − 2022 (+6.39 kt CO_2 of *2.D.3.1* emissions in 2022).

4.6 Electronics Industry (CRT Category 2.E) – Integrated Circuit or Semiconductor Manufacturing (2.E.1)

4.6.1 Source Category Description

Emissions: HFC, PFC, SF_6, NF_3

Key Source: yes (SF_6-2.E)

All emissions from 2.E Electronics Industry arise from subcategory 2.E.1 Integrated Circuit or Semiconductor.

4.6.2 Methodological Issues

Three semiconductor manufacturing companies in Austria currently emit CF_4, CHF_3, C_2F_6, C_3F_8, C_4F_8, NF_3 and SF_6. Emissions are calculated by the companies from the annual consumption of each fluid by plant and the effectiveness of the respective abatement technologies (Tier 2a according to IPCC 2006). According to the reporting obligation under the Austrian Industrial Gas Ordinance (see next chapter for more information), semiconductor manufacturers have to report their use of fluorinated gases every year. Therefore, plant specific data is available since 1999. In the manufacturing plants of one operator, fluorinated gases are used in a closed system, where they are recycled for repeated use. These gases were reported as potential emissions in earlier years.

Because of confidentiality claimed for consumption data in this industry emissions are reported in the CRT only for the sum of HFC and PFC. Gases and their applications are presented below:

- SF_6: Isolation gas for high-voltage measurement / process gas for plasma-etching,
- CF_4, C_2F_6, C_3F_8, C_4F_8, NF_3: Process gas for plasma-etching / cleaning chemical vapour deposition,
- CHF_3: Process gas for plasma-etching

Emission Trends

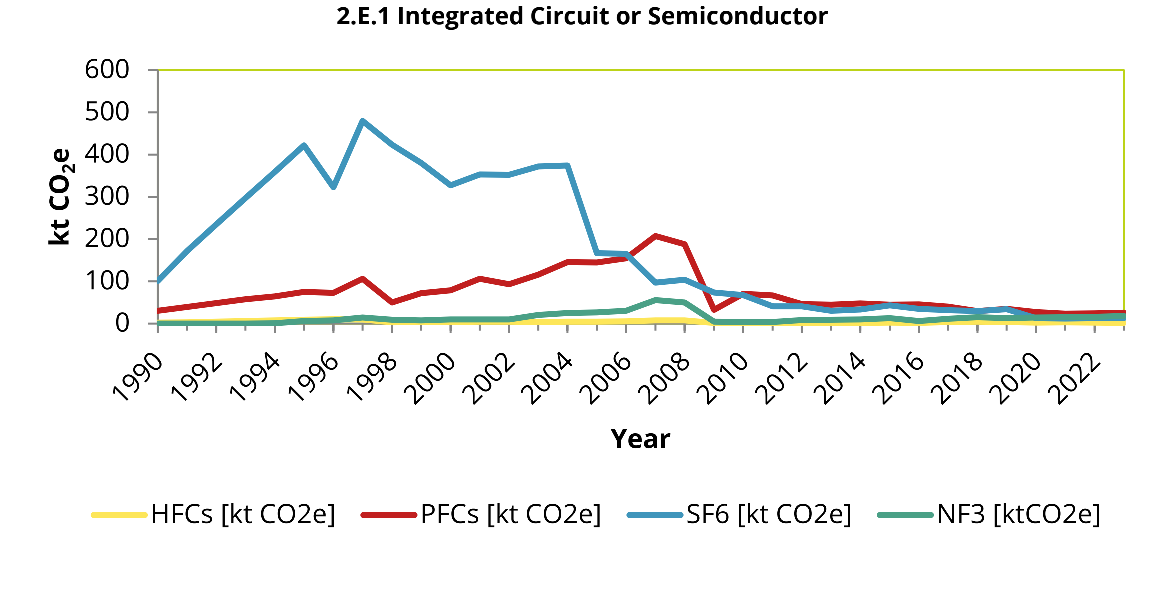
Emissions of this sector amount to 0.4% of the emissions of the IPPU sector, and to 0.09% of the national total. Emissions in 2023 were 56% lower than in 1990.

Emissions of PFCs and SF_6 were constantly increasing during the 1990s, until one semiconductor manufacturer quadrupled its exhaust air purification capacity between 1997 and 1998, reducing emissions remarkably. The increasing emissions of CF_4, C_2F_6 and SF_6 in the other years are due to an increase of semiconductor production. The lower emissions in 2009 compared to 2008 are due to the economic crisis that very strongly affected the manufacture of semiconductors. From 2019 to 2020, emission dropped by 36% due to the economic downtorn as a result of the Covid 19 pandemic. In 2023, emissions levels are similar to the ones reported for 2020.

Table 154: Emissions of Sector 2.E Electronics Industry.

Year	HFCs	PFCs	SF_6	NF_3	Total
			[kt CO_2e]		
1990	2.04	30.62	100.39	0.00	**133.05**
1995	9.04	75.28	421.59	6.03	**511.93**
2000	4.01	79.09	327.10	9.84	**420.03**
2005	4.22	144.93	166.31	26.36	**341.82**
2010	1.72	70.51	67.57	3.85	**143.65**
2011	1.73	66.43	40.69	3.84	**112.69**
2012	1.75	45.95	41.11	8.02	**96.83**
2013	1.77	44.62	30.62	9.13	**86.14**
2014	1.68	48.02	33.18	9.89	**92.78**
2015	1.98	44.89	42.95	12.60	**102.43**
2016	1.79	45.65	34.60	5.75	**87.79**
2017	3.77	39.75	32.17	11.24	**86.93**
2018	4.30	29.40	29.26	15.46	**78.41**
2019	3.39	34.70	34.31	12.74	**85.13**
2020	2.62	27.01	12.89	14.10	**56.61**
2021	2.96	23.40	11.91	15.07	**53.33**
2022	2.22	23.90	12.56	16.11	**54.79**
2023	1.50	25.91	13.16	17.84	**58.41**
1990-2023	**27%**	**-15%**	**-87%**		**-56%**

Figure 26: Emissions from 2.E.1 Integrated Circuit or semiconductor.



Source: Umweltbundesamt

According to the Association of Electronics Industry (FEEI – Fachverband der Elektro- und Elektronikindustrie), all three producers emphasized that no specific use of gases as 'Heat Transfer Fluids' can be reported, as these are competing processes. This is why there is no activity data reported under *2.E.4*.

4.6.3 Category-specific QA/QC

EF obtained by industry inquiries were compared with the IPCC default values.

4.6.4 Uncertainty Assessment

Activity data (consumption) uncertainty is estimated to be low (5%) because information from all considered producers is used for inventory preparation. The uncertainty for emission factors is estimated to be 10%. This leads to a combined uncertainty of emissions of 11.2%.

4.6.5 Recalculations

Reported data was corrected by the producer from 2020 onwards (−0.68 kt CO_2e in 2022).

4.7 Product Uses as Substitutes for Ozone Depleting Substances (CRT Category 2.F)

4.7.1 Source Category Description

Emissions: HFC, PFC

Key Source: yes (2.F.1: HFC)

This category includes the following emission sources:

- refrigeration and air conditioning equipment
- foam blowing
- fire extinguishers
- aerosols
- solvents

There is no production of Halocarbons in Austria.

In 2002, an Austrian regulation on cutting emissions from F-Gases was issued 2002 and included bans of different kind of uses and a reporting obligation on amounts used for most sub sectors[78]. As with the regulations on EU level explained below the Austrian ordinance became obsolete, it was repealed in 2022.

On the European level, the so-called F-gas Regulation[79] includes a number of measures to reduce emissions such as recovery of equipment containing F-gases for e.g. refrigeration, air conditioning and heat pump equipment, equipment containing F-gas based solvents, fire protection systems and fire extinguishers, high-voltage switchgear (Article 4 of the F-gas Regulation).

This Regulation is implemented by the Austrian Ordinance on training and certification of personnel working with F-Gases[80]. According to Article 2(2) of this Ordinance, personnel in charge of handling, refilling etc.,have to prove their knowledge about recovery techniques and prevention of emissions.

The F-gas regulation was repealed in 2014, and replaced by Regulation (EU) No 517/2014 of the European Parliament and of the council of 16 April 2014 on fluorinated greenhouse gases. This new regulation provides, in addition to the above mentioned measures, the legislative background to cutting back the amount of F-gases placed on the market inside the EU. This will mostly affect emissions in sector *2.F*.

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[78] „HFKW-FKW-SF6-Verordnung (Industriegasverordnung)"; Federal Law Gazette II No 447/2002.

[79] Regulation (EC) No 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases. F-Gas Regulation 2006, replaced by F gas regulation 2017/2014.

[80] „Bundesgesetz zur Reduktion der Emissionen fluorierter Treibhausgase (Fluorierte Treibhausgase-Gesetz 2009)"; Federal Law Gazette I No 103/2009.

Emission Trends

For the category *2.F Product Uses as Substitutes for Ozone Depleting Substances*, greenhouse gas emissions started to occur in 1993 due to the use of HFCs as substitutes for ozone depleting substance (ODS Substitutes[81]) mainly for foam blowing. From 2000 onwards the main use is as a refrigerant.

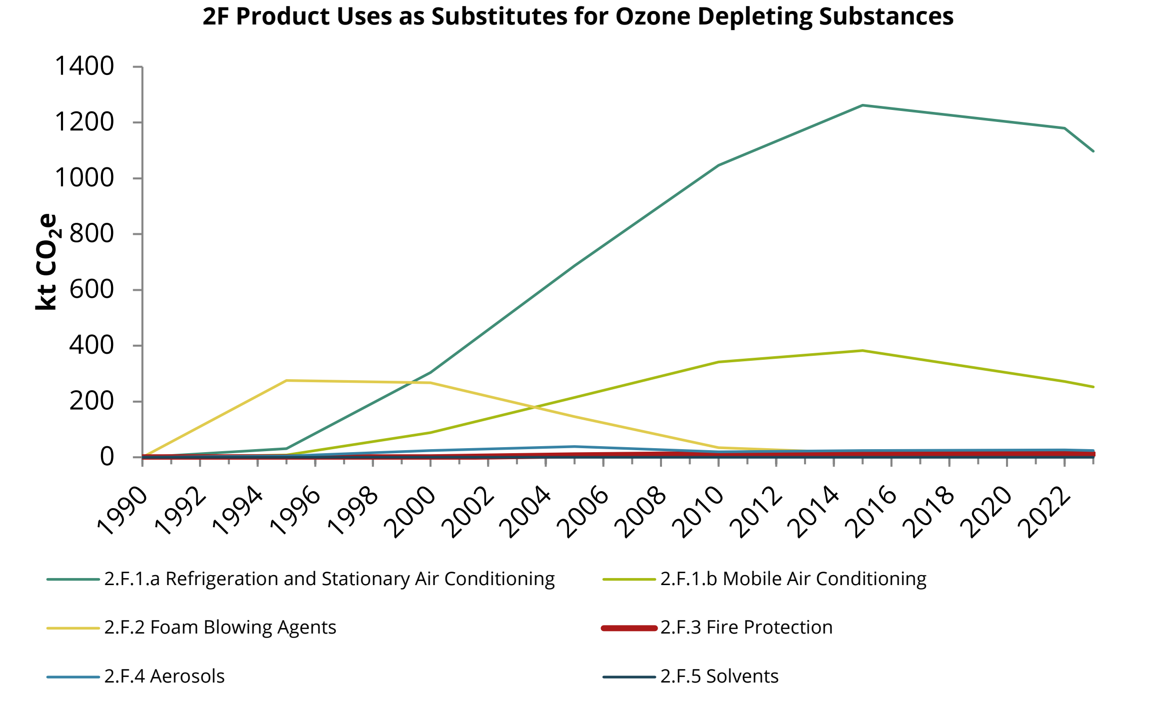
In 2023, F-Gas emissions from Category *2.F* amounted to 1.4 Mio t CO_2 equivalents. Emissions strongly increased since 1993 as HCF have been used increasingly as refrigerant, as well as other uses described below. In 2019, emissions from this sector started to decline for the first time, which is due to the effects of the EU F-Gas regulation (Regulation No. 2017/2014) and the MAC directive.

Table 155: Emissions from 2.F Product Uses as Substitutes for Ozone Depleting Substances.

Year	2.F.1.a Refrigeration and Stationary Air Conditioning	2.F.1.e Mobile Air Conditioning	2.F.2 Foam Blowing Agents	2.F.3 Fire Protection	2.F.4 Aerosols	2.F.5 Solvents
			[kt CO_2e]			
1990	NO	NO	NO	NO	NO	NO
1995	31.24	8.27	275.30	NO	4.09	NO
2000	303.48	88.33	267.35	0.03	24.53	0.38
2005	687.05	214.46	146.12	6.40	38.44	NO
2010	1 046.39	341.74	34.70	11.00	19.79	NO
2011	1 145.01	358.29	15.99	13.14	19.91	NO
2012	1 184.39	368.29	15.83	12.92	20.49	NO
2013	1 224.11	372.78	15.66	10.67	22.29	NO
2014	1 240.75	376.57	15.50	11.58	23.24	NO
2015	1 262.30	382.60	15.34	11.67	23.82	NO
2016	1 259.95	387.31	15.19	11.12	24.85	NO
2017	1 306.86	373.26	15.03	12.23	24.90	NO
2018	1 423.83	354.57	14.88	23.51	25.96	NO
2019	1 365.07	328.27	14.73	12.16	25.82	NO
2020	1 338.06	309.16	14.58	10.71	23.75	NO
2021	1 210.44	292.65	14.44	11.74	23.39	NO
2022	1 179.91	271.99	14.30	11.24	26.63	NO
2023	1 097.75	252.82	14.15	11.24	24.44	NO
2005–2023	**+60%**	**+18%**	**-90%**	**+75%**	**-36%**	

[81] ODS are regulated under the Montreal Protocol and are therefore not considered under the UNFCCC and the Kyoto Protocol.

Figure 27: Emissions from 2.F Product Uses as Substitutes for Ozone Depleting Substances.



Source: Umweltbundesamt

4.7.2 Methodological Issues

Data about consumption of HFC, PFC and SF_6 were mainly obtained directly from importers and end users.

From 2004 to 2022, there was a reporting obligation under the Austrian Industrial Gas Ordinance[82] for users of fluorinated gases in the following applications: refrigeration and air-conditioning, foam blowing, semiconductor manufacture, electrical equipment, fire extinguishers and aerosols. Data is either reported electronically with a system set up by the Umweltbundesamt or per mail (electronic or letter) to the Ministry for Environment (these reports are then forwarded to the Umweltbundesamt to be combined with data from the electronic system).

The first reporting year was 2003, from this year on the end users of fluorinated gases are obliged to report annually about the amounts used and recycled. Theoretically, almost the entire activity data used for inventory preparation is covered by the reporting obligation. Data for semiconductor manufacture *2.E*) and electrical equipment (*2.G*) and partly for other sub sectors are taken from this data base[83]. However, especially the refrigeration sector is large and diverse, there are numerous small enterprises, and not all of them are organised in an industry association, they are hard to

[82] Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über Verbote und Beschränkungen teilfluorierter und vollfluorierter Kohlenwasserstoffe sowie von Schwefelhexafluorid (HFKW-FKW-SF_6-V), Federal Law Gazette II No. 447/2002.

[83] For semiconductor manufacture, plant specific data is available for the whole time series; for the other categories the data had to be extrapolated for the other years (see respective sub chapters for description).

reach and to inform about the reporting obligation. Also, there was no enforcement of the reporting obligation. Due to incomplete reporting, for the refrigeration and air conditioning sector the data could not be used for inventory preparation. Therefore, for this sector, a top down methodology is applied: information on total import of refrigerants was obtained from all relevant importers, refrigerants used in other subsectors were subtracted and the remaining quantities were allocated in the refrigeration and air conditioning sector.

Actual emissions for all subcategories were estimated using a country specific methodology; most emission factors are based on actual data, some are taken from literature or are expert judgements from the respective industries. For most sources, emissions are calculated from annual stocks using emission factors. Additionally emissions can occur during production or disposal of halocarbon/SF_6 containing products, and all these emissions have been accounted for. Annual stocks correspond to the amounts of FCs stored in applications in the previous year, minus emissions of the previous year, plus consumption of the previous year.

The following subchapters present emission factors and data sources used for the respective subcategories.

Methodologies have been developed in studies addressing the country-specific situation:

- (Umweltbundesamt, 2001a): All sub categories of Category *2.F* for 1990 to 2000
- (Obernosterer, et al., 2004): Re-evaluation of sub category foam blowing
- Austrian estimates of emissions from the sources *2.F.4* Aerosols and *2.F.5* Solvents, based on a European evaluation of emissions from this sector (Harnisch, Schwarz, 2003), disaggregated to provide a top-down estimate for Austria.
- (Leisewitz, Schwarz, 2010): All sub categories of Category *2.F* for the years 2000 to 2007; some sub categories for 2008 as well.
- Leisewitz, 2012: Category *2.F.1* for the year 2010, which served as a basis for a further re-evaluation of the model (which included several changes described above.

Further methodological improvements and updates of parameters were made by the inventory team in subsequent years, particularly for industrial and commercial refrigeration and stationary air conditioning.

Table 156 provides the data sources and interpolation methods for each sub-category and each year.

Table 156: Data sources for categories 2.F.1 to 2.F.9.

Category	**Data source**	
	collected	**Intra/extrapolation technique / remarks**
Import data for total FC consumption in Austria	2000, 2004, 20071)	Expert judgement based on information from countries with similar structure1) (1990–1999)
	from 2010 annually	Linear (other years)
2.E.1 Electronics Industry – Integrated Circuit or Semiconductor	for all years	Information on activity data and measured emissions from all producers
2.F Product Uses as Substitutes for Ozone Depleting Substances		

Category	Data source	
	collected	Intra/extrapolation technique / remarks
2.F.1 a Refrigeration and Stationary Air Conditioning		
Industrial and Commercial refrigeration	20071) 2010 2014, 2020 and 2022 (supermarkets refilling/stock) 2022 (parameter update for other than supermarkets)	Before 2007: expert judgement based on information from countries with similar structure1) 2022: parameters for industrial and commercial refrigeration except supermarkets were derived by the inventory experts from actual data from 1 000 installations and consultations with industry experts. Supermarkets were updated in 2 Linear (other years)
Room air conditioning	2000, from 2017 annually	(linear) interpolation based on expert judgement No HFCs prior to 2000 annual collection of market data, expert judgement for HFC filling
Heat pumps	for all years	annual collection of market data, expert judgement for HFC filling
Domestic refrigeration	1993, 1994, 2004, 2005	Linear No HFCs in new refrigerators prior to 1993 and after 2008
Transport refrigeration	20005), 2007, 20115), from 2015 onwards annually	before 2000: expert judgement based on information from countries with similar structure1)) Linear (other years) annual collection of market data, expert judgement for HFC filling and parameters
2.F.1.b Mobile air conditioning	for all years	No HFCs in vehicles prior to 1993 collection of vehicles added to the stock and new fillings of vehicles produced in Austria, parameters based on expert judgement, except for busses where EF is derived from actual leakage data was available for recent years
2.F.2 Foam blowing agents	2000–2010	Value of 2000 was used for 1993-1992). No (new) HFCs in foams prior to 1993 and 2010.
2.F.3 Fire protection	for all years	
2.F.4 Aerosols	from 2000 annually	detalled data for medical areosols, for technical aerosols derived from german data
2.F.5 Solvents	2001, 2002	derived from german data
2.G. Other Product Manufacture and Use		
2.G.1. Electrical equipment	1990–1999, from 2003 annually	Linear annual collection of SF6 filled in new equipment and disposal and expert judement
2.G.2: SF6 and PFCs from Other Product Uses		

Category	Data source	
	collected	Intra/extrapolation technique / remarks
Noise insulating windows (2.G.2.a)	1999–2003	Based on production data3)
Tyres (2.G.2.a)	1998–2003	No SF6 in tyres in other years
Research (2.G.2.b)	1990, 2000–2014, 2016	Linear
Shoes (2.G.2.a)	2003–20054)	No PFCs in shoes in other years

1) Leisewitz & Schwarz (2010)

2) Obernosterer et al. (2004)

3) Production data and share of noise insulating windows

4) Using data from Germany

5) Using indicators (refilling volume, refilling rates)

For more information on data sources and methods, please refer to the following subchapters. An overview of emissions of fluorinated gases by sub-category is presented in Table 157.

Table 157: Emissions of IPCC Category 2.F by sub-category 1990, 1995, 2000, 2005, 2010, 2015, 2022, 2023.

GHG	GWP	Unit	1990	1995	2000	2005	2010	2015	2022	2023
2.F.1 Refrigeration and Air Conditioning Equipment										
2.F.1.a Refrigeration and Stationary Air Conditioning										
HFC-32	677	t	0.00	0.25	2.84	10.53	25.79	45.96	94.63	101.07
HFC-125	3170	t	0.00	2.44	23.30	59.23	105.72	143.57	173.29	166.80
HFC-134a	1300	t	0.00	8.81	94.64	188.96	217.40	248.66	166.29	164.00
HFC-152a	138	t	0.00	0.01	0.04	0.04	0.01	0.00	0.00	0.00
HFC-143a	4800	t	0.00	2.48	21.80	50.93	80.15	91.51	71.49	58.57
HFC-23	12400	t	0.00	0.00	0.00	0.16	2.11	0.93	0.39	0.34
HFC-227ea	3350	t	0.00	0.00	0.00	0.00	0.06	0.54	0.40	0.34
HFC-245fa	858	t	0.00	0.00	0.00	0.00	0.12	0.25	0.35	0.25
HFC-236fa	8060	t	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06
C2F6	11100	t	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
C3F8	8900	t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.F.1.b Mobile Air Conditioning										
HFC-134a	1300	t	0.00	6.37	67.95	164.97	262.88	294.30	209.22	194.47
2.F.2 Foam Blowing Agents										
HFC-134a	1300	t	0.00	203.10	140.56	84.85	9.66	9.34	8.90	8.84
HFC-152a	138	t	0.00	81.68	595.17	204.65	134.36	0.00	0.00	0.00
HFC-245fa	858	t	0.00	0.00	1.50	4.55	2.16	1.92	1.63	1.60
HFC-365mfc	804	t	0.00	0.00	1.50	4.57	2.17	1.94	1.65	1.61
2.F.3 Fire Protection										
HFC-23	12400	t	0.00	0.00	0.00	0.43	0.86	0.86	0.86	0.86
HFC-227ea	3350	t	0.00	0.00	0.00	0.31	0.09	0.30	0.16	0.16

GHG	GWP	Unit	1990	1995	2000	2005	2010	2015	2022	2023
					2.F.4 Aerosols					
HFC-134a	1300	t	0.00	3.15	18.87	29.57	15.23	17.98	19.94	18.28
HFC-227ea	3350	t	0.00	0.00	0.00	0.00	0.00	0.13	0.21	0.20
					2.F.5 Solvents					
HFC-43-10mee	1650	t	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.00
Total	**kt CO_2e**		**0**	**319**	**684**	**1092**	**1454**	**1696**	**1504**	**1400**

4.7.2.1 Refrigeration and Air Conditioning (2.F.1)

This sub sector can be divided into:

a. Category of stationary refrigeration covering large plants/facilities that are **filled on site**, emissions are estimated using a **top down model**:
   - Industrial refrigeration
   - Commercial refrigeration except supermarktes, where actual data is available

b. Rest of the sector 2.F.1 including parts that are, **for the most part, not filled in Austria (or at least not filled on site)**, emissions are estimated using a **bottom up approach**:
   - Domestic refrigeration
   - Transport refrigeration
   - Mobile air conditioning
   - Stationary air conditioning including heat pumps
   - Supermarkets (part of CRT category commercial refrigeration)
   - Commercial stand-alone refrigeration equipment manufacturing (part of CRT category commercial refrigeration)

Details on a) top down model

1. **Total refrigerant imported/total refrigerant used**

   Data on total refrigeration imported is obtained from all relevant importers; values were available for the years 2000, 2004, 2007 and all years from 2010 onwards. There are a handful of large importers that cover about 95% of the market. Additionally there are several small importers that change over the years.

   For 2001 to 2009, the time series was established by interpolation for the years in between where no data on imports/use was available. For the years before 2000, the total consumed amounts were estimated based on information collected by (Leisewitz, Schwarz, 2010) in the Austrian industry on the use of HFCs in refrigeration equipment.

   For the years 2018 onwards, an expert judgement based on information from importers and modelled amounts needed for refilling MACs was made to account for illegal imports and imports not transacted via the main importers (such as cross boarder shopping and online shopping). An average of 15% of regular imported amounts was accounted for on top for these additional amounts (additional amounts were estimated for R410A and R134a; for R410A the estimated excess import is 5%-20% of official imports, for R134a on average 34%).

2. Refrigerant consumption in sub categories considered

Annual consumptions estimated bottom up (e.g. use for filling of new mobile ACs and refilling of mobile ACs and transport refrigeration in Austria) were subtracted from the total.

The remaining amount (residuum) was broken down into the use in each industrial and commercial refrigeration (other than supermarkets) based on information from refrigeration service companies (Leisewitz, Schwarz, 2010), a time series for the split was applied, on average about 10% of the residuum was accounted for as use in industrial refrigeration.

3. Estimation of emissions

The refrigerant consumption covers refrigerants filled in the new equipment and refrigerants used for refilling.

In the first year, total consumption is used for filling into new equipment. For the subsequent years a part is used for refilling, where the amount refilled has to equal the amount emitted in the year before (which equals stock of the year before multiplied with emission = leakage factor), and the remaining amount is used for filling of new equipment. Based on these assumptions the annual stock is calculated.

For some years, specially, consumption of a certain refrigerant is less than the amount needed for refilling (i.e. leackage of the year before). As the eaffected years (starting from around 2017 onwards) do correlate with bans and the phase out of HFC use in the EU that began to take effect, and refrigerants concerned are high GWP refrigerants mostly, it is assumed that this is due to early decommissioning or retrofitting of installations. The "missing" amounts are substracted from stock and considered as decommissioned amounts.

For 1990 and 2000 the EF applied is based on an expert judgement by (Leisewitz, Schwarz, 2010).

Values for lifetime of equipment per sector, which are required to calculate the refrigerant stock, as well as EF for emissions from manufacturing (= emissions from first fill), and EF for disposal emissions were also taken from (Leisewitz, Schwarz, 2010).

For the 2025 submission, EF for 2020 and lifetime of equipment for Industrial Refrigeration and Commercial Refrigeration other than supermarkets was derived from actual data of roughly 1000 units in commercial and industrial refrigeration.

Table 158: Emission factors used for the top down model (IPCC Category 2.F.1).

Sub category	Equipment lifetime	EF for first fill emissions	EF for emissions from stock*	*IPCC default EF*	EF for disposal
Industrial refrigeration	20	0.2%	7.5%%	*7–25%*	30%
Commercial refrigeration other than supermarkets	20	0.2%	1990: 20% 2000: 15% 2020: 7.5%	*10–35%*	30%

* *interpolation in between, latter value used for subsequent years.*

Data sets/information considered for the expert judgements made in 2024 are given below, results have also been discuseed with industry experts**.**

EF for industrial and commercial refrigeration (other than supermarkets)

- Expert judgments for 2010 (by German experts Schwarz and Geschrey)
  - 7,5% for industrial refrigeration
  - 15% for commercial refrigeration
- Random sampling in 2021/2022:
  - One unit with EF of 14%
  - Ten units with no refillings (0% leakage)
    - sampling size is too small to interpret separately
- 2022: About 500 installations in industrial companies (with good service and maintainance)
  - EF 7% for set ups as in commercial refrigeration (weighted average for all units and refrigerants)
  - EF 4% for industrial set ups
  - EF 17%, average for about 20 special setups in industrial companies (with good service and maintainance)
- 2022: About 300 units commercial refrigeration voluntary reporing, also including small units and some AC
  - EF 3% (weighted average for all units and refrigerants)
- 2020:/2022 About 80% of all supermarkets (considered as separate sub category)
  - EF 6% (weighted average for all units and refrigerants)
- EU F-Gas regulation 2014 setting more stringend standards regarding leakage control, trainings and certification for personnel handling with HFCs, which most probably leads to decrease of EF
- VDKF 2023[84] (voluntary reporting, no full coverage, includes plug-in devices)
  - 2.8% leakage for commercial refrigeration

The data and information suggests a bias of voluntary reporting, as these show lower leckage rates than data sets that cover all installations (e.g. from bigger companies that report for all of their installations). Also, the data show that around 60% of installations are not refilled, at least not over the period recorded. The remaining installations have comparativley high emissions, with average leakage rates of around 12%.

Lifetime of equipment:

- Expert judgments (Leisewitz, Schwarz, 2010)
  - 10 years for industrial refrigeration
  - 10 years for supermarkets
  - 14 years for commercial refrigeration
- Information from industry/derived from industry data
  - 15-25 years for supermarkets

[84] „Analyse von Kältemittel-Emissionen der Kälte- und Klimaanlagen in Deutschland" in VDKF (Verband Deutscher Kälte-Klima_Fachfirmen) Information Jahrgang 33, Nr. 5-6 Mai-Juni 2023 and Juli-August 2023

  - Medium age of installations 15 and 17 years (two data sets, one of 300 and another of 500 installations)
  - Average age of decommissioning 19 years for a data set of 500 installations
- IPCC defaults
  - 7-15 years for commercial ref
  - 15-30 years for industrial ref including food processing and storage
  - 15-30 years for chillers

Emissions from decommissioning are estimated as 30% of initial filling (Leisewitz, Schwarz, 2010), the remaining 70% are reported as recovered. Some data on actually recovered amounts (total amount of mix of blends) of F-gases is available, however it is not clear if it is complete. Investigations are ongoing to improve the estimate for emissions from decommissioning.

Details on b) bottom up approach for the rest of the sub category 2.F.1

Domestic refrigeration

Refrigerators for domestic use are mainly imported to Austria (the little production that occurs is considered in commercial refrigeration manufacture).

R134a as refrigerant was introduced by industry at the end of 1993 as replacement of R12 which is a CFC. For this year it was assumed that 100% of the equipment operated with R134a. In the following years R134a was replaced by R600a (iso-butane), therefore – until 2005 – a share of 1% of R134a filled refrigerators was considered. For the years after the share was set to zero as the replacement in Europe was practically complete. An average charge of 0.1 kg per refrigerator was assumed.

The number of new equipment was estimated as approx. 10% of the total number of refrigerators/freezers (with 1.3 fridges/freezers per household) in 1995, amounting to 400.000 per year which was held constant from 1993 to 2005.

EF according to (Leisewitz, Schwarz, 2010):

- emissions from stock: 0.3%
- disposal: 30% (life time 15 years)

Transport refrigeration

This group includes refrigerated road vehicles (vans, trucks, trailers). Manufacturing of refrigeration units does not take place in Austria. Emissions occur from stock and from disposal.

LEISEWITZ UND SCHWARZ, 2010 estimated the stock and refilling of refrigeration units (share of stock = emissions from stocks: 29% for R134a and R410a, 15% for R404a and 10% for R422a) for the year 2007, based on information from a main furnisher of refrigeration units. For the years before 2007 data was extrapolated by (Leisewitz, Schwarz, 2010) using information on stock development from the industry expert. Data for 2008–2012 were extrapolated, taking into account additional data for 2011, obtained from the same industry contact person. Data on HFC amounts from 2013 onwards is based on information obtained from transport refrigeration service companys.

An EF for disposal of 30% and a life time of 10 years were estimated by (Leisewitz, Schwarz, 2010).

Mobile air conditioning

Sub categories considered were passenger cars, trucks, busses, agricultural machines, rail and manufacturing of vehicles for construction sites. In Austria the use of R134a for mobile AC started in 1994, for passenger cars it ended in 2017 due to the European MAC directive.

Passenger cars

Detailed data on brands and models of newly registered passenger cars was available for 2004. This information was combined by (Leisewitz, Schwarz, 2010) with information on HFC charge per AC and AC quota taken from a German study (Schwarz, 2004). For the other years until 2008 data on new registrations per brand were combined with average fill levels and average AC quotas per brands taken from the same study. The fill levels and AC quotas of 2008 were also used for 2009 and 2010. For 2011 and again for 2012 the AC quotas for the main brands were updated using data from the Austrian subsidiaries. The detailed data covers 93–99% of the new registered cars, total charge for all newly registered cars were extrapolated assuming an average charge and quota of the cars with detailed data for the remaining cars.

Information on amounts filled in new cars within Austria was obtained directly from the producers.

EF estimated by (Leisewitz, Schwarz, 2010) applied for

- emissions from manufacturing: 0.7%
- emissions from stock: 10%
- disposal: 30% (life time 12 years)

Trucks

Vans, trucks and trailers were considered separately. R134a charge was taken from a typical model for the different types: For trucks, Mercedes Benz Atego and for trailers, Mercedes Benz Actros average values from (Schwarz, 2004) were used. AC quotas were also taken from (Schwarz, 2004).

Data on new registrations for 2004 was also used for the years until 2009. For the years before the data was estimated by (Leisewitz, Schwarz, 2010). From 2010 onwards data on new registrations from Austrian statistics have been used.

EF estimated by (Leisewitz, Schwarz, 2010) applied for

- emissions from manufacturing: 0.5%
- emissions from stock: 10%/15%
- disposal 30% (life time 10 years)

Buses

Data on new registrations were taken from Statistics Austria from 2003 onwards; for the years before the data was estimated by (Leisewitz, Schwarz, 2010). 55% were estimated to correspond to urban buses, and 45% to coaches. AC quotas and AC charges were taken from SCHWARZ (2004).

- EF derived from actual refill data of about 900 busses over 10 years: 25%
- Disposal: 30% (life time 10 years)

Agricultural machines

Tractors and harvesters were considered separately. Data on new registrations were taken from Statistics Austria from 2006 onwards, for the years before the data was estimated by (Leisewitz, Schwarz, 2010). AC quotas and AC charges were taken from from (Schwarz, 2004)..

Data on filling in newly manufactured agricultural machines (fist fill) in Austria were obtained directly from producers.

EF estimated by LEISEWITZ & SCHWARZ (2010) applied for

- emissions from manufacturing: 0.3%
- emissions from stock: 15%/25%
- disposal: 30% (life time 10 years)

Rail

Rail includes railways, tramways and metro. Data for stocks and production (first fills) were directly obtained from operators and producers.

EF estimated by (Leisewitz, Schwarz, 2010) applied for

- emissions from manufacturing: 0.04%
- emissions from stock: 5%
- disposal: 30%

Vehicles for construction sites

Figures on first fill of vehicles for construction sites were directly obtained from the producers. Emissions were calculated applying a product manufacturing factor of 0.3% (EF estimated by (Leisewitz, Schwarz, 2010).

Stationary air conditioning

This category includes small mobile room AC devices, split devices, Variable Refrigerant Flow (VRF), chillers as well as heat pumps.

Chillers and partly VRF devices are imported pre-filled, the assembled system is filled up, or topped up respectively, with refrigerants on site, whereas the other, smaller devices are imported prefilled.

Stationary air conditioning

Data on annual sales as well as the filling volumes, type of used refrigerants (R407C and R410A) and the market development were estimated based on information from the AC industry for the years 2000–2008 (Leisewitz, Schwarz, 2010). Using further information and expert judgments from the AC industry in recent years (2019–2022) a consistant time series for all different devices was established.

Average charges were used for various types of equipment, ranging between 1 and 83 kg per unit, based on data from industry. An average lifetime of 10 years is assumed for small devices and 15 years for VRF and chillers. From this data stocks were estimated. Applied EF were taken from (Leisewitz, Schwarz, 2010) combined with recent information from industry (2.5% for all years for pre-filled devices, and 10% for 1990 to 4% in 2010 for filled on-site devices).

Heat pumps

Heat pumps use energy stored in the ground, ground water or air. The installation of heat pumps with HFC started in Austria in the 1990s. The stock of equipment in 1995 was estimated to be > 50 000 units in total. About 75% of the newly installed equipment in 2017 was dedicated to space heating and about 24% to heating of water for domestic use as the main areas of application. Heat pumps are manufactured in Austria, exports roughly outweigh the imports, thus manufacture roughly equals newly installed systems. F-gases used are R-134a, R-404A, R-407C and R-410A, propane is also of importance.

Underlying data on installed heat pumps are obtained from an annual report (BIERMAYR et al. 2013–2023). The amounts of HFCs filled into the different types of heat pumps and the share of the individual HFCs were estimated by (Leisewitz, Schwarz, 2010) using information from industry experts; for 2017 the share of HFC used was updated. Average charges were used for various types of equipment, ranging between 0.7 and 2.5 kg per unit, based on data from industry. The Austrian Heat Pump Association is planning on commissioning a study for the inventory.

Applied EF were also estimated by (Leisewitz, Schwarz, 2010):

- product manufacturing 0.1%
- emissions from stock 2%
- disposal 30% (life time 15 years)

Commercial stand-alone refrigeration equipment manufacturing (part of CRT category commercial refrigeration)

Here emissions from manufacturing of small refrigeration equipment mostly for export ("stand-alone" commercial application including also some equipment for domestic refrigeration) are included.

Two Austrian companies manufacture smaller "stand-alone" equipment for commercial and domestic refrigeration (fridges, freezers) with HFC R-134a and R-404A. The equipment is mostly exported. Both companies communicated their data on F-gas consumption. Emissions from manufacturing are estimated to equal 0.1%.

Supermarkets (part of CRT category commercial refrigeration)

Data and information from (Leisewitz, Schwarz, 2010) was complemented with data from major supermarket chains from 2015, 2020 and 2022, data was extrapolated to all super markets using market volumes. From this information time series of stock and emissions = leakage = refilling was prepared. As the methodology is based on estimating the stock, it is not necessary to make a assumption for life time, reductions of the stock are considered as decommissioning. According to information from supermarkets, stocks of medium and high GWP refrigerants increased until around 2015,

4.7.2.2 Foam Blowing Agents (2.F.2)

According to the Austrian Industrial Gas Ordinance the usage of HFC in the area of foam manufacturing and placing on the market is generally prohibited (the ordinance established the possibility of exceptions under specific conditions which were in fact not applied).

Close Cell Foams (2.F.2.a)

XPS plates

For many years the main blowing agent for manufacturing of XPS hard foam was CO_2. In Austria, from 1995 to 2004 also products blown with R134a were sold and from 2000 to 2010 one Austrian company used R152a as blowing agent for a small portion of about 3% of its XPS production in case of short-dated lots for which CO_2 driven XPS foam is not suitable due to longer storage needs with regard to shrinking behaviour.

Data on R152a consumption were obtained directly from the producer; the total amount consumed is assumed to be emitted during production.

R134a from XPS plates was calculated by (Leisewitz, Schwarz, 2010) based on information from industry experts (see Table 159).

25% of consumption is emitted in the production process. Stocks were calculated from the remainder; emissions from stocks were estimated based on information from producers.

Emissions from disposal are not yet to be expected as the lifetime of the foam products is long (around 50 years).

PU hard foam

PU plates and PU sandwich panels blown with R134a were sold in Austria from 2000 to 2004 (usually hydrocarbons and CO_2 are used as blowing agents). Emissions were calculated by (Leisewitz, Schwarz, 2010) from information from industry experts (see Table 159).

PU pipe insulation

About 10% of the market of PU insulating foam for pipes in Austria has been blown with HFC-245fa and HFC-365mcf during 2000–2004. Emissions were calculated by (Leisewitz, Schwarz, 2010) based on information from industry experts (see Table 159). From 2005 onwards usage of HFC in this foam sector is prohibited as well as in the other areas.

HFC-245fa and HFC-365mfc are F-gases that are not regulated under the Convention; this is why emissions of these gases are not included in national totals, but reported in CRT Table 9(b) as additional GHG.

Table 159: PU pipe insulation.

	XPS plates	**PU plates**	**PU sandwich panels**	**PU pipe insulation**
Sales in Austria (estimated from production/import/ export)	350 000 to 480 000 m³/year	17 000 to 18 000 m³/year	350 000 m³ in 2003 (2% growth per year)	41 000 to 62 000 m³/year
Average density	33 kg/m³	33 kg/m³	41 kg/m³	62.5 kg/m³
Market shares of R134a	15% until 1999 10% afterwards	10%	25%	5% each
Average propellant content	6.5% R134a	3% R134a	3% R134a	12% R245fa and R365mfc
Half life time	Until 2004 100mm plates: 85 years;	150 years	200 years	30 years

	XPS plates	PU plates	PU sandwich panels	PU pipe insulation
	since 2005 80mm plates: 60 years			
Annual diffusion rate (EF)	1.15% (until 2004) and 0,81% (from 2005)	0.46%	0.35%	2.28%
EF (manufacturing)	25%	10%	10%	10%

Open Cell Foams (2.F.2.b)

PU one component foam

For PU one component foam (OCF), propellants used include HFC-free formulations (flammable gases, propane and butane among others), blends of flammable gases and HFC-134a or HFC-152a. HFC-134a and HFC-152a were used as blowing agents for OCF from 1993 onwards in Austria. OCF without HFC was used in Austria for the first time in 1999. The Austrian Industrial Gas Ordinance prohibits the use of OCF with HFC from 2006 onwards. Exemptions according to Article 7(4) IV are possible for fire protection products. The European F-gas Regulation provides a ban on HFC in OCF with a GWP > 150 starting July 2008; HFC-152a (with a GWP of 140) is not affected by this ban. From 2004/2005 onwards the Industrial Gas Ordinance provoked a rigorous decrease of HFC consumption in OCF to a niche of about 5% of the OCF market.

PU OCF containing foams were produced in Austria from 1993 to 2008, data on consumption was obtained directly from industry; the EF applied for calculating manufacturing emissions is 1.5%.

The annual consumption in Austria was estimated to be 4.4 million cans in 1993 (where the first HFC containing cans were sold) 6 million cans from 2000–2010. 60% of these cans contain HFCs (from 2006 onwards only 5%); on average one can contains 660g of foam with a propellant content of 13%. The share of R134a was 67% until 1999, 50% until 2005 and 0% thereafter; the remainder is R152a.

For estimating emissions from the OFC consumption in Austria it is assumed that the blowing agent is emitted completely in the first year.

4.7.2.3 Fire Protection (2.F.3)

Stationary fire protection systems for flooding indoor spaces today mainly use inert gases. Formerly used ozone layer depleting halones were replaced by HFCs in some cases. HFC-23 and HFC-227ea in fire extinguishers were first introduced to the Austrian market in 1993 and 1996, respectively. F-gases for fire-fighting are imported in cylinders and filled in fixed installed systems. Fire protection companies re-export recovered F-gas for disposal to the foreign traders/manufacturers.

For HFC-227ea, detailed data on consumption for new equipment, the stock in existing fixed flooding systems, annual losses (refilling) and recovered F-gases for disposal are obtained directly from the fire protection companies every year.

For HFC-23, due to lack of data from the one relevant company, data of 2008 was also used for the subsequent years, which probably overestimates emissions as the 2008 emissions from stock were higher than in all years before. However, no better methodology is available as emissions from stock result from fire incidents, and information on the fire extinguisher capacity where they occur is not available (only statistics on the insurance volume of fire incidents exists, but this only poorly correlates to emissions).

HFC emissions occur from filling in fixed systems, from stocks (in case of false alarm, fire, leakage, accidents etc.) and from disposal. Test flooding, in former times an important source of emissions, did not take place from 2000 onwards. The emission factor for filling of fixed systems is calculated as 0.05%, the EF for disposal as 1%, both figures accord with literature and reports from fire protection companies. The average implied EF from bank is 1.6% for HFC-227ea and 1% for HFC-23, which is within the range given in the IPCC 2006 guidelines (page 7.63) for installed flooding systems (2 ± 1% per year).

4.7.2.4 Aerosols (2.F.4)

Metered dose inhalers

Production:

Metered dose inhalers containing R134a were produced in Austria from 1995 to 2010. Data on consumption was obtained directly from the producer from 2000 onwards, for the years before, production data was extrapolated using the Austrian GDP; the EF applied for calculating manufacturing emissions is 1.5%.

Import:

Additionally, metered dose inhaler are imported since 1995. Detailed data on imported metered dose inhalers and their R134a content from 2000 onwards is provided annually in a pharmaceutical market survey. Since 2012, a new product containing 227ea has been sold in Austria. Charges per unit are based on industry data and range between 6 and 15 g per container. Based on this data, consumption is calculated, where all propellant is assumed to be released in the same year. For the years prior 2000 consumption was extrapolated using the Austrian GDP.

Aerosols

Technical aerosols

One Austrian company manufactured a technical aerosol for cleaning of cameras (use within the country, no export) until 2008. For the years 2000 and 2003 to 2008, data on consumption was obtained directly from the producer. For the years before and in between production data was extrapolated using the Austrian GDP; the EF applied for calculating manufacturing emissions is 1.5%. All propellant is assumed to be released in the year of production (product is assumed to be consumed in the year of purchase).

Novelty aerosols

The amount of imported novelty aerosols is estimated as 0.4% of the European Union market (estimated by the *European Organisation of Aerosol Manufacturers* to range between 940 t/year in 2000 and 100 t in 2009). The value of the year 2000 is also used for the years before. This share was verified by comparison with reported data from importers. From 2004 onwards, marketing of novelty sprays is prohibited in Austria. Under the assumption that certain exceptions are allowed and remainders are sold a continuous decrease in consumption is assumed. Emissions were estimated assuming that 100% are emitted in the first year. A further decrease in 2018 is assumed as a result of the ban established under the EU F-gas Regulation. It is planned to re-evaluate this category in one of the next submissions.

4.7.2.5 Solvents (2.F.5)

Information about HFC-43-10mee used as solvent was taken from a European evaluation of emissions from this sector (Harnisch, Schwarz, 2003) for the years 2001 and 2002, subsequently disaggregated to provide a top-down Austrian estimate. The other years were estimated using the Austrian GDP as indicator. Since 2004 the use of HFC in solvents is prohibited in Austria. Since then no further use occurred, which has been confirmed by industry during the latest inquiries.

Emissions were estimated assuming that 100% are emitted in the first year.

4.7.3 Category-specific QA/QC

EF obtained by industry inquiries were discussed with national experts and compared with values from other countries and IPCC default values.

The total consumption of HFC obtained by the main importers was checked against official statistical information which showed good correlation for recent years (for early years the categories defined in the statistics do not allow comparision of data).

4.7.4 Uncertainty Assessment

2.F.1 Refrigeration and Air Conditioning

The uncertainty of the activity data was estimated to be 10%. Used activity data (information directly obtained from importers showed good correlation with official statstics, also an estimate was accounted for on top to account for additional illegal or legal inport not covered in the data.

The emission factor mainly depends on the allocation of the sub sectors which is relatively uncertain. Additionally the uncertainty of the emission factors of the sub-sectors is to be considered – the uncertainty of the EF is assumed to be 50%. This results in an overall uncertainty of 51%.

2.F.2 Foam

Activity data uncertainty is estimated to be 20%. The amounts used are well documented due to the reporting obligation under the Austrian Industrial Gas Ordinance. The amount of foam sold in Austria is an estimate and their share in specific years varies.

The uncertainty of the emission factor is set to 100% as emissions were estimated assuming that they are emitted in the first year, which results in a combined uncertainty of 102%.

2.F.3 Fire extinguishers

The uncertainty of the activity data is estimated to be 10%. To the stock reported by the plant operators, a rate increase of 10% is added in order to ensure that all activities are covered.

The emission factor for filling and suction at demolition is set at 20%, which results in a combined uncertainty of 22%.

2.F.4 Aerosols

Activity data uncertainty is estimated to be 20%. In Austria filled amounts are well documented, also the amounts of medical aerosols sold. Sale of novelty sprays is estimated based on data from the EU market, however there is a good conformity with the data reported for Austria.

Most of the aerosol used is emitted to 100%, the emissions from manufacturing are relatively uncertain, therefore total uncertainty of the emission factor is assumed to be 10%, resulting in a combined uncertainty of 22%.

4.7.5 Recalculations

2.F Refrigeration and Air Conditioning

Compared to last year, several major improvements in Category *2.F* were implemented (details are given below). The total effect of all recalculations over the time series 1990-2022 is −0.3% of total F-Gas emissions reported now compared to last year's submission. The overall trend and the peak of F-Gases in 2018 remained the same. For the years before 2018, emissions reported now are lower than estimated last year, which is mainly due to the re-assessment of total imports and the allocation to sub sectors as well as the implementation of an updated emission factor for commercial refrigeration. Emissions from 2020 onwards are higher, which is mainly due to the revision of lifetime of refrigeration equipment leading to a shift of emissions from decommissioning to later years.

A short description of the recalculations is given below for each sub-category. Additionally, the total consumption of F-gases and the allocation to sub sectors was re-assessed, which affected input data for commercial and industrial refrigeration (input data for these two sub-categories are residual amounts not consumed by the other categories for which consumption is estimated bottom up).

2.F.1.a Commercial Refrigeration and 2.F.1.c Industrial Refrigeration

Emission factors and lifetime of equipment applied were updated based on actual data from about 1000 units in commercial and industrial refrigeration. The data showed that the applied emission factor for commercial refrigeration other than supermarkets previously was overestimated, and it was changed from 15% for all years to 7.5% in 2020 (interpolated in years in between). This results in lower emissions especially for recent years, but − as a result on the methodology which has refrigerant consumption as the main input parameter − on the other hand increases the stock as less amounts are needed for refilling, so more amounts are left for new installations. Also the updating of the second relevant parameter - lifetime of equipment - had an increasing effect on stock: data showed that the lifetime of equipment was previously underestimated (14 years was changed to 20 years for commercial and from 10 to 20 years for industrial refrigeration). Also, this resulted in a delay of emissions from decommissioning. Overall, the update of the two parameters roughly counterbalanced each other for ex-post emissions.

Also, emissions from commercial refrigeration other than supermarkets are now calculated based on emissions from every refrigerant separately (previously refrigerants were grouped according their GWP), as expected, the deviation of the two approaches is small (about 1%).

The implemented improvements concerning total refrigerant consumption described above, and the improvements made for MACs described below lowered the amounts of refrigerants attributed to the industrial and commercial sector, particularly for the 2010s.

For 2022, emissions from commercial refrigeration are now 18.95 kt CO_2e higher than in the last submission, and those from industrial refrigeration 18.49 kt CO_2e higher.

2.F.1.e Mobile Air Conditioning

In the course of the QA/QC plan an in-depth re-assessment of the methodology for this source category was made, leading to several improvements which resulted in an increase of emissions from this subcategory (+51.72 kt CO_2e for 2022):

- The applied default value for emissions from busses (15%) was updated using data from a sample of about 900 buses, which had an average of 25% leakage per year.
- The assumption on average filling of MACs was revised (previously emissions from MACs were calculated based on the assumption that the average filling is only 70% of the nominal filling, which would imply that about half of the MAC units, which need a minimum filling of about 60% to work properly, would not work during their lifetime; now the average filling is assumed to be 90% of the nominal filling and stock). As this increased emissions, this also resulted in an increase of F-Gas need for refilling, which reduces the residual amount assigned to commercial and industrial refrigeration.

2.F.1.d Transport refrigeration

For this year's submission, additional data reported for 2020 was incorporated also affecting 2021 and 2022 emissions (+0.69 kt CO_2e in 2022).

2.F.1.f Stationary Air Conditioning

Data was recalculated for 2020 as shares of the different refrigerant used in the different appliances was updated (−0.36 kg CO_2e in 2022).

2.F.3 Fire Protection

Amounts previously reported as refilling (= emissions) in 2022 actually corresponded to new fillings and this was corrected (−1.23 kt CO_2e in 2022).

2.F.4.b Aerosols

The methodology from technical aerosols was reviewed in the course of the QA/QC plan, leading to the correction of a transcription error (+0.13 kt CO_2e in 2022).

4.7.6 Planned Improvements

Following a finding by the ERT, it is planned to further assess recovery of HFCs, and the amount destroyed or recycled.

Regarding **fire extinguishers**, further attempts will be made to obtain information on the use of R23 currently refused by the responsible company.

4.8 Other Product Manufacture and Use (CRT Category 2.G)

4.8.1 Source Category Description

Emissions: PFC, SF_6, N_2O

Key Source: yes (SF_6 – 2.G.2)

This category comprises SF_6 emissions from Electrical Equipment (*2.G.1*), SF_6 and PFC emissions from Other Product Uses (*2.G.2*), as well as N_2O emissions from Product Uses (*2.G.3*).

Emission Trends

Emissions from this category amount to 2.6% of the IPPU sector, which equals 0.6% of total emissions.

Table 160: Emissions from 2.G Other Product Manufacture and Use.

GHG	2.G.1 Other product manufacture and use – Electrical Equipment		2.G.2 Other product manufacture and use – SF_6 and PFCs from other product use			2.G.3 N_2O from Product Use	Total
	SF_6	kt CO_2e	SF6	C_3F_8	kt CO_2e	N_2O	kt CO_2e
GWP	**[23 500]**		**[22 800]**	**[8 830]**		**[265]**	
1990	0.47	11.13	5.30	0.00	124.44	442.52	**252.90**
1995	0.63	14.74	11.14	0.00	261.86	442.52	**393.93**
2000	0.75	17.55	8.98	0.00	211.01	442.52	**346.43**
2005	0.97	22.88	13.40	0.00	314.87	252.52	**409.94**
2010	1.28	30.01	10.57	0.00	248.32	177.12	**325.35**
2011	1.28	30.17	10.46	0.00	245.77	165.22	**319.81**
2012	1.39	32.55	10.35	0.00	243.21	155.79	**317.12**
2013	1.43	33.61	10.27	0.00	241.40	154.05	**315.92**
2014	1.51	35.47	10.16	0.00	238.85	146.23	**313.15**
2015	1.59	37.44	10.06	0.00	236.31	141.36	**311.25**
2016	1.68	39.55	13.97	0.00	328.38	142.45	**405.74**
2017	1.69	39.64	13.81	0.00	324.55	136.26	**400.36**
2018	1.81	42.53	13.65	0.00	320.69	140.01	**400.37**
2019	1.86	43.71	15.68	0.00	368.48	149.69	**451.93**
2020	1.93	45.41	16.65	0.00	391.17	156.29	**478.02**
2021	1.99	46.67	12.95	0.00	304.28	147.72	**390.11**
2022	1.98	46.44	12.81	0.00	300.97	154.57	**388.42**

GHG	2.G.1 Other product manufacture and use – Electrical Equipment		2.G.2 Other product manufacture and use – SF_6 and PFCs from other product use			2.G.3 N_2O from Product Use	Total
	SF_6	kt CO_2e	SF6	C_3F_8	kt CO_2e	N_2O	kt CO_2e
GWP	**[23 500]**		**[22 800]**	**[8 830]**		**[265]**	
2023	2.15	50.52	13.04	0.00	306.36	154.99	**398.00**
1990–2023		**+354%**			**+146%**		**+57%**

4.8.2 Methodological Issues

Due to the diversity of this sector, methodological issues are described in each sub-category.

4.8.2.1 SF_6 Electrical Equipment (2.G.1)

SF_6 is used as an arc quenching and insulating gas in high-voltage (> 36 kV [110–380 kV]) and medium-voltage (1–36 kV) switchgear and control gear. The equipment – mainly Gas-Insulates Systems (GIS) – has not been manufactured in Austria during the reporting period, all has been imported. High-voltage GIS (HV GIS) operate with a high operating pressure (up to 7 bar) and large gas quantities. They are imported with a transport filling and are filled up on site. The systems are "closed for life" and have to be replenished in their lifetime. Emissions from operating HV systems are higher than emissions from medium-voltage GIS (MV GIS). These operate with lower overpressure and small gas quantities of only some kg/system. They are already charged with SF_6 when imported and are hermetically closed ("sealed for life"). Both categories of equipment have lifetimes of 30–40 years.

According to Article 15(2) of the Austrian Industrial Gas Ordinance, the use of SF_6 is only allowed in electro-technical systems and appliances of voltage > 1 kV if specific reporting obligations are fulfilled (Article 15(4)). The sector of high and medium voltage switchgear is hence not subject to restrictions of the use of SF_6.

Information on SF_6 stocks in electrical equipment from 2003 onwards was obtained from energy suppliers and industrial facilities (as mentioned above, there is a reporting obligation for operators of SF_6 filled equipment since 2004). Data for 2000–2002: estimation based on an annual growth rate 2003–2007 of 16.9% for MV-GIS and 4.1% for HV-GIS. 2% was added to the reported stock to account for equipment used in industry that is not reported otherwise. For 1990–1999 the stock was calculated from consumption data of this sector.

Amounts of SF_6 refilled in equipment is reported each year by an association of energy suppliers; this information is the basis for the estimations. Manufacturing emissions from first filling were estimated to be 1% according to reported data, the disposal EF is assumed to equal 2%.

In Austria, no destruction of SF_6 in electrical equipment takes place when disposing. Disposed quantities are recovered, emissions from disposal are estimated to be 2%. The disposed amount is also reported by energy suppliers for the years 2004 onwards, the values 2000–2003 were estimated using average disposal rates of 2004–2008: 0.03% for HV and 0.1% for MV. For the years before the average value of 2000–2008 was used.

The amount of SF_6 used in switchgear is reported under the Austrian Industrial Gas Ordinance, by two umbrella organisations covering all switchgear in use. Thus, the amount of SF_6 currently in use, as well as SF_6 used for refill or filling of new equipment is reported.

4.8.2.2 SF_6 and PFCs from Other Product Uses (2.G.2)

Particle accelerators (Research)

SF_6 is used in particle accelerators (linear accelerators, linacs) as insulating gas to prevent electrical flash over. A small number of high voltage equipment (0.3→ 23 MV) is or has been used in Austria in academic research, in industry and medical therapy. The larger HV equipment for research and industrial purposes normally operates with an accelerator and HV generator situated in a tank insulated with SF_6 that is mostly pressurized. Gas losses occur at servicing, repair or adjustment of the device. SF_6 contained in one accelerator can amount up to 0.5 t.

Linear accelerators for medical radiotherapy (cancer therapy) are industrially made and prefilled. Their waveguide is SF_6 insulated; the filling volume (a value of 0.44 kg is assumed) is much smaller than the above-mentioned equipment in research and industry. Electronic microscopes (> 100 kV) have a high voltage tank filled with ~5 kg SF_6.

Manufacturers and operators provided the number of devices operating in Austria. Data on filling volume and refilling have been collected from the institutions and companies operating the equipment, from manufacturers and from service companies. Emissions from bank are equal to the amounts provided in company reports for refilling of losses.

The annual F-gas consumption (first filling of new products) normally is very small (in the order of kg) and exceeded 400 kg in one year only. The stock is about 1 t for recent years. The implied EF is in the order of 8%, but there is a wide difference between the several types of equipment.

Noise insulating windows

Nose insulating windows containing SF_6 were produced in Austria from 1980 to 2003, when the Austrian Industrial Gas Ordinance prohibited this use.

For the years before 1999 consumption and emissions from production were estimated from total production and the share of SF_6 production using the following information from industry:

- 16 mm gap results in about 16l/m^2 of which there are 8l SF_6 per m^2 window
- Filling from 1996 is only 6l SF_6/window
- Overfill of 3l per m^2 window (manual filling) = emissions from manufacture
- Density of SF_6: 6.18 kg/m^3

SF_6 consumption was reported by industry for the years 1999–2003; one third of the consumption is overfill (thus equals emissions from manufacture).

The leakage per year is 1% of the initial fill (which considered premature breaking).

The residual amount after the lifetime of 25 years is assumed to be emitted immediately due to breaking of glass.

Tyres

SF_6 shows a low permeability through rubber (cf. IPCC GL 2006, p. 8.31). The German tyre manufacturer Continental AG exploited this property and offered in the 1990s tyres with SF_6 as filling gas instead of air. In Austria the national tyre and automotive trade sold tyres with SF_6 as filling gas filled within the country. The gas used for this purpose was supplied by only one SF_6 importer, who reported on the amount of SF_6 sold to the Austrian tyre and automotive trade. As of 2003, the Austrian Industrial Gas Ordinance abruptly stopped the usage of SF_6 as filling gas for tyres by legal prohibition.

According to IPCC GL 2006 it is assumed that SF_6 completely emits from car tyres with their disposal three years after filling. Filling emissions are regarded to be insignificant. Disposal emissions are therefore assumed to equal the amount consumed three years earlier.

Shoes

Nike introduced sport shoes with gas cushions filled with SF_6 in the early 1990s. From 2003 to 2006 the company used as alternative PFC (C_3F_8) for the same purpose. Shoes with F-gas cushions were not manufactured in Austria but imported. SF_6 emissions from sport shoe soles occurred in Austria up to 2006, C_3F_8 emission from 2006 to 2008.

Data on the import of these products to Austria were not provided by Nike. It was accepted as plausible that the German and the Austrian market could be regarded as comparable. Data on the German market are well documented. Austria has 10% of the population compared to Germany, hence the same percentage was assumed for annual consumption of such footwear in Austria. In case of perfluoropropane the European consumption in 2003–2005 is known and the Austrian market is estimated to be 2.5% (= 10% of the German market).

Operating emissions during use of the footwear are not considered. The lifetime of sport shoes is estimated to be 3 years. At the disposal of old shoes 100% of the initial filling is released to the atmosphere (i.e. EF=100%). Disposal emissions are therefore assumed to equal the amount imported in sport shoes three years earlier.

4.8.2.3 N_2O from Product Uses (2.G.3)

Medical Applications (2.G.3.a)

In this category N_2O emissions from the use of anaesthesia and also small amounts of technical N_2O use is reported. Technical use include applications in electronic industries such as semiconductor manufacture, and other uses not further specified. It is reported together with medical use due to confidentiality reasons. Medical N_2O use has significantly decreased due to shorter duration of anaesthesia during operations and more local anaesthetics than general anaesthesia. Also, in recent years mixtures of N_2O and O_2 came into use, which are included in the reported figures.

Data for 2001–2012 was obtained from an industrial association, that collected data from its members (ÖIGV - Österreichische Industriegaseverband, 2013), figures comprise total N_2O sales to end users. Since 2013 data is obtained directly from all relevant retailers and producers of N_2O, and also include small amounts of technical grade N_2O, that are reported to be used in electronic industries.

Additional N_2O use is reported from semiconductor manufacturers, which are considered as additional, direct imports. Also, some information on destruction efficiency of the abatement installed is provided, which is used to estimate emissions from this use. As data is only reported for recent years, but N_2O was used over the whole time series, an expert judgement was made for years with no actual data.

For N_2O used as an anaesthetic, it is assumed that 100% are emitted in the year of sale. For technical N_2O use other than in semiconductor manufacture also 100% emission is assumed, as no details concerning the actual application is available.

Propellant for Pressure and Aerosol Products (2.G.3.b)

N_2O is used as propellant for cream; it is applied in capsules or in ready to use cans.

For **capsules** all producers reported data on amounts sold in Austria, these values were used for all years as all three producers confirmed that the market in Austria is saturated and has been stable over the years.

For **ready to use cans**, data from supermarkets and wholesale were extrapolated to the overall market in Austria using market shares for retail trade. As for capsules, the estimation is reported by companies for the whole time series.

It is assumed that all N_2O from capsules and cans sold in one year are emitted in the same year. According to the main producers, Austria is a saturated market with only minor changes in use of propellant cream since the 1990s, and thus the same value of AD that was elaborated in 2020 can be used for the whole time series.

Organic Rankine Cycles (2.G.4.b)

So far, one plant in Austria has been identified, where Solkatherm (mixture containing HFC 365 mfc) has been in use since 2005. The plant opened in 2000, when 3 000 kg of 3m PF-5052 (PFC C5F12) were filled in. These 3 000 kg were then decommissioned in 2005, and 3 000 kg of 365mfc were filled in. Since then, no emissions (no refills) were recorded. No records are available for the time before 2005, but it is assumed that no emissions took place then.

According to expert judgement[85], 2% emissions were thus considered during filling in, and 20% at decommissioning. This results in emissions for the years 2000 and 2005.

It still cannot be ruled out that there are other ORC plants in operation in Austria, as not all ORC plant operators replied before this submission. As soon as this information is available it will be considered in the inventory.

[85] Implementierung der ab dem Berichtsjahr 2013 gültigen IPCC Guidelines for National Greenhouse Gas Inventories 2006 in die Inventarerhebung fluorierter Treibhausgase (HFKW, FKW, SF_6, NF_3), Climate Change 17/2015, Öko-Recherche.

4.8.3 Category-specific QA/QC

EF obtained by industry inquiries were compared with the IPCC default values. The total consumption of N_2O, PFC and SF_6 was obtained by the main importers and this data was checked against information from professional organisations and statistics.

For N_2O used as cream propellant the estimation for capsules was estimated by two approaches: on the one hand based on data from producers, on the other hand based on retail sail data; the difference of the approaches is within the assumed uncertainty.

4.8.4 Uncertainty Assessment

2.G.1 Electrical Equipment

Activity data uncertainty is estimated to be low (5%) as data are reported from industry and additionally 2% is added to the calculation to account for equipment not covered in the reported figures. As for the emission factor, uncertainty is estimated to be very high (100%).

2.G.2 SF_6 and PFCs from Other Product Uses

According to emissions levels, the most important sub source is noise insulating windows. The uncertainty for activity data is estimated to be 25%, emission factor uncertainty is assumed to be relatively high (50%) because it is based on several assumptions.

2.G.3 N_2O from Product Uses

Uncertainty for emissions from this category is assumed to be at 20% for Activity Data, for the EF the uncertainty was assumed to be 0%, as all N_2O contained is assumed to be emitted. This resulted in a combined uncertainty of 20%.

4.8.5 Recalculations

2.G.1 Other product manufacture and use - Electrical Equipment

The emission factor for 2022 was corrected (was 2%, should be 1% like in other years; −2.76 kt CO_2e in 2022).

2.G.3.a Medical N_2O use

Additional technical use was identified, emissions are reported together with medical use due to confidentiality reasons (+8.90 kt CO_2e in 2022).

2.G.4.a Fireworks

CO_2 emissions from fireworks are estimated for the first time in this years' submission (+0.05 kt CO_2 in 2022).

5 AGRICULTURE (CRT SECTOR 3)

5.1 Sector Overview

This chapter gives information about the estimation of greenhouse gas emissions from Sector *Agriculture* in correspondence to the data reported under the Sector 3 in the Common Reporting Tables.

The following sources exist in Austria: domestic livestock activities with enteric fermentation and manure management, agricultural soils, field burning of agricultural residues, liming, urea application and other carbon-containing fertilizers.

As a result of previous UNFCCC reviews the ERT recommended that Austria update its information on animal waste management system (AWMS) distribution (ARR 2006, ARR 2008). Hence, in 2008 the Umweltbundesamt commissioned the University of Natural Resources and Applied Life Sciences with the revision of the national emission model of the sector agriculture (Amon, Hörtenhuber, 2010). Data on AWMS distribution was taken from the research project "Animal husbandry and manure management systems in Austria" (Amon, et al., 2007a), a comprehensive survey on the agricultural practice in Austria. This study was followed by surveys in 2018 (Pöllinger, et al., 2018) and 2024 (Pöllinger, et al., 2025).

In 2013 the Umweltbundesamt commissioned the University of Natural Resources and Applied Life Sciences with the update of the national emission model of the whole sector agriculture by using the methodologies according to the IPCC 2006 Guidelines (Amon, Hörtenhuber, 2014).

In submission 2021 Austria included CO_2 emissions from calcium ammonium nitrate (CAN) in its inventory as encouraged during the ESD Review 2020.

In submission 2019, the agricultural model has been revised by implementing new input data on agricultural practices in Austria, taken from the research project "Surveys on manure management from agricultural livestock farming in Austria (TIHALO II) (Pöllinger, et al., 2018)". Furthermore, the N flow has been improved according to the EMEP/EEA methodologies (EEA 2019), which also effected Austria's GHG emissions (Amon, Hörtenhuber, 2019). In response to questions raised during the comprehensive ESD Review 2020 (EEA, 2020a) and the NEC Review 2021 (European Commission, 2021) on Austria's feeding assumptions, the Umweltbundesamt initiated a representative study. The feeding of cattle and swine has changed substantially in the last two decades and it was decided to update the national inventory on the basis of latest available science. Thus, from 2020 to 2022 the University of Natural Ressources and Life Sciences Vienna carried out a specific research project on country-specific animal feeding and nutrition ("MiNutE" study, (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023). In submission 2022, Austria included updated and representative values for nitrogen and energy intake, excretion of nitrogen (N_{ex}) and volatile solids (VS_{ex}) into the inventory.

In the current submission 2025, the agricultural model has been improved by implementing representative up-to-date input data on agricultural practices from the research project "Surveys on manure management from agricultural livestock farming in Austria (TIHALO III) (Pöllinger, et al., 2025)". For this project, as for the previous ones (Amon, et al., 2007a) and (Pöllinger, et al., 2018), a comprehensive survey has been carried out. The 2019 IPCC Refinement was implemented over all agriculture source categories as well, documented in (Hörtenhuber, 2025). Furthermore, for the non-key livestock categories sheep, goats, horses, poultry, deer and rabbits specific feeding and nutrition data was gathered and analysed. Based on that information, Tier 2 methodologies according to the 2019 IPCC Refinement could be implemented. Consequently, country-specific GE-intake values and updated $VS_{excretion}$ and $N_{excretion}$ values have been generated according to (IPCC 2019).

Austria follows the N-flow approach by using country specific methodologies for the calculation of direct N_2O emissions from animal manure applied to soils (*3.D.1.b.i*) and indirect N_2O emissions from leaching and run-off (*3.D.2.b*). In response to a recommendation of the ERT (ARR 2013, para 51 and 52) additional descriptions have been included from NIR 2014 onwards (Annex 5.1). Methodological details regarding the calculation of gaseous N losses of NH_3, NO_x and N_2 are extensively described in Austria's Informative Inventory Report 2025 (Umweltbundesamt, 2025b).

To give an overview of Austria's agricultural sector some information is provided below (according to the 2020 Farm Structure Survey – full survey) (Statistik Austria, 2022a) and (BML, 2000-2024): Agriculture in Austria is rather small-scaled: 154 593 farms are managed, 54.9% of these farms manage less than 20 ha, whereas only 5.7% of the Austrian farms manage more than 100 ha cultivated area. 118 432 holdings are classified as situated in less favoured areas. Related to the federal territory Austria has the highest share of mountainous areas in the EU (70%). The structural change of Austria´s Agriculture is continued: the number of agricultural holdings decreased between 2010 and 2020 by 11% whereas the size of holdings increased in this period. In 2010, an average total area of 42.6 ha was managed on a holding, in 2020 it increased to 44.9 ha.

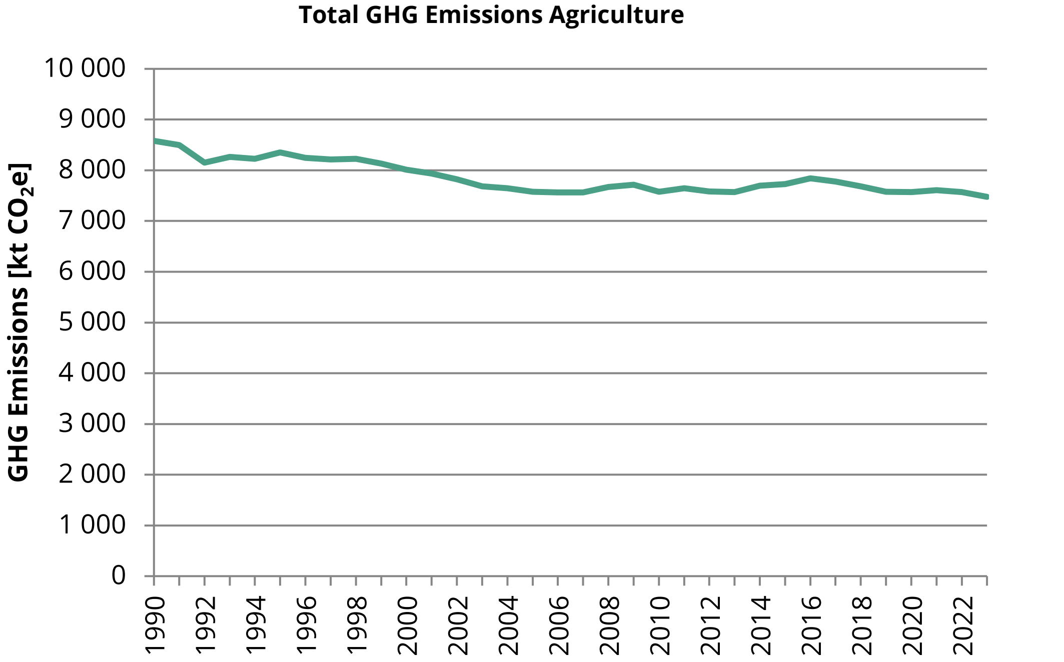
The agricultural area comprises 2.60 million hectares that is a share of ~ 31% of the total territory (forestry ~ 41%, other area ~ 11%). The shares of the different agricultural activities are as follows:

- 51% arable land,
- 22% grassland (meadows mown several times and seeded grassland),
- 24% extensive grassland (meadows mown once, litter meadows, rough pastures, alpine pastures and mountain meadows),
- 3% other types of agricultural land-use (vineyards, orchards, house gardens, vine and tree nurseries).

5.1.1 Emission Trends

In the year 2023 the sector agriculture contributed 10.9% to the total of Austria's greenhouse gas emissions (without LULUCF). The trend of GHG emissions from 1990 to 2023 shows a decrease of 12.9% for this sector (see Figure 28 and Table 162) due to a decrease in activity data.

Figure 28: Trend of total GHG emissions from agriculture.



Source: Umweltbundesamt

The main drivers for the trend shown in Figure 28 are decreasing livestock numbers and lower amounts of N-fertilizers applied on agricultural soils. From 2022 to 2023 GHG emissions decreased by 1.3%, mainly due to falling emissions from mineral fertilizer application (−7.4%). The reasons for this reduction are lower sales volumes due to the pandemic and the war in the Ukraine, which lead to higher energy and raw material prices also affecting the fertilizer market. Additionally, livestock numbers of cattle (−1.4%) fell in 2023 resulting in lower GHG emissions from enteric fermentation. Swine, sheep and goat numbers decreased as well (−5.0%, −2.2% and −2.1%, respectively).

Emission trends per gas

From 1990 to 2023 CH_4 emissions from agriculture decreased by 11.7%. N_2O emissions fell by 18.0% and CO_2 emissions increased by 71.7%. Trends are presented in Table 161.

Table 161: Emissions of greenhouse gases from 1990–2023 from agriculture.

Year	**GHG emissions [kt]**		
	CH_4	**N_2O**	**CO_2**
1990	205.86	10.30	85.92
1995	202.86	9.77	84.22
2000	189.91	9.83	89.33
2005	178.36	9.39	95.54
2010	182.31	8.89	112.35
2011	180.63	9.29	125.99
2012	179.63	9.13	133.67

Year	GHG emissions [kt]		
	CH_4	N_2O	CO_2
2013	180.54	9.01	127.21
2014	181.76	9.35	132.78
2015	182.41	9.34	145.49
2016	183.42	9.64	151.61
2017	184.21	9.33	150.71
2018	182.58	9.12	154.83
2019	180.81	8.93	150.78
2020	180.35	8.94	148.94
2021	181.74	8.94	149.29
2022	182.95	8.69	149.17
2023	181.79	8.45	147.51
Trend 1990–2023	**-11.7%**	**-18.0%**	**71.7%**

Emission trends per sub category

Table 162 presents total GHG emissions and trend 1990–2023 from agriculture by sub-categories as well as the contribution to the overall inventory emissions. Important categories are *3.A Enteric Fermentation* (6.3%) and *3.D Agricultural Soils* (2.6%) followed by *3.B Manure Management* (1.8%).

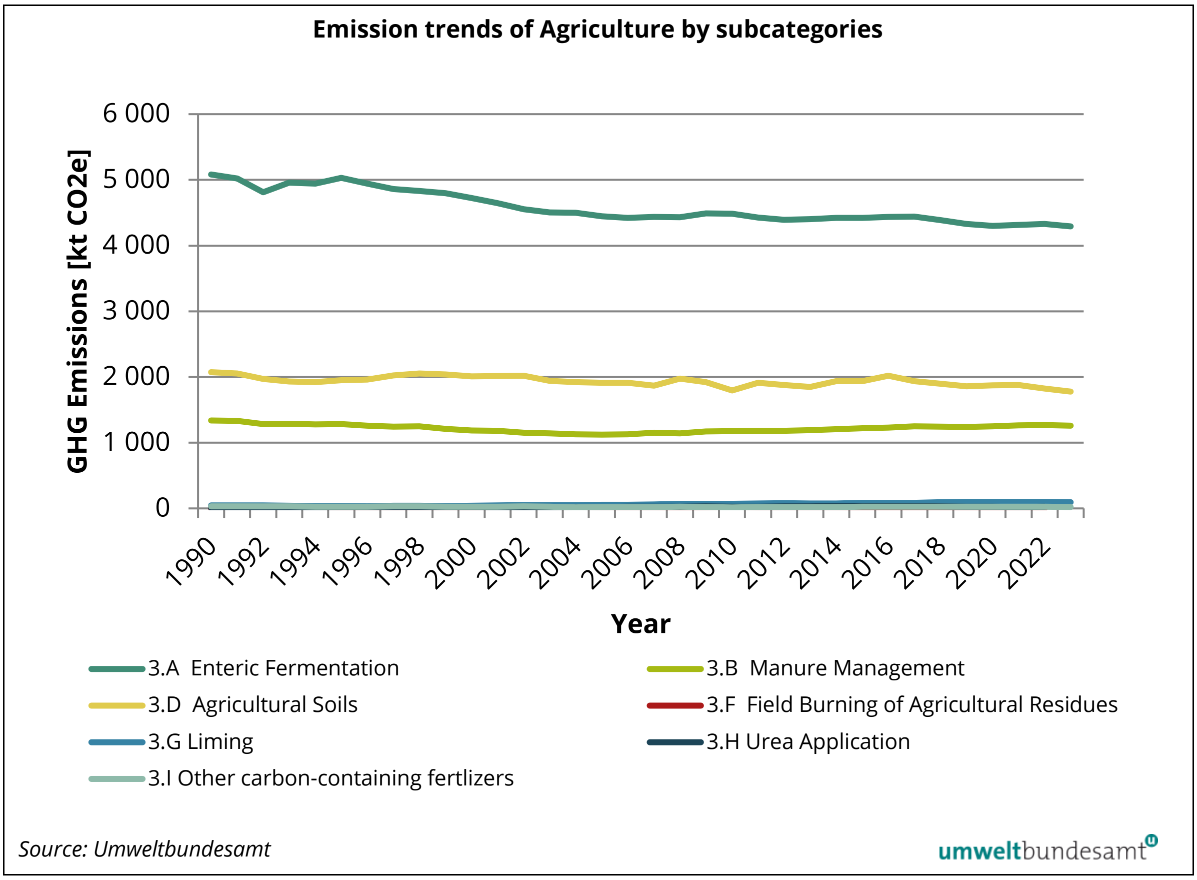
Table 162: GHG emissions 1990–2023 of agriculture by sub categories.

Year	GHG emissions [kt CO_2 equivalent] by sub categories							
	3	3.A	3.B	3.D	3.F	3.G	3.H	3.I
1990	8 580.70	5 081.96	1 338.29	2 073.39	1.14	45.67	9.60	30.66
1995	8 353.31	5 031.00	1 284.33	1 952.64	1.11	35.68	19.79	28.76
2000	8 012.71	4 725.45	1 188.52	2 008.40	1.00	42.60	19.36	27.37
2005	7 578.06	4 443.67	1 123.35	1 914.58	0.93	53.62	21.89	20.03
2010	7 574.06	4 486.18	1 178.51	1 796.29	0.73	68.61	28.85	14.89
2011	7 645.02	4 426.81	1 181.19	1 910.56	0.47	77.15	27.47	21.37
2012	7 583.91	4 390.51	1 183.38	1 876.08	0.27	80.84	30.63	22.20
2013	7 569.88	4 402.20	1 192.91	1 847.35	0.22	75.34	30.28	21.60
2014	7 699.08	4 420.06	1 207.63	1 938.32	0.29	75.14	34.04	23.59
2015	7 726.95	4 422.81	1 221.62	1 936.83	0.20	83.43	34.90	27.15
2016	7 842.58	4 438.26	1 232.38	2 020.13	0.21	83.80	39.26	28.55
2017	7 780.57	4 443.01	1 249.90	1 936.82	0.14	86.03	38.30	26.38
2018	7 683.13	4 388.38	1 244.54	1 895.27	0.11	96.50	32.03	26.30
2019	7 579.15	4 328.03	1 241.46	1 858.78	0.10	99.40	26.77	24.61
2020	7 568.29	4 299.33	1 247.50	1 872.51	0.00	98.94	24.54	25.47
2021	7 606.93	4 315.74	1 264.43	1 877.47	NO	99.11	23.12	27.06
2022	7 573.44	4 331.39	1 268.58	1 824.30	NO	99.20	25.54	24.43

Year	GHG emissions [kt CO_2 equivalent] by sub categories							
	3	**3.A**	**3.B**	**3.D**	**3.F**	**3.G**	**3.H**	**3.I**
2023	7 476.99	4 292.14	1 259.38	1 777.96	NO	95.29	30.07	22.15
Share in Austrian Total 2023	**10.9%**	**6.2%**	**1.8%**	**2.6%**	**0.0%**	**0.1%**	**0.0%**	**0.0%**
Trend 1990–2023	**-12.9%**	**-15.5%**	**-5.9%**	**-14.2%**	**-100.0%**	**108.7%**	**213.4%**	**-27.8%**

As can be seen in Figure 29 and Table 162 the overall trend concerning emissions from most of the sub categories is decreasing with the exception of liming and urea application. The main reason for the decrease of emissions from enteric fermentation is the decrease in cattle numbers. In manure management a slighter decrease of emissions can be observed mainly due to the rising share of liquid systems, which partly compensates the falling cattle numbers. Fluctuations of emissions from agricultural soils are mainly due to varying underlying activity data (especially the sales figures of mineral fertilizers). Emissions from liming and urea application follow the increased application from 1990 onwards. The declining emissions trend of calcium ammonium nitrate (CAN) can be explained with decreasing activity data.

Figure 29: Emission trends of agriculture by subcategories.



As can be seen in Table 163, in 2023 about 57.4% of emissions from agriculture originate from enteric fermentation and 23.8% from agricultural soils. Manure management contributes about 16.8% and the source categories liming, urea application and other carbon-containing fertilisers are emitting only a negligible part (1.3%, 0.4% and 0.3%, respectively in 2023). Field burning of agricultural wastes did not occur in 2023 anymore ("NO").

Table 163: Share of sub categories of agriculture,1990 and 2023.

	GHG emissions [%] by sub categories							
Year	**3**	**3.A**	**3.B**	**3.D**	**3.F**	**3.G**	**3.H**	**3.I**
1990	100%	59.2%	15.6%	24.2%	0.0%	0.5%	0.1%	0.4%
2023	100%	57.4%	16.8%	23.8%	NO	1.3%	0.4%	0.3%

5.1.2 Key Categories

The key category analysis is presented in Chapter 1.4.

5.1.3 Methodology

The calculation of CH_4 emissions from enteric fermentation follows the IPCC 2019 Refinement.

Cattle and swine emissions are estimated on the basis of a country-specific study ("MiNutE", see below) in which specific data on animal characteristics and animal feeding were collected and analysed for the development of improved methodologies in accordance to IPCC Tier 2. Emissions from the non-key animal categories sheep, goats, poultry, horses, deer and rabbits are also calculated by using the Tier 2 methodology. N_2O emissions from animal manure applied to soils were calculated using a country specific methodology following the N-flow approach.

For the calculation of emissions from enteric fermentation – poultry, horses and rabbits some factors and parameters from Switzerland (e.g. GE-intake, methane conversion rate) were used in order to apply the Tier 2 methodology according to IPCC. Farming practices in Switzerland are very similar to the Austrian ones.

2020 to 2022 a new research project on country-specific animal feeding and nutrition ("MiNutE" study, Hörtenhuber, et al., 2022b; Hörtenhuber, et al., 2023) has been carried out by the University of Natural Resources and Life Sciences, Vienna. In submission 2022 Austria included the updated and representative values for nitrogen and energy intake, excretion of nitrogen (N_{ex}) and volatile solids (VS_{ex}) into its agriculture inventory.

Consistent AWMS distributions used in manure management are based on (Konrad, 1995), (Amon, et al., 2007a), (Pöllinger, et al., 2018) and (Pöllinger, et al., 2025). The study results of the so-called TIHALO II survey (Pöllinger, et al., 2018) were implemented in submission 2019 within a specific project for the revision of the national inventory (Amon, Hörtenhuber, 2019). In the current submission 2025, Austria included the results of the new TIHALO III survey (Pöllinger, et al., 2025). This implementation was carried out under scientific supervision as well, documented in (Hörtenhuber, 2025).

Country specific methane conversion factors (MCF) were applied for liquid systems of cattle and swine. The MCFs are based on studies carried out at the University of Natural Resources and Applied Life Science (BOKU), Department for Sustainable Agriculture, Division of Agricultural Engineering (DAE) (Amon, et al., 2002b), (Amon, et al., 2006), (Amon, et al., 2007b). For all other systems emission factors of the 2019 IPCC Refinement was used.

As recommended in the Centralized Review 2003, for the estimation of emissions from field burning of agricultural wastes the IPCC methodology using default emission factors was applied. In response to an encouragement of the ERT in the Centralized Review 2010, Austria provided a refined estimate on the basis of relevant crops.

In submission 2015 Austria introduced a national value for $Frac_{Leach}$ (0.15154) based on a national study (Eder, et al., 2015) for the calculation of indirect emissions from nitrogen leaching and run-off.

The following table presents an overview of the country specific data used in agriculture including a short indication on the sources for this data as recommended in the ARR 2013, Table 8 (para 49).

Table 164: Information on country specific data.

Category	Parameter	Source
3.A Enteric Fermentation		
3.A.1 Cattle	GE-Intake	(Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023)
3.A.2 Sheep	GE-Intake	(Hörtenhuber, 2025)
3.A.3 Swine	GE-Intake	(Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023)
3.A.4.c Deer	GE-Intake	(Hörtenhuber, 2025)
3.A.4.d Goats	GE-Intake	(Hörtenhuber, 2025)
3.A.4.f Horses	GE-Intake	(Hörtenhuber, 2025)
3.A.4.g Poultry	GE-Intake	(FOEN, 2024), (Hörtenhuber, 2025)
3.A.4.h Rabbits	GE-Intake	(Hörtenhuber, 2025)
3.B Manure Management		
3.B (all livestock)	AWMS distribution	(Konrad, 1995, Amon, et al., 2007a, Pöllinger, et al., 2018, Pöllinger, et al., 2025), carried out in (Amon, Hörtenhuber, 2010), (Amon, Hörtenhuber, 2019), (Hörtenhuber, 2025)
3.B (cattle, swine, chicken, horses)	Anaerobic digestion	(Amon, et al., 2002b), E-CONTROL (2006–2021, 2022, 2023b), (Kompost- und Biogasverband, 2024, Hörtenhuber, et al., 2022a), (Hörtenhuber, et al., 2022a), (Hörtenhuber, 2025)
3.B.1 Cattle	VS excretion	(Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023)

Category	Parameter	Source
3.B.3 Swine	VS excretion	(Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023)
3.B (all other livestock)	VS excretion	(Hörtenhuber, 2025)
3.B.1 Cattle, 3.B.3 Swine	MCF liquid systems	(Amon, et al., 2006), (Amon, et al., 2007b)
3.B (cattle, swine, chicken)	MCF anaerobic digestion	(FNR, 2010); (Amon, 2011)
3.B (cattle, swine)	N excretion	(Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023)
3.B (all other livestock)	N excretion	(Hörtenhuber, 2025)
3.D. Agricultural Soils		
Austria's N-flow model	Country-specific consideration of N-losses	(Amon, et al., 2002b), (Amon, Hörtenhuber, 2008), (Amon, Hörtenhuber, 2010), (Amon, Hörtenhuber, 2014), (Amon, Hörtenhuber, 2019), (Hörtenhuber, 2025)
3.D.1 Direct Soil Emissions		
Sewage sludge spreading	N content data	(Umweltbundesamt, 1997)
Compost application		Expert judgement by Umweltbundesamt, 2011-2024a
Mineralization/immobilization of soil organic matter		C losses reported in sector LULUCF (4.B.1.3)
Cultivation of organic soils		(Umweltbundesamt, 2025d) see sector LULUCF
3.D.2 Indirect Soil Emissions		
Austria's N-flow model	Country-specific consideration of N-losses	(Amon, et al., 2002b), (Amon, Hörtenhuber, 2008), (Amon, Hörtenhuber, 2010), (Amon, Hörtenhuber, 2014), (Amon, Hörtenhuber, 2019), (Hörtenhuber, 2025), (Eder, et al., 2015)

Background information on the parameters listed above is provided in the methodological descriptions of the respective chapters of the NID.

5.1.4 Quality Assurance and Quality Control (QA/QC)

The following sector specific QA/QC procedures have been carried out:

1. Activity data check
   - ✓ Check for transcription errors, comparison with published data (BML 2023b),
   - ✓ Consistency checks of sub-categories with totals,
   - ✓ Plausibility checks of dips and jumps,

2. Emission factors
   - ✓ Check of implied emission factors (time series) and CRT background data,
   - ✓ Comparison with IPCC default values and factors reported by other countries;
3. Calculation by spread sheets
   - ✓ Consistent use of livestock characterization,
   - ✓ Cross-checks through all steps of calculation,
   - ✓ Documentation of sources and correct use of units;
4. Results (emissions)
   - ✓ Check of recalculation differences,
   - ✓ Plausibility checks of dips and jumps;
5. Documentation
   - ✓ Findings and corrections marked in the spread sheets,
   - ✓ Improvement list (internal and external findings).

In the Austrian QMS regularly extensive QA and verification activities are carried out (Tier 2 QA). In 2012 Agriculture was validated. Some minor inconsistencies with respect to the AWMS data have been found and corrected.

Due to the revision of the Austrian inventory model for sector agriculture according to the 2006 IPCC GL and the EMEP/EEA GB 2013 an external review by Austrian Agricultural experts within the framework of a stakeholder meeting was held in 2014. Applied values and parameters were discussed and validated by the national experts (Umweltbundesamt, 2014a).

In submission 2019 the agricultural model was revised as new data on the agricultural practice in Austria became available from the TIHALO II survey (Pöllinger, et al., 2018) as well as due to improvements of the N-flow according to the EMEP/EEA GB 2016 (Amon, Hörtenhuber, 2019). Within the framework of this revision a stakeholder meeting (so-called "inventory talks") was held in 2018 in order to discuss applied values, parameters, time series and study results with Austrian agricultural experts (Umweltbundesamt, 2018).

In submission 2022, Austria included updated and representative values for nitrogen and energy intake, excretion of nitrogen (Nex) and volatile solids (VSex) into the inventory taken from a specific research project on country-specific animal feeding and nutrition ("MiNutE" study, (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023)). The results were presented and discussed with Austrian agricultural experts as well.

In submission 2022, emission calculations of *3.I (Other carbon-containing fertilizers)* have been validated. Austria's import statistics were checked with regard to the assumptions on limestone and dolomite contents. The investigations confirmed the current approach using the arithmetic mean of limestone and dolomite.

In 2023, Austria verified its NH_3 estimates by comparing them with the calculations and results of the 3*.B Manure Management N flow tool* from the European Environment Agency (EEA - European Environment Agency). Basically, the comparison showed a good correlation of trends and emission levels between the two calculations. The Austrian N-flow model for cattle and swine is much more complex and there was a need to simplify the calculations in order to be able to use the EEA N-flow tool. One of the conclusions therefore was that the national circumstances in terms of feeding and agricultural practices would not be represented adequately by standardized tools. Minor issues found in the national inventory during this verification exercise (mainly affecting air emissions) have already been implemented into the 2024 submission.

Just as for NH_3 , GHG emissions from livestock were verified as well in 2024. This verification was carried out with JRC´s AgrEE Tool (JRC, 2024). For methane, the results were nearly identical to Austria´s inventory. Only a minor issue could be identified and was corrected in submission 2025. In the case of N_2O, most results show good agreement as well. In *3.B Manure Management* and cattle < 1 yr slight differences were detected. However, a further investigation of the results from the AgrEE Tool was limited as the Tool is not transparent enough to understand each calculation step.

In 2025, the results of the newest survey on agriculture practice in Austria (TIHALO III) (Pöllinger, et al., 2025) were implemented into the Austrian Agriculture model. Furthermore, the 2019 IPCC Refinement was fully implemented for all livestock related emission sources and methodological improvements of the ammonia inventory have been carried out. New inventory results, applied values and parameters were discussed and validated by the national experts and stakeholders within the framework of an so-called "inventory talk" (Umweltbundesamt, 2025c).

Source specific procedures are presented in the respective sub-chapters. A general description of Austria's QMS (Quality Management System), activities and improvements 2023 is presented in Chapter 1.5.

5.1.5 Uncertainty Assessment

The following chapter gives an estimate of uncertainties with respect to N_2O, CH_4 and CO_2 emissions from enteric fermentation, manure management, agricultural soils, field burning, liming, urea application as well as carbon-containing fertilisers. Overall uncertainties result from uncertainties in the activity data and from uncertainties in the emission factors.

Animal waste management system distribution (AWMS)

AWMS distribution is based on the following surveys: (Konrad, 1995), TIHALO I (Amon, et al., 2007a), TIHALO II (Pöllinger, et al., 2018) and TIHALO III (Pöllinger, et al., 2025). Uncertainties are estimated with ± 10%.

Country specific MCF for liquid manure systems:

MCF values have a great impact on estimation of methane emissions from manure management. Default MCF values given in the 2019 Refinement to the 2006 IPCC GL are derived from a limited number of laboratory studies and theoretical considerations. Following (IPCC 2019), the default values may have a large uncertainty for an individual country because they may not reflect the specific manure management conditions present within the country. For that reason IPCC recommends to develop country-specific MCFs that reflect the specific management systems used in particular countries or regions if possible. It is highly necessary to measure MCF values under field conditions.

At the University of Natural Resources and Applied Life Sciences a three-year measurement campaign on emissions from manure stores financed by the Federal Ministry of Agriculture, Forestry, Environment, and Water Management and the Federal Ministry for Education, Science, and Culture was carried out (Amon, et al., 2002a), (Amon, et al., 2006), (Amon, et al., 2007b). Published results have been integrated into the revised GHG inventory. The country specific MCFs reflect the agricultural practice and the climate conditions in Austria better than the default values. The uncertainty range for the country specific MCF is estimated to be ± 20% (Amon, Hörtenhuber, 2010).

Activity data and emission factors

Uncertainties were derived by analysing official Austrian livestock numbers published in June and December each year. Comparing these two data sets the standard deviation was calculated. As a conservative approach the doubled standard deviation was taken, leading to an uncertainty for cattle of 1% and for swine of 4%.

Uncertainties of emission factors for CH_4 emissions of enteric fermentation were considered 20% for cattle, swine, sheep and all other animals as all Austrian livestock categories are calculated by using a Tier 2 methodology (IPCC 2019) since submission 2025. Uncertainties of emission factors for CH_4 from manure management were assessed at 20% for livestock categories calculated with Tier 2 methodology and partly country specific parameters (cattle and swine) and 30% for all other animal categories following IPCC 2019. An uncertainty of 100% was taken for direct N_2O emissions (IPCC 2019). Uncertainty of indirect N_2O emissions from manure management was treated like indirect N_2O emissions from agricultural soils, as described in detail below.

(Winiwarter, Rypdal, 2001) noted that the largest contributor to uncertainty for several existing GHG inventories is N_2O emissions from soils. Thus it is worthwhile to consider this source in some more detail – even if no real improvement of the situation should be expected at this time. While IPCC (2000) assumes two orders of magnitude as the uncertainty margin, re-evaluation of basically the same data leads to a considerable improvement of the situation to estimated 30%–300% of the best estimate, lognormal distribution (IPCC 2006). This range is closer but still higher compared to the one estimated by (Winiwarter, Rypdal, 2001), who assumed uncertainty in a triangular distribution between 50 and 200%.

The IPCC methodology (IPCC 2006) recommends separate treatment of direct and indirect emissions. Uncertainties of emission factors of indirect emissions are not significantly different from those of direct emissions, and the underlying processes (microbial nitrification/denitrification) are identical. Thus it was decided to treat the uncertainties of direct and indirect emissions as being correlated.

Table 165 presents uncertainties for emissions as well as for activity data and the EFs of the key categories of agriculture according to the error propagation method (Tier 1).

Table 165: Uncertainties of emissions and emission factors (key categories agriculture).

Categories		**CH_4 Emissions**	**N_2O Emissions**	**CO_2 Emissions**	**EF CH_4**	**EF N_2O**	**EF CO_2**
3.A.1	Cattle	+/-20%	–	–	+/-20%	–	–
3.A.4	Other livestock	+/-20%	-	-	+/-20%	-	-
3.B.1	Cattle	+/-20%	+/- 100%	–	+/-20%	+/-100%	–
3.B.3	Swine	+/-20%	+/- 100%	-	+/-20%	+/-100%	-
3.B.4	Other livestock	+/-30%	+/- 100%	-	+/-20%	+/-100%	-
3.B.5	Indirect N2O emissions	-	+/- 200%	-	-	-	-

Categories		CH_4 Emissions	N_2O Emissions	CO_2 Emissions	EF CH_4	EF N_2O	EF CO_2
3.D.1	Direct Soil Emissions	–	+/- 200%	–	–	+/-200%	–
3.D.2	Indirect Emissions	–	+/- 200%	–	–	+/-200%	–
3.G	Liming	-	-	+/-50%	-	-	+/-50%
	Activity Data						
Animal Population – Cattle				+/- 1%			
Animal Population – Swine				+/- 4%			
Animal Population – Sheep and Other				+/- 10%			
Area Data & Fertilizer Input (combined)				+/- 5%			

5.1.6 Recalculations

Update of activity data

3.A Enteric Fermentation, 3.B Manure Management, 3.D Agricultural Soils

AWMS data – new survey 'TIHALO III'

The research project 'Animal husbandry and manure management systems in Austria' ('TIHALO I' (Amon, et al., 2007a) and 'TIHALO II' (Pöllinger, et al., 2018)) has been followed-up by a new investigation ('TIHALO III' (Pöllinger, et al., 2025)). In this project, as in its predecessors, a comprehensive survey of the agricultural practices in Austria has been carried out. The results of this study (data on livestock feeding, management systems and practices, application techniques for 2023) were used as the basis for the calculation of Austria's emission inventory in submission 2025 resulting in revisions for CH_4 and N_2O emissions in all animal related emission sources.

The most significant impact to Austria's GHG inventory was the introduction of the manure management system 'pit storage below animal confinements'. The system 'slurry separation' was also implemented as a new manure management system for cattle and swine, mainly affecting ammonia emissions.

Background data for feeding and nutrition of cattle

Due to the updated proportions of grazing for all cattle categories according to the new 'TIHALO III' study as described above, the net energy for activity was revised. The net energy for pregnancy of breeding heifers at 1-2 years of age was also recalculated, as more accurate data on the calving age and days in gestation were used for the entire time series instead of using constant values. These improvements led to revisions of the gross energy intake (GE), $N_{excretion}$ and $VS_{excretion}$ for breeding heifers at 1-2 years of age for the entire time series and for the remaining cattle categories between 2018 and 2022.

Updated feeding and nutrition for sheep, goats, horses, poultry, deer and rabbits

For the non-key livestock categories sheep, goats, horses, poultry, deer and rabbits available feeding and nutrition data was gathered and analysed. Based on that information, Tier 2 methodologies according to the 2019 IPCC Refinement were applied. Consequently, country-specific GE-intake values and updated $VS_{excretion}$ and $N_{excretion}$ values have been generated according to IPCC (2019).

Livestock data – horses and deer

For 2023 new livestock numbers for horses became available from Austria's *Green Report* (BML, 2024a). Data for the years 2018-2022 were determined by interpolation. For deer, the entire time series was revised: data from IACS (INVEKOS)[86] available from 2000 onwards was used (BML, 2024a) instead of the numbers previously used based on the farm structure surveys 2010 and 2020. IACS provides annual and more complete data for deer compared to the farm structure surveys. Animal numbers for the years 1990-1999 were determined by trend extrapolation.

Livestock data – rabbits

Rabbits were included for the first time in the inventory as a new animal category. Rabbit livestock numbers based on IACS (INVEKOS) for the years from 2000 onwards were taken as activity data (BML, 2024a). Animal numbers for the years 1990-1999 were determined by trend extrapolation. Emissions of CH_4 and N_2O from rabbits are for the first time recorded in the source categories *Enteric Fermentation* (*3.A.4.h.i.*), *Manure Management* (*3.B.4.h.i.*) and *Animal manure applied to soils (3.D.1.b.i.)*.

Biogas plants

Updated figures for biogas plants for 2018-2022 (E-CONTROL, 2024a) resulted in slightly revised CH_4 and N_2O emissions with an impact on the source categories *3.B Manure Management, 3.D.1.b.i. Animal manure applied to soils* and *3.D.1.b.iii. Other organic fertilizers applied to* soils for 2018-2022.

Other legumes

Activity data from other legumes, lupines, lentils, chickpeas and vetches were included under source category *3.D.1.d. Crop residues* for the first time.

Organic soils (i.e. histosols)

In previous submissions, organic soils were only reported in the grassland category. In 2024, a new national study on organic soils (Umweltbundesamt, 2025d) was finalized and updated activity data on organic soils became available. According to the study results, organic soils occur on both grassland and arable land. More information is included in the LULUCF chapter.

3.D.a.2.c Other organic fertilisers

Based on the updated activity data for biogas plants (see above), the N_2O emissions for the years 2018-2022 were slightly revised (+0.00003 kt N_2O for 2022).

3.D.1.e. Mineralization/immobilization associated with loss/gain of soil organic matter (N_2O)

Revisions of activity data in cropland remaining cropland categories (for more information see LULUCF chapter) resulted in revised N_2O emissions for the entire time series (+0.01 kt N_2O for 2022).

[86] Integrated Administration and Control System (IACS): tool for transparency and accountability in funding payments

Improvements of methodologies and emission factors

3.A Enteric Fermentation (CH_4)

For sheep, goats, horses, poultry, deer and rabbits, for the first time emissions were calculated based on the Tier 2 methodology according to (IPCC 2019) and country-specific EFs (equation 10.21) using updated activity and nutrition data (AWMS data, feeding and nutrition, livestock data, new emission source rabbits– see above). The improvements resulted in overall higher emission amounts for the entire time series (+1.7 kt CH_4 for 2022).

3.B Manure Management (CH_4, direct and indirect N_2O)

Methane and N_2O emissions have been revised due to the use of new and updated activity (AWMS data, feeding and nutrition, livestock data, new emissions source of rabbits, biogas - see above) and the application of the 2019 Refinement of the IPCC GL for all livestock categories. In particular, the implementation of the manure management system 'pit storage below animal confinements' resulted in higher CH_4 emissions over the entire time series.

Revisions of the ammonia inventory showed an increasing effect on emission levels of indirect N_2O emissions. The update of the total ammoniacal nitrogen (TAN) values for liquid and solid manure of cattle and swine resulting in higher ammonia emissions had the most significant impact. TAN values used in previous submissions taken from (Schechtner, 1991) were amongst the lowest in European countries. Revised values were derived from measurement data from (Pötsch, 2019) and adjusted with the N-losses provided in the German and Swiss inventories.

In total, the entire time series of 3.*B Manure Management* was revised upwards (+5.7 kt CH_4 for 2022, +0.4 kt N_2O total for 2022).

3.D Agricultural Soils (N_2O)

3.D.1.b.i Animal manure applied to soils

Due to revised methodologies and activity data used for emission calculations in categories *3.A* and *3.B* (see above) the quantities of animal manure applied to soils were revised for the entire time series. Higher ammonia emissions from manure management resulted in lower N amounts available for application on soils and thus to lower N_2O emissions for the entire time series (-0.2 kt N_2O for 2022).

3.D.1.c. Urine and dung deposited by grazing animals

Livestock related updates (livestock numbers, N excretion values) as well as new data on Austrian agricultural practices from the new TIHALO III-survey as already described before, led to recalculated N_2O emissions from grazed animals. Additionally, updated EFs from the 2019 IPCC Refinement were applied, resulting in revisions for the entire time series (-0.2 kt N_2O for 2022).

3.D.1.d. Crop residues

In addition to the updated activity data for other legumes (see above), methodological improvements were made in the calculations of cover crops. The above-ground residue dry matter value was taken from a recent national study (Erhart, et al., 2021b). The 2019 IPCC default values of grass-clover mix were used for the calculations. These improvements resulted in an overall increase in N_2O emissions for the entire time series (+0.3 kt N_2O for 2022).

3.D.1.f. Cultivation of organic soils (i.e. histosols)

In addition to the updated activity data for organic soils (see above) methodological improvements have been carried out by using the emission factors according to (Umweltbundesamt, 2025d). Detailed information is provided in the LULUCF chapter. The revisions affected the entire time series (-0.02 kt N_2O for 2022).

3.D.b Agricultural Soils (indirect soil emissions – N_2O)

Atmospheric deposition: reasons for revised estimates are the updated activity data (see above) and the improvements made within the ammonia inventory (esp. the updated TAN values for cattle and swine). Furthermore, NH_3-emissions from crop residues were calculated for the first time contributing to the indirect N_2O-Emisisons from atmospheric deposition. As a result, the indirect N_2O emissions from atmospheric deposition have been revised upwards for the entire time series (+0.1 kt N_2O for 2022).

N leaching and run-off: updated activity data and methodological improvements affected revised N amounts from animal manure applied to soils, grazing, crop residues and mineralisation resulting in revised emissions for the entire time series (+0.3 kt N_2O for 2022).

5.1.7 Completeness

Table 166 gives an overview of the IPCC categories included in this chapter and presents the transformation matrix from SNAP categories. It also provides information on the status of emission estimates of all subcategories. A "✓" indicates that emissions from this sub-category have been estimated.

Table 166: Overview of sub-categories of agriculture: transformation into SNAP codes and status of estimation.

IPCC Category		SNAP		CO_2	CH_4	N_2O
3.A	**ENTERIC FERMENTATION**	**1004**	**ENTERIC FERMENTATION**	**NA**	✓	**NA**
3.A.1	Cattle	–	–	NA	✓	NA
3.A.1.a	Dairy Cattle	100401	Dairy cows	NA	✓	NA
3.A.1.b	Non-Dairy Cattle	100402	Other cattle	NA	✓	NA
3.A.2	Sheep	100403	Ovines	NA	✓	NA
3.A.3	Swine	100404	Fattening pigs	NA	✓	NA
3.A.4	Other Livestock			NA	✓	NA
3.A.4.a	Buffalo	100414	Buffalos	NO	NO	NO
3.A.4.b	Camels	100413	Camels	NO	NO	NO
3.A.4.c	Deer	100415	Other	NA	✓	NA
3.A.4.d	Goats	100407	Goats	NA	✓	NA
3.A.4.e	Horses	100405	Horses	NA	✓	NA
3.A.4.f	Mules and asses	100406	Mules and asses	IE[1)]	IE[1)]	IE[1)]

IPCC Category		SNAP		CO_2	CH_4	N_2O
3.A.4.g	Poultry	100408 /09/10	Laying hens, broilers, other poultry	NA	✓	NA
3.A.4.h	Other (Rabbit, Reindeer, Ostrich, fur-bearing animals, Other)	100415	Other	NA	✓2)	NA
3.B.	**MANURE MANAGEMENT**	**1005**	**MANURE MANAGEMENT REGARDING ORGANIC COMPOUNDS**	**NA**	✓	**NA**
		1009	**MANURE MANAGEMENT REGARDING NITROGEN COMPOUNDS**	**NA**	**NA**	✓
3.B.1	Cattle	–	–	NA	✓	✓
3.B.1.a	Dairy Cattle	100501	Dairy cows	NA	✓	✓
3.B.1.b	Non-Dairy Cattle	100502	Other cattle	NA	✓	✓
3.B.2	Sheep	100505	Ovines	NA	✓	✓
3.B.3	Swine	100503	Fattening pigs	NA	✓	✓
3.B.4	Other Livestock	–	–	NA	✓	✓
3.B.4.a	Buffalo	100514	Buffalos	NO	NO	NO
3.B.4.b	Camels	100513	Camels	NO	NO	NO
3.B.4.c	Deer	100515	Deer	NA	✓	✓
3.B.4.d	Goats	100511	Goats	NA	✓	✓
3.B.4.e	Horses	100506	Horses	NA	✓	✓
3.B.4.f	Mules and asses	100506	Mules and asses	IE1)	IE1)	IE1)
3.B.4.g	Poultry	100507 /08/09	Laying hens, broilers, Other poultry (ducks, gooses,...)	NA	✓	✓
3.B.4.h	Other (Rabbit, Reindeer, Ostrich, fur-bearing animals, Other)	100415	Other	NA	✓2)	✓2)
3.B.5	Indirect N2O emissions			NO	NO	✓
3.C	**RICE CULTIVATION**	**100103** **100103**	**Rice Field (with fertilizers)** **Rice Field (without fertilizers)**	**NO**	**NO**	**NO**
3.D	**AGRICULTURAL SOILS**	**1001** **1002**	**Cultures with fertilizers** **Cultures without fertilizers**	**NA**	**NA**	✓
3.D.1	Direct N2O emissions from managed soils	1001/1002	Cultures with and without fertilizers	NA	NA	✓
3.D.1.a	Inorganic N fertilizers	1001	Cultures with fertilizers	NA	NA	✓
3.D.1.b	Organic N fertilizers	1001	Cultures with fertilizers	NA	NA	✓
3.D.1.b.i	Animal manure applied to soils	1001	Cultures with fertilizers	NA	NA	✓
3.D.1.b.ii	Sewage sludge applied to soils	1001	Cultures with fertilizers	NA	NA	✓
3.D.1.b.iii	Other organic fertilizers applied to soils	1001	Cultures with fertilizers	NA	NA	✓

IPCC Category		SNAP		CO_2	CH_4	N_2O
3.D.1.c	Urine and dung deposited by grazing animals	1002	Cultures without fertilizers	NA	NA	✓
3.D.1.d	Crop residues	1001	Cultures with fertilizers	NA	NA	✓
3.D.1.e	Mineralization/immobilization associated with loss/gain of soil organic matter	1002	Cultures without fertilizers	NA	NA	✓
3.D.1.f	Cultivation of organic soils (i.e. histosols)	1002	Cultures without fertilizers	NA	NA	✓
3.D.1.g	Other	–	–	NO	NO	NO
3.D.2	Indirect N2O Emissions from managed soils	1001	Cultures with fertilizers	NA	NA	✓
3.D.2.a	Atmospheric deposition	1001	Cultures with fertilizers	NA	NA	✓
3.D.2.b	Nitrogen leaching and run-off	1001	Cultures with fertilizers	NA	NA	✓
3.E	**PRESCRIBED BURNING OF SAVANNAS**	**–**	**–**	**NO**	**NO**	**NO**
3.F	**FIELD BURNING OF AGRICULTURAL RESIDUES**	**1003**	**ON-FIELD BURNING OF STUBBLE, STRAW, …**	**NA**	✓	✓
3.F.1	Cereals	100301	Cereals	NA	✓[3)]	✓[3)]
3.F.2	Pulses	100302	Pulse	NO	NO	NO
3.F.3	Tubers and Roots	100303	Tuber and Root	NO	NO	NO
3.F.4	Sugar Cane	100304	Sugar Cane	NO	NO	NO
3.G	**Liming**	**1006**	**Use of pesticides and limestone**	✓	**NA**	**NA**
3.G.1	Limestone CaCO3	1006	Use of pesticides and limestone	✓	NA	NA
3.G.2	Dolomite CaMg(CO3)2	1006	Use of pesticides and limestone	✓	NA	NA
3.H	**Urea application**	**1006**	**Use of pesticides and limestone**	✓	**NA**	**NA**
3.I	Other carbon-containing fertilisers	1006	Use of pesticides and limestone	✓	NA	NA

[1)] *included in 3.A.4.e Horses, SNAP 100406;* [2)]*included in 3.B.4.e Horses, SNAP 100506*

[2)] *The livestock category Other in 3.A.4.h and 3.B.4.h comprises rabbits*

[3)] *emissions reported for 1990–2020; for 2021, 2022 and 2023 "not occurring"*

In response to a recommendation of the UNFCCC Review 2023 (ARR 2023), Austria provides further information on mules and asses: Official statistics and farmstructure surveys do not report mules and asses separately ("horses and other solipeds"). Legal framework for these surveys at EU level is regulation (EU) 2018/1091. However, animal numbers of donkeys are only of very little importance in Austria. The Association of Austria´s "donkey friends" (IA-AUSTRIA Interessensgemeinschaft österr. Eselfreunde) estimates for Austria a donkey population of about 1 500 to 2 000 animals. This corresponds to a share of about 1% of the total number of horses and solipeds (130 000) and is far below the uncertainty of activity data (+/-10%). The reporting of IE for donkeys and considering them in the horse category is therefore a conservative approach to prevent Austria's inventory from underestimation.

5.1.8 Planned Improvements

In the course of the stakeholder meeting due to the latest inventory revision " (Umweltbundesamt, 2025c), some issues were identified that need further investigation. This concerns, for example, the inclusion of ÖPUL promotion data for solid-liquid separation, available on a yearly basis, in future inventories. Additionally, some minor issues for improvement were identified regarding feeding and nutrition for sheep, goats, layers and deer (e.g. further investigation of the lactation period for sheep and goats) to be implemented in the next inventory.

For CRT category *3.F Field burning*, there are slight differences between the 2006 IPCC GL and the 2019 Refinement (e.g. combustion factors for agricultural residues according to Table 6). It is planned, to apply the 2019 Refinement for this emission source in the next submission.

The 2019 Refinement provides disaggregated emission factors for N_2O from N inputs to agricultural soils in wet and dry climates. It is planned to identify the allocation in Austria and apply the dis-aggregated emission factors for the next submissions.

5.2 Enteric fermentation (CRT Category 3.A)

Key source: CH_4 3.A.1 Cattle, CH_4 3.A.4 Other livestock

This chapter describes the estimation of CH_4 emissions from enteric fermentation. In 2023 84.3% of agricultural CH_4 emissions arose from this category.

5.2.1 Source Category Description

CH_4 emissions amounted to 181.5 kt in 1990 and have decreased by 15.5% to 153.3 kt in 2023. Al-most all emissions of category 3.A (93.7% in 2023) are caused by cattle farming, thus CH_4 emissions from *Cattle (3.A.1)* are a key source. The contribution of *Dairy Cattle (3.A.1.a)* decreased from 53.9% in 1990 to 46.2% in 2023.

Table 167: Greenhouse gas emissions from enteric fermentation by sub-categories 1990–2023.

Year	CH4 emissions [kt] per Livestock Category									
	3.A	3.A.1.a	3.A.1.b	3.A.2	3.A.3	3.A.4.c	3.A.4.d	3.A.4.e	3.A.4.g	3.A.4.h
	Total	Dairy Cattle	Non-Dairy	Sheep	Swine	Other/ Deer	Other/ Goats	Other/ Horses	Other/ Poultry	Other/ Rabbits
1990	181.50	97.88	76.08	2.93	3.13	0.20	0.17	0.86	0.24	0.002
1995	179.68	80.38	90.84	3.46	3.00	0.24	0.25	1.26	0.24	0.002
2000	168.77	73.23	87.43	3.22	2.71	0.28	0.26	1.45	0.20	0.002
2005	158.70	65.15	85.41	3.09	2.64	0.32	0.25	1.61	0.22	0.002
2010	160.22	65.98	85.42	3.41	2.63	0.36	0.33	1.85	0.24	0.002
2011	158.10	65.63	83.65	3.44	2.55	0.36	0.33	1.90	0.24	0.002
2012	156.80	65.80	82.11	3.47	2.53	0.36	0.33	1.95	0.25	0.002

Year	CH4 emissions [kt] per Livestock Category									
	3.A	3.A.1.a	3.A.1.b	3.A.2	3.A.3	3.A.4.c	3.A.4.d	3.A.4.e	3.A.4.g	3.A.4.h
	Total	Dairy Cattle	Non-Dairy	Sheep	Swine	Other/ Deer	Other/ Goats	Other/ Horses	Other/ Poultry	Other/ Rabbits
2013	157.22	66.67	81.74	3.40	2.47	0.36	0.33	2.00	0.26	0.001
2014	157.86	67.91	81.21	3.33	2.44	0.34	0.32	2.04	0.27	0.001
2015	157.96	67.65	81.41	3.37	2.44	0.37	0.35	2.09	0.27	0.001
2016	158.51	68.99	80.29	3.61	2.40	0.37	0.38	2.18	0.28	0.001
2017	158.68	69.60	79.44	3.83	2.44	0.39	0.42	2.27	0.29	0.001
2018	156.73	68.93	78.10	3.88	2.41	0.40	0.42	2.30	0.30	0.001
2019	154.57	67.97	76.87	3.84	2.41	0.42	0.42	2.32	0.30	0.001
2020	153.55	68.49	75.35	3.76	2.43	0.43	0.42	2.35	0.31	0.001
2021	154.13	68.66	75.62	3.84	2.42	0.44	0.46	2.38	0.31	0.001
2022	154.69	71.73	73.22	3.83	2.28	0.46	0.45	2.41	0.31	0.001
2023	153.29	70.87	72.83	3.75	2.18	0.48	0.44	2.44	0.31	0.001
Share 2023	**100%**	**46.2%**	**47.5%**	**2.4%**	**1.4%**	**0.3%**	**0.3%**	**1.6%**	**0.2%**	**0.0%**
1990–2023	**-15.5%**	**-27.6%**	**-4.3%**	**27.9%**	**-30.6%**	**132.1%**	**161.4%**	**184.6%**	**30.7%**	**-64.8%**

The overall reduction is caused by a decrease in total numbers of cattle and swine. However, in the case of dairy cows the reduction of animals is partly counterbalanced by an increase in emissions per animal (because of the increasing milk yield and the connected gross energy intake since 1990).

Following a recommendation of the centralized review 2008 CH_4 emissions from *Non-Dairy Cattle* are reported separately:

Table 168: Greenhouse gas emissions from non-dairy cattle (3.A.1.b) by sub-categories 1990–2023.

Year	CH_4 emissions [kt] of Non-Dairy Cattle (3.A.1.b) sub-categories					
	3.A.1.b Total	Suckling Cows > 2 yr	Young Cattle < 1 yr	Breeding Heifers 1–2 yr	Fattening Heifers 1–2 yr	Other Cattle > 2 yr
1990	76.08	4.65	19.96	18.33	22.51	10.63
1995	90.84	21.23	17.66	18.98	21.94	11.03
2000	87.43	26.11	16.35	17.41	16.09	11.47
2005	85.41	28.55	15.61	16.18	14.97	10.09
2010	85.42	27.79	15.79	13.25	18.44	10.14
2011	83.65	27.40	15.52	13.05	17.72	9.96
2012	82.11	26.58	15.68	13.14	17.27	9.44
2013	81.74	25.34	15.69	13.61	17.67	9.42
2014	81.21	24.67	15.79	13.67	17.56	9.53
2015	81.41	24.12	15.67	13.94	17.82	9.86
2016	80.29	23.35	15.91	13.83	17.46	9.75

Year	CH_4 emissions [kt] of Non-Dairy Cattle (3.A.1.b) sub-categories					
	3.A.1.b Total	Suckling Cows > 2 yr	Young Cattle < 1 yr	Breeding Heifers 1–2 yr	Fattening Heifers 1–2 yr	Other Cattle > 2 yr
2017	79.44	22.30	15.74	13.72	18.11	9.58
2018	78.10	21.60	15.61	13.64	17.51	9.73
2019	76.87	21.07	15.29	13.32	17.79	9.40
2020	75.35	20.58	15.14	13.06	17.25	9.32
2021	75.62	20.06	15.51	13.14	17.69	9.22
2022	73.22	17.04	15.40	14.57	16.99	9.22
2023	72.83	16.93	14.92	14.57	16.74	9.67
Share 2023	**100%**	**23%**	**20%**	**20%**	**23%**	**13%**
1990–2023	**-4.3%**	**264.3%**	**-25.2%**	**-20.5%**	**-25.6%**	**-9.1%**

The rise in suckling cow numbers (see Table 169) partly counterbalances the decreasing emission trend of all the other non-dairy cattle sub-categories. These sub-categories include both, female cattle and bulls.

5.2.2 Methodological Issues

The IPCC Tier 2 method was applied for all livestock categories. The 2019 IPCC Guidelines however do not provide methodologies for the categories poultry and rabbits.

For the detailed calculation of CH_4 emissions from poultry, horses and rabbits parameters and factors such as methane conversion rates or GE-intakes were taken from the Swiss inventory (FOEN, 2024). Agricultural practices in Switzerland are very similar to those in Austria: Both countries have a small structured agriculture due to similar alpine conditions and comparable traditions. In both countries high shares of farms manage less than 20 ha (in Austria 55% and in Switzerland about 56%).

Activity data

The Austrian official statistics (Statistik Austria, 2024a) provides national data of annual livestock numbers on a very detailed level. These data are based on livestock counts held in December each year[87].

Table 169 and Table 170 presents applied animal data. Background information is listed below:

From 1990 onwards: The continuous decline of dairy cattle numbers is connected with the increasing milk yield per cow: For the production of milk according to Austria's milk quota every year a smaller number of cows is needed.

[87] For cattle livestock counts are also held in June, but seasonal changes are very small (between 0% and 2%). Livestock counts of sheep are only held in December (sheep is only a minor source for Austria and seasonal changes of the population are not considered relevant).

1991: A minimum counting threshold for poultry was introduced. Farms with less than 11 poultry were not considered any more. However, the contribution of these small farms is negligible, both with respect to the total poultry number and to the trend. The increase of the soliped population between 1990 and 1991 is caused by a better data collection from riding clubs and horse breeding farms.

1993: New characteristics for swine and cattle categories were introduced in accordance with Austria's entry into the European Economic Area and the EU guidelines for farm animal population categories. In 1993 part of the "Young cattle < 1 yr" category was included in the "Young cattle 1–2 yr" category. This shift is considered to be insignificant: no inconsistency in the emission trend of "Non-Dairy Cattle" category was recorded.
In the same year "Young swine < 50 kg" were shifted to "Fattening pigs > 50 kg" (before 1993 the limits were 6 months and not 50 kg which led to the shift) causing distinct inconsistencies in time series. Following a recommendation of the Centralized Review 2003, the age class split for swine categories of the years 1990–1992 was adjusted using the split from 1993.

1993: For the first time other animals e.g. deer (but not wild living animals) were counted. Following the recommendations of the Centralized Review 2004, to ensure consistency and completeness animal number of 1993 was used for the years 1990 to 1992.

1995: The financial support of suckling cow husbandry increased significantly in 1995 when Austria became a Member State of the European Union. The husbandry of suckling cows is used for the production of veal and beef; the milk yield of the cow is only provided for the suckling calves. Especially in mountainous regions with unfavourable farming conditions, suckling cow husbandry allows an extensive and economic reasonable utilisation of the pastures. Suckling cow husbandry contributes to the conservation of the traditional Austrian alpine landscape.

1996–1998: The market situation affected a decrease in veal and beef production, resulting in a declining suckling cow husbandry. Farmers partly used their former suckling cows for milk production. Thus, dairy cow numbers slightly increased at this time. Reasons are manifold: Changing market prices, BSE epidemic in Europe and change of consumer behaviour, milk quota etc.

1998–2000; 2006–2008: increasing/decreasing swine numbers: The production of swine has a high elasticity to prices: Swine numbers are changing due to changing market prices very rapidly. Market prices change due to changes in consumer behaviour, saturation of swine production, epidemics etc.

Table 169: Domestic livestock population and its trend 1990–2023 (I).

Year	Population size [heads] * Livestock category						
	Dairy	**Non-Dairy**	**Suckling Cows**	**Young Cattle < 1 yr**	**Breeding Heifers 1–2 yr**	**Fattening Heifers, Bulls, Oxen 1–2 yr**	**Other Cattle > 2 yr**
1990	904 617	1 679 297	47 020	925 162	254 883	305 920	146 312
1995	706 494	1 619 331	210 479	691 454	266 108	298 244	153 046

Year	Population size [heads] * Livestock category						
	Dairy	Non-Dairy	Suckling Cows	Young Cattle < 1 yr	Breeding Heifers 1–2 yr	Fattening Heifers, Bulls, Oxen 1–2 yr	Other Cattle > 2 yr
2000	621 002	1 534 445	252 792	655 368	246 382	220 102	159 801
2005	534 417	1 476 263	270 465	628 426	229 874	206 429	141 069
2010	532 735	1 480 546	260 883	634 052	187 386	256 266	141 959
2011	527 393	1 449 134	256 831	623 364	184 160	245 770	139 009
2012	523 369	1 432 249	248 438	628 715	184 932	238 968	131 196
2013	529 560	1 428 722	236 655	626 970	191 002	243 546	130 549
2014	537 744	1 423 457	229 986	629 401	191 049	241 408	131 613
2015	534 098	1 423 512	224 348	624 483	194 493	244 588	135 600
2016	539 867	1 414 524	216 678	632 150	192 455	239 588	133 653
2017	543 421	1 400 055	207 007	623 517	190 364	248 227	130 940
2018	532 873	1 379 935	200 475	618 218	188 698	239 685	132 859
2019	524 068	1 355 452	195 480	605 322	183 402	243 023	128 225
2020	524 783	1 330 649	190 685	598 598	179 120	235 277	126 969
2021	526 461	1 343 639	185 692	611 007	180 083	240 992	125 865
2022	550 554	1 310 517	157 811	596 990	199 330	230 800	125 586
2023	543 032	1 292 437	156 746	577 237	199 236	227 319	131 899
Trend 90–23	**-40.0%**	**-23.0%**	**233.4%**	**-37.6%**	**-21.8%**	**-25.7%**	**-9.9%**

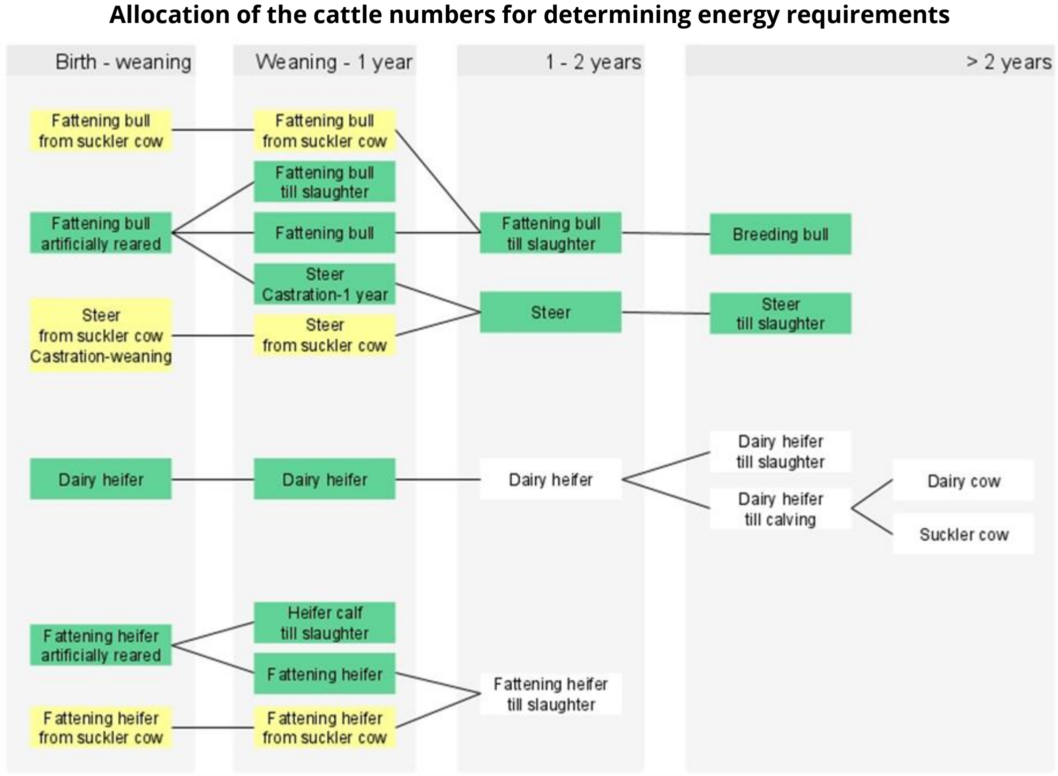
The FAO agricultural data base (FAOSTAT) provides worldwide harmonized data (FAO AGR. STATISTICAL SYSTEM 2001). In the case of Austria, these data come from the national statistical system (Statistik Austria). However, there are inconsistencies between these two data sets. Analysis shows that there is often a time gap of one year between the two data sets. FAOSTAT data are seemingly based on the official Statistik Austria data but there is an annual attribution error. In the Austrian inventory Statistik Austria data is used, they are the best available.

Cattle numbers decreased by 1.4 % in 2023 compared to the year before (both, dairy cows and other cattle: - 1.4 %). According to the Green Report 2024 (BML, 2024a) the reason for this decline is the ongoing structural change; the number of cattle farms also decreased by 2.2 % compared to 2022.

Splitting of cattle categories for background calculations

In order to be able to take more precise feeding assumptions and energy requirement calculations into account, the livestock categories "cattle <1 year", "cattle 1–2 years, breeding animals", "cattle 1–2 years, fattening animals", "dairy cows", "suckling cows" and "other cattle > 2 years" were further subdivided. For this subdivision additional data from AgrarMarkt Austria (AMA) were used. However, the numbers of animals per superordinate category (see Table 169) based on (Statistik Austria, 2024a) were not changed.

Figure 30: Allocation of the cattle numbers for determining energy requirements.



Source: Umweltbundesamt umweltbundesamt

Reallocation of swine categories

The number of pigs was reclassified to allow a more accurate calculation of energy requirements by dividing them into three categories: "breeding sows (including suckling piglets up to 8 kg live weight) and boars", "piglets 8 to 32 kg live weight" and "fattening pigs" (see Table 170).

Breeding sows and boars

The livestock numbers of category "breeding pigs over 50 kg", taken from livestock census data of Statistics Austria, also include gilts above 50 kg until first insemination, which make up approximately 19% of this category. In terms of feed intake and nutrient excretion they correspond more to category "fattening pigs" and have therefore been assigned to that category. Breeding boars, which comprise just about 2% of "breeding pigs (over 50 kg)" were calculated similarly as sows in terms of feed intake and excretions.

Piglets 8 to 32 kg

In the official Austrian livestock census, piglets between 8 and 32 kg live weight are divided into the categories "up to 20 kg" and "young pigs 20–50 kg". The number of piglets 8 to 32 kg used for emission calculations was determined on the basis of rearing days and body weight.

Fattening pigs

As the category "fattening pigs above 32 kg to the end of fattening" is not provided in the livestock census, it had to be derived from the categories "piglets 20–50 kg" and "pigs 50 kg to end of fattening". In addition, the category "gilts above 50 kg before first insemination" was added, since these were subtracted from the breeding sows category.

The total number of pigs according to Statistics Austria (Statistik Austria, 2024a) exceeds the total number of pigs used in the inventory calculations as they do not consider litters <8kg. This can be explained by the emission factors of breeding sows which already take into account the emissions of suckling piglets up to 8 kg live weight. The Austrian swine numbers are presented in the following table:

Table 170: Domestic livestock population and its trend 1990–2023 (II).

Year	**Livestock category – Population size [heads]***										
	Total Swine (including litter <8kg)**	**Total Swine (excluding litter <8kg)**	**Young & Fattening Pigs incl. gilts**	**Breeding Sows without replacement gilts**	**Young Swine 8-32 kg**	**litter <8kg[4)]**	**Sheep**	**Goats**	**Horses[1)]**	**Deer[2)]**	**Rabbits[3)]**
1990	3 687 981	3 470 006	2 002 846	374 956	1 092 204	217 975	309 912	37 343	49 200	21 762	49 385
1995	3 706 185	3 262 871	1 878 195	368 616	1 016 060	443 314	365 250	54 228	72 491	25 656	45 064
2000	3 347 931	2 948 771	1 723 098	307 020	918 653	399 160	339 238	56 105	82 943	29 507	33 434
2005	3 169 541	2 812 822	1 694 649	287 570	830 604	356 719	325 728	55 100	92 560	34 038	33 853
2010	3 134 156	2 776 522	1 696 999	261 410	818 113	357 634	358 415	71 768	106 280	37 715	33 485
2011	3 004 907	2 669 093	1 643 448	249 725	775 920	335 814	361 183	72 358	109 024	37 865	33 488
2012	2 983 158	2 646 917	1 635 956	239 999	770 962	336 241	364 645	73 212	111 768	38 335	32 202
2013	2 895 841	2 575 599	1 594 771	231 750	749 078	320 242	357 440	72 068	114 512	37 843	31 676
2014	2 868 191	2 544 151	1 577 174	224 983	741 994	324 040	349 087	70 705	117 256	36 283	31 643
2015	2 845 451	2 525 795	1 572 529	225 158	728 108	319 656	353 710	76 620	120 000	39 471	25 922
2016	2 792 803	2 483 812	1 549 287	218 773	715 751	308 991	378 381	82 735	125 000	39 743	27 383
2017	2 820 082	2 507 701	1 570 251	221 197	716 252	312 381	401 480	91 134	130 000	41 673	26 425
2018	2 776 574	2 471 234	1 562 976	210 675	697 584	305 340	406 336	91 536	131 667	42 508	25 778
2019	2 773 225	2 468 737	1 557 498	211 058	700 181	304 488	402 658	92 504	133 333	44 650	23 857
2020	2 806 461	2 495 809	1 571 571	208 364	715 874	310 652	393 764	92 758	135 000	45 779	21 982
2021	2 785 587	2 479 172	1 568 407	205 556	705 209	306 415	402 345	100 601	136 667	47 130	20 769
2022	2 650 151	2 352 717	1 489 800	191 188	671 729	297 434	400 664	99 019	138 333	48 866	18 887
2023	2 516 455	2 233 290	1 409 940	186 584	636 766	283 165	391 868	96 941	140 000	50 502	17 402
Trend 90–23	**-31.8%**	**-35.6%**	**-29.6%**	**-50.2%**	**-41.7%**	**29.9%**	**26.4%**	**159.6%**	**184.6%**	**132.1%**	**-64.8%**

** from 1990 to 1992 adjusted age class split for swine as recommended in the centralized review (October 2003)*
*** total number of Swine according to (Statistik Austria, 2024a) and published in (BML, 2024a)*
1) for the years 2000–2002, 2004–2014, 2016 and 2018–2022: interpolated values
2) 1990-1999: trend extrapolation; data from 2000 based on Integrated Administration and Control System (IACS) published in (BML, 2024a)
3) 1990-1999: trend extrapolation; data from 2000 based on Integrated Administration and Control System (IACS) published in (BML, 2024a)
4) not applied because already considered in the emission factors of breeding sows

Swine, goat and sheep numbers decreased in 2023 compared to 2022 (−5.0%, −2.2% and −2.1%, respectively).

Horse numbers since 2015 are annually published in the Ministry of Agriculture's Green Reports in (BML, 2024a), p. 53) and based on an estimate by the Austrian Horse Breeding Association which includes both agricultural and leisure horses. The years 2016 and 2018-2022 were interpolated. Horse numbers used for the years before 2004 are based on livestock accountings and are assessed to be representative for Austria. Data for the years 2004 to 2014 were derived by interpolation.

Table 171: Domestic livestock population and its trend 1990–2023 (III).

Year	**Livestock category – Population size [heads]***					
	Total Poultry	**Chicken***	**Laying hens***	**Broilers***	**Turkeys****	**Other Poultry****
1990	13 820 961	13 139 151	8 392 369	4 746 782	524 616	157 194
1995	13 959 316	13 157 078	7 899 011	5 258 067	679 477	122 761
2000	11 786 670	11 077 343	6 555 815	4 521 528	588 522	120 805
2005	13 489 222	12 801 345	6 678 696	6 122 650	568 854	119 022
2010	14 644 413	13 918 813	7 061 377	6 857 436	615 813	109 787
2011	15 020 126	14 305 565	7 373 407	6 932 158	610 708	103 853
2012	15 395 838	14 692 317	7 685 438	7 006 879	605 602	97 919
2013	15 771 551	15 079 069	7 997 468	7 081 601	600 497	91 985
2014	16 334 620	15 634 432	8 356 808	7 277 624	597 071	103 117
2015	16 897 690	16 189 796	8 716 148	7 473 648	593 645	114 249
2016	17 460 759	16 745 159	9 075 488	7 669 671	590 219	125 381
2017	18 033 026	17 309 548	9 190 513	8 119 035	584 503	138 975
2018	18 605 292	17 873 937	9 305 538	8 568 399	578 787	152 569
2019	19 177 559	18 438 326	9 420 563	9 017 763	573 070	166 162
2020	19 749 825	19 002 715	9 535 588	9 467 127	567 354	179 756
2021	19 749 825	19 002 715	9 535 588	9 467 127	567 354	179 756
2022	19 749 825	19 002 715	9 535 588	9 467 127	567 354	179 756
2023	19 749 825	19 002 715	9 535 588	9 467 127	567 354	179 756
Trend 90–23	**42.9%**	**44.6%**	**13.6%**	**99.4%**	**8.1%**	**14.4%**

* *interpolated values for the years 2004–2009, 2011–2012, 2014–2015 and 2017–2019*

** *value for 1999 is not available – value derived from the average share of previous and following 5 years of total other poultry; interpolated values for the years 2004–2009, 2011–2012, 2014–2015 and 2017–2019*

Animal numbers of poultry, deer and rabbits are not included in the livestock counts held in December each year but gathered within Austria's farm structure surveys carried out as complete surveys every 10 years. The latest farm structure survey was carried out in 2020. Livestock data for poultry (layers, broilers, turkeys and other poultry was included on the basis of the final results of the 2020 survey (Statistik Austria, 2022a). The 2020 figures were taken for the years 2021, 2022 and 2023.

For deer and rabbits, the livestock numbers used in the inventory are based on the IACS (Integrated Administration and Control System[88]) published in (BML, 2024a). IACS provides annual and more complete data for deer compared to the farm structure surveys. Animal numbers for the years 1990-1999 were determined by trend extrapolation. For rabbits, the IACS data is also considered as the best data source.

5.2.2.1 Cattle (3.A.1)

Key Source: Yes (CH_4)

CH_4 emissions from enteric fermentation – cattle (sum of dairy and non-dairy cattle) are a key source due to the contribution to total greenhouse gas emissions in Austria and also due to its contribution to the total inventory's trend. In the year 2023, emissions from enteric fermentation – cattle contributed 5.9% to total greenhouse gas emissions in Austria.

CH_4 emissions were calculated using the IPCC Tier 2 methodology and country-specific values. In submission 2022, the study results of the research project "MiNutE" (Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023) carried out by the University of Natural Resources and Life Sciences, Vienna, have been implemented. Within the framework of this country specific study refined calculations for cattle and swine were elaborated establishing a dynamic use of national parameters on the basis of latest available science. Activity data were obtained from national statistics and are presented in Table 169 and Table 170.

Emission factors

Country specific emission factors were used. They were calculated from the specific gross energy intake and the methane conversion factor (2019 Refinement to the 2006 IPCC GL, Equation 10.21).

$$EF = \frac{GE * (\frac{Ym}{100}) * 365}{55.65}$$

EF = emission factor, kg CH_4 head^{-1} yr^{-1} *GE= gross energy intake, MJ head^{-1} day^{-1}*
Y_m = Methane conversion factor, per cent of gross energy in feed converted to methane
The factor 55.56 (MJ/kg CH_4) is the energy content of methane

Table 172: Methane conversion factors (Y_m) 1990–2023 for cattle categories in Austria.

Year	**Methane conversion factor (Y_m)**					
	Dairy cows	**Suckling cows**	**Breeding heifers 1–2 years**	**Fattening heifers 1–2 years**	**Cattle <1 year**	**Cattle >2 years**
1990	6.50	6.50	6.30	6.30	4.34	6.30
1995	6.47	6.50	6.30	6.30	4.68	6.30
2000	6.43	6.50	6.30	6.30	4.58	6.30
2005	6.40	6.50	6.30	6.30	4.51	6.30

[88] Integrated Administration and Control System (IACS): tool for transparency and accountability in funding payments

Year	Methane conversion factor (Y_m)					
	Dairy cows	**Suckling cows**	**Breeding heifers 1–2 years**	**Fattening heifers 1–2 years**	**Cattle <1 year**	**Cattle >2 years**
2010	6.36	6.50	6.30	6.30	4.38	6.30
2011	6.36	6.50	6.30	6.30	4.36	6.30
2012	6.35	6.50	6.30	6.30	4.36	6.30
2013	6.34	6.50	6.30	6.30	4.37	6.30
2014	6.33	6.50	6.30	6.30	4.37	6.30
2015	6.33	6.50	6.30	6.30	4.36	6.30
2016	6.32	6.50	6.30	6.30	4.35	6.30
2017	6.31	6.50	6.30	6.30	4.35	6.30
2018	6.31	6.50	6.30	6.30	4.34	6.30
2019	6.30	6.50	6.30	6.30	4.32	6.30
2020	6.30	6.50	6.30	6.30	4.31	6.30
2021	6.30	6.50	6.30	6.30	4.32	6.30
2022	6.30	6.50	6.30	6.30	4.41	6.30
2023	6.30	6.50	6.30	6.30	4.42	6.30

As explained in Chapter 5.2.2, the feeding assumptions and energy demand calculations were developed on the basis of a very detailed analysis of the Austrian livestock population (see Figure 30). These detailed considerations elaborated in (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023) made it necessary to proceed on the basis of the latest available scientific literature. For emission calculation Austria therefore uses the most updated information on methane conversion factors (Y_m) provided in the 2019 Refinement to the 2006 IPCC GL, Table 10.12.

Methane conversion factor (Y_m) dairy cows

For 2023, a methane conversion factor for "medium producing cows" of 6.3 was applied based on the annual milk yield of 7 287 kg and feed digestibility of 71.7% of Austrian dairy cows. For 1990, a methane conversion factor for low producing cows of 6.5 was taken based on the annual milk yield of 3 791 kg of Austrian dairy cows and considerations on feed digestibility.

The average methane conversion factor for all the other non-dairy cattle categories resulted in a value of 5.48 for 2023.

Methane conversion factor (Y_m) suckling cows

A methane conversion factor for "low producing cows" of 6.5 was applied. Despite higher feed digestibility of the average feed ration of Austrian suckler cows, suckling cows can be counted as low producing cows due to their low milk yield.

Methane conversion factor (Y_m) breeding and fattening cattle

A methane conversion factor of 0 was applied for unweaned calves fed mainly with milk. For all other categories of breeding and fattening cattle, a methane conversion factor of 6.3 was taken. This value is recommended for cattle feed rations consisting of more than 75% high quality forage, mixed rations and for a feed digestibility of 62-71%. Although the average feed digestibility of breeding and fattening cattle in Austria is higher, the proportion of high-quality basic feed is mostly 75% or higher.

For the Gross Energy Intake country specific values were applied. The estimation was made separately for all cattle categories.

Gross energy intake of dairy cows (3.A.1.a):

In previous submissions the Austrian specific values for dairy cows were derived from (Gruber, Steinwidder, 1996), (Pötsch, et al.) and (Gruber, Pötsch, 2006). Calculations on gross energy intake used since submission 2022 were elaborated within a country-specific study on animal feeding and nutrition ("MiNutE" study, (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023).

Gross energy intake of dairy cattle is calculated using equation 10.16 taken from the 2019 Refinement to the 2006 IPCC GL, which is derived based on the summed net energy requirements and the energy availability characteristics of the feed.

The following information has been used for feed intake estimates:

Body mass

Data on body mass form the basis for the calculation of the maintenance net energy. The body mass of the most common breeds Fleckvieh, Braunvieh and Holstein for the years from 2016 onwards were derived from the Efficient Cow project (Egger-Danner, et al., 2016). In this project, body mass was assessed as part of the dairy performance tests. Data from cows in or after their first lactation were used. The cows' weight was evaluated repeatedly (46 896 weight assessments in total) and increases with rising milk yield.

Animal husbandry

The parameters of animal husbandry are used to calculate the net energy for activity. This depends on how much time the animals spend in the barn, on the pasture or on the mountain pasture. The proportion of grazed cows was derived from country specific studies "TIHALO I, II and III" and weighted with the average number of grazing hours per day and the number of grazing days per year (Amon, et al., 2007a); (Pöllinger, et al., 2018); (Pöllinger, et al., 2025). For the proportion of dairy cows on pasture in 1990 an expert estimate by Alfred Pöllinger was used. Data for the years between 1990, 2005, 2017 and 2023 were interpolated.

Milk yield

The milk yield and the fat content of the milk are needed for the calculation of net energy for lactation. The protein content of the milk is used in the calculation of N retention. Austrian dairy cattle show average milk yields from 3 791 kg/cow (1990) to 7 287 kg/cow (2023). The time series of average milk yields per dairy cow was taken from national statistics and are presented in Table 174. Data on the average fat content and protein content of milk were derived from information provided by AgrarMarkt Austria (AMA).

Gestation

The proportion of animals that experience gestation in a year is used to calculate the net energy for gestation. The percentage of gestating cows is calculated by dividing 365 days by the days between calvings. For the years 2007–2023, the days between two subsequent calvings were calculated per breed and weighted accordingly, based on the data of the annual breeding data reports (Zucht-Data, 2023). For small-framed breeds, the calving interval of Grauvieh was used, for medium- and large-framed breeds the calving interval of Pinzgauer was used. In 2022, Fleckvieh cows had a calving interval of 390 days, Brown Swiss of 420 days, Holstein of 412 days, Grauvieh of 406 days and Pinzgauer of 400 days. For 2023 the figures of 2022 have been taken.

Feeding

The average crude protein content in dry matter and the proportion of crude ash in dry matter were derived from the Efficient Cow project (Egger-Danner, et al., 2016) for the years 2016–2019. The value for 2002 is based on the mean value of two national studies (Steinwidder, Guggenberger, 2003); (Gruber, Steinwender, 1992). The years in between were derived by interpolation. The average feed digestibility in Austria for dairy cows was estimated by nutrition expert Dr. Erich Pötsch (2005) based on model calculations from (Gruber, Steinwidder, 1996) on feed intake, performance and excretion. Feed digestibility is expressed as a percentage and adjusted to the level of the annual milk yield.

Table 173: Parameters for calculating GE intake for dairy cattle in Austria 1990–2023.

Year	net energy for maintenance	net energy for animal activity	net energy for lactation	net energy for work	net energy for pregnancy	ratio net energy for maintenance to digestible energy	digestibility of feed
	MJ day^{-1}	MJ day^{-1}	MJ day^{-1}	MJ day^{-1}	MJ day^{-1}		%
1990	49.88	1.03	31.97	0.00	4.63	0.52	66.48
1995	50.14	0.86	39.25	0.00	4.65	0.52	67.70
2000	50.70	0.69	44.56	0.00	4.69	0.52	68.58
2005	51.22	0.52	49.91	0.00	4.73	0.53	69.43
2010	51.74	0.51	52.64	0.00	4.78	0.53	69.89
2011	51.82	0.50	53.60	0.00	4.78	0.53	70.08
2012	51.89	0.50	55.39	0.00	4.80	0.53	70.37
2013	52.00	0.49	55.68	0.00	4.81	0.53	70.43
2014	52.10	0.49	56.31	0.00	4.82	0.53	70.55
2015	52.18	0.49	56.78	0.00	4.86	0.53	70.60
2016	52.28	0.48	58.41	0.00	4.86	0.53	70.87
2017	52.26	0.48	59.17	0.00	4.86	0.53	71.03
2018	52.24	0.52	61.23	0.00	4.86	0.53	71.38
2019	52.19	0.57	61.96	0.00	4.83	0.53	71.49
2020	52.18	0.61	63.04	0.00	4.82	0.53	71.65
2021	52.17	0.66	62.80	0.00	4.81	0.53	71.59
2022	52.14	0.70	62.65	0.00	4.83	0.53	71.60
2023	52.11	0.74	62.97	0.00	4.82	0.53	71.65

For dairy cattle there was a 24.4% increase of GE intake between 1990 and 2023 mainly due to an increase of the milk yield per dairy cow in this time (lactation performance). The resulting emission factor is presented in the following table:

Table 174: Annual milk yield, gross energy intake and CH_4 emission factors of dairy cattle 1990–2023.

Year	Average live body weight	Milk Yield	Gross Energy Intake	Emission Factor
	kg	[kg/cow*yr]	[MJ/head*day]	[kg CH_4/head*yr]
1990	676	3 791	253.8	108.20
1995	681	4 619	268.3	113.78
2000	691	5 210	279.6	117.92
2005	700	5 783	290.6	121.92
2010	710	6 100	296.8	123.86
2011	711	6 227	298.6	124.44
2012	713	6 418	302.0	125.73
2013	715	6 460	302.7	125.89
2014	716	6 542	304.0	126.29
2015	718	6 579	305.2	126.66
2016	720	6 759	308.2	127.79
2017	719	6 865	309.3	128.08
2018	719	7 104	312.7	129.36
2019	718	7 179	313.9	129.71
2020	718	7 286	315.9	130.51
2021	718	7 249	315.6	130.41
2022	717	7 250	315.3	130.28
2023	717	7 287	315.8	130.51

1) *From 1995 onwards data have been revised by Statistik Austria.*

Up to the early 1990ies Austrian dairy husbandry was determined by traditional Austrian green feeding and traditional Austrian breeds. From the mid 1990ies onwards milk production has been intensified: diets with higher energy concentration were fed and the share of high yield breeds (e.g. Holstein Friesian) in dairy farming was increased. Anyhow, the traditional Austrian breed "Fleckvieh" (about 700 kg live weight) still dominates the herd.

GE Gross energy intake of non-dairy cattle (3.A.1.b)

Suckling cows

In the framework of the national study on country-specific animal feeding and nutrition ("MiNutE" study, (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023) the gross energy intake was calculated by applying equation 10.16 taken from the 2019 Refinement to the 2006 IPCC GL (IPCC 2019). The parameters for calculating GE intake for suckling cows are provided in Table 175.

Body mass

A comparison of the body mass of suckling cows and dairy cows showed that suckling cows have about 50 kg less body mass than dairy cows (Gruber, et al., 2001, Gruber, et al., 2015, Häusler, et al., 2015)

Animal husbandry

Similar to the dairy cows, the proportion of grazed suckling cows was derived from the TIHALO studies (Amon, et al., 2007a); (Pöllinger, et al., 2018), (Pöllinger, et al., 2025) and from expert judgement (Pöllinger, 2008) for the year 1990. The proportion of suckling cows was weighted with the grazing time and the grazing days per year. Data for the years between 1990, 2005, 2017 and 2023 were interpolated.

Milk yield

The husbandry of suckling cows is used for the production of veal and beef. The milk yield of the cow is only provided for the suckling calves. A new born calve has around 40 kg and suckles until it weighs about 350 kg. As a rule of thumb under the national circumstances in Austria 10 kg milk are needed for 1 kg gain in weight for a calve.

The study „Mutterkuh und Ochsenhaltung 2003" in which 56 holdings in Styria, Lower Austria, Carinthia and Salzburg were investigated, reports daily rates of weight increases of 1 020 g (2002) and 1 060 g (2003). Calves were suckled about 300 days (Grabner, et al., 2004). An experiment based on measurements made from 1978 to 1987 (Steinwender, Gold, 1989) shows similar results: The daily increase of weight of young bulls was 1 225 g and of young cows 1 044 g.

Thus, for 1990 in the Austrian Greenhouse Gas Emission Inventory an average milk yield of 3 000 kg was applied (see Table 176).

In a study with Austrian suckling cows (Simmental) carried out from 2004 to 008, the influence of duration of suckling period (180 days and 270 days) on milk yield and body weight of cows and weight gain of calves was determined (Steinwidder, et al., 2006). Cows were fed with forage of low quality. Anyhow, the average milk yield per suckling period was on a high level: For 6 months of suckling an average milk yield of 2 245 kg, and for 9 month of suckling an average milk yield of 3 351 kg per cow has been measured (Häusler, 2009). The daily gains of the beef cattle (Simmental x Limousin steers and heifers) were 1.27 and 1.28 kg for the 180 or 270 days of suckling, respectively.

In consideration of the low forage quality identified in the study mentioned above, the suckling periods of up to 300 days and a calculated demand of 3 500 kg milk per calve, an average milk yield of 3 500 kg has been assumed for the years from 2004 onwards. Values between 1990 and 2004 have been derived by interpolation (see Table 176).

Gestation

Information on the calving interval were derived from the 2012, 2014 and 2019 suckling cow and steer husbandry working group reports ("Arbeitskreisberichte" zu Mutterkühen und Ochsen).

Feeding

For the year 1990 a crude protein content of 11.9% was applied, which is the crude protein requirement for a milk yield of 3 000 kg milk per year according to (Gruber, Pötsch, 2006). Starting in 2004, a milk yield of 3 500 kg milk per year is assumed, for which a crude protein content of 12% is taken, corresponding to the feeding recommendation for suckler cows (Steinwidder, Guggenberger, 2003).

The percentage of crude ash in dry matter was derived from national studies (Steinwidder, Guggenberger, 2003); (Gruber, Pötsch, 2006) and corresponds to the values used in previous inventories. Based on these studies, a crude ash content of 11% was adopted for milk yields up to 7 000 kg. A crude ash content of 11% in DM was therefore adopted for suckling cows from 1990 to 2023.

The average feed digestibility was assessed in an expert evaluation for dairy cows by (Pötsch, et al., 2005), based on model calculations taken fromn (Gruber, Steinwidder, 1996) on feed intake, performance and excretions. The values for dairy cattle were adopted and adjusted to the level of annual milk yield for suckling cows.

Table 175: Parameters for calculating GE intake for suckling cows in Austria 1990–2023.

Year	net energy for mainte-nance	net energy for animal activity	net energy for lactation	net energy for work	net energy for pregnancy	ratio net energy for mainte-nance to digestible energy	digestibility of feed
	MJ day^{-1}	MJ day^{-1}	MJ day^{-1}	MJ day^{-1}	MJ day^{-1}		%
1990	47.09	1.19	25.30	0.00	4.36	0.51	65.31
1995	47.36	1.28	27.01	0.00	4.37	0.52	65.57
2000	47.93	1.37	28.72	0.00	4.41	0.52	65.84
2005	48.46	1.50	30.21	0.00	4.44	0.52	66.05
2010	48.99	1.70	30.21	0.00	4.47	0.52	66.05
2011	49.05	1.75	30.13	0.00	4.56	0.52	66.05
2012	49.12	1.80	30.21	0.00	4.61	0.52	66.05
2013	49.25	1.86	30.17	0.00	4.54	0.52	66.05
2014	49.34	1.90	30.13	0.00	4.57	0.52	66.05
2015	49.44	1.95	30.21	0.00	4.57	0.52	66.05
2016	49.54	2.00	30.24	0.00	4.57	0.52	66.05
2017	49.52	2.06	30.17	0.00	4.56	0.52	66.05
2018	49.51	2.12	30.17	0.00	4.55	0.52	66.05
2019	49.45	2.17	30.21	0.00	4.54	0.52	66.05
2020	49.44	2.23	30.28	0.00	4.53	0.52	66.05
2021	49.42	2.29	30.32	0.00	4.53	0.52	66.05
2022	49.40	2.34	30.24	0.00	4.53	0.52	66.05
2023	49.37	2.40	30.24	0.00	4.53	0.52	66.05

For suckling cows, net energy for maintenance accounts for the largest share of energy demand. In the following table it can be observed that the GE-intake increased over the time series which is largely influenced by rising net energy for maintenance and lactation.

Table 176: Annual milk yield, gross energy intake and CH_4 emission factors of suckling cows 1990–2023.

Year	Average live body weight	Milk Yield	Gross Energy Intake	Emission Factor
	kg	[kg/cow*yr]	[MJ/head*day]	[kg CH_4/head*yr]
1990	626	3 000	231.81	98.83
1995	631	3 179	236.61	100.87
2000	641	3 357	242.31	103.30
2005	650	3 500	247.64	105.57
2010	660	3 500	249.87	106.52
2011	661	3 500	250.20	106.67
2012	663	3 500	250.92	106.97
2013	665	3 500	251.18	107.09
2014	666	3 500	251.56	107.25
2015	668	3 500	252.20	107.52
2016	670	3 500	252.76	107.76
2017	669	3 500	252.63	107.70
2018	669	3 500	252.71	107.74
2019	668	3 500	252.79	107.77
2020	668	3 500	253.13	107.92
2021	668	3 500	253.37	108.02
2022	667	3 500	253.24	107.96
2023	667	3 500	253.30	107.99

Other non-dairy cattle categories:

As for dairy and suckling cows, the gross energy intake for all other cattle categories were calculated using equation 10.16 taken from the 2019 Refinement to the 2006 IPCC GL. The other non-dairy cattle categories were further subdivided (see Figure 30) within the national study on feeding and nutrition in order to be able to take more precise feeding assumptions and energy requirement calculations. Detailed information on the parameters used for the calculations and the relevant country-specific background data on weight, growth, husbandry and feeding is extensively described for the different cattle categories in (Hörtenhuber, et al., 2022a).

As a result of the updated information from the study on animal feeding and nutrition ("MiNutE" study, (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023) and the application of the 2019 IPCC Refinements, a dynamic time series could be generated. In previous submissions emissions from enteric fermentation of Non-Dairy Cattle were calculated with a constant gross energy intake for the whole time series.

In the following tables the GE intakes and the resulting CH_4 EF of the different other non-dairy cattle categories are indicated. For cattle < 1 year GE intake and EF are significant lower due to the unweaned calves fed mainly with milk. Dairy calves do not yet excrete relevant amounts of methane and, due to the methane conversion factor of YM = 0, have no influence on the calculation during the milk suckling and drinking phase.

Table 177: Gross energy intake of other cattle categories 1990–2023.

Year	Breeding heifers 1–2 years	Fattening heifers, bulls & oxen 1–2 years	Cattle <1 year	Cattle >2 years
	[MJ GE day^{-1}]			
1990	174.08	178.09	75.88	175.81
1995	172.66	178.00	83.20	174.42
2000	171.00	176.91	83.11	173.65
2005	170.37	175.49	84.02	173.09
2010	171.18	174.17	86.73	172.84
2011	171.52	174.45	86.99	173.46
2012	171.93	174.94	87.16	174.12
2013	172.50	175.58	87.28	174.70
2014	173.15	175.99	87.47	175.31
2015	173.48	176.28	87.77	175.92
2016	173.90	176.35	88.12	176.59
2017	174.39	176.58	88.48	177.11
2018	174.94	176.83	88.73	177.30
2019	175.74	177.14	89.15	177.47
2020	176.46	177.45	89.52	177.58
2021	176.65	177.62	89.59	177.28
2022	176.85	178.15	89.12	177.63
2023	176.96	178.26	89.21	177.34

The resulting emission factors are presented in the following table:

Table 178: CH_4 emission factors of other cattle categories 1990–2023.

Year	Breeding heifers 1–2 years	Fattening heifers, bulls & oxen 1–2 years	Cattle <1 year	Cattle >2 years
		[kg CH^4/head*yr]		
1990	71.93	73.59	21.58	72.64
1995	71.34	73.55	25.54	72.07
2000	70.66	73.10	24.94	71.76
2005	70.40	72.51	24.84	71.52
2010	70.73	71.97	24.91	71.42
2011	70.87	72.08	24.90	71.67

Year	Breeding heifers 1–2 years	Fattening heifers, bulls & oxen 1–2 years	Cattle <1 year	Cattle >2 years
		[kg CH⁴/head*yr]		
2012	71.04	72.29	24.94	71.95
2013	71.28	72.55	25.03	72.19
2014	71.55	72.72	25.08	72.44
2015	71.68	72.84	25.10	72.69
2016	71.86	72.87	25.16	72.97
2017	72.06	72.96	25.24	73.18
2018	72.29	73.07	25.25	73.26
2019	72.62	73.19	25.26	73.33
2020	72.91	73.32	25.30	73.38
2021	72.99	73.39	25.39	73.25
2022	73.07	73.61	25.80	73.40
2023	73.12	73.66	25.85	73.28

5.2.2.2 Swine (3.A.3)

Key Source: No

Methane emissions from enteric fermentation – swine contributed 1.4% to total emissions from enteric fermentation in 2023. The Tier 2 methodology according to (IPCC 2019) and country-specific values have been used.

Feeding assumptions and energy demand calculations were developed on a very detailed level elaborated in (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023). Activity data are obtained from national statistics and are presented in Table 170.

Emission factors

Country specific emission factors were used, calculated from the specific gross energy intake in line with Equation 10.21 of (IPCC 2019).

$$EF = [GE * (Y_m/100) * 365 \text{ days})/55.65]$$

EF = emission factor, kg CH_4 head^{-1} yr^{-1}
GE= gross energy intake, MJ head^{-1} day^{-1}
Y_m = Methane conversion factor, per cent of gross energy in feed converted to methane
The factor 55.56 (MJ/kg CH_4) is the energy content of methane

Methane Conversion factors taken from (Dämmgen, et al., 2012) are indicated in Table 179.

Table 179: Methane conversion factors (Y_m) for swine

Swine category	Methane conversion factor (Y_m)
Breeding sows	0.71
Fattening pigs	0.46
Piglets 8–32 kg	0.44
Swine total	**0.48 (weighted average)**

Feed intake data was derived from the country-specific study on animal feeding and nutrition ("Mi-NutE" study, (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023). Based on (Priller, 2004) typical rations for Austrian pig farming were compiled in 2020 by national nutrition experts.

Detailed information on performance indicators, feed quantities and components of feed rations as well as ingredients of the feed components are described in (Hörtenhuber, et al., 2022a).

Table 180: GE-intake and CH_4 emission factors of swine categories 1990–2023.

Year	Breeding sows		Fattening pigs		Piglets 8–32 kg	
	GE-intake	EF	GE-intake	EF	GE-intake	EF
	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]
1990	43.7	2.04	10.9	1.00	1.9	0.33
1995	44.2	2.06	10.9	1.01	1.9	0.34
2000	44.6	2.08	10.8	1.02	1.9	0.35
2005	45.1	2.10	10.8	1.03	1.9	0.36
2010	47.3	2.20	10.9	1.04	1.9	0.35
2011	47.7	2.22	10.9	1.05	1.9	0.35
2012	48.1	2.24	10.9	1.05	1.9	0.35
2013	48.6	2.26	10.9	1.05	1.9	0.35
2014	49.0	2.28	11.0	1.06	1.9	0.35
2015	49.4	2.30	11.0	1.06	1.9	0.35
2016	49.9	2.32	11.0	1.06	1.8	0.34
2017	50.3	2.34	11.0	1.07	1.8	0.34
2018	50.7	2.36	11.0	1.07	1.8	0.34
2019	51.2	2.38	11.1	1.07	1.8	0.34
2020	51.2	2.38	11.1	1.07	1.8	0.34
2021	51.2	2.38	11.1	1.07	1.8	0.34
2022	51.2	2.38	11.1	1.07	1.8	0.34
2023	51.2	2.38	11.1	1.07	1.8	0.34

5.2.2.3 Sheep (3.A.2), and Other livestock (3.A.4: Deer, Horses, Goats, Poultry and Rabbits)

Key Source: CH_4 3.A.4

As presented in Table 167, CH_4 emissions from sheep, and other livestock (poultry, horses, goats, deer and rabbits) are only minor emission sources of enteric fermentation in Austria. Together they contributed 4.8% to total emissions from this category in 2023. The most important sub-category is sheep, with a contribution of 2.4%, followed by horses (1.6%), deer and goats with each about (0.3%), poultry (0.2%) and rabbits (0.001%) (figures are also presented in Table 167).

The Tier 2 methodology according to (IPCC 2019) has been used. Feeding assumptions and energy demand calculations were elaborated and documented in (Hörtenhuber, 2025).

Emission factors

Country specific emission factors were calculated from the specific gross energy intake in line with Equation 10.21 according to (IPCC 2019).

Table 181: Methane conversion factors (Y_m) for sheep and other livestock

livestock category	Methane conversion factor (Y_m)	Data source
sheep	6.70	(IPCC 2019), Table 10.13)
deer	6.70	factor for sheep used
goats	5.50	(IPCC 2019), Table 10.13)
horses	2.45	(FOEN, 2024)
layers	0.16	(FOEN, 2024)
broilers	0.16	(FOEN, 2024)
turkeys	0.16	(FOEN, 2024)
other poultry	0.16	(FOEN, 2024)
rabbits	0.60	(FOEN, 2024)

Table 182: GE-intake and CH_4 emission factors of sheep, deer, goats and horses 1990–2023.

Year	sheep		deer		goats		horses	
	GE-intake	EF	GE-intake	EF	GE-intake	EF	GE-intake	EF
	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]
1990	21.50	9.45	21.44	9.42	12.59	4.54	108.50	17.44
1995	21.54	9.47	21.44	9.42	12.61	4.55	108.50	17.44
2000	21.58	9.48	21.44	9.42	12.62	4.55	108.50	17.44
2005	21.62	9.50	21.44	9.42	12.64	4.56	108.50	17.44
2010	21.65	9.51	21.44	9.42	12.65	4.56	108.50	17.44
2011	21.66	9.52	21.44	9.42	12.65	4.56	108.50	17.44
2012	21.67	9.52	21.44	9.42	12.65	4.57	108.50	17.44
2013	21.67	9.52	21.44	9.42	12.66	4.57	108.50	17.44

Year	sheep		deer		goats		horses	
	GE-intake	EF	GE-intake	EF	GE-intake	EF	GE-intake	EF
	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]
2014	21.68	9.53	21.44	9.42	12.66	4.57	108.50	17.44
2015	21.69	9.53	21.44	9.42	12.66	4.57	108.50	17.44
2016	21.70	9.53	21.44	9.42	12.67	4.57	108.50	17.44
2017	21.70	9.54	21.44	9.42	12.67	4.57	108.50	17.44
2018	21.71	9.54	21.44	9.42	12.67	4.57	108.50	17.44
2019	21.72	9.54	21.44	9.42	12.67	4.57	108.50	17.44
2020	21.73	9.55	21.44	9.42	12.68	4.57	108.50	17.44
2021	21.73	9.55	21.44	9.42	12.68	4.57	108.50	17.44
2022	21.74	9.55	21.44	9.42	12.68	4.57	108.50	17.44
2023	21.75	9.56	21.44	9.42	12.68	4.58	108.50	17.44

Table 183: GE-intake and CH_4 emission factors of poultry and rabbits 1990–2023.

Year	layers		broilers		turkeys		other poultry		rabbits	
	GE-intake	EF	GE-intake	EF	GE-intake	EF	GE-intake	EF	GE-intake	EF
	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]	[MJ GE day^{-1}]	[kg CH_4/head*yr]
1990	1.79	0.019	1.19	0.011	5.58	0.048	1.52	0.011	1.20	0.05
1995	1.79	0.019	1.24	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2000	1.79	0.019	1.29	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2005	1.79	0.019	1.33	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2010	1.79	0.019	1.38	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2011	1.79	0.019	1.39	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2012	1.79	0.019	1.40	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2013	1.79	0.019	1.40	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2014	1.79	0.019	1.41	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2015	1.79	0.019	1.42	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2016	1.79	0.019	1.43	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2017	1.79	0.019	1.44	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2018	1.79	0.019	1.45	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2019	1.79	0.019	1.46	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2020	1.79	0.019	1.47	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2021	1.79	0.019	1.48	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2022	1.79	0.019	1.49	0.011	5.58	0.048	1.52	0.011	1.20	0.05
2023	1.79	0.019	1.50	0.011	5.58	0.048	1.52	0.011	1.20	0.05

Detailed information on performance indicators, feed quantities, components of feed rations as well as ingredients of the feed components are documented in (Hörtenhuber, 2025). In the following, a short summary of the most important input data for the respective livestock categories is given.

Sheep

- Lactation and gestation was included for the share of female sheep
- 14% crude protein in dry matter
- Protein content of milk is taken from (Bellof, Leber, 2019), number of milk sheep is taken from (BML, 2024a) → average Austrian milk sheep: 408 kg milk/year with 5% protein content
- Average live weight before slaughter of 48.2 kg in 2022 is based on expert judgement by (Roland Taferner, Austrian Federal Association for Sheep and Goats, 2021)
- Assumption: no differences in feeding and performance over the time series
- GE-intake, $VS_{excretion}$ and $N_{excretion}$ are calculated according to IPCC 2019

Table 184: Net energy requirements and digestibility of feed for sheep.

Reference	Parameter	Unit	1990	2023
IPCC 2019, TABLE 10A.5	Average body mass	[kg average animal^{-1}]	40	40
Equation 10.3 (IPCC 2019)	Net energy requirement maintenance	[MJ NE animal^{-1} day^{-1}]	3.87	3.87
Equation 10.5 (IPCC 2019)	Net energy requirement activity	[MJ NE animal^{-1} day^{-1}]	0.43	0.51
Equation 10.7 (IPCC 2019)	Net energy requirement growth	[MJ NE animal^{-1} day^{-1}]	1.29	1.29
Equation 10.10 (IPCC 2019)	Net energy requirement lactation	[MJ NE animal^{-1} day^{-1}]	0.47	0.47
Equation 10.13 (IPCC 2019)	Net energy requirement pregnancy	[MJ NE animal^{-1} day^{-1}]	0.26	0.26
Equation 10.14 (IPCC 2019)	Ratio of net energy available in diet for maintenance to digestible energy consumed (REM)		0.51	0.51
Equation 10.15 (IPCC 2019)	Ratio of net energy available for growth in a diet to digestible energy consumed (REG)		0.31	0.31
	Digestibility of feed	[kg animal-1 year-1]	65	65

Deer

This animal category covers red deer and fallow deer. Additionally, the so-called "new world camels" (e.g. llamas, alpacas, etc.) are included. However, these animals are only of minor importance.

- In Austrian game reserves usually one dominant male deer and possibly two secondary male ones are kept. Mostly there are female animals and about one third are young animals, which are born in spring of the previous year and are removed in autumn. Based on this information, it can be assumed that on average, 50% of the animals are fully-grown female deer. The others are young deer, assuming 40% of the final live weight for those within their first year of live and 80% of the live weight for those of one year.
- In total, an average live weight of 51.2 kg was determined for deer.
- Beside the different body weight, calculations are in line with of those of sheep
- GE-intake, $VS_{excretion}$ and $N_{excretion}$ are calculated according to IPCC 2019

Table 185: Net energy requirements and digestibility of feed for deer.

Reference	Parameter	Unit	1990-2023
Hörtenhuber 2025	Average body mass	[kg average animal^{-1}]	51.2
Equation 10.3 (IPCC 2019)	Net energy requirement maintan-ance	[MJ NE animal^{-1} day^{-1}]	4.66
Equation 10.5 (IPCC 2019)	Net energy requirement activity	[MJ NE animal^{-1} day^{-1}]	0.43
Equation 10.7 (IPCC 2019)	Net energy requirement growth	[MJ NE animal^{-1} day^{-1}]	0.77
Equation 10.10 (IPCC 2019)	Net energy requirement lactation	[MJ NE animal^{-1} day^{-1}]	0.47
Equation 10.13 (IPCC 2019)	Net energy requirement pregnancy	[MJ NE animal^{-1} day^{-1}]	0.32
Equation 10.14 (IPCC 2019)	Ratio of net energy available in diet for maintenance to digestible en-ergy consumed (REM)		0.51
Equation 10.15 (IPCC 2019)	Ratio of net energy available for growth in a diet to digestible en-ergy consumed (REG)		0.31
	Digestibility of feed	[kg animal-1 year-1]	65

Horses

According to the IPCC 2006 guidelines or the 2019 refinement there are no default parameters and factors available for applying the Tier 2 methodology of enteric fermentation for horses. The following parameters, factors and assumptions have been used:

- Live weight of 377 kg according to (EEA 2023). This value is in accordance with the average live weight of slaughtered horses (387 kg).
- GE intake, methane conversion rate (Ym) and digestibility were taken from the Swiss inventory (FOEN, 2024)
- 12% crude protein in dry matter
- $VS_{excretion}$ and $N_{excretion}$ are calculated according to IPCC 2019

Table 186: Net energy requirements and digestibility of feed for horses.

<table>
<tr><th>Reference</th><th>Parameter</th><th>Unit</th><th>1990-2023</th></tr>
<tr><td>IPCC 2019, TABLE 10A.5</td><td>Average body mass</td><td>[kg average animal^{-1}]</td><td>377</td></tr>
<tr><td>Equation 10.3 (IPCC 2019)</td><td>Net energy requirement maintanance</td><td>[MJ NE animal^{-1} day^{-1}]</td><td rowspan="7">Net energy requirements not calculated for horses. GE-intake directly taken from the Swiss inventory (FOEN, 2024).</td></tr>
<tr><td>Equation 10.5 (IPCC 2019)</td><td>Net energy requirement activity</td><td>[MJ NE animal^{-1} day^{-1}]</td></tr>
<tr><td>Equation 10.7 (IPCC 2019)</td><td>Net energy requirement growth</td><td>[MJ NE animal^{-1} day^{-1}]</td></tr>
<tr><td>Equation 10.10 (IPCC 2019)</td><td>Net energy requirement lactation</td><td>[MJ NE animal^{-1} day^{-1}]</td></tr>
<tr><td>Equation 10.13 (IPCC 2019)</td><td>Net energy requirement pregnancy</td><td>[MJ NE animal^{-1} day^{-1}]</td></tr>
<tr><td>Equation 10.14 (IPCC 2019)</td><td>Ratio of net energy available in diet for maintenance to digestible energy consumed (REM)</td><td></td></tr>
<tr><td>Equation 10.15 (IPCC 2019)</td><td>Ratio of net energy available for growth in a diet to digestible energy consumed (REG)</td><td></td></tr>
<tr><td></td><td>Digestibility of feed</td><td>[kg animal-1 year-1]</td><td>70</td></tr>
</table>

Goats

- Lactation and gestation was included for the share of female goats
- 15% crude protein in dry matter
- Protein content of milk is taken from (Bellof, Leber, 2019), number of milk goats is taken from (BML, 2024a) → average Austrian milk goat: 647 kg milk/year with 3.2% protein content
- Average live weight before slaughter of 24.6 kg in 2022
- Assumption: no differences in feeding and performance over the time series
- GE-intake, $VS_{excretion}$ and $N_{excretion}$ are calculated according to IPCC 2019

Table 187: Net energy requirements and digestibility of feed for goats.

Reference	Parameter	Unit	1990	2023
IPCC 2019, TABLE 10A.5	Average body mass	[kg average animal^{-1}]	40	40
Equation 10.3 (IPCC 2019)	Net energy requirement maintanance	[MJ NE animal^{-1} day^{-1}]	3.87	3.87
Equation 10.5 (IPCC 2019)	Net energy requirement activity	[MJ NE animal^{-1} day^{-1}]	0.18	0.21
Equation 10.7 (IPCC 2019)	Net energy requirement growth	[MJ NE animal^{-1} day^{-1}]	0.33	0.33
Equation 10.10 (IPCC 2019)	Net energy requirement lactation	[MJ NE animal^{-1} day^{-1}]	0.26	0.26
Equation 10.13 (IPCC 2019)	Net energy requirement pregnancy	[MJ NE animal^{-1} day^{-1}]	0.29	0.29
Equation 10.14 (IPCC 2019)	Ratio of net energy available in diet for maintenance to digestible energy consumed (REM)		0.54	0.54
Equation 10.15 (IPCC 2019)	Ratio of net energy available for growth in a diet to digestible energy consumed (REG)		0.35	0.35
	Digestibility of feed	[kg animal-1 year-1]	75	75

Poultry

The 2019 IPCC Refinement as well as the 2006 IPCC GL do not provide specific methodologies for the estimation of emissions from poultry.

For the calculation of emissions from layers industry data according to (Lohmann Tierzucht) and for broilers data of (LFI, 2023) was taken. For turkeys and other poultry information was implemented according to Kartzfehn (2021).

Layers

- The average digestibility of 75% according to IPCC 2019 was applied
- GE-intake of 1.8 MJ per animal and day taken as basis from Swiss inventory (FOEN, 2024) for 1990. The value for 2023 was determined by national calculations according to (Hörtenhuber 2025) taking into account the calorific value of 110 g feed per layer and day as provided in (LFI, 2023).
- The MCF was taken from the Swiss inventory (FOEN, 2024)
- $VS_{excretion}$ was calculated according to IPCC 2019, Tier 2 methodology based on GE-intake; an ash content of 10% was used for the entire time series.

- $N_{excretion}$ is calculated according to IPCC 2019, subtracting the nitrogen retention from the nitrogen intake according to (equation 10.31A). For 1990 17.5% and for 2023 17.0% crude protein in dry matter was applied. Further details are documented in (Hörtenhuber, 2025).

Broilers

- The average digestibility of 89 according to IPCC 2019 was applied
- 7 fattening periods per year were used for the entire time series, in 1990 an average fattening period was 45 days, in 2023 it was 35 days
- In 1990 the GE-intake was 1.2 MJ, in 2023 1.5 MJ. This assumption is based on industry data (Lohmann Tierzucht), with the variation stemming from different shares of organic broilers (0% in 1990, 8% in 2023)
- The MCF was taken from the Swiss inventory (FOEN, 2024)
- $VS_{excretion}$ was calculated according to IPCC 2019, Tier 2 methodology based on GE-intake; an ash content of 10% was used for the entire time series.
- $N_{excretion}$ is calculated according to IPCC 2019, subtracting the nitrogen retention from the nitrogen intake according to (equation 10.31A). For 1990 22% and for 2023 21% crude protein in dry matter was applied. Further details are documented in (Hörtenhuber, 2025).

In the following table, an overview of the used parameters for layers, broilers, turkeys and other poultry is given.

Table 188: Net energy requirements and digestibility of feed for poultry.

Reference	Parameter	Unit	1990	2023
Hörtenhuber 2025 based on IPCC 2019	Average body mass – layers	[kg average animal^{-1}]	1.9	1.9
Hörtenhuber 2025 based on IPCC 2019	Average body mass – broilers	[kg average animal^{-1}]	1.0	1.0
IPCC 2019, TABLE 10A.5	Average body mass – turkeys	[kg average animal^{-1}]	6.8	6.8
IPCC 2019, TABLE 10A.5	Average body mass – other poultry	[kg average animal^{-1}]	2.7	2.7
Equation 10.3 (IPCC 2019)	Net energy requirement maintanance	[MJ NE animal^{-1} day^{-1}]	Net energy requirements not calculated for poultry. GE-intake directly taken from the Swiss inventory (FOEN, 2024).	
Equation 10.5 (IPCC 2019)	Net energy requirement activity	[MJ NE animal^{-1} day^{-1}]		
Equation 10.7 (IPCC 2019)	Net energy requirement growth	[MJ NE animal^{-1} day^{-1}]		
Equation 10.10 (IPCC 2019)	Net energy requirement lactation	[MJ NE animal^{-1} day^{-1}]		
Equation 10.13 (IPCC 2019)	Net energy requirement pregnancy	[MJ NE animal^{-1} day^{-1}]		
Equation 10.14 (IPCC 2019)	Ratio of net energy available in diet for maintenance to digestible energy consumed (REM)			
Equation 10.15 (IPCC 2019)	Ratio of net energy available for growth in a diet to digestible energy consumed (REG)			
	Digestibility of feed – layers	[kg animal-1 year-1]	75	75

Reference	Parameter	Unit	1990	2023
Hörtenhuber 2025 based on IPCC 2019	Average body mass – layers	[kg average animal^{-1}]	1.9	1.9
Hörtenhuber 2025 based on IPCC 2019	Average body mass – broilers	[kg average animal^{-1}]	1.0	1.0
IPCC 2019, TABLE 10A.5	Average body mass – turkeys	[kg average animal^{-1}]	6.8	6.8
IPCC 2019, TABLE 10A.5	Average body mass – other poultry	[kg average animal^{-1}]	2.7	2.7
	Digestibility of feed – broilers	[kg animal-1 year-1]	87	89
	Digestibility of feed – turkeys	[kg animal-1 year-1]	89	89
IPCC 2019	Digestibility of feed – other poultry	[kg animal-1 year-1]	73	73

Rabbits

- Average live weight of 1.5 kg was taken from EEA 2023; live weight bevor slaughter is about 3 kg.
- GE intake, methane conversion rate (Y_m) and digestibility were taken from the Swiss inventory (FOEN, 2024)
- 16% crude protein in dry matter
- $VS_{excretion}$ and $N_{excretion}$ are calculated according to (IPCC 2019)

Table 189: Net energy requirements and digestibility of feed for rabbits.

Reference	Parameter	Unit	1990-2023
EMEP/EEA 2023	Average body mass	[kg average animal^{-1}]	1.5
Equation 10.3 (IPCC 2019)	Net energy requirement maintanance	[MJ NE animal^{-1} day^{-1}]	Net energy requirements not calculated for rabbits. GE-intake directly taken from the Swiss inventory (FOEN, 2024).
Equation 10.5 (IPCC 2019)	Net energy requirement activity	[MJ NE animal^{-1} day^{-1}]	
Equation 10.7 (IPCC 2019)	Net energy requirement growth	[MJ NE animal^{-1} day^{-1}]	
Equation 10.10 (IPCC 2019)	Net energy requirement lactation	[MJ NE animal^{-1} day^{-1}]	
Equation 10.13 (IPCC 2019)	Net energy requirement pregnancy	[MJ NE animal^{-1} day^{-1}]	
Equation 10.14 (IPCC 2019)	Ratio of net energy available in diet for maintenance to digestible energy consumed (REM)		
Equation 10.15 (IPCC 2019)	Ratio of net energy available for growth in a diet to digestible energy consumed (REG)		
	Digestibility of feed	[kg animal-1 year-1]	75

5.2.3 Category-specific QA/QC

In category 3.A the following source specific QA/QC procedures have been carried out:

- ✓ Gross energy intake data elaborated by scientific experts from the Agricultural Research and Education Centre (AREC) Raumberg-Gumpenstein, derived from peer reviewed sources;
- ✓ External review by Austrian agricultural experts (stakeholder meeting "inventory talks" 2010) (Umweltbundesamt, 2010b);
- ✓ Audit of data supplier: milk yield data (Statistik Austria), livestock data;
- ✓ Differences to default values checked, explained and documented;
- ✓ Expanded QA and verification activities in 2012: in-depth review of the agriculture model.
- ✓ Expanded QA/QC of the software tool (calculation sheets) for new and revised sources (e.g. crop residues, energy crops performed in 2015)
- ✓ External review of the revised agricultural model according to the 2006 IPCC GL by Austrian agricultural experts: stakeholder meeting "inventory talks" 2014 (Umweltbundesamt, 2014a).
- ✓ External review of the revised agricultural model (Amon, Hörtenhuber, 2019) according to the new data on the agricultural practice (Pöllinger, et al., 2018) by Austrian agricultural experts: stakeholder meeting "inventory talks" 2018 (Umweltbundesamt, 2018).
- ✓ External review of the updated and representative values for nitrogen and energy intake, excretion of nitrogen (N_{ex}) and volatile solids (VS_{ex}) based on the research project on country-specific animal feeding and nutrition ("MiNutE" study, (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023) by Austrian agricultural experts.
- ✓ Verification of the Austrian inventory results with the AgrEE Tool (Umweltbundesamt, 2024e)
- ✓ External review of the revised agricultural model (Hörtenhuber, 2025) according to the new data on the agricultural practice (Pöllinger, et al., 2025), the implementation of the 2019 IPCC Refinement and improvements in the ammonia inventory by Austrian agricultural experts: stakeholder meeting "inventory talk" 2025 (Umweltbundesamt, 2025c).

Sector specific routine control procedures are provided in chapter 5.1.4.

5.2.4 Uncertainties

Uncertainties are presented in Table 165.

5.2.5 Recalculations

Update of activity data

Please refer to chapter 5.1.6.

Improvements of methodologies and emission factors

For sheep, goats, horses, poultry, deer and rabbits, for the first time emissions were calculated based on the Tier 2 methodology according to IPCC 2019 and country-specific EFs (equation 10.21) Updated activity and nutrition data (AWMS data, feeding and nutrition, livestock data, new emission source rabbits – see above) were used. The improvements resulted in overall higher emission amounts for the entire time series (+1.7 kt CH_4 for 2022).

5.3 Manure management (CRT Category 3.B)

Key source: CH_4 and N_2O from 3.B.1 Cattle; N_2O from 3.B.3 Swine, 3.B.4 Other livestock and 3.B.5 Indirect N_2O emissions

This chapter describes the estimation of CH_4 and N_2O emissions from animal manure. In 2023 15.7% of the agricultural CH_4 emissions and 20.6% of the agricultural N_2O emissions were caused by this category.

5.3.1 Source Category Description

CH_4 and N_2O emissions from manure management are presented in the following tables:

Table 190: CH_4 emissions from manure management 1990–2023.

Year	CH_4 emissions from manure management [kt]									
	Livestock categories									
	3.B Total	3.B.1.a Dairy Cattle	3.B.1.b Non-Dairy	3.B.2 Sheep	3.B.3 Swine	3.B.4.c Other/ Deer	3.B.4.d Other/ Goats	3.B.4.e Other/ Horses	3.B.4.g Other/ Poultry	3.B.4.h Other/ Rabbits
1990	24.33	10.42	6.80	0.08	6.59	0.34	0.09	0.00	0.00	0.001
1995	23.15	8.35	8.19	0.09	6.04	0.33	0.14	0.01	0.00	0.001
2000	21.12	7.47	7.86	0.08	5.25	0.28	0.16	0.01	0.00	0.001
2005	19.63	6.52	7.69	0.08	4.85	0.29	0.18	0.01	0.00	0.001
2010	22.07	7.64	9.19	0.09	4.62	0.31	0.20	0.01	0.00	0.001
2011	22.51	7.93	9.43	0.09	4.52	0.32	0.21	0.01	0.00	0.001
2012	22.81	8.13	9.57	0.09	4.46	0.33	0.21	0.01	0.01	0.001
2013	23.32	8.47	9.86	0.09	4.32	0.34	0.22	0.01	0.00	0.001
2014	23.89	8.85	10.12	0.09	4.24	0.35	0.22	0.01	0.00	0.001
2015	24.44	9.06	10.48	0.09	4.20	0.37	0.23	0.01	0.01	0.001
2016	24.91	9.39	10.63	0.09	4.17	0.38	0.24	0.01	0.01	0.001
2017	25.53	9.69	10.87	0.10	4.21	0.39	0.25	0.01	0.01	0.001
2018	25.85	9.83	11.07	0.10	4.18	0.39	0.25	0.01	0.01	0.001
2019	26.23	9.99	11.26	0.10	4.21	0.40	0.26	0.01	0.01	0.001
2020	26.80	10.33	11.40	0.09	4.29	0.41	0.26	0.01	0.01	0.001
2021	27.61	10.70	11.82	0.09	4.32	0.40	0.26	0.01	0.01	0.001
2022	28.26	11.51	11.84	0.09	4.13	0.40	0.26	0.01	0.01	0.000
2023	28.49	11.68	12.07	0.09	3.98	0.40	0.27	0.01	0.01	0.000
Share 2023	**100%**	**41%**	**42%**	**0%**	**14%**	**1%**	**1%**	**0%**	**0%**	**0%**
1990–2023	**17.1%**	**12.1%**	**77.5%**	**14.5%**	**-39.6%**	**17.0%**	**184.6%**	**152.4%**	**132.1%**	**-64.8%**

From 1990 to 2023 CH_4 emissions from manure management increased by 17% to 28.49 kt. This trend is mostly driven by the emissions from cattle and can be attributed to an increasing VS excretion per animal, as well as an increase in manure management systems with high methane conversion rates, like untreated liquid systems, pit storage below animal confinements or deep litter systems.

Table 191: Direct N_2O emissions from manure management per livestock category 1990–2023.

Year	**Direct N_2O emissions from manure management [kt]**									
	Livestock categories									
	Direct	**3.B.1.a**	**3.B.1.b**	**3.B.2**	**3.B.3**	**3.B.4.c**	**3.B.4.d**	**3.B.4.e**	**3.B.4.g**	**3.B.4.h**
	Total	**Dairy**	**Non-Dairy**	**Sheep**	**Swine**	**Other/ Deer**	**Other/ Goats**	**Other/ Horses**	**Other/ Poultry**	**Other/ Rabbits**
1990	2.014	0.769	0.754	0.030	0.418	0.012	0.027	0.002	0.001	0.0002
1995	1.933	0.624	0.839	0.036	0.377	0.012	0.040	0.003	0.001	0.0001
2000	1.811	0.569	0.827	0.033	0.320	0.010	0.046	0.004	0.002	0.0001
2005	1.726	0.517	0.819	0.032	0.291	0.011	0.051	0.003	0.002	0.0001
2010	1.661	0.484	0.805	0.035	0.261	0.011	0.058	0.005	0.002	0.0001
2011	1.629	0.475	0.786	0.036	0.255	0.011	0.060	0.005	0.002	0.0001
2012	1.607	0.472	0.771	0.036	0.248	0.011	0.061	0.005	0.002	0.0001
2013	1.589	0.471	0.764	0.035	0.238	0.011	0.063	0.005	0.002	0.0001
2014	1.581	0.476	0.757	0.034	0.231	0.012	0.064	0.004	0.002	0.0001
2015	1.573	0.469	0.757	0.035	0.226	0.012	0.066	0.005	0.002	0.0001
2016	1.562	0.470	0.744	0.037	0.222	0.012	0.069	0.005	0.002	0.0001
2017	1.559	0.470	0.735	0.040	0.222	0.013	0.072	0.006	0.002	0.0001
2018	1.510	0.445	0.711	0.040	0.221	0.013	0.072	0.006	0.002	0.0001
2019	1.462	0.419	0.687	0.039	0.223	0.013	0.073	0.006	0.003	0.0001
2020	1.425	0.403	0.662	0.037	0.228	0.013	0.074	0.006	0.003	0.0001
2021	1.402	0.385	0.653	0.037	0.230	0.013	0.075	0.006	0.003	0.0001
2022	1.354	0.384	0.615	0.037	0.221	0.013	0.076	0.006	0.003	0.0001
2023	1.302	0.360	0.595	0.035	0.214	0.012	0.077	0.006	0.003	0.0001
Share 2023	**100%**	**28%**	**46%**	**3%**	**16%**	**1%**	**6%**	**0%**	**0%**	**0%**
1990–2023	**-35.3%**	**-53.2%**	**-21.0%**	**16.2%**	**-48.8%**	**-0.2%**	**184.6%**	**153.8%**	**132.1%**	**-64.8%**

From 1990 to 2023 the direct N_2O emissions from manure management decreased by 35.3% to 1.30 kt. Emissions of cattle dominate the trend. The reduction of dairy cow numbers is partly counterbalanced by an increase in emissions per animal (because of the increasing gross energy intake, milk production and N excretion of dairy cattle since 1990).

Table 192: Direct, indirect and total N_2O Emissions from manure management 1990–2023.

Year	N_2O emissions from manure management [kt]			
	3.B	3.B. direct	3.B.5 indirect	
	Total	Total	Atm. deposition	Leaching
1990	2.480	2.014	0.466	NO
1995	2.400	1.933	0.467	NO
2000	2.254	1.811	0.443	NO
2005	2.165	1.726	0.439	NO
2010	2.115	1.661	0.454	NO
2011	2.078	1.629	0.449	NO
2012	2.055	1.607	0.448	NO
2013	2.038	1.589	0.449	NO
2014	2.032	1.581	0.451	NO
2015	2.027	1.573	0.454	NO
2016	2.019	1.562	0.456	NO
2017	2.019	1.559	0.460	NO
2018	1.965	1.510	0.455	NO
2019	1.913	1.462	0.451	NO
2020	1.876	1.425	0.450	NO
2021	1.854	1.402	0.452	NO
2022	1.801	1.354	0.447	NO
2023	1.742	1.302	0.440	NO
Share 2023	**100%**	**75%**	**25%**	**NO**
1990–2023	**-29.8%**	**-35.3%**	**-5.6%**	**-**

Total N_2O emissions (direct and indirect) from sector *3.B Manure Management* decreased by 29.8% between 1990 and 2023. The share of direct N_2O emissions in total N_2O emissions from sector *3.B* is 74.8% and 25.2% of indirect N_2O emissions in 2023. This reduction is largely driven by cattle and the decreasing livestock numbers.

5.3.2 Methodological Issues

For the estimation of CH_4 emissions from manure management, cattle (identified as key category) and swine, the IPPC-Tier 2 methodology and country specific parameters were used. In submission 2019 the CH_4 emission estimates for the other livestock categories have been improved by moving from the Tier 1 to the Tier 2 methodology using country-specific AWMS distributions and IPCC default parameters.

Within the inventory update carried out for submission 2010 the following improvements were made:

- implementation of more accurate data on animal waste management system distribution gathered through an Austrian survey (Amon, et al., 2007a);
- improved consideration of the amount of slurry stored under cool and under warm conditions;
- new country specific emission factors for slurry storage;
- introduction of deep litter systems with best available emission factors.

Inventory revision 2015 (Amon, Hörtenhuber, 2014) concentrated on implementing the IPCC 2006 Guidelines.

In 2018 another improvement of the agricultural model has been carried out (Amon, Hörtenhuber, 2019) by implementing the new input data on agricultural practices in Austria from the research project "Surveys on manure management from agricultural livestock farming in Austria (TIHALO II) (Pöllinger, et al., 2018)" and by improving the N flow according to the EMEP/EEA GB 2016. Although the biggest revisions were recorded in Austria's ammonia inventory, there were some inventory updates with significant impacts to Austria's GHG inventory:

- Increased share of liquid systems (cattle)
- Introduction of the system 'deep litter < 1 month'
- Improved calculations for the non-key animals sheep, goats and poultry

In submission 2020 Austria's agricultural N-flow model was further improved by implementing the EMEP/EEA Guidebook 2019, since 2024 the EMEP/EEA Guidebook 2023 is used.

In submission 2022 updated and representative values for nitrogen and energy intake, excretion of nitrogen (N_{ex}) and volatile solids (VS_{ex}), taken from a new research project on country-specific animal feeding and nutrition ('MiNutE study', (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023) have been included into the inventory.

In submission 2025, the results of the research project 'Animal husbandry and manure management systems in Austria' ('TIHALO III', (Pöllinger, et al., 2025) were implemented into the agriculture model. The results of this study provided new data on livestock feeding, management systems and practices as well as application techniques for 2023. The most significant impact to Austria's GHG inventory was the introduction of the manure management system 'pit storage below animal confinements'. The system 'slurry separation' was also implemented as a new manure management system for cattle and swine, mainly affecting ammonia emissions. Furthermore, the 2019 Refinement was implemented for sector *3.B Manure Management* and methodological improvements in the ammonia inventory inventory have been carried out. The total ammoniacal nitrogen (TAN) values for liquid and solid manure of cattle and swine were updated according to the latest science.

Animal Waste Management Systems (AWMS)

AWMS data used in the national inventory is based on the following national surveys on agricultural practices (Konrad, 1995), (Amon, et al., 2007a), (Pöllinger, et al., 2018) and (Pöllinger, et al., 2025). The research project 'Animal husbandry and manure management systems in Austria (TIHALO I)' (Amon, et al., 2007a) has been carried out as a comprehensive survey on the agricultural practices in Austria. Within this project, the Division of Agricultural Engineering (DAE) of the Department for Sustainable Agricultural Systems of the University of Natural Resources and Applied Life Sciences

(BOKU) closely co-operated with the Swiss College of Agriculture, the Austrian Chamber of Agriculture, the Umweltbundesamt, the Agricultural Research and Education Centre Raumberg-Gumpenstein and the Statistics Austria. The statistical sampling plan (5 000 Austrian farms, return rate of 39%) was set up with the assistance of the Statistics Austria to guarantee the selection of a representative sample.

As a result of TIHALO I, for the year 2005 updated representative data on animal husbandry and manure management systems all over Austria was available. For the year 1990 AWMS data based on (Konrad, 1995) was used. In this study data on existing Austrian conditions were derived from a research survey carried out on 720 randomly-chosen agricultural enterprises in the years 1989–1992.

In 2017 the TIHALO I study has been followed-up by a new research project (TIHALO II) (Pöllinger, et al., 2018). For this project, as for the previous one, a comprehensive survey on the agricultural practices in Austria has been carried out. 5 000 questionnaires were sent to the farmers and a return rate of 37% could be achieved. Compared to the first TIHALO study, the questionnaire for the farmers was additionally available as an online version, which was used by more than 50% of the participants. The current study was conducted by the Agricultural Research and Education Centre Raumberg-Gumpenstein as lead, but in close cooperation with the Austrian Chamber of Agriculture, the Federal Institute of Agricultural Economics, the Federal Ministry for Sustainability and Tourism[89] and the Umweltbundesamt. So, for 2017 new information on livestock feeding, management systems and practices as well as application techniques in Austria became available.

In 2023 a third research study on Austria´s husbandry and manure management systems was carried out (TIHALO III) (Pöllinger, et al., 2025). As in TIHALO II, the current research project was carried out by the Agricultural Research and Education Centre Raumberg-Gumpenstein as lead again. Similar to its predecessor, 5 000 questionnaires were sent to the farmers and a return rate of nearly 40% could be achieved. In the new study TIHALO III, most of the farmers used the online version of the questionnaire (about 90%). In the current submission 2025, the new data for the reporting year 2023 became available and was implemented.

For the creation of a plausible time series the AWMS distribution of 1990 (based on (Konrad, 1995) partly had to be adopted. Changes to the year 1990 were derived from the TIHALO I, TIHALO II and TIHALO III study results and expert opinions (DI Alfred Pöllinger, Agricultural Research and Education Centre Raumberg-Gumpenstein) carried out in (Amon, Hörtenhuber, 2019) and (Hörtenhuber, 2025). AWMS data from 2006–2016 and 2018-2022 were derived by linear extrapolation.

Information on anaerobic digestion is based on data published by the Austrian Energy Regulator (E-CONTROL, 2006–2021), (E-CONTROL, 2022-2024), (E-CONTROL, 2024a) and (Kompost- und Biogasverband, 2024). 1990 data are based on (Amon, et al., 2002b).

For the livestock categories sheep, poultry, horses, goats and deer country specific AWMS data has been applied. Data are based on the TIHALO II (Pöllinger, et al., 2018) and expert judgement (Pöllinger, 2018), carried out in (Amon, Hörtenhuber, 2019) as well as the TIHALO III results (Pöllinger, et al., 2025), carried out in (Hörtenhuber, 2025). Only for horses, deer and rabbits, the AWMS distribution has been kept constant over the entire time series.

Austria's AWMS data are provided in Table 193 and Table 194.

[89] From 2020 onwards „The Federal Ministry for Agriculture, Regions and Tourism"

Table 193: Manure Management System distribution in Austria 2023.

Livestock category	Liquid/ Slurry	Solid Storage	Pit storage	Deep bedding	Pasture/ Range/ Paddock	Com-posting	Anaero-bic Di-gestion	Other Systems
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
Dairy cattle	53.5	9.6	12.1	3.7	6.7	0.6	3.2	10.6
Non-dairy cattle	29.6	4.5	9.0	35.4	10.4	2.0	3.2	5.9
Suckling cows	31.1	13.1	0.7	23.5	20.8	1.9	3.2	5.6
Cattle < 1 year	14.8	2.9	8.9	56.2	9.3	2.9	3.2	1.8
Breeding heifers 1–2 years	39.4	1.0	10.4	25.0	6.7	1.6	3.2	12.7
Fattening heifers, bulls and oxen 1–2 years	39.6	3.3	12.7	28.1	6.3	1.3	3.2	5.6
Other cattle > 2 years	34.1	2.7	13.1	28.0	10.4	1.6	3.2	7.0
Sheep	0.0	55.0	0.0	0.0	45.0	0.0	0.0	0.0
Goats	0.0	90.0	0.0	0.0	10.0	0.0	0.0	0.0
Horses	0.0	80.0	0.0	0.0	20.0	0.0	0.0	0.0
Swine (Total)	67.0	7.8	13.7	5.9	0.0	0.3	0.7	4.5
Breeding sows	62.0	15.4	10.3	3.5	0.0	0.9	0.7	7.2
Young and fattening pigs	68.1	6.3	14.4	6.4	0.0	0.1	0.7	4.0
Chicken	0.0	94.5	0.0	0.0	4.8	0.0	0.7	0.0
Layers	0.0	91.3	0.0	0.0	8.0	0.0	0.7	0.0
Broilers	0.0	97.7	0.0	0.0	1.6	0.0	0.7	0.0
Other poultry	0.0	99.3	0.0	0.0	0.7	0.0	0.0	0.0
Turkeys	0.0	99.3	0.0	0.0	0.7	0.0	0.0	0.0
Other Poultry	0.0	99.3	0.0	0.0	0.7	0.0	0.0	0.0
Deer	0.0	20.0	0.0	0.0	80.0	0.0	0.0	0.0
Rabbits	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 194: Other systems 2023 in detail.

Livestock category	Yard	Separated	Aerobic Treatment
	[%]	[%]	[%]
Dairy cattle	2.4	7.6	0.7
Non-dairy cattle	2.3	3.2	0.4
Suckling cows	5.0	0.5	0.3
Cattle < 1 year	1.6	0.0	0.3
Breeding heifers 1–2 years	1.7	10.4	0.6
Fattening heifers, bulls and oxen 1–2 years	2.2	2.7	0.8

Livestock category	**Yard**	**Separated**	**Aerobic Treatment**
	[%]	**[%]**	**[%]**
Other cattle > 2 years	1.6	5.0	0.4
Sheep	0.0	0.0	0.0
Goats	0.0	0.0	0.0
Horses	0.0	0.0	0.0
Swine (Total)	2.3	1.2	1.0
Breeding sows	2.3	4.2	0.7
Young and fattening pigs	2.4	0.5	1.1
Chicken	0.0	0.0	0.0
Layers	0.0	0.0	0.0
Broilers	0.0	0.0	0.0
Other poultry	0.0	0.0	0.0
Turkeys	0.0	0.0	0.0
Other Poultry	0.0	0.0	0.0
Deer	0.0	0.0	0.0
Rabbits	0.0	0.0	0.0

Small farms more frequently use solid manure systems, whereas large farms make more use of slurry systems. The time series on AWMS shows for cattle a decreasing share of solid systems. Pasture decreased by 2017, but is increasing again since then. Liquid systems, pit storage below animal confinements, anaerobic digestion and ‘other systems’ are increasing. Composting is of minor importance and shares are quite stable. For other cattle, deep bedding systems are increasing. Young and fattening pigs as well as breeding sows are increasingly held on liquid systems. Between 2017 and 2023 the share of solid systems increased again, however liquid systems still are the most common system for swine. The rearing of sheep, goats, horses and deer is of minor importance in Austria. In general, these livestock categories are pastured and their housings are based on solid systems (straw).

Influence of application time on stored liquid slurry

Cattle

The evaluation of the TIHALO questionnaires (Amon, et al., 2007a) produced the following results: 32% of the slurry is applied in spring, 42% in summer and 25% in autumn (n=933 farms, projected by Statistik Austria to representative Austrian conditions). Following data on the storage of slurry were derived:

On average are:

- in spring 55% of the stores’ capacity filled,
- in summer 45% of the stores’ capacity filled,
- in autumn 37.5% of the stores’ capacity filled,
- in winter 62.5% of the stores’ capacity filled.

Swine

The evaluation of the TIHALO questionnaires (Amon, et al., 2007a) produced the following results: 57% of the slurry is applied in spring, 27% in summer and 16% in autumn (n=628 farms, projected by Statistik Austria to representative Austrian conditions). Following data on the storage of slurry were derived:

On average are:

- in spring 43% of the stores' capacity filled,
- in summer 41% of the stores' capacity filled,
- in autumn 50% of the stores' capacity filled,
- in winter 75% of the stores' capacity filled.

Emission measurements under field conditions showed, that an increase in methane emissions during slurry storage was only observed during the summer season. The following table presents the slurry stored in cold and warm season per animal category as used in the national inventory.

Table 195: Liquid slurry – percentage storage in cold and warm season for 2023.

Livestock category	Liquid slurry storage	
	warm season [%]	cold season [%]
Dairy cattle	20.8	79.2
Suckling cows	16.2	83.8
Cattle < 1 year	20.0	80.0
Breeding heifers 1–2 years	20.8	79.2
Fattening heifers, bulls and oxen 1–2 years	20.9	79.1
Non-dairy cattle > 2 years	19.7	80.3
Breeding sows	19.6	80.4
Young and fattening pigs	19.6	80.4

Derivation of manure digested in biogas plants

In submission 2022, the calculation of the amounts and proportions of digested manure (VS_{ex} and N_{ex}) was restructured together with the calculation of N from plant-based substrates. The same or comparable data sources were used as in previous submissions.

Data basis for the estimation are published numbers of biogas plants under contract for electricity supply, annual energy amounts (kWh) produced from Austrian biogas plants and the energy-related distribution of the substrates used. Below additional information on the derivation of manure digested in biogas plants is provided as recommended in the ARR 2013, para 49.

Biogas plant numbers have been obtained from Amon, et al. (2002b) for the years 1990 to 2000 and from the annual reports of the Austrian Energy Regulator E-Control for the years from 2005 to 2021. For 2022, plant numbers could be directly obtained from the Herkunftsnachweisdatenbank (Guarantees of origin (GO)-database) of E-Control (E-CONTROL, 2024a). Plant numbers between the years 2000 and 2005 have been derived by interpolation.

Energy amounts (kWh) from animal manure were taken from the annual reports of E-Control and from 2020 onwards from Kompost- und Biogasverband (2024). As before 2007 the energy shares of animal manures were not reported, those of the year 2007 have been used backwards to the year 1990. The total annual mass of manure used as substrates was calculated from the total annual energy amounts from manure with factors for kWh per t of substrate (cattle slurry and solid manure, pig slurry and solid manure, chicken manure) and by using default values of Agency for renewable resources (2021).

The following default values have been used: 1 m³ methane = 9.97 kWh energy, 1 density methane = 0.72 kg/m³, CHP electric efficiency = 28 to 47 %. For the latter value, not a simple average value between the minimum and the maximum of the range was used, but a weighted average, which evaluates the minimum value two thirds and the maximum value one third. Thus, a better agreement with alternative and previously used values on kWh per t substrate could be determined. For this purpose, values from LFL Bayern (2017) were used to calculate the amount of bioas-CH_4 per t substrate. IPCC default B_0 values were applied

Table 196 Characteristic values for the calculation of the VS_{ex} amounts and substrate amounts in biogas plants.

	cattle slurry	cattle solid	pig slurry	pig solid	chicken manure
kg V_{Sex} per kg CH_4	12.92	12.92	5.53	5.53	6.85
kg CH_4 per t fresh matter (FM) manure input	14.21	49.50	12.24	44.58	32.19

Table 197: Numbers of biogas plants and amounts of digested manure 1990–2023.

Year	Biogas plant	Energy amounts from animal manure	Annually digested manure	$V_{Sexcretion}$ anaerobically digested
	[number]	[kWh /yr]	[t DM/yr]	[t /yr]
1990	5	458 707	3 764	615
1995	38	3 486 177	28 610	4 672
2000	120	11 008 980	90 347	14 753
2005	231	21 192 286	173 918	28 400
2010	289	45 962 844	441 240	69 427
2011	288	28 639 327	232 831	42 290
2012	291	29 640 442	242 322	43 628
2013	293	30 658 365	252 004	44 993
2014	289	31 693 096	261 877	46 385
2015	291	32 082 582	266 911	46 087
2016	287	34 130 324	250 290	58 844
2017	288	32 215 830	238 378	55 165
2018	288	33 530 717	245 236	59 378
2019	283	27 105 432	189 190	52 836
2020	280	34 225 452	238 886	66 714

Year	Biogas plant	Energy amounts from animal manure	Annually digested manure	$V_{Sexcretion}$ anaerobically digested
	[number]	[kWh /yr]	[t DM/yr]	[t /yr]
2021	272	38 134 987	266 173	74 335
2022	274	31 066 006	216 834	60 556
2023	293	36 563 970	255 208	71 273

Table 197 shows increasing biogas plant numbers along with rising amounts of digested amounts of manure.

Activity data

(Statistik Austria, 2024a) provides national data of annual livestock numbers on a very detailed level (see Table 169, Table 170, Table 171). These data are basis for the estimation.

5.3.2.1 Estimation of CH_4 Emissions

CH_4 emissions of cattle and swine are estimated with the Tier 2 approach. This method requires detailed information on animal characteristics and on the manner in which the manure is managed. The following formula has been used (IPCC 2019), Equation 10.23):

$$EF_T = (VS_{(T)} * 365) * [B_{0(T)} * 0.67 \text{ kg m}^{-3} * \Sigma_{S,k} \ MCF_{S,k}/100 * AWMS_{(T,S,k)}]$$

$EF_{(T)}$ *= annual CH_4 emission factor for livestock category T, kg CH_4 animal^{-1}yr^{-1}*

$VS_{(T)}$ *= daily volatile solid excreted for livestock category T, kg dry matter animal^{-1}yr^{-1}*

$B_{0(T)}$ *= maximum methane producing capacity for manure produced by livestock category T, m³ CH_4 kg^{-1} of VS excreted*

0,67 *= conversion factor of m³ CH_4 to kilograms CH_4*

$MCF_{(S,k)}$ *= methane conversion factors for each manure management system S by climate region k, %*

$AWMS_{(T,S,k)}$= fraction of livestock category T`s manure handled using animal waste management systems S in climate region k, dimensionless

Methane conversion factors (MCF)

The default MCF values for 'cool climate regions' presented in the 2019 Refinement to the IPCC 2006 GL (Table 10.17) were used for the following systems:

- Pasture, Range, Paddock (MCF: 0.47%),
- Solid Storage (MCF: 2.00%),
- Pit storage below animal confinements (MCF: 12%)
- Anaerobic digester:
  - liquid slurry anaerobically digested (MCF: 1.00%),
  - solid storage anaerobically digested (MCF: 3.55%)
- Composting (MCF: 0.50%),
- Aerobic Treatment (MCF: 0.00%),
- Yard: the MCF of Pasture, Range, Paddock was applied (MCF: 0.47%).

As recommended by the UNFCCC Review 2023 (ARR 2023), Austria provides the following additional information on its country-specific MCF values for liquid manures of cattle and swine: According to the IPCC 2006 Guidelines, cool climates have an average temperature below 15°C. In 2023, the average temperature in Austria's cities was at maximum by about 14 °C (e.g. in Vienna); the coldest regions in Austria's mountains recorded an average of -4.5°C (Geosphere Austria, 2024a). The overall mean temperature in Austria was 8.7°C in 2023 (Geosphere Austria, 2025).

The following table provides the mean temperatures for Austria and for the village of Gross-Enzersdorf from 1990 to 2023. The Gross-Enzersdorf research station, in which the emission measurements for the development of the national MCFs have been carried out, is thus located in one of the warmest regions in Austria.

Following the 2006 IPCC Guidelines as well as the 2019 Refinement default values may not encompass the potentially wide variation within the defined categories of management systems, therefore country-specific MCFs that reflect the specific management systems used in particular countries or regions should be developed. If possible, field measurements should be conducted for each climate region to replace the default MCF values.

In order to improve the accuracy of the inventory, a three-year measurement campaign was therefore carried out in Austria by the University of Natural Resources and Applied Life Sciences from 1999 to 2002 (Amon, et al., 2002a), (Amon, et al., 2006), (Amon, et al., 2007b) In order to prevent the inventory from under-estimation, one of the warmest regions in Austria was selected for this purpose. Table 198 shows that average temperatures of the years of the measurement campaign (10.6°C, 11.5 °C and 10.4°C) are within the range of all other years and well below the 15°C threshold for a temperate climate according to the 2006 IPCC Guidelines.

Table 198: Average temperature of Austria since 1990

year	Mean temperature	Mean temperature	year	Mean temperature	Mean temperature
	Austria [°C]*	Gross-Enzers-dorf [°C]**		Austria [°C]*	Gross-Enzers-dorf [°C]**
1961–1990	6.2				
1990	7.0	10.3	2007	7.9	11.5
1991	6.1	9.3	2008	7.8	11.4
1992	7.4	10.9	2009	7.6	11.0
1993	6.8	NR	2010	6.8	9.8
1994	8.1	11.3	2011	7.8	10.9
1995	6.8	10.2	2012	7.7	11.3
1996	5.9	8.8	2013	7.5	10.8
1997	7.0	9.8	2014	8.6	11.8
1998	7.2	10.6	2015	8.3	11.8
1999	7.1	10.6	2016	8.0	11.3
2000	7.9	11.5	2017	7.8	11.4
2001	7.2	10.4	2018	8.7	12.2
2002	7.9	11.2	2019	8.5	12.1

year	Mean temperature	Mean temperature	year	Mean temperature	Mean temperature
	Austria [°C]*	Gross-Enzers-dorf [°C]**		Austria [°C]*	Gross-Enzers-dorf [°C]**
2003	7.4	10.7	2020	8.1	11.6
2004	6.9	10.3	2021	7.3	10.9
2005	6.5	10.0	2022	8.6	11.9
2006	7.1	10.6	2023	8.7	12.2

* *the average temperature for Austria from 1990 onwards is determined by adjusting the mean temperature 1961-1990 with the yearly deviation taken from the HISTALP database*[90] *provided by (Geosphere Austria, 2024b). Please refer also to https://www.umweltbundesamt.at/klima/dashboard*

***Yearbook of the ZAMG* https://www.zamg.ac.at/cms/de/klima/klimauebersichten/jahrbuch *(Geosphere Austria, 2025)*

Country specific MCF for liquid systems of cattle and swine

IPCC encourages measurements of emissions from manure management under field conditions in order to improve the basis of emission estimates. The Division of Agricultural Engineering (DAE) at the University of Natural Resources and Applied Life Sciences (BOKU) has carried out a three-year measurement campaign on emissions from manure stores financed by the Federal Ministry of Agriculture, Forestry, Environment, and Water Management and the Federal Ministry for Education, Science, and Culture. Emission rates have now been published in peer reviewed publications (Amon, et al., 2002a, Amon, et al., 2006, Amon, et al., 2007b). They can therefore be used for calculating MCF values for liquid manure systems.

Table 199: Country specific MCFs for liquid systems (Amon, et al., 2006), (Amon, et al., 2007b).

Animal Category	cold season [%]	warm season [%]
Cattle	0.97	37.22
Swine	3.27	3.87

The country specific MCFs have been applied to the amounts of liquid manure storage under cold and warm climate conditions (see Table 199). The extensive emission measurements under field conditions showed, that an increase in methane emissions during slurry storage was only observed during the summer season. The low temperature in all other seasons in Austria reduces methane formation significantly during slurry storage. Emission measurements were carried out in one of the warmest Austrian regions (research station Gross-Enzersdorf, located in the pannonian region) and therefore may tend to overestimate MCF values. As presented in Table 198 Austria´s average temperature is well below 10°C for the entire time series. Since 1990 the average temperature at the Gross-Enzersdorf research station varies between 9.8 and 12.2 °C indicating that the national MCFs from (Amon, et al., 2006), (Amon, et al., 2007b) are representative for the entire time series.

The following table presents country-specific average MCF values for liquid systems (cattle and swine) for the years 1990 to 2023. There are small annual variations of the average MCFs due to

[90] The *HISTALP-database of homogenized, monthly climatic records enables to analyse the climate change in the alps from the middle of the 18th century (Auer, et al. 2007).*

slightly changing AWMS distributions from year to year, depending on the proportion of liquid manure stored under warm conditions in summer (June, July, August) and under cold conditions (during the rest of the year): an increased proportion of liquid manure stored under cold conditions leads to slightly lower average MCFs, an increased proportion of liquid manure stored under warm conditions in summer leads to slightly higher average MCFs.

Table 200: Average MCFs of dairy and other cattle as well as swine for liquid systems 1990–2023.

year	Dairy Cattle	Other Cattle	Swine
	[%]	[%]	[%]
1990	8.4	8.4	3.4
1995	8.4	8.2	3.4
2000	8.3	8.0	3.4
2005	8.2	8.0	3.4
2010	8.4	7.9	3.4
2011	8.4	7.9	3.4
2012	8.4	7.9	3.4
2013	8.4	7.9	3.4
2014	8.4	7.9	3.4
2015	8.4	7.9	3.4
2016	8.5	7.9	3.4
2017	8.5	7.9	3.4
2018	8.5	7.9	3.4
2019	8.5	7.9	3.4
2020	8.5	8.0	3.4
2021	8.5	8.0	3.4
2022	8.5	8.0	3.4
2023	8.5	8.0	3.4

The following table presents the average MCFs for other systems for the years 1990 and 2023.

Table 201: Average MCFs for other systems 1990 and 2023.

Animal Category	1990 [%]	2023 [%]
Dairy Cattle	0.5	4.9
Other Cattle	0.5	2.6
Swine	0.5	0.8

In submission 2010 deep litter systems were introduced to the Austrian AWMS distribution (Amon, et al., 2007a). Based on new survey data (Pöllinger, et al., 2018) a differentiation into deep litter < 1 month and deep litter > 1 month has been implemented into inventory submission 2019.

For deep litter systems < 1 month the default MCF value of 2.75% for the system *cattle and swine deep bedding < 1 month* was taken (2019 IPCC GL ,Table 10.17).

In Austria manure from deep litter systems > 1 month is usually removed twice a year – in spring and in autumn. The bedding is continuously added, there is no mixing**.** Austrian measurements showed that CH_4 emissions from farmyard manure were always lower than CH_4 emissions from liquid manure. In the IPCC Refinement the default MCF for deep litter systems (6 months) equals the default MCF for liquid systems. Hence, for Austria the chosen MCF of 21% (IPCC 2019) is a conservative estimate.

Compared to the previous inventory, the average MCFs for other systems are significantly lower now, because deep litter systems are no longer included and are reported separately in accordance with the CRT. Other systems now comprise yard, separation and aerobic treatment. Solid-liquid separation is increasing since 2017, which explains the higher average MCFs in 2023 than in 1990.

MCF used for yards

In yards aerobic processes are predominant, the dung dries after excretion. Thus, seen from the microbiological point of view, conditions for methane production from dung excreted on yards are unfavourable: CH_4 is only formed under anaerobic and wet conditions. The creation of methane in yards is best reflected in the 2019 IPCC MCF of 0.47%.

Maximum methane producing capacity (B_{0i})

The IPCC default values were used (Table 10.16 (IPCC 2019)).

5.3.2.1.1 Cattle (3.B.1)

Key Source: Yes (CH_4, N_2O)

Austrian specific values for cattle are calculated dependent on annual milk yields (dairy and suckling cows), growth, activity and maintenance information as well as corresponding feed intake data (gross energy intake, feed digestibility, ash content, see chapter 5.2.2.1 and Table 202).

In submission 2022 feed intake assumptions were updated within the framework of the new country specific study on animal feeding and nutrition (Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023). Calculation of VS excretion rates follows equation 10.24 provided in (IPCC 2019).

$$VS = [GE * (1 - DE\%/100) + (UE * GE)] * [(1 - ASH)/18.45]$$

VS = *volatile solid excretion per day on a dry-organic matter basis, kg VS day*$^{-1}$
GE = *gross energy intake, MJ day*$^{-1}$
DE% = *digestibility of the feed in percent (e.g. 60 percent)*
*(UE * GE)* = *urinary energy expressed as fraction of GE. The default value of 0.04GE has been taken.*
ASH = *ash content of manure calculated as a fraction of the dry matter feed intake*
18.45 = *conversion factor for dietary GE per kg of dry matter (MJ kg-1).*

Volatile solid (VS) excretion – dairy cattle

The following table provides the parameters used for determining the VS excretion of dairy cattle. VS excretion rates increased over the time series. Information on GE intake, feed digestibility and ash content are described in chapter 5.2.2.1.

Table 202: Feed intake and VS excretion of Austrian dairy cattle for the period 1990–2023.

Year	GE intake [MJ day^{-1}]	Digestibility of feed [%]	Ash content in dry matter [%]	VS excretion [kg VS day^{-1}]
1990	253.80	66.48	8.83	4.71
1995	268.30	67.70	8.83	4.81
2000	279.55	68.58	8.83	4.89
2005	290.60	69.43	8.82	4.97
2010	296.82	69.89	8.82	5.00
2011	298.55	70.08	8.82	5.00
2012	301.97	70.37	8.81	5.02
2013	302.69	70.43	8.81	5.02
2014	303.96	70.55	8.81	5.03
2015	305.20	70.60	8.81	5.04
2016	308.25	70.87	8.81	5.05
2017	309.29	71.03	8.81	5.04
2018	312.72	71.38	8.81	5.04
2019	313.90	71.49	8.81	5.04
2020	315.86	71.65	8.81	5.05
2021	315.61	71.59	8.81	5.06
2022	315.30	71.60	8.81	5.05
2023	315.84	71.65	8.81	5.05

Volatile solid (VS) excretion – suckling cows

In submission 2022 VS excretion rates of suckling cows have been updated according to (Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023). In the table below the feed intake parameters relevant for VS excretion are provided. Further information on GE intake, feed digestibility and ash content are included in chapter 5.2.2.1.

Table 203: Feed intake and VS excretion of Austrian suckling cows for the period 1990–2023.

Year	GE intake [MJ day^{-1}]	Digestibility of feed [%]	Ash content in dry matter [%]	VS excretion [kg VS day^{-1}]
1990	231.81	65.31	11.00	4.33
1995	236.61	65.57	11.00	4.39
2000	242.31	65.84	11.00	4.46
2005	247.64	66.05	11.00	4.53
2010	249.87	66.05	11.00	4.57
2011	250.20	66.05	11.00	4.58
2012	250.92	66.05	11.00	4.59
2013	251.18	66.05	11.00	4.60
2014	251.56	66.05	11.00	4.61

Year	GE intake [MJ day-1]	Digestibility of feed [%]	Ash content in dry matter [%]	VS excretion [kg VS day-1]
2015	252.20	66.05	11.00	4.62
2016	252.76	66.05	11.00	4.63
2017	252.63	66.05	11.00	4.62
2018	252.71	66.05	11.00	4.63
2019	252.79	66.05	11.00	4.63
2020	253.13	66.05	11.00	4.63
2021	253.37	66.05	11.00	4.64
2022	253.24	66.05	11.00	4.64
2023	253.30	66.05	11.00	4.64

Volatile solid (VS) excretion – other non-dairy cattle

As for dairy and suckling cows Austrian specific values on VS excretion for all other non-dairy cattle categories were calculated in (Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023) by applying Equation 10.24 provided in (IPCC 2019).

Instead of calculations based on a constant gross energy intake as in previous submissions, dynamic VS excretion rates could be determined (see Table 204).

The data used for the calculation of VS excretion of the livestock categories *Non-Dairy Cattle* (GE intake, ash content, digestibility) is described in detail in (Hörtenhuber, et al., 2022a). As indicated in chapter 5.2.2 (see Figure 30), the other cattle categories had to be further subdivided in order to calculate at the required level of detail.

Table 204: VS excretion of Austrian other cattle categories for the period 1990–2023.

Year	Breeding heifers 1-2 years [kg VS day-1]	Fattening heifers 1-2 years [kg VS day-1]	cattle <1 year [kg VS day-1]	cattle >2 year [kg VS day-1]
1990	3.30	2.73	0.88	3.21
1995	3.27	2.73	1.05	3.22
2000	3.24	2.73	1.05	3.22
2005	3.23	2.73	1.07	3.23
2010	3.24	2.76	1.11	3.21
2011	3.25	2.76	1.12	3.23
2012	3.26	2.77	1.12	3.24
2013	3.27	2.77	1.12	3.25
2014	3.28	2.78	1.13	3.26
2015	3.29	2.78	1.13	3.27
2016	3.29	2.79	1.14	3.28
2017	3.30	2.80	1.14	3.29
2018	3.31	2.80	1.15	3.29
2019	3.33	2.81	1.16	3.29

Year	Breeding heifers 1-2 years [kg VS day^{-1}]	Fattening heifers 1-2 years [kg VS day^{-1}]	cattle <1 year [kg VS day^{-1}]	cattle >2 year [kg VS day^{-1}]
2020	3.34	2.82	1.16	3.29
2021	3.35	2.82	1.16	3.28
2022	3.35	2.81	1.16	3.29
2023	3.35	2.81	1.16	3.28

5.3.2.1.2 Swine (3.B.3)

Key Source: No

Volatile solid (VS) excretion – swine

Since submission 2022 updated country-specific VS excretion rates determined on the basis of animal diets taken from (Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023) and calculated according to equation 10.24 provided in (IPCC 2019) are used. Information on energy intake, ash content and digestibility is described in (Hörtenhuber, et al., 2022a). The following table presents the VS excretion rates for the swine categories:

Table 205: VS excretion from Austrian swine for the period 1990–2023.

Year	Breeding sows [kg VS day^{-1}]	Young & fattening pigs [kg VS day^{-1}]	Young swine 8–32 kg [kg VS day^{-1}]
1990	0.59	0.38	0.14
1995	0.60	0.38	0.14
2000	0.61	0.38	0.14
2005	0.62	0.39	0.15
2010	0.64	0.38	0.14
2011	0.64	0.38	0.14
2012	0.64	0.38	0.14
2013	0.65	0.37	0.14
2014	0.65	0.37	0.14
2015	0.66	0.37	0.13
2016	0.66	0.37	0.13
2017	0.66	0.37	0.13
2018	0.67	0.37	0.13
2019	0.67	0.37	0.13
2020	0.67	0.37	0.13
2021	0.67	0.37	0.13
2022	0.67	0.37	0.13
2023	0.67	0.37	0.13

Piglets (< 8 kg) were not taken into account because the emission factors for breeding sows already take into account the emissions of suckling piglets up to 8 kg live weight.

5.3.2.1.3 Sheep (3.B.2) and Other livestock (3.B.4: Poultry, Horses, Goats, Deer, Rabbits)

Key Source: No

CH_4 emissions of sheep, poultry, horses, goats, deer and rabbits are estimated with the Tier 2 approach (equation 10.23 of the 2019 Refinement to the 2006 IPCC GL).

The VS excretion is calculated according to (IPCC 2019) by using equation 10.24.

Table 206: Country-specific $VS_{excretion}$ rates of sheep and other livestock 1990-2023

Years	sheep	deer	goats	horses	layers	broilers	turkeys	Other poultry	rabbits
	VS excretion [kg VS day^{-1}]								
1990	0.364	0.363	0.153	1.572	0.023	0.008	0.026	0.015	0.016
1995	0.365	0.363	0.154	1.572	0.023	0.008	0.026	0.015	0.016
2000	0.366	0.363	0.154	1.572	0.023	0.008	0.026	0.015	0.016
2005	0.366	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2010	0.367	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2011	0.367	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2012	0.367	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2013	0.367	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2014	0.367	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2015	0.367	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2016	0.368	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2017	0.368	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2018	0.368	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2019	0.368	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2020	0.368	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2021	0.368	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2022	0.368	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016
2023	0.368	0.363	0.154	1.572	0.023	0.007	0.026	0.015	0.016

Values used to calculate VS_{ex}-rates are shown in Table 207. These are determined according to (IPCC 2019), required background information is based on literature and expert judgements documented in Hörtenhuber (2025). Feeding assumptions are explained in detail in chapter 5.2.2.3. For sheep, goats and broilers values are interpolated between 1990 and 2023, for all other livestock categories they are kept constant over the time series.

Table 207: Gross energy demand and digestibility of feed of sheep and other livestock in Austria

Livestock category	Year	Gross energy demand	Digestibility of feed
		[MJ animal-1 day1]	**[%]**
Sheep	1990	21.50	65.0
	2023	21.75	65.0
Goats	1990	12.59	75.0
	2023	12.68	75.0
Horses		108.50	70.0
Deer		21.44	65.0
Rabbits		1.20	75.0
Layers		1.79	75.0
Broilers	1990	1.19	87.0
	2023	1.50	89.0
Turkeys		5.58	89.0
Other Poultry*		1.52	72.5

*ducks, geese

For B_0 and MCF the 2019 IPCC default values were used. Information on animal waste management systems is indicated in Table 193.

Table 208: IPCC default values used for CH_4 calculation of sheep and other livestock in Austria.

Livestock category	CH_4 producing potential (B_0)– pasture/range paddock	CH_4 producing potential (B_0) – solid systems	MCF pasture/range /paddock	MCF solid systems	MCF digested solid
	[m^2 CH_4 kg^{-1} VS]	**[m^2 CH_4 kg^{-1} VS]**	**[%]**	**[%]**	**[%]**
Sheep	0.19	0.19	0.47	2.00	NR
Goats	0.19	0.18	0.47	2.00	NR
Horses	0.19	0.30	0.47	2.00	NR
Layers	0.19	0.39	0.47	1.50	1.00
Broilers	0.19	0.36	0.47	1.50	1.00
Turkeys	0.19	0.36	0.47	1.50	1.00
Other Poultry (ducks, geese,..)	0.19	0.36	0.47	1.50	1.00
Deer	0.19	0.19	0.47	2.00	NR
Rabbits	NR	0.32	NR	2.00	NR

Data source: IPCC 2019, Table 10.16; for rabbits (Table 10.15), Table 10.17 (MCF)

NR = not relevant

The Austrian inventory does not distinguish between horses and mules and asses. Mules and asses are included in the horse category (3.B.4.e) and are only of very little importance in Austria (please refer to chapter 5.1.7). Thus, CH_4 emissions from the manure of horses were estimated with the default values of horses.

The deer category (3.B.4.c) includes red deer, sika deer and fallow deer. Additionally, the so-called "new world camels" (e.g. llamas, alpacas, etc.) are included in this category, but are only of minor importance. According to (IPCC 2019), there are partly default values for deer available. If not, the values for sheep were applied (e.g. B_0 values), because sheep is the most similar animal category to deer.

5.3.2.2 Estimation of direct N_2O Emissions from manure management

Key Source: 3.B.1, 3.B.3, 3.B.4

Following the guidelines, all direct and indirect emissions of N_2O occurring before the manure is applied to soils (during the storage and treatment of manure or otherwise used for feed, fuel or construction purposes) are reported under manure management.

For the estimation of direct N_2O emissions from manure management systems Austria uses a Tier 2 approach. The IPCC methodology for estimating N_2O emissions from manure management entails multiplying the total amount of N excretion (from all animal species/categories) in each type of manure management system by an emission factor for that type of manure management system. Emissions are then summed over all manure management systems (see formulas below).

N excretion per animal waste management system:

$$Nex_{(S)} = \sum_{(T)}[N_{(T)} \text{ x } Nex_{(T)} \text{ x } AWMS_{(T,S)}]$$

$Nex_{(S)}$ = N excretion in manure management system S [kg yr^{-1}]
$N_{(T)}$ = number of animals of type T in the country
$Nex_{(T)}$ = N excretion of animals of type T in the country [kg N $animal^{-1}$ yr^{-1}]
$AWMS_{(T,S)}$ = fraction of $Nex_{(T)}$ that is managed in animal waste management system S for animals of type T in the country
T = type of animal category

Direct N_2O emission per animal waste management system:

$$N_2O_{(S)} = \sum[Nex_{(S)} \text{ x } EF_{3(S)}] * (44/28)$$

$N_2O_{(S)}$ = direct N_2O emissions from manure management system S in the country [kg N_2O yr^{-1}]
$Nex_{(S)}$ = N excretion in manure management system S [kg yr^{-1}]
$EF_{3(S)}$ = N_2O-N emission factor for manure management system S [kg N_2O-N per kg of Nex in $MS_{(S)}$]

Animal Waste Management System (AWMS)

The animal waste management system distribution data applied to estimate N_2O emissions from *Manure Management* is the same as used for the estimation of CH_4 emissions from *Manure Management* (see Table 194).

N excretion

In previous years country specific N excretion values were based on (Gruber, Pötsch, 2006), (Pötsch, et al., 2005), (Steinwidder, Guggenberger, 2003), (Unterarbeitsgruppe N-adhoc, 2004), (ZAR, 2004) and Richtlinien Sachgerechter Düngung (BML, 2022b). However, the feeding of cattle and swine has changed in the last two decades. Therefore, a research project on country-specific animal feeding and nutrition ("MiNutE" study, (Hörtenhuber, et al., 2022b), (Hörtenhuber, et al., 2023) has been carried out by the University of Natural Ressources and Life Sciences, Vienna. As a result, updated and representative values for energy intake, excretion of nitrogen (N_{ex}) and volatile solids (VS_{ex}) are available. New data have been included into the inventory of submission 2022.

Within the framework of this country specific study, the necessary information was compiled and derived from official statistical data, international and national technical literature, representative data from producer associations (e.g. ZAR, project "Efficient Cow" (Egger-Danner, et al., 2016)), feed analyses and feed calculations of the project partner and the feed company Fixkraft (fixkraft.at, based on the feeding strategies of their customers). The results were supplemented and revised with information from experts, e.g. feeding advisors from the chambers of agriculture, working group advisors and additional data surveys on farms.

The extensive results of the "MiNutE" study made it possible to calculate national excretion values at a much more detailed level based on the latest available scientific literature (IPCC 2019).

Cattle

The annual N excretion rates were calculated with Equation 10.31A (IPCC 2019), which can be estimated as the difference between the total nitrogen taken in by the animal and the total nitrogen retained for growth and milk production.

$$Nex_{(T)} = (N_{intake(T)} - N_{retention(T)}) * 365$$

$Nex_{(T)}$ = annual N excretion rates, kg N animal^{-1} yr^{-1}

$N_{intake(T)}$ = the daily N intake per head of animal of species/category T, kg N animal^{-1} day^{-1}

$N_{retention(T)}$ = amount of daily N intake by head of animal of species / category T, that is retained by animal of species/category T, kg N animal^{-1} day^{-1},

365 = Number of days in a year

The same dietary assumptions have been used as for modelling methane emissions from CRT sector *3.A Enteric Fermentation* (see chapter 5.2).

N intake rates are determined by applying equation 10.32 (IPCC 2019) based on the gross energy intake and crude protein in dry matter. The energy demand of cattle has been also calculated by applying the 2019 Refinement to the 2006 IPCC GL, taking into account body mass and weight gain performance, husbandry, milk yield, gestation and feeding parameters. Crude protein in dry matter was calculated using data from different national studies (Egger-Danner, et al., 2016), (Häusler, Steinwidder, 2004), (Steinwidder, Guggenberger, 2003), (Gruber, Steinwender, 1992) and is detailed documented in (Hörtenhuber, et al., 2022a).

N retention rates are calculated by applying equation 10.33 of the 2019 Refinement to the 2006 IPCC GL. For dairy and suckling cows the respective milk yields and protein in milk is taken into account. Milk yields are presented in Table 209. For dairy cows the milk yield is provided annually by Statistics Austria, published in (BML, 2024a). For suckler cows an annual milk yield of 3 000 kg for 1990 and of 3 500 kg for the years from 2004 onwards was determinded (Häusler, 2009). Data on the average fat content and protein content of milk from dairy cows for the years 1991–2023 were derived from information provided by AgrarMarkt Austria (AMA). Due to missing data for the year 1990, the value of 1991 was adopted. Similar to dairy cows, the AMA data on the average fat and protein content of delivered has been used as the measured milk fat content of cows of beef breeds does not differ significantly to those of dairy cows according to (Scholz, et al., 2001). For the other cattle categories the average daily weight gain and net energy for growth are the parameters needed. The average daily weight gain was determined on the basis of national studies, detailed described in (Hörtenhuber, et al., 2022a). Net energy for growth has been calculated by applying equation 10.15 (IPCC 2019).

Table 209: Austria specific N excretion values of dairy and suckling cows for the period 1990–2023.

Year	**Dairy cows**		**Suckling cows**	
	Milk yield [kg yr^{-1}]	**Nitrogen excretion [kg/animal*yr]**	**Milk yield [kg yr^{-1}]**	**Nitrogen excretion [kg/animal*yr]**
1990	3 791	91.05	3 000	72.18
1995	4 619	92.44	3 179	72.85
2000	5 210	93.92	3 357	74.14
2005	5 783	97.00	3 500	75.46
2010	6 100	99.88	3 500	76.37
2011	6 227	100.57	3 500	76.44
2012	6 418	102.15	3 500	76.71
2013	6 460	102.38	3 500	76.76
2014	6 542	103.08	3 500	76.95
2015	6 579	103.65	3 500	77.20
2016	6 759	104.88	3 500	77.30
2017	6 865	105.13	3 500	77.25
2018	7 104	106.10	3 500	77.23
2019	7 179	106.37	3 500	77.20
2020	7 286	106.94	3 500	77.28
2021	7 249	106.90	3 500	77.37
2022	7 250	107.10	3 500	77.48
2023	7 287	107.04	3 500	77.40

[1] *From 1995 onwards data have been revised by Statistik Austria, which led to significant higher milk yield data of Austrian dairy cows.*

Table 210: Austria specific N excretion values of other cattle for the period 1990–2023.

Year	**Nitrogen excretion [kg/animal*yr]**			
	breeding heifers 1–2 years	**fattening heifers & bulls & oxen 1–2 years**	**cattle <1 year**	**cattle >2 year**
1990	60.17	58.53	30.53	63.75
1995	59.64	58.46	33.18	63.40
2000	59.02	58.14	33.74	63.10
2005	58.79	57.51	34.60	62.75
2010	59.06	57.93	36.35	62.46
2011	59.17	58.00	36.45	62.66
2012	59.31	58.17	36.41	62.90

Year	Nitrogen excretion [kg/animal*yr]			
	breeding heifers 1–2 years	fattening heifers & bulls & oxen 1–2 years	cattle <1 year	cattle >2 year
2013	59.51	58.37	36.25	63.12
2014	59.74	58.48	36.20	63.34
2015	59.84	58.57	36.30	63.54
2016	59.98	58.62	36.37	63.75
2017	60.15	58.66	36.43	63.90
2018	60.34	58.67	36.50	63.90
2019	60.63	58.78	36.70	63.92
2020	60.88	58.97	36.82	63.96
2021	60.95	59.01	36.78	63.83
2022	61.02	58.93	35.93	63.96
2023	61.07	58.98	35.98	63.85

Swine

Annual N excretion rates of the categories breeding pigs (sows and boars), piglets 8-32 kg, and fattening pigs were calculated using equation 10.31A provided in the 2019 Refinement to the IPCC 2006 GL.

N intake rates for swine are estimated with equation 10.32A taking into account dry matter intake per day during a specific growth stage and the crude protein in dry matter for growth stage.

Following the 2019 Refinement to the IPCC 2006 Guidelines, the N retention rates vary among different swine categories. So, for breeding sows equation 10.33A, for piglets equation 10.33B and for fattening pigs equation 10.33C have been applied.

Information on performance indicators (daily gain of weight, average slaughter weights, etc.), feed quantities (energy requirements, crude protein content per kg feed, information N-reduced feeding etc.) and components of feed rations is summarized in (Hörtenhuber, et al., 2022a).

Table 211: Austria specific N excretion values of swine for the period 1990–2023.

Year	Nitrogen excretion [kg/animal*yr]		
	breeding sows plus litter	fattening pigs	piglets 8–32 kg
1990	23.2	14.8	3.7
1995	22.9	14.6	3.7
2000	22.6	14.5	3.8
2005	22.3	14.3	3.8
2010	22.3	13.8	3.6
2011	22.3	13.7	3.6
2012	22.3	13.6	3.6
2013	22.3	13.5	3.5
2014	22.3	13.4	3.5

Year	Nitrogen excretion [kg/animal*yr]		
	breeding sows plus litter	fattening pigs	piglets 8–32 kg
2015	22.2	13.3	3.5
2016	22.2	13.2	3.5
2017	22.2	13.1	3.4
2018	22.2	13.0	3.4
2019	22.1	12.9	3.4
2020	22.1	12.9	3.4
2021	22.1	12.9	3.4
2022	22.1	12.9	3.4
2023	22.1	12.9	3.4

Other livestock

N excretion values are estimated by using the Tier 2 methodology of the 2019 Refinement of the 2006 IPCC GL, equation 10.31A, option 2.

Feeding assumptions and parameters used for the respective animal category are described in chapter 5.2.2.3.

Table 212: Austria specific N excretion values of non-key livestock categories according to (IPCC 2019).

Years	Sheep	Goats	Horses	Laying Hens	Broil-ers	Tur-keys	Other poultry	Deer	Rab-bits
	Nitrogen excretion [kg animal^{-1} year^{-1}]								
1990	8.24	4.17	40.70	0.57	0.47	1.88	0.93	8.11	0.20
1995	8.26	4.17	40.70	0.56	0.43	1.82	0.93	8.11	0.20
2000	8.28	4.18	40.70	0.55	0.40	1.76	0.93	8.11	0.20
2005	8.29	4.19	40.70	0.55	0.37	1.69	0.93	8.11	0.20
2010	8.31	4.19	40.70	0.54	0.33	1.63	0.93	8.11	0.20
2011	8.31	4.19	40.70	0.54	0.33	1.62	0.93	8.11	0.20
2012	8.32	4.20	40.70	0.54	0.32	1.61	0.93	8.11	0.20
2013	8.32	4.20	40.70	0.54	0.31	1.59	0.93	8.11	0.20
2014	8.32	4.20	40.70	0.54	0.31	1.58	0.93	8.11	0.20
2015	8.33	4.20	40.70	0.54	0.30	1.57	0.93	8.11	0.20
2016	8.33	4.20	40.70	0.53	0.29	1.56	0.93	8.11	0.20
2017	8.33	4.20	40.70	0.53	0.29	1.54	0.93	8.11	0.20
2018	8.34	4.20	40.70	0.53	0.28	1.53	0.93	8.11	0.20
2019	8.34	4.20	40.70	0.53	0.27	1.52	0.93	8.11	0.20
2020	8.34	4.21	40.70	0.53	0.27	1.51	0.93	8.11	0.20
2021	8.35	4.21	40.70	0.53	0.26	1.49	0.93	8.11	0.20
2022	8.35	4.21	40.70	0.53	0.25	1.48	0.93	8.11	0.20
2023	8.35	4.21	40.70	0.53	0.25	1.47	0.93	8.11	0.20
Trend 90-23	**1.3%**	**1.0%**	**0.0%**	**-7.0%**	**-47.2%**	**-22.1%**	**0.0%**	**0.0%**	**0.0%**

Livestock numbers per category can be found in Table 169, Table 170 and Table 171. Data on manure management system distribution is presented in Table 193 and Table 194.

Emission factors

N_2O emission factors of the 2019 Refinement to the 2006 IPCC Guidelines have been used for all AWMS.

Emission factors applied in the Austrian inventory are listed in the following table.

Table 213: Emission factors for N_2O from manure management.

Animal Waste Management System	Emission factor [kg N_2O-N per kg N excreted]	Reference
Liquid/Slurry	0.004*	IPCC 2019, Table 10.21
Pit storage below animal confinements	0.002	IPCC 2019, Table 10.21
Solid Storage	0.01	IPCC 2019, Table 10.21
Pasture/Range/Paddock (cattle, poultry and pigs)	0.004	IPCC 2019, Table 11.1
Pasture/Range/Paddock (sheep and ´other animals´)	0.003	IPCC 2019, Table 11.1
Composting	0.005	IPCC 2019, Table 10.21
Aerobic Treatment	0.01	IPCC 2019, Table 10.21
Anaerobic Digester	0.0006	IPCC 2019, Table 10.21
Deep Litter	0.010	IPCC 2019, Table 10.21
Poultry manure (with/without litter)	0.001	IPCC 2019, Table 10.21

* *The average N_2O emission factor of liquid slurry was calculated from the proportion of untreated slurry without national crust (zero emissions following IPCC, 2019) and the proportion which is aerated, covered, or with natural crust (EF of 0.005 following IPCC, 2019).*

Yard

In the IPCC Guidelines no emission factor for yard is available. It is assumed, that the storage of the yard manure equals the average manure management systems distribution in Austria (see Table 193 and Table 194). Thus, the implied N_2O emission factor of all systems (except pasture) has been used.

Scientific background for this approach:

N_2O emissions result from the interaction of manure N with organic carbon that is present in soils and in straw. This explains the higher IPCC N_2O EFs of pasture, solid systems or composting compared to liquid slurry EF or the EF of slurry from anaerobic digesters. The presence of organic carbon favours N_2O formation. Applying the N_2O EF of pasture or solid systems for N_2O emissions from yards would result in an overestimation of N_2O emissions, as there is neither soil-C nor straw-C in the yard.

Manure excreted in yards regularly (daily) enters the storage; urine is continuously discharged to the storage. Keeping the high uncertainties of N_2O emissions in mind, the weighted implied N_2O EFs of all systems (except pasture) per animal category are a conservative approach that tends to overestimate yard emissions, as these values include high shares of solid storage systems.

Table 214: N_2O emission factors used for the calculation of N_2O from yards 1990–2023.

Year	Dairy	Non-Dairy	Swine
		[kg N_2O-N per kg N excreted]	
1990	0.006	0.006	0.006
1995	0.006	0.006	0.006
2000	0.006	0.007	0.006
2005	0.006	0.007	0.006
2010	0.006	0.006	0.005
2011	0.006	0.006	0.006
2012	0.006	0.006	0.005
2013	0.006	0.006	0.005
2014	0.005	0.006	0.005
2015	0.005	0.006	0.005
2016	0.005	0.006	0.005
2017	0.005	0.006	0.005
2018	0.005	0.006	0.005
2019	0.005	0.006	0.005
2020	0.005	0.006	0.006
2021	0.004	0.006	0.006
2022	0.004	0.006	0.006
2023	0.004	0.005	0.006

For the calculation of the losses of gaseous N species (NH_3-N, NO_x-N, N_2) the mass-flow procedure pursuant to EMEP/EEA methodologies (EEA 2023) has been applied. A brief description of methodologies and emission factors applied in the Austrian NH_3 and NO_x inventory under the NEC Directive as well as the UNECE/LRTAP convention is provided in chapter 5.4.2.1.

5.3.2.3 Estimation of indirect N_2O emissions from manure management (3.B.5)

Key Source: Yes (Tier 2)

Following the 2006 IPCC Guidelines and the 2019 Refinement, indirect N_2O emissions from atmospheric deposition result from volatile nitrogen losses primarily occurring in the forms of ammonia and nitric oxide. Nitrogen losses begin at the point of excretion and continue through on-site management in storage and treatment systems. Further nitrogen can be lost through run-off and leaching into soils from the solid storage of manure at outdoor areas.

Indirect N_2O emissions through N-leaching and run-off from manure storage

Relevant information concerning Austria's animal housings and manure storage systems was derived from national publications, recommendations and regulations, i.e. from ÖKL (Österreichisches Kuratorium für Landtechnik und Landentwicklung), from the Austrian Institute of Construction Engineering (OIB) and on regional regulations of the federal states of Lower Austria (Niederösterreich) and Salzburg.

According to ÖKL-Merkblatt 24 (ÖKL 2011), a watertight construction of animal housings and manure storage systems is generally required. Water tightness has to be certificated for funding administrations. Furthermore, the tightness of the constructions is required in construction laws of the federal states and the Austrian Institute of Construction Engineering (OIB) (section 3.4.2 in OIB Guideline 3) (OIB 2011).

The OIB Guideline 3[91] is directly implemented in the laws of all federal states' in Austria except for Salzburg and Lower Austria. Lower Austria and Salzburg implemented comparable laws, which ensure the closeness of animal housing and storage constructions. A demand on tightness can also be derived from Austrian laws concerning groundwater protection (§ 30) and according to environmental protection regulations of the federal states (Kreuzhuber, 2013), documented in (Amon, Hörtenhuber, 2014).

Considering the legal background in Austria, leaching from sector manure management does not occur in Austria and is thus reported as "not occurring".

Indirect N_2O emissions through volatilization losses from manure management

Following the 2019 Refinement to the 2006 IPCC GL, indirect N_2O emissions due to volatilization of N from manure management were calculated using Tier 2 methodology. Austria considers a detailed flow of nitrogen throughout the animal housing and manure management systems.

The indirect N_2O emissions from volatilization of N in forms of NH_3 and NO_x are estimated following equation 10.26 (IPCC 2019) multiplied with the default IPCC emission factor presented in the 2019 Refinemet to the IPCC 2006 GL in Table 11.3, which is 0.01 kg N_2O-N (kg NH_3-N+NO_x-N volatilised).

$$N_{volatilisation\text{-}AWMS} = \sum_S [\sum_{T,P} [(N_{(T,P)} * Nex_{(T,P)} * AWMS_{(T,S,P)}) + N_{cdg(S)}) * (Frac_{GasMS\ (T,S)})]] * EF$$

$N_{(T,P)}$ = *number of head of livestock species/category T, for productivity system P, when applicable*

$Nex_{(T,P)}$ = *annual average N excretion per head of species/category T, for productivity system P, when applicable in kg N animal^{-1} yr^{-1}*

$N_{cdg(S)}$ = *amount of nitrogen from co-digestates added to bioga*s plants such as food wastes or *purpose grown crops, kg N yr^{-1} where the system (s) refers exclusively to anaerobic digestion*

P = *productivity class, high or low, to be considered if using the Tier 1a approach*

$AWMS_{(T,S)}$ = *fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure system S*

$Frac_{GasMS}$ = *percent of managed manure nitrogen for livestock category T that volatilizes as NH_3 and NO_x in the manure management system S,%*

The country specific value of $Frac_{GasMS}$ includes the following N losses calculated within the Austrian N-flow model:

- NH_3-N losses from housing, storage, yard
- NO_x-N losses from manure management

[91] http://www.oib.or.at/

Table 215: NH_3-N and NO_x-N volatilisation losses as well as N_2-losses of manure management systems 1990 to 2023.

Year	N losses from manure management systems total	NH_3-N losses from manure management systems	NO_x-N losses from manure management systems	N_2-losses from manure management systems	$Frac_{GASMS}$*
	[t N/yr]	[kg N/yr]	[kg N/yr]	[kg N/yr]	(N_{losses}/Nex)
1990	40 278	29 286 415	354 582	10 637 465	0.15
1995	39 847	29 368 143	337 434	10 141 527	0.16
2000	37 456	27 860 486	308 920	9 286 204	0.16
2005	36 820	27 659 929	294 874	8 865 206	0.17
2010	37 155	28 628 671	274 374	8 251 736	0.17
2011	36 609	28 318 663	266 746	8 023 582	0.17
2012	36 388	28 272 727	261 099	7 854 403	0.17
2013	36 259	28 286 005	256 482	7 716 331	0.17
2014	36 343	28 470 923	253 230	7 619 262	0.17
2015	36 394	28 637 251	249 476	7 507 072	0.18
2016	36 435	28 799 248	245 581	7 390 660	0.18
2017	36 528	29 027 010	241 204	7 259 904	0.18
2018	35 951	28 740 294	231 848	6 979 290	0.18
2019	35 409	28 489 349	222 431	6 696 844	0.18
2020	35 114	28 446 886	214 282	6 452 652	0.18
2021	34 983	28 534 919	207 213	6 241 033	0.18
2022	34 385	28 266 605	196 542	5 921 400	0.18
2023	33 593	27 791 991	186 320	5 614 620	0.18

** FracGASMS according to IPCC 2019: sum of NH_3-N and NO_x-N losses*

5.3.3 Category-specific QA/QC

In the categories *3.B.1* (cattle) and *3.B.3* (swine) the following source specific QA/QC procedures have been carried out:

- ✓ VS and N excretion data elaborated by national experts (Agricultural Research and Education Centre Raumberg-Gumpenstein, University of Natural Resources and Applied Life Sciences), derived from peer reviewed sources;
- ✓ Surveys on AWMS conducted by scientific experts;
- ✓ Country specific MCF derived from peer reviewed studies;
- ✓ Differences to default values explained and documented;
- ✓ Rationale for selecting MCFs and EFs explained and documented;
- ✓ Audit of data supplier: milk yield data (Statistik Austria), livestock data;
- ✓ External review by Austrian agricultural experts (stakeholder meetings "inventory talks" 2010) (Umweltbundesamt, 2010b),
- ✓ Expanded QA and verification activities in 2012: in-depth review of the agriculture model.

- ✓ Expanded QA/QC of the software tool (calculation sheets) for new and revised sources (e.g. crop residues, energy crops performed in 2015)
- ✓ External review of the revised agricultural model according to the 2006 IPCC GL by Austrian agricultural experts: stakeholder meeting "inventory talks" 2014 (Umweltbundesamt, 2014a).
- ✓ External review of the revised agricultural model (Amon, Hörtenhuber, 2019) according to the new data on the agricultural practice (PÖLLINGER et al. 2018) by Austrian agricultural experts: stakeholder meeting "inventory talks" 2018 (Umweltbundesamt, 2018).
- ✓ External review of the updated and representative values for nitrogen and energy intake, excretion of nitrogen (N_{ex}) and volatile solids (VS_{ex}) based on the research project on country-specific animal feeding and nutrition ("MiNutE" study, (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023) by Austrian agricultural experts.
- ✓ Verification of the calculations for NH_3 emissions from animal husbandry with the *3.B Manure Management N flow tool* of the EEA.
- ✓ Verification of the Austrian inventory results with the AgrEE Tool (Umweltbundesamt, 2024e)
- ✓ External review of the revised agricultural model (Hörtenhuber, 2025) according to the new data on the agricultural practice (Pöllinger, et al., 2025), the implementation of the 2019 IPCC Refinement and improvements in the ammonia inventory by Austrian agricultural experts: stakeholder meeting "inventory talk" 2025 (Umweltbundesamt, 2025c).

Sector specific routine control procedures are provided in chapter 5.1.4.

5.3.4 Uncertainties

Uncertainties are presented in Table 165.

5.3.5 Recalculations

Update of activity data

Please refer to chapter 5.1.6.

Improvements of methodologies and emission factors

3.B Manure Management (CH_4, direct and indirect N_2O)

Methane and N_2O emissions have been revised by using new and updated activity data (AWMS data, feeding and nutrition, livestock data, new emissions source of rabbits, biogas - see chapter 5.1.6) and the 2019 Refinement of the IPCC GL for all livestock categories. In particular, the implementation of the manure management system 'pit storage below animal confinements' resulted in higher CH_4 emissions over the entire time series.

Revisions of the ammonia inventory showed an increasing effect on emission levels of indirect N_2O emissions. The update of the total ammoniacal nitrogen (TAN) values for liquid and solid manure of cattle and swine resulting in higher ammonia emissions had the most significant impact. TAN values used in previous submissions taken from (Schechtner, 1991) were amongst the lowest in European countries. Revised values were derived from measurement data from (Pötsch, 2019) and adjusted with the N-losses provided in the German and Swiss inventories.

In total, the entire time series of 3.*B Manure Management* was revised upwards (+5.7 kt CH_4 for 2022, +0.4 kt N_2O total for 2022).

5.4 Agricultural soils (CRT Category 3.D)

Key source: N_2O from 3.D.1 and 3.D.2

5.4.1 Source Category Description

N_2O emissions from the source categories *3.D.1 Direct soil emissions* and 3.*D.2 Indirect soil emissions* are key categories.

In 2023 79.4% of total N_2O emissions from agriculture (57.8% of total Austrian N_2O emissions) originated from agricultural soils, the rest stemmed from manure management.

Emissions from this category (N_2O) contributed 2.6% (1 777.96 kt CO_2 equivalents) to Austria's total greenhouse gas emissions in the year 2023. This is 23.8% of all GHG emissions from the sector agriculture.

The trend of N_2O emissions from this category is decreasing: in 2023 emissions were 14.2% below 1990 levels.

Table 216 presents N_2O emissions of agricultural soils by sub-category as well as their trends and their share in total N_2O emissions.

Table 216: N_2O emissions from agricultural soils, 1990–2023.

	N_2O emissions [kt]													
Year	**3.D Total**	**3.D.1 Direct Soil Emissions**	**Inorganic N-Fertilisers**	**Organic N- Fertiliser**	Animal manure applied to soils	Sewage sludge applied to soils	Other organic fertilizers applied to soils	**Urine and dung deposited by grazing**	**Crop Residues**	**Mineralization**	**Organic Soils**	**3.D.2 Indirect Soil Emissions**	**Athm. Deposition**	**Nitrogen Leaching and run-off**
1990	7.82	6.06	2.20	2.42	2.40	0.02	0.00	0.11	1.18	0.01	0.14	1.76	0.75	1.01
1995	7.37	5.73	2.00	2.32	2.27	0.03	0.02	0.09	1.17	0.01	0.14	1.64	0.68	0.96
2000	7.58	5.96	1.89	2.17	2.11	0.03	0.03	0.07	1.67	0.01	0.14	1.62	0.63	0.99
2005	7.22	5.70	1.58	2.10	2.02	0.02	0.06	0.06	1.82	0.01	0.14	1.52	0.58	0.94
2010	6.78	5.31	1.39	2.15	2.04	0.03	0.08	0.06	1.56	0.01	0.14	1.47	0.59	0.88
2011	7.21	5.68	1.63	2.12	2.01	0.03	0.08	0.06	1.72	0.01	0.14	1.53	0.59	0.94
2012	7.08	5.57	1.69	2.11	2.00	0.03	0.09	0.06	1.56	0.01	0.14	1.51	0.59	0.92
2013	6.97	5.47	1.65	2.10	1.99	0.02	0.09	0.06	1.51	0.01	0.14	1.50	0.59	0.91
2014	7.31	5.76	1.76	2.11	2.00	0.02	0.09	0.06	1.68	0.01	0.14	1.56	0.60	0.95
2015	7.31	5.75	1.90	2.11	2.00	0.03	0.09	0.06	1.51	0.01	0.14	1.56	0.61	0.95

N₂O emissions [kt]															
Year	**3.D Total**	**3.D.1 Direct Soil Emissions**	**Inorganic N-Fertilisers**	**Organic N- Fertiliser**	Animal manure applied to soils	Sewage sludge applied to soils	Other organic fertilizers applied to soils	**Urine and dung deposited by grazing**	**Crop Residues**	**Mineralization**	**Organic Soils**	**3.D.2 Indirect Soil Emissions**	**Athm. Deposition**	**Nitrogen Leaching and run-off**
2016	7.62	6.01	1.99	2.13	2.00	0.03	0.09	0.06	1.67	0.01	0.14	1.62	0.62	0.99
2017	7.31	5.74	1.89	2.13	2.01	0.03	0.09	0.06	1.50	0.01	0.14	1.57	0.62	0.95
2018	7.15	5.62	1.81	2.09	1.97	0.03	0.09	0.07	1.49	0.01	0.14	1.53	0.60	0.93
2019	7.01	5.52	1.66	2.06	1.94	0.03	0.09	0.07	1.58	0.01	0.14	1.49	0.58	0.92
2020	7.07	5.57	1.68	2.04	1.93	0.03	0.09	0.07	1.61	0.01	0.14	1.50	0.57	0.92
2021	7.08	5.58	1.75	2.04	1.93	0.03	0.08	0.08	1.56	0.02	0.14	1.50	0.57	0.93
2022	6.88	5.43	1.59	2.02	1.91	0.03	0.08	0.08	1.55	0.04	0.14	1.46	0.56	0.90
2023	6.71	5.29	1.47	1.98	1.87	0.03	0.08	0.09	1.58	0.04	0.14	1.42	0.54	0.88
Share 2023	**100.0%**	**78.9%**	**22.0%**	**29.5%**	**27.8%**	**0.5%**	**1.1%**	**1.3%**	**23.5%**	**0.5%**	**2.1%**	**21.1%**	**8.0%**	**13.1%**
1990–2023	**-14.2%**	**-12.7%**	**-33.0%**	**-18.3%**	**-22.0%**	**59.6%**	**4117.4%**	**-22.8%**	**33.4%**	**338.9%**	**0.0%**	**-19.6%**	**-28.3%**	**-13.2%**

5.4.2 Methodological Issues

Austria uses IPCC Tier 1 and country specific methodologies for the calculation of N_2O emissions from agricultural soils. In response to recommendations of the ERT (ARR 2013, para 51 and 52) additional descriptions of the Austrian N-flow model have been included since NIR 2014 (see Annex 5.1).

Table 217: N_2O emission factors for agricultural soils.

Category	Emission Factor [kg N_2O-N/kg N]	Source
3.D.1 Direct N_2O Emissions from Managed Soils		
a. Inorganic N fertilizers b. Organic N fertilizers i. Animal manure applied to soils ii. Sewage sludge applied to soils iii. Other organic fertilizers applied to soils (energy crops from biogas plants, compost)	0.01	IPCC 2019 (Table 11.1)
c. Urine and dung deposited by grazing animals (cattle, pigs, poultry)	0.004	IPCC 2019 (Table 11.1)
c. Urine and dung deposited by grazing animals (sheep and ´other animals´)	0.003	IPCC 2019 (Table 11.1)
d. Crop residues	0.01	IPCC 2019 (Table 11.1)
e. Mineralization/immobilization associated with C-losses	0.01	IPCC 2019 (Table 11.1)

Category	Emission Factor [kg N_2O-N/kg N]	Source
f. Cultivation of organic soils	3.65 [kg N_2O-N/ha]: grassland 7.66 [kg N_2O-N/ha]: cropland	(Umweltbundesamt, 2025d)
3.D.2 Indirect N2O Emissions from managed soils		
a. Atmospheric deposition	0.01	IPCC 2019 GL (Table 11.3)
b. Nitrogen leaching (and run-off)	0.011	IPCC 2019 GL (Table 11.3)

Activity Data

Data for necessary input parameters (activity data) were taken from the following sources:

Table 218: Data sources for nitrogen input to agricultural soils.

Category	Activity Data Sources
3.D.1 Direct soil emissions	
Inorganic N fertilizers (mineral fertilizers)	Total mineral fertilizer consumption (including urea): National data provided by Agrarmarkt Austria (AMA) and published annually in the official national reports "Grüne Berichte" (BML, 2024a)1).
Animal manure applied to soils	Calculations within source category 3.B
Sewage sludge applied to soils	Water Quality Report 2000 (Philippitsch, et al., 2001), Report on sewage sludge (Umweltbundesamt, 1997), Austrian report on water pollution control (BMLFUW, 2002a), Data deliveries from Austria's federal provinces (Umweltbundesamt, 2011-2024b)
Other organic fertilizers applied to soils	Energy crops from biogas plants: Ökostromberichte 2006–2021 (E-CONTROL, 2006–2021), EAG-Monitoringbericht 2022 (E-CONTROL, 2022-2024), HKN-database (E-CONTROL, 2024a); raw material balances for 2007, 2009, 2011, 2014, 2015, 2016, 2017 & 2018 (E-CONTROL, 2006–2021), (E-CONTROL, 2022-2024); (Kompost- und Biogasverband, 2024) Compost application: AD elaborated from treated amounts in composting plants (chapter waste, Table 321) and application paths worked out by (Umweltbundesamt, 2015)
Urine and dung deposited by grazing animals	Calculations within source category 3.B
Crop residues	Harvest amounts of agricultural crops (BML, 2024a)
Mineralization/immobilization associated with C-losses	C losses reported in sub category 4.B.1.3 'Perennial converted to annual' (see chapter LULUCF)
Cultivation of organic soils	Organic soils area (grassland and cropland) is estimated on the basis of (Umweltbundesamt, 2025d)
3.D.2 Indirect soil emissions	
Atmospheric deposition	Amount of manure left for spreading calculated within source category 3.B. Mineral fertilizer data obtained from (BML, 2024a)1)
Nitrogen leaching (and run-off)	see above (synthetic fertilizers, animal waste, sewage sludge)

[1)] *Agrarmarkt Austria Marketing (https://www.ama.at) is Austria's entity preparing the national mineral fertilizer statistics annually published in (BML, 2024a) (www.gruenerbericht.at and www.agraroekonomik.at).*

Mineral fertilizer application

Austria's official national mineral fertilizer statistics (total amounts, including urea) is compiled by Agrarmarkt Austria, AMA, and annually published by the Austrian Federal Ministry of Agriculture, Forestry, Regions and Water Management in its official reports (BML, 2024a).

The S & A report 2004 noticed high inter-annual variations in N_2O emissions of sector *3.D.1.a Inorganic N-fertilizers*. These variations are caused by the effect of storage: Sales data are changing very rapidly due to changing market prices. Additionally, the fertilizer tax intensified this effect at the beginning of the 1990ies. However, not the whole amount purchased is applied in the year of purchase. Considering this effect, Austria uses the arithmetic average of each two years as activity data. For reasons of transparency, the time series of fertilizer sales data, presented in Table 219, includes the year 1989 as starting point as Austria uses the average mean of sold fertilizers of the years 1989 and 1990 as activity data for 1990.

In the in-country review 2007 it was recommended to consider revising the time series by determining actual fertilizer use in accordance with the IPCC good practice guidance. However, investigations showed that data on the actual fertilizer use are not available in Austria. Therefore it has been decided to continue to use the official fertilizer sales data as input data for the emission inventory. The UNFCCC centralized review 2008 considered the use of fertilizer sales data as an appropriate alternative (ARR 2008, para 50). Austria's approach is fully in line with the 2006 IPCC Guidelines, *Chapter 11.2.1.3 – Choice of activity data*, which states that annual fertiliser consumption data may be collected from official country statistics, often recorded as fertiliser sales and/or as domestic production and imports. In 2016 the UNFCCC centralized review confirmed the Austrian approach (ARR 2016, para A.6).

Time series for fertilizer consumption is presented in Table 219. For detailed information on different types of mineral fertilizers used in Austria, please refer to "Austria's Informative Inventory Report 2025 – Submission under the UNECE Convention on Long-range Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants" (Umweltbundesamt, 2025b).

Table 219: Mineral fertilizer N consumption in Austria 1990–2023 and arithmetic average of each two years.

Year	Annual Nutrient Sales Data [t N/yr]	Weighted Nutrient Consumption [t N/yr]
1989	140 916	–
1990	139 042	139 979
1995	128 000	127 368
2000	121 600	120 550
2005	99 700	100 250
2010	90 629	88 465
2011	116 751	103 690
2012	97 721	107 236
2013	112 005	104 863
2014	111 615	111 810
2015	130 252	120 934
2016	122 623	126 438

Year	Annual Nutrient Sales Data [t N/yr]	Weighted Nutrient Consumption [t N/yr]
2017	117 704	120 163
2018	113 136	115 420
2019	98 234	105 685
2020	115 676	106 955
2021	106 483	111 080
2022	96 253	101 368
2023	91 454	93 853

Data source: AMA data (Agrarmarkt Austria, www.ama.at) published in the "Green Reports" of the Federal Ministry of Agriculture, Forestry, Regions and Water Management (BML, https://www.bml.gv.at/): https://gruenerbericht.at/cm4/

Legume cropping areas

The yearly numbers of the legume cropping areas were taken from official statistics (BML, 2024a) and (Statistik Austria, 1990-2024).

Table 220: Cropped area legume production and others, 1990–2023.

	Areas [ha]						
Year	peas	soja beans	horse/field beans	clover hey, lucerne, …	Other forage renewed annually*	Meadows ploughed every four years**	Cover crops***
1990	40 619	9 271	13 131	57 875	3 650	39 233	3 000
1995	19 133	13 669	6 886	71 024	4 928	40 586	73 379
2000	41 114	15 537	2 952	74 266	4 087	56 794	437 276
2005	36 037	21 429	3 549	88 974	9 185	76 501	475 938
2010	13 562	34 378	4 344	106 080	16 525	59 169	300 969
2011	11 715	38 123	6 028	104 800	17 162	58 534	303 121
2012	10 704	37 126	6 852	104 808	18 046	56 794	301 810
2013	7 248	42 027	6 194	101 861	17 326	60 087	285 509
2014	6 863	43 832	7 862	102 369	18 203	59 899	269 812
2015	7 274	56 895	10 780	100 364	18 592	57 503	276 689
2016	7 733	49 791	10 823	96 672	18 266	52 117	275 547
2017	6 721	64 467	10 296	94 209	17 477	50 029	268 515
2018	6 917	67 624	7 645	96 098	20 445	52 431	278 946
2019	5 333	69 207	5 713	101 671	22 785	53 098	269 682
2020	5 616	68 424	5 492	104 449	24 559	50 440	261 238
2021	5 652	76 430	6 188	100 351	22 390	50 602	250 557
2022	5 880	93 142	5 538	94 726	21 508	48 194	259 637
2023	7 072	87 577	6 041	87 408	24 507	45 827	279 415

* *value for 1991 is interpolated as no data is available*

** *(BML, 2024a), 1991–1994 and 1996 (Statistik Austria, 1990-2024)*

*** *greening variants A+B+C+D until 2014. From 2015 onwards a new funding period started (BML, 2024a). Only small amounts before 1995.*

Harvest Data

Harvest data and data of the cultivated area were taken from (BML, 2024a) and the datapool of (Bundesanstalt für Agrarwirtschaft und Bergbauernfragen, 2024) and are presented in Table 221: and Table 222.

Table 221: Harvest Data I, 1990–2023.

	Harvest [1 000 t]									
Year	**corn**	**wheat**	**rye**	**barley**	**oats**	**maize (corn)**	**Other* cereals**	**potato**	**sugar beet**	**fodder beet**
1990	5290	1404	396	1521	244	1620	104	794	2494	171
1995	4452	1301	314	1065	162	1474	136	724	2886	85
2000	4490	1313	183	855	118	1852	171	695	2634	47
2005	4880	1453	164	880	128	2021	234	763	3084	17
2010	4776	1518	161	778	98	1956	265	672	3132	11
2011	5669	1782	202	859	110	2453	263	816	3456	12
2012	4839	1275	205	662	93	2351	252	665	3114	10
2013	4545	1598	235	734	87	1639	252	604	3466	8
2014	5658	1804	233	846	106	2334	335	751	4244	11
2015	4784	1726	171	840	96	1638	312	536	2853	7
2016	5642	1970	188	860	95	2180	349	767	3534	8
2017	4813	1437	129	782	77	2076	313	653	2994	8
2018	4747	1371	177	695	75	2130	299	698	2150	6
2019	5363	1605	201	833	78	2299	348	751	1965	5
2020	5595	1660	219	870	84	2412	350	886	2092	6
2021	5226	1529	152	738	89	2435	284	770	3017	5
2022	5118	1685	168	758	84	2114	308	686	2710	5
2023	5139	1721	175	763	60	2105	315	594	2645	4

* *mixed grain, triticale*

Table 222: Harvest Data II, 1990–2023.

	Harvest [1 000 t]									
Year	**silo-green maize**	**clover-hey**	**rape**	**Sun-flower**	**soja bean**	**horse-/fodder bean**	**peas**	**vegeta-bles**	**oil pumkin**	**Other leg-umes***
1990	4289	457	102	57	18	41	145	273	3	0.9
1995	3996	549	268	61	31	17	60	302	5	0.9
2000	3531	493	125	55	33	7	97	361	6	1.6
2005	3600	705	104	81	61	10	90	384	8	7.0
2010	3557	682	171	66	95	11	31	457	15	13
2011	4006	631	180	74	109	18	36	557	16	12
2012	4003	588	149	53	104	16	15	471	13	11

	Harvest [1 000 t]									
Year	**silo-green maize**	**clover-hey**	**rape**	**Sun-flower**	**soja bean**	**horse-/fodder bean**	**peas**	**vegeta-bles**	**oil pumkin**	**Other leg-umes***
2013	4199	547	197	51	83	14	18	464	10	10
2014	4072	630	198	58	118	21	17	555	11	12
2015	3807	484	112	38	136	25	19	442	19	11
2016	4172	636	142	60	153	28	19	473	30	13
2017	3697	514	117	51	193	23	15	452	15	12
2018	3777	488	121	60	184	16	17	427	15	13
2019	3954	519	107	64	215	13	13	460	16	13
2020	4277	607	100	56	203	14	13	483	23	16
2021	4006	564	86	74	235	16	13	501	26	16
2022	3882	521	91	56	246	14	14	497	28	15
2023	3987	484	86	65	270	14	14	473	15	17

** other legumes, lupines, lentils, chickpeas and vetches*

Table 223: Cultivation Area I, 1990–2023.

	Area [ha]								
Year	**wheat**	**rye**	**barley**	**oats**	**maize (corn)**	**Other* cereals**	**potato**	**sugar beet**	**fodder beet**
1990	278 226	93 041	292 424	61 956	198 073	24 717	31 760	49 758	3 845
1995	255 910	76 826	229 099	40 778	173 352	31 705	27 036	51 643	1 759
2000	293 806	52 473	223 762	32 981	187 802	37 224	23 737	42 836	1 036
2005	288 960	42 847	191 740	30 218	189 637	48 108	22 186	44 690	296
2010	302 852	45 699	168 891	26 576	201 137	56 997	21 973	44 841	193
2011	304 334	45 943	153 286	25 029	217 100	53 613	22 851	46 580	179
2012	308 179	48 525	150 576	24 815	219 702	51 392	21 782	49 263	170
2013	297 286	56 108	142 574	23 165	201 917	52 221	21 128	50 849	168
2014	304 645	48 241	145 825	23 297	216 316	58 347	21 384	50 604	169
2015	302 965	39 563	151 769	23 501	188 728	59 934	20 368	45 436	134
2016	315 088	37 312	140 425	22 512	195 252	60 360	21 221	43 497	133
2017	295 029	34 476	138 903	23 245	209 476	60 872	22 991	42 684	131
2018	292 654	40 725	139 270	21 452	209 903	61 700	23 755	31 246	116
2019	277 291	43 679	137 242	20 596	220 690	64 190	23 969	27 878	107
2020	277 912	42 735	134 801	20 135	212 596	60 274	24 260	26 319	100
2021	277 447	32 869	123 624	24 360	218 198	54 102	22 562	37 852	89
2022	292 863	34 432	122 547	20 278	215 335	55 377	21 441	33 985	84
2023	280 367	38 471	122 708	17 624	212 000	56 690	20 623	35 678	66

** mixed grain, triticale*

Table 224: Cultivation Area II, 1990–2023.

	Area [ha]									
Year	**silo-green maize**	**clover-hey**	**rape**	**Sun-flower**	**soja bean**	**horse-/fodder bean**	**peas**	**vegeta-bles**	**oil pumkin**	**Other leg-umes***
1990	107 134	54 225	40 844	23 336	9 271	13 131	40 619	8 390	9 000	404
1995	90 682	66 096	89 246	28 550	13 669	6 886	19 133	8 482	8 957	404
2000	73 960	70 179	51 762	22 336	15 537	2 952	41 114	8 173	10 376	737
2005	76 987	79 789	35 251	30 179	21 429	3 549	36 037	8 042	16 271	3 321
2010	81 239	89 555	53 803	25 411	34 378	4 344	13 562	9 112	26 464	6 494
2011	81 444	87 638	53 636	26 049	38 123	6 028	11 715	10 024	26 119	4 979
2012	82 375	86 762	55 821	23 362	37 126	6 852	10 704	8 800	22 741	4 540
2013	110 818	84 535	58 557	21 808	42 027	6 194	7 248	9 523	17 884	4 362
2014	83 464	84 166	52 816	20 540	43 832	7 862	6 863	9 710	22 382	5 032
2015	91 989	81 772	37 529	19 061	56 895	10 780	7 274	9 455	31 816	5 518
2016	84 643	78 406	39 662	18 189	49 791	10 823	7 733	10 143	38 928	6 236
2017	82 188	76 732	40 502	22 018	64 467	10 296	6 721	10 282	22 397	5 842
2018	83 349	75 653	40 504	21 504	67 624	7 645	6 917	10 152	23 241	6 064
2019	85 684	78 886	35 966	21 245	69 207	5 713	5 333	10 463	25 220	6 632
2020	86 792	79 889	31 827	23 828	68 424	5 492	5 616	10 259	35 438	7 646
2021	84 557	77 960	28 273	24 678	76 430	6 188	5 652	10 247	39 131	8 121
2022	82 227	73 218	28 385	24 291	93 142	5 538	5 880	9 858	37 310	7 512
2023	93 772	62 902	26 546	24 066	87 577	6 041	7 072	9 821	28 425	8 019

** other legumes, lupines, lentils, chickpeas and vetches*

Sewage sludge application on fields

In the frame of the reporting obligation under the Urban Wastewater Directive (91/271/EEC) the annual amount of sewage sludge as ton dry substance per year (t DS/a) is collected by the authorities of the Austrian Provincial Governments. After quality assessment and aggregation the data are reported once a year to the national authorities.

Table 225: Amount of sewage sludge (dry matter) produced in Austria, 1990–2023.

Year	Total [t dm]	agriculturally applied [t dm]	agriculturally applied [%]	Applied sewage sludge N [t N]
1990	161 936	31 507	19.5	1 232
1995	390 500	42 400	10.9	1 654
2000	392 909	43 220	11.0	1 686
2005	290 110	35 541	12.3	1 386
2010	262 805	44 354	16.9	1 730
2011	265 962	43 796	16.5	1 708
2012	266 949	41 487	15.5	1 618

Year	Total [t dm]	agriculturally applied [t dm]	agriculturally applied [%]	Applied sewage sludge N [t N]
2013	238 273	38 231	16.0	1 491
2014	239 044	39 626	16.6	1 545
2015	234 880	46 861	20.0	1 828
2016	237 921	48 684	20.5	1 899
2017	236 180	47 549	20.1	1 854
2018	234 481	48 170	20.5	1 879
2019	233 499	49 676	21.3	1 937
2020	228 009	48 357	21.2	1 886
2021	193 623	47 909	24.7	1 868
2022	196 448	50 229	25.6	1 959
2023	197 269	50 409	25.6	1 966

Amounts of agriculturally applied sewage sludge were obtained from: Water Quality Report 2000 (Philippitsch, et al., 2001), Report on sewage sludge (Umweltbundesamt, 1997), Austrian report on water pollution control (BMLFUW, 2002a), and submissions from Austria's federal provinces to the Umweltbundesamt (Umweltbundesamt, 2011-2024a).

Application of compost on fields

Total amounts of compost (composting plants and home composting) were taken from Table 321 (chapter waste). Based on (Buchgraber, et al., 2003) and (Egle, et al., 2014) a share of 45% of the compost from composting plants is applied in sector agriculture. The dry matter content of 40% for compost is derived from (Georg Thieme Verlag KG).

Table 226: Amount of compost (dry matter) produced in Austria, 1990–2023.

Year	Total amount of compost [t dm]	agriculturally applied [t dm]	agriculturally applied [%]	Applied compost N [t N]
1990	83 561	4 303	5.1	60
1995	230 215	49 597	21.5	694
2000	293 394	62 568	21.3	876
2005	337 811	81 236	24.0	1 137
2010	366 861	93 140	25.4	1 304
2011	383 990	100 612	26.2	1 409
2012	408 881	111 488	27.3	1 561
2013	395 643	105 092	26.6	1 471
2014	406 344	109 334	26.9	1 531
2015	403 880	107 489	26.6	1 505
2016	427 051	116 967	27.4	1 638
2017	428 747	117 254	27.3	1 642
2018	426 617	116 502	27.3	1 631
2019	440 388	121 782	27.7	1 705

Year	Total amount of compost [t dm]	agriculturally applied [t dm]	agriculturally applied [%]	Applied compost N [t N]
2020	445 348	123 677	27.8	1 731
2021	458 589	129 337	28.2	1 811
2022	453 852	126 333	27.8	1 769
2023	449 514	123 711	27.5	1 732

5.4.2.1 Direct soil emissions (3.D.1)

Key Source: Yes (N_2O)

Direct soil emissions are the most important sub-category of *3.D Agricultural Soils*. 78.9% (5.29 kt in 2023) of N_2O emissions from agricultural soils arise from this sub-category (see Table 216).

N_2O emissions from the following sources were estimated:

- Inorganic N fertilizers (mineral fertilizers and urea)
- Organic N fertilizers
  - Animal manure applied to soils,
  - Sewage sludge applied to soils,
  - Other organic fertilizers applied to soils
- Urine and dung deposited by grazing animals
- Incorporation of *crop residues* after harvest
- Mineralization/immobilization associated with loss/gain of soil organic matter
- Cultivation of organic soils (i.e. histosols)

Following IPCC 2006 and 2019, N_2O is calculated from overall N additions to soils without subtraction of the amounts that volatilize as NH_3-N and NO_x-N during and after application as it had to be done according to the 1996 IPCC GL.

Direct N_2O emissions from manure applied to soils were calculated using a country specific methodology based on the N-flow approach. N_2O emissions from all other sources were calculated using the 2019 IPCC Tier 1 methodology. Calculation methods are described in the following subchapters. The conversion from N_2O-N to N_2O emissions is performed by multiplication with (44/28).

5.4.2.1.1 Nitrogen input through application of inorganic (mineral) N fertilizers (3.D.1.a)

The method applied for calculation of direct N_2O emissions is IPCC Tier 1 (IPCC 2019), Equation 11.1).

$$N_2O\text{-}N_{\ N\ inputs} = F_{SN} * EF_1$$

N_2O-$N_{N\ inputs}$ = *annual direct N_2O-N emissions produced from managed soil, kg N_2O-N yr^{-1}*
F_{SN} = *annual amount of synthetic fertilizer N (mineral and urea) applied to soils, kg N yr^{-1} – (see Table 219)*
EF_1 = *emission factor for N_2O emissions from N inputs, kg N_2O-N (kg N input)$^{-1}$ (IPCC 2019), table 11.1)*

5.4.2.1.2 N input from organic N fertilizers to cropland and grassland (3.D.1.b)

Organic N fertilizers (F_{ON}) include the following N-inputs to soils (IPCC 2019), equation 11.3):

$$F_{ON} = F_{AM} + F_{SEW} + F_{COMP} + F_{OOA}$$

- Nitrogen input through the application of animal manure to soils, excluding grazing (F_{AM})
- Nitrogen input through the application of sewage sludge to soils (F_{SEW})
- Nitrogen input through the application of compost to soils (F_{COMP})
- Nitrogen inputs through other organic amendments (F_{OOA}) used as fertiliser (in Austria energy crops from biogas plants applied to soils).

Nitrogen input from animal manure applied to soils (3.D.1.b.i)

A country specific methodology based on the N-flow approach was used. According to the IPCC method, nitrogen from manure that is used as a biofuel should be subtracted, but this is irrelevant for Austria because in Austria manure is not used as a biofuel at all.

Nitrogen left for spreading

After storage, manure is applied to agricultural soils. Manure application is connected with NH_3-N, NO_x-N, N_2O-N and N_2 losses that depend on the amount of manure N. With regard to a comprehensive treatment of the nitrogen budged, Austria established a link between the ammonia and nitrous oxide emissions inventory. This procedure enables the use of country specific data, which is more accurate than the use of the default values for $Frac_{GasMS}$ provided in the 2019 IPCC GL, table 10.22.

From total N excretion by Austrian livestock, the following losses were subtracted:

- N excreted during grazing,
- NH_3-N losses from the housings and yards,
- NH_3-N losses from manure storages,
- NH_3-N losses from biogas plants,
- NO_x-N losses from manure management,
- N_2O-N losses from manure management,
- N_2 losses from manure storages.

The remaining N is applied to agricultural soils.

Table 227: Animal manure left for spreading on agricultural soils per livestock category 1990–2023 (I).

Year	Nitrogen left for spreading [t N per year]					
	IPCC Livestock Categories					
	total	dairy cattle	suckling cows	all other cattle	breeding sows & litter	young & fattening pigs
1990	152 473	60 057	2 394	50 883	6 510	25 596
1995	144 653	48 453	10 619	47 777	6 260	24 078
2000	134 378	44 017	12 739	43 463	5 097	22 127
2005	128 447	39 789	13 613	41 473	4 664	21 599

Year	Nitrogen left for spreading [t N per year]					
	IPCC Livestock Categories					
	total	dairy cattle	suckling cows	all other cattle	breeding sows & litter	young & fattening pigs
2010	129 972	41 130	12 982	42 602	4 361	20 923
2011	127 787	41 052	12 733	41 573	4 183	20 068
2012	127 001	41 435	12 303	41 047	4 039	19 839
2013	126 687	42 082	11 671	41 366	3 919	19 202
2014	127 015	43 086	11 318	41 347	3 821	18 863
2015	127 114	43 094	11 023	41 700	3 841	18 644
2016	127 410	44 166	10 616	41 506	3 745	18 225
2017	127 710	44 627	10 087	41 435	3 801	18 313
2018	125 603	44 008	9 730	40 832	3 595	17 982
2019	123 540	43 237	9 449	40 191	3 575	17 729
2020	122 670	43 365	9 192	39 390	3 508	17 855
2021	122 571	43 324	8 927	39 773	3 441	17 734
2022	121 395	45 211	7 569	39 339	3 182	16 794
2023	118 877	44 392	7 480	38 855	3 087	15 843

Table 228: Animal manure left for spreading on agricultural soils per livestock category 1990–2023 (II).

Year	Nitrogen left for spreading [t N per year]						
	IPCC Livestock Categories						
	total	poultry	sheep	goats	horses/ solipeds	deer	rabbits
1990	152 473	4 462	1 258	121	1 161	26	6
1995	144 653	4 059	1 485	176	1 710	31	6
2000	134 378	3 375	1 381	182	1 957	36	4
2005	128 447	3 572	1 328	179	2 184	41	4
2010	129 972	3 720	1 464	233	2 507	46	4
2011	127 787	3 845	1 476	235	2 572	46	4
2012	127 001	3 922	1 490	238	2 637	47	4
2013	126 687	3 999	1 461	235	2 701	46	4
2014	127 015	4 107	1 428	230	2 766	44	4
2015	127 114	4 234	1 447	250	2 831	48	3
2016	127 410	4 331	1 549	269	2 949	48	3
2017	127 710	4 385	1 644	297	3 067	51	3
2018	125 603	4 378	1 621	296	3 106	52	3
2019	123 540	4 294	1 565	297	3 145	54	3
2020	122 670	4 333	1 489	295	3 185	56	3
2021	122 571	4 290	1 479	318	3 224	57	3

Year	Nitrogen left for spreading [t N per year]						
	IPCC Livestock Categories						
	total	poultry	sheep	goats	horses/ solipeds	deer	rabbits
2022	121 395	4 233	1 431	310	3 263	59	2
2023	118 877	4 193	1 359	302	3 303	61	2

A more detailed description of the methods applied for the calculation of NH_3 and NO_x emissions is given in the report "Austria's Informative Report 2025 – Submission under the UNECE Convention on Long-range Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants" (Umweltbundesamt, 2025b)[92]. Following a recommendation of the in-country review 2007, more information on the calculation of volatilization ratios has been included to the NID (see below).

NH_3 emissions from cattle and swine are estimated using a country specific methodology following the N-flow approach. NH_3 emissions from sheep, goats, horses, poultry, deer and rabbits are estimated using the EMEP/EEA Tier 2 methodology (EEA 2023).

NH_3 emissions from housing (cattle and swine)

Table 229 provides the NH_3-N emission factors used in the calculation of NH_3 emissions from animal housing according to (Eidgenössische Forschungsanstalt für Agrarökologie und Landbau Zürich-Reckenholz, 1997) and (Döhler, et al., 2002). For cattle they differentiate between loose housing and tied housing systems, which is relevant for Austria.

Table 229: Emission factors for NH_3 emissions from animal housing.

Manure management system	kg NH3-N (kg N excreted)$^{-1}$
Cattle, tied systems, liquid slurry system	0.040
Cattle, tied systems, solid storage system	0.039
Cattle, loose houses, liquid slurry system	0.118
Cattle, loose houses, solid storage system	0.118
Young & Fattening pigs, liquid slurry system	0.150
Young & Fattening pigs, solid storage system	0.150
Sows plus litter, liquid slurry system	0.167
Sows plus litter, solid storage system	0.167

In submission 2019 the grooved floor system for cattle and the partly slatted floor systems for swine was implemented to the Austrian ammonia inventory (Amon, Hörtenhuber, 2019). Specific abatement factors from the *UNECE Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions* (UNECE, 2015) were used.

[92] https://www.ceip.at/status-of-reporting-and-review-results/2025-submission

NH_3 emissions from manure storage

NH_3 emissions from storage are estimated from the amount of N left in the manure when the manure enters the storage. This amount of N is calculated as following:

From total N excretion the N excreted during grazing and the NH_3-N losses from housing (see above) are subtracted. The remaining N enters the store.

Cattle and swine

Table 230 provides NH_3 emission factors for the storage of cattle and swine manures (Eidgenössische Forschungsanstalt für Agrarökologie und Landbau Zürich-Reckenholz, 1997).

Table 230: NH_3 emission factors for manure storage.

Manure storage system	kg NH_3-N (kg TAN)$^{-1}$
Cattle, liquid slurry system	0.15
Cattle, solid storage system	0.30
Pigs, liquid slurry system	0.12
Pigs, solid storage system	0.30

TAN content in excreta

The detailed method makes use of the total NH_3 nitrogen (TAN) when calculating emissions. TAN contents for Austrian cattle and swine manure is given in (Hörtenhuber, 2025).

Table 231: TAN content for Austrian cattle and swine manure according to (Hörtenhuber, 2025) .

Manure	TAN content for Austria [%]	Manure	TAN content for Austria [%]
cattle – solid storage system	30.0	pig – solid storage system	40.0
cattle – liquid slurry system	60.0	pig – liquid slurry system	75.0

Austria's ammonia inventory additionally uses specific abatement factors to emission factors for a range of manure treatment options taken from the Swiss ammonia inventory model 'DYNAMO' (Menzi, et al., 2003, Reidy, et al., 2008, Reidy, Menzi, 2005). These abatement factors are fully consistent with the abatement factors provided in the UNECE Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions (UNECE, 2015). For further information please refer to "Austria's Informative Inventory Report 2025" (Umweltbundesamt, 2025b).

Sheep, goats, horses, poultry and deer

The EMEP/EEA Tier 2 methodology was applied. Tier 2 uses a mass flow approach based on the concept of a flow of TAN through the manure management system (EEA 2023). Table 232 presents the default EMEP/EEA Tier 2 NH_3-N emission factors and associated parameters used in the calculations for Austria's non-key livestock categories (EEA 2023), Table 3-9). Information on AWMS is provided in Table 193; country specific N excretion values are presented in Table 232.

Table 232: Default Tier 2 NH_3-N EF and associated parameters for the Tier 2 methodology.

NFR	Livestock category	proportion of TAN	EF housing	EF storage	EF spreading
3.B.2	Sheep	0.50	0.22	0.32	0.90
3.B.4.d	Goats	0.50	0.22	0.28	0.90
3.B.4.e	Horses (mules, asses)	0.60	0.22	0.35	0.90
3.B.4.g.i	Laying hens	0.70	0.20	0.08	0.45
3.B.4.g.ii	Broilers	0.70	0.21	0.30	0.38
3.B.4.g.iii	Turkeys	0.70	0.35	0.24	0.54
3.B.4.g.iv	Other poultry	0.70	0.38(*)	0.21(*)	0.50(*)
3.B.4.h	Other animals (Deer)(**)	0.50	0.22	0.32	0.90
3.B.4.h	Other animals (Rabbits)	0.60	0.22	0.35	0.90

*) *EF = weighted mean of ducks & geese for 2023*

**) *In Austria the livestock category deer contains red deer, sika deer and fallow deer. Additionally, the so-called "new world camels" (e.g. llamas, alpacas, etc.) are also included in this category, but are only of minor importance.*

In submission 2019 for layers the management system "manure belt with covered storage" was implemented into Austria's ammonia inventory (Amon, Hörtenhuber, 2019) using specific abatement factors from the *UNECE Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions* (UNECE, 2015).

NO_x emissions from manure management

NO_x-N-losses from manure management were calculated according to the Tier 2 methodology as outlined in the EMEP/EEA Emission Inventory Guidebook 2023 (EEA 2023). The calculations make use of the mass-flow approach based on the concept of a flow of TAN through the manure management system.

Emission factors for slurry and solid NO are taken from the EMEP/EEA GB 2023 chapter 3.B, Table 3-10.

For cattle and swine national TAN contents were taken from (Schechtner, 1991, see Table 231). Default TAN values according to the EMEP/EEA GB 2023 Table 3-9, are applied for sheep, goats, horses, poultry and deer. Detailed information is included in "Austria's Informative Inventory Report 2025" (Umweltbundesamt, 2025b).

N_2 emissions from manure management

In submission 2019 for the first time N_2 losses have been considered in Austria's N flow model(Amon, Hörtenhuber, 2019). For both, slurry and litter-based manures, the default N_2 emission factors from Table 3-10 (EEA 2023a) were used. For further information, please refer to "Austria's Informative Inventory Report 2025" (Umweltbundesamt, 2025b).

NH_3-N and NO_x-N volatilisation losses associated with manure application

Volatilisation losses following the application of organic N fertilizers on soils are basis for the estimation of indirect N_2O emissions from atmospheric deposition. NH_3-N and NO_x-N emission factors used in Austria's Air Emission Inventory are briefly described in chapter indirect N_2O emissions from soils/ deposition (5.4.2.2).

Nitrogen input through sewage sludge application (3.D.1.b.ii)

N_2O emissions

The method applied for the calculation of N_2O emissions is IPCC Tier 1 with a default emission factor of 1.0% N_2O-N per kg N input to agricultural soils.

In Austria fertilisation by sewage sludge is very small. In 2023 N_2O emissions from sewage sludge contributed only 0.5% of N_2O emissions from category 3.D Agricultural Soils.

N content data of sewage sludge was obtained from (Umweltbundesamt, 1997). The study contains sewage sludge analyses carried out by the Umweltbundesamt. Digested sludge samples from 17 municipal sewage sludge treatment plants taken in winter 1994/1995 were investigated with regard to more than one hundred inorganic, organic and biological parameters in order to get an idea of the quality of municipal sewage sludge. Following this study a mean value of 3.9% N in dry matter was taken.

In 2007 the N-content value of sewage sludge was re-examined. The comparison with national studies (Zessner, 1999) and (ÖWAV-Regelblatt Nr. 17 – Landwirtschaftliche Verwertung von Klärschlamm 2004 – www.oewav.at) approved the value of 3.9% N/dm.

The amount of nitrogen input from agriculturally applied sewage sludge was calculated according to the following formula:

$$F_{Sslu} = Sslu_N * Sslu_{agric}$$

F_{Sslu} = Annual nitrogen input to soils by agriculturally applied sewage sludge [t N]
$Sslu_N$ = Nitrogen content in dry matter [%] – 3.9%
$Sslu_{agric}$ = Annual amount of sewage sludge agriculturally applied [t/t] (see Table 225)

The annual agricultural consumption of sewage sludge is presented in Table 225.

Other organic fertilizers applied to soils (energy crops from biogas plants and compost) (3.D.1.b.iii)

This sub-category includes the N inputs from energy crops applied to soils as fertilizer after the digestion process in biogas plants and the N inputs from the application of compost to agriculture soils.

Activity data

Energy crops

The calculation of N from anaerobically digested energy crops (digestates) was done on the basis of raw material and energy balances reported by E-Control (E-CONTROL, 2006–2021) as well as (Kompost- und Biogasverband, 2024). N content of digested energy crops was derived from specific literature (Resch, R., Guggenberger, T., Wiedner, G., Kasal, A., Wurm, K., Gruber, L., Ringdorfer, F., 2006);

(Landesbetrieb Landwirtschaft Hessen, 2013); (Süd-Treber GmbH, 2021). Amounts of digested manure N are calculated in sector manure management.

Compost

Activity data for agricultural compost application was derived by expert judgement by Umweltbundesamt (2015) on the basis of treated amounts and application pathways (Buchgraber, et al., 2003) and (Egle, et al., 2014). Based on (Cord-Landwehr, 2000); (KRANERT UND CORD-LANDWEHR 2010); (Georg Thieme Verlag KG) and (Brunstermann, 2007) an organic mass loss of 50% during the composting process has been applied. For compost a dry matter content of 40% (Georg Thieme Verlag KG) was used. The N-content of dry matter of 1.4% was derived from (Amlinger, et al., 2005).

Table 233: N from biogas slurry and compost 1990–2023.

Year	Digestates (livestock manures) [kg N year^{-1}]	Digestates (veg. part) [kg N year^{-1}]	N from compost [kg N year^{-1}]
1990	44 676	55 953	60 236
1995	329 615	425 239	694 352
2000	1 028 231	1 342 861	875 945
2005	1 972 934	2 585 007	1 137 307
2010	4 641 123	3 542 337	1 303 964
2011	2 771 005	3 967 113	1 408 564
2012	2 872 767	3 982 333	1 560 827
2013	2 965 763	3 997 529	1 471 292
2014	3 065 009	4 012 634	1 530 673
2015	3 068 496	4 124 919	1 504 839
2016	3 620 773	4 291 965	1 637 533
2017	3 404 377	4 330 692	1 641 556
2018	3 506 733	4 074 312	1 631 028
2019	3 524 670	3 769 877	1 704 948
2020	3 703 504	3 704 000	1 731 477
2021	3 910 496	3 476 634	1 810 716
2022	4 079 437	3 412 586	1 768 664
2023	4 224 002	3 168 191	1 731 956

Methodology

IPCC Tier 1 methodology and the default emission factor of 1.0% N_2O-N per kg N input to agricultural soils were used.

5.4.2.1.3 Urine and dung deposited by grazing animals (3.D.1.c)

Key Source: No

Following the IPCC Guidelines, N_2O emissions resulting from nitrogen input through excretions of grazing animals (directly dropped onto the soil) are calculated under *Manure Management* but reported under *Agricultural Soils*. Austria uses the Default EF according to (IPCC 2019).

$$N_2O\text{-}N_{\ PRP} = F_{PRP} * EF_{3\ PRP}$$

N_2O-N $_{PRP}$ = annual direct N_2O-N emissions from urine and dung inputs to grazed land, kg N_2O-N yr^{-1}.

F $_{PRP}$ = annual amount of urine and dung nitrogen deposited on soils during grazing [t N] – see Table 234

$EF_{3\ PRP}$ = default emission factors for N_2O emissions from urine and dung N deposited on pasture, range and paddock by grazing animals [t N_2O-N/t N], – 0.004 for cattle and swine and 0.003 for sheep, goats, horses and other animals (IPCC 2019) – table 11.1).

Table 234: Nitrogen excreted during grazing on pasture, range and paddock (N_{exPRP}) 1990–2023.

Year	N excretion grazing [t]
1990	17 916
1995	15 053
2000	12 212
2005	9 648
2010	10 190
2011	10 225
2012	10 255
2013	10 256
2014	10 319
2015	10 435
2016	10 589
2017	10 665
2018	11 305
2019	11 896
2020	12 516
2021	13 278
2022	13 701
2023	14 303

5.4.2.1.4 Nitrogen input from incorporation of crop residues (3.D.1.d)

Austria uses the IPCC 2006 Tier 1 methodology for emission calculation.

Additionally to the residues from harvest crops (including legume crops) the following N amounts returned to soils are included:

- N from meadows ("seeded pastures") ploughed every four years
- N from other forage crops on arable land renewed annually
- N from cover crops

According the IPCC 2006 GL biological nitrogen fixation has been removed as a direct source of N_2O due to the lack of evidence of significant emissions arising from the fixation process itself.

N from meadows ploughed every four years („Wechselwiesen")

Specific seeded pastures have to be ploughed every few years and followed by another crop to formally remain the status "arable land". Following Austrian experts these kind of meadows are ploughed (and covered by another crop) every four years according to (Amon, Hörtenhuber, 2014) and (Umweltbundesamt, 2014a). Activity data on seeded pastures („Wechselwiesen") were taken from the Green Reports (BML, 2024a). The average N content of residues was derived on the basis of the assumption that 25% of plants are legume forages and 75% are non-legume forages (Amon, Hörtenhuber, 2014) and (Umweltbundesamt, 2014a). Average dry matter net yield per hectare (7 000 kg dm for common management) was taken from (Buchgraber, Gindl, 2004).

N from other forage crops on arable land renewed annually

Activity data on other forage crop area renewed annually was taken from the Green Reports (BML, 2024a).

The average N content of residues was derived on the basis of the assumption that 25% of plants are legume forages and 75% are non-legume forages according to (Amon, Hörtenhuber, 2014) and (Umweltbundesamt, 2014a). Average dry matter net yield per hectare (7 000 kg dm for common management) was taken from (Buchgraber, Gindl, 2004).

N from crop residues of cover crops

N from the crop residues of cover crops were calculated with the default values for grass-clover mixtures in table 11.2 in the IPCC 2006 GL, as these were deemed most fitting. A constant above ground biomass of 2.5 tonnes per hectar dry matter was applied. This value comes from an Austrian study that evaluated different types of cover crops, in different regions in Austria over 12 years (Erhart, et al., 2021a). Activity data (areas with cover crops) are taken from Austria's Green Reports (BML, 2000-2024) based on INVEKOS data.

Methodology

Austria applies the 2006 IPCC Tier 1 methodology, equation 11.7A. For emission calculation the default emission factor of 1.0% N_2O-N per kg N input to agricultural soils is used.

Applied parameters are presented in Table 235.

Table 235: Input factors used for estimation of N added to soils from crop residues (IPCC 2006, Table 11.2).

	Slope	**Inter-cept**	**N content of above-ground residues (N_{AG})**	**Ratio of below-ground residues to above-ground biomass (R_{BG-BIO})**	**N content of below-ground residues (N_{BG})**	**dry matter fraction of harvested product***	**$Frac_{Renew}$**
Wheat**	1.09	0.88	0.006	0.22	0.009	0.86	1.0
Rye	1.09	0.88	0.005	0.22	0.011	0.86	1.0
Barley	0.98	0.59	0.007	0.22	0.014	0.86	1.0
Oats	0.91	0.89	0.007	0.25	0.008	0.86	1.0

	Slope	Inter-cept	N content of above-ground residues (N_{AG})	Ratio of below-ground residues to above-ground biomass (R_{BG-BIO})	N content of below-ground residues (N_{BG})	dry matter fraction of harvested product*	$Frac_{Renew}$
Other cereals***	1.09	0.88	0.006	0.22	0.009	0.86	1.0
Maize (corn)	1.03	0.61	0.006	0.22	0.007	0.86	1.0
Potato	0.1	1.06	0.019	0.20	0.014	0.22	1.0
Sugarbeet	0.1	1.06	0.019	0.20	0.014	0.22	1.0
Fodderbeet	0.1	1.06	0.019	0.2	0.014	0.20	1.0
Maize (silo)	1.03	0.61	0.006	0.22	0.007	0.32	1.0
Clover-hay	0.29	0	0.027	0.40	0.019	0.86	0.48
Rape	1.13	0.85	0.008	0.19	0.008	0.91	1.0
Sunflower	1.13	0.85	0.008	0.19	0.008	0.91	1.0
Sojabean	0.93	1.35	0.008	0.19	0.008	0.88	1.0
Fodderbean	1.13	0.85	0.008	0.19	0.008	0.88	1.0
Peas	1.13	0.85	0.008	0.19	0.008	0.86	1.0
Vegetables	1.07	1.54	0.016	0.20	0.014	0.20	1.0
Oil pumpkin	1.07	1.54	0.016	0.20	0.014	0.92	1.0
Other legumes	1.13	0.85	0.008	0.19	0.008	0.88	1.0
Other forages	0.30	0	0.018	0.505	0.0145	1.00	1.0
Meadows ploughed every four years	0.30	0	0.018	0.505	0.0145	1.00	0.25
Cover crops	0.30	0	0.025	0.8	0.016	NA	1.0

* *Country specific values are taken from (Umweltbundesamt, 1998) and (Statistik Austria, 2015) for grains, maize, potato, sugar beet, silo maize, rape, sunflower, soja bean, fodder bean, peas and oil pumpkin.*

***IPCC defaults for "grains" chosen, as IPCC default values for wheat are not appropriate for Austria.*

****Mixed grain, mainly triticale. IPCC defaults for "grains" chosen.*

$Frac_{Renew}$: For most of the crops the total area is renewed annually ($Frac_{Renew}$ = 1).

In the case of clover hay a $Frac_{Renew}$ of 0.48 is used. This factor has been determined by analysing INVEKOS data for the period 2007 to 2013 based on the mean cultivation time without ploughing. Within this investigation for individual parcels with cultures of clover, clover-grass, and lucerne (alfalfa) the development over time was observed. Data analyses resulted in a cultivation time of 2.1 years (weighted mean).

Meadows are ploughed every four years resulting in a $Frac_{Renew}$ factor of 0.25 (see above).

Activity data

Harvest data were taken from (BML, 2024a) and the datapool of (Bundesanstalt für Agrarwirtschaft und Bergbauernfragen, 2024) and are presented in Table 221: and Table 222. Legume cropping areas were available from official statistics (BML, 2024a) and (Statistik Austria, 1990-2024) and can be found in Table 220.

5.4.2.1.5 Mineralization/immobilization associated with loss/gain of soil organic matter (3.D.1.e)

In Austria N_2O emissions from this source category are occurring only in a very small scale.

Methodology

N_2O emissions from mineralisation due to management changes on 'cropland remaining cropland' are calculated using equation 11.8 from the 2006 IPCC guidelines (no changes in the 2019 Refinement) and the IPCC default emission factor of 0.01 kg N_2O-N/kg N. For the C:N ratio the default value of 10 has been used.

Activity data

The annual losses of soil carbon (tons of C) are taken as reported under *4.B.1 Cropland remaining cropland* (see chapter 6.3.4.1). In the following table, all subdivisions of cropland remaining cropland that are losing soil carbon and hence contributing to the emissions under category *3.D.1.e*, are indicated as recommended in the UNFCCC Review 2023 (ARR 2023) (UNFCCC, 2023).). In the following table, all subdivisions of cropland remaining cropland that are losing soil carbon and hence contributing to the emissions under category *3.D.1.e*, are indicated as recommended in the UNFCCC Review 2023 (ARR 2023) (UNFCCC, 2023).

Table 236: Soil carbon losses in 4.B.1 Cropland remaining cropland 1990–2023.

years	4.B.1.1 Annual cropland remaining annual cropland	4.B.1.2 Perennial cropland remaining perennial cropland	4.B.1.3 Perennial cropland to annual cropland	4.B.1.4 Annual cropland to perennial cropland	Total C losses
	[kt C]				
1990	0.00	0.00	-5.16	6.99	**-5.16**
1995	8.89	1.45	-5.12	6.94	**-5.12**
2000	54.10	1.15	-5.07	6.88	**-5.07**
2005	79.19	7.28	-5.02	6.91	**-5.02**
2010	77.42	6.83	-6.67	5.87	**-6.67**
2011	76.17	6.85	-6.75	5.59	**-6.75**
2012	75.28	6.80	-6.77	5.29	**-6.77**
2013	73.86	6.58	-6.72	5.04	**-6.72**
2014	71.36	5.94	-6.77	4.83	**-6.77**
2015	58.22	3.76	-7.28	4.72	**-7.28**
2016	49.73	4.32	-7.51	4.70	**-7.51**
2017	41.00	4.74	-7.46	4.76	**-7.46**
2018	32.07	4.76	-7.47	4.61	**-7.47**
2019	24.33	4.75	-7.61	4.43	**-7.61**
2020	14.03	4.76	-7.75	4.21	**-7.75**
2021	-3.48	-0.86	-7.90	4.04	**-12.24**
2022	-14.34	-1.01	-8.02	3.79	**-23.37**
2023	-12.72	-1.56	-8.37	3.26	**-22.64**

5.4.2.1.6 Cultivation of organic soils (i.e. histosols) (3.D.1.f)

In a project regarding extent, drainage status and resulting GHG-emissions of drained organic soils in Austria, activity data and emission factors were estimated based on vast cartographic materials and an extensive literature research (Umweltbundesamt, 2025d).

Methodology

The emissions from organic soils were estimated following the guidance of chapter 2 of the 2013 Wetland Supplement (IPCC, 2014). Direct on-site emissions of N_2O are estimated based on a literature study on emission factors for Austrian conditions and therefore constitute a Tier 2 methodology. For cropland, an EF of 7.66 kg N_2O-N/ha/yr and for grassland a N_2O-N EF of 3.65 kg N_2O-N/ha/yr was determined according to (Umweltbundesamt, 2025d). For further information, please refer to LULUCF chapters 6.3.4.1.7 and 6.4.4.1.3.

The associated N_2O emissions are reported in sector Agriculture under CRT source category *3.D.6 Cultivation of organic soils (i.e. histosols)* in line with the IPCC Reporting Guidelines.

Activity data

Activity data was compiled in the above mentioned project concerning drained organic soils in Austria. Data sources include among others the soil map for agriculture "eBOD" (BFW, 2024a), soil estimate results of the financial soil evaluation (BMF, BEV, 2024) and the updated version of the Mire Conservation Catalogue (Steiner, Reiter, 1992). The estimation resulted in a total area of 41 381 ha orgnic soils in agricultural use wheras 34 789 ha occur in grassland and 6 583 ha in cropland. The total area of cropland soils are assumed to be drained because current use would not be possible otherwise and 32.5% of grassland organic soils are drained based on water saturation and mapped drainage information based on the melioration register. This results in a total area of 17 907 ha drained organic agricultural soils which was applied for the whole time series, whereas 6 583 ha of drained organic soils were identified in cropland and 11 324 ha in the grassland category.

5.4.2.2 Indirect soil emissions (3.D.2)

Key Source: Yes (N_2O)

According to the IPCC definition, indirect N_2O emissions are caused by atmospheric deposition of nitrogen onto soils and by nitrogen leaching and runoff from soils.

Indirect N_2O emissions through atmospheric nitrogen deposition (3.D.2.a)

A country specific methodology was used. Detailed calculations of volatilisation losses follow the N-flow approach and result in country specific values of $Frac_{GASF}$ and $Frac_{GASM}$.

Emissions were calculated following equation 11.9 provided in the 2019 Refinement to the IPCC 2006 GL

$$N_2O_{(ATD)}\text{-}N = [(F_{SN} * Frac_{GASF}) + ((F_{ON} + F_{PRP}) * Frac_{GASM})] * EF_4$$

$N_2O_{(ATD)}$-N	*= annual amount of N_2O-N produced from atmospheric deposition of N volatilised from managed soils, kg N_2O-N*
F_{SN}	*= annual amount of synthetic fertilizer N applied to soils [t N] (see Table 219)*
$Frac_{GASF}$	*= Fraction of synthetic fertilizer N that volatilises as NH_3 and NO_x, kg N volatilised (kg of N applied)$^{-1}$*
F_{ON}	*= annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}*
F_{PRP}	*= annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr^{-1}*
$Frac_{GASM}$	*= Fraction of applied organic N fertilizer materials (F_{ON}) and of urine and dung N deposited by grazing animals (F_{PRP}) that volatilises as NH_3 and NO_x, kg N volatilised (kg of N applied or deposited)$^{-1}$*
EF_4	*= emission factor for N_2O emissions from N volatilisation and re-deposition on soils and water surfaces, kg N_2O-N (kg NH_3-N + NO_x-N volatilised) (IPCC 2019, Table 11.3)*

Country specific volatilisation fraction of synthetic N fertilizers ($Frac_{GASF}$) includes:

- NH_3-N and NO_x-N losses from urea and non-urea N fertilizers

Country specific volatilisation fraction of organic N fertilizers and N deposited by grazing animals ($Frac_{GASM}$) includes:

- NH_3-N and NO_x-N losses from animal manure applied to agricultural soils
- NH_3-N and NO_x-N losses from dung and urine deposited by grazing animals
- NH_3-N and NO_x-N losses from sewage sludge applied to agricultural soils
- NH_3-N and NO_x-N losses from biogas digestates applied to agricultural soils
- NH_3-N and NO_x-N losses from compost applied to agricultural soils

Table 237: NH_3-N and NO_x-N volatilisation losses from synthetic fertilizers, organic N fertilizers (including grazing) as well as from grazing alone 1990 to 2023.

Year	N losses mineral fertilizer (incl. urea)	$Frac_{GASF}$	N losses from applied organic N fertilizer materials and grazing	$Frac_{GASM}$	N losses from urine and dung N deposited by grazing animals	$Frac_{GASPRP}$
	[t N/yr]	(N_{losses}/N_{FERT})	[t N/yr]	($N_{losses}/N_{FON+FPRP}$)	[t N/yr]	($N_{losses}/_{NFPRP}$)
1990	10 761	0.09	36 925	0.22	1 248	0.07
1995	9 483	0.08	33 975	0.21	1 086	0.07
2000	8 970	0.08	30 690	0.20	911	0.07
2005	8 022	0.08	28 432	0.20	755	0.08
2010	7 759	0.08	29 184	0.20	810	0.08
2011	8 343	0.08	28 823	0.20	816	0.08
2012	8 680	0.08	28 692	0.20	822	0.08
2013	8 513	0.08	28 721	0.20	826	0.08
2014	9 048	0.08	28 898	0.20	834	0.08
2015	9 495	0.08	28 996	0.20	844	0.08
2016	9 992	0.07	29 167	0.20	861	0.08
2017	9 617	0.07	29 205	0.20	873	0.08

Year	N losses mineral fertilizer (incl. urea)	$Frac_{GASF}$	N losses from applied organic N fertilizer materials and grazing	$Frac_{GASM}$	N losses from urine and dung N deposited by grazing animals	$Frac_{GASPRP}$
	[t N/yr]	(N_{losses}/N_{FERT})	[t N/yr]	($N_{losses}/N_{FON+FPRP}$)	[t N/yr]	($N_{losses}/_{NFPRP}$)
2018	8 955	0.07	28 742	0.20	915	0.08
2019	8 038	0.08	28 266	0.20	955	0.08
2020	7 980	0.09	28 008	0.20	997	0.08
2021	8 141	0.08	27 772	0.19	1 048	0.08
2022	7 534	0.08	27 369	0.19	1 077	0.08
2023	7 306	0.08	26 297	0.19	1 117	0.08

Following a recommendation of the in-country review 2007, additional background information on the calculation of volatilization ratios has been included to the NIR (see below).

A detailed description of the method applied for NH_3 and NO_x is given in the report 'Austria's Informative Inventory Report 2025 – Submission under the UNECE Convention on Long-range Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants' (Umweltbundesamt, 2025b).

NH_3-N and NO_x-N volatilization losses from mineral fertilizer application

With regard to a comprehensive treatment of the nitrogen budget, Austria established a link between the ammonia and nitrous oxide emissions inventory. This procedure enables the use of country specific data, which is more accurate than the use of the default value for $Frac_{GASF}$.

NH_3 and NO_x emissions from sector *3 Agriculture* are estimated according to the EMEP/EEA 2023 Guidebook (EEA 2023).

NH_3 emissions from synthetic fertilizers are estimated using a country specific methodology which requires detailed information on fertilizer application. The EMEP/EEA GB 2023 provides specific NH_3 emission factors for different types of synthetic fertilizers and for normal and high pH soils (EEA 2023), table 3-2). A 'normal' pH is a pH of 7.0 or below, a 'high' pH is a pH of more than 7.0 (usually calcareous soils) as defined in (EEA 2023). 65% of Austria´s soils are classified as normal and 35% as high based on Austrian Soil Information System – BORIS – (http://www.borisdaten.at).

For more detailed information, please refer to 'Austria's Informative Inventory Report 2025 – Submission under the UNECE Convention on Long-range Transboundary Air Pollution and Directive (EU) 2016/2284 on the reduction of national emissions of certain atmospheric pollutants' (Umweltbundesamt, 2025b).

For the calculation of NO_x-N losses the Tier 1 methodology according to the EMEP/EEA GB 2023 is applied. Emissions of NO_x are calculated as a fixed percentage of total fertilizer nitrogen applied to soil. For all mineral fertilizer types the default emission factor of 4% is used (0.04 kg NO per kg applied fertilizer-N).

NH_3-N volatilization losses occurring during manure application

NH_3 emission factors for spreading of slurry and farmyard manure (expressed as share of TAN) following (Reidy, et al., 2008) have been applied:

Table 238: Emission factors for NH_3 emissions from animal waste application.

Application technique	kg NH_3-N (kg TAN)$^{-1}$
spreading solid manure cattle	0.79
spreading solid manure pigs	0.81
broadcast spreading liquid manure cattle	0.50
broadcast spreading liquid manure pigs	0.25

Austria's ammonia inventory considers various techniques used for manure application in Austria (AMON & HÖRTENHUBER 2019) and (Hörtenhuber, 2025). Specific abatement factors were obtained from the *UNECE Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions* (UNECE, 2015). For more information please refer to Austria's Informative Inventory Report 2025 (Umweltbundesamt, 2025b).

NO_x-N emissions from animal manure applied to soils

The Tier 1 methodology according to the EMEP/EEA GB 2023, chapter 3.D, is applied. The default emission factor of 0.04 kg NO per kg of organic fertilizer-N spread on agricultural soils is used, which has been taken from table 3-1 (EEA 2023).

NH_3-N and NO_x-N volatilization losses from sewage sludge application

For the calculation of NH_3-N losses the EMEP/EEA default emission factor for sewage sludge of 0.13 kg NH_3/kg fertilizer N was applied (EEA 2023).

NO_x emissions were estimated according to the EMEP/EEA GB 2023 ((EEA 2023), see Annex 5.1) using the default Tier 1 EF of NO for sewage sludge (0.04 kg NO_2/kg sewage sludge N).

NH_3-N and NO_x-N volatilization losses from biogas slurry application (energy crops)

For the calculation of NH_3-N losses from energy crops applied to soils as fertilizer after the digestion process (biogas slurry), the EMEP/EEA Tier 1 approach and the default emission factor for other organic wastes of 0.08 kg NH_3 per kg N applied was applied (EEA 2023), Table 3-1).

NO_x-N losses were estimated with the EMEP/EEA Tier 1 approach and the default emission factor for other organic wastes of 0.04 kg NO per kg waste N applied (EEA 2023), Table 3-1).

NH_3-N and NO_x-N volatilization losses from compost application

NH_3-N losses from compost applied to soils as fertilizer were calculated with the EMEP/EEA Tier 1 approach and the default emission factor for other organic wastes of 0.08 kg NH_3 per kg N applied (EEA 2023), Table 3-1).

NO_x-N losses were estimated with the EMEP/EEA Tier 1 approach and the default emission factor for other organic wastes of 0.04 kg NO per kg N applied (EEA 2023), Table 3-1).

Indirect N_2O emissions from nitrogen leaching and run-off (3.D.2.b)

A country-specific methodology based on the N-flow approach and country specific losses by leaching and runoff was used.

Results of a country specific study (Eder, et al., 2015) determine a value of 15.154% for the fraction of leaching losses from nitrogen additions to Austria's managed soils. The peer reviewed study used 22 lysimeters, covering a wide range of soils, climatic conditions and management practices in Austria, to evaluate nitrogen losses through leaching and to calculate an Austria-specific value of $Frac_{LEACH}$.

The emission calculation follows the following formula (equation 11.10, (IPCC 2019):

$$E\text{-}N_2O_{LL} = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) * Frac_{LEACH} * EF_5$$

$E\text{-}N_2O_{LL}$ = N_2O emissions from leaching losses, expressed as N_2O-N [t N]

F_{SN} = Annual amount of nitrogen in synthetic fertilizers (mineral and urea) applied on soils [kg N] (see Table 219)

F_{ON} = Annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils [kg N]

F_{PRP} = Annual amount of urine and dung N produced by grazing animals and directly dropped on agricultural soils during grazing [kg N]

F_{CR} = amount of N in crop residues (above- and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually [kg N]

F_{SOM} = Annual amount of N mineralised in mineral soils associated with loss of soil C from soil organic matter as a result of changes to land use or management [kg N] → not occurring in Austria [NO]

$Frac_{LEACH}$ = Fraction of all N added to/mineralised in managed soils that is lost through leaching and run off (country specific value of 0.15154 following (Eder, et al., 2015)

EF_5 = Emission factor for N_2O from N leaching and runoff, kg, N_2O-N (0.011 [kg/kg] following (IPCC 2019) ,Table 11.3)

5.4.3 Category-specific QA/QC

In the categories 3.D the following source specific QA/QC procedures have been carried out:

- ✓ NH_3-N, NO_x-N and N_2 losses calculated in compliance to the obligations under EU NEC Directive and UNECE/LRTAP Convention;
- ✓ Methods and emission factors reviewed by the EAGER[93] network;
- ✓ Plausibility of CRT N-fractions checked;
- ✓ Differences to IPCC default values explained and documented;
- ✓ External review by Austrian agricultural experts (stakeholder meeting "inventory talks" 2010) (Umweltbundesamt, 2010b);
- ✓ Expanded QA and verification activities in 2012: in-depth review of the agriculture model.
- ✓ Expanded QA/QC of the software tool (calculation sheets) for new and revised sources (e.g. crop residues, energy crops performed in 2015)
- ✓ External review of the revised agriculture inventory according to the 2006 IPCC GL by Austrian agricultural experts: stakeholder meeting "inventory talks" 2014 (Umweltbundesamt, 2014a)
- ✓ External review of the revised agricultural model (Amon, Hörtenhuber, 2019) according to the

[93] European Agricultural Gaseous Emissions Inventory Researchers Network (EAGER)

new data on agricultural practice (Pöllinger, et al., 2018) by Austrian agricultural experts: stakeholder meeting "inventory talks" 2018 (Umweltbundesamt, 2018).

- ✓ External review of the updated and representative values for nitrogen and energy intake, excretion of nitrogen (N_{ex}) and volatile solids (VS_{ex}) based on the research project on country-specific animal feeding and nutrition ("MiNutE" study, (Hörtenhuber, et al., 2022b); (Hörtenhuber, et al., 2023) by Austrian agricultural experts.
- ✓ Verification of the calculations for NH_3 emissions from animal husbandry with the *3.B Manure Management N flow tool* of the EEA.
- ✓ Verification of the Austrian inventory results with the AgrEE Tool (Umweltbundesamt, 2024e)
- ✓ External review of the revised agricultural model (Hörtenhuber, 2025) according to the new data on the agricultural practice (Pöllinger, et al., 2025), the implementation of the 2019 IPCC Refinement and improvements in the ammonia inventory by Austrian agricultural experts: stakeholder meeting "inventory talk" 2025 (Umweltbundesamt, 2025c).

Sector specific routine control procedures are provided in chapter 5.1.4.

5.4.4 Uncertainties

Uncertainties are presented in Table 165.

5.4.5 Recalculations

Update of activity data

Please refer to chapter 5.1.6.

Improvements of methodologies and emission factors

3.D.1.b.i Animal manure applied to soils

Due to revised methodologies and activity data used for emission calculations in categories *3.A* and *3.B* (see chapters 5.2 and 5.3) the quantities of animal manure applied to soils were revised for the entire time series. Higher ammonia emissions from manure management resulted in lower N amounts available for application on soils and thus to lower N_2O emissions for the entire time series (-0.2 kt N_2O for 2022).

3.D.1.c. Urine and dung deposited by grazing animals

Livestock related updates (livestock numbers, N excretion values, please refer to chapter 5.1.6) as well as new data on Austrian agricultural practices from the new TIHALO III survey as already described before, led to recalculated N_2O emissions from grazed animals. Additionally, updated EFs according to the 2019 IPCC Refinement were applied, resulting in revisions for the entire time series (-0.2 kt N_2O for 2022).

3.D.1.d. Crop residues

In addition to the updated activity data for other legumes (please refer to chapter 5.1.6), methodological improvements were made in the calculations of cover crops. The above-ground residue dry matter value was taken from a recent national study (Erhart, et al., 2021b). The 2019 IPCC default values of grass-clover mix were used for the calculations. These improvements resulted in an overall increase in N_2O emissions for the entire time series (+0.3 kt N_2O for 2022).

3.D.1.f. Cultivation of organic soils (i.e. histosols)

In addition to the updated activity data for organic soils (please refer to chapter 5.1.6) methodological improvements have been carried out by using the emission factors according to (Umweltbundesamt, 2025d). Detailed information is provided in chapter 6 on LULUCF. The revisions affected the entire time series (-0.02 kt N_2O for 2022).

3.D.b Agricultural Soils (indirect soil emissions – N_2O)

Atmospheric deposition: reasons for revised estimates are the updated activity data (please refer to chapter 5.1.6) and the improvements made within the ammonia inventory (esp. the updated TAN values for cattle and swine). Furthermore, NH_3-emissions from crop residues were calculated for the first time contributing to the indirect N_2O-emissions from atmospheric deposition. As a result, the indirect N_2O emissions from atmospheric deposition have been revised upwards for the entire time series (+0.1 kt N_2O for 2022).

N leaching and run-off: updated activity data and methodological improvements affected revised N amounts from animal manure applied to soils, grazing, crop residues and mineralisation resulting in revised emissions for the entire time series (+0.3 kt N_2O for 2022).

5.5 Field burning of agricultural residues (CRT Category 3.F)

Key source: no

5.5.1 Source Category Description

This category comprises burning straw from cereals and residual wood of vinicultures on open fields in Austria.

Burning agricultural residues on open fields in Austria is legally restricted by provincial law and since 1993 additionally by federal law and is only occasionally permitted on a very small scale. Therefore the contribution of emissions from field burning of agricultural waste to the total emissions is very low.

In the years 2021, 2022 and 2023 no emissions occurred in this category ("not occurring"). CH_4 and N_2O emissions for the years from 1990 to 2023 are presented in Table 239.

Table 239: Emissions from field burning (3.F) 1990–2023.

Year	CH_4 [kt]	N_2O [kt]
1990	0.03	0.001
1995	0.03	0.001
2000	0.03	0.001

Year	**CH_4 [kt]**	**N_2O [kt]**
2005	0.03	0.001
2010	0.02	0.001
2011	0.01	0.000
2012	0.01	0.000
2013	0.01	0.000
2014	0.01	0.000
2015	0.01	0.000
2016	0.01	0.000
2017	0.00	0.000
2018	0.00	0.000
2019	0.00	0.000
2020	0.00	0.000
2021	NO	NO
2022	NO	NO
2023	NO	NO
Trend 1990–2023	**–100%**	**–100%**
Share in Agriculture 2023	**0%**	**0%**

5.5.2 Methodological Issues

5.5.2.1 Cereals (3.F.1)

Following a recommendation of the Centralized Review 2003 the IPCC method with default emission factors was applied. In response to questions raised during the UNFCCC centralized review 2010, the estimate has been improved by providing a breakdown of the emissions on a crop by crop basis.

In submission 2016 the calculation has been updated according to the 2006 IPCC GL, equation 2.27. Default emission factors were applied, taken from (IPCC 2006, Table 2.5); default combustion factors from the 2006 IPCC GL, Table 2.6, were used. Dry matter fractions were taken from (Statistik Austria, 2015). IPCC default residue/crop product ratios as used in source category *3.D.1.d crop residues* (see also chapter on N from crop residues 5.4.2.1.4) were applied. Parameters are presented in the following table:

Table 240: Input parameters used to estimate emissions from field burning of cereals.

	Combustion factor [%]	**Dry matter fraction [t/t]**	**Residue/Crop product (ExF) [t/t]**
Wheat	0.90	0.86	1.26
Barley	0.90	0.86	1.09
Oats	0.90	0.86	1.22
Rye	0.90	0.86	1.32
Other cereals*	0.90	0.86	1.29

* *mixed grain, triticale*

According to the Austrian Chamber of Agriculture (Austrian Chamber of Agriculture, 2022) and (Austrian Chamber of Agriculture, 2024), no field burning has been practised in 2021, 2022 and 2023 and is thus reported as "NO". In the last years the areas burnt were decreasing steadily, in the year 2020 only 5 ha were burnt. For 1990 an average value of 2 500 ha was indicated for Austria's main cultivation regions (Presidential Conference of the Austrian Chambers of Agriculture, 2004). The extrapolation to Austria's total cereal production area resulted in a value of 2 630 ha.

5.5.3 Category-specific QA/QC

Sector specific routine control procedures are provided in chapter 5.1.4.

5.5.4 Recalculations

No recalculations have been carried out.

5.6 Liming (CRT Category 3.G)

Key Source: CO_2 from 3.G Liming

5.6.1 Source Category Description

The application of lime to agricultural soils is a source of CO_2 emissions. It is used to reduce soil acidity and improve plant growth in managed systems, particularly agricultural lands and managed forests. Adding carbonates to soils in the form of lime (e.g. calcic limestone ($CaCO_3$), or dolomite ($CaMg(CO_3)_2$) leads to CO_2 emissions as the carbonate limes dissolve and release bicarbonate ($2HCO_3$-), which evolves into CO_2 and water (H_2O) (IPCC 2006).

Table 241: CO_2 emissions from Liming (3.G) 1990–2023.

Year	Limestone [kt]	Dolomite [kt]
1990	36.79	8.87
1995	28.75	6.93
2000	33.69	8.91
2005	44.25	9.38
2010	57.27	11.34
2011	63.61	13.54
2012	65.68	15.16
2013	60.48	14.85
2014	61.02	14.12
2015	68.20	15.23

Year	Limestone [kt]	Dolomite [kt]
2016	68.22	15.57
2017	69.62	16.40
2018	78.03	18.48
2019	80.78	18.62
2020	80.56	18.38
2021	80.75	18.35
2022	80.84	18.36
2023	77.62	17.66
Share in 3.G 2023	**81.5%**	**18.5%**
Trend 1990–2023	**111.0%**	**99.1%**
Trend 2022–2023	**-4.0%**	**-3.8%**

5.6.2 Methodological Issues

In response to a question raised during the ESD review 2019 regarding the reporting of 'NO' for emissions from dolomite application, Austria carried out an investigation on that issue. As a result, Austria improved its calculations and reports CO_2 emissions from the use of dolomite from submission 2020 onwards.

Activity data

Since submission 2020 new activity data on the amounts of both, limestone and dolomite, have become available. New data are based on specific information from Austria's biggest trading company and on sales data. In previous submissions application amounts of limestone were estimated on the basis of annual area data (ha) and assumptions on limestone application.

Table 242: Application of limestone and dolomite in Austria (arithmetic average of each two years).

Year	Liming [tons year^{-1}]		
	Limestone	Dolomite	Total
1990	83 623	18 612	102 235
1995	65 330	14 540	79 871
2000	76 560	18 701	95 261
2005	100 557	19 673	120 230
2010	130 155	23 795	153 950
2011	144 578	28 398	172 975
2012	149 268	31 808	181 075
2013	137 463	31 163	168 625
2014	138 679	29 631	168 310
2015	155 005	31 945	186 950
2016	155 053	32 673	187 725
2017	158 235	34 415	192 650

Year	Liming [tons year^{-1}]		
	Limestone	**Dolomite**	**Total**
2018	177 336	38 760	216 095
2019	183 581	39 065	222 645
2020	183 085	38 565	221 651
2021	183 532	38 504	222 036
2022	183 716	38 524	222 240
2023	176 418	37 058	213 475

Total application amounts for Austria provided in Table 242 are derived from annual sales data of Austria's biggest trade company for carbonate liming materials (www.bodenkalk.at) and expert judgement on domestic production and market (Dominik Gruber, Bodenkalk company). Provided annual amounts of calcic limestone and dolomite are considered to be representative for Austria.

Not the whole amount purchased is applied in the year of purchase. Considering this effect, Austria uses the arithmetic average of each two years as activity data. This approach has been chosen in consistency with the approach used in the estimation of N_2O emissions from mineral fertiliser application (see chapter 5.4.2).

Methodology

The Tier 1 methodology following equation 11.12 (IPCC 2006)[94] for calculating the CO_2 emissions has been applied.

$$CO_2{-}C\ Emission = (M_{Limestone} \cdot EF_{Limestone}) + (M_{Dolomite} \cdot EF_{Dolomite})$$

CO_2–C Emission = annual C emissions from lime application, tonnes C yr^{-1}
M = annual amount of calcic limestone ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$), tonnes yr^{-1}
EF = emission factor, tonne of C (tonne of limestone)$^{-1}$.

Emission Factors

The IPCC default emission factors for limestone (0.12) and dolomite (0.13) have been applied.

5.6.3 Category-specific QA/QC

Sector specific routine control procedures are provided in chapter 5.1.4.

5.6.4 Recalculations

No recalculations have been carried out.

[94] No Refinement (IPCC 2019)

5.6.5 Planned Improvements

No improvements are planned.

5.7 Urea Application (CRT Category 3.H)

Key Source: No

5.7.1 Source category description

CO_2 is lost by adding urea to soils during fertilisation. Urea ($CO(NH_2)_2$) is converted into ammonium (NH_4^+), hydroxyl ion (OH^-), and bicarbonate (HCO_3^-), in the presence of water and urease enzymes. The formed bicarbonate evolves into CO_2 and water, similar to the soil reaction during addition of lime (IPCC 2006 GL).

Table 243: Emissions from Urea Application (3.H) 1990–2023.

Year	CO_2 emissions [kt]
1990	9.60
1995	19.79
2000	19.36
2005	21.89
2010	28.85
2011	27.47
2012	30.63
2013	30.28
2014	34.04
2015	34.90
2016	39.26
2017	38.30
2018	32.03
2019	26.77
2020	24.54
2021	23.12
2022	25.54
2023	30.07
Trend 1990–2023	**213.4%**
Share in Agriculture 2023	**20.4%**

5.7.2 Methodological Issues

For the CO_2-C emissions from urea usage, the IPCC 2006[95] Tier 1 methodology is applied using equation 11.13. The amount of urea used is multiplied with an emission factor. The default emission factor of 0.20 for urea, which is equivalent to the carbon content of urea on an atomic weight basis (20% for $CO(NH_2)_2$), is applied.

$$CO_2-C\ Emission = M \cdot EF$$

CO_2–C Emission = annual C emissions from urea application, tonnes C yr-1
M = annual amount of urea fertilisation, tonnes urea yr-1
EF = emission factor, tonne of C (tonne of urea)-1

Activity Data

The activity data taken for the amount of urea used in agriculture are the same as used for the calculation of N containing emissions (see Table 219). It comprises non-stabilized and stabilized urea quantities.

Table 244: Urea used in agriculture 1990-2023.

Year	Weighted Urea Consumption [t N/yr]	Urea used in agriculture [t UREA/yr]
1990	6 107	13 085
1995	12 592	26 983
2000	12 320	26 400
2005	13 932	29 855
2010	18 357	39 335
2011	17 481	37 460
2012	19 489	41 763
2013	19 266	41 285
2014	21 662	46 418
2015	22 212	47 597
2016	24 983	53 535
2017	24 375	52 232
2018	20 380	43 671
2019	17 035	36 503
2020	15 616	33 462
2021	14 712	31 526
2022	16 255	34 833
2023	19 138	41 010

RWA: Raiffeisen Ware Austria, sales company

[95] No Refinement (IPCC 2019)

5.7.3 Category-specific QA/QC

Sector specific routine control procedures are provided in chapter 5.1.4.

5.7.4 Recalculations

No recalculations have been carried out.

5.7.5 Planned Improvements

No improvements are planned.

5.8 Other carbon-containing fertilizers (CRT Category 3.I)

Key Source: No

5.8.1 Source category description

CAN (calcium ammonium nitrate) fertilizers include limestone or dolomite and therefore emit CO_2 when applied to soils.

Table 245: Emissions from Other carbon-containing fertilizers (3.I) 1990–2023.

Year	CO_2 emissions [kt]
1990	30.66
1995	28.76
2000	27.37
2005	20.03
2010	14.89
2011	21.37
2012	22.20
2013	21.60
2014	23.59
2015	27.15
2016	28.55
2017	26.38
2018	26.30
2019	24.61
2020	25.47
2021	27.06

Year	CO_2 emissions [kt]
2022	24.43
2023	22.15
Trend 1990–2023	**-27.8%**
Share in Agriculture 2023	**15.0%**

5.8.2 Methodological Issues

Activity Data

CAN fertilizer data is fully consistent with AD amounts used in source category 3.D.1.1 Inorganic N fertilizers and corresponds to the fertiliser type specific AD used in the Tier 2 calculations within Austria's ammonia inventory under the LRTAP Convention and NEC Directive (Umweltbundesamt, 2025b). In consistency with the calculations under source category 3.D.1.1 the arithmetic average of each two years was used as activity data.

Methodology

CAN traded in Austria contains 27% nitrogen. From this share the composition can be derived considering the molar weights of the two components (Ammoniumnitrate NH_4NO_3 and limestone or dolomite). This results in a share of 23 weight% of limestone (or dolomite, respectively).

Table 246: Amounts of calcium ammonium nitrate in Austria 1990–2023.

Year	Calcium ammonium nitrate (CAN)	Calcium ammonium nitrate (CAN)	Limestone (or dolomite) contained in CAN
	[t N]	[t]	[t]
1990	79 024	292 680	66 898
1995	74 114	274 495	62 742
2000	70 547	261 286	59 723
2005	51 614	191 164	43 695
2010	38 384	142 162	32 494
2011	55 080	204 001	46 629
2012	57 214	211 904	48 435
2013	55 660	206 148	47 120
2014	60 808	225 213	51 477
2015	69 977	259 174	59 240
2016	73 583	272 528	62 292
2017	67 977	251 768	57 547
2018	67 774	251 015	57 375
2019	63 431	234 930	53 698
2020	65 632	243 081	55 561
2021	69 745	258 317	59 044
2022	62 955	233 168	53 296
2023	57 087	211 433	48 327

Finally, the Tier 1 methodology following equation 11.12 (IPCC 2006[96]) for calculating the CO_2 emissions from lime application has been applied.

$$CO_2{-}C\ Emission = (M_{Limestone} \bullet EF_{Limestone}) + (M_{Dolomite} \bullet EF_{Dolomite})$$

CO_2–C Emission = *annual C emissions from lime application, tonnes C yr^{-1}*
M = *annual amount of calcic limestone ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$), tonnes yr^{-1}*
EF = *emission factor, tonne of C (tonne of limestone)$^{-1}$.*

According to information of producers and importers both lime and dolomite containing CAN is applied in Austria. Therefore, the arithmetic average of limestone and dolomite has been applied. This approach was accepted by the TERT (EEA, 2020a).

In submission 2022, Austria checked its import statistics in order to validate its assumptions on limestone and dolomite contents. The investigations confirmed the current approach using the arithmetic mean of limestone and dolomite.

5.8.3 Category-specific QA/QC

Sector specific routine control procedures are provided in chapter 5.1.4.

5.8.4 Recalculations

No recalculations have been carried out.

5.8.5 Planned Improvements

No improvements are planned.

[96] No Refinement (IPCC 2019)

6 LULUCF (CRT SECTOR 4)

6.1 Sector Overview

This chapter describes the GHG emissions and removals arising from land use, land-use change and forestry (LULUCF). Table 247 presents total sector emissions and removals, as well as the category contributions to the sectors CO_2 balance.

Table 247: Emissions and removals (+/-) from Sector 4 LULUCF by category and gas - kt CO_2 and CO_2eq.

Year	Carbon dioxide emissions/removals [kt CO_2]								[kt CO_2eq]	[kt CO_2eq]	[kt CO_2eq]
	4 Total	**4.A Forest land**	**4.B Crop land**	**4.C Grass land**	**4.D Wet lands**	**4.E Settle ments**	**4.F Other land[1)]**	**4.G HWP**	**Total CH_4**	**Total N_2O[2)]**	**Total CO_2eq**
1990	-13 974	-13 583	375	792	65	999	502	-3 122	37	180	-13 756
1995	-18 622	-18 464	330	575	52	1 041	413	-2 569	37	188	-18 397
2000	-18 279	-18 692	175	582	56	1 082	406	-1 889	37	182	-18 060
2005	-15 447	-14 555	76	834	68	1 238	353	-3 461	37	182	-15 228
2010	-11 958	-12 074	62	663	103	1 245	495	-2 452	37	187	-11 734
2011	-11 250	-11 111	60	659	107	1 228	494	-2 687	37	186	-11 027
2012	-9 378	-9 847	48	652	104	1 226	493	-2 055	37	185	-9 156
2013	-5 240	-6 619	64	656	130	1 176	492	-1 138	37	183	-5 020
2014	-10 046	-11 177	83	657	105	1 167	491	-1 372	37	181	-9 828
2015	-4 303	-5 568	122	686	94	1 123	494	-1 254	37	180	-4 085
2016	-8 341	-9 764	190	659	109	1 104	497	-1 137	37	179	-8 125
2017	-4 646	-5 498	255	638	94	1 085	501	-1 719	37	179	-4 430
2018	1 617	1 028	285	596	94	1 079	504	-1 969	37	178	1 831
2019	5 788	4 672	311	595	91	1 074	507	-1 462	37	176	6 002
2020	-1 162	-3 661	358	597	91	1 064	510	-122	37	175	-950
2021	-3 572	-4 356	447	584	90	1 038	514	-1 889	37	173	-3 362
2022	-415	-1 112	475	585	90	1 022	517	-1 992	38	171	-206
2023	7 323	5 362	429	593	90	1 008	520	-678	37	169	7 530
1990 – 2023	**-152%**	**-139%**	**14%**	**-25%**	**39%**	**1%**	**4%**	**-78%**	**0%**	**-6%**	**-155%**

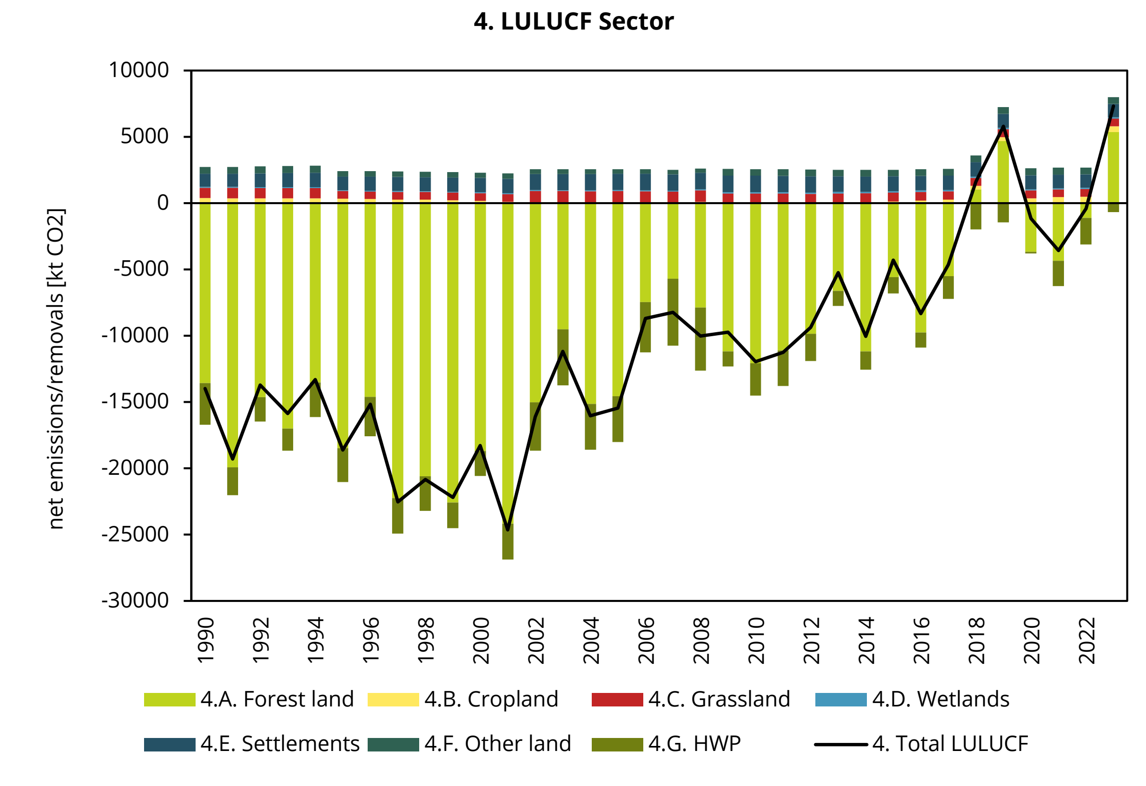
1) Only land use conversions are reported

21) direct and indirect N_2O

Table 247 and Figure 31 show that the LULUCF sector has generally been a net sink in the past decades in Austria. However, the overall trend shows a significant decrease in net removals since 2001. In the years 2018, 2019 and 2023, the LULUCF sector was even a net source of emissions, due to changes in the biomass and mineral soil pools of the subcategory 'Forest land remaining forest land' (*4.A.1*) with subsequent impacts on the annual total GHG balance of the LULUCF sector.

The most important category is Forest land, which essentially dictates the level and trend in LULUCF total emissions/removals. For example, the net LULUCF emissions in 2018, 2019 and 2023 were driven by the respective net emissions from this category. The Forest land results of the last years were heavily influenced by high shares of salvage logging due to natural disturbances, single dry years with significant drops of the biomass increment and high mineral soil carbon losses in 2023, which was (before 2024) the warmest year ever measured in Austria (in each month). Harvested wood products represent the second most important category, contributing consistent, and at times substantial, removals of CO_2. All other sub-categories of the LULUCF sector represent net sources of GHG emissions.

Figure 31: Carbon dioxide emissions and removals (+/-) from Sector 4 LULUCF and its respective categories [kt CO_2].



Source: Umweltbundesamt

6.1.1 Emission Trends

In 2023, the LULUCF sector was again (after 2018 and 2019) a net source of CO_2 emissions which amounted to 7 323 kt CO_2, while CH_4 (37 kt CO_2eq) and N_2O (169 CO_2eq) emissions together amounted to an additional 206 kt in CO_2 equivalent. Therefore, the LULUCF sector in 2023 amounted to 7 530 kt in CO_2 equivalent, which corresponds to 11% of national total GHG emissions (without LULUCF) in 2023.

The most important category is Forest land (4.A) with net emissions of 5 399 kt CO_2 equivalent in 2023 (including indirect N_2O emissions). Harvested Wood Products (HWP, 4.G) is the largest sink category and contributed removals of 678 kt CO_2 equivalent. Total net emissions arising from the other categories amounted to 2 809 kt CO_2 equivalent in 2023 (including indirect emissions).

The net carbon stock changes in forest biomass (subcategory 4.A.1) demonstrate considerable interannual variation and thus have a major impact on the overall results in sector 4. Figures for annual growth and for annual harvest of forest biomass differ significantly year by year due to annual variations in influencing factors like weather conditions, timber demand and prices, as well as occurrance of windthrow and other disturbance events (e.g. low increment in 2003, 2013, 2015, 2018,and 2019; very high harvest rates in 2007, 2008, 2019, 2021 to 2023 caused by natural disturbances). Overall, the net sink has significantly decreased between 1990 and 2023. The main drivers of this trend are the biomass and mineral soil carbon pools. The dynamics in forest biomass gains and losses explain high annual variations, as well as the overall declining sink strength of the Forest land category and the LULUCF sector. In addition to the aforementioned year-to-year variations, it should also be noted that annual increment has generally decreased over the time series, while harvest rates on the other hand have been increasing. Natural disturbances (especially, bark beatle outbreaks due to droughts, storm and ice) have led to high amounts of wood harvested due to salvage logging in the past years. Finally, changes in forest mineral soil carbon stocks (particularly in subcategory *4.A.1*) also vary substantially between years due to dynamics in weather (and harvest residues) that affect inputs to the soil C pool, as well as rates of soil decomposition. Indeed variations in the forest soil C pool have a substantial influence on the LULUCF sector as a whole. For example, lower increments and relatively high harvest rates in 2018, 2019 and 2023 coincided with substantial net C losses from the forest soil pool, leading to substantial net CO_2 emissions from the Forest land category and the LULUCF sector as a whole.

6.1.2 Key Categories

The overall key category analysis is presented in Chapter 1.4.

6.1.3 Methodology

The methodologies for estimating emissions/removals from LULUCF are described in detail in the subchapters 6.1 to 6.8. However, due to the NFI as the source of data for LUC to and from forests, the methodology for calculating emissions/removals due to land use changes from Forest land (which are subcategories of *4.B – 4.F*) are included in the methodological description of emissions/removals due to Land converted to forest land. The next two subchapters nonetheless give a sector overview on the methods used for estimating the LULUCF emissions/removals.

6.1.3.1 Activity data

Austria applies the default transition period of 20 years for areas undergoing land conversion. As such, annual land transition matrices, starting 20 years before the base year 1990, need to be compiled.

The Austrian system for representing total annual areas of land-use categories and annual conversions between land-use categories is based predominantly on national sources of spatially-explicit land-use and land-use change oberservations. The system relies on four separate pre-processing elements that pre-process respective input data on land use and land-use conversion in Austria.

The outputs of these pre-processing elements feed into an integregation element, where depending on the hierarchical treatment of the respective land use and conversion categories, specific further adjustments, interpolations and extrapolations are made to derive final annual land transition matrices that are:

- Complete and consistent with respect to the total area of the Austrian territory (use of subcategory "Other land"); and
- Consistent in terms of the land-use and conversion category areas within and across years (Initial land-use category areas of the previous year plus the respective net conversions to those categories equal the final land-use category areas)

The system furthermore incorporates ancilliary spatial input data to proportionally resolve annual time series of land-use conversion across five ecoregions, according to the national forest growth regions. This regionalisation of the land-use conversion categories allows for the application of region-specific initial and post-conversion stock values for estimating changes in the soil carbon pool due to land-use change.

In terms of the hierarchical treatment of different sources of land use and conversion data, the national forest inventory (NFI) is considered the element that provides the most reliable and long-term source of input data to the system. The NFI provides repeated in situ classification of Forest land areas (as well as land-use changes to- and from Forest land) at permanent, georeferenced plots distributed over a 4 x 4 km grid over the country. This *NFI* pre-processing element therefore provides total Forest land areas, as well as conversions to- and from Forest land, that are unchanged and directly incorporated into the annual land transition matrices. Furthermore, given the known locations of the NFI plots, the element also provides conversions to- and from Forest land for each of the five ecoregions. The other element providing direct inputs of conversion data to the annual land transition matrices is the *IACS (CL<->GL)* pre-processing element. Here, the spatially-explicit Integrated Administrative Control System (IACS) is merged with a map of the five ecoregions and sampled to quantify total annual conversions between Cropland and Grassland, as well as respective conversions for each of the five eocregions. As not all Cropland and Grassland areas are contained within the IACS data, the changes are quantified as yearly precentages relative to the total IACS Croplands areas. To derive the final total annual conversion areas between Cropland and Grassland, these relative values are multiplied with the total Cropland area produced in the *LU Area Statistics* pre-processing element. In this element, initial time series of annual total areas of the land use categories Cropland, Grassland, Wetlands, Settlements and Other land are produced by synthesizing aggregated national area statistics derived from maps and geospatial databases, as well as statistical surveys. These initial area estimates however do not flow directly into the annual land transition matrices but instead undergo further adjustment (Cropland), are used for extrapolation (Wetlands, Settlements) or are used simply for QC comparison purposes (Grassland and Other land) via the *LULUC Data Integration* element. The final pre-processing element is the *LULUC Mapping* element. Here, wall-to-wall, 5 x 5 m resolution land use maps for the years 2016, 2018, 2020 and 2022 are produced in a geographic information system that integrates spatially-explicit, data layers on land use and land cover from various sources. The resulting raster data for each year, as well as a rasterised layer of the five ecoregions are combined together at the pixel level to generate a tabular output providing the respective total areas of all possible pixel combinations of ecoregion and land use over the different years. Additionally, the *LULUC Mapping* element processes the EEA CLMS CORINE Land Cover layers for 1990, 2000, 2006, 2012, and 2018 (EEA, 2020b), and combines the derived land-use conversions to Settlements with a vector layer of the five ecoregions. This is done to inform the regional resolution of Cropland- and Grassland conversions to Settlements pre-2016.

While the outputs of the NFI and *IACS (CL<->GL)* element feed directly into the annual land transition matrices and subsequent inventory calculations, the outputs of all input elements are nonetheless processed together in the *LULUC Data integration element*. Here, the final annual total and ecoregion area estimates of the remaining land use and conversion categories are processed further to ensure full completeness and consistency in the final land use and land-use change time series.

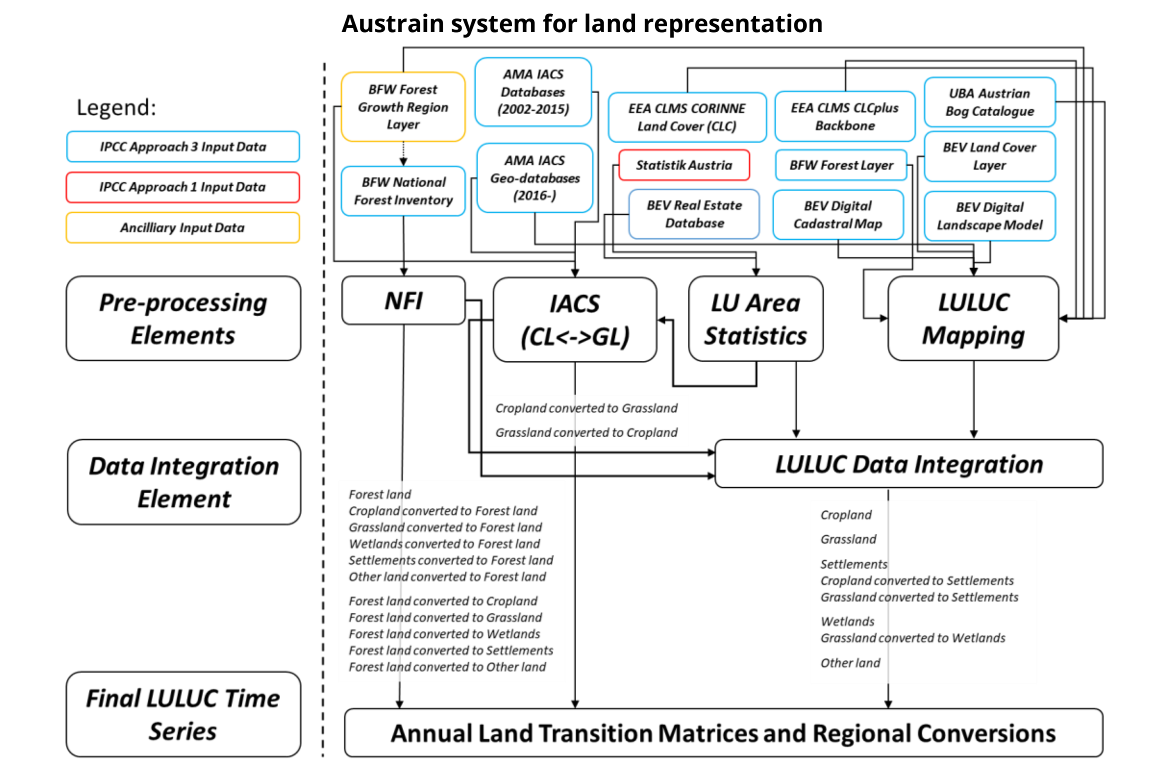
Considering the definitions and guidance in Chapter 3 of Volume 4 of the 2006 IPCC Guidelines, the Austrian system for land representation constitutes a spatially-explict approach 3 method for land representation. Statistical time series on land use (derived themselves from maps and geospatial databases (approach 3), as well as surveys (approach 1)) are used to extrapolate and ensure consistency in the annual land transition matrices over the whole time series. This system for land respresentation was introduced for the first time in the 2024 revision and has been improved upon further for this 2025 submission with the additional ecoregion-specific area quantification of all land-use categories. The system continues to apply the following expert judgements and assumptions that certain land use changes are considered not occurring in Austria:

- Wetlands, Settlements or Other land converted to Cropland or Grassland – the total area of Cropland and Grassland is decreasing, whereas the areas of Settlement and Wetland increase over the time period (see Table 249). Furthermore, from an economical and practical point of view any re-conversion of Settlements and Wetlands to Cropland or Grassland are considered as very unlikely. Other land is not suited for Cropland and Grassland use.
- Cropland or Settlements converted to Wetlands – it is assumed that LUC to water bodies occur close to existing water bodies, which are mainly from Grassland.
- Wetlands converted to Settlements

Analysis of the 2016, 2018, 2020 and 2022 high-resolution land use maps do not provide compelling evidence to contradict these assumptions. However, the validility of these expert judgements will be continuously evaluated as updated and further spatially-explicit datasets become available for subsequent years.

The following paragraphs describe in brief the main elements of the national system for quantifying annual land use and land-use change areas in Austria and the sources of spatial and statistical data that feed into them. Furthermore, Figure 32 illustrates graphically how the elements are linked. Annex 5.2 furthermore provides a comprehensive description of the Austrian system for land representation.

Figure 32: Austrian system for land representation.



Source: Umweltbundesamt

***NFI* pre-processing element: Processing of the data from national forest inventory for total Forest land area and conversions to- and from Forest land.** The area of Forest land, as well as the land-use change areas from- and to Forest land, are based on data from the National Forest Inventory (NFI). The Austrian NFI uses a geographically fixed grid system to classify land-use and land-use change at specific, permanent plot locations over time. For each mean year of an NFI cycle, data on the total forest area are provided, with annual area data between two consecutive NFI cycles calculated by linear interpolation. The land-use changes from and to forests are based on area measurements of such activities at the NFI grid points. The sum of observed areas of each afforestation and deforestation category are divided by the years between respective inventory cycles to derive annual estimates of land-use changes to and from Forest land. In addition to national total areas, Forest land, as well as the conversions to and from Forest land, are stratified by forest type (forests not in yield, and coniferous and deciduous forests in yield) and forest growth region (i.e. the five applied ecoregions in the GHG inventory). For gap-filling of annual areas since 2019 (mid-point of the last NFI cycle), the rates of afforestation and deforestation derived from the last two NFI cycles (2007/09 and 2016/21) are assumed to have remained constant. Based on these assumed conversion values, the total Forest land area from 2019 is extrapolated to the end of the time series. The Forest land category subchapter (see 6.2.2), as well as Annex 5.2, provides further details on the NFI and the processing of the area data on total Forest land and forest conversions. The derived annual time series of total Forest land and all categories of land conversion to and from Forest land are included directly and unchanged in the annual land transition matrices. Likewise the derived conversions to and from Forest land for each ecoregion then flow directly and unchanged into the inventory calculations of soil carbon stock changes caused by afforestation and deforestation. Nonetheless, the data on total Forest land area, and total conversions to and from

Forest land, also feed into the LULUC Data Integration element to ensure area consistency in the land transition matrix between categories and years.

***IACS (CL<->GL)* pre-processing element: IACS sampling for land conversions between Cropland and Grassland.** The conversions between annual cropland, perennial cropland and grasslands are calculated in this specific pre-processing element that synthesizes the available, spatially explicit information contained in the databases behind the national agricultural subsidy payment system, the Integrated Administration and Control System (IACS) administered by the Agrarmarkt Austria (AMA). This element queries the historic tabular database pre-2015 and merges this with the geo-databases (Geospatial Aid Application (GSAA datasets) available since 2016 (see also 6.3.2). Furthermore, the sampled agricultural land units are intersected with forest growth regions (BFW, 2024d) to derive the proportional ecoregion contributions to the respective total landuse change/conversions areas.

Short-term and oscillating conversions between the Cropland and Grassland categories can occur in agricultural management; however, such conversions can have important implications for LULUCF estimates. Therefore, for these conversions a specific method and analysis of spatially-explicit data on Cropland and Grassland land parcels is applied to filter such short-term (≤ five years) oscillating conversions. The IPCC inventory approach to LULUCF calculates the carbon stock changes caused by land-use change over a conversion period, for which the default length is 20 years. Consequently, areas undergoing an annual land-use change are assigned to the respective land conversion category for the conversion period, so that they can be multiplied by the correct, national/regional carbon stock change factors and/or emission factors. However, short-term oscillating changes between land use categories on the same land parcels would lead to such land areas being included in two land conversion categories multiple times over the conversion period. The IPCC Guidelines recommend to keep such short-term oscillating land areas in the main category. A method was thus developed and refined over previous submissions to filter short-term conversions between Cropland and Grassland areas based on land plot-level data from IACS. Based on a sample of land parcels for the years 2002–2015, as well as high-resolution sampling of the annual IACS GSAA data on plots (*Schläge*) available since 2016 (AMA, 2023), the method removes oscillating land conversions at the land unit level. Subsequently, long-term Cropland conversions to Grassland and Grassland conversions to Cropland are derived from the corrected sample and expressed as percentages of total Cropland area. These percentages are then multiplied by the annual areas of Cropland (from the *LU Area Statistics* element) to derive national level estimates of Cropland conversions to Grassland and Grassland conversions to Cropland. The Cropland category subchapter (see 6.3.2), as well as Annex 5.2, provide further details on this specific pre-processing element. The derived annual time series of Cropland conversions to Grassland and Grassland conversions to Cropland are included directly and unchanged into the annual land transition matrices; however, the data also feed into the *LULUC Data Integration* element to ensure area consistency in the land transition matrix between categories and years. Furthermore, with the aforementioned, proportional regional splits, land-use change/conversion areas between annual cropland, perennial cropland and Grassland per ecoregion are derived. Likewise, this ecoregion LUC areas flow directly into the inventory calculations of soil carbon stock changes caused by land-use changes/conversions between Cropland and Grassland.

***LU Area Statistics*: Pre-processing of land use area statistics derived from maps, geospatial databases and surveys.** In this element area statistics (derived from national maps, spatial databases and surveys) on total Cropland, Grassland, Wetland, Settlement and Other land are pre-processed before feeding into other elements of the system (*IACS (CL<->Gl); LULUC Data Integration*).

Note that area estimates from this pre-processing element do not feed directly into the annual land transition matrices and are instead used for the following purposes:

- Cropland area statistics feed into the IACS (CL <-> GL) pre-processing element to upscale the sampled land use changes/conversions between Cropland and Grassland and are furthermore subject to minor consistency adjustments in the LULUC Data Integration element.
- Wetlands and Settlements area statistics are used in the LULUC Data Integration element for extrapolation purposes of the pre-2016 areas and to infer total conversions to these categories.
- Grassland and Other land area statistics are used to QC-check the final Grassland and Other land area time series derived from LULUC Data Integration element.

The initial estimates of total **Cropland and Grassland** areas are based on data taken from national statistics (Statistik Austria, 2022c, Statistik Austria, 2024b), in particular the data from the *Agrarstrukturerhebung* (Farm Structure Survey, FSS). Comprehensive Farm Structure Surveys (*Vollerhebungen*) were conducted in 1990, 1995, 1999, 2010 and 2020 (Statistik Austria, 2001, Statistik Austria, 2013a, Statistik Austria, 2022c, ÖSTAT, 1991, ÖSTAT, 1996), with intervening random sample Farm Structure Surveys carried out in 1993, 1997, 2003, 2005, 2007, 2013 and 2016 (ÖSTAT, 1994, ÖSTAT, 1998, Statistik Austria, 2005, Statistik Austria, 2005, Statistik Austria, 2006, Statistik Austria, 2008, Statistik Austria, 2014a, Statistik Austria, 2018). The FSS area estimates are based on the responses to questionnaires sent to all farms and forest enterprises, or a random subset thereof. For the preceding years, specifically 1960, 1970 and 1980, data are taken from the *Land- und forstwirtschaftliche Betriebszählung* (Census of agricultural and forestry enterprises), which was the statistical survey programme that preceded the FSS. The FSS statistics are complemented by data according to the the IACS database (Statistik Austria, 2024), as well as other subcategory-specific sources such as the specific vineyard surveys (*Weingartengrunderhebungen*) for the years 2009, 2015 and 2020 (Statistik Austria, 2011, Statistik Austria, 2016, Statistik Austria, 2021c). Further details on how these statistics are processed are provided in Annex 5.2 as well as the respective category subchapters of the NID (see 6.3.2 and 6.4.2).

The initial estimates of the total area of **Wetlands, Settlements and Other land** are based on data from the Real Estate Database (BEV, 2024c). This database covers the whole area of Austria and gathers the land uses of real estate within the municipalities in digital cadastral maps, based on *in situ* land surveying. It is provided by the Austrian Federal Office of Metrology and Surveying (Bundesamt für Eich- und Vermessungswesen, BEV), available for the whole time series back to 1970 and is updated annually since 2005. The total areas per category are compiled by extracting areas of the respective land-use classes from the database. Further details on how these statistics are processed are provided in Annex 5.2 as well as the respective category subchapters of the NID (see 0, 0 and 6.7.2).

***LULUC Mapping*: Pre-processing element for spatially-explicity mapping of land use and land-use change.** In this element, 5 x 5 m resolution land-use maps for the years 2016, 2018, 2020 and 2022 are compiled and combined with a respective map of the BFW forest growth regions (BFW, 2024d) to derive total and regional estimates of land use and land-use change for 2016 onwards. A number of spatial datasets are pre-processed and integrated according to a hierarchy that considers both the temporal and thematic accuracy for the respective datasets. The individual datasets are summarised below:

- The 2022 Water Body Layer (*Digitales Landschaftsmodell – Gewässer*), a high-precision vector dataset mapping water bodies that is produced and made available by BEV (BEV, 2023c). This dataset maps both flowing and standing water bodies for the 2022 reference year. However, for the LULUC Mapping it is used only for mapping the standing water bodies
- The Digital Cadastral Map (*Digitale Katastralmappe;* DKM) is a wall-to-wall vector dataset delineating all cadastral land parcels in Austria and attributing parcel land use according to the 26 DKM classes (see Annex 5.2). The datasets for the reference years 2016, 2018, 2020 and 2022 (BEV, 2024a) are produced and made available by the Austrian Federal Office of Metrology and Surveying (Bundesamt für Eich- und Vermessungswesen, BEV).
- BEV Land Cover is a dataset of land cover based on automatised intrepretation of orthophotos taken between 2016 and 2020. This dataset is produced and made available by BEV (BEV, 2024b). This layer provides for better mapping of Other land. Based on the land cover class *non-vegetated surface*, the layer is used to reclassify parts of alpine grasslands (*Almen*) according to IACS as Other land.
- IACS: Fields (*INVEKOS Feldstücke*) is the geospatial aid application (GSAA) vector dataset of the Integrated Administration and Control System (IACS) that delinates and classifies the subsidized agricultural fields. The datasets for the reference years 2016, 2018, 2020 and 2022 are administered and made available by the *AgrarMarkt Austria* (AMA, 2022a). As mentioned above, the mapping of the category alpine grassland (*Almen*) is corrected where parts of these fields overlap with the land cover class *non-vegetated surface* according to BEV Land Cover. Furthermore, the mapping of agricultural fields is supplemented by additional IACS GSAA datasets, IACS: Plots (*INVEKOS Schläge*). According to this vector dataset (AMA, 2022c) so-called additional landscape elements (*Landschaftselemente*) for the same reference years are mapped, and based on their proximity to the closest IACS field, they are assigned a respective LU classification.
- The BFW Forest Layer (*BFW Waldkarte*) is a vector dataset produced and made available by the same federal agency responsible for the NFI (Bundesforschungszentrum für Wald, BFW) based on the national forest definition and interpretation of orthophotos from the years 2013 to 2018 (BFW, 2023). The layer is used as a stand-alone map of Forest land (Code 10) and is furthermore used to reclassify the IACS category alpine grassland (*Almen*) as Forest land where parts of these fields overlap with the BFW Forest layer.
- The non-IACS agriculture layer is an in-house dataset that uses the aforementioned DKM and BEV Land Cover layers, as well as the land-use layer of the DLM (*Digitales Landschaftsmodell – Gebietsnutzung*; (BEV, 2023b)) and the CLMS CLC+ Backbone (EEA, 2023). The integration of the datasets is used to map potential agricultural land, particularly Grassland, which lies outside of the IACS reference area.
- A pre-final version of the updated Austrian Mire Conservation Catalogue (*Österreichischer Moorschutzkatalogue*) that maps Austrian mires and is compilied by the Environment Agency Austria (Umweltbundesamt, 2023b).

The above datasets are incorporated according a hierarchy that determines which datsaset (or subset thereof) provides the ultimate land classification in cases of overlap (Annex 5.2). For the years 2016, 2018, 2020 and 2022 respective land-use layers (e.g. *LU 2016* to *LU 2022*) are compiled using a harmonized collection of datasets, principally for the purpose of mapping land-use changes. A best guess baseline land use status map (*LU 2022 Baseline*) is compiled for year 2022 with additional datasets only available for the 2022 reference year. The LU 2016-2022 layers and LU 2022 Baseline layer are compiled in a GIS software and exported as seperate 5 x 5 m raster files. A complementary 5 x 5 m raster layer of the BFW forest growth regions is also exported. An R script combines the above raster files and calculates the sum area of the occurring land-use and ecoregion combinations over the above layers.

In addition to the above, this element also pre-processes the status layers of 1990, 2000, 2006, 2012 and 2018 CORINE Land Cover maps (EEA, 2020b) and the BFW forest growth regions. The above vector layers are intersected with one another, with the resulting attribute table further processed in R to translate the CLC classes to national LU categories and to correct oscillating land conversions over time (Annex 5.2). The dataset is finally filtered for polygons containing conversions to Settlements from Cropland and Grassland and based on the associated area attribute, the percentage of conversions per ecoregion per category are calculated to derive regional contributions of pre-2016 conversions to Settlements from agricultural lands.

LULUC Data Integration: **Integration element to complete and ensure consistency in the final annual land transition matrices**. In this final integration element, all outputs of the pre-processing elements are integrated to derive the final remaining estimates of annual land use and land-use change areas.

First of all, the combine output of 2016-2022 LU layers and forest growth regions (LULUC Mapping pre-processing element) is processed to derive relative regional splits of the following land-use change categories:

- Grassland converted to Wetlands
- Cropland converted to Settlements
- Grassland converted to Settlements

The derived 2016-2022 time series of percentage conversions per category and ecoregion are then extrapolated as follows:

- Regional splits in conversions between 2020 and 2022 are extrapolated for the years 2023 onwards
- Regional splits in Grassland converted to Wetlands between 2016 and 2018 are assumed constant and extrapolated back to 1971
- Regional splits in Cropland- and Grassland conversions to Settlements are extrapolated back to 1990 according to the processed output of the CLC and forest growth region intersection. The repective regional splits for the conversions assessed from the 1990 and 2000 CLC layers are used to extrapolate back further to 1971.

The derived time series of relative regional splits in the above conversion categories are then multiplied by the respective annual total conversion areas. These final total conversion areas are compiled in this element together with the times series of final total areas of Cropland, Grassland, Wetlands, Settlement and Other land. The final compilation of these total category and conversion areas is done in the following step-wise approach.

- Step 1: Compilation of the 2022 total Grassland, Wetlands and Settlement areas according to the area totals of the best-estimate LU 2022 Baseline layer.
- Step 2: Compilation of the 2016 onward time series of total Wetlands and Settlement areas starting with the respective 2022 baseline estimates. To do this, total annual conversions

areas to and from these categories are derived from the combination of LU 2016, LU 2018, LU 2020 and LU 2022 layers. The annual conversion areas derived from LU 2020 and LU 2022 layers are extrapolated for 2023 onwards. From these total to and from conversion areas, annual net conversion areas for Wetlands and Settlements are derived for 2016 to 2023. Starting with the 2022 baseline areas and extrapolating backwards and forwards according to the derived net changes, respective 2016-2023 time series of total Wetlands and Settlement areas are derived.

- Step 3: Extrapolation of annual total Wetland and Settlement areas back to 1970 is done using respective time series compliled in the LU Area Statistics pre-processing element from the Real Estate Database. This is done by seperately normalising the entire Wetland and Settlement area time series from the LU Area Statistics element by the respective 2016 values to create time series of proportional area changes relative to 2016 values. Multiplying these 1970–2015 time series of relative changes by the 2016 total areas derived from the spatial datasets in step 2 above, allows for the final time series of annual total Wetland and Settlements area for 1970 onwards to be compiled.
- Step 4: Inference of the land-use changes to Wetlands and Settlements. First of all, the respective changes to and from Forest land (output of the NFI element) are accounted for, resulting in a residual net change in both categories that needs to be balanced between conversions to and from the other categories. This is done for Wetlands and Settlements as follows:
  - Step 4.a: LUC to Wetlands. For Wetlands, the remaining net change (a net increase over time) is assumed to be explained completely by Grassland conversions to Wetlands, allowing for the annual areas of this conversion category to be quantified as such. The above assumption was verified by the net conversion of Grassland to Wetland derived from analysis of the 2016, 2018, 2020 and 2022 LU layers.
  - Step 4.b: LUC to Settlements. For Settlements, the remaining net change (a net increase over time) is assumed to be explained completely by conversions of agricultural land (Cropland and Grassland) to Settlements. The above assumption was verified by the net conversion of Cropland and Grassland to Settlements derived from analysis of the 2016, 2018, 2020 and 2022 GIS layers. The relative split between conversions from Cropland and conversions from Grassland are calculated by first estimating the conversions from Cropland and then inferring the remaining net increase in Settlements as conversions from Grassland.
    - Step 4.b.i: Croplands converted to Settlements (+ Consistency adjustment of total Cropland area) For the years 2017 onwards, the yearly areas of Cropland converted to Settlements are estimated from the net conversion of Cropland to Settlement derived from the 2016, 2018, 2020 and 2022 GIS layers. These conversions, together with conversions between Cropland and Forest land (NFI) and conversions between Cropland and Grassland (IACS (Cl <->Gl)) yield a net change in Cropland area that is compared to the net change in Cropland area according to the Cropland area time series from the LU Area Statistics element. Leaving the 2020 Cropland area estimate unchanged (estimated based on the latest comprehensive FSS), the cumulative difference in the two annual net changes in Cropland area are sequentially added to each year's Cropland area as one goes back from 2019 to 1970. In the other direction, the cumulative difference in the two net changes in Cropland area are sequentially subtracted from each year's Cropland area as one moves forward from 2021 onwards. The

above adjustments thus produce an initially corrected Cropland area time series that is consistent with conversions to and from Cropland for 2016 onwards. This initially corrected Cropland area time series is then used to infer the conversions of Cropland to Settlement occurring between 1971 and 2016. For this part of the time series, after taking into account conversions to and from Forest land (NFI element) and conversions to and from Grassland (IACS (CL<->GL) element), a residual net change in Cropland remains (a net decrease) that is quantified as Cropland conversion to Settlements. Where the residual net change in Cropland area provides a larger annual area than that required to explain the residual net increase in Settlement area, these cumulative differences are sequentially subtracted from each year's Cropland area as one goes back from 2015 to 1970. Before deriving the final Cropland conversion areas to Settlements for 1971 to 2016, a last adjustment is made to achieve consistency with the 2010 Cropland area according to that years comprehensive FSS. The above intermediate corrections of the Cropland area time series cause a deviation from the 2010 FSS estimate of total Cropland area. This total residual is thus allocated as an additional yearly correction to the years 2015 to 2011. These yearly corrections are sequentially cumulated and added to each year's Cropland area as one goes back from 2015 to 1970. This final corrected Cropland area time series thus yields a net change in Cropland area, which after accounting for conversion to and from Forest land and Grassland, yields a final time series of inferred Cropland conversions to Settlements that ensure:

- Consistency in the land transition matrices;
- Consistency with the 2016-2022 GIS analysis of Cropland converted to Settlements; and
- Consistency with the Cropland area estimates according to the FSS in the years of the comprehensive surveys e.g. 2020 and 2010.

The above adjustments of the total Cropland area lead to small corrections (<|1%|) of the initial Cropland area estimates from LU Area Statistics element for some of the years in between the comprehensive FSS surveys. At the subcategory level, the above area changes are reflected in the annual cropland areas.

- Step 4.b.ii: Grassland converted to Settlements and compilation of the total Grassland area time series. After quanfiying and accounting for Cropland conversions to Settlement, the remaining residual net change in Settlement area is quantified 1:1 as Grassland conversion to Settlements. This step marks not only the completion of all occurring conversions to Settlements but also all occurring conversions to and from Grassland. With all yearly Grassland conversions estimated from 1970 onwards (to and from Forest land, NFI; to and from Cropland, IACS (CL<->GL); conversions to Wetlands and to Settlements, LULUC Data Integration), the Grassland area is estimated for all years back to 1970 starting with the 2022 baseline estimate from step 1. Likewise, the conversions for 2023 onwards are used to extrapolate the Grassland areas forward from the 2022 baseline estimate.

- Step 4.c: Regional LUCs to Wetlands and Settlements are then calculated by multiplying the total areas of the individual conversion categories by respective time series containing the associated regional splits (described at the beginning of this subchapter).

- Step 5: Estimate of the Other land areas. Finally, with the annual areas of Forest land, Cropland, Grassland, Wetlands and Settlements calculated, Other land is quantified as the difference between the total area of the Austrian territory and the total estimated area of the five land use categories above. Note that if the above five land use category areas were summed together with the Other land areas according to the Real Estate Database, the resulting sum of annual areas of all land use categories would be 0.8% lower- to 0.1% higher than the total territorial area of Austria. From these small differences, it is assumed that the Austrian system for land representation gives an accurate picture of how the total Austrian area is distributed between the land use categories over time.

The table below summarises the approaches and main data sources used for estimating the areas of the individual land use and land-use change categories.

Table 248: Overview of IPCC approaches and data sources used for land representation applied in Austria

Category	Approach(es)	Main data sources
4.A Forest land - total area	Approach 3	NFI
4.A.1 Forest land remaining forest land - total area	Approach 3	NFI
4.A.1.a Forest land remaining forest land: coniferous	Approach 3	NFI
4.A.1.b Forest land remaining forest land: decidous	Approach 3	NFI
4.A.1.c Forest land remaining forest land: forest not in yield	Approach 3	NFI
4.A.2 Land converted to forest land	Approach 3	NFI
4.A.2.a Cropland converted to forest land	Approach 3	NFI
4.A.2.b Grassland converted to forest land	Approach 3	NFI
4.A.2.c Wetland converted to forest land	Approach 3	NFI
4.A.2.d Settlements converted to forest land	Approach 3	NFI
4.A.2.e Other Land converted to forest land	Approach 3	NFI
4.B Cropland - total area	Approach 3 & 1	IACS, Farm Structure Survey
4.B.1.a.i *Annual remaining annual*	Approach 3	IACS
4.B.1.a.ii *Perennial remaining perennial*	Approach 3	IACS
4.B.1.c *Perennial converted to annual*	Approach 3	IACS
4.B.1.b *Annual converted to perennial*	Approach 3	IACS
4.B.2 Land converted to cropland	Approach 3	NFI, IACS
4.B.2.a Forest Land converted to cropland	Approach 3	NFI
4.B.2.b Grassland Land converted to cropland	Approach 3	IACS
4.B.2.b.i Grassland converted to annual cropland	Approach 3	IACS
4.B.2.b.ii Grassland converted to perennial cropland	Approach 3	IACS
4.B.2.c Wetland Land converted to cropland	NO	NO
4.B.2.d Settlements converted to cropland	NO	NO
4.B.2.e Other Land converted to Cropland	NO	NO
4.C Grassland - total area	Approach 3	IACS, DKM, non-IACS agri layer

Category	Approach(es)	Main data sources
4.C.2 Land converted to grassland	Approach 3	NFI, IACS
4.C.1.a Forest land converted to grassland	Approach 3	NFI
4.C.1.b Cropland converted to grassland	Approach 3	IACS
4.C.1.b.i annual cropland converted to grassland	Approach 3	IACS
4.C.1.b.i perennial cropland converted to grassland	Approach 3	IACS
4.C.1.c Wetland land converted to grassland	NO	NO
4.C.1.d Settlements converted to grassland	NO	NO
4.C.1.e Other land converted to grassland	NO	NO
4.D Wetlands - total area	Approach 3	DKM, Austrian Mire Conservation Catalogue, Water Body Layer
4.D.2 Land converted to wetlands	Approach 3	NFI, DKM, IACS, Real Estate Database
4.D.2.a Forest land converted to wetlands	Approach 3	NFI
4.D.2.b Cropland converted to wetlands	NO	NO
4.D.2.c Grassland converted to wetlands	Approach 3	DKM, IACS, Real Estate Database
4.D.2.d Settlements converted to wetlands	NO	NO
4.D.2.e Other land converted to wetlands	NO	NO
4.E Settlements - total area	Approach 3	DKM
4.E.2 Land converted to settlements	Approach 3	NFI, DKM, IACS, Real Estate Database
4.E.2.a Forest land converted to settlements	Approach 3	NFI
4.E.2.b Cropland converted to settlements	Approach 3	DKM, IACS, Real Estate Database
4.E.2.c Grassland converted to settlements	Approach 3	DKM, IACS, Real Estate Database
4.E.2.d Wetlands converted to settlements	NO	NO
4.E.2.e Other land converted to settlements	NO	NO
4.F Other land - total area	Inferred	Residual
4.F.2 Land converted to other land	Approach 3	NFI
4.F.2.a Forest land converted to other land	Approach 3	NFI
4.F.2.b Cropland converted to other land	NO	NO
4.F.2.c Grassland converted to other land	NO	NO
4.F.2.d Wetlands converted to other land	NO	NO
4.F.2.e Settlement converted to other land	NO	NO

Table 249 presents land use data and data for land use changes for the years 1990 and 2023 for the total area of Austria as used for the calculations.

Table 249: Land use and LUC data for Austria for the years 1990 and 2023.

Area in ha	**1990**	**2023**	**Diff 1990–2023**
4.A Forest land - total area	3 892 518	4 024 124	131 606
4.A.1 Forest land remaining forest land - total area	3 632 699	3 897 055	264 356
4.A.1.a Forest land remaining forest land: coniferous	2 441 632	2 457 064	15 432
4.A.1.b Forest land remaining forest land: decidous	727 733	993 331	265 598
4.A.1.c Forest land remaining forest land: forest not in yield	463 333	446 660	-16 674
4.A.2 Land converted to forest land	259 819	127 069	-132 750
4.A.2.a Cropland converted to forest land	30 962	11 973	-18 989
4.A.2.b Grassland converted to forest land	144 197	56 755	-87 442
4.A.2.c Wetland converted to forest land	12 534	8 249	-4 284
4.A.2.d Settlements converted to forest land	17 122	8 790	-8 332
4.A.2.e Other Land converted to forest land	55 004	41 302	-13 703
4.B Cropland - total area	1 500 824	1 392 806	-108 018
4.B.1 Cropland remaining cropland	1 461 847	1 322 911	-138 936
4.B.1.a.i *Annual remaining annual*	1 356 461	1 241 311	-115 150
4.B.1.a.ii *Perennial remaining perennial*	83 810	57 870	-25 940
4.B.1.c *Perennial converted to annual*	10 179	13 899	3 721
4.B.1.b *Annual converted to perennial*	11 397	9 831	-1 566
4.B.2 Land converted to cropland	38 978	69 896	30 918
4.B.2.a Forest Land converted to cropland	4 125	2 530	-1 596
4.B.2.b Grassland Land converted to cropland	34 852	67 366	32 514
4.B.2.b.i Grassland converted to annual cropland	34 376	66 144	31 768
4.B.2.b.ii Grassland converted to perennial cropland	476	1 222	746
4.B.2.c Wetland Land converted to cropland	NO	NO	NO
4.B.2.d Settlements converted to cropland	NO	NO	NO
4.B.2.e Other Land converted to Cropland	NO	NO	NO
4.C Grassland - total area	1 812 974	1 605 754	-207 220
4.C.1 Grassland remaining grassland	1 752 872	1 494 683	-258 188
4.C.2 Land converted to grassland	60 102	111 070	50 968
4.C.1.a Forest land converted to grassland	32 467	34 348	1 880
4.C.1.b Cropland converted to grassland	27 635	76 723	49 088
4.C.1.b.i annual cropland converted to grassland	27 189	74 606	47 417
4.C.1.b.i perennial cropland converted to grassland	446	2 117	1 671
4.C.1.c Wetland land converted to grassland	NO	NO	NO
4.C.1.d Settlements converted to grassland	NO	NO	NO
4.C.1.e Other land converted to grassland	NO	NO	NO
4.D Wetlands - total area	133 660	154 344	20 685
4.D.1 Wetlands remaining wetlands	124 152	133 445	9 293

Area in ha	1990	2023	Diff 1990–2023
4.D.2 Land converted to wetlands	9 507	20 899	11 392
4.D.2.a Forest land converted to wetlands	1 706	3 991	2 285
4.D.2.b Cropland converted to wetlands	NO	NO	NO
4.D.2.c Grassland converted to wetlands	7 801	16 908	9 107
4.D.2.d Settlements converted to wetlands	NO	NO	NO
4.D.2.e Other land converted to wetlands	NO	NO	NO
4.E Settlements - total area	359 931	560 457	200 526
4.E.1 Settlements remaining settlements	217 372	434 900	217 528
4.E.2 Land converted to settlements	142 559	125 557	-17 002
4.E.2.a Forest land converted to settlements	9 792	11 075	1 283
4.E.2.b Cropland converted to settlements	114 907	56 264	-58 643
4.E.2.c Grassland converted to settlements	17 860	58 218	40 358
4.E.2.d Wetlands converted to settlements	NO	NO	NO
4.E.2.e Other land converted to settlements	NO	NO	NO
4.F Other land - total area	687 093	649 514	-37 579
4.F.1 Other land remaining other land	668 959	629 891	-39 068
4.F.2 Land converted to other land	18 134	19 623	1 489
4.F.2.a Forest land converted to other land	18 134	19 623	1 489
4.F.2.b Cropland converted to other land	NO	NO	NO
4.F.2.c Grassland converted to other land	NO	NO	NO
4.F.2.d Wetlands converted to other land	NO	NO	NO
4.F.2.e Settlement converted to other land	NO	NO	NO
Total area	8 387 000	8 387 000	

6.1.3.1.1 Organic soils

Drained organic soils represent a significant source of emissions in the Austrian greenhouse gas inventory. Due to the uncertainty in previous analyses of organic soils for the Austrian greenhouse gas inventory, a comprehensive survey was carried out to better determine the area of organic soils in Austria, their land-use and respective drainage status. For this purpose, all available data sets were evaluated with regard to the IPCC definition of organic soils and maps believed to be lost (historical peatland cadastre of the monarchy), which were rediscovered in archives, digitised and integrated into the evaluation. In addition, GIS databases on drainage and land use were included in the analyses. A total of 100 119 ha of organic soils according to the IPCC definition were identified on the basis of the analyses in Austria. There are 41 571 ha under forest, 36 223 ha under grassland, 6 583 ha under arable land, 13 809 ha under wetlands and 1 933 ha in settlement areas. Of the total area of organic soils, 41 326 ha were estimated to have been drained (Umweltbundesamt, 2025d).

Austria currently reports the emissions from organic soils under the remaining land categories (e.g. Forest land remaining forest land) and assumes the areas of organic soil to be constant over the entire time series. Respective areas of mineral and organic soils sum up to the total area of remaining land in the respective years as can be seen in table Table 250 for the example of the latest inventory year 2023. Note that for organic soils, only emissions from the area of drained organic soils are reported following the 2013 Wetland Supplement (IPCC, 2014).

Occurance of drainage is based on an extensive GIS analysis of land use and drainage information from cartographic sources. Even though some GIS information on Forest land drainage was available, it did not cover the full extent of Austria's Forest land area. Therefore drainage in Forest land is based on soil expert opinion. GIS information on cropland as well as settlement was inferred purely from the intersection of organic soils and respective land use, assuming that in such cases these land-uses can only occur on organic soils if they have been drained. Wetlands and Grassland drainage is based on spatial explicit drainage information, wheras peat extraction sites were assessed based in literature research (Umweltbundesamt, 2025d).

Table 250: Overview of area distribution between mineral soils and organic soils as well as drained organic soil area. Exemplary area data for 2023

Land use (remaining)	Area organic soil [ha]		Area mineral soil [ha]	Total area remaining land [ha]
	Total	Drained		
Forest land	41 571	20 786	3 855 484	3 897 055
Cropland (annual)	6 583	6 583	1 234 728	1 241 311
Grassland	36 223	11 324	1 458 461	1 494 683
Wetlands	13 809	701	119 637	133 445
Peat extraction	103	103	0	104
Flooded land	1 726	0	119 636	121 363
Other Wetlands	11 979	597	0	12 082
Settlement	1 933	1 933	432967	434900

6.1.3.2 Definition of C-pools

As recommended by the ERT during the ICR 2013 a detailed description of the C-pools as used in the GHG-reporting of Austria is given in the table below.

Table 251: Definitions of C-pools.

Pools		Description
Living biomass	Above ground biomass	Forest land: All living biomass (DBH > 5cm) above the soil including stem, stump, branches, seeds, bark and foliage (foliage only of evergreen trees). At ARD sites and LUC from and to forests all forest biomass (shrubs, forest understory) with a DBH > 0 cm to 5 cm is also taken under consideration. Other subcategories: All living biomass is taken under consideration
	Below ground biomass	All living biomass of live roots with a diameter > 2 mm.

Pools		Description
Dead organic matter	Dead wood	All non-living woody biomass not contained in the litter or soil, standing on the ground, without dead roots, as they are already considered as part of the litter or soil.
	Litter	All non-living biomass lying dead in various states of decomposition above the mineral or organic soil.
Soils	Soil organic matter	All organic matter in mineral and organic soils (including peat) to a soil depth of 50 cm for Forest land remaining forest land, and all land conversion categories. Only for Cropland remaining cropland are the estimates for the mineral soil pool limited to a soil depth of 30 cm.

6.1.3.3 Emission factors

The calculations of the emissions follow the methods described in the 2006 IPCC GL, with an almost complete use of higher tier methods and carbon stock change-/emission factors derived from national data. Austria is consistently closing gaps in national input data for relevant subcategories with surveys and studies. The most important national statistics and data sources for the used emission factors are the Austrian national forest inventory, agricultural statistics, studies on cropland and grassland biomass, as well as studies on the cropland soil organic carbon content and the results of the country-wide soil surveys. Furthermore, specific national studies have been implemented to come up with carbon stock change-/emission factors for the categories "settlements" and "other land".

6.1.4 Quality Assurance and Quality Control (QA/QC)

The calculations of the data for category 4 are embedded in the overall QA/QC-system of the Austrian GHG inventory (see Chapter 1.5).

Important elements of QA/QC:

- ✓ Are the correct values used (check for transcription errors …)?
- ✓ Check of plausibility of input data (time-series, order of magnitude …)
- ✓ Is the data set complete for the whole time series?
- ✓ Check of calculation units. ..
- ✓ Check of plausibility of results (time-series, order of magnitude …)
- ✓ Correct transformation/transcription into CRT
- ✓ Where possible data is checked with data from other sources
- ✓ order of magnitude checks …
- ✓ Are all references clearly made?
- ✓ Are all assumptions documented?

Specific elements of QA/QC for LULUCF:

The input data estimates and results are checked as follows. The results of these checks are described in the QA/QC documentation:

1) Bottom-up check

1.1) Input data

1.1.1) Check for the plausibility of the activity data and their trend

Step 1: Documentation of the most important reasons for changes and non-changes of activity data

Step 2: Check and documentation if these changes or non-changes of activity data fit to trends of underlying conditions

Step 3: If step 1 and 2 do not allow any explanation further check of the used data sources and their estimates (see 1.2) and/or communication with the data providers

1.1.2) Check for plausibility of the emission factors as well as the related input data and their trends

Step 1: Documentation of the most important reasons for changes and non-changes of emission factors

Step 2: Check and documentation if these changes or non-changes of emission factors fit to trends of underlying conditions

Step 3: If step 1 and 2 do not allow any explanation further check of the used data sources and their estimates (see 1.2) and/or communication with the data providers

1.1.3) Check of input data for completeness

1.2) Estimations

1.2.1) Check of the correctness of all equations in the estimate files

1.2.2) Check of the correctness of all interim results

1.3) Check of the plausibility of the results and their trends related to point 1.1 and documentation of the plausibility of changes and non-changes on basis of point 1.1

1.4) Check of the correctness of all data and results transfer

2) Top-down check

2.1) Check the consistency between sum of land use areas and the total official area for Austria.

2.2) Comparison of the used activity data with those from other statistics. Documentation of the results of these comparisons and documentation of the reasons for the choice of statistics when data deviate more than 5% compared to other statistics

2.3) Comparison of the used emission factors and underlying input data with those of other data sources (e.g. from literature results in NIR/NIDs of other comparable regions and IPCC default values). Documentation of the results of these comparisons. Further check according to points 1.1 and 1.2 as well as check on the suitability of the used input data in case of implausible differences. Documentation of this further check.

6.1.5 Uncertainty Assessment

The uncertainty in the LULUCF GHG balance is estimated by using the @Risk-Software, which runs Monte-Carlo-simulations of spreadsheet GHG emission calculations. For that purpose, the uncertainties of all activity data, emission factors and input parameters for emission factors were defined. For each subcategory a bottom-up analysis of the uncertainties of the estimated emission/removal figures for the subcategory was carried out. All pools and gases were included in this analysis. Correlations between the parameters were taken into consideration during the simulations. To calculate uncertainties the emission calculation procedures were repeated with 10 000 to 100 000 iteration steps, with uncertainty expressed as the 95% confidence interval (standard deviation of the multiple simulation outputs multiplied by 2), which is in line with IPCC 2006 GL. This procedure was applied to each LULUCF subcategory and for the total LULUCF sector emissions/removals.

The average uncertainty of the total LULUCF sector emissions/removals across the years is ±4 232 kt CO_2eq. The average relative uncertainty across the time series is ±70% of the total LULUCF emissions/removals; ±45% if 2022 with very high relative uncertainties due to a net LULUCF result close to zero is excluded from the estimate of the average.

The biomass and soil carbon stock changes of *4.A.1* have in most years the highest impact on the total emissions/removals of the LULUCF sector. As a consequence, the uncertainty of these emissions/removals (around ±40% for the forest biomass pool and ±57 % for the forest soil pool) also have a significant impact on the uncertainty of the total emissions/removals of the LULUCF sector.

All other subcategories contribute to a clearly smaller extent to the results and, hence, uncertainty of the LULUCF totals, despite their partly very high relative uncertainties (in %) in their respective total emissions/removals.

Regarding the high uncertainty of the LULUCF sector it is important to understand that the LULUCF sector is the only one where the total emissions/removals of the sector are the result of both additions and subtractions (biomass gains minus biomass losses and net emissions minus net removals from the subcategories and their respective pools). This is – following the rules of error propagation – one of the main reasons why the relative uncertainties of LULUCF are higher than in other sectors. Furthermore, the relative uncertainty depends significantly on the level of the net emission/removal – the closer the net result is to zero the higher is the relative uncertainty. So, even the use of country specific and sophisticated methods may result in typically high relative LULUCF uncertainty figures. Another issue is the use of higher tiers in LULUCF which does not necessarily reduce the uncertainty of the figures. For instance, a Tier 1 approach assumes the soil C stock does not change, and thus associated uncertainties in estimating soil C stock changes are also not considered. So, despite the large potential errors of not including this important C stock, the calculated uncertainties would be lower.

6.1.6 Recalculations

The GHG balance of the LULUCF sector has been revised since the last submission in 2024. Due to methodological improvements affecting all categories apart from *Other land,* the 1990–2022 time series of annual total GHG emissions/removals from LULUCF vary from the previous submission by -4 462 to +7 714 kt CO_2e per year. Methodological changes and impacts on emissions/removals at the category level are detailed below.

The whole time series of recalculations is included in Annex 7 to the NID.

4.A Forest land

The increment, drain and dead wood results for recent years were updated on basis of an analysis of intermediate results of the ongoing NFI cycle 2022/27. These new results caused a significant change of the biomass and dead wood results of the most recent years since 2019, but resulted also in minor (before 2009) and intermediate (2009 to 2018) revised biomass and dead wood results of previous years. The forest soil C stock changes were also recalculated for the complete time series based on the intermediate results of the ongoing NFI 2022/27 cycle, as well as improved calibration- and spin-up procedures of the model. A detailed and comprehensive study was finalized in 2024 (Umweltbundesamt, 2025d), where the area of organic soils in Austria, their land use and drainage status and related emission factors were analysed on the basis of various geographic, historic and other data sources. Based on this study, drained organic soils in *Forest land* were identified, for which emissions for the whole time series are estimated for the first time. Together, these improvements caused changes of the annual net removals for the whole time series of the *Forest land* category in the range of -4 903 to +7 071 kt CO_2e per year compared to the last submission in 2024.

4.B Cropland

For area consistency reasons a minor adjustment of the total Cropland area was carried out. This had only negligable impacts on Cropland revisions, but did influence other categories (Grasslan and Settlements) do to the subsequent impacts on inferred conversions from Cropland to these categories. The Grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes involving Grassland and consequently have an impact on the results of the land-use change category Grassland to Cropland. With respect to soil carbon stock changes, improvements have been made to regionalize the Grassland conversions to Cropland across five ecoregions (forest growth areas) to utilise ecoregion-specific soil carbon stocks for the pre- and post-conversion stocks. The stocks are moreover now for the depth 0-50 cm instead of the previously used 0-30 cm depth, ensuring consistency across all calculations of LUC-induced soil carbon stock changes e.g. Forest land conversions to Cropland. On basis of the national study on organic soils in Austria (Umweltbundesamt, 2025d), drained organic soils in Cropland were identified, for which emissions for the whole time series are estimated for the first time. These improvements caused upward revisions of the annual net emissions for the whole time series of the Cropland category in the range of +155 to +204 kt CO2e per year compared to the last submission in 2024.

4.C Grassland

For area consistency reasons, a minor adjustment of the total Grassland area was carried out. The revision of the Cropland area time series, particularly pre-1990 affected both the total area of Grassland, as well as the conversions of Cropland to Grassland. The Grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes to Grassland and consequently have an impact on the results of the Grassland category. With respect to soil carbon stock changes, improvements have been made to regionalize the Cropland conversions to Grassland across five ecoregions (forest growth areas) to utilise ecoregion-specific soil carbon stocks for the pre- and post-conversion stocks. The stocks are moreover now for the depth 0-50 cm instead of the previously used 0-30 cm depth, ensuring consistency across all calculations of LUC-induced soil carbon stock changes e.g. Forest land conversions to Cropland. On basis of the organic soils study (Umweltbundesamt, 2025d), the area of drained organic soils in Grassland and the related emissions were slightly revised. These improvements caused upward revisions of the annual net emissions for the whole time series of the Grassland category in the range of +85 to +149 kt CO_2e per year compared to the last submission in 2024.

4.D Wetlands

For area consistency reasons a minor adjustment of the total *Wetland* area was carried out. The grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes involving *Grassland* and consequently have an impact on the results of the land-use change category *Grassland* to *Wetlands*. On basis of the national study on organic soils (Umweltbundesamt, 2025d), drained organic soils in *Wetlands* and areas of historic peat extraction were identified, for which emissions for the whole time series are estimated for the first time. Activity data for the biomass burning subcategory has been revised due to the availability of a new data source from the BraMaSchi Project. These improvements caused upward revisions of the annual net emissions for the whole time series of the *Wetlands* category in the range of +12 to +22 kt CO_2e per year compared to the last submission in 2024.

4.E Settlements

Since the last submission, the split of agricultural conversions to Settlements between Cropland and Grassland has been revised. For the years 2017 onwards the conversions of Cropland and Grassland to Settlements are now based directly on the spatial analysis of the 2016-2022 LU layers instead of being inferred from the Cropland statistics. Conversions from Cropland to Settlements for the years pre-2017 remain based on the inference from Cropland statistics; however, here also imporvements have been made to ensure consistency with the comprehensive Farm Structure Survey estimates (e.g. 2010 and 2020) and also correct an error affecting the pre-1990 time series. The above improvements affect both Cropland converted to Settlements and Grassland converted to Settlements. Furthermore, the Grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes involving Grassland and consequently have an impact on the results of the land-use change category Grassland to Settlement. With respect to soil carbon stock changes, improvements have been made to regionalize the Cropland and Grassland conversions to Settlements across five ecoregions (forest growth areas) to utilise ecoregion-specific soil carbon stocks for the pre- and post-conversion stocks. The stocks are moreover now for the depth 0-50 cm instead of the previously used 0-30 cm depth, ensuring consistency across all calculations of LUC-induced soil carbon stock changes e.g. Forest land conversions to Settlements. Forest land conversions to Settlements previously used 0-50 cm stocks and pre-conversion stocks stratified across the five ecoregions. Also here the methodology has been improved, implementing also post-conversion Settlement soil carbon stocks that are stratified too. Finally, on basis of a national study on organic soils, drained organic soils in Settlement were identified, for which emissions for the whole time series are estimated for the first time. These improvements caused upward revisions of the annual net emissions for the whole time series of the *Settlement* category in the range of +106 to +352 kt CO_2eq per year compared to the last submission in 2024.

4.F Other land

GHG emissions and removals from *Other land* have not been revised since the 2024 submission. Improvements in the Austrian system for land representation have led to small revisions in the total Other land area; however, these improvements have not affected conversions from Forest land to Other land – the only subcategory causing carbon stock changes and GHG emissions in Other land.

4.G HWPs

The *HWP* production figures for the year 2022 were updated in the most recent FAO statistics and very minor corrections were recorded in the years 2019-2021. Consequently, the HWP figures for this submission had to be updated accordingly. The recalculations in the *HWP* category led to lower removals of this subcategory of 118 kt CO_2e for 2022.

6.1.7 Completeness

Table 252 gives an overview of the new IPCC categories included in this chapter and the corresponding sub-divisions for which the calculations are made. It also provides information on the status of emission estimates of all subcategories. A "✓" indicates that emissions/removals from this subcategory have been estimated; for LULUCF CO_2 emissions/removals are estimated.

Table 252: IPCC categories according to the IPCC 2006 Guidelines.

IPCC categories[97]/ Sub division for calculation	Description	Status for CO_2	Other GHG
4 A	Forest land	✓	
4.A.1	Forest land remaining forest land	✓	
Coniferous	*Increase, decrease, net change in biomass carbon stock*	✓	
Deciduous	*Increase, decrease, net change in biomass carbon stock*	✓	
Forest not in yield	*Net change in biomass carbon stock*	✓	
	Net carbon stock change in dead organic matter	✓	
	Net carbon stock change in soils	✓[1], IE[5]	IE[5]
4.A.2	Land converted to forest land	✓	
4.A.2.a	Cropland converted to forest land	✓	
	Carbon stock change in biomass	✓	
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soils	✓	
4.A.2.b	Grassland converted to forest land	✓	
	Carbon stock change in biomass	✓	
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soils	✓	✓ N_2O
4.A.2.c	Wetlands converted to forest land	✓	
	Carbon stock change in biomass	✓	
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soils	✓	

[97] IPCC categories – applied according to the 2006 IPCC 2006 Guidelines for National Greenhouse Gas Inventories.

IPCC categories[97]/ Sub division for calculation	**Description**	**Status for CO_2**	**Other GHG**
4.A.2.d	Settlements converted to forest land	✓	
	Carbon stock change in biomass	✓	
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soils	✓	
4.A.2.e	Other land converted to forest land	✓	
	Carbon stock change in biomass	✓	
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soils	✓	
4.B	Cropland	✓	
4.B.1	Cropland remaining cropland	✓	
Annual remaining annual	*Carbon stock change in living biomass*	✓	
Annual remaining annual	*Carbon stock change in soils*	✓, IE[5)]	IE[2,5)]
Perennial remaining perennial	*Carbon stock change in living biomass*	✓	
Perennial remaining perennial	*Carbon stock change in soils*	✓	
Annual converted to perennial	*Carbon stock change in living biomass*	✓	
Annual converted to perennial	*Carbon stock change in soils*	✓	
Perennial converted to annual	*Carbon stock change in living biomass*	✓	
Perennial converted to annual	*Carbon stock change in soils*	✓	
4.B.2	Land converted to cropland	✓	
4.B.2.a	Forest land converted to cropland	✓	
	Carbon stock change in biomass	✓	
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soils	✓	✓ N_2O
4.B.2.b	Grassland converted to cropland	✓	
	Carbon stock change in living biomass	✓	
	Carbon stock change in soils	✓	✓ N_2O
4.B.2.c	Wetland converted to cropland	NO	
4.B.2.d	Settlements converted to cropland	NO	
4.B.2.e	Other land converted to cropland	NO	
4.C	Grassland	✓	
4.C.1	Grassland remaining grassland	✓	
	Carbon stock change in soils	NA, IE[5)]	IE[2, 5)]
4.C.2	Land converted to grassland	✓	
4.C.2.a	Forest land converted to grassland	✓	
	Carbon stock change in biomass	✓	
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soils	✓	
4.C.2.b	Cropland converted to grassland	✓	

IPCC categories[97]/ Sub division for calculation	Description	Status for CO_2	Other GHG
	Carbon stock change in living biomass	✓	
	Carbon stock change in soil	✓	
4.C.2.c	Wetland converted to grassland	NO	
4.C.2.d	Settlements converted to grassland	NO	
4.C.2.e	Other land converted to grassland	NO	
4.D	Wetlands	✓	
4.D.1	Wetlands remaining wetlands	NE/NO/IE[5)]	IE[5)]
4.D.1.a	Peat extraction remaining peat extraction	IE[5)]	IE[5)]
4.D.1.b	Flooded land remaining flooded land	IE[5)]	IE[5)]
4.D.1.c	Other wetlands remaining other wetlands	IE[5)]	IE[5)]
4.D.2.a	Forest land converted to wetlands	✓	
	Carbon stock change in living biomass	✓	
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soil	✓	
4.D.2.b	Cropland converted to wetlands	NO	
4.D.2.c	Grassland converted to wetlands	✓	
	Carbon stock change in living biomass	✓	
	Carbon stock change in soil	✓	
4.D.2.d	Settlements converted to wetlands	NO	
4.D.2.e	Other land converted to wetlands	NO	
4.E	Settlements		
4.E.1	Settlements remaining settlements	IE[5)]	IE[5)]
4.E.2.a	Forest land converted to settlements	✓	
	Carbon stock change in living biomass	✓	
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soil	✓	✓ N_2O
4.E.2.b	Cropland converted to settlements	✓	
	Carbon stock change in living biomass	✓	
	Carbon stock change in soil	✓	✓ N_2O
4.E.2.c	Grassland converted to settlements	✓	
	Carbon stock change in living biomass	✓	
	Carbon stock change in soil	✓	✓ N_2O
4.E.2.d	Wetlands converted to settlements	NO	
4.E.2.e	Other land converted to settlements	NO	
4.F	Other Land		
4.F.1	Other land remaining other land	NE	
4.F.2.a	Forest land converted to other land	✓	
	Carbon stock change in living biomass	✓	

IPCC categories[97]/ Sub division for calculation	**Description**	**Status for CO_2**	**Other GHG**
	Net carbon stock change in dead organic matter	✓	
	Carbon stock change in soil	✓	✓ N_2O
4.F.2.b	Cropland converted to other land	NO	
4.F.2.c	Grassland converted to other land	NO	
4.F.2.d	Wetlands converted to other land	NO	
4.F.2.e	Settlements converted to other land	NO	
4.G	Harvested wood products		
4.G.1	Solid wood	✓	
4.G.1.a	Sawn wood	✓	
4.G.1.b	Wood panels	✓	
4.G.2.a	Paper and paper board	✓	
4(I)	Direct nitrous oxides emissions from nitrogen inputs to managed soils	NO	
4(II)	Emissions and removals from drainage and rewetting and other management of organic and mineral soils	✓	✓ CH_4 ✓ N_2O
4(II)A.1	Forest land remaining forest land	✓	✓ CH_4 ✓ N_2O
4(II)B.1	Cropland remaining cropland	✓	✓ CH_4 IE[2)]
4(II)C.1	Grassland remaining grassland	✓	✓ CH_4 IE[2)]
4(II)D.1	Wetlands remaining wetlands	✓	✓ CH_4 ✓ N_2O
4(II)E.1	Settlements remaining settlements	✓	✓ CH_4 ✓ N_2O
4(III)	Direct and indirect nitrous oxide (N2O) 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	NA	✓ N_2O
4(III)A.2.a	Grassland converted to forest land	NA	✓ N_2O
4(III)B.2.a	Forest land converted to cropland	NA	✓ N_2O
4(III)B.2.b	Grassland converted to cropland	NA	✓ N_2O
4(III)E.2.a	Forest land converted to settlements	NA	✓ N_2O
4(III)E.2.b	Cropland converted to settlements	NA	✓ N_2O
4(III)E.2.c	Grassland converted to settlements	NA	✓ N_2O
4(III)F.2.a	Forest land converted to other land	NA	✓ N_2O
4(IV) 4 A 1 BiomassBurn_contr.	Biomass burning: controlled: Forest land remaining forest land	NO	NO
4(IV) 4 A 1 BiomassBurn_wildfires	Biomass burning: Wildfires: Forest land remaining forest land	IE[3)]	✓ N_2O ✓ CH_4
4(IV) 4 B 1 BiomassBurn_wildfires	Biomass burning: Wildfires: Cropland remaining cropland	NA	IE[4)] ✓ N_2O ✓ CH_4

IPCC categories[97]/ Sub division for calculation	Description	Status for CO_2	Other GHG
4(IV) 4 C 1 BiomassBurn_wild-fires	Biomass burning: Wildfires: Grassland remaining grass-land	NA	✓ N_2O ✓ CH_4
4(IV) 4 D 1 BiomassBurn_wild-fires	4.D.1 Biomass Burning: Wildfires: Wetlands remaining wetlands	NA	✓ N_2O ✓ CH_4
4(G)	C stock changes in Harvested Wood Products	✓	

1) CO_2 emissions/removals from changes in soil carbon stock of 4.A.1. are estimated for coniferous and deciduous forests. For forest not in yield, the soil carbon pool is assumed to be in equilibrium (notation key NA).

2) N2O emissions included in Agriculture

3) CO_2 emissions caused by wildfires (CRT Table 4(IV)) are included in the category 4.A.1. Data on the area affected by wildfires are available for the years 1990 to 2021.

4) Included in grassland remaining grassland category.

5) Emissions from drained organic soils are reported under 4(III).

6.1.8 Planned improvements

In the course of the inventory improvement process for LULUCF the used input parameters and applied methods are continuously re-evaluated. A number of potential future improvements have been identified, which will be considered for inclusion in future inventory submissions. These include:

- One project, which started at the end of 2023, is still ongoing and is expected to deliver results that will improve LULUCF methods in the quantification of non-agricultural woody biomass on croplands and grasslands (e.g. single trees/tree groups, hedgerows etc) and development of respective carbon stock change factors.
- For cropland it is planned to update the calculation of annual cropland biomass for calculating losses and gains in the year of conversion from annual to perennial cropland and vice versa, based on recent national statistics.

All these improvements will be finalised until submission 2026.

6.2 Forest land (CRT Category 4.A)

6.2.1 Category description

In Austria, a total of 4.02 million ha (47.9%) is classified as Forest land (BFW, 2022). Since the first national forest inventory (NFI 1961–1970) there has been a steady increase in the total standing forest C stock in Austria. The sustaining of Austrian forests in the past has helped to maintain an important carbon stock in the Austrian landscape and avoid net CO_2 emissions to the atmosphere from the sector LULUCF. In 1990, Austrian forests represented a carbon stock of 339 ± 42 Mt carbon from biomass and 463 ± 185 Mt carbon from soil, i.e. humus layer plus mineral soil to 50 cm depth. This total carbon stock is equivalent to approximately 40 times the total Austrian greenhouse gas emissions (in CO_2 equivalent) in the year 1990 (Umweltbundesamt, 2000). Recently the Forest land category became a net GHG source in single years, namely in 2018, 2019 and 2023. The net source values in these years are explained by a combination of high harvest rates due to natural disturbances, low increments due to weather conditions and net C losses from the soil pool.

Emission/Removal trends of forest land

In Austria, the area of Forest land has been constantly increasing since 1990 (

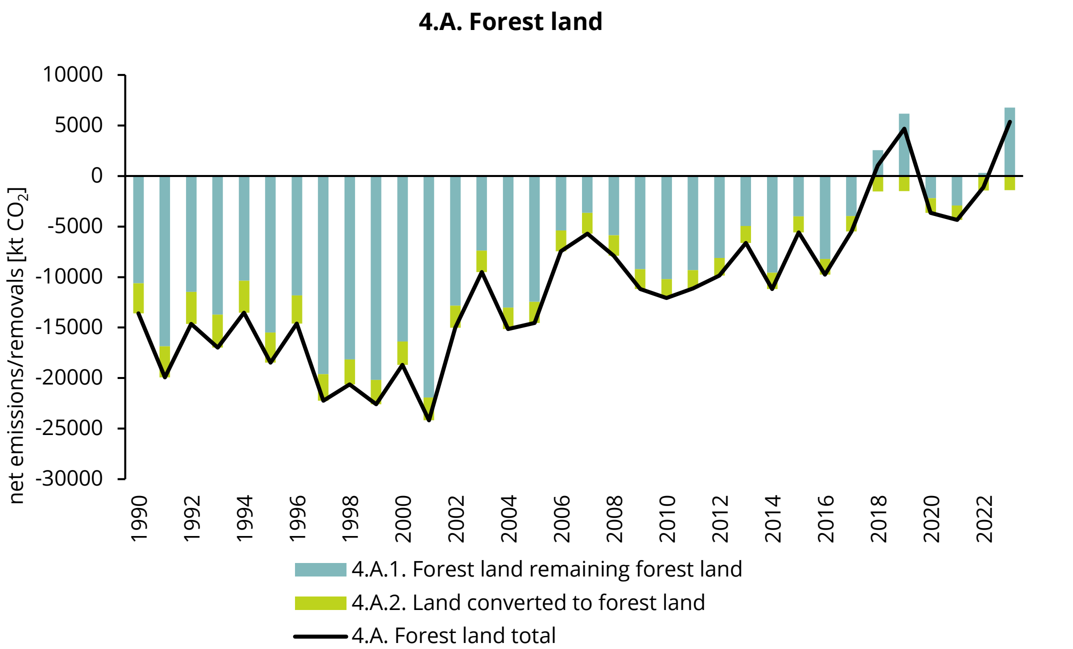
Figure 35). However, Land converted to forest land subcategories show a decreasing trend with the exception of Other land to forest land which is stagnating (Figure 36).

The annual net CO_2 results under sector *4.A* of the reported period 1990–2023 range from removals of -24 180 kt CO_2 to emissions of 5 362 kt CO_2 (mean: -11 066 kt CO_2). The most important subcategory is Forest land remaining forest land (*4.A.1*); however, land use changes to forests (*4.A.2*) and from forests (*4.B.2* to *4.F.2*) also contribute significantly to the net CO_2 balance of the LULUCF sector.

Between 1990 and 2023, the net carbon balance of the Forest land category fluctuated from a carbon sink sequestering 17% of the total CO_2 equivalent GHG emissions without LULUCF, to a source contributing an additional 8% to national total GHG emissions in the year 2023. The trend over the time series, however, shows a strong decrease of net removals towards a net source of emissions which can be explained by the increased impacts of climate change (droughts and natural disturbances).

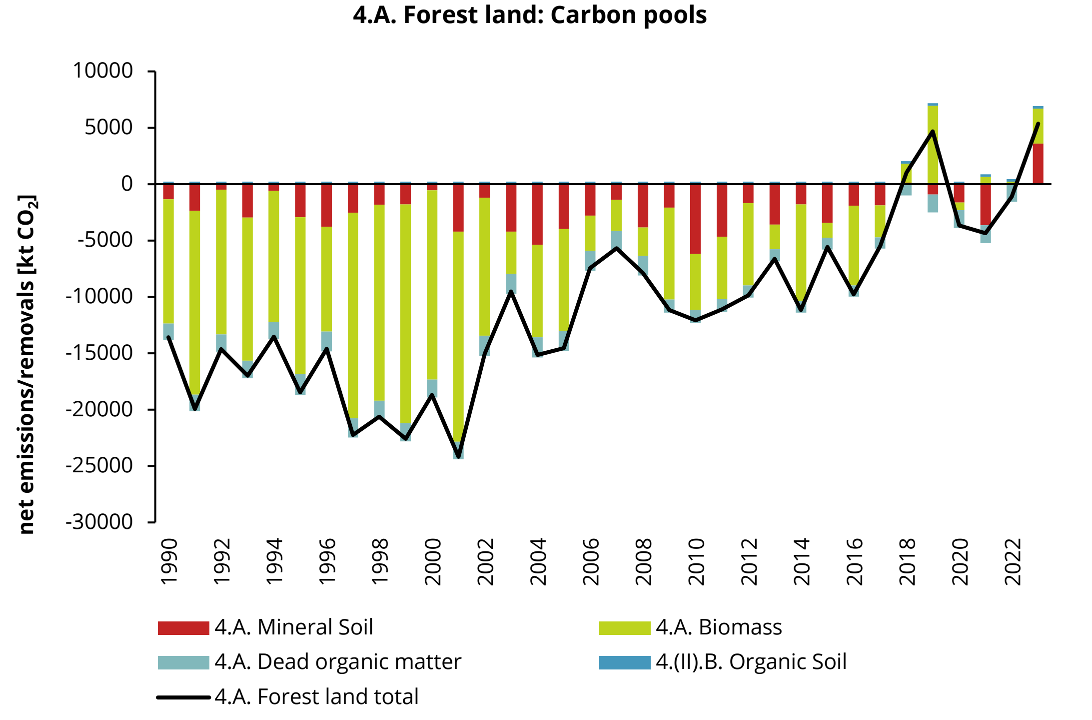
For the reported period 1990 to 2023, the total annual net CO_2 emissions and removals from Forest land remaining forest land range between -22 141 and 6 541 kt CO_2. Net removals from land-use changes to forest range from about -3 287 kt CO_2 to -1 402 kt CO_2. The total annual emissions from land-use changes from forests (deforestation) vary between 973 and 1 405 kt CO_2.

Figure 33: CO_2 removals/emissions (+/-) from IPCC Category 4.A Forest Land by forest land remaining forest land and land use change to forest land over 20 years from 1990–2023 [kt CO_2].



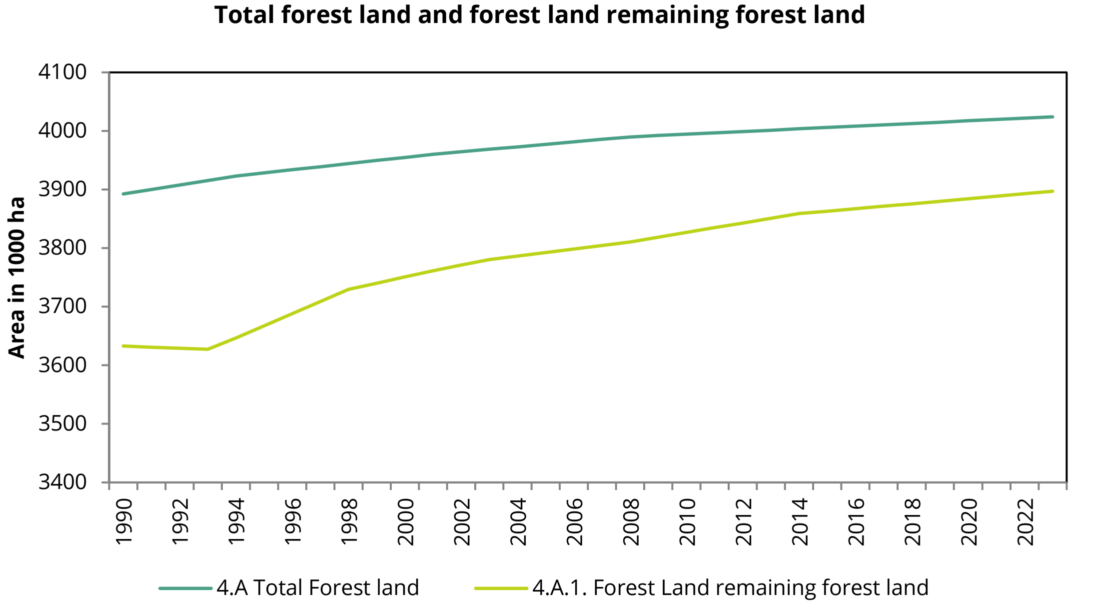
Source: Umweltbundesamt

Figure 34: CO_2 removals/emissions (+/-) from IPCC Category 4.A Forest Land by carbon pools from 1990–2023 [kt CO_2].



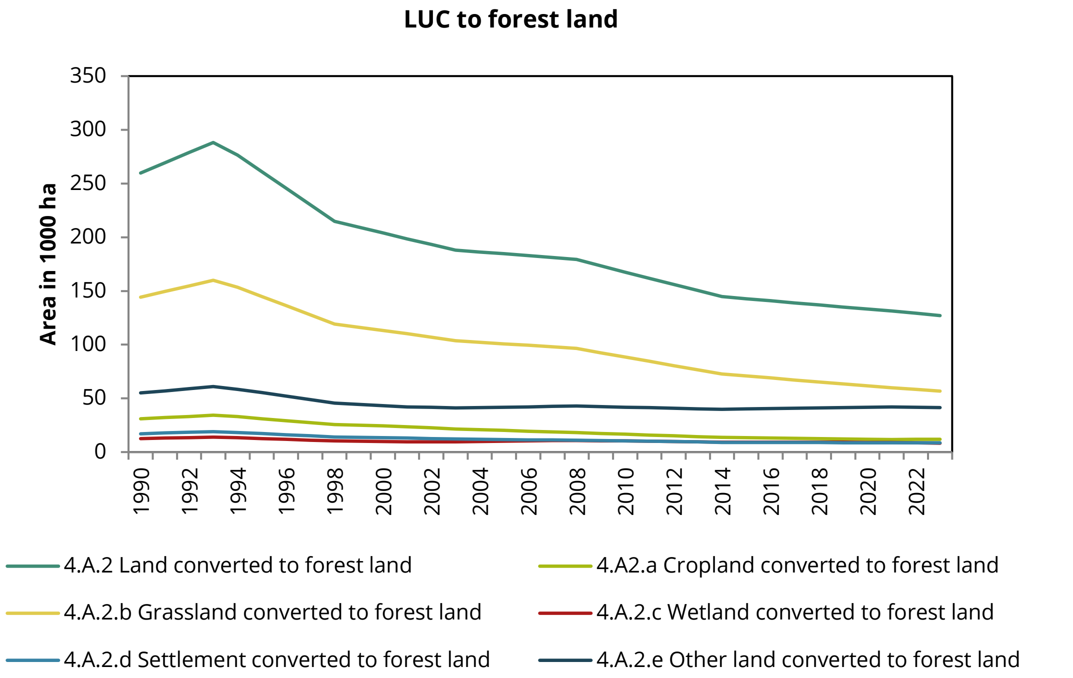
Source: Umweltbundesamt

Figure 35: Trend of total forest land and forest land remaining forest land.



Source: Umweltbundesamt

Figure 36: Trend of LUC to forest land (below) covering a conversion period of 20 years from 1990 to 2023 in 1 000 ha (Total forest land includes also forest out of yield).



Source: Umweltbundesamt

The net carbon stock changes of the category *4.A* vary considerably between single years. The reason for this variation is that the figures for annual growth and for annual harvest differ significantly year by year due to variations in factors influencing growth and harvest like weather conditions, timber demand and prices and/or wind throws, bark beetle infestations and other natural disturbances. This leads to high yearly variations in these gross gains and losses and net changes in stocks. For example, large annual increases in the soil C pool combined with low harvest rates and high increment resulted in a strong sink of CO_2 in 2001. In contrast, very high harvest rates due to natural disturbances in e.g. 2018, 2019 and 2023 combined with net emissions out of the forest soil pool and lower increment rates (in case of 2018, 2019 and 2023) due to the weather conditions lead to net emissions out of the Forest land category. It should be noted that the above dyamics in the Forest land category (and the LULUCF sector as a whole), are driven mainly by the respective carbon stock changes in the subcategory 4.A.1 Forest land remaining forest land.

The variation within the net removals time series for 4.A.2 Land converted to forest land is mainly due to the change of LUC areas and the composition of the previous land use types across the time series.

Table 253: Total areas and land-use change areas of forest land (1990–2023) in kha – transition period of 20 years for LUC lands.

	4.A Total Forest land	4.A.1. Forest Land remaining forest land	4.A.2 Land converted to forest land	4.A2.a Cropland converted to forest land	4.A.2.b Grassland converted to forest land	4.A.2.c Wetland converted to forest land	4.A.2.d Settlement converted to forest land	4.A.2.e Other land converted to forest land
1990	3 893	3 633	260	31	144	13	17	55
1995	3 928	3 667	261	31	145	13	17	55
2000	3 955	3 751	204	24	113	10	13	43
2005	3 977	3 793	185	20	101	10	12	42
2010	3 994	3 827	168	17	88	10	10	42
2011	3 997	3 835	162	16	85	10	10	41
2012	3 999	3 843	156	15	81	10	10	41
2013	4 001	3 851	150	14	77	10	9	40
2014	4 004	3 859	145	14	73	9	9	40
2015	4 006	3 863	143	13	71	9	9	40
2016	4 008	3 867	141	13	69	9	9	40
2017	4 010	3 872	139	13	67	9	9	41
2018	4 013	3 876	137	13	65	9	9	41
2019	4 015	3 880	135	12	63	9	9	41
2020	4 017	3 884	133	12	62	9	9	42
2021	4 020	3 888	131	12	60	9	9	42
2022	4 022	3 893	129	12	58	9	9	42
2023	4 024	3 897	127	12	57	8	9	41

Table 254: CO_2 removals/emissions (+/-) from IPCC Category 4.A Forest Land from 1990–2023, kt CO_2, N_2O and CH_4 in kt CO_2 equiv.

	4.A Total Forest land CO_2	4.A.1. Forest land remaining Forest land CO_2	4.A.2. Land converted to Forest land CO_2	4.A.2.a Cropland converted to Forest land CO_2	4.A.2.b Grassland converted to Forest land CO_2	4.A.2.c Wetlands converted to Forest land CO_2	4.A.2.d Settlements converted to Forest land CO_2	4.A.2.e Other Land converted to Forest land CO_2	4(II)A1_CO_2_Drained organic soils in CO_2	4(II)A1_CH_4_Drained organic soils CH_4 in CO_2eq	4(II)A1_N_2O_Drained organic soils N_2O in CO_2eq	4(III)A2 Direct and indirect N_2O emissions due to C losses in managed soils N2O in CO_2eq	4(IV)A1_Biomass burning wildfires in CO_2	4(IV)A1_Biomass burning wildfires CH_4 in CO_2eq	4(IV)A1_Biomass burning wildfiresN_2O in CO_2eq	4.A Total Forest land_CO_2eq
1990	-13 583	-10 846	-2 959	-412	-985	-88	-327	-1 146	223	3	17	30	IE	0.52	0.27	-13 532
1995	-18 464	-15 710	-2 977	-414	-992	-89	-329	-1 153	223	3	17	30	IE	0.08	0.04	-18 413

	4.A Total Forest land CO_2	4.A.1. Forest land remaining Forest land CO_2	4.A.2. Land converted to Forest land CO_2	4.A.2.a Cropland converted to Forest land CO_2	4.A.2.b Grassland converted to Forest land CO_2	4.A.2.c Wetlands converted to Forest land CO_2	4.A.2.d Settlements converted to Forest land CO_2	4.A.2.e Other Land converted to Forest land CO_2	4(II)A1_CO_2_Drained organic soils in CO_2	4(II)A1_CH_4_Drained organic soils CH_4 in CO_2eq	4(II)A1_N_2O_Drained organic soils N_2O in CO_2eq	4(III)A2 Direct and indirect N_2O emissions due to C losses in managed soils N2O in CO_2eq	4(IV)A1_Biomass burning wildfires in CO_2	4(IV)A1_Biomass burning wildfires CH_4 in CO_2eq	4(IV)A1_Biomass burning wildfiresN_2O in CO_2eq	4.A Total Forest land_CO_2eq
2000	-18 692	-16 593	-2 322	-323	-773	-69	-257	-900	223	3	17	23	IE	0.11	0.06	-18 648
2005	-14 555	-12 691	-2 086	-267	-672	-72	-221	-855	223	3	17	23	IE	0.08	0.04	-14 512
2010	-12 074	-10 421	-1 875	-218	-570	-73	-193	-820	223	3	17	22	IE	0.13	0.07	-12 031
2011	-11 111	-9 525	-1 808	-207	-542	-72	-187	-800	223	3	17	21	IE	0.11	0.06	-11 069
2012	-9 847	-8 328	-1 741	-196	-513	-71	-181	-780	223	3	17	21	IE	0.14	0.08	-9 806
2013	-6 619	-5 167	-1 674	-185	-484	-69	-175	-760	223	3	17	20	IE	0.24	0.12	-6 578
2014	-11 177	-9 792	-1 608	-174	-456	-68	-169	-741	223	3	17	19	IE	0.15	0.08	-11 137
2015	-5 568	-4 206	-1 585	-169	-442	-68	-168	-737	223	3	17	19	IE	0.36	0.19	-5 528
2016	-9 764	-8 426	-1 561	-164	-427	-68	-167	-734	223	3	17	19	IE	0.05	0.03	-9 725
2017	-5 498	-4 183	-1 538	-160	-413	-68	-166	-731	223	3	17	19	IE	0.09	0.05	-5 459
2018	1 028	2 321	-1 515	-155	-399	-68	-165	-728	223	3	17	19	IE	0.18	0.09	1 067
2019	4 672	5 941	-1 492	-150	-385	-68	-163	-725	223	3	17	18	IE	0.11	0.06	4 711
2020	-3 661	-2 416	-1 468	-145	-370	-68	-162	-722	223	3	17	18	IE	0.17	0.09	-3 623
2021	-4 356	-3 134	-1 444	-141	-356	-68	-161	-719	223	3	17	18	IE	0.48	0.25	-4 317
2022	-1 112	88	-1 423	-142	-348	-66	-162	-705	223	3	17	17	IE	0.70	0.37	-1 073
2023	5 362	6 541	-1 402	-144	-340	-63	-164	-691	223	3	17	17	IE	0.20	0.10	5 399

6.2.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The information on forest area is based on data of the Austrian National Forest Inventory (BFW, 2022, Schieler, et al., 1995, Winkler, 1997). The NFI was carried out in the periods 1961–70, 1971–80, 1981–85, 1986–90, 1992–96, 2000–02, 2007–09, and 2016-21, with continuous measurements since the the last NFI period measuring one sixth of the Austrian forest each year and covering the total forest area.

The NFI uses a permanent 4 x 4 km grid across all of Austria with four permanent sample plots of 300 m^2 size at each grid point. The NFI provides representative and systematically measured data for the total Austrian forest area and for all Austrian areas of LUCs from and to forests. This includes the areas of the complete category *4.A* and the areas of the subcategories *4.B.2.1*, *4.C.2.1*, *4.D.2.1*, *4.E.2.1* and *4.F.2.1*. The NFI grid covers the whole area of Austria and provides measured data on the total Austrian forest area with a statistical error of ±1.2% (see BFW 2022a). Each grid point is terrestrially inspected during each NFI assessment for a potential af-/reforestation.

Due to its representativeness and coverage, the NFI data allow an unbiased reporting of the complete Austrian forest area and its change by LUCs from and to forests. As such the NFI consistutes a fundamental element of the Austrian system for land representation (see 6.1.3.1). The following subsections describe in detail how annual time series of the total Forest land area, as well as land-use conversion to and from Forest land, are derived from the NFI data. The derived data feed directly into the annual land tranisition matrices and into the subsequent calculation of respective subcategory calculations of GHG emissions and removals.

6.2.2.1 Methods used to derive annual data of FL remaining FL on the basis of the existing NFI datasets

The NFIs provide for each NFI period data on the area of productive forests and non-productive forests (forests not in yield) – those sum up to the total forest area in Austria and represent averages for the NFI assessment period.

By linear interpolation (area according to NFI is located in the mean year of NFI measurement period) annual figures for these areas are estimated. Furthermore, the NFIs provide information on the ratio of area covered by coniferous and deciduous trees.

The calculation of the annual data for **FL remaining FL** is then based on the following data (all based on NFI assessments), steps and considerations:

1. Total annual area of productive forests (forests in yield) is reduced by the area of LUC to productive FL over the previous 20 years (as sum of 20 years LUC transition period). For 1990: 3 169 kha. This is the sum of the figures of 1.1.a and 1.1.b in Table 249.
2. The result of step 1 is then split according to the area-distribution of coniferous and deciduous trees. e.g. for 1990: coniferous 2 432 kha + deciduous 737 kha = 3 169 kha (see Table 249 and CRT table).
3. LUC to forests not in yield also takes place and is assessed by the NFIs and after 20 years of transition period those areas are considered as FL remaining FL. Analogous to step 1, the total annual area of forests not in yield is reduced by the total area of LUC to forests not in yield. For 1990: 463 kha (see 1.1.c in Table 249).
4. Total forest land remaining forest land in CRT Table 4.A is the sum of step 1 and 3 (For 1990 3 633 kha).

The result of step 4 and the total 20 year LUC to forest land sum up to the total forest area according to NFI (e.g. in 1990: 3 633 kha + 260 kha = 3 893 kha).

6.2.2.2 Estimation of the annual LUC from and to FL and their splitting into the different subcategories

Total LUC areas to and from forests are available from the individual NFIs, whereby a division of these areas by the respective interim NFI assessment period leads to data for the annual LUCs. For years after the latest NFI, annual LUC areas calculated from the last inventory are assumed to occur in the subsequent years.

The specific shares of individual land use categories of these LUCs were assessed in the NFIs 2000/02 and 2007/09 and in the NFI 2016/21 (which cover the observation periods between the years of the NFI periods 1992/96 to 2000/02. 2000/02 to 2007/09 and 2007/09 to 2016/21). In case a land use change has been observed at an inventory plot of the NFI, the type of the non-forest land was recorded. The various past/previous LU categories as assessed by the NFI were aggregated according to the 2006 IPCC Guidelines LU categories (Table 255).

Intermediate area results of the ongoing NFI cycle 2022/27 are available, however the sample size is considered inadequate for estimate land-use change areas to and from Forest land. Therefore, the LUC area results of NFI 2016/21 were extrapolated to the last years.

Table 255: LU-classification systems (IPCC 2006 Guidelines and NFI 2000/02, 2007/09 and NFI 2016/21).

Land use categories in the IPCC 2006 GL	LU classifications for LUC from and to forests according to the NFI (2000/02, 2007/09 and NFI 2016/21)
Cropland	Annual cropland Perennial cropland Fallow, agricultural land
Grassland	Grassland (intensive. extensive use) Pastures (incl. slopes)
Wetlands	Water bodies Mires, peatland Reed area
Settlements	Industry, mining Traffic area Landfills, dumps Urban, residential zone
Other land	Unmanaged alpine dwarf shrub heaths Scree Rock Others

Table 256: Land use changes to forest (% and ha) observed from 1990 to 2021 (covering the NFI periods 1986/90, 1992/96, 2000/02, 2007/09 and 2016/21; based on BFW 2022a).

Categories of land use changes according to the IPCC 2006 GL	1990 – NFI 1992/96		NFI 1992/96 – NFI 2000/02		NFI 2000/02 – NFI 2007/09		NFI 2007/09 – NFI 2016/21	
	LUC to forest land (%)	LUC to forest land [1 000 ha]	LUC to forest land (%)	LUC to forest land [1 000 ha]	LUC to forest land (%)	LUC to forest land [1 000 ha]	LUC to forest land (%)	LUC to forest land [1 000 ha]
Cropland (4.A.2.1)	11.9	6.9	11.9	6.5	6.2	3.4	10.9	6.7
Grassland (4.A.2.2)	55.5	32.0	55.5	30.1	50.2	27.8	42.2	25.8
Wetlands (4.A.2.3)	4.8	2.8	4.8	2.6	8.7	4.8	5.5	3.4
Settlements (4.A.2.4)	6.6	3.8	6.6	3.6	5.0	2.8	7.8	4.8
Other land (4.A.2.5)	21.2	12.2	21.2	11.5	29.9	16.6	33.7	20.6
Total	**100.0**	**57.7**	**100.0**	**54.3**	**100.0**	**55.4**	**100.0**	**61.2**

Table 257: Land use changes from forest (% and ha) observed from 1990 to 2021 (covering the NFI periods 1986/90, 1992/96, 2000/02, 2007/09 and 2016/21; based on BFW 2022a).

Categories of land use changes according to the IPCC 2006 GL	1990 – NFI 1992/96		NFI 1992/96 – NFI 2000/02		NFI 2000/02 – NFI 2007/09		NFI 2007/09 – NFI 2016/21	
	LUC from forest land (%)	LUC from forest land [1000 ha]	LUC from forest land (%)	LUC from forest land [1000 ha]	LUC from forest land (%)	LUC from forest land [1000 ha]	LUC from forest land (%)	LUC from forest land [1000 ha]
Cropland (4.A.2.1)	6.2	1.2	6.2	1.1	6.1	1.6	2.7	1.0
Grassland (4.A.2.2)	49.0	9.5	49.0	8.5	56.7	14.5	45.0	16.8
Wetlands (4.A.2.3)	2.6	0.5	2.6	0.4	2.2	0.6	6.7	2.5
Settlements (4.A.2.4)	14.8	2.9	14.8	2.6	20.0	5.1	13.9	5.2
Other land (4.A.2.5)	27.4	5.3	27.4	4.7	15.0	3.8	31.7	11.8
Total	**100.0**	**19.4**	**100.0**	**17.3**	**100.0**	**25.6**	**100.0**	**37.3**

As shown in Table 256 and Table 257 the land-use changes to and from forests mainly appear to be from/to grassland sites (42–56% or 45–57%, respectively).

For the years 1994 back to 1970 it was assumed that the measured land use changes between two previous NFI periods show the same ratio of distribution between land use change subcategories as between the NFI periods 1992/96 to 2000/02. For the NFI periods 1986/90 and 1992/96 the total areas of LUC to forests and the total areas of LUC from forests are available, but no further distribution into the different LUC subcategories. Consequently, the ratios of change areas from and to FL from/to individual land use categories according to NFI 2000/02 results could be applied directly to split the total LUC areas between NFIs 1986/90 and 1992/96 into the LUC categories. For the years from 1983 back to 1970 (NFIs before NFI 1986/90) only the net changes of the total forest area according to these older NFIs (1961/70, 1971/80, 1981/85) are available. These figures on the net forest area changes plus the information on LUC areas from/to forest according to the more recent NFIs were used to estimate the LUC areas from and to forests for these years: It was assumed that the detected net forest area changes between two NFI periods are based on the same ratio in LUC distribution (LUC to forests vs. LUC from forests) as between the more recent NFI periods. The ratio was always related to the total net increase or loss of forest area between two consecutive previous NFIs. The subsequent classification of the total LUC to/from forest between the LUC sub-categories again assumed the same distribution as between the NFI period 1992/96 to 2000/02. Thus, for the years from 1983 back to 1970 annual LUC areas from and to forest could be estimated.

It should be noted that the areas of the annual LUCs to and from forests show stepwise changes between NFI observation periods, while they remain constant within the NFI observation periods. The reason for this is that the average annual LUC area within a NFI observation period can be assessed with sufficient accuracy but not the specific LUC area of single years of the observation period. Interpolations across NFI periods would thus be unsuitable. With NFI 2016/21 new increment and drain data from land-use change sites was derived by observing the stock changes in biomass and dead wood that occurred over a period of 10 years. To accommodate this, LUC areas in transition have been split into two categories – short-term and long-term LUC – and multiplied with the respective average annual growth and harvest rates that were observed during the NFI 2016/21.

For the estimates of changes in litter and soil carbon stocks, the LUC area was further stratified according to five forest growth regions (Bohemian Massif, Inner Alps, Calcareous Alps, Foothills and Alpine ridge). The area information for these regional LUCs is also based on the results of NFI 2000/02, NFI 2007/09 and NFI 2016/21. The results are finally summed up according to the areas of LUC as shown in Table 256 and Table 257. The specific carbon stocks for litter and soil for each forest growth region are shown in Table 270.

6.2.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The National Forest Inventory (NFI) of Austria is the main data provider for estimating the areas and GHG balance of the Forest land category. Consequently, and for reasons of consistency, the applied forest definition for the reporting follows the definition used within the NFI. The selected parameters are:

- Minimum land area: 0.05 ha;
- Minimum crown cover: 30% (status as observed *in situ* or potential of the standing stock to reach this threshold);
- Minimum height: 2 m (status as observed *in situ* or potential of the standing stock to reach this threshold);
- Average width of forest area more than 10 m.

Permanently unstocked areas that are directly connected with forest in terms of space and forestry enterprise and contribute directly to its management (such as forest hauling systems, wood storage places, forest glades, forest roads) also represent forests. However, 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 are not defined as forests but rather perennial cropland. Rows of trees (except shelter belts for wind protection) and areas with woody plants in a park structure are not categorised as forests, but rather the land use category to which they belong (e.g shelter belts in Cropland, woody plants in parks in Settlements).

6.2.4 Methodological Issues

The following table provides an overview of the IPCC Tier methodology applied per category and pool in Forest land, including the significant pools (in grey) identified in the year 2023. All sub-categories of forest land are key categories for CO_2.

Table 258 Overview of IPCC tiers applied per pool in the forest land category. Significant pools of key categories are highlighted in grey and are based on the assessment of the year 2023

To	**Forest land**						
From	living biomass	dead wood	litter	mineral soil	organic soil	4(II) drained organic soils	4(IV) biomass burning
Forest land	T3	T3	IE (T3 mineral soil)	T3	IE	T2	IE
Cropland	T3	T3	T2	T2	NO	NO	NO
Grassland	T3	T3	T2	T2	NO	NO	NO
Wetlands	T3	T3	T2	NA	NO	NO	NO
Settlements	T3	T3	T2	T2	NO	NO	NO
Other land	T3	T3	T2	T2	NO	NO	NO

6.2.4.1 Forest Land remaining Forest Land (4.A.1)

6.2.4.1.1 Biomass

The country-specific method for estimating GHG emissions/removals from sector *4.A.1 Forest land remaining forest land* closely follows the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The use of country-specific conversion factors and biomass functions for tree branches, needles and below ground biomass provide more accurate and appropriate figures for Austrian forests. The main basis of the estimates are measured data for the forest area, stemwood volume increment and drain (harvest and other losses) of the growing stock (for both stemwood over bark with a diameter at breast height > 5 cm) according to the NFI (BFW, 2024b, BFW, 2022, BFW, 2011, Tomppo, et al., 2010, Schieler, et al., 1995, Winkler, 1997).

The NFI was carried out in the periods 1961–70, 1971–80, 1981–85, 1986–90, 1992–96, 2000–02, 2007–09 and 2016–21. In addition, for this submission 2025, an analysis of intermediate results (intermediate NFI 2022/23) of the currently ongoing NFI 2022/27 was carried out to obtain up to date biomass and dead wood values for the recent years since 2019 (BFW 2024). This intermediate NFI 2022/23 contains repeated measurements of those plots that were previously measured in 2016/17 and provides representatitive data for one third of all NFI plots. For the latter reason, the results have a higher uncertainty compared to the results of a complete NFI cycle. However, the current estimates for Forest land contain the most recent available data based on the NFI and reflect recent trends more accurately than a dataset containing all NFI plots which would require to include information back to the NFI 07/09 (e.g for the plots measured in the year 2021 it would be necessary to compare against the NFI period 07/09, because there was no NFI between 2010 and 2015).

The NFI provides mean values for annual increment and drain between individual NFI observation periods. Each inter-inventory period spans the midpoint of one inventory to the midpoint of the next inventory e.g. 2001 to 2008 is the period between NFI 2000-02 and NFI 2007-09. However, rather than assume a constant average annual drain and a constant annual increment between inventory periods, relative indices[98] are used to distribute NFI drain and increment more realistically between the years based on national harvest statistics and relative increment indices based on tree ring analyses. For submission 2025, the relative increment indices were updated for the years 2018-2022 based on the results of the intermediate NFI 22/23.

In addition to the NFI drain data, which are based on measurements in the forests, further harvest statistics exist (Table 259): the annually reported records of timber harvest (BML, 1964–2023) and the Austrian wood balance (BMK, 2024b). While it is assumed that the NFI provides more accurate figures on the total stemwood drain between inventories, the annually reported records of timber harvest are used to derive annual "relative harvest indices" for individual years (see below). For the corresponding inter-inventory period, the annual indices are calculated from proportional deviation of annual timber harvest values from their respective mean annual timber harvest for the inter-inventory (observation) period. The annual average drain from the NFI for the inter-inventory period is therefore adjusted by multiplying by the annual harvest index. In the same manner, representative Austrian sets of tree ring cores (BFW, pers. comm. from 2022) are used to calculate the relative indices for distribute the average NFI increments over the years of the time series (see paragraph above).

Table 259: Overview of the different harvest statistics in Austria.

Statistics	**Characteristics/methodological approach**	**Units of drain or harvested wood**
NFI – national forest inventories	Uses permanently marked grid (4x4 km) all over Austria, periodical investigation of sampling sites; measurements of increment and total stemwood drain (and other parameters) at permanent sampling plots in the forest.	m^3 total stemwood over bark
National annual records of timber harvest (HEM)	No measured data, annual reporting on wood disposal and wood going into self-consumption, declaration provided by forest authorities, wood from non-forest soils is not included; there is some underestimation of harvest in small-sized forest (private owners).	m^3 extracted stemwood under bark
National wood balance (HB)	No measured data, calculations based on NFI and HEM; includes also wood from non-forest areas and takes more possible and suspected domestic wood sources than HEM into account. available for specific years	m^3 extracted stemwood under bark

The above methods allow accurate estimates for individual years for the category *4.A.1* (Table 260). The figures for annual growth and for annual drain, and thus carbon stock changes, may differ significantly year to year and outliers exist (e.g. very low increment in 2003, 2013, 2015, 2018 and 2019; very high harvest rates in 2007, 2008, 2019, 2022, 2023 due to natural disturbances). Several factors influence growth and drain variations such as weather conditions, timber demand and prices, and natural forest disturbances such as windthrows and bark beetle infestations. Such factors explain the high annual variations in the CO_2 net removals by Austrian forests.

[98] Values for the relative variation in the individual years of the time series.

Table 260: Increment and drain in the Austrian forests in yield on basis of NFIs and interpolated on basis of relative indices[99]. The bold and non-bold font indicate to which NFI observation period the average and annual increment and drain figures belong.

Year	Average annual increment according to NFI 1000 m³ o.b	annual increment interpolated on basis of indices 1000 m³ o.b.	average annual drain according to NFI 1000 m³ o.b	annual drain interpolated on basis of indices 1000 m³ o.b.
1985	**31 416**	**32 243**	**19 846**	**19 358**
1986		**30 314**		**20 201**
1987		**31 416**		**19 583**
1988		**31 416**		**21 275**
1989		30 379		20 265
1990		28 473		23 034
1991	27 337	27 231	19 521	16 849
1992		25 498		17 958
1993		25 325		17 969
1994		27 116		21 052
1995		**28 985**		**18 461**
1996		**26 477**		**20 071**
1997	**31 255**	**33 772**	**18 797**	**19 690**
1998		**32 209**		**18 766**
1999		**33 967**		**18 832**
2000		**30 743**		**17 752**
2001		**32 632**		**18 007**
2002		31 195		21 166
2003		26 810		24 317
2004		30 008		23 500
2005	30 371	30 734	25 888	23 483
2006		29 349		27 281
2007		31 987		30 395
2008		32 514		31 076
2009		**30 643**		**24 601**
2010		**29 359**		**26 221**
2011		**31 301**		**27 495**
2012		**31 928**		**26 502**
2013		**26 570**		**25 574**
2014	**29 227**	**31 771**	**26 016**	**25 131**
2015		**26 413**		**25 809**

[99] Please note that these increment and harvest rates do not represent those for "FL remaining FL", but those for "FL remaining FL" plus all subcategories of LUC from and to FL due to the Austrian-wide assessment of the NFIs.

Year	Average annual increment according to NFI 1000 m³ o.b	annual increment interpolated on basis of indices 1000 m³ o.b.	average annual drain according to NFI 1000 m³ o.b	annual drain interpolated on basis of indices 1000 m³ o.b.
2016		**30 236**		**24 652**
2017		**27 855**		**25 952**
2018		**26 194**		**28 224**
2019		24 573		31 011
2020		27 752		27 543
2021		29 096		30 218
2022	28 149	31 175	30 345	31 756
2023		28 149		31 198

Given the coverage of the NFI, increment and drain data from the NFI integrate all possible biomass additions to- and losses from Austrian forests. This means that changes in the total standing forest stock due to land use changes, re-growth by forests, traditional (non-commercial) fuel wood consumption, forest land conversion, mortality, forest fires (wild-fires) and other damages are represented in the NFI increment and drain data.

In order to fulfil the requirements of the reporting format and to report on the subcategory *4.A.1 Forest land remaining forest land*, estimates of emissions and removals from biomass with a DBH ≥ 5cm due to annual land use changes from and to forests are subtracted respectively from the total biomass increment and drain according to the NFI. The approaches for calculating CO_2 emissions and removals related to land use changes are described in chapter 6.2.4.2. This step thus provides respective biomass increment and drain for forests in yield that are included under Forest land remaining forest land.

For the 2023 submission, a method was developed to estimate net biomass stock changes of *forests not in yield* back to 1990 based on the NFI 2016/21, which for the first time sampled the above-ground biomass and deadwood stocks in forests not in yield. For submission 2025, the simulations which were carried out by the Austrian Federal Research Centre for Forests (BFW) were updated with information from the intermediate NFI 22/23. For each of the sampled plots, the trees were grouped into 12 species-DBH classes (4 species groups x 3 DBH classes). For each of these classes, parameters describing mortality and harvest were derived based on sampling of *minimally managed protective forests in yield* in the last five NFIs (NFI 1992/96 to 2016/21). In terms of growth, mortaility and harvest, this subset of forests in yield were considered as very similar to forests not in yield. With the intermediate NFI 22/23, for the first time data on growth and drain for *forest not in yield* became available, although only for one third of the NFI plots. In addition, also for *minimally managed protective forests in yield* new data was available from the intermediate NFI 22/23. Based on these new data, the model parameters were updated considering the existing and new growth and drain rates with different weightings. In addition, an analysis of the new results for the spruce yield class showed that *forests not in yield* are generally located on poorer sites than *minimally managed protective forests in yield*. Therefore, the annual growth at tree level at *forests not in yield* was reduced by 15%. When trees disappear on a plot in a certain year, new trees are simulated to appear on the plots in the previous year. The dimensions of the newly-appearing trees, were derived randomly from the sample trees in the respective species-DBH class of the NFI sample. With these growth and drain rates, the declining dimensions of the standing trees (trees sampled in the plots as well as trees that appear in previous years via reversed mortalility simulations) were retrospectively simulated. Based on the above growth and drain simulations, a time series of average per ha net biomass stock change (volume) of *forests not in yield* was derived for the time series 1990–2021. Multiplication with respective wood densities, biomass expansion factors and carbon contents, and area of *Forest not in yield remaining forest not in yield* (all from the NFI) allowed conversion of the stock change units to kt C. For the years 2022 and 2023 the value of 2021 was extrapolated. The values will be updated again when new NFI data are available. Note that due to this model-approach, it is not possible to split the biomass carbon stock changes in gains and losses, because only a net result is provided. Therefore, "IE" is reported for biomass losses for forests not in yield in the CRT table 4.A.

Wood densities

Shrinkage values, wood densities (absolute dry mass (dm)) and C contents for all tree species in Austria are used to convert the increment and drain of m^3 stemwood over bark (o.b.) which is measured by the NFI into t carbon increment and t carbon drain of the stemwood o.b. The mean wood densities according to Table 261 represent aggregated values on basis of the species composition of increment and drain in Austria (see example in Table 262 for last two complete NFIs) and on country-specific values for the shrinkage and wood densities for all individual tree species (Austrian Standard ÖNORM B3012). These conversion factors are calculated for each inventory period and separately for increment and drain respectively. Between the inventories they show only minor differences (< 1%) because the shares of the tree species change very slowly.

Further details on the approach and methodology are given in (Umweltbundesamt, 2000).

Table 261: Conversion factors for the stemwood o.b. of the Austrian forests; mean of several NFIs.

Conversion factors	Coniferous	Deciduous
m3 o.b. to t dm (stemwood)	0.38	0.54
t dm to t C (stemwood)	0.50	0.48

Table 262: Share of tree species in total stemwood increment and drain of the NFIs 2007/09 and 2016/21. (BFW 2022a).

Tree species	% in total increment NFI 07/09	% in total drain t NFI 07/09	% in total increment NFI 16/21	% in total drain NFI 16/21
spruce	66.4	68.7	64.5	67.0
fir	4.2	4.0	4.0	4.0
larch	3.9	4.0	4.4	3.9
pine (pinus sylvestris)	4.0	6.3	4.5	6.6
pine (pinus nigra)	0.2	0.6	0.6	0.6
pinus cembra	0.2	0.1	0.2	0.1
weymouth pine (pinus strobus)	0.0	0.0	0.0	0.0
douglas fir	0.1	0.0	0.3	0.1
Total coniferous	**79**	**84**	**79**	**82**

Tree species	% in total increment NFI 07/09	% in total drain t NFI 07/09	% in total increment NFI 16/21	% in total drain NFI 16/21
beech (fagus sylvatica)	9.1	6.8	9.4	6.6
oak	2.2	2.2	2.4	1.6
hornbeam	0.8	0.5	0.9	0.8
ash	2.7	1.2	2.0	2.7
maple	1.4	0.7	1.8	0.7
elm	0.2	0.2	0.2	0.2
chestnut	0.2	0.2	0.1	0.2
robinia	0.3	0.3	0.3	0.4
sorbus, prunus	0.3	0.3	0.5	0.4
birch	0.7	0.9	0.7	0.8
alder	1.3	1.3	1.0	1.5
lime tree (Tilia)	0.4	0.2	0.4	0.2
poplar (Populus alba, Populus tremula)	0.5	0.5	0.6	0.6
poplar (Populus nigra. populus canadensis)	0.4	0.8	0.4	0.6
willow (Salix)	0.4	0.4	0.4	0.4
Total deciduous	**21**	**16**	**21**	**18**
Total	**100**	**100**	**100**	**100**

Biomass functions (BF)

The increment and drain of the other tree compartments (branches, needles, roots) are estimated with the help of biomass functions (Table 263:) and C contents for these tree compartments (coniferous: 0.47, deciduous: 0.48). The biomass functions were derived with the help of numerous single tree data from Austrian forest sites (see literature given below). Biomass functions as listed in Table 263: are applied to each single tree at the NFI plots of each NFI period to derive increment and drain of branches and roots of these trees. Only the evergreen needle biomass is estimated (leaves of deciduous trees become part of the soil C pool within one year). The compiled results for each tree species are further extrapolated to the total Austrian (productive) forest. These estimates are also carried out at the Austrian Federal Research Centre for Forests (BFW).

Table 263: Used biomass functions.

Tree species	Tree parts	Input parameter	Literature
Norway spruce (Douglas fir and other coniferous species than listed below)	Branches, needles	Dbh, height, crown ratio	(Eckmüllner, 2006)
Fir	Branches, needles	Dbh, crown ratio	(Ledermann, Neumann, 2006)
Pine	Branches. needles	Dbh, height, crown ratio	(Eckmüllner, 2006)
Larch	Branches	Dbh, height, crown ratio	(Rubatscher, et al., 2006)

Tree species	Tree parts	Input parameter	Literature
Beech	Branches	Dbh, crown ratio	(Ledermann, Neumann, 2006)
Oak	Branches	Dbh, crown ratio	(Ledermann, Neumann, 2006)
Oak (coppice)	Branches	Dbh, crown ratio	(Hochbichler, et al., 2006)
Hornbeam	Branches	Dbh, crown ratio	(Ledermann, Neumann, 2006)
Ash	Branches	Dbh, crown ratio	(Gschwantner, et al., 2010)
Other hardwood deciduous species	Branches	Dbh, crown ratio	(Gschwantner, et al., 2010)
Poplar	Branches	Dbh, crown ratio	(Gschwantner, et al., 2010)
Other weed tree species	Branches	Dbh, crown ratio	(Gschwantner, et al., 2010)
All	Roots	Dbh, age	(Offenthaler, Hochbichler, 2006, Wirth, et al., 2004)

On basis of the results of these biomass functions the average biomass expansion ratios according to Table 264 for total tree biomass/stemwood biomass were derived. The aggregated expansion factors in Table 264 are not used for the estimates, but are provided as additional information for transparency reasons and to allow comparisons.

Table 264: Average expansion ratios total tree biomass/stemwood biomass for the Austrian forests for the period 1990–2008. Aggregated values derived from the single NFI tree data on basis of the applied biomass functions (based on BFW, pers. comm. from 2011).

Expansion ratio t dm stemwood → t dm whole tree (incl. also below ground biomass)	Coniferous	Deciduous
increment	1.62	1.63
drain	1.60	1.59

The resulting mean annual biomass increments and drain of the other tree biomass compartments (needles, branches, roots) for the individual NFI periods are converted to figures for single years in the same way as described above for stemwood (i.e. using the relative increment and harvest indices).

6.2.4.1.2 Dead wood

The estimates on C-stock changes in dead wood include only standing dead wood, because any falling dead tree (part) is accounted for as a C flux to litter/soil in the modeling of the litter/soil C stock changes (see chapter 6.2.4.1.3.). Since national data on the stock of dead wood are available from the NFI, the method constitutes a Tier 3 method.

Based on the data of the NFI, the stock of dead wood (on average of all tree species) for the total forest area is 4.5 m^3 ha^{-1} for the inventory period 1992/96, 6.1 m^3 ha^{-1} for the inventory period 2000/02, 8.4 m^3 ha^{-1} for the inventory period 2007/09, 9.7 m^3 for the inventory period 2016/21 and 11.1 m^3 ha^{-1} for the intermediate NFI 22/23.

Based on the NFI 2016/21, stock changes in dead wood for forests in yield are available at land use change areas from and to forests which are extrapolated for the years afterwards until the 2022/27

NFI is completed. In order to fulfill the requirements of the reporting format and to report only the category *4.A.1 Forest land remaining forest land* without any double-counting, estimates of emissions and removals from C-stock changes of dead wood due to annual land use changes from and to forests are subtracted from the totals derived from the NFI. For the calculation of the C-stock changes, the conversion factors for stemwood as shown in Table 261 were used. These conversion factors do not include any estimates for roots and branches of the dead trees. The rationale is that dead roots are already part of the soil C pool and dead trees have usually only a negligible branch mass. It was assumed that the ratio between deciduous and coniferous dead wood is equal to the deciduous/coniferous ratio of the living trees.

For the 2023 submission, a method was developed to estimate net deadwood stock changes for forest not in yield back to 1990 based on the NFI 2016/21, which for the first time sampled the above-ground biomass and deadwood stocks in forests not in yield. From the NFI 2016/21 sampling of these areas, the ratio between the deadwood stock and the standing biomass stock was derived and used as a coefficient by which the simulations of the annual standing biomass stock was multiplied. This method was updated for the current 2025 submission with 2018/23 NFI data. A time series of average per ha net deadwood stock change (volume) of these forests was derived for the time series 1990–2021. For the years 2022–2023 the value of 2021 was extrapolated. The values will be updated when new NFI data 2022/27 is available. Multiplication with respective wood densities, expansion factors and carbon contents, and area of Forest not in yield remaining forest not in yield (all from the NFI) allowed conversion of the stock change units to kt C.

The results of the NFIs and simulations demonstrate an increase of dead wood in Austria. While not always a major contributor to the total C-balance of Forest land and the LULUCF sector, the associated annual net C-stock changes, which are equivalent to removals ranging between 257 kt CO_2 and 988 kt CO_2, are nonetheless significant.

6.2.4.1.3 Litter and soil

For the submission 2023, the dynamics of soil carbon in Forest land remaining forest land (forest in yield) were estimated for the first time with the simulation model Yasso20 (Viskari, et al., 2022), a more advanced version of the previously used Yasso07 (Finnish Environment Institute, 2011). This model was selected because it can be parameterised using data from national forest and soil inventories and is thus well-suited for such country-level applications. This method was updated for the current 2025 submission with NFI data until 2023.

The model simulation for Austria was based on data from two monitoring programs, the Austrian National Forest Inventory and the Austrian Forest Soil Survey. The Austrian NFI comprises 11 000 permanent sampling plots that are located on a regular grid. The soil monitoring network is part of this grid and comprises 529 sites. Soil sampling was repeated at 130 sites within the EU wide BioSoil project and these data were used to validate the model results. Furthermore, estimated aboveground and belowground litter inputs used to drive the model were previously validated against data from Austrian long-time monitoring sites. The Yasso simulations were carried out by the Austrian Federal Research Centre for Forests (BFW), the same institution responsible for the Austrian National Forest Inventory, the Austrian Forest Soil Survey and other forest monitoring activities.

Yasso20 model simulations of annual soil carbon stocks were made for each of the NFI plots that were considered as *Forest land remaining forest land* since NFI 1986/90 (ca. 8 700 plots). The start of the time series of the simulations was set at 1985 after necessary spin-up simulations starting in

1961 to achieve a relative steady state in the SOC stocks that were on average similar to mean measured forest soil carbon stocks from the Austrian Forest Soil Survey (ca. 120 t C/ha). The calibration for alligning the measured mean stock with modelling ouput was changed with this submission which led to overall smaller variations in stock changes. The annual aboveground and belowground flux of carbon to the soil and the chemical quality of the carbon input were estimated, at single-tree level, on the basis of the results of the Austrian NFIs (standing stock and drain at the plots) and with allometric functions for the conversion of stemwood to total tree biomass (see chapter 6.2.4.1.1). Any litterfall, dead roots input, any harvest residues input (e.g. needles, branches, pieces of stem, stump, roots) and *fallen* dead trees were estimated for the NFI plots and were included as C flux to the litter/soil in the Yasso simulations of the soil C stock changes. Therefore, the Yasso simulations also account for any flux of dead wood to the litter/soil (e.g. falling dead trees and branches, stumps and non-extracted tree parts after harvest). To avoid any double counting all these compartments are not accounted in the estimates of the dead wood stock pool, but only the changes in standing dead wood.

A further improvement in the soil C simulations with Yasso20 was the use of monthly air temperature and annual precipitation data to drive the model, and the use of these annual variations in soil carbon stock changes in the inventory (rather than a stable average stock change over the time series). The needed meteorological time series for each simulated NFI plot were taken from a 1 km^2 resolution weather data set[100] provided by the Austrian weather service, *Geosphere Austria* (formerly ZAMG).

The output of Yasso for each NFI plot is a yearly time series of the total litter/soil C pool and its changes, which is divided into the following pools: woody matter, non-woody matter and the acid-, water-, ethanol- and insoluble fractions. Yasso does not allow distinguishing between the C stock changes in the single litter and soil horizons and instead provides totals for the litter layer C plus the soil C pool. Therefore, the total litter and soil C stock changes of the subcategory 4.A.1 Forest land remaining forest land are reported under the mineral soil C pool changes in the CRTs. Note, however, that this removal/emission has to be finally adjusted for soil C stock losses due potential increases in unstocked forest land (particularly forest roads).

Forest roads and other unstocked areas of Forest land for forest management purposes are accounted as Forest land according to the Austrian and FAO forest definitions (see chapter 6.2.3). The Austrian NFIs provide detailed information on the area of forest roads and a further specific study on forest roads in Austria was used (Winkler, 2003). The estimates give an average area of approx. 700 ha per year that is converted from stocked forests to fortified macadam or gravel forest roads in the period covered by NFIs. According to (Winkler, 2003), 50% of these fortified forest roads have vegetation (beside the wheel ruts) and the other half has no vegetation. For those without vegetation, 0 t C per ha and for those with vegetation 60 t C per ha was assumed as the respective equilibrium soil C stock (0–50 cm). Assuming an average soil C stock of 130 t C per ha of forests in yield according to the results of the Biosoil project, a given yearly incease in forest road area is associated with a net soil C loss of 100 t C per ha over a 20 year transition period. This approach is completely consistent with the soil C stock discounting method according to the 2006 IPCC guidelines.

Finally, it should be reiterated that the above methods were applied to estimate 4.A.1 soil carbon stock changes in forests in yield. As part of the same national study dedicated to improving Yasso simulations of forest in yield, simulations were also made for forests not in yield. In the years 2022

[100] https://www.zamg.ac.at/cms/de/forschung/klima/klimatografien/spartacus

and 2023 the first re-measuring of the 16/21 NFI forests not in yield data was performed. Therefore single tree measures and site parameters were available for Yasso modelling. Growth and mortality was based on these measurements modelled backwards until 1990. The simulations yielded substantial temporal variations in the annual soil carbon stock changes (-3.1 to +1.2 t C/ha/yr), but a clear tendency of annual C stock increases across the majority of the period since 1990. Furthermore, the simulated carbon stocks were 10% higher than average forest carbon stocks for forests in yield according to the Austrian Forest Soil Survey (ca. 120 t C ha). Considering the aforementioned factors and the lack of soil C measurements in forests not in yield to validate these simulated stocks and stock changes, it was considered inappropriate to use these simulations in the LULUCF GHG inventory calculations. Therefore, the soil carbon stocks of forests not in yield under 4.A.1 are reported with tier 1 methodology, considering the pool to be in equilibrium.

6.2.4.1.4 Drainage of organic soils

Emissions due to historic drainage of organic soils occur in all land use categories except for Other land. Emissions are included in category "4(II).A.1 Forest land remaining forest land". In a dedicated project regarding extent, drainage status and resulting GHG-emissions of organic soils in Austria, activity data and emission factors (Table 265) were estimated (Umweltbundesamt, 2025d). All estimates follow the guidance of chapter 2 of the 2013 Wetland Supplement (IPCC, 2014). Direct on-site emissions of CO_2, CH_4 and N_2O ("$CO_{2\ on\text{-}site}$," ," $EF_{CH4\_landc,n}$" and "$N_2O–N_{OS}$") are estimated based on a literature study on emission factors for Austrian conditions and constitute therefore tier 2 methodology. Off-site emissions from dissolved organic carbon (DOC) export ("$EF_{DOC\_drained}$") and CH_4 emissions from drainage ditches ("EF_{CH4_ditch}" including $Frac_{ditch}$) have a minor contribution and are therefore estimated using the default values from table 2.2 and 2.4 of the Wetland supplement. Information on AD is available in 6.1.3.1.1.

Table 265: Forest land EF of drained organic soils

GHG	Unit	EF	95% confidence interval		Source
$CO_{2\ on\text{-}site}$	$t\ CO_2\text{-}C\ ha^{-1}\ a^{-1}$	2.62	1.30	3.94	(Umweltbundesamt, 2025d)
$EF_{DOC\_drained}$	$t\ C\ ha^{-1}a^{-1}$	0.31	0.19	0.46	2013 Wetland Supplement, Table 2.2
$EF_{CH4\_landc,n}$	$kg\ CH_4\ ha^{-1}\ a^{-1}$	0.24	-0.69	1.16	(Umweltbundesamt, 2025d)
EF_{CH4_ditch}	$kg\ CH_4\ ha^{-1}\ a^{-1}$	217	41	393	2013 Wetland Supplement, Table 2.4
$N_2O–N_{OS}$	$kg\ N_2O\text{-}N\ ha^{-1}\ a^{-1}$	1.97	0.55	3.38	(Umweltbundesamt, 2025d)

Estimation of CO_2 emissions follows equation 2.2. The respective EFs are provided in Table 265 wheras no burning of drained organic soils is recorded to occur in Austria.

Estimation of CH_4 emissions follows equation 2.6. The respective EFs are provided in Table 265.

Estimation of N_2O emissions follows equation 2.7. The respective EF is provided in Table 265.

6.2.4.1.5 Biomass burning

The controlled burning of managed forest is not carried out in Austria. CO_2 emissions caused by biomass burning due to wildfires in forests are included in category *4.A.1 Forest land remaining forest land*, as already reported in previous reports. Estimates of emissions from non-CO_2 gases from this category are reported. Equation 2.27 of the 2006 IPCC Guidelines following a Tier 1 method was applied.

$$L_{fire}\text{ (t GHG)} = A*M_B*C_f*G_{ef}*10^{-3}$$

A area burnt (ha)
M_B mass of available fuel, t dm ha^{-1} (Table 2.4)
C_f combustion factor
G_{ef} emission factor, g kg^{-1} dm (Table 2.5)

Data on the annual area affected by wildfires are available for the years 1990 to 2023 from the yearly updated statistics "Documentation of forest degradation factors" (BFW, 2024c) and range between 8 and 270 ha/year. According to the references in the 2006 IPCC Guidelines a mean value of 19.8 t ha^{-1} biomass consumption was applied. This represents the product of available biomass density on the land before combustion (M_B) and the combustion factor (C_f). The emission factors (G_{ef}) for N_2O and CH_4 were taken from table 2.5 of IPCC 2006 Guidelines.

However, due to the small area concerned, the amounts of N_2O and CH_4 emissions caused by wildfires are negligible, with annual sum N_2O and CH_4 emissions ranging between 0.032 and 1.07 kt CO_2 equivalents.

6.2.4.2 Land Use Changes to Forest Land (4.A.2)

Austria applies the default transition period of 20 years for areas undergoing land conversion. Therefore, all annual LUCs since 1971 are required for the calculation of annual GHG emissions and removals for 1990 onwards.

6.2.4.2.1 Biomass

Based on the results of the NFI 2016/21 the experts of the Federal Research Centre for Forests provided detailed, measured values for increment and drain at the areas of LUC to and from forests (BFW, 2022). The data are available for coniferous and deciduous trees (diameter at breast height (dbh) ≥ 5cm) and for two age classes of the land-use change lands (long-term ARD areas, where the LUC occurred before the previous NFI period (i.e. before 2007/09) and short term ARD areas, where the LUC occurred after the previous NFI period (i.e. after 2007/09). For forest biomass with a dbh < 5cm the stock changes were estimated. The respective values for biomass increment and biomass drain (DBH ≥ 5 cm), and for biomass stock changes (DBH < 5 cm) are summarised in Table 266 and Table 267.

Table 266: Annual biomass increment and drain (DBH ≥ 5 cm) at ARD areas.

	Biomass increment DBH ≥ 5 cm. total tree biomass (t/ha/a)		Biomass drain DBH ≥ 5 cm. total tree biomass (t/ha/a)[101]	
	coniferous	**deciduous**	**coniferous**	**deciduous**
long term AR areas	2.11	1.67	0.38	1.19
short term AR areas	1.06	1.05	0.00	0.00
long term D areas	0.18	0.34	0.28	0.26
short term D areas	0.17	0.12	81.15	34.31

Table 267: Annual biomass stock change (DBH < 5 cm) at ARD areas.

	Biomass stock changes DBH < 5 cm (t/ha/a)			
	Above ground		**Below ground**	
	coniferous	**deciduous**	**coniferous**	**deciduous**
long term AR areas	-0.0027	0.0276	-0.0005	0.0030
short term AR areas	0.0053	0.0723	0.0007	0.0080
long term D areas	0.0017	-0.0048	0.0003	-0.0005
short term D areas	0.0002	0.0076	0.0000	0.0008

The biomass stock changes at the LUC lands to and from forests of the whole time series were calculated with the factors given in in Table 266 and Table 267.

Conversion factors (BF, C)

The detailed biomass assessment at the ARD areas allowed the application of the same biomass functions as used in sector 4.A.1. (see Biomass functions (BF)) to derive biomass increment and biomass harvest of trees with a DBH ≥ 5cm. The stock changes of biomass < 5 cm are estimated based on counting of trees between NFI 07/09 and 16/21.

Table 268: Carbon conversion factors for forest biomass land use changes areas from and to forest land.

Conversion factors t dm to t C	increment		harvest	
	coniferous	**deciduous**	**coniferous**	**deciduous**
Above ground – stem	0.498	0.484	0.497	0.485
other tree compartments – branches. roots	0.473	0.481	0.473	0.481

[101] Drain on short term D areas is shown as total observed biomass drain caused by deforestation (t/ha) instead of a yearly average over the duration of the assessment period, following the assumption that biomass is not lost continuously but instead within the year in which the deforestation takes place.

Over the whole time series, the average annual net C stock change in living biomass (DBH>0) per ha for areas with LUC to forests amounts to:

$$\Delta C_{BM} = 1.08 \text{ t C ha}^{-1} \text{ a}^{-1}$$

For areas with LUC from forests to other land uses the calculations lead to the following result of average annual net C stock change in living biomass (DBH>0cm) per ha and year over the time series:

$$\Delta C_{BM} = -2.66 \text{ t C ha}^{-1} \text{ a}^{-1}$$

In the year of LUC from forests to other land uses, the following average annual C stock drain in living biomass (DBH>5cm) per ha and year is applied:

$$\Delta C_{BM\ drain} = -58.95 \text{ t C ha}^{-1} \text{ a}^{-1}$$

An overview of the emissions/removals from land use changes to forests is given in Table 254.

6.2.4.2.2 Dead wood

Based on stock changes between the NFIs 2007/09 and 2016/21 the experts of the Federal Research Centre for Forests provided detailed, measured values for stock changes of standing dead wood at areas of LUC to and from forests across time. This includes also measurements of changes in dead wood stocks in the transition period which are already present at the LUC areas in the year of land-use change (BFW, 2022). The stock changes are listed in Table 269. As with living biomass, the change in dead wood biomass per ha is given for short- and long term LUC areas and is calculated over the 20 year transition period as described above.

Table 269: Annual stock changes of dead wood at ARD areas based on the NFI 2016/21 (BFW 2022a).

	Stock changes – dead wood (t/ha/a)
long term AR areas	0.17
short term AR areas	0.05
long term D areas	-0.004
short term D areas	-1.22

6.2.4.2.3 Litter and soil

Soil and litter C stock changes were calculated for all land use change subcategories to and from forests. The soil C stock changes were stratified according to the specific soil C pools of different land use changes and additionally, according to five forest growth regions in Austria (Bohemian Massif, Inner Alps, Calcareous Alps, Foothills and Alpine ridge). To calculate the soil C stock changes due to LUC, a number of data sources were synthesized into a land-use soil C stock look-up table (Table 270). The table provides the estimates of C stocks in mineral soils (0–50 cm) and litter according to different land uses and forest growth regions. As the table shows, agricultural soil C stocks were calculated based on data from the Austrian Soil Information System (BORIS - see references). Forest soil and litter C stocks are based on the results of the EU-wide Biosoil project (BFW, 2009), which was carried out on 140 sites of the former forest soil survey (BFW, 1992). For the other land use categories, national estimates based on literature values or expert judgement were applied. The estimate and expert judgment of the soil C stocks in areas of settlements and traffic areas is based on the same approach as described in chapter 6.6.4.2.2 (in this chapter information about the assessment of the share of sealed area in settlements is provided). For the "other land uses" of Other land (those which are not alpine shrub lands, rocks and stone slopes) we assume a C stock of only 30 t C ha^{-1} due to the shallow depth of these soils. Note that where the original data provide two or more stratified soil C stock values for a given LU category, weighted averages were calculated (weighted by the relative area of each stratum). From the 2024 submission onwards the soil carbon stock for Settlements in land conversions between Forest land and Settlements is updated due to a new sealing ratio (see chapter 6.6.4.1.2). Furthermore, the application of the average sealing fraction to respective growth region mineral soil carbon stocks of *grassland (intensive-use)* yields stratified mineral soil carbon stocks for Settlements.

Table 270: Specific C-stocks (t C ha^{-1}) for litter and mineral soil (0–50 cm) stratified according to five forest growth regions in Austria.

IPCC LU categories	National LU categories	Forest growth regions					Source
		Bohemian Massif	Inner alps	Calcareous alps	Foothills	Alpine Ridge	
		t C ha^{-1} (0–50 cm)					
Forest – litter	Forest	40	24	24	19	26	(BFW, 2009)
Forest – mineral soil	Forest	88	91	109	77	117	(BFW, 2009)
Cropland	Cropland	56	90	80	65	90	Umweltbundesamt – see footnote 102 below
	Orchards/ Vineyards	71	71	71	71	71	(Gerzabek, et al., 2005b)
Grassland	grassland intensive use	75	95	100	79	94	Umweltbundesamt– see footnote 102 below
	grassland extensive use	132	130	120	139	139	Umweltbundesamt– see footnote 102 below
Wetlands	Surface waters and reed beds:	0	0	0	0	0	expert judgement
Settlements	Settlements and traffic area	36	45	47	37	45	Umweltbundesamt– see chapter 6.6.4.2.2

[102]The values for forests, cropland and grassland represent regional averages which are based on Austrian soil inventories for forests BFW (2009) and for agricultural land (Amt der Steiermärkischen Landesregierung (1988-1996); Amt der Oberösterreichischen Landesregierung (1993); Amt der Niederösterreichischen Landesregierung (1994); Amt der Salzburger Landesregierung (1993); Amt der Burgenländischen Landesregierung (1996); Amt der Kärntner Landesregierung (1999), compiled in the Austrian Soil Information System BORIS. The data have been stratified according to the Austrian forest growth regions.

IPCC LU categories	National LU categories	Forest growth regions					Source
		Bohe-mian Massif	Inner alps	Calcare-ous alps	Foothills	Alpine Ridge	
		t C ha^{-1} (0–50 cm)					
	Industrial and mining areas. dumps	36	45	47	37	45	Umweltbundesamt– see chapter 6.6.4.2.2
Other land	Alpine shrub lands	119	119	119	119	119	(Körner, et al., 1993)
	Rocks and stone slopes:	0	0	0	0	0	expert judgement
	Other land uses	30	30	30	30	30	expert judgement

For the LUC calculations, the average soil C stocks for each land-use category were furthermore weighted by the respective relative area contributions to the total LUC to forests and the total LUC from forests. The NFIs 2000/02, 2007/09 and 2016/21 specify the LUC areas from and to forests over a broader range of LUC categories than the existing six major IPCC land use categories (see Table 270). LUC areas are reported for additional LU substrata for each forest growth region. Consequently, for each land use change category from and to forest area, weighted mean values of soil C-stocks for each subcategory and growth region were calculated for each NFI period (NFI 1992/96 to 200/02, NFI 2000/02 to 2007/09 and NFI 2007/09 to NFI 2016/21). Given the variation in relative contributions of the strata to LUC to forests and LUC from forests, and variation between the inventory periods, the C stocks for each LU category differ between the respective look-up tables (Table 271, Table 272 and Table 273).

Table 271: Area weighted mean values for carbon stocks in mineral soils (0–50 cm) of land use change areas from and to forest land between the NFI periods 1992/96 and 2000/02 and previous NFIs.

	C-stocks (t ha^{-1}) in soils (0–50 cm)[1]									
Land use categories (IPCC –GPG)	LUC to forest (forest growth regions)					LUC from forest (forest growth regions)				
	Bohemian Massif	Inner alps	Calc. alps	Foot-hills	Alpine Ridge	Bohemian Massif	Inner alps	Calc. alps	Foot-hills	Alpine Ridge
Forest	88	91	109	77	117	88	91	109	77	117
Cropland	56	90	77	65	73	56	-	71	65	90
Grassland	77	123	117	85	125	75	116	115	88	128
Wetlands	-	-	-	-	-	-	-	-	-	-
Settlements	36	45	47	37	45	36	45	47	37	45
Other land	30	53	21	27	51	30	73	40	30	25

[1] - no LUC from/to forest could be observed in these regions

Table 272: Area weighted mean values for carbon stocks in mineral soils (0–50 cm) of land use change areas from and to forest land between the NFI periods 2000/02 and 2007/09.

	C-stocks (t ha^{-1}) in soils (0–50 cm)[1]									
Land use categories (IPCC –GPG)	**LUC to forest (forest growth regions)**					**LUC from forest (forest growth regions)**				
	Bohemian Massif	**Inner alps**	**Calc. alps**	**Foot-hills**	**Alpine Ridge**	**Bohemian Massif**	**Inner alps**	**Calc. alps**	**Foot-hills**	**Alpine Ridge**
Forest	88	91	109	77	117	88	91	109	77	117
Cropland	57	90	78	65	81	56	-	-	68	88
Grassland	91	128	117	87	130	75	128	114	124	128
Wetlands	-	-	-	-	-	-	-	-	-	-
Settlements	36	-	47	37	45	36	45	47	37	45
Other land	39	46	49	30	49	-	53	22	13	41

[1] - no LUC from/to forest could be observed in these regions

Table 273: Area weighted mean values for carbon stocks in mineral soils (0–50 cm) of land use change areas from and to forest land between the NFI period 2007/09 and the NFI period 2016/21.

	C-stocks (t ha^{-1}) in soils (0–50 cm)[1]									
Land use categories (IPCC –GPG)	**LUC to forest (forest growth regions)**					**LUC from forest (forest growth regions)**				
	Bohemian Massif	**Inner alps**	**Calc. alps**	**Foot-hills**	**Alpine Ridge**	**Bohemian Massif**	**Inner alps**	**Calc. alps**	**Foot-hills**	**Alpine Ridge**
Forest	88	91	109	77	117	88	91	109	77	117
Cropland	60	-	74	66	72	56	-	-	67	-
Grassland	87	128	115	93	128	75	124	114	109	125
Wetlands	-	-	-	-	-	-	-	-	-	-
Settlements	36	45	47	37	45	36	45	47	37	45
Other land	119	67	52	86	71	-	59	29	47	66

[1] - no LUC from/to forest could be observed in these regions

The estimates of the soil C stock changes for LUC areas from and to forests were split into litter (humus layer, see Table 270) and mineral soil (see Table 271, Table 272 and Table 273) and follow the equations below. The changes are estimated annually on a regional basis (forest growth region) and summed up for each LUC subcategory in the CFT tables. Based on the LUC data to and from forest, which are stratified between the forest growth areas in the NFI, soil C stock changes were calculated by applying the corresponding values from the tables above to the equations below. For the years up to 2001, the mineral soil C stocks from Table 271 were applied; between 2002 and 2008, Table 272; and from 2009 onwards, Table 273. After completion of NFI 2022/27 an update for these mineral soil stock estimates for the years after 2019 will be carried out.

Annual carbon stock changes in soils at LUC areas from and to forest land:

$$\Delta SOC = A*(SOC_O - SOC_{O\text{-}T})/20$$

ΔSOC = average annual carbon stock change in soils (t C a^{-1}) over the LUC transition period of 20 years

A = conversion area from or to forest land for a transition period of 20 years

SOC_O = carbon stock in soils after conversion, respectively (e.g mineral forest soils in the Calcareous Alps →109 t C ha^{-1}, see Table 272)

$SOC_{O\text{-}T}$ = carbon stock in soils before conversion, respectively (e.g. area weighted mean value of soil C stocks from grassland converted to forest land in the Calcareous Alps: 117 t C ha^{-1}, see Table 272).

Annual carbon stock changes in litter at LUC areas from and to forest land:

$$\Delta C_{LT} = A* (C_{LTo} - C_{LTo\text{-}t})/T$$

ΔC_{LT} = average annual carbon stock change in litter (t C a^{-1})

A = annual area of land converted from forests; or, 20-year LUC area for land converted to forests.

C_{LTo} = carbon stock in litter after conversion, (e.g. 24 t C ha^{-1} for Calcareous Alps, see Table 270)

$C_{LTo\text{-}t}$ = carbon stock in litter before conversion, respectively

T = transition period for the litter carbon stock changes (1 year for LUC areas from forest. 20 years for LUC areas to forest)

Regarding LUCs from and to Wetlands, it is assumed that Wetlands (flooded land) have a soil C stock of 0 t C ha^{-1}. Using the IPCC approach of calculating the C stock change between a period of 20 years leads to unrealistic annual C stock gains (WL to FL) or losses (FL to WL) in mineral soils for these LUCs. Due to a lack of information in the relevant literature, no C-stock changes in mineral soil are assumed for LUC between Forest land and Wetlands. The changes WL to FL are higher than those of FL to WL, and FL can be expected to have higher C stocks in soil. Therefore, this approach represents a conservative estimate.

6.2.4.2.4 Direct and indirect N_2O emissions from N mineralization/immobilization associated with loss of soil organic matter resulting from land use change on mineral soils (4(III))

Increases in available N due to soil C losses from human induced land use changes enhance the mineralisation of soil organic N and therefore cause N_2O emissions. These emissions have been calculated for Grassland converted to forest land because of related C losses in mineral soils. According to the key category analysis, N_2O emissions in the LULUCF sector are a key category. To estimate the associated N_2O emissions, the tier 2 method as provided in the IPCC 2006 GL is applied following eq. 11.1.

To calculate the net annual amount of N mineralized (F_{SOM}, eq. 11.1) from the net carbon stock change (CSC) due to the land use change in the mineral soil, the CSC was divided by the country specific C/N ratio of grassland soils (12, source: see footnote[102]) and multiplied by the default emission factor (EF_1) from Table 11.1 in the IPCC 2006 Guidelines. Then the result was converted from the amount of annual direct N_2O-N to N_2O emissions.

In addition to the direct N_2O emissions from mineralized soil nitrogen, indirect N_2O emissions occur due to the mineralized N which is leached from the soil . The IPCC 2006 Guidelines provide the following tier 2 methodology in Chapter 11 (eq. 11.10).

$Frac_{LEACH}$ is a country-specific factor of 0.15154 (Eder, et al., 2015) and EF_5 is provided in Table 11.3 of the IPCC 2006 Guidelines.

6.2.5 Uncertainty Assessment

The Austrian Federal Research Centre for Forests carried out an in-depth re-assessment of the uncertainty of the biomass C stock changes in Austrian Forests calculated from the NFI BFW (BFW, 2010, internal report). A ±40% uncertainty was estimated for the average annual net change in the biomass C stock in the NFI period 2000/02.

It is important to note that due to the design of the NFI the total change in the forest biomass stock also includes the biomass changes caused by LUC to and from forests. So, this ±40% uncertainty is valid for the total biomass changes at "forest land rem. forest land" plus lands of the subcategories with LUC to forests. As a consequence, the estimates of the overall uncertainty of sector 4 were carried out with the total net biomass changes at all forest lands and with the related uncertainty of this total net change.

The stock of dead wood is assessed within the NFI and with the same methods as living biomass. Therefore, we assume that the figures of the dead wood stock change have the same uncertainty as those of living tree biomass (±40%).

For the 2023 submission an improved estimate for the forest soil carbon stock changes on basis of an improved method and model was carried out for the whole time series (see chapter 6.2.4.1.3). For validation purposes, model simulations were conducted on a subset of 123 plots for which soil carbon stocks were measured in 1989 and 2009. The simulated and measured mean soil C stock changes did not differ significantly from one another. However, the comparsion showed the spatial variation (standard deviation) of the measured soil carbon stock changes was ca. 3.5 times higher than that of the simulations. This was considered in the uncertainty estimation. For each year of the time series of ca. 8600 plot simulations an average carbon stock change was calculated, together with a respective standard deviation. Based on the above comparison with measured soil carbon stock changes, this standard deviation was increased by a factor of 3.5. For each year, a standard error was calculated (from the increased standard deviation), which was subsequently used to estimate respective 95% confidence intervals. Over the time series an average uncertainty of ±57 % was derived, representing a substantial decrease in the soil carbon stock change uncertainties that were reported before the 2023 submission.

The uncertainty of the forest area in yield was estimated with ±2%. In addition, the uncertainties of the estimates of the litter/soil C stock changes due to forest road construction (about 10% of the total emissions of the litter/soil pool of 5.A.1) have the following uncertainties associated with the input data: Annual area of forest road construction: ±100% until 1994, ±60% after 1994; soil C stock of the forest road: triangle distribution with 10, 30 and 60 t C ha^{-1}.

For the LUC lands to and from forests the following uncertainties of the input parameters were used. Table 274 shows the uncertainties for the areas of the subcategories with LUC to and from forests:

Table 274: Uncertainties of LUC areas to and from forests.

	before NFI 1985/90[1]	since NFI 1985/90[1]
Annual LUC area CL to FL or FL to CL	±200%	±80%
Annual LUC area GL to FL or FL to GL	±200%	±10%
Annual LUC area WL to FL or FL to WL	±200%	±120%
Annual LUC area SL to FL or FL to SL	±200%	±80%
Annual LUC area OL to FL or FL to OL	±200%	±80%
Annual LUC area to or from FL	±200%	±10%

[1] *Distributions were truncated at 0, because negative areas are not possible*

The uncertainty of the LUC areas to and from forest reflects the statistical design of the NFI. The different uncertainties between the time series reflect the fact that since NFI 1981/85 a fixed grid system has been installed which allows a separate assessment of both, gains and losses of forest land. The NFIs before could only detect the net changes of the forest area between the NFI periods. The differences in the uncertainties of single subcategories reflect the different size of the LUC areas of these subcategories – the constant absolute uncertainty in estimated LUC in ha results in an increasing relative uncertainty the smaller the respective LUC is.

For the litter/soil C stocks of all LUC areas the uncertainties according to Table 275 were used for the estimate of the uncertainties of soil C stock changes. These uncertainties are based on the results of the Austrian soil inventories (Forest land, Cropland and Grassland), on the information of the related literature according to Table 270 (other land) or on expert judgment based on information from related studies. For data based on soil inventories, two-times the standard error of mean was taken as the uncertainty estimate instead of twice the standard deviation as in previous submissions.

Table 275: Uncertainties of the litter/soil C stocks in the forest growth regions according to Table 270.

IPCC LU categories	National LU categories	Forest growth regions					Austria
		Bohemian Massif	Inner alps	Calcareous alps	Foothills	Alpine Ridge	
		%					
Forest – litter	Forest	±29	±34	±29	±29	±16	±13
Forest – mineral soil	Forest	±30	±18	±14	±26	±13	±8
Cropland	Annual cropland. fallows	±4	±20	±18	±3	±12	±2
	Vineyards. Orchards/ garden land	±3	±25	±20	±2	±15	±2
Grassland	grassland intensive use	±7	±8	±5	±4	±4	±3
	grassland extensive use	±5	±7	±10	±21	±9	±5
Settlements	Settlements and traffic area	Triangle distribution between 5–75 t C ha^{-1}					

IPCC LU categories	National LU categories	Forest growth regions					Austria
		Bohemian Massif	Inner alps	Calcareous alps	Foothills	Alpine Ridge	
		%					
	Industrial and mining areas. dumps	Triangle distribution between 5–75 t C ha^{-1}					
Other land	Alpine shrub lands	Triangle distribution 15–119–567 t C ha^{-1}					
	Rocks and stone slopes:	Uniform distribution 0–13 t C ha^{-1}					
	Other land uses	Uniform distribution 0–70 t C ha^{-1}					

The uncertainties of the area of drained organic forest soils and emission factors from such soils were taken from the report of the national study on organic soils in Austria (Umweltbundesamt, 2025d). The uncertainties of the area of drained organic forest soils was defined as a triangle distribution with a minimum of 18,9 kha and a maximum of 21.3 kha. The uncertainties of the emission factors from drained organic forest soils are ±50 % for CO_2, ±383 % for CH_4 and ±72 % for N_2O. The uncertainties for the used default emission factors for ditches were taken from the 2013 Wetlands supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2014).

The uncertainties for the N_2O emission factors from soil due to land-use changes can be seen in Table 287, chapter 6.3.5.

For the forest fire estimates default uncertainties for the biomass consumption and emission factors according to the IPCC 2006 GL were used.

Monte-Carlo simulations based on the above uncertainties and distribution assumptions gave an average uncertainty of the total emissions/removals of the complete forest land category of ±3 990 kt CO_2eq across the years. The average uncertainty across the time series is ±43%.

As expected from the high share of the Forest land category in the total Austrian area and the large contribution of Forest land to the total GHG balance of the LULUCF sector, the Forest land category has the largest impact on the total sector uncertainty.

6.2.6 Category-specific QA/QC

The NFI is based on a very comprehensive quality assurance system which allows the exact identification of sample points in the field, guarantees the repeated measurement of the right trees (permanent marked grid) and flags up implausible figures for individual parameters during the measurements on site and any missing trees compared to the period before (further details are given in (Hauk, Schadauer, 2009, Schieler, Hauk, 2001).

The calculation of the data for category *4.A* is embedded in the overall QA/QC-system of the Austrian GHG inventory (see chapter 6.1.4).

6.2.7 Recalculations

The increment, drain and dead wood results for recent years were updated on the basis of an analysis of intermediate results of the ongoing NFI cycle 2022/27. These new results caused a significant change of the biomass and dead wood results of the most recent years since 2019, but resulted also in minor (before 2009) and intermediate (2009 to 2018) revised biomass and dead wood results of previous years. The forest soil C stock changes were also recalculated for the complete time series based on the intermediate results of the ongoing NFI 2022/27 cycle, as well as improved calibration- and spin-up procedures of the model. A detailed and comprehensive study was finalized in 2024 (Umweltbundesamt, 2025d), where the area of organic soils in Austria, their land use and drainage status and related emission factors were analysed on the basis of various geographic, historic and other data sources. Based on this study, drained organic soils in *Forest land* were identified, for which emissions for the whole time series are estimated for the first time. Together, these improvements caused changes of the annual net removals for the whole time series of the *Forest land* category in the range of -4 903 to +7 071 kt CO_2e per year compared to the last submission in 2024.

6.2.8 Planned improvements

See Chapter 6.1.8.

6.3 Cropland (CRT Category 4.B)

6.3.1 Category description

Emissions and removals from Cropland remaining cropland and Land converted to cropland are reported under Category 4.B Cropland. The calculations were made for all individual years from 1990 to 2023. Some management practices (e.g. slash and burn etc.) and some LUC subcategories (categories *4.B.2.3*, *4.B.2.4*, *4.B.2.5*) do not occur in Austria. Changes in dead wood and litter carbon stocks do not occur in Cropland, apart from respective carbon losses in these pools due to Forest land converted to Cropland. In the recent organic soils study (see chapter 6.1.3.1.1), 6 583 ha of drained organic soils were identified in Cropland, for which emissions for the whole time series have been estimated for the first time. These improvements caused changes of the annual net emissions for the whole time series of the *Cropland* category in the range of up to 193 kt CO_2e per year compared to the last submission in 2024.

Emissions/removals were estimated for the subcategories and related sources/sinks as shown in Table 276.

Table 276: Sources (or sinks) considered for cropland.

Category/source or sink
4.B Cropland – total
4.B.1 Cropland remaining cropland
- carbon stock change in biomass of "perennial cropland remaining perennial cropland" and carbon stock changes in biomass due to conversions between annual and perennial cropland

Category/source or sink
- soil carbon stock changes due to management changes in "annual cropland remaining annual cropland" and "perennial cropland remaining perennial cropland" and due to conversions between annual and perennial cropland
- N_2O, CH_4 emissions due to wildfires ("IE" under the Grassland category)
4.B.2 Land converted to cropland
4.B.2.1 Forest land converted to cropland
- carbon stock change in biomass due to LUC from forest land to cropland
- carbon stock change in DOM[103] due to LUC from forest land to cropland
- carbon stock change in SOM[104] due to LUC from forest land to cropland
- Direct and indirect N_2O emissions from soils due to LUC from forest land to cropland
4.B.2.2 Grassland converted to cropland
- carbon stock change in biomass due to LUC from grassland to cropland
- carbon stock change in SOM due to LUC from grassland to cropland
- Direct and indirect N2O emissions from soils due to LUC from grassland to cropland
4(II)B1_Drained organic soils CO_2, CH_4 in CO_{2eq}, N_2O in CO_{2eq}
4(III)B2_Direct and indirect N_2O emissions due to C losses in managed soils,_N_2O in CO_{2eq}

In 2023, ca 1.39 million ha were identified as Cropland including annual and perennial crops (Statistik Austria, 2018, Statistik Austria, 2022c, Statistik Austria, 2024b). The total Cropland area in Austria has generally been decreasing over the reported time series.

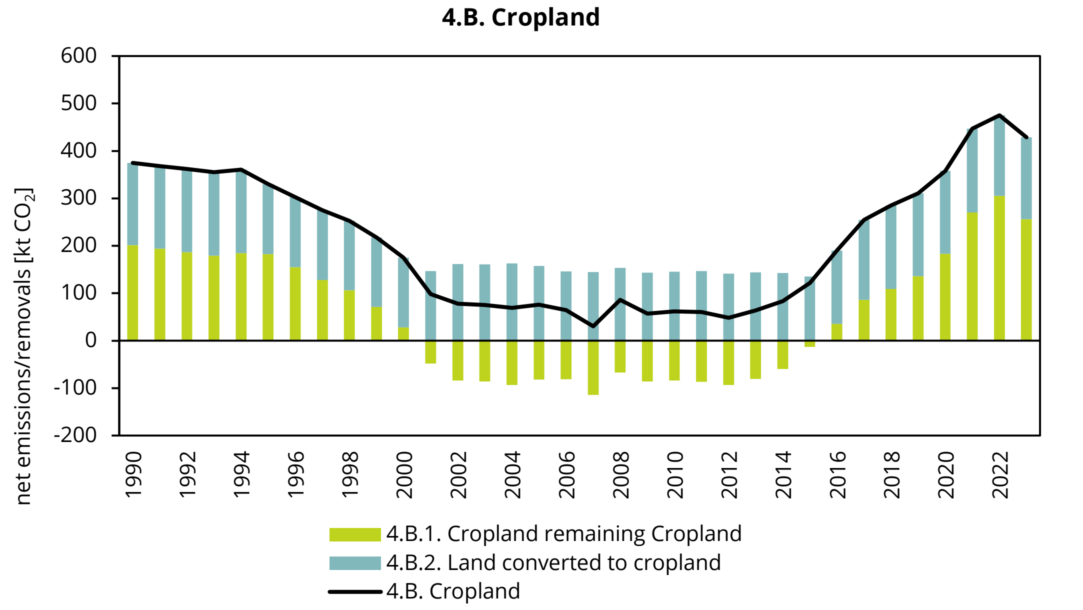
The total CO_2 emissions of Cropland range between 30 and 475 Gg CO_2, with emissions reported during the 90s, reduced emissions between 2000 and 2015, and again rising emissions since 2016 (

Table 278). The CO_2 emissions during the 90s were mainly caused by the soil C loss caused by conversions from Grassland to annual cropland and from Forest land to Cropland. The reduced CO_2 emissions between 2000 and 2015 are largely due to the increase of soil organic carbon in Cropland remaining cropland, due to specific management measures implemented by the Austrian agri-environmental program, ÖPUL. This program was introduced in 1995, when Austria joined the EU. After 2015 the net CO_2 emissions from this subcategory have been increasing. The reason for this is that the increases in soil carbon stocks resulting from the ÖPUL programme are starting to level off as the land parcels applying ÖPUL measures reach their new equilibrium soil carbon stocks. Furthermore, the area of Cropland applying certain ÖPUL measures has also been decreasing over time, leading to soil carbon stock losses.

[103] DOM = Dead Organic Matter

[104] SOM = Soil Organic Matter

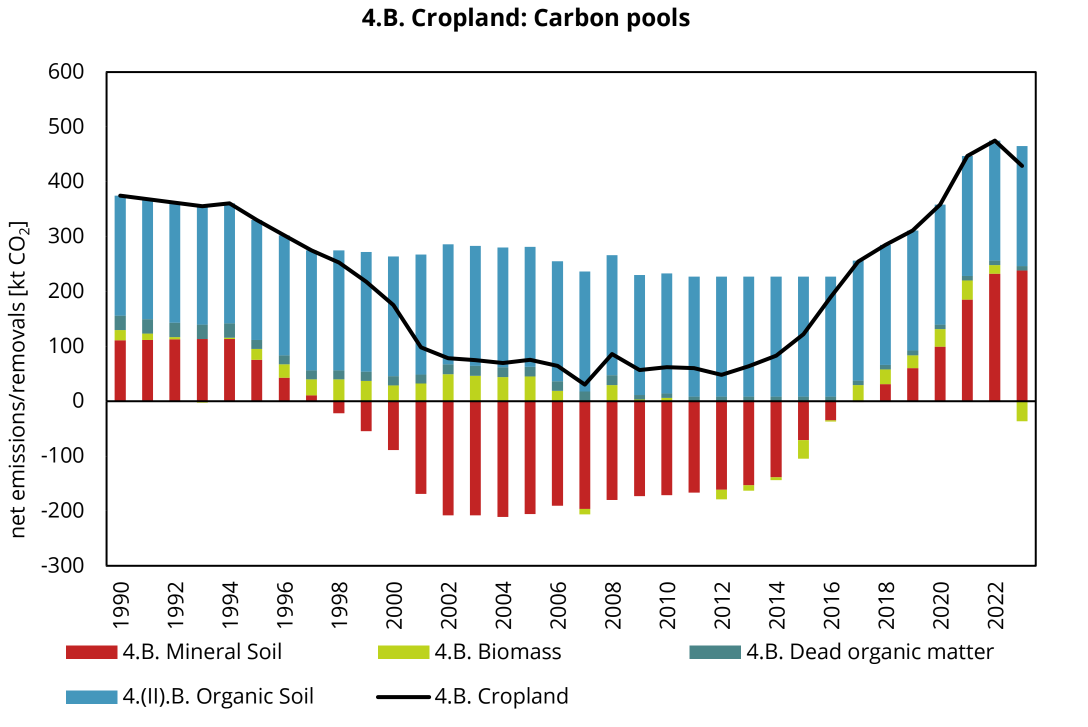
Figure 37: Emissions /removals (+/-) from cropland (1990–2023) by cropland remaining cropland and land use change to cropland in kt CO_2.



Source: Umweltbundesamt

In 2023, the total land use change area to cropland was 69 896 ha (over a transition period of 20 years). The total annual carbon dioxide emissions of Land converted to cropland over 1990–2023 range from 135 kt CO_2 to 176 kt CO_2 (Table 278).

Figure 38: Emissions /removals (+/-) from cropland (1990–2023) by carbon pools in kt CO_2.



Source: Umweltbundesamt

Table 277: Total areas and land-use change areas of cropland (1990–2023) in ha – transition period of 20 years for LUC lands.

	4.B Total cropland	4.B.1 Cropland remaining cropland-total	4.B.1.a annual remaining annual & perennial remaining perennial cropland	4.B.1.b perennial cropland converted to annual cropland	4.B.1.c annual cropland converted to perennial cropland	4.B.2 Land converted to cropland	4.B.2.a Forest Land converted to cropland	4.B.2.b Grassland Land converted to cropland - total	4.B.2.b.i Grassland converted to annual cropland	4.B.2.b.ii Grassland converted to perennial	4.B.2.c Wetland converted to Cropland	4.B.2.d Settlement converted to cropland	4.B.2.e Other Land converted to cropland
1990	1 500 824	1 461 847	1 440 271	10 179	11 397	38 978	4 125	34 852	34 376	476	NO	NO	NO
1995	1 493 201	1 453 891	1 432 471	10 105	11 315	39 310	4 710	34 600	34 128	473	NO	NO	NO
2000	1 473 875	1 435 112	1 413 903	10 006	11 203	38 763	4 504	34 260	33 792	468	NO	NO	NO
2005	1 464 088	1 425 684	1 404 672	9 913	11 099	38 403	4 463	33 941	33 477	464	NO	NO	NO
2010	1 440 524	1 391 543	1 368 964	11 891	10 689	48 981	3 792	45 190	44 651	539	NO	NO	NO
2011	1 433 776	1 384 637	1 362 351	11 864	10 422	49 139	3 644	45 495	44 878	617	NO	NO	NO
2012	1 427 828	1 377 665	1 355 697	11 829	10 139	50 162	3 497	46 665	46 016	649	NO	NO	NO
2013	1 422 909	1 371 830	1 350 216	11 763	9 851	51 079	3 350	47 729	47 047	682	NO	NO	NO
2014	1 417 031	1 364 262	1 342 546	11 810	9 906	52 769	3 202	49 567	48 819	748	NO	NO	NO
2015	1 409 198	1 351 804	1 329 031	12 526	10 247	57 394	3 143	54 251	53 350	901	NO	NO	NO
2016	1 401 305	1 340 908	1 317 508	12 801	10 599	60 397	3 083	57 313	56 295	1 018	NO	NO	NO
2017	1 396 039	1 334 250	1 310 651	12 637	10 962	61 788	3 023	58 765	57 667	1 098	NO	NO	NO
2018	1 394 961	1 332 795	1 309 330	12 531	10 933	62 167	2 964	59 203	58 062	1 141	NO	NO	NO
2019	1 393 850	1 331 069	1 307 658	12 561	10 851	62 781	2 904	59 877	58 704	1 173	NO	NO	NO
2020	1 391 834	1 328 302	1 305 036	12 602	10 665	63 532	2 844	60 688	59 502	1 186	NO	NO	NO
2021	1 391 262	1 326 975	1 303 777	12 683	10 515	64 288	2 785	61 503	60 300	1 203	NO	NO	NO
2022	1 392 376	1 325 548	1 302 464	12 775	10 310	66 828	2 657	64 170	62 941	1 229	NO	NO	NO
2023	1 392 806	1 322 911	1 299 181	13 899	9 831	69 896	2 530	67 366	66 144	1 222	NO	NO	NO

Table 278: Emissions /removals (+/-) from cropland (1990–2023) in kt CO_2,CH_4 and N_2O emissions in kt CO_2eq; other land use changes are not occurring.

	4.B Total Cropland_CO_2	4.B.1 Cropland remaining Cropland - total	4.B.1.a. Annual remaining annual and perennial remaining perennial cropland	4.B.1.b. Annual cropland converted to perennial cropland	4.B.1.c. Perennial cropland converted to annual cropland	4.B.2 Land converted to cropland	4.B.2.a Forest land converted to cropland	4.B.2.b Grassland converted to cropland - total	4.B.2.b.i Grassland converted to annual cropland	4.B.2.b.ii Grassland converted to perennial cropland	4.(II).B.1 Drained organic soils CO_2	4.(II).B.1 Drained organic soils CH_4 in CO_2eq	4.(II).B.1 Drained organic soils N_2O in CO_2eq	4.(III).B.2 Direct and indirect N_2O emissions due to C losses in managed soils_N_2O in CO_2eq	4.B Total Cropland_CO_2eq
1990	375	-18	-18	-9	10	173	94	79	78	0.79	219	11	IE	11	397
1995	330	-36	-37	-9	10	148	69	79	78	0.78	219	11	IE	11	353
2000	175	-190	-191	-9	10	147	69	78	77	0.78	219	11	IE	11	197
2005	76	-301	-299	-11	10	157	82	75	75	0.58	219	11	IE	11	98
2010	62	-302	-303	-11	11	146	41	104	103	1.14	219	11	IE	13	87
2011	60	-305	-303	-14	12	147	40	106	104	2.22	219	11	IE	13	85
2012	48	-312	-310	-14	12	141	40	102	100	1.47	219	11	IE	14	73
2013	64	-299	-298	-13	12	144	39	105	104	1.51	219	11	IE	14	89
2014	83	-278	-285	-5	12	143	38	105	103	2.23	219	11	IE	14	109
2015	122	-232	-244	1	11	135	38	98	94	3.96	219	11	IE	16	149
2016	190	-183	-195	0	12	154	37	117	114	3.39	219	11	IE	16	218
2017	255	-133	-145	0	13	169	37	132	129	2.86	219	11	IE	17	283
2018	285	-109	-112	-10	13	176	36	139	137	2.31	219	11	IE	17	313
2019	311	-83	-84	-11	12	175	36	139	137	2.16	219	11	IE	17	339
2020	358	-35	-34	-13	12	175	35	140	138	1.87	219	11	IE	17	387
2021	447	52	52	-12	12	176	35	142	140	1.95	219	11	IE	17	476
2022	475	86	87	-13	12	170	35	136	133	2.19	219	11	IE	18	504
2023	429	38	40	-13	11	172	34	138	136	2.03	219	11	IE	19	459

6.3.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The data for total Cropland areas were taken from national statistics (Statistik Austria, 2018, Statistik Austria, 2022c, Statistik Austria, 2024b), that were processed in the *LU Area Statistics* element of the Austrian system for land representation (see 6.1.3.1 and Annex 5.2). The area of Cropland remaining cropland represents the total Cropland area minus Land converted to cropland.

The Cropland area time series is based mainly on the the Cropland area statistics of „Statistik Austria". These data are based on the Farm Structure Survey (FSS). In the years when the full FSS was conducted (1990, 1995, 1999, 2010 and 2020) these data were taken (ÖSTAT, 1991, ÖSTAT, 1996, Statistik Austria, 2001, Statistik Austria, 2013a, Statistik Austria, 2022c). In some intermediate years random sample Farm Structure Surveys were carried out (1993, 1997, 2003, 2005, 2007, 2013 and 2016 (ÖSTAT, 1994, ÖSTAT, 1998, Statistik Austria, 2005, Statistik Austria, 2006, Statistik Austria, 2008, Statistik Austria, 2014a, Statistik Austria, 2018). The FSS area estimates are based on the responses to questionnaires sent to all farms and forest enterprises, or a random subset thereof. For the preceding years, specifically 1960, 1970 and 1980, data are taken from the *Land- und forstwirtschaftliche Betriebszählung* (Census of agricultural and forestry enterprises), which was the statistical survey programme that preceded the FSS. In this 2025 submission, the pre-1990 statistical time series were reassessed leading to revised estimates of the 1970-1980 Cropland area, which had follow-on effects on estimats of Cropland conversions to Settlements, as well as conversions between Cropland and Grassland. For more recent years, the FSS are complemented by the Cropland area data according to the data base of the Integrated Administration and Control System (IACS). Since joining the EU in 1995, Austria operates the IACS data base, which in contrast to FSS is updated yearly, but includes only Cropland area (and Grassland area) of farms that receive support under the CAP. Nonetheless, the propotion of total Cropland in the IACS data base has increased over time, with almost all Cropland now included.

For the total annual cropland area the data from the FSS differ somewhat from the IACS data. In most years the area taken from the FSS database is slightly larger, because a larger number of farms is included in FSS compared to IACS. Since the 2022 submission the annual total cropland area is simply interpolated (linear) for the non-FSS years and over certain intermediate random sample FSS years (e.g. 2003 and 2005), for which time series consistency issues were identified. For the coming years until the next FSS we extrapolate using the relation factor of the FSS 2020 and IACS annual cropland area of every year.

Data for perennial cropland area (viticulture, orchards, house gardens, Christmas trees and perennial energy crops) were also taken from the full and random sample FSS data, with intermediate years interpolated.

In the orchards time series there are two discontinuities which led to substantial area changes:

- Between 1968 and 1969 there was a sharp increase in the orchard area, probably caused by the inclusion of extensive orchards area for the first time.
- Between 1982 and 1983 there was a considerable decrease in the orchard area probably due to the changed delimitation: the threshold for the minimum unit was raised from 0.5 to 1 ha. In addition, from 1983 on, municipalities were no longer obliged to report small areas and unproductive agricultural areas, which were reported before under the orchards category.

For time series consistency, the area for orchards was extrapolated backwards until 1960.

In the time series for house gardens two sharp changes occurred:

- Between 1982 and 1983: this is probably due to the changed delimitation: the threshold for the minimum unit was raised from 0.5 to 1 ha. In addition, from 1983 on municipalities were no longer obliged to report small areas and unproductive agricultural areas, which were reported before under the house gardens category.
- Between 1994 and 1995: This might be a result of the new Common Agricultural Policy (CAP) of the EU, because house gardens are no longer supported under this policy, and it is likely that these areas were then reported under cropland or grassland.

For time series consistency the area of house gardens between 1960 and 1995 was therefore interpolated to remove the above potential systematic errors during this period.

Since the 2022 submission, the planted vineyard area of the basic vineyard surveys (Weingartengrunderhebungen) for the years 2009, 2015 and 2020 (Statistik Austria, 2011, Statistik Austria, 2016, Statistik Austria, 2021c) was used for the viticulture area, as these explicitly comprise the vineyard area planted with vine stems. For time series consistency the area of vineyards between 2009, 2015 and 2020 was interpolated.

After the above filtering and interpolation steps have been performed, the annual time series of total Cropland area undergoes a minimal correction in the *LULUC Data Integration* element of the Austrian system for land representation to ensure full consistency in the land transition matrices (see 6.1.3.1 and Annex 5.2). These adjustments of the total Cropland area lead to small corrections (<|1%|) of the initial Cropland area estimates from LU Area Statistics element for some of the years in between the comprehensive FSS surveys. At the subcategory level, the above area changes are reflected in the areas of annual cropland.

Areas for land-use change/conversions between grassland, annual cropland and perennial cropland have been estimated from spatially-explict data from IACS. The processing of these data take place within a dedicated element (the *IACS (CL<->GL)* element) of the Austrian system for land representation. In Austria the majority of famers participate in the CAP and therefore the IACS data base comprises about 99% of the total agricultural area according to the FSS (2020: IACS: 2 564 931 ha, FSS: 2 602 666 ha, (BML, 2023). IACS: Plots (*INVEKOS Schläge Österreich*) are Geospatial Aid Application (GSAA) datasets that contain annual geographical representation of the agricultural land units per farm. It includes quantitative data including plot area and boundaries and qualitative attribute data on crop culivation. In Austria, it is obligatory that, in the case of application for-/receipt of CAP subsidies, agricultural land parcels are identified at the plot level (graphically and digitally) using farm maps (cartographic documents which comprise an aerial photograph and the outline of the individual parcels).

By means of these data, detailed information on areas of Cropland (annual, perennial) and Grassland, as well as changes between the two categories, are derived. However, as IACS data is primarily used for yearly administration of payments, it does not contain a fully-consistent and complete identification of land use and management of parcels over time. Furthermore, in 2016, the format of the data changed from a classical database structure to a GIS system, whereby the individual fields and plots (and associated land use and management information) are now spatially delineated. Some workaround is thus necessary for the analysis of time series (see next paragraphs).

The *IACS (CL<->GL)* element queries the historic tabular database pre-2015 and merges this with the geodatabases (GSAA datasets) available since 2016. The five processing steps of this element are described in detail below:

- **Step 1: Sampling of IACS GIS data for the years 2016 onwards**. For the years 2016 onwards AMA publishes IACS-GSAA datasets of the polygons delineating the single plots of subsidized agricultural fields as geopackage files e.g. the *INVEKOS Schläge Österreich 2023-2* dataset (AMA, 2023). As an attribute, the *Schlagnutzungsart* is attached to each plot polygon and describes cultivation practise applied to that plot over that year's vegetation period. In QGIS, these IACS data are sampled by intersection of these polygons with a point vector layer marking the centre points (centroids) of the 100m x 100m cells of the INSPIRE geographical grid system. Importantly, the applied point vector layer has already been pre-intersected with the vector layers of the *2016 Digitale Katastralmappe* (BEV, 2016) and the forest growth regions (BFW, 2024d) to extract cadastral pacel-ID number and ecoregion at the centroid locations, respectively. Consequently, the above intersections provide information on agricultural land use (*Schlagnutzungsart*) at each centroid point for year post-2016 together with geoinformation on the associated land parcel-ID and the ecoregion. The attribute table of this intersection is exported as a csv file, with the *Schlagnutzungsart* subsequently translated to annual cropland, perennial cropland or Grassland according to a translation table based on the national land use definitions.

- **Step 2: Merging of data from 2016 onwards with the IACS data from the previous database format (2002-2015)**. A SQL query of the previous IACS database and subsequent processing was done to generate a 2002-2015 time series of agricultural land use (again based on the *Schlagnutzungsart*) for each cadastral land parcel contained within the database. First of all the database is queried to extract the following attributes for each agricultural plot (*Schlag*):
  - Plot ID
  - Plot area (ha)
  - *Schlagnutzungsart* at the plot
  - Cadastral land parcel ID (one or more plots can be associated to single cadastral land parcel; likewise, a single plot can span over two cadastral land parcels)

After querying these data for all available years (2002-2015), the individual *Schlagnutzungsart* codes are assigned to either annual cropland, perennial cropland or Grassland according to the aforemented *Schlagnutzungsart*-LU Crossalk. The data are then aggregated at the cadastral land parcel level. For each land parcel-ID, the total IACS area and the total area per land use are calculated for each year between 2002 and 2015. Due to some inconsistency and incompleteness issues in the previous database, as well as the consequence that data from 2016 onwards can only be joined at the aggregated land parcel level, a subset of the queried data was retained for analysis of LUCs. The selection of the subset was based on land parcels that are:

- available for all years; and
- relatively constant in terms of area size over the time series; and
- categorised by relatively homogenous land-use

After selection of the subset, the area data are removed to produce a table of agricultural land-use for each individual land parcel-ID between 2002 and 2015. This subset of 2002-2015 data are then merged with the IACS GIS data for the years 2016 onwards using cadastral parcel-IDs as the joining variable common to both datasets. The result is a 2002-2023 time series of IACS agricultural land use (categorised as *annual cropland, perennial cropland, grassland* and *other*) for each INSPIRE grid point (i.e. for each ha) of the Austrian territory, albeit incomplete for the years 2002-2015.

- **Step 3: Correction of short-term land-use changes/conversions and regional contributions**. In this step, the processing routine checks for- and subsequently corrects short-term land-use changes/conversions between annual cropland, perennial cropland, grassland and other. The check and correction is implemented to detect annual changes in agricultural land use at each INSPIRE grid point, and check if the subsequent land use remains stable for at least the following five years. If within the subsequent 5 years after conversion, another land-use change (e.g. backwards to the initial subcategory) is detected, the initial conversion is removed by correcting the land use to that of the previous year, as demonstrated in the example below.

Orginal:

Inspire Grid	Ecoregion	2002	2003	2004	2005	2006	2007
100mEXXXXXNYYYYY	Foot Hills	C ann	**G**	C ann	C ann	**G**	C ann

Corrected:

Inspire Grid	Ecoregion	2002	2003	2004	2005	2006	2007
100mEXXXXXNYYYYY	Foot Hills	C ann	**C ann**	C ann	C ann	**C ann**	C ann

Obviously, the routine is limited in being able to detect and correct short-term land-use changes/conversions in the last fives of the time series. Therefore, the above detection and correction process produces partially corrected time series of agricultural land-use at each INSPIRE grid point. Therefore, for subsequent processing in the next step, the total conversion areas per conversion category per year of the partially corrected and the orginal uncorrected datasets are calculated. The respective corrected and uncorrected total conversion areas up to the last five available years are compared to derive average reduction factors for each land-use conversion. As such, the time series of total conversion areas per conversion category per year are derived as follow:

- Total yearly conversion areas from the (partially) corrected dataset except for the last five years (2003-2018)
- Total yearly conversion areas from the orginal uncorrected dataset for the last five years (2019-2023) multiplied by the aforementioned category-specific reduction factors

The partially corrected dataset is nonetheless utilised further in this step to calculate the relative regional contributitions to each conversion category. For example, for each year and each conversion category, the total conversion area per ecoregion is divided by the total conversion area for the whole dataset. To extrapolate back in time, the mean regional distributions per conversion category between 2003 and 2010 were calculated and were assumed as representative for the years 1971 to 2002.

- **Step 4: Calculation of land-use changes/conversions as percentages of total analysed Cropland area, harmonisation and extrapolation over the time series.** After the above correction for short-term land-use changes/conversions, the annual land-use change/conversion areas in ha are expressed as percentages of the total cropland area per year in the respective analysed datasets. This is done because the completeness of the above synthesised IACS dataset, from which the yearly conversion areas are sampled, varies over time particularly between the 2002-2015 tabular database and the post-2016 geodatabases. Furthermore, even in the increasingly complete post-2016 geodatabase, a small proportion of the total Austrian Cropland area is not included.

For conversions between the annual and perennial cropland, as well as changes from grassland to annual/perennial cropland, the change/conversion areas are expressed in percentages of the total analysed Cropland area in the same year. For changes from annual/perennial cropland to grassland, the annual changes are expressed as percentages of total analysed Cropland area in the previous year. The rationale behind using Cropland area, rather than respective Cropland and Grassland areas is that the time series for this total estimated Cropland area in the inventory is considered more reliable than the total estimated Grassland area.

The result of the above is a time series of land-use changes/conversions between annual cropland, perennial cropland and grassland expressed as percentages of the analysed total Cropland area (total area either in the same year or the year before). Before these can be applied to calculate total land-use changes/conversions over the Austrian territory, the data from 2002 to 2015 are first harmonised with those from 2016 onwards. First of all, the values for changes/conversions between 2015-2016 are omitted, because of the sharp peaks caused by the change from an aggregrate land-parcel classification to a classification at the INSPIRE ha resolution. Secondly, we adjust the average level of the respective changes/conversions between 2002 and 2015 to that of the average changes/conversions from 2016 onwards. As 2002-2015 represents only a subset of the land parcels within IACS, a systematic bias is expected in the data pre-2015 and is thus corrected for by the difference in mean land use changes/conversions between 2002-2015 and 2016 onwards. After this level correction, the gaps introduced by omitting the land use changes/conversions between 2015 and 2016 are filled by interpolation. Finally, the historic annual land-use changes/conversions outside of the IACS data range (between 2001/2002 back to 1970/1971) are filled by extrapolating the respective mean annual shares of land use changes/conversions calculated between 2002/2003 and 2009/2010.

- **Step 5: Total and regional area estimates of land-use changes/conversions for the Austrian territory.** The result of the above four steps of the processing routine is a 1971-2023 time series of yearly land-use changes/conversions between annual cropland, perennial cropland and grassland expressed as percentages of the total analysed Cropland area in the IACS datasets (total Cropland area in the same year for changes to and conversions between annual and perennial cropland; or total Cropland area in the previous year for land-use changes to Grassland). To obain the final total land-use change/conversion areas between annual cropland, perennial cropland and Grassland, the above precentages are multiplied with the estimate of total Austrian Cropland area produced in the pre-processing element LU Area Statistics (described in the next subchapter). The derived, final total land-use change/conversion areas between annual cropland, perennial cropland and Grassland are included directly and unchanged in the annual land transition matrices. Nonetheless, these final estimates of yearly changes between Cropland and Grassland also feed into the LULUC Data Integration element to ensure area consistency in the land transition matrix between categories and years. Finally, land-use change/conversion areas between annual cropland, perennial cropland and Grassland per ecoregion are derived according to the respective yearly regional splits calculated in step 3. These regional estimates flow directly directly into the inventory calculations of soil carbon stock changes caused by land-use changes/conversions between Cropland and Grassland.

In 2023, the following land-use change areas derived from the above method amounted to:

- Annual cropland to perennial cropland – 0.02% of the total Cropland area in 2023
- Perennial cropland to annual cropland – 0.1% of the total Cropland area in 2023
- Grassland to perennial cropland – 0.003% of the total Cropland area in 2023
- Grassland to annual cropland – 0.4% of the total Cropland area in 2023
- Annual cropland to grassland – 0.3% of the total Cropland area in 2023
- Perennial cropland to grassland – 0.02% of the total Cropland area in 2023

The total areas of the LUC Forest land to Cropland, as well as the conversion areas per ecoregion, are provided by the *NFI* element of the Austrian system for land representation (see chapter 6.2.2.2).

LUCs from Wetlands, from Settlements and from Other land to Cropland do not occur in Austria. This assumption is based on the fact that the Cropland area shows a general steady decrease over time and that the areas of Wetlands, Settlements and Other land are simply not suitable for conversion to Cropland:

a. Settlement areas increased steadily in the last decades mainly by LUC from agricultural areas.
b. Settlement areas and soils – once converted – cannot usually be used for cropland cultivation.
c. There is also a higher economic value for land dedicated to building land than agricultural land i.e. there is no economic incentive for re-conversion.
d. Other lands are located in high altitude or very steep areas and therefore have unfavorable ecological conditions for cultivating crops.

6.3.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The (Statistik Austria, 2008) classification was used for land use definitions:

- Annual cropland (arable land planted with annual crops such as e.g. cereals, corn, rape, field vegetables, strawberries, potatoes, soya beans, energy grass);
- Perennial cropland (viticulture, orchards, plantations for fruits, tree nurseries, Christmas trees, perennial woody energy crops with a rotation period < 30 years);
- House gardens (farm-based gardens devoted to the cultivation of agricultural products mostly used for non-profit househol (Statistik Austria, 2008)d demand of the farmer's family. This category includes annual as well as perennial crops).

6.3.4 Methodological Issues

The following table provides an overview of the IPCC Tier methodology applied per category and pool in cropland, including the significant pools (in grey) for the year 2023. All reported sub-categories of cropland are key categories for CO_2.

Table 279 Overview of IPCC tiers applied per pool in the cropland category. Significant pools of key categories are highlighted in grey and are based on the assessment of the year 2023

To	**Cropland**					
From	living biomass	dead organic matter	mineral soil	organic soil	4(II) drained organic soils	4(IV) biomass burning
Forest land	T3	T3	T2	NO	NO	NO
Cropland	T1, T2	NO	T2	IE	T2	IE (Grassland)
Grassland	T2	NO	T2	NO	NO	NO
Wetlands	NO	NO	NO	NO	NO	NO
Settlements	NO	NO	NO	NO	NO	NO
Other land	NO	NO	NO	NO	NO	NO

6.3.4.1 Cropland remaining Cropland (4.B.1)

This section provides information about emissions/removals for cropland remaining cropland and comprises:

a. annual remaining annual cropland
b. perennial remaining perennial cropland
c. annual cropland converted to perennial cropland
d. perennial cropland converted to annual cropland

The areas of annual crops and woody perennial species like orchards, vineyards, perennial house gardens, plantations for Christmas trees and woody energy crops are considered in line with the 2006 IPCC GL, Vol. 4, Ch. 5.1 (IPCC, 2006).

The carbon stock changes of living biomass in the subcategory "annual cropland remaining annual cropland" are considered to be zero. For annual crops in the subcategory "annual cropland remaining annual cropland" the increase in biomass stocks in a single year is assumed to be equal to biomass losses from harvest and mortality in the same year – thus there are no net emissions/removals from biomass in the subcategory "annual cropland remaining annual cropland" (2006 IPCC GL, Vol. 4, Ch. 5.2.1.1).

Emissions/removals were estimated for the changes in woody perennial biomass stocks of the subcategory "perennial cropland remaining perennial cropland" (above-ground and below-ground biomass, see chapter 6.3.4.1.1). In addition, according to 2006 IPCC GL, the emissions/removals from stock changes in living biomass (above-ground and below-ground) at conversion areas between annual and perennial croplands have to be considered (2006 IPCC GL, Vol. 4, Ch. 5.3). Consequently, these emissions/removals were estimated for conversion areas from annual cropland to perennial cropland and vice versa. For that purpose, the carbon stocks of annual crops and perennial crops were estimated and applied to estimate the related emissions/removals (see chapters 6.3.4.1.2 and 6.3.4.1.3).

All biomass stocks and stock changes for Cropland remaining cropland were estimated using country-specific values. The root/shoot ratio of 0.3 for Christmas trees as well as for energy crops (wood) was used for the below-ground biomass. This root/shoot ratio was derived from the results of the Af-/Reforestation assessment (see chapter 6.2.4.2.1, Tier 2 for below-ground biomass-accumulation according to the IPCC 2006 GL).

The above- and belowground biomass stock and stock changes of orchards and vineyards are estimated using country specific values from a national study undertaken in 2016 and 2017 (see chapter 6.3.4.1.1).

Dead organic matter (DOM) (including the two pools dead wood and litter) is considered not occurring in Cropland remaining cropland. This corresponds to the Tier 1 method according to the IPCC 2006 GL (Vol.4, Ch. 5.2.2.1).

All soil carbon stocks and soil carbon stock changes were estimated using country specific values.

The methodology for the assessment of the mineral soil carbon stock changes (CSC) in annual cropland remaining annual cropland and perennial cropland remaining perennial cropland is based on the results of national studies of long-term field experimental plots (Spiegel, H., Dersch, G., Hösch, J. & Baumgarten, A., 2007, Umweltbundesamt, 2010a). These studies made it possible to assess the impact of different management regimes (e.g. tillage and organic inputs) on soil carbon stocks and subsequently to estimate the appropriate management factors for the inventory calculations. The method assigns land units into combinations of three tillage types (no-tillage, reduced tillage and full tillage) with variations of input types and input type combinations:

- with/without input from cover crops (between two main crops or evergreen system), which are incorporated into the soil,
- with/without manure input and
- with low/high crop residues input.

The area with cover crops (greening measures) was calculated based on IACS data for 2002 and 2016, the greening areas in the years in between were interpolated. The following rules were applied:

- For 2002, the area of the greening variant E (rape) was excluded, because rape is managed as a main crop and harvested; thus the remains are not incorporated in the soil in springtime.
- For 2016 the area of the greening variant "evergreen system" had to be adapted, because actually only a share (about 29 %) of these areas is covered by cover crops.

The total annual carbon dioxide removals/emissions of *4.B.1* range between -333 and + 87 kt CO_2 (see

Table 278).

In the following subchapters the methodologies and applied factors for the estimates are explained in detail.

6.3.4.1.1 Changes in carbon stock in biomass of annual cropland remaining annual cropland and perennial cropland remaining perennial cropland (4.B.1.a)

In accordance with the 2006 IPCC GL, Vol. 4, Ch. 5.2.1.1, the carbon stock changes of living biomass in the subcategory "annual cropland remaining annual cropland" are estimated to be zero.

For the subcategory "perennial cropland remaining perennial cropland" the C stock changes in biomass are estimated. Perennial cropland includes:

- Viticulture (vineyards),
- Orchards: this category includes plantations of woody plants for the purpose of obtaining fruits (99 % of the total orchard area) as well as tree nurseries (1% of the total orchard area),
- Gardens: a 50% share of house gardens is assumed to be perennial,
- Energy crops: short rotation plantations < 30 years (perennial woody energy crops) and
- Christmas tree plantations.

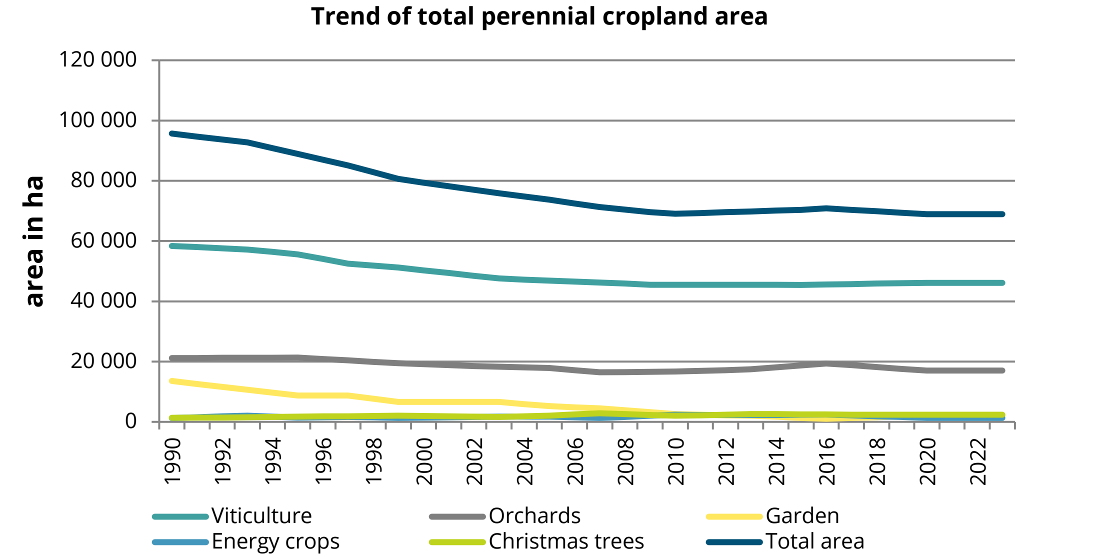
The observation period started in 1960 and is based entirely on the activity data from Statistik Austria derived from the Farm Structure Surveys (FSS) data (see ch. 6.3.1), yearly agricultural statistics (Statistik Austria, 2022b, Statistik Austria, 2024b) and vineyards surveys, where the years between surveys are interpolated (Statistik Austria, 2011, Statistik Austria, 2016, Statistik Austria, 2021c). As the time series from the 1960´s showed some inconsistencies due to the intervals of full agricultural surveys and changes in data collection, the data of the time series were interpolated and thus smoothed across these inconsistent periods. As activity data for perennial cropland, except vineyards since 2009, are available only from Farm Structure Surveys, the areas of the last available FSS are reported until the next FSS data are available.

Table 280: Estimated total area of perennial crops from 1990–2023 in ha.

	Viticulture	Orchards	Garden	Energy crops	Christmas trees	Total area
1990	58 364	21 146	13 572	1 254	1 347	95 683
1995	55 627	21 335	8 774	1 463	1 754	88 953
2000	50 304	19 140	6 609	1 403	1 962	79 418
2005	46 892	17 882	5 191	1 700	2 048	73 713
2010	45 517	16 671	2 576	2 330	2 002	69 096
2011	45 502	16 928	2 393	2 299	2 204	69 325
2012	45 486	17 185	2 209	2 267	2 406	69 554
2013	45 470	17 442	2 026	2 236	2 608	69 782
2014	45 454	18 088	1 690	2 298	2 554	70 084
2015	45 439	18 734	1 355	2 359	2 499	70 386
2016	45 584	19 380	1 019	2 421	2 445	70 849
2017	45 729	18 789	1 279	2 149	2 421	70 367
2018	45 874	18 198	1 539	1 878	2 396	69 886
2019	46 020	17 607	1 799	1 606	2 372	69 404
2020	46 165	17 016	2 060	1 334	2 348	68 923
2021	46 165	17 016	2 060	1 334	2 348	68 923
2022	46 165	17 016	2 060	1 334	2 348	68 923
2023	46 165	17 016	2 060	1 334	2 348	68 923

Figure 39 illustrates the decrease of the total perennial cropland area from 1990 to 2009 and the subsequent stabilisation of areas thereafter. The decrease up to 2009 was mainly caused by the continuous decline in the vine and fruit growing area and, in particular, the house garden area. The variability in biomass C stock changes from year to year is caused by the general trend of the area development, and also by the conversions from perennial cropland to other agricultural land uses. Such changes are usually due to economic reasons and are carried out at the end of the rotation period.

Figure 39: Trend of total perennial cropland area (ha) from 1990–2023.



Source: Umweltbundesamt, based on data from Statistik Austria

In 2016 and 2017, a national survey to estimate the biomass for viticulture and orchards was conducted by Umweltbundesamt. Winemakers and orchard farmers were contacted with the support of the Austrian agricultural chamber. In the case of vineyard/orchard clearing, the farmers were asked to weigh the cleared biomass and to fill out a questionnaire and provide information on their plantations (species, weight of above and belowground biomass of the plants, number of weighted plants, number of plants per ha, age of the plants). From the results of the survey of 28 vineyards and 20 orchards, average Austrian biomass stocks at the end of the rotation period, annual biomass growth rates and the average rotation periods for these perennial cultures were derived (Table 281). The annual biomass growth rates were determined by means of regression analysis. For the conversion from fresh biomass to dry matter the country specific values of 0.56 for wine and 0.5 for orchards were applied.

Table 281: Biomass carbon stock and annual biomass carbon accumulation rate of perennial cropland cultures.

Perennial crop	Carbon stock of above- and belowground biomass at end of rotation period (t C ha^{-1})	Annual increase in above- and below-ground biomass carbon stock (t C ha^{-1} a^{-1})	Rotation period (years)	Method
Vineyards	3.37	0.096	35	country specific values
Orchards	13.41	0.745	18	country specific values
House gardens	13.41	0.745	18	country specific values
Christmas trees	46.8	4.68	10	country specific values
Energy wood crops	39	6.50	6	country specific values

For calculating the carbon stock change of living biomass of vineyards remaining vineyards the following equation was applied using country specific data:

*Annual change in biomass = (area of viticulture remaining viticulture * annual carbon accumulation rate) – (area of viticulture remaining viticulture 35 years earlier * 0.029 (i.e. proportion of area at end of rotation period) * biomass carbon stock at end of rotation period)*

From the national survey on viticulture a country-specific average value for total above and below ground vineyard biomass stock at the end of rotation period of 3.37 t C ha^{-1} was estimated. The annual accumulation rate of vineyard biomass is 0.096 t C ha^{-1} a^{-1} and the rotation period of wine is 35 years.

For orchards the carbon stock of above and below ground biomass stock at the end of rotation period amounts to 13.41 t C ha^{-1}. Based on the information provided by the famers the average rotation period of orchards is 18 years. The annual biomass accumulation rate is 0.745 t C ha^{-1} a^{-1}.

For calculating the carbon stock change of living biomass from orchards remaining orchards the following equation was applied using country specific data:

*Annual change in biomass = (area of orchard remaining orchard * annual carbon accumulation rate) – (area of orchard remaining orchard 18 years earlier * 0,056 (i.e. proportion of area at end of rotation period)* biomass carbon stock at end of rotation period)*

For 50% of the house garden area, the same emission factor as for orchards is applied. It is assumed that this perennial proportion of house garden area is covered completely by orchards.

Viticulture and orchards have by far the highest proportion of the perennial cropland area. Therefore, their biomass emission factors are considered in the LUCs and conversions involving perennial cropland. Weighted means for perennial cropland biomass in case of conversions or LUCs is calculated on basis of the different areas and emission factors for vineyards and orchards. The approach is considered to provide the most accurate estimates of perennial biomass stocks and stock changes for Austria and is justified as follows:

- vineyards and orchards have by far the highest proportion of the perennial cropland area (about 95% including the orchard share of house gardens), and therefore their biomass carbon stock change factors are representative and suitable for land-use changes/conversions of perennial cropland;
- the area of the other perennial cultures (perennial energy crops, Christmas trees) is not only much smaller, but also more stable across time (Figure 39); and
- the respective stocks and stock change factors are country-specific values that have been derived from national biomass sampling studies of perennial crop types.

Therefore, the weighted mean factors from vineyards and orchards are considered to be appropriate, since they represent the subcategories with the highest shares in perennial cropland area and have undergone the most significant decreases in area in the past.

In relation to the area of land-use conversions, it is assumed that land-use changes/conversions involve vineyards and orchards crops in the same ratio as their area distribution, based on means for the years back to 1990. As such, the following values are applied for perennial croplands in case of LUCs and conversions: an average perennial biomass carbon stock before conversion of 6.09 t C ha^{-1} and an average annual biomass carbon accumulation rate of 0.27 t C $ha^{-1}a^{-1}$.

Christmas trees and woody energy crops have only a small share of the perennial cropland area and the calculation is based on country specific values (Tier 2). For Christmas trees and woody energy crops a country specific steady state of biomass increase over 10 years and 6 years of rotation period, respectively, was assumed. The energy wood crop cultivation was assumed to start in 1990 (according to Statistik Austria), so after a rotation period of 6 years, that is from 1996 onwards, the energy wood crops cause gross emissions parallel to gross removals in the growing biomass.

For calculating the carbon stock change of living biomass from Christmas tree cultures remaining Christmas tree cultures the following equation was applied using country specific data:

*Annual change in biomass = (area of Christmas tree cultures remaining Christmas tree cultures * Carbon accumulation rate) – (area of Christmas tree cultures remaining Christmas tree cultures 10 years earlier * 0.1 (i.e. proportion of area at end of rotation period)* biomass carbon stock at end of rotation period)*

According to the fertilizing recommendations (BMLFUW, 2008a) and expert judgement a country specific average value of 36 t C ha^{-1} for the carbon stock of Christmas trees at harvest (above-ground biomass) was used. The rotation period for Christmas trees is 10 years, which leads to an accumulation rate of 3.6 t C ha^{-1} a^{-1} in above-ground biomass. By using the root/shoot ratio of 0.3 for Christmas trees, which was derived from the results of the Af-/Reforestation assessment (see chapter 6.2.4.2.1), also the belowground biomass was estimated. Consequently, a 4.68 t C ha^{-1} a^{-1} annual total biomass accumulation rate and a total biomass carbon stock of 46.8 t C ha^{-1} at harvest was computed and applied for Christmas trees cultures (above-ground and below-ground) for all years.

For energy wood crops a country specific value of 30 t C ha^{-1} for the carbon stock at harvest for above ground biomass was used (Splechtna, Glatzel, 2005). According to this literature the rotation period for energy wood crops is six years. This leads to an annual carbon accumulation rate in above ground biomass of 5 t C ha^{-1} a^{-1} for energy crops. By using the root/shoot ratio of 0.3 for energy crops (wood), which was derived from the ARD-NFI-results, the belowground biomass could be estimated as well. Including the root biomass, a factor of 6.5 t C ha^{-1} a^{-1} total annual biomass accumulation rate and a total biomass carbon stock of 39 t C ha^{-1} at harvest was computed and applied for energy wood crops biomass (above-ground and below-ground) for all years.

For calculating the carbon stock change of living biomass on energy wood crops the following equation was applied:

*Annual change in biomass of energy crops = (area of energy wood crops remaining energy wood crops * Carbon accumulation rate) – (area of energy wood crops remaining energy wood crops 6 years earlier * 0.166 (i.e. proportion of area at end of rotation period)* biomass carbon stock at end of rotation period)*

6.3.4.1.2 Changes in carbon stocks in biomass of annual cropland converted to perennial cropland (4.B.1.b)

The total conversion area from annual cropland converted to perennial cropland over a transition period of 20 years was 9 831 ha in 2023.

The applied method is consistent with the 2006 IPCC approaches for LUCs (IPCC 2006, ch. 5.3 "Land converted to cropland", ch. 5.3.1.1 for biomass calculations). It is important to note that the 2006 IPCC GL do not foresee any method for conversions between annual and perennial cropland in the cropland category. However, annual cropland and perennial cropland have different C stocks and C accumulation rates in both biomass and soil. Therefore our approach to account for the C stock changes due to conversions between annual cropland and perennial cropland gives a more accurate picture of the emissions/removals of the subcategory "cropland remaining cropland". This approach regarding soil C stock changes of such conversion lands does not represent any double accounting to the estimates in the soil C pool (the estimates in chapters 6.3.4.1.4. and 6.3.4.1.6), because the estimates of the soil C stock changes in these subcategories only account for the change in "land management factors" of "annual cropland remaining annual cropland" and for the change between the equilibrium soil C stocks of annual cropland and perennial cropland (or vice versa) when conversions between these two cropland subcategories occur. The activity data for estimating these emissions/removals strictly represent the areas of these "cropland remaining cropland" subcategories.

In accordance with the method described in chapter 5.3.1.1 and equation 2.15 and 2.16 of the 2006 IPCC GL the biomass gains or losses of annual crops due to LUC to/from annual cropland have to be accounted once, namely in the initial year of LUC (even though annual crops represent a biomass C pool only during the growing season and not during the whole year).

For the calculation of the annual change in carbon stocks in living biomass of annual cropland converted to perennial cropland the 2006 IPCC GL equations 2.15 and 2.16 were applied (IPCC, 2006). For perennial cropland a weighted average annual growth according to the Austrian survey on viticulture and orchards (0.27 t C $ha^{-1}a^{-1}$) was assumed for each year of the whole transition period of 20 years (see chapter 6.3.4.1.1).

$$\text{Annual change in biomass} = \text{conversion area for a transition period of 20 years} * \Delta C_{growth} + \text{annual area of currently converted land} * L_{conversion}$$

L conversion = *C after –C before*

C_{after} = *carbon stock immediately after conversion is 0*

ΔC_{growth} = *country-specific value for perennial crops carbon accumulation rate is 0.27 t C* $ha^{-1}a^{-1}$ *(annual growth rate in each year of the whole transition period of 20 years)*

C_{before} = *country specific value of carbon stock of annual crops before conversion is 6.67 t C* $ha^{-1}a^{-1}$ *(biomass loss accounted only for the year of conversion)*

For the annual cropland biomass losses in the year of conversion from annual to perennial cropland, the country-specific average biomass stock in annual cropland was calculated from national statistics (Statistik Austria, 2007). For all annual crops mentioned in the Statistical Report, the harvested yield biomass has been taken and the related biomass of straw, leaves or other aboveground plant parts not covered by the "yield biomass" have been estimated on basis of plant specific expansion factors to yield to total aboveground biomass. Root/shoot ratios for the individual crops of the United States Department of Agriculture were applied to estimate the total plant biomass. Since the U.S. are located also in the temperate region, the use of the U.S. root/shoot ratios seem most appropriate. These factors represent the average root/shoot values from 1990–2005 for different types of annual crops (West T.O., 2008).The estimated Austrian aboveground biomass in annual crops was multiplied with the root/shoot ratios to provide an estimate of the below-ground biomass. The means of the annual above-ground and below-ground biomass of the crops were calculated and weighted by the related area of these crops in Austria to get the average annual cropland biomass. The estimated annual cropland biomass stock represents the peak annual cropland biomass during the growing season and the average for a time-period of 10 years.

This led to a figure of 6.67 t C ha^{-1} for the biomass in annual cropland that is used for the estimates of LUCs to and from annual cropland. This country specific value is 33.4 % higher than the 2006 IPCC GL default value (5.0 t C ha^{-1}).

6.3.4.1.3 Changes in carbon stocks in biomass of perennial cropland converted to annual cropland (4.B.1.c)

The total conversion area from perennial cropland converted to annual cropland over a transition period of 20 years was 13 899 ha in 2023.

The rationale for these estimates and the applied methods are described in chapter 6.3.4.1.2. For the calculation of the annual change in carbon stocks of living biomass of perennial cropland converted to annual cropland the 2006 IPCC GL equations 2.15 and 2.16 were applied (IPCC, 2006). For the perennial cropland biomass before conversion the average value of 6.09 t C ha^{-1} was applied. This weighted mean is derived from the Austrian survey on carbon stocks of vineyards and orchards (see chapter 6.3.4.1.1)

According to the 2006 IPCC GL the gains of the annual cropland biomass during LUCs to annual cropland are accounted only once, in the initial year of LUC to annual cropland (see also chapter 6.3.4.1.2 for the considerations in behind):

$$\textit{Annual change in biomass} = \textit{annual area of currently converted land} * (L_{conversion} + \Delta C\ \textit{growth})$$

$L_{conversion}$ = $C_{after} - C_{before}$

C_{after} = *carbon stock immediately after conversion is 0*

ΔC_{growth} = *country-specific value for annual crops carbon accumulation rate is 6.67 t C $ha^{-1}a^{-1}$(see chapter 6.3.4.1.2; accounted only for the year of LUC)*

C_{before} = *country-specific value for carbon stock of perennial cropland biomass before conversion is 6.09 t C ha^{-1}(accounted only for the year of conversion)*

6.3.4.1.4 Changes of carbon stocks in mineral soils of "annual cropland remaining annual cropland" and "perennial cropland remaining perennial cropland" (4.B.1.a)

Emissions/removals due to mineral soil C stock changes in "annual cropland remaining annual cropland" were calculated using a country-specific methodology (Tier 2). For the soil organic carbon content the Austrian specific average value of 50 t C ha^{-1} for 0–30 cm depth of cropland was assumed for 1990 which is based on the results of the Austrian soil inventory (Gerzabek, et al., 2003, Gerzabek, et al., 2005a, Strebl, et al., 2003). This assumption is supported by the fact that the soil inventories were carried out between 1988 and 1996. Furthermore, we assumed that this Austrian specific soil C stock for cropland represents a steady state that already includes the effects of the management for the period before 1990 and that cropland management was rather stable in that pre-1990 period.

The SOC gains and losses due to applied agricultural management practices in the two cropland remaining cropland categories (annual cropland and perennial cropland) are calculated following closely the 2006 IPCC GL, where the IPCC equation 2.25 includes a management factor (F_{MG}), a land-use factor (F_{LU}) and an input factor for input of organic matter (F_I) (Table 5.5, IPCC, 2006).

In a study by the Austrian Agency for Health and Food Safety (AGES) and Umweltbundesamt (Umweltbundesamt, 2010a) the IPCC default management factors for SOC (soil organic carbon) stock change were assessed against results from national long-term field experiments of AGES (Spiegel, H., Dersch, G., Hösch, J. & Baumgarten, A., 2007). The results of the C stock change rates for the agricultural experimental plots were allocated to different management types (management factors) like tillage types and input types:

- The country-specific land-use factor (F_{LU}) for long-term cultivated cropland soils of 0.93 is applied according to the results of the long-term field experiments of AGES (Umweltbundesamt, 2010a).
- The stock change factors for management (F_{MG}) were also applied according to the results of the long-term field experiments of AGES (Spiegel, H., Dersch, G., Hösch, J. & Baumgarten, A., 2007), showing the effects of different tillage types (minimum, reduced and conventional tillage) on soil organic carbon. According to these results, F_{MG}-full and F_{MG}-reduced have the same country specific management factor of 1.0. For F_{MG}-no-till, the country specific management factor of 1.09 was derived (Umweltbundesamt, 2010a).
- Country-specific stock change factors for input (F_I) were also derived: F_I-Low does not occur in Austria, F_I-medium was assigned a management factor of 1.0, F_I-high-without manure was assigned with a factor of 1.05 and for the input type F_I-high-with manure a factor of 1.11 was derived as mean value of results in the long-term field experiments (Umweltbundesamt, 2010a). Table 282 shows the revised national factors used compared to the respective IPCC default values (for cool, temperate, moist regime).

Table 282: Relative stock change factors for cropland according to IPCC default values and revised national factors.

Factor value type		Level	IPCC default 2006 IPCC GL (cool, temperate, moist regime)	Applied revised national factors (Umweltbundesamt, 2010a)
Land use (F_{LU})	F_{LU}	Long-term cultivated	0.69	0.93
Tillage (F_{MG})	F_{MG1}	Full	1.00	1.00
	F_{MG2}	Reduced	1.08	1.00
	F_{MG3}	No-Till	1.15	1.09
Input (F_I)	F_{I1}	Low	0.92	0.95
	F_{I2}	Medium	1.00	1.00
	F_{I3}	High – without manure	1.11	1.05
	F_{I4}	High – with manure	1.44	1.11

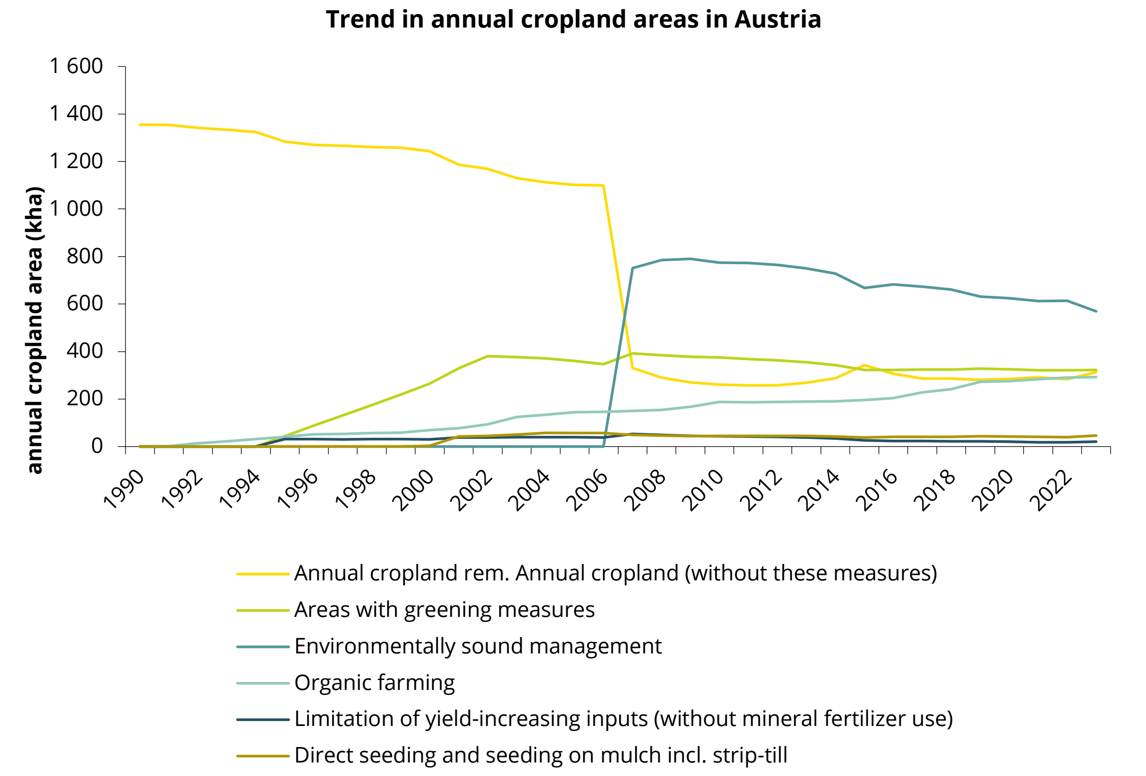
Based on the above national factors, the area of annual cropland is distributed between the respective tillage and input types so that the corresponding factors can be applied.

As a starting point, the annual cropland area per year was split between areas implementing no measures or areas implementing one of four Agri-environment-climate Measures (AECM) according to the Austrian ÖPUL program (BMLFUW - Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, 2016, BML - Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft, 2023), which is part of the CAP Strategic Plan of the Common Agricultural Policy. ÖPUL started in 1995, but the single management measures started in different years. The five groups are as follows:

- cropland with organic farming,
- cropland with limitation of yield-increasing inputs (without mineral fertilizer use),
- cropland with environmentally sound management (UBAG, UBB),
- cropland with direct seeding and seeding on mulch incl. strip-till,
- the area of annual cropland without measures.

These areas are available for the whole time series (Figure 40) and were taken from the agricultural statistics based on IACS data.

Figure 40: Trend of annual cropland areas in Austria with selected Agri-environment-climate measures (kha).



Source: Umweltbundesamt based on IACS data

The areas within each of the five groups were further subdivided according to the results of an IACS data analysis and the FSS survey, resulting in combinations of different tillage and input regimes. Twenty-four combinations resulted from the following three tillage types and eight input combinations:

1. Three tillage types: area with no-tillage, area with reduced tillage and area with full tillage. The percentage share of cropland areas with these three tillage types was applied according to the results of the full FSS in 2010 (Statistik Austria, 2013a). According to this FSS 973 069 ha (73.3%) of annual cropland were managed with full tillage (conventional ploughing method with mouldboard plough and implement combinations). 326 731 ha (24.6%) were managed by conservation or reduced tillage methods (ploughless tillage

systems, with cultivator, harrow) and only 28 349 ha (2.1%) were managed by direct seed without previous tillage (no-tillage systems). The share of no-tillage systems was confirmed by the figures of the follow-up FSS in 2016. The relative trend across years was adjusted by the trend of the AECM cropland area with direct seeding and seeding on mulch incl. strip-till. This approach is justified by the relationship of this AECM type with reduced tillage approaches.

2. Eight input combinations depending on inputs from cover crops, manure and crop residues:
   a. With-/without input from cover crops at cropland, specifically at the areas of two dedicated AECM measures : "Cover crops at arable land – intermediate crops (cover crops between two main crops)" and "Cover crops at arable land – "Evergreen" system (both compiled in the trend line "areas with greening measures" in Figure 40 above).
   b. With-/without manure input: on basis of figures for the livestock number of each cropland farm. The indicator "Livestock units (LU) per hectare" was calculated at farm level and if the value was > 0.5 LU/ha, a manure input to cropland is assumed.
   c. Crop types with low or high crop residues input: The different annual crop types in the Austrian cropland were divided into crops with high residues and crops with low residues based on (BML, 2024c).

Based on IACS data for the years 2002 and 2016, the annual cropland areas of each of the five AECM groups (and the respective divisions across the three tillage regimes) were distributed between the eight possible input combinations. The respective shares derived in 2002 and 2016 were interpolated to derive respective areas for 2003 to 2015, while the shares of 2016 were assumed to remain constant to extrapolate the areas for 2017 onwards. The respective shares of 2002 were extrapolated back to 1990 taking into account that greening measures (affecting the assignment "with-/without input from cover crops) were first implemented in 1995.

The possible combinations and related soil C stock change factors are shown in Table 283.

Table 283: Possible combinations of management types of annual cropland areas and assigned management factors.

Tillage	Cover crops	Manure	Crop residues	F_{LU}	F_{MG}	F_{I}	Average equilibrium cropland soil C stock in 1990 (from soil inventories) (t C ha^{-1} for 0–30 cm)	Estimated reference soil C stock based on the factor combination F_{LU} 0.93, F_{MG} 1.0, F_{I} 1.0 as typical for the management before 1990 (t C ha^{-1} for 0–30 cm)	Estimated new equilibrium soil C stock after 20 years according to management measure combination in line (t C ha^{-1} for 0–30 cm)	Yearly soil C stock change according to management measure combination in line (t C ha^{-1} a^{-1})
Full	No	Yes	Low	0.93	1.0 (full)	1.0 (Medium)	50	53.8	50	0
Full	No	Yes	High	0.93	1.0 (full)	1.0 (Medium)	50	53.8	50	0
Full	No	No	Low	0.93	1.0 (full)	1.0 (Medium)	50	53.8	50	0
Full	No	No	High	0.93	1.0 (full)	1.0 (Medium)	50	53.8	50	0
Full	Yes	Yes	Low	0.93	1.0 (full)	1.11 (High – with manure)	50	53.8	55.5	0.28
Full	Yes	Yes	High	0.93	1.0 (full)	1.11 (High – with manure)	50	53.8	55.5	0.28
Full	Yes	No	Low	0.93	1.0 (full)	1.05 (High – w.out manure)	50	53.8	52.5	0.13
Full	Yes	No	High	0.93	1.0 (full)	1.05 (High – w.out manure)	50	53.8	52.5	0.13
Reduced	No	Yes	Low	0.93	1.0 (reduced)	1.0 (Medium)	50	53.8	50	0
Reduced	No	Yes	High	0.93	1.0 (reduced)	1.0 (Medium)	50	53.8	50	0
Reduced	No	No	Low	0.93	1.0 (reduced)	1.0 (Medium)	50	53.8	50	0
Reduced	No	No	High	0.93	1.0 (reduced)	1.0 (Medium)	50	53.8	50	0

Tillage	Cover crops	Manure	Crop residues	F_{LU}	F_{MG}	F_I	Average equilibrium cropland soil C stock in 1990 (from soil inventories) (t C ha^{-1} for 0–30 cm)	Estimated reference soil C stock based on the factor combination F_{LU} 0.93, F_{MG} 1.0, F_I 1.0 as typical for the management before 1990 (t C ha^{-1} for 0–30 cm)	Estimated new equilibrium soil C stock after 20 years according to management measure combination in line (t C ha^{-1} for 0–30 cm)	Yearly soil C stock change according to management measure combination in line (t C ha^{-1} a^{-1})
Reduced	Yes	Yes	Low	0.93	1.0 (reduced)	1.11 (High – with manure)	50	53.8	55.5	0.28
Reduced	Yes	Yes	High	0.93	1.0 (reduced)	1.11 (High – with manure)	50	53.8	55.5	0.28
Reduced	Yes	No	Low	0.93	1.0 (reduced)	1.05 (High – w.out manure)	50	53.8	52.5	0.13
Reduced	Yes	No	High	0.93	1.0 (reduced)	1.05 (High – w.out manure)	50	53.8	52.5	0.13
No	No	Yes	Low	0.93	1.09 (no)	1.0 (Medium)	50	53.8	54.5	0.23
No	No	Yes	High	0.93	1.09 (no)	1.0 (Medium)	50	53.8	54.5	0.23
No	No	No	Low	0.93	1.09 (no)	1.0 (Medium)	50	53.8	54.5	0.23
No	No	No	High	0.93	1.09 (no)	1.0 (Medium)	50	53.8	54.5	0.23
No	Yes	Yes	Low	0.93	1.09 (no)	1.11 (High – with manure)	50	53.8	60.5	0.52
No	Yes	Yes	High	0.93	1.09 (no)	1.11 (High – with manure)	50	53.8	60.5	0.52
No	Yes	No	Low	0.93	1.09 (no)	1.05 (High – w.out manure)	50	53.8	57.2	0.36
No	Yes	No	High	0.93	1.09 (no)	1.05 (High – w.out manure)	50	53.8	57.2	0.36

For the subcategory "perennial cropland remaining perennial cropland" the soil carbon stock changes have also been calculated based on the assignment of the three factors F_{LU}, F_{MG} and F_I (Table 282). The IPCC default value for F_{LU} is applied according to 2006 IPCC GL, table 5.5, for perennial/tree crops, which is 1.0. For vineyards as well as for orchards, soil erosion measures (AECM) were introduced in 1995. For these areas, selected management factors derived for annual corplands were extrapolated to the perennial croplands, based on the following assumptions. A management factor F_{MG} for reduced tillage 1.0 (see Table 282) was assigned due to year-round, area-wide cover crops (greening) at the machine tracks in vineyards and orchards (BMLFUW - Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, 2016, BML - Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft, 2023). All the other vineyards and orchards were categorized as full tillage; however, no difference in the management factor was assumed (F_{MG} = 1.0, see Table 282). In contrast, a differentiation was made for the input factor, F_I. For the areas with the soil erosion measure, an input factor F_I of 1.05 was applied, which is the Austrian value for annual croplands with high input – without manure, see Table 282. This was justified because of the year-round, area-wide cover crops (greening) at the machine tracks in vineyards and orchards implementing these soil erosion measures (BML - Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft, 2023).

The areas, where these soil erosion measures are applied, are taken from IACS data.

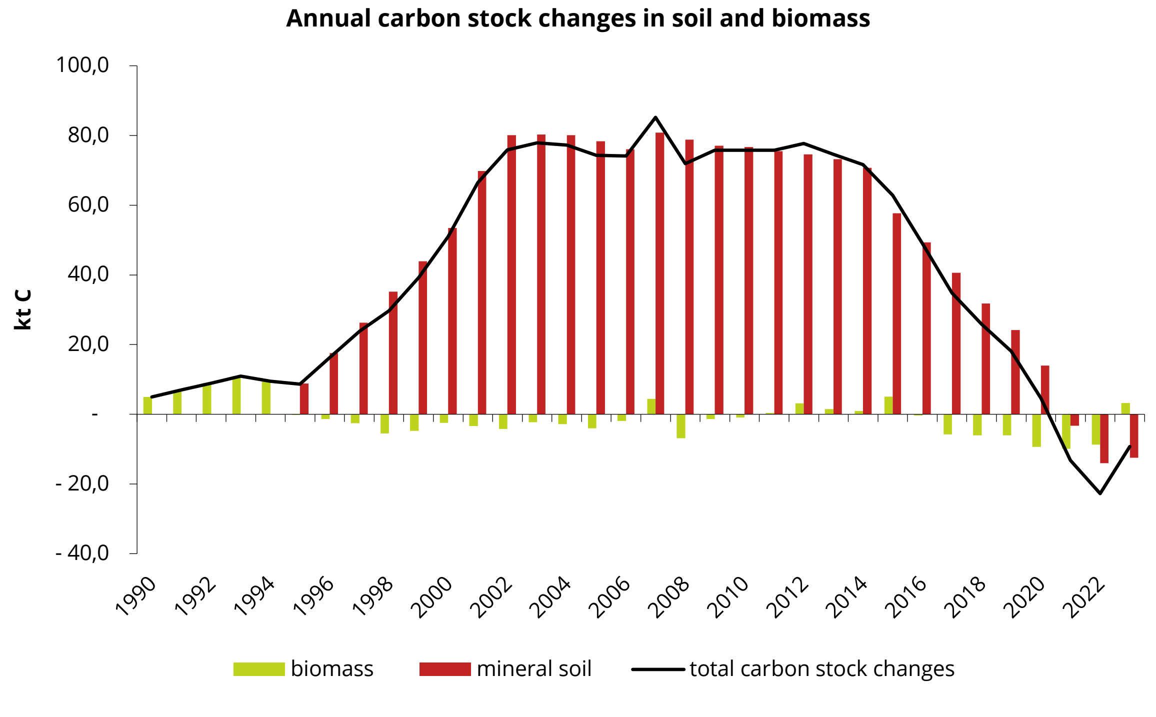
Table 284: Perennial cropland management measures and assigned management factors.

Management measures	**F_{LU}**	**F_{MG}**	**F_I**	**Average equilibrium perennial cropland soil C stock in 1990 (from soil inventories) (t C ha^{-1} for 0–30 cm)**	**Estimated reference soil C stock based on the factor combination F_{LU} 1.0, F_{MG} 1.0, F_I 1.0 as typical for the management before 1990 (t C ha^{-1} for 0–30 cm)**	**Estimated new equilibrium soil C stock after 20 years according to management measure combination in line (t C ha^{-1} for 0–30 cm)**	**Yearly soil C stock change according to management measure combination in line (t C ha^{-1} a^{-1})**
Cropland with soil erosion measure: vineyards	1.0	1.0	1.05	57	57	59.85	0.14
Cropland with soil erosion measure: orchards	1.0	1.0	1.05	57	57	59.85	0.14
Other perennial cropland without soil erosion measures	1.0	1.0	1.00	57	57	57.00	-

Inter-annual variations in the emissions/removals within the subcategory cropland remaining cropland are driven to a large extent by changes in the soil carbon stocks. Soil carbon stocks have increased to varying extents depending on specific management changes in agricultural land as defined and promoted in the Austrian Agri-environment-climate Scheme – ÖPUL (relevant ÖPUL measures are cover crops, organic farming, tillage reduction). In 1995 with Austria's joining of the EU, the first Agri-environment Scheme was applied and accordingly led to an estimated increase of the annual soil carbon stock change by more than 40 kt C a^{-1}. In the following CAP periods from 2000–

2006 and 2007–2013 further increases in the annual C stock changes occur due to the increase of areas where the specific Agri-environment Measures were implemented (see Figure 41). However, Figure 41 shows a decrease in the mineral soil C stock gains since 2015, as the areas implementing the ÖPUL measures reached the end of the 20-year transition period and achieved their new equilibrium soil C stocks. It is planned to further resample the long-term experimental plots in order to check the appropriateness of the 20-year transition period for soil C stock changes due to cropland management changes in Austria.

Figure 41: Annual carbon stock changes in soil and biomass of the subcategory annual cropland remaining annual cropland and perennial cropland remaining perennial cropland (kt C).



Source: Umweltbundesamt

It should be noted that the Agri-environment measures described have caused an increase of the average mineral soil carbon stock (0–30 cm depth) of annual cropland in Austria from 50 t C ha^{-1} to about 51 t C ha^{-1} over the time series. In response to a 2023 ARR review recommendation regarding transparency, the following information is provided: For soil carbon stock changes resulting from land-use changes/conversions, we use national, ecoregion-specific average reference carbon stocks (0-50 cm) for the pre and post converison land uses that are constant in time (see respective land-use change chapters). Therefore, the estimated losses of mineral soil carbon in e.g. the land-use change category Cropland to Settlements do not take into account the losses of "additional" soil carbon that was previously gained due to management improvements in cropland. Nonetheless, the loss of this "additional" carbon from management improvement is accounted (essentially *included elsewhere*) for under Cropland remaining cropland, as these areas decrease over time.

The basis for the mineral soil carbon stock changes in annual cropland remaining annual cropland and perennial cropland remaining perennial cropland are the *total* cropland areas implementing the respective ÖPUL measures. As such any decrease in the areas implementing certain measures, regardless whether this is due to changes in agricultural management or due to land-use change or conversion, is fully accounted for in Cropland remaining cropland. Indeed, the total Cropland area implementing certain measures that enhance soil carbon have been decreasing recently, again due to changes in agricultural management, but also partially due to land-use changes and conversions from Cropland. As it is these activity data on total areas which feed into the subcategory inventory model, this has led to the calculation of a recent net decrease in mineral soil carbon stocks of Cropland remaining cropland in the last three years (Figure 41). These losses represent a partial re-emission of the soil carbon gains achieved with the ÖPUL management improvement measures, which again is partially due to land-use changes and conversions from Cropland. This approach likely represents a minor misallocation of emissions and removals between Cropland remaining cropland and respective conversion subcategories (e.g. Cropland converted to Settlements). However, the approach avoids any potential double accounting and thus ensures complete and accurate estimates of emissions and removals at the LULUCF sector level.

6.3.4.1.5 Changes of carbon stock in soils of annual cropland converted to perennial cropland (4.B.1.b)

The conversion area from annual cropland to perennial cropland (in conversion status for a time period of 20 years) changed from 11 397 ha to 9 831 ha from 1990 to 2023.

The rationale for estimating the soil C stock changes of this conversion has been given in chapter 6.3.4.1.2.

Emissions/removals were calculated by ecoregion-specific values for carbon stocks in mineral soils of annual and perennial cropland. Twenty-year conversion areas per ecoregion were multiplied by ecoregion-specific carbon stock change values derived from the respective category- and ecoregion-specific soil carbon stocks for mineral soils between 0 and 50 cm depth (Table 270).

According to the 2006 IPCC GL (Equation 2.25, IPCC 2006) annual rates of carbon stock change are estimated as the difference in stocks at two points in time divided by the time dependence of the stock change factors. For each ecoregion (e.g. *Foothills*), the equation is implemented as follows:

$$\textit{Annual change in carbon stock of mineral soils in annual cropland converted to perennial cropland} = \Delta SOC_{20} * \textit{conversion area for a transition period of 20 years}$$

$$\Delta SOC = (SOC_0 - SOC_{0-T})/20 = 0.30\ t\ C\ ha^{-1}\ a^{-1}$$

ΔSOC_{20} average annual carbon stock change in soils of annual cropland converted to perennial cropland ($t\ C\ ha^{-1}\ a^{-1}$) over a conversion transition period of 20 years

SOC_0 carbon stock in soils 20 years after conversion from annual to perennial cropland (i.e. average C stock in 0–50 cm of perennial cropland soils in e.g. the ecoregion Foothills →71 $t\ C\ ha^{-1}$

SOC_{0-T} carbon stock in Austrian annual cropland soils before conversion (i.e. average C stock in 0 – 50 cm of annual cropland soils in e.g. the ecoregion Foothills → 65 $t\ C\ ha^{-1}$

The above calculuation is repeated for each ecoregion (Foothills, Bohemian Massif, Inner Alps, Calcareous Alps, and Alpine Ridge) and summed to give the total change in mineral soil carbon stocks caused by annual cropland converted to perennial cropland.

6.3.4.1.6 Changes of carbon stocks in soils of perennial cropland converted to annual cropland (4.B.1.c)

The area in conversion from perennial cropland to annual cropland for a time period of 20 years is rather stable and ranges from 9 913 ha to 13 899 ha from 1990 to 2023.

The rationale for estimating the soil C stock changes of this LUC has been given in chapter 6.3.4.1.2.

Emissions/removals were calculated by ecoregion-specific values for carbon stocks in mineral soils of annual and perennial cropland. Twenty-year conversion areas per ecoregion were multiplied by ecoregion-specific carbon stock change values derived from the respective category- and ecoregion-specific soil carbon stocks for mineral soils between 0 and 50 cm depth (Table 270).

For each ecoregion (e.g. *Foothills*), the equation is implemented as follows:

Annual change in carbon stock of mineral soils in annual perennial converted to annual cropland =
*ΔSOC_{20} * conversion area for a transition period of 20 years*

$$\Delta SOC = (SOC_0 - SOC_{0-T})/20 = -0.30 \ t \ C \ ha^{-1} \ a^{-1}$$

ΔSOC_{20}	*average annual carbon stock change in soils of perennial cropland converted to annual cropland (t C ha^{-1} a^{-1}) over a conversion transition period of 20 years*
SOC_0	*carbon stock in soils 20 years after conversion from perennial to annual cropland (i.e. average C stock in 0–50 cm of annual cropland soils in e.g. the ecoregion Foothills → 65 t C ha^{-1}*
SOC_{0-T}	*carbon stock in Austrian annual cropland soils before conversion (i.e. average C stock in 0 – 50 cm of perennial cropland soils in e.g. the ecoregion Foothills → 71 t C ha^{-1}*

The above calculuation is repeated for each ecoregion (Foothills, Bohemian Massif, Inner Alps, Calcareous Alps, and Alpine Ridge) and summed to give the total change in mineral soil carbon stocks caused by perennial cropland converted to annual cropland.

6.3.4.1.7 Drainage of organic soils

Emissions due to historic drainage of organic soils occurs in all land use categories except Other land. CO_2 and CH_4 emissions are included in category "4(II).B.1 Cropland remaining cropland" and N_2O emissions are included under the sector Agriculture "3.D.1.f. Cultivation of organic soils". In a dedicated project regarding extent, drainage status and resulting GHG-emissions of organic soils in Austria, activity data and emission factors (Table 285) were estimated (Umweltbundesamt, 2025d). All estimates follow the guidance of chapter 2 of the 2013 Wetland Supplement (IPCC, 2014). Direct on-site emissions of CO_2, CH_4 and N_2O ("$CO_{2\ on\text{-}site}$," ," $EF_{CH4\_landc,n}$" and "$N_2O–N_{OS}$") are estimated based on a literature study on emission factors for Austrian conditions and constitute therefore tier 2 methodology. Off-site emissions from dissolved organic carbon (DOC) export("$EF_{DOC\_drained}$") and CH_4 emissions from drainage ditches ("EF_{CH4_ditch}" including $Frac_{ditch}$) have a minor contribution and are therefore estimated using the default values from table 2.2 and 2.4 of the wetland supplement. Information on AD is available in 6.1.3.1.1.

Table 285: Cropland EF of drained organic soils

GHG	Unit	EF	95% confidence interval		Source
$CO_{2\ on\text{-}site}$	$t\ CO_2\text{-}C\ ha^{-1}\ a^{-1}$	8.76	5.17	12.34	Umweltbundesamt, 2025d
$EF_{DOC\_drained}$	$t\ C\ ha^{-1}a^{-1}$	0.31	0.19	0.46	2013 Wetland Supplement, Table 2.2
$EF_{CH4\_landc,n}$	$kg\ CH_4\ ha^{-1}\ a^{-1}$	3.04	-2.12	8.21	Umweltbundesamt, 2025d
EF_{CH4_ditch}	$kg\ CH_4\ ha^{-1}\ a^{-1}$	1165	335	1995	2013 Wetland Supplement, Table 2.4
$N_2O\text{–}N_{OS}$	$kg\ N_2O\text{-}N\ ha^{-1}\ a^{-1}$	7.66	3.33	11.98	Umweltbundesamt, 2025d

Estimation of CO_2 emissions follows equation 2.2. The respective EFs are provided in Table 285 wheras no burning of drained organic soils is recorded to occur in Austria.

Estimation of CH_4 emissions follows equation 2.6. The respective EFs are provided in Table 285.

Estimation of N_2O emissions follows equation 2.7. The respective EF is provided Table 285.

6.3.4.1.8 Biomass burning

Since this 2024 submission, emissions from wildfires on Cropland and Grassland are estimated and reported due to the availability of a new data source, the Forest Fire Database (BOKU, 2023). However, the available activity data in the Forest Fire Database does not distinguish fires on agricultural land between Cropland and Grassland, meaning that Cropland wildfires are included elsewhere under the Grassland category. For more information about the respective methodology see chapter 6.4.4.1.5.

6.3.4.2 Land use changes to Cropland (4.B.2)

6.3.4.2.1 Forest land converted to cropland (4.B.2.1)

The methodology and activity data are described in the chapters 6.2.2 and 6.2.4.2. The area in conversion from Forest land to Cropland (for a time period of 20 years) ranged from 2 530 ha in 2023 to 4 792 ha in 1994 causing annual net emission rates from 34.1 kt CO_2 to 97.2 kt CO_2, respectively, due to the loss of biomass and C stock changes in soil and litter.

For the calculation of the annual change of carbon stocks the IPCC Tier 3 approach is used for biomass and deadwood, while Tier 2 is used for litter and mineral soil. In both cases, emissions/removals were calculated by country specific values. The changes of the soil carbon stocks were stratified according to five forest growth regions. The stratified LUC areas and soil C stocks according to these growth regions were used for the estimates. The method is described in chapter 6.2.4.2.

It should be noted that the areas of the annual LUCs to and from forests show stepwise changes between NFI observation periods while they remain constant within the NFI observation periods (for explanation see chapter 6.2.2.2). These stepwise LUC area changes have implications on the emissions/removals of FL to CL which, as a consequence, also change in a stepwise fashion for certain pools (e.g. biomass, dead wood, litter;

Table 278). An interpolation across observation periods is considered unsuitable and is therefore not carried out.

Direct and indirect N_2O emissions from N mineralization/immobilization associated with loss of soil organic matter in mineral soils resulting from Forest land converted to Cropland (4(III))

According to the key category analysis, N_2O emissions in the LULUCF sector are a key category. To estimate the associated N_2O emissions the Tier 2 method as provided in the IPCC 2006 GL is applied (Eq.11.1).

To calculate the net annual amount of N mineralized (F_{SOM}, eq. 11.8) from the net carbon stock change (CSC) in the mineral soil due to the land use change, the CSC was divided by the country specific C/N ratios of forest land soils (19, source: see (BFW, 1992) and multiplied by the default emission factor (EF_1) from Table 11.1 in the IPCC 2006 GL. Finally, the result was converted from the amount of annual direct N_2O-N to N_2O emissions.

In addition to the direct N_2O emissions from managed soils, related indirect emissions also occur. The IPCC 2006 Guidelines provide a Tier 2 methodology in Chapter 11 (eq. 11.10) which is applied.

$Frac_{LEACH}$ is a country specific factor of 0.15154 (Eder, et al., 2015) and the emission factor EF_5 is taken from Table 11.3 of the IPCC 2006 Guidelines.

6.3.4.2.2 Grassland converted to cropland (4.B.2.2)

This section provides information about emissions/removals for Grassland converted to cropland and comprises:

a. Grassland converted to annual cropland
b. Grassland converted to perennial cropland

Data for land-use change from Grassland to Cropland were estimated from IACS as described in chapter 6.3.2. The use of the IACS system for the assessment of the conversions/LUCs within and between Cropland and Grassland (see chapter 6.3.2) allows a more accurate annual assessments of these activities since 2002. This leads to higher annual variations in this period than before 2002. Activity data of Grassland converted to cropland in the 20 year conversion status are reported in Table 277. Emissions were estimated applying a country-specific methodology (Tier 2) for biomass carbon stocks and for soil carbon stocks.

The average area undergoing land use change from Grassland to annual cropland over a period of 20 years is 43 266 ha, ranging from 33 310 ha to 66 144 ha for the period 1990 to 2023. Subsequent annual emissions from these land conversions ranged between 63 and 140 kt CO_2.

The average area undergoing land-use change from Grassland to perennial cropland over a period of 20 years for 1990–2023 is 673 ha.

Changes of carbon stock in biomass of grassland converted to annual cropland

Country-specific data for Grassland biomass from the Agricultural Research and Education Centre Raumberg-Gumpenstein (Höhere Bundeslehr- und Forschungsanstalt Raumberg-Gumpenstein) were used. Based on the C-storage in stubble and root biomass in fertile meadows, rough pastures and cultivated pastures at two locations in Austria (Kienach and Puttserersee, see Bohner, et al., 2016), area weighted values for stubble (0.47 t C ha^{-1}) and root biomass (1.25 t C ha^{-1}) were calculated. For the aboveground Grassland biomass a value of 2.95 t C ha^{-1} was applied (detailed description see chapter 6.4.4.2.2). That leads to a country specific value for the carbon stock of above ground and below ground Grassland biomass before conversion of 4.67 t C ha^{-1}. For the calculation of the annual change in carbon stocks in living biomass of Grassland converted to cropland equations 2.15 and 2.16 were applied (IPCC, 2006).

$$\textit{Annual change in biomass} = \textit{annual area of currently converted land} * (L_{conversion} + \Delta C_{growth})$$

$L_{conversion}$ = $C_{after} - C_{before}$

ΔC_{growth} = *country specific value for annual carbon accumulation rate in annual crops is 6.67 t C $ha^{-1}a^{-1}$(see Chapter6.3.4.1.1. accounted only for the year of LUC)*

C_{after} = *carbon stock immediately after conversion is 0*

C_{before} = *country specific value for carbon stock of grassland biomass before conversion is 4.67 t C ha^{-1}(see Chapter 6.4.4.2.2; biomass loss accounted only in the year of LUC)*

Changes of carbon stock in biomass of grassland converted to perennial cropland

For perennial cropland a weighted mean for annual growth according to the Austrian survey on viticulture and orchards (0.27 t C $ha^{-1}a^{-1}$, see chapter 6.3.4.1.1) was used for the whole LUC transition period of 20 years:

$$\textit{Annual change in biomass} = \textit{conversion area for a transition period of 20 years} * \Delta C_{growth} + \textit{annual area of currently converted land} * L_{conversion}$$

$L_{conversion}$ =$C_{after} - C_{before}$

For the calculation the following values were used:

ΔC_{growth} = *annual carbon accumulation rate in perennial crops is 0.27 t C $ha^{-1}a^{-1}$(annual growth rate in each year of the whole LUC transition period of 20 years)*

C_{after} = *carbon stock immediately after conversion is 0*

C_{before} = *country specific value for carbon stock of grassland biomass before conversion. 4.67 t C ha^{-1} (description see Chapter 6.4.4.2.2. biomass loss accounted only in the year of LUC).*

The data in the CRT table represent Grassland converted to annual cropland and Grassland converted to perennial cropland separately.

Changes of carbon stock in mineral soils of grassland converted to annual cropland

Only mineral soils were considered in this category assuming that Grassland on organic soils was not converted to cropland.

Emissions/removals were calculated by ecoregion-specific values for carbon stocks in mineral soils of annual cropland and Grassland (see stock for *Grassland – intensive use*). Twenty-year conversion areas per ecoregion were multiplied by ecoregion-specific carbon stock change values derived from the respective category- and ecoregion-specific soil carbon stocks for mineral soils between 0 and 50 cm depth (Table 270).

For each ecoregion (e.g. *Foothills*), the equation is implemented as follows:

Annual change in carbon stock of mineral soils in grassland converted to annual cropland =
*Δ SOC_{20} * conversion area for a transition period of 20 years*

$$\Delta SOC = (SOC_0 - SOC_{0\text{-}T})/20 = -0.70 \ t \ C \ ha^{-1} \ a^{-1}$$

ΔSOC_{20} average annual carbon stock change in soils of annual cropland converted to perennial cropland (t C ha^{-1} a^{-1}) over a conversion transition period of 20 years

SOC_0 carbon stock in soils 20 years after conversion from grassland to annual cropland (i.e. average C stock in 0–50 cm of annual cropland soils in e.g. the ecoregion Foothills → 65 t C ha^{-1}

$SOC_{0\text{-}T}$ carbon stock in Austrian annual cropland soils before conversion (i.e. average C stock in 0 – 50 cm of grassland soils (intensive use) in e.g. the ecoregion Foothills → 79 t C ha^{-1}

The above calculuation is repeated for each ecoregion (Foothills, Bohemian Massif, Inner Alps, Calcareous Alps, and Alpine Ridge) and summed to give the total change in mineral soil carbon stocks caused by Grassland converted to annual cropland.

Changes of carbon stock in mineral soils of grassland converted to perennial cropland

Only mineral soils were considered in this category assuming that Grassland on organic soils was not converted to cropland.

Emissions/removals were calculated by ecoregion-specific values for carbon stocks in mineral soils of perennial cropland and Grassland (see stock for *Grassland – intensive use*). Twenty-year conversion areas per ecoregion were multiplied by ecoregion-specific carbon stock change values derived from the respective category- and ecoregion-specific soil carbon stocks for mineral soils between 0 and 50 cm depth (Table 270).

For each ecoregion (e.g. *Foothills*), the equation is implemented as follows:

Annual change in carbon stock of mineral soils in grassland converted to perennial cropland =
*Δ SOC_{20} * conversion area for a transition period of 20 years*

$$\Delta SOC = (SOC_0 - SOC_{0\text{-}T})/20 = -0.40 \ t \ C \ ha^{-1} \ a^{-1}$$

ΔSOC_{20} average annual carbon stock change in soils of annual cropland converted to perennial cropland (t C ha^{-1} a^{-1}) over a conversion transition period of 20 years

SOC_0 carbon stock in soils 20 years after conversion from grassland to perennial cropland (i.e. average C stock in 0–50 cm of perennial cropland soils in e.g. the ecoregion Foothills → 71 t C ha^{-1}

$SOC_{0\text{-}T}$ carbon stock in Austrian annual cropland soils before conversion (i.e. average C stock in 0 – 50 cm of grassland soils (intensive use) in e.g. the ecoregion Foothills → 79 t C ha^{-1}

The above calculuation is repeated for each ecoregion (Foothills, Bohemian Massif, Inner Alps, Calcareous Alps, and Alpine Ridge) and summed to give the total change in mineral soil carbon stocks caused by Grassland converted to perennial cropland.

The data in the CRT table represent grassland converted to annual cropland and grassland converted to perennial cropland.

Direct and indirect N_2O emissions from N mineralization/immobilization associated with loss of soil organic matter in mineral soils resulting from Grassland converted to Cropland (4(III))

According to the key category analysis, N_2O emissions in the LULUCF sector are a key category. To estimate the associated N_2O emissions, the Tier 2 method as provided in the IPCC 2006 GL is applied (Eq.11.1).

To calculate the net annual amount of N mineralized (F_{SOM}, eq. 11.8) from the net carbon stock change (CSC) in the mineral soil due to the land use change, the CSC was divided by the country specific C/N ratio of grassland soils (12, source: see footnote[102]) and multiplied by the default emission factor (EF_1) from Table 11.1 in the IPCC 2006 Gl. Finally, the result was converted from the amount of annual direct N_2O-N to N_2O emissions.

In addition to the direct N_2O emissions from managed soils, related indirect emissions also occur. The IPCC 2006 Guidelines provide a tier 2 methodology in Chapter 11 (eq. 11.10) which is applied.

$Frac_{LEACH}$ is a country specific factor of 0.15154 (Eder, et al., 2015) and EF_5 is provided in Table 11.3 of the IPCC 2006 Guidelines.

6.3.5 Uncertainty Assessment

For the Monte Carlo simulations the following uncertainties of the input parameters were used:

Table 286: Uncertainties of areas in the CL category.

	Before 2003	**Since 2003**
Total cropland	±4%	±4%
Perennial cropland	±20%	±20%
Annual LUC area CL to FL or FL to CL	see Chapter 6.2.5., Table 274	see Chapter 6.2.5., Table 274
Annual LUC area pCL to aCL. aCL to pCL. GL to aCL, GL to pCL	±120%[1]	±40%

[1] For area uncertainties > 100%, distributions were truncated at 0 as negative areas are not possible

These uncertaintie estimates originate from:

- Total cropland area: based on information from data source (Statistik Austria)
- Perennial cropland area: based on information from data source (Statistik Austria)
- Annual LUC area pCL to aCL. aCL to pCL. GL to pCL, GL to aCL: Expert judgement

Table 287: Uncertainties of the input data for the emission factors in the CL category (distributions were truncated at the minima and maxima).

	stock	growth rate or emission factor
Annual CL biomass	±15%	±15%
Vineyards	±17%	±42%
Orchards	±23%	±33%
Perennial energy plants	Triangle Distribution with 21-30-45 t C ha^{-1}	Triangle Distribution with 3.5-5.0-7.5 t C ha^{-1}
Christmas trees	±40%	±40%
Grassland biomass	±45%	±45%
Soil C stock change in CL rem Cl		±40%
Soil C stocks for LUC to CL	see Chapter 6.2.5. Table 275	
N_2O emission factor for soil at LUC to CL (default)		Triangle Distribution with 0.003-0.01-0.03
C/N ratio grassland soils	±55%	
C/N ratio forest soils	±58%	
C/N ratio cropland soils	±10%	
Indirect N_2O emission from leaching and run-off –FRACleach		±130%
Indirect N_2O emission from leaching and run-off –emission factor (default)		Triangle Distribution with 0.0005-0.0075-0.025

These uncertainties were derived from the following sources:

- Annual CL biomass: for yield based on an assessment from the annual yield statistics; for the expansion factors based on expert judgement
- Vineyards and orchards biomass: based on the survey results
- Perennial energy plants: assessment based on the results of the study that was used (Splechtna, Glatzel, 2005)
- Christmas trees: assessment based on the results of the study that was used (BMLFUW, 2008a)
- Grassland biomass: for yield based on an assessment from the annual yield statistics; for the expansion factors based on expert judgement
- Soil C stock change in CL rem CL: assessment based on the results of Umweltbundesamt, 2010a
- N2O emission factors for soil at LUC to CL: IPCC 2006 GL
- C/N ratios of soils: assessment on basis of the Austrian soil inventory results

The uncertainties of the area of drained organic cropland soils and emission factors from such soils were taken from the related study (Umweltbundesamt, 2025d). The uncertainties of the area of drained organic cropland soils was defined as a triangle distribution with a minimum of 5.6 kha and a maximum of 7.6 kha. The uncertainties of the emission factors from drained organic cropland soils are ±41 % for CO_2, ±170 % for CH_4 and ±56 % for N_2O. The uncertainties for the used default emission factors for ditches were taken from the IPCC 2013 Wetland Supplement (IPCC, 2014).

On the basis of these input uncertainties the Monte Carlo simulations led to an average uncertainty in the total emissions/removals of the Cropland category over the time series of ±134 kt CO_2eq (range: ±126 kt CO_2eq to ±145 kt CO_2eq). The average relative uncertainty is ±88% (range: ±27% to ±270%) depending on the absolute value of the net emissions or removals of the sector. Years with net emissions and removals of the cropland subcategory close to 0 show logically very high relative uncertainties.

It should be noted that the net emission/removals of the Cropland category are the result of subtractions between emissions and removals of several subcategories and pools. Only in single cases are they are correlated. In line with error propagation laws, the uncertainty of such net values based on subtractions of uncorrelated parameters are additive and therefore rather high in relative terms.

6.3.6 Category-specific QA/QC

The calculation of the data for category *4.B* is embedded in the overall QA/QC-system of the Austrian GHG inventory (see Chapter 6.1.4).

6.3.7 Recalculations

For area consistency reasons a minor adjustment of the total Cropland area was carried out. This had only negligable impacts on Cropland revisions, but did influence other categories (Grassland and Settlements) due to the subsequent impacts on inferred conversions from Cropland to these categories. The Grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes involving Grassland and consequently have an impact on the results of the land-use change category Grassland to Cropland. With respect to soil carbon stock changes, improvements have been made to regionalize the Grassland conversions to Cropland across five ecoregions (forest growth areas) to utilise ecoregion-specific soil carbon stocks for the pre- and post-conversion stocks. The stocks are moreover now for the depth 0-50 cm instead of the previously used 0-30 cm depth, ensuring consistency across all calculations of LUC-induced soil carbon stock changes e.g. Forest land conversions to Cropland. On basis of the national study on organic soils in Austria (Umweltbundesamt, 2025d), drained organic soils in Cropland were identified, for which emissions for the whole time series are estimated for the first time. These improvements caused upward revisions of the annual net emissions for the whole time series of the Cropland category in the range of +155 to +204 kt CO_2e per year compared to the last submission in 2024.

6.3.8 Planned improvements

See Chapter 6.1.8.

6.4 Grassland (CRT Category 4.C)

6.4.1 Category description

In this category emissions/removals from Grassland (Grassland remaining grassland and Land converted to grassland) are considered. In 2023 1.6 million ha of Austria were managed as Grassland. This area estimation is based on assessment of spatially-explicit, national datasets introduced for the 2024 submission as part of the improved Austrian system for land representation (for detailed descriptions see chapters 6.1.3.1 and 6.4.2). Since 1990 the area of grassland has generally been decreasing each year. Total Grassland includes one cut meadows, two cut meadows and three or more cut meadows, permanent pastures, litter meadows, rough pastures, alpine meadows and pastures, grassland where agricultural grassland management was stopped and fallow grassland (grassland in good agricultural and ecological condition no longer used for production; formerly called "GLÖZ").

The annual CO_2 emissions from the Grassland category in Austria amounted to 792 kt CO_2 in 1990 and 593 kt CO_2 in 2023. The main drivers of the emissions are carbon stock changes in mineral soils and biomass due to LUC from Forest land to Grassland, as well as carbon stock losses from drained organic soils under Grassland remaining grassland.

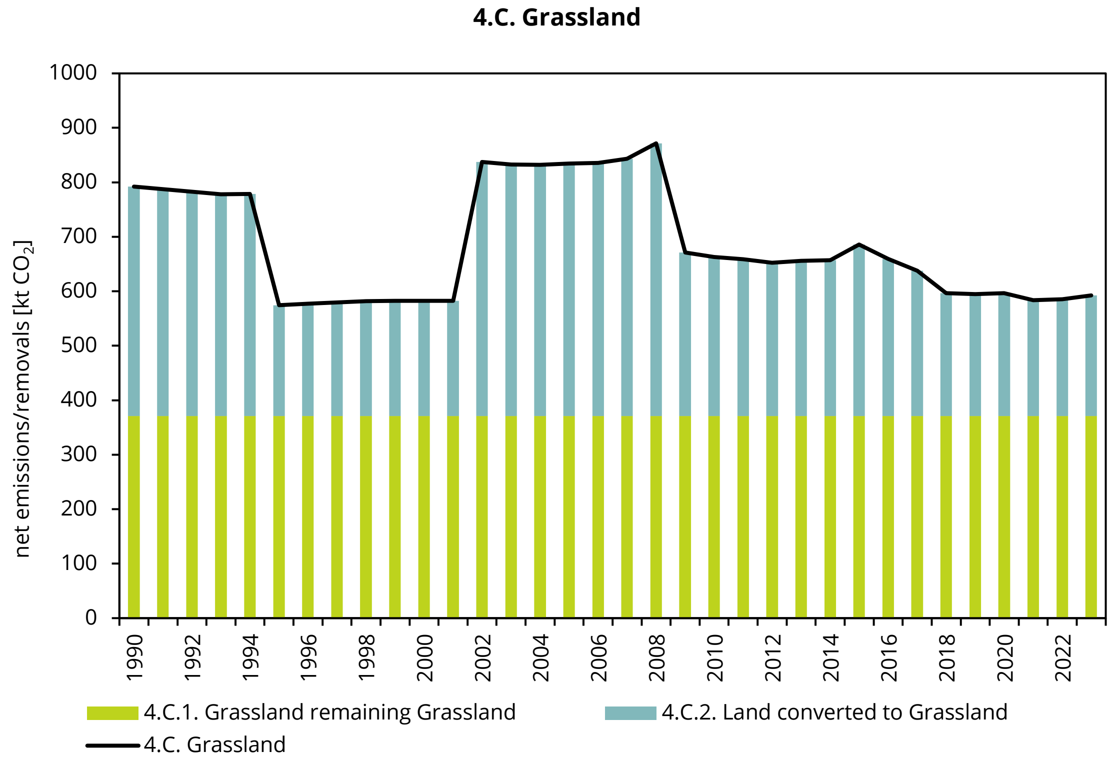
Since 2006 an increase of LUC areas from cropland to grassland can be observed.

Some management practices (e.g. slash and burn etc.) and some subcategories (*4.C.2.3*. *4.C.2.4*. *4.C.2.5*) do not occur in Austria. Furthermore, changes in dead wood and litter carbon stocks do not occur in Grassland, apart from respective carbon losses in these pools due to Forest land converted to Grassland.

Table 288: Sources (or sinks) considered for grassland.

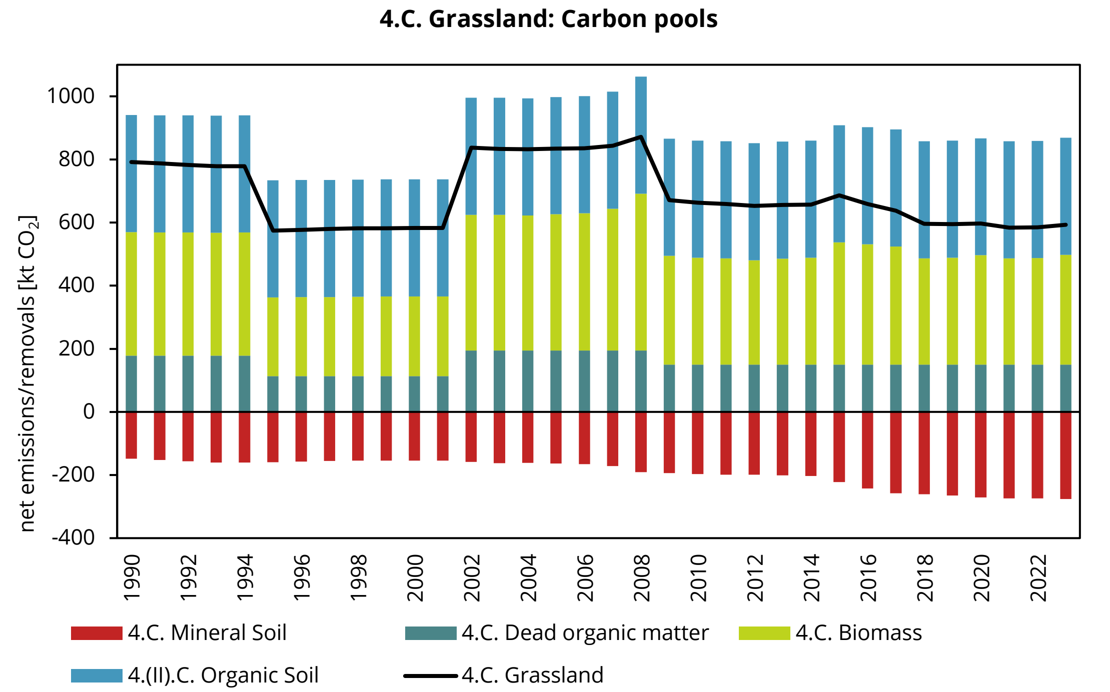
Category/source or sink
4.C Grassland – total
4.C.1 Grassland remaining grassland
emissions from drained organic soils in grassland
- N_2O, CH_4 emissions due to wildfires
4.C.2 Land converted to grassland
4.C.2.1 Forest land converted to grassland
- carbon stock change in biomass due to LUC from forest land to grassland
- carbon stock change in DOM due to LUC from forest land to grassland
- carbon stock change in SOM due to LUC from forest land to grassland
4.C.2.2 Cropland converted to grassland
- carbon stock change in biomass due to LUC from cropland to grassland
- carbon stock change in SOM due to LUC from cropland to grassland

Figure 42: Emissions/removals (+/-) from grassland (1990–2023) by grassland remaining grassland and land use change to grassland in kt CO_2.



Source: Umweltbundesamt

Figure 43: Emissions/removals (+/-) from grassland (1990–2023) by carbon pools in kt CO_2.



Source: Umweltbundesamt

Table 289: Total areas and land-use change areas of grassland 1990–2023 in ha; transition period of 20 years for LUC lands.

	4.C Total grassland	4.C.1 Grassland remaining grassland	4.C.2 Land converted to grassland	4.C.2.a Forest Land converted to grassland	4.C.2.b Cropland converted to grassland - total	4.C.2.b.i annual cropland converted to grassland	4.C.2.b.ii Perennial cropland converted to grassland	4.C.2.c Wetlands converted to grassland	4.C.2.d Settlements converted to grassland	4.C.2.e Other land converted to grassland
1990	1 812 974	1 752 872	60 102	32 467	27 635	27 189	446	NO	NO	NO
1995	1 756 664	1 692 156	64 508	37 069	27 439	26 996	443	NO	NO	NO
2000	1 718 609	1 655 980	62 629	35 442	27 187	26 748	439	NO	NO	NO
2005	1 678 328	1 614 975	63 353	36 433	26 919	26 485	435	NO	NO	NO
2010	1 651 372	1 574 191	77 181	33 840	43 341	42 889	452	NO	NO	NO
2011	1 648 443	1 570 452	77 991	33 534	44 456	44 026	430	NO	NO	NO
2012	1 644 204	1 566 271	77 933	33 228	44 705	44 296	408	NO	NO	NO
2013	1 639 529	1 560 996	78 533	32 923	45 610	45 161	449	NO	NO	NO
2014	1 636 837	1 557 230	79 607	32 617	46 990	46 311	679	NO	NO	NO
2015	1 638 129	1 550 032	88 097	33 001	55 096	53 753	1 343	NO	NO	NO
2016	1 639 041	1 543 499	95 542	33 384	62 157	60 471	1 686	NO	NO	NO
2017	1 637 816	1 535 861	101 955	33 768	68 187	66 478	1 709	NO	NO	NO
2018	1 632 403	1 529 234	103 169	34 152	69 017	67 297	1 720	NO	NO	NO
2019	1 627 061	1 522 396	104 665	34 535	70 130	68 372	1 758	NO	NO	NO
2020	1 622 623	1 515 420	107 203	34 919	72 284	70 496	1 789	NO	NO	NO
2021	1 617 896	1 509 443	108 453	35 303	73 151	71 316	1 835	NO	NO	NO
2022	1 611 483	1 502 476	109 008	34 825	74 183	72 320	1 863	NO	NO	NO
2023	1 605 754	1 494 683	111 070	34 348	76 723	74 606	2 117	NO	NO	NO

Table 290: Emissions/removals (+/-) from grassland in kt CO_2, CH_4 and N_2O in kt CO_2eq (1990–2023).

	4.C Total grassland_CO_2	4.C.1 Grassland remaining grassland	4.C.2 Land converted to grassland	4.C.2.a Forest land converted to grassland	4.C.2.b Cropland converted to grassland-total	4.C.2.b.i Annual cropland converted to grassland	4.C.2.b.ii Perennial cropland converted to grassland	4.C.2.c Wetlands converted to grassland	4.C.2.d Settlements converted to grassland	4.C.2.e Other Land converted to grassland	4(II)C1_CO_2_Drained organic soils in CO_2	4(II)C1_CH_4_Drained organic soils CH_4 in CO_2eq	4(II)C1_N_2O_Drained organic soils N_2O in CO_2eq	4(IV)C1_Biomass burning wildfires_CO_2	4(IV)C1_Biomass burning wildfires_CH_4 in CO_2eq	4(IV)C1_Biomass burning wildfires_N_2O in CO_2eq	4.C Total grassland_CO_2eq
1990	792	0	421	479	-58	-57	-0.54	NO	NO	NO	371.1	18.94	IE	NA	NE	NE	811
1995	575	0	203	261	-57	-57	-0.54	NO	NO	NO	371.1	18.94	IE	NA	NE	NE	593
2000	582	0	211	268	-57	-56	-0.53	NO	NO	NO	371.1	18.94	IE	NA	NE	NE	601
2005	834	0	463	518	-55	-54	-0.64	NO	NO	NO	371.1	18.94	IE	NA	0.000	0.000	853
2010	663	0	292	374	-82	-82	-0.33	NO	NO	NO	371.1	18.94	IE	NA	0.007	0.004	682
2011	659	0	288	374	-87	-86	-0.63	NO	NO	NO	371.1	18.94	IE	NA	0.012	0.006	678

	4.C Total grassland_CO_2	4.C.1 Grassland remaining grassland	4.C.2 Land converted to grassland	4.C.2.a Forest land converted to grassland	4.C.2.b Cropland converted to grassland-total	4.C.2.b.i Annual cropland converted to grassland	4.C.2.b.ii Perennial cropland converted to grassland	4.C.2.c Wetlands converted to grassland	4.C.2.d Settlements converted to grassland	4.C.2.e Other Land converted to grassland	4(II)C1_CO_2_Drained organic soils in CO_2	4(II)C1_CH_4_Drained organic soils CH_4 in CO_2eq	4(II)C1_N_2O_Drained organic soils N_2O in CO_2eq	4(IV)C1_Biomass burning wildfires_CO_2	4(IV)C1_Biomass burning wildfires_CH_4 in CO_2eq	4(IV)C1_Biomass burning wildfires_N_2O in CO_2eq	4.C Total grassland_CO_2eq
2012	652	0	281	375	-94	-93	-0.60	NO	NO	NO	371.1	18.94	IE	NA	0.033	0.017	671
2013	656	0	285	376	-91	-91	-0.33	NO	NO	NO	371.1	18.94	IE	NA	0.017	0.009	675
2014	657	0	286	377	-91	-91	0.31	NO	NO	NO	371.1	18.94	IE	NA	0.010	0.005	676
2015	686	0	315	376	-61	-62	1.43	NO	NO	NO	371.1	18.94	IE	NA	0.023	0.012	705
2016	659	0	288	375	-87	-86	-0.86	NO	NO	NO	371.1	18.94	IE	NA	0.011	0.006	678
2017	638	0	266	374	-108	-105	-2.58	NO	NO	NO	371.1	18.94	IE	NA	0.029	0.015	656
2018	596	0	225	373	-148	-145	-2.67	NO	NO	NO	371.1	18.94	IE	NA	0.024	0.013	615
2019	595	0	224	372	-148	-146	-2.60	NO	NO	NO	371.1	18.94	IE	NA	0.024	0.013	614
2020	597	0	226	371	-145	-143	-2.70	NO	NO	NO	371.1	18.94	IE	NA	0.007	0.004	616
2021	584	0	213	370	-157	-154	-2.72	NO	NO	NO	371.1	18.94	IE	NA	0.015	0.008	603
2022	585	0	214	372	-158	-155	-2.88	NO	NO	NO	371.1	18.94	IE	NA	0.005	0.003	604
2023	593	0	222	375	-153	-151	-1.90	NO	NO	NO	371.1	18.94	IE	NA	0.041	0.021	612

6.4.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

In previous submissions pre-2024, total Grassland area was estimated from national statistics on agricultural land use (e. g. Statistik Austria, 2022c). However, as part of continuous inventory QA/QC, consistency issues in these statistics were identified. These statitsics represent Grassland under agricultural ownership only, despite the existence of other Grassland areas in Austria. As an interim solution in the 2022 and 2023 submissions, national statistics on agricultural Grassland area were used as a first estimate, that was iteratively corrected as part of the process to ensure area consistency in the national land transition matrices. However, as detailed in section 6.1.3.1, the Austrian system for land representation, in particular the methods for estimating Grassland areas, has been fundamentally improved and is now based predominantly on spatially-explicit data sources.

National statistics on the total agricultural Grassland area are generated by Austrian Farm Structure Surveys (FSS): full FSS were conducted in 1990, 1995, 1999, 2010 and 2020 (ÖSTAT, 1991, ÖSTAT, 1996, Statistik Austria, 2001, Statistik Austria, 2013a, Statistik Austria, 2022c) and random sample Farm Structure Surveys were carried out in 1993, 1997, 2003, 2005, 2007, 2013 and 2016 (ÖSTAT, 1994, ÖSTAT, 1998, Statistik Austria, 2005, Statistik Austria, 2006, Statistik Austria, 2008, Statistik Austria, 2014a, Statistik Austria, 2018). The full surveys are based on the responses to questionnaires sent to all farms and forest enterprises and cover 90% of the area of Austria. In the years between two full surveys, the data have been interpolated (eg. 2010–2020). For the years after the last FSS in 2020, agricultural Grassland areas for 2021 and 2022 are extrapolated using the long-term annual trend derived from the 2003 and 2020 area estimates. In previous submissions, the inter-/extrapolated time series from the national statistics (albeit with corrections for alpine pastures as described in the 2015 submission) were considered as robust estimates of the total Grassland area in Austria. However, after consultations with the providers of these statistics, it emerged that the decline in Grassland area according to these statistics is overestimated. Given that the statistics are based only on grassland areas owned by farmers, the estimates do not adequately account for areas of Grassland, that are no more owned by farmers, but nonetheless do not lose their status as managed Grassland per national land use definitions (e.g. Grasslands that are no longer owned by farmers, but are used for hunting by the new owners).

The time series of areas derived from the FSS statistics therefore no longer serve as the basis for Grassland area estimations. As part of the *LULUC Mapping* element (6.1.3.1) of the Austrian system for land representation, a spatially-explicit quantification of Grassland is derived from the best-estimate 2022 LU baseline layer. By integrating multiple national layers, in particular the 2022 IACS (AMA, 2022b) and DKM layers (BEV, 2023a), as well as a custom-made agriculture layer (based on the BEV Land Cover- (BEV, 2024b), DLM-Gebietsnutzung (BEV, 2023c) and the CLC+ Backbone (EEA, 2023) datasets), a complete and spatially-explicit estimate of total Grassland area for 2022 was derived. This estimate then feeds into the *LULUC Data Integration* element, where the annual time series of respective land-use changes to and from Grassland are used to extrapolate the annual Grassland area from 2022 back to 1970, as well as forward extrapolation for 2023 onwards.

The areas of the Forest land converted to Grassland are provided by the *NFI* element of the Austrian system for land representation (see chapter 6.2.2.2), while conversions of Cropland to Grassland are provided by the *IACS (CL<->GL)* element (see Chapter 6.3.2). Both elements provide national total-, as well as ecoregion-specific, conversion areas. Note that the revised Cropland area time series, partcularly for the years pre-1990 (see Chapter 6.3.2), which are used to upscale conversions between Cropland and Grassland have led to revised area and emissions estimates for Cropland converted to Grassland.

Based on expert judgement, it is assumed that LUCs from Wetlands, from Settlements and from Other land to grassland do not occur in Austria. This assumption is based on the fact that the grassland areas show a steady decrease. In addition, Wetlands, Settlements and Other land areas are not suited (anymore) for a land use as grassland:

- Drainage of wetlands for the purpose of grassland use was carried out in Austria in former decades. For reasons of nature conservation new drainages do not occur for many years.
- Settlement areas increased steadily in the last decades mainly by LUC from agricultural areas.
- Settlement areas and soils – once converted – cannot be used for grassland.
- There is also a higher economic value for land dedicated to building land than agricultural land i.e. there is no economic incentive for re-conversion.
- "Other lands" are found at the highest elevations or steepest areas of Austria. The subsequent unfavorable ecological conditions do not allow any agricultural use.

6.4.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The STATISTIK AUSTRIA classification for grassland was used for land use definitions (Statistik Austria, 2022c):

- One cut meadows,
- Two cut meadows,
- Three and more cut meadows,
- Litter meadows,
- Permanent Pastures,
- Rough Pastures,
- Alpine meadows and pastures,
- Fallow grassland: grassland in good agricultural and ecological condition no longer used for production.
- Grassland where grassland management was stopped and/or the area is no longer managed agriculturally

In addition, grassland not owned by farmers is included in this category.

6.4.4 Methodological Issues

Emissions were estimated by applying country-specific methodologies (Tier 2) for both biomass carbon stocks and soil carbon stocks.

The following table provides an overview of the IPCC Tier methodology applied per category and pool in grassland, including the significant pools (in grey) for the year 2023. All reported sub-categories of grassland are key categories for CO_2.

Table 291 Overview of IPCC tiers applied per pool in the grassland category. Significant pools of key categories are highlighted in grey and are based on the assessment of the year 2023.

To	**Grassland**					
From	living biomass	dead organic matter	mineral soil	organic soil	4(II) drained organic soils	4(IV) biomass burning
Forest land	T3	T3	T2	NO	NO	NO
Cropland	T2	NO	T2	NO	NO	NO
Grassland	T1/NA	NO	T1/NA	IE	T2	NA
Wetlands	NO	NO	NO	NO	NO	NO
Settlements	NO	NO	NO	NO	NO	NO
Other land	NO	NO	NO	NO	NO	NO

6.4.4.1 Grassland remaining grassland (5.C.1)

The area of Grassland remaining grassland in 2023 was estimated at 1.5 million ha.

The annual CO_2 emissions from Grassland remaining grassland between 1990 and 2023 are 371.1 kt CO_2 representing only constant emissions from drained organic soil, now consistently reported in CRT table 4(II). Due to recent research results, carbons stock changes in mineral soils of Grassland remaining grassland are assumed as zero and reported with the "NA" notation key (detailed information see following chapter 6.4.4.1.2).

6.4.4.1.1 Changes in carbon stocks in biomass of Grassland remaining grassland

According to IPCC 2006 Guidelines the biomass carbon stock changes of Grassland remaining grassland are assumed to be zero.

6.4.4.1.2 Changes in carbon stocks in mineral soils of Grassland remaining grassland

In previous submissions, a Tier 2 method was used for estimating the changes of mineral soil carbon stocks due to management changes in Grassland remaining grassland. The method closely followed the approach presented in the IPCC 2006 Guidelines.

Recently, an Austrian project was completed, which assessed the mineral soil carbon stock changes at long-term experimental grassland plots with different management regimes in terms of different fertilizer applications and cutting frequencies. This analysis was complemented by studying the mineral soil carbon stock changes at a large number of agricultural practice grassland sites in Upper Austria, stratified according to site and climatic conditions as well as different management types (Dersch, et al., 2023). The study showed significantly higher mineral soil carbon stocks in the upper 10 cm of soil only for those experimental plots with solid manure fertilization. All other studied differences in management had no significant impact on the carbon stock of the top soil layer. In the last years, the solid manure fertilization decreased in Austria, which – based on the results from the experimental plots – would suggest a recent trend towards a decrease in mineral soil carbon stocks in grassland. On the contrary, significant increases in mineral soil carbon stocks in topsoils (0–10 cm) were detected at the managed grassland sites in Upper Austria that were sampled by Dersch, et al. (2023) and by repeated measurements of grassland sites in Lower Austria by another study (Wenzel, et al., 2022). The reasons for these increases are not yet known. The conflicting results of the above studies therefore do not currently allow for an accurate national assessment of the changes in mineral soil carbon stocks in grassland due to changes in management. Furthermore, nation-wide reassessments of the soil inventories are not available. Therefore, it was decided to revoke the previous approach of estimating the mineral soil carbon stock changes in Grassland remaining grassland and substitute it with an assumption that mineral soil carbon stocks in this subcategory are in equilibrium (Tier 1 – no change in management). This is considered an interim solution until nation-wide reassessments of the soil inventories become available and/or until the influencing parameters for the grassland soil carbon stock changes reported in literature are well understood. Only then, accurate management factors for Grassland remaining grassland can be derived and implemented in the GHG inventory.

6.4.4.1.3 Drainage of organic soils

Emissions due to historic drainage of organic soils occurs in all land use categories except Other land. CO_2 and CH_4 emissions are included in category "4(II).C.1 Grassland remaining grassland" and N_2O emissions are included under the sector Agriculture "3.D.1.f. Cultivation of organic soils". In a dedicated project regarding extent, drainage status and resulting GHG-emissions of organic soils in Austria activity data and emission factors (Table 292) were estimated (Umweltbundesamt, 2025d). All estimates follow the guidance of chapter 2 of the 2013 Wetland Supplement (IPCC, 2014). Direct on-site emissions of CO_2, CH_4 and N_2O ("$CO_{2\ on\text{-}site}$," ," $EF_{CH4\_landc,n}$" and "$N_2O–N_{OS}$") are estimated based on a literature study on emission factors for Austrian conditions and constitute therefore tier 2 methodology. Off-site emissions from dissolved organic carbon (DOC) export("$EF_{DOC\_drained}$") and CH_4 emissions from drainage ditches ("EF_{CH4_ditch}" including $Frac_{ditch}$) have a minor contribution and are therefore estimated using the default values from table 2.2 and 2.4 of the wetland supplement. Information on AD is available in 6.1.3.1.1.

Table 292: Grassland EF of drained organic soils

GHG	Unit	EF	95% confidence interval		Source
$CO_{2\ on\text{-}site}$	t CO_2-C ha^{-1} a-1	8.63	6.35	10.91	Umweltbundesamt, 2025d
$EF_{DOC\_drained}$	t C $ha^{-1}a^{-1}$	0.31	0.19	0.46	2013 Wetland Supplement, Table 2.2
$EF_{CH4\_landc,n}$	kg CH_4 ha^{-1} a^{-1}	1.57	-2.32	5.47	Umweltbundesamt, 2025d
EF_{CH4_ditch}	kg CH_4 ha^{-1} a^{-1}	1165	335	1995	Umweltbundesamt, 2025d
$N_2O–N_{OS}$	kg N_2O-N ha^{-1} a^{-1}	3.65	0.63	6.68	Umweltbundesamt, 2025d

Estimation of CO_2 emissions follows equation 2.2. The respective EFs are provided in Table 292 wheras no burning of drained organic soils is recorded to occur in Austria.

Estimation of CH_4 emissions follows equation 2.6. The respective EFs are provided in Table 292.

Estimation of N_2O emissions follows equation 2.7. The respective EF is provided in Table 292.

6.4.4.1.4 Biomass burning

In the 2024 submission, emissions caused by biomass burning were estimated for this category for the first time. Emissions due to wildfires in Cropland and Grassland are now estimated and reported together under category 4(IV)C.1 Grassland remaining Grassland, because the activity data can not be separated between these categories. Estimates of wildfire emissions of CH_4 and N_2O from this category are reported. Based on the IPCC 2006 Guidelines, equation (2.27) following a Tier 2 method was applied.

$$L_{fire}\ (t\ GHG) = A * M_B * C_f * G_{ef} * 10^{-3}$$

A area burnt (ha)
M_B mass of available fuel, t dm ha^{-1} (Table 2.4)
C_f combustion factor
G_{ef} emission factor, g kg^{-1} dm (Table 2.5)

Data on the area affected by wildfires is based on the Forest Fire Database ("Waldbrand-Datenbank Österreich") of the Institute of Silviculture, University of Natural Resources and Life Sciences, Vienna (BOKU, 2023). In addition to forest fires and reed belt burnings, the database includes yearly area data on open field burning back to 2001. The average national biomass stock of grassland and cropland biomass constitutes the mass of available fuel (4.3 t/ha) and was updated in this submission based on the new biomass stocks for Grassland (see 6.4.4.2.2). The default factor for C_f was taken from table 2.6 of the IPCC 2006 Guidelines for wheat residues which appeared most suitable (0.9). The default emission factors (G_{ef}) for N_2O and CH_4 are derived from table 2.5 of the IPCC 2006 Guidelines (for agricultural residues).

The total Cropland and Grassland area affected by fires varies greatly from year to year, with an average for the whole time series of 40 ha. Therefore, the amounts of N_2O and CH_4 emissions caused by wildfires on Cropland and Grassland are negligible, with annual sum N_2O and CH_4 emissions ranging between zero and 0.04 kt CO_2 equivalents. Due to the negligible GHG emission contribution in years, for which the areas of such fires were recorded (since 2001), it is considered appropriate to report these emissions for the years before with "not estimated".

6.4.4.2 Land use change to Grassland (4.C.2)

6.4.4.2.1 Forest Land converted to Grassland (4.C.2.1)

The methodology and activity data are described in Chapters 6.2.2 and 6.2.4.2. The area in conversion from Forest land to Grassland for a time period of 20 year ranges from 32 467 ha to 37 716 ha between the years 1990 and 2023. The main part of conversion occurs from forests to pasture causing annual emissions due to the loss of biomass and C stock changes in soil and litter between 260.8 kt CO_2 and 522.8 kt CO_2.

For the calculation of the annual change of biomass and deadwood carbon stocks, an IPCC Tier 3 approach is used. Tier 2 is used for litter and soil carbon stock changes. Emissions/removals were calculated by country-specific values. The changes of soil carbon stocks were stratified according to five forest growth regions. The stratified LUC areas and soil C stocks according to these growth regions were used for the estimates. The method is described in Chapter 6.2.4.2.

It should be noted that the areas of the annual LUCs to and from forests show stepwise changes from NFI observation periods while they remain constant within each NFI observation period (for explanation see chapter 6.2.2.2). These stepwise LUC area changes have implications on the emissions/removals of FL to GL which, as a consequence, also change in a stepwise fashion for certain pools (e.g. biomass, dead wood, litter). The significant contribution of this category to the total GL results is indicated by the same stepwise changes in the emissions/removals of the total GL category (Table 289). An interpolation across these steps is considered unsuitable and is therefore not carried out.

6.4.4.2.2 Cropland converted to Grassland (4.C.2.2)

The average annual land use change area from annual cropland to grassland from 1990–2023 is 2 736 ha. The average annual land use change area (1990–2023) from perennial cropland to grassland is 72 ha. The total area in conversion status for a time period of 20 years amounts to 27 635 ha in 1990 and 76 723 ha in 2023. Considering the area of the 20 years transition period this leads to annual removals of -57.8 kt CO_2 in 1990 and -153.0 kt CO_2 in 2023.

The use of the IACS system for the assessment of conversions from Cropland to Grassland (see chapter 6.3.2) allows more accurate annual assessments of the activities since 2002. This leads to higher annual variations in this period than before 2002. Since 2008, a higher conversion rate from Cropland to Grassland has been observed. This is likely caused by the changed framework conditions due to EU regulations concerning the protection of grasslands.

Changes of carbon stock in biomass of annual cropland converted to grassland

The carbon stock of living biomass in annual cropland was estimated by using country-specific data from Statistic Austria (Statistik Austria, 2007). The average mean of the above and belowground biomass of the annual crops in cropland was estimated with 6.67 t C ha^{-1} (see Chapter 6.3.4.1.2).

A country-specific carbon stock in living grassland biomass was estimated. The calculation was done by using country-specific grassland biomass data from Statistic Austria (Statistik Austria, 2024h) and from the Agricultural Research and Education Centre (AREC) Raumberg-Gumpenstein (Bohner, et al., 2016).

The national mean Grassland biomass C stock was calculated from the mean biomass yields of the subcategories one cut meadows, two cut meadows, three and more cut meadows, litter meadows, rough pastures and cultivated pastures, which were weighed by the total area of these different grassland categories. For previous submissions, the mean biomass yields and areas per grassland category of the 10-year period 1996-2005 were used for the calculations. For this submission, the mean of the more recent time period of 2011-2020 was calculated as well. In order to account for the entire time series, a mean value was calculated from both 10-year periods. The calculation led to an average biomass yield per year of 5.9 t dm ha^{-1} for Austrian grasslands, these are 2.95 t C per ha and year.

As recommended by the ERT and in order to make the estimation process more transparent, the yields, areas and weighting factors are presented in Table 293.

Table 293: Area weighted mean values of grassland biomass.

1996-2005	**area in ha (avg 10 year)**	**weighting factor**	**yield in t (avg 10 year)**	**contribution to weighted mean (t dm ha^{-1})**
one cut meadows	54 827	0.05	2.8	0.1
two and more cut	844 126	0.78	6.0	4.7
litter meadows	17 126	0.02	3.1	0.05
culture pastures	74 839	0.07	6.7	0.5
rough pastures	90 264	0.08	2.4	0.2
weighted grassland yield (t dm ha^{-1})				5.5
weighted grassland yield (t C ha^{-1})				2.8
2011-2020				
one cut meadows	31 931	0.035	3.2	0.11
two cut meadows	248 298	0.27	5.2	1.43

three and more cut meadows	494 478	0.54	7.4	4.04
litter meadows	7 053	0.01	2.8	0.02
culture pastures	72 800	0.08	6.38	0.51
rough pastures	53 619	0.06	2.74	0.16
weighted grassland yield (t dm ha-1)				6.28
weighted grassland yield (t C ha-1)				3.14

Avg weighted grassland yield (t dm ha^{-1}) for the entire time series	**5.9**
Avg weighted grassland yield (t C ha^{-1}) for the entire time series	**2.95**

In order to calculate country-specific root and stubble biomass factors, values for C-storage in stubble and root biomass in fertile meadows, rough pastures and cultivated pastures at two locations in Austria (Kienach and Puttterersee) were used (Bohner, et al., 2016). Here, too, weighting factors were determined according to the area shares of the three investigated grassland categories of the total grassland area. Based on this data, the above ground stubble biomass was determined at 0.94 t dm ha^{-1} (0.47 t C ha^{-1}) and the root biomass at 2.5 t dm ha^{-1} (1.25 t C ha^{-1}).

The total Grassland biomass of 4.67 t C ha^{-1} comprises the above ground biomass (2.95 t C ha^{-1}) plus the root biomass (1.25 t C ha^{-1}) and the stubble biomass (0.47 t C ha^{-1}).

For the calculation of the annual change in carbon stocks of living biomass of annual cropland converted to grasslands, the following equations were applied – equations 2.15 and 2.16 (IPCC 2006).

*Annual change in biomass =annual area of currently converted land * (L $_{conversion}$ + ΔC $_{growth}$)*

$L_{conversion}$ = C_{after} – C_{before}

C_{after} = carbon stock immediately after conversion is 0

ΔC_{growth} = country specific value for grassland biomass 5.70 t C ha^{-1}a^{-1}(accounted only for the year of LUC)

C_{before} = country specific value of carbon stock of annual crops before conversion is 6.67 t C ha^{-1}a^{-1}(see Chapter 6.3.4.1.2; accounted only for the year of LUC)

Changes of carbon stock in biomass of perennial cropland converted to grassland

The average area of annual land use change from perennial cropland converted to Grassland between 1990-2023 is 72 ha. The general equation and methodological approach is described above, using the same biomass stock for Grassland biomass (4.67 t C ha^{-1}) to calculate gains after conversion. The lost perennial cropland biomass due to this LUC is 6.09 t C ha^{-1} (see chapter 6.3.4.1.1):

C_{before} = country specific value (Tier 2) of biomass carbon stock of perennial crops before conversion is 6.09 t C ha^{-1}

The results in the CRT table provide the biomass carbon stock changes of annual cropland converted to grasslands and perennial cropland converted to grasslands separately, as well as the sum of these subcategories.

Changes of carbon stock in mineral soil of annual cropland converted to grassland

The area in conversion from annual cropland converted to Grassland for a time period of 20 years amounts to 27 189 ha and 74 606 ha in the years 1990 and 2023, respectively.

Emissions/removals were calculated by ecoregion-specific values for carbon stocks in mineral soils of annual cropland and Grassland (*intensive-use*). Twenty-year conversion areas per ecoregion were multiplied by ecoregion-specific carbon stock change values derived from the respective category- and ecoregion-specific soil carbon stocks for mineral soils between 0 and 50 cm depth (Table 270).

According to the 2006 IPCC GL (Equation 2.25, IPCC 2006) annual rates of carbon stock change are estimated as the difference in stocks at two points in time divided by the time dependence of the stock change factors. For each ecoregion (e.g. *Foothills*), the equation is implemented as follows:

Annual change in carbon stock of mineral soils in annual cropland converted to grassland =
$\Delta\ SOC_{20}$ ** conversion area for a transition period of 20 years*

$$\Delta\ SOC = (SOC_0 - SOC_{0\text{-}T})/20 = 0.70\ t\ C\ ha^{-1}\ a^{-1}$$

$\Delta\ SOC_{20}$ *average annual carbon stock change in soils of annual cropland converted to grassland (t C ha*$^{-1}$ *a*$^{-1}$*) over a conversion transition period of 20 years*

SOC_0 *carbon stock in soils 20 years after conversion from annual cropland to grassland (i.e. average C stock in 0–50 cm of grassland soils in e.g. the ecoregion Foothills →79 t C ha*$^{-1}$

$SOC_{0\text{-}T}$ *carbon stock in Austrian annual cropland soils before conversion (i.e. average C stock in 0 – 50 cm of annual cropland soils in e.g. the ecoregion Foothills → 65 t C ha*$^{-1}$

The above calculuation is repeated for each ecoregion (Foothills, Bohemian Massif, Inner Alps, Calcareous Alps, and Alpine Ridge) and summed to give the total change in mineral soil carbon stocks caused by annual cropland converted to Grassland.

Changes of carbon stock in mineral soil of perennial cropland converted to grassland

The area in conversion status from perennial cropland converted to Grassland for a time period of 20 years amounts to 446 ha and 2 117 ha in the years 1990 and 2023.

Emissions/removals were calculated by ecoregion-specific values for carbon stocks in mineral soils of perennial cropland and Grassland (*intensive-use*). Twenty-year conversion areas per ecoregion were multiplied by ecoregion-specific carbon stock change values derived from the respective category- and ecoregion-specific soil carbon stocks for mineral soils between 0 and 50 cm depth (Table 270).

According to the 2006 IPCC GL (Equation 2.25, IPCC 2006) annual rates of carbon stock change are estimated as the difference in stocks at two points in time divided by the time dependence of the stock change factors. For each ecoregion (e.g. *Foothills*), the equation is implemented as follows:

Annual change in carbon stock of mineral soils in perennial cropland converted to grassland =
$\Delta\ SOC_{20}$ ** conversion area for a transition period of 20 years*

$$\Delta\ SOC = (SOC_0 - SOC_{0\text{-}T})/20 = 0.40\ t\ C\ ha^{-1}\ a^{-1}$$

$\Delta\ SOC_{20}$ *average annual carbon stock change in soils of perennial cropland converted to grassland (t C ha*$^{-1}$ *a*$^{-1}$*) over a conversion transition period of 20 years*

SOC_0 *carbon stock in soils 20 years after conversion from perennial cropland to grassland (i.e. average C stock in 0–50 cm of grassland soils in e.g. the ecoregion Foothills →79 t C ha*$^{-1}$

$SOC_{0\text{-}T}$ *carbon stock in Austrian perennial cropland soils before conversion (i.e. average C stock in 0 – 50 cm of annual cropland soils in e.g. the ecoregion Foothills → 71 t C ha*$^{-1}$

The above calculuation is repeated for each ecoregion (Foothills, Bohemian Massif, Inner Alps, Calcareous Alps, and Alpine Ridge) and summed to give the total change in mineral soil carbon stocks caused by perennial cropland converted to Grassland.

The results in the CRT table provide the soil carbon stock changes of annual cropland converted to grasslands and perennial cropland converted to grasslands separately, as well as the sum of these subcategories.

6.4.5 Uncertainty Assessment

Table 294: Uncertainties of areas in the GL category.

	Before 2003	Since 2003
Total grassland	±8%	±8%
Annual LUC area CL to FL or FL to CL	see Chapter 6.2.5. Table 274	see Chapter 6.2.5. Table 274
Annual LUC area pCL to GL	±120%[1]	±40%
Annual LUC area aCL to GL	±120%[1]	±40%

[1] *For area uncertainties > 100%, distributions were truncated at 0 as negative areas are not possible*

These uncertainties were derived from the following sources:

- Total grassland: based on information from data source (Statistik Austria)
- Annual LUC area pCL to GL: expert judgement
- Annual LUC area aCL to GL: expert judgement

The uncertainties of the emission- and carbon stock change factors, as well as respective input values used to derived them, were given in the Chapters 6.2.5 and 6.3.5.

The uncertainties of the area of drained organic grassland soils and emission factors from such soils were taken from the related study (Umweltbundesamt, 2025d). The uncertainties of the area of drained organic grassland soils was defined as a triangle distribution with a minimum of 10.1 kha and a maximum of 12.7 kha. The uncertainties of the emission factors from drained organic grassland soils are ±26 % for CO_2, ±248 % for CH_4 and ±83 % for N_2O. The uncertainties for the used default emission factors for ditches were taken from the IPCC 2013 Wetland Supplement (IPCC, 2014).

The Monte Carlo simulations resulted in the following average uncertainty for the total emissions/removals of the Grassland category in the time series: ±217 kt CO_2eq. The relative uncertainties in the single years range from ±27 to ±39%.

It should be noted that the net emission/removals of the Grassland category are the result of subtractions between emissions and removals of several subcategories and pools. Only in single cases are they correlated. In line with error propagation laws the uncertainty of such net values based on subtractions of uncorrelated parameters are additive and therefore rather high in relative terms.

6.4.6 Category-specific QA/QC

The calculation of the data for category *4.C* is embedded in the overall QA/QC-system of the Austrian GHG inventory (see Chapter 6.1.4).

6.4.7 Recalculations

For area consistency reasons, a minor adjustment of the total Grassland area was carried out. The revision of the Cropland area time series, particularly pre-1990 affected both the total area of Grassland, as well as the conversions of Cropland to Grassland. The Grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes to Grassland and consequently have an impact on the results of the Grassland category. With respect to soil carbon stock changes, improvements have been made to regionalize the Cropland conversions to Grassland across five ecoregions (forest growth areas) to utilise ecoregion-specific soil carbon stocks for the pre- and post-conversion stocks. The stocks are moreover now for the depth 0-50 cm instead of the previously used 0-30 cm depth, ensuring consistency across all calculations of LUC-induced soil carbon stock changes e.g. Forest land conversions to Cropland. On basis of the organic soils study (Umweltbundesamt, 2025d), the area of drained organic soils in Grassland and the related emissions were slightly revised. These improvements caused upward revisions of the annual net emissions for the whole time series of the Grassland category in the range of +85 to +149 kt CO_2e per year compared to the last submission in 2024.

6.4.8 Planned improvements

See Chapter 6.1.8.

6.5 Wetlands (CRT Category 4.D)

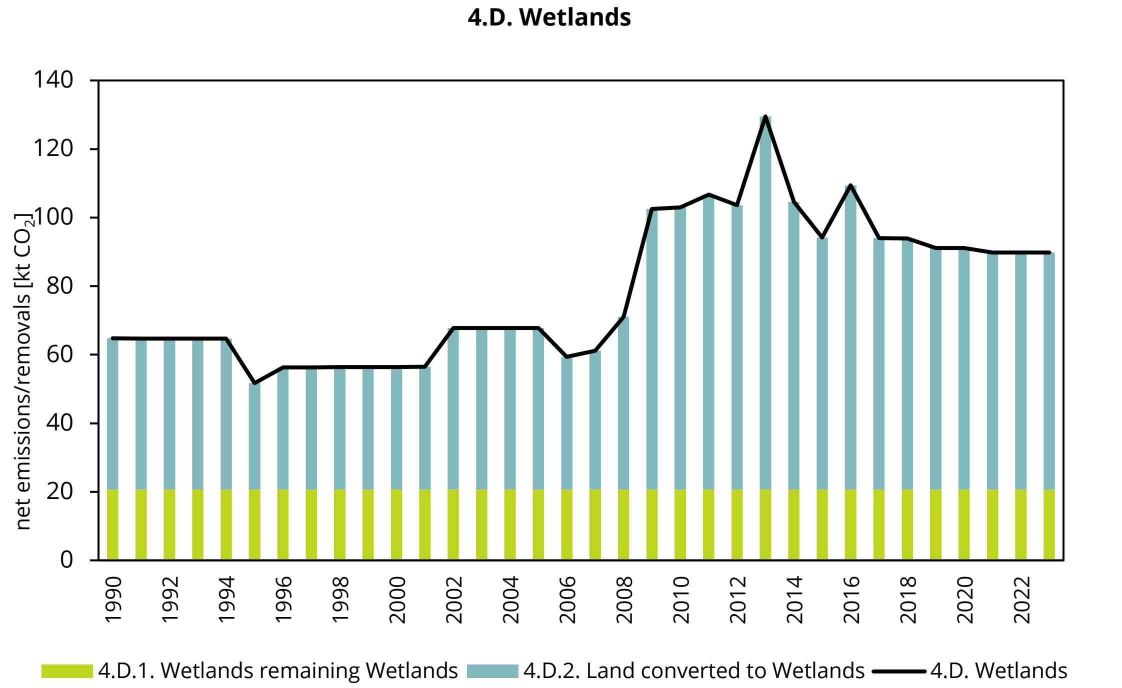
6.5.1 Category description

In this category emissions/removals from the subcategories "Wetlands remaining wetlands" and "Land converted to wetlands" are considered.

The wetland area ranges from 133 660 ha in 1990 to 154 344 ha in 2023. Along the time series a steady increase in wetland area could be observed. This increase is due to an increase in the area of water bodies whereas peatland area is assumed constant over the time series.

Emissions mainly occur in this category in case of land use changes from forestland and grassland to wetlands due to the loss of previos carbon stocks (Land converted to wetlands) and due to CO_2 emissions due to the loss of SOC in organic soils (which are accounted for in "Wetlands remaining wetlands"). Table 295 and Table 296 show the land use change and removals/emissions from LUC to wetlands from 1990–2023.

Figure 44: Emissions/removals (+/-) of wetlands (1990–2023) by wetlands remaining wetlands and land use change to wetlands in kt CO_2.



Source: Umweltbundesamt

Table 295: Total areas and land-use change areas of wetland 1990–2023 in ha.

	4.D Total wetland	**4.D.1 Wetland remaining wetland**	**4.D.2 Land converted to wetland**	**4.D.2.a Forest land converted to wetlands**	**4.D.2.b Cropland converted to wetlands**	**4.D.2.c Grassland converted to wetlands**	**4.D.2.d Settlements converted to wetlands**	**4.D.2.e Other Land converted to wetlands**
1990	133 660	124 152	9 507	1 706	NO	7 801	NO	NO
1995	135 934	121 772	14 161	1 948	NO	12 213	NO	NO
2000	139 534	120 307	19 227	1 863	NO	17 364	NO	NO
2005	143 135	121 242	21 893	1 806	NO	20 087	NO	NO
2010	146 225	123 332	22 893	1 898	NO	20 995	NO	NO
2011	147 273	124 024	23 249	2 037	NO	21 212	NO	NO
2012	148 145	124 717	23 429	2 175	NO	21 253	NO	NO
2013	150 535	125 409	25 126	2 314	NO	22 812	NO	NO
2014	151 474	126 102	25 373	2 453	NO	22 920	NO	NO
2015	151 811	126 611	25 200	2 628	NO	22 573	NO	NO
2016	153 044	127 386	25 658	2 803	NO	22 855	NO	NO
2017	153 382	128 161	25 221	2 978	NO	22 243	NO	NO
2018	153 720	128 935	24 784	3 153	NO	21 631	NO	NO
2019	153 889	129 710	24 179	3 327	NO	20 852	NO	NO

	4.D Total wetland	4.D.1 Wetland remaining wetland	4.D.2 Land converted to wetland	4.D.2.a Forest land converted to wetlands	4.D.2.b Cropland converted to wetlands	4.D.2.c Grassland converted to wetlands	4.D.2.d Settlements converted to wetlands	4.D.2.e Other Land converted to wetlands
2020	154 059	130 485	23 574	3 502	NO	20 072	NO	NO
2021	154 154	131 260	22 895	3 677	NO	19 217	NO	NO
2022	154 249	132 352	21 897	3 834	NO	18 063	NO	NO
2023	154 344	133 445	20 899	3 991	NO	16 908	NO	NO

Table 296: Emissions/removals (+/-) from wetlands in kt CO_2, CH_4 and N_2O in kt CO_2eq (1990–2023).

	4.D Total wetland_CO_2	4.D.1 Wetland remaining wetland	4.D.2 Land converted to wetland	4.D.2.a 1 Forest land converted to wetland	4.D.2.b Cropland converted to Wetland	4.D.2.c Grassland converted to wetland	4.D.2.d Settlements converted to wetland	4.D.2.e Other land converted to wetland	4(II)D1_CO_2_Drained organic soil in CO_2	4(II)D1_CH_4_Drained organic soil CH_4 in CO_2eq	4(II)D1_N_2O_Drained organic soil N_2O in CO_2eq	4(IV)D1_Biomass burning wildfires_CO_2	4(IV)D1_Biomass burning wildfires_CH_4 in CO_2eq	4(IV)D1_Biomass burning wildfire_N_2O in CO_2eq	4.D Total wetland_CO_2eq
1990	65	IE	44	29	NO	16	NO	NO	21	0.21	0.92	NA	NO	NO	66
1995	52	IE	31	18	NO	13	NO	NO	21	0.21	0.92	NA	NO	NO	53
2000	56	IE	36	18	NO	18	NO	NO	21	0.21	0.92	NA	NO	NO	58
2005	68	IE	47	24	NO	23	NO	NO	21	0.21	0.92	NA	NO	NO	69
2010	103	IE	82	67	NO	16	NO	NO	21	0.21	0.92	NA	0.01	0.01	104
2011	107	IE	86	67	NO	19	NO	NO	21	0.21	0.92	NA	0.00	0.00	108
2012	104	IE	83	67	NO	16	NO	NO	21	0.21	0.92	NA	0.01	0.00	105
2013	130	IE	109	67	NO	42	NO	NO	21	0.21	0.92	NA	NO	NO	131
2014	105	IE	84	66	NO	17	NO	NO	21	0.21	0.92	NA	0.00	0.00	106
2015	94	IE	74	66	NO	7	NO	NO	21	0.21	0.92	NA	0.00	0.00	95
2016	109	IE	89	66	NO	22	NO	NO	21	0.21	0.92	NA	0.00	0.00	111
2017	94	IE	73	66	NO	7	NO	NO	21	0.21	0.92	NA	0.01	0.01	95
2018	94	IE	73	66	NO	7	NO	NO	21	0.21	0.92	NA	0.00	0.00	95
2019	91	IE	70	66	NO	4	NO	NO	21	0.21	0.92	NA	0.00	0.00	92
2020	91	IE	70	66	NO	4	NO	NO	21	0.21	0.92	NA	0.10	0.07	92
2021	90	IE	69	66	NO	3	NO	NO	21	0.21	0.92	NA	0.00	0.00	91
2022	90	IE	69	66	NO	3	NO	NO	21	0.21	0.92	NA	0.03	0.02	91
2023	90	IE	69	66	NO	3	NO	NO	21	0.21	0.92	NA	0.15	0.11	91

6.5.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The Austrian system for land representation, in particular the methods for estimating Wetland areas, has been fundamentally improved and is now based predominantly on spatially-explicit data sources (see 6.1.3.1).

In previous submissions, the total wetland area was taken from the regional information derived from the Real Estate Database available since 1995 (BEV, 2024c). This database covers the whole area of Austria and gathers the land uses of real estate within the municipalities in digital cadastral maps. It is provided by the Austrian Federal Office of Metrology and Surveying (Bundesamt für Eich- und Vermessungswesen, BEV) and is updated annually since 2005. The change in the annual water body area pre-2005 was calculated from the mean average increase of water bodies for the periods 1971–1981, 1981–1995 and 1995–2005.

These statistics, processed in the *LU Area Statistics* element, still inform the estimates of Wetland areas and are used for extrapolating purposes. However, as part of the improved Austrian system for land representation, Wetland areas for recent years are estimated based on integrating different national sources of spatially-explicit land use data.

As part of the *LULUC Mapping* element (6.1.3.1) of the Austrian system for land representation, a spatially explicit quantification of Wetlands is derived from the best-estimate 2022 baseline status layer. By integrating multiple national layers, in particular the 2022 DKM (BEV, 2024a),the 2022 Water Body Layer (*Digitales Landschaftsmodell – Gewässer* (BEV, 2023c) and the updated Austrian Mire Conservation Catalogue (Umweltbundesamt, 2023b), a complete and spatially-explicit estimate of total Wetland area for 2022 was derived. This estimate, together with LUC estimates from the other elements then feeds into the *LULUC Data Integration* element, where the annual time series of respective land-use changes to and from Wetlands are used to extrapolate the annual Wetland area from 2022 back to 1970.

First of all, the 2022 Wetland area is extrapolated back to 2016 based on the 2017–2022 time series of all land-use changes to and from Wetlands that were quantified from the change areas between the other 2016, 2018, 2020 and 2022 LU layers. Likewise, the changes between 2020 and 2022 are used to extrapolate the Wetland areas for the years 2023 onwards. The annual total Wetland areas are further extrapolated back to 1970 using the respective statistical time series described above. This is done by seperately normalising the entire Wetland statistical time series by the respective 2016 value to create a time series of proportional area changes (relative to 2016 total areas). Mutlipying this 1970–2015 time series of relative changes by the 2016 total areas derived from the spatial datasets allows for the final time series of annual total Wetland area for 1970 onwards to be compiled.

After compiling the final time series of total Wetland area for 1970 onwards, the changes in area over time (increase) have to be balanced by respective land-use changes to and from these categories. In Austria the increase of Wetlands (rivers, standing water bodies) is mainly due to the building of water reservoirs e.g. for water power stations or quarry ponds as well as the reconstruction from natural river courses. According to expert judgment, it is considered that these activities occur primarily on grasslands and forest areas and do not affect Cropland, Settlements or Other land. Furthermore national statistics show a steady increase of settlement area and since 2000 and a general increase in other land. Thus, LUC from these categories to Wetlands are considered not occurring in Austria.

Conversions between Wetlands and Forest land are quantified by the *NFI* element (see 6.2.2.2). By accounting for these conversions, a residual net change in Wetland area (a residual increase) is calculated and this is assumed to be explained completely by Grassland conversions to Wetlands, allowing for the annual areas of this conversion category to be quantified as such. The above assumption was verified by the net conversion of Grassland to Wetland derived from analysis of the 2016, 2020 and 2022 GIS layers.

The area in conversion status of land converted to wetland for a time period of 20 years ranges from 9 507 ha to 25 658 ha for the period 1990 to 2023.

6.5.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories (e.g. land use and land-use change matrix)

The wetland area in correspondence to the LULUCF category comprises the following subcategories of the national Real Estate Database classification system:

- Rivers
- Lakes and reservoirs
- Water's edge areas

It is not possible to distinguish the areas of managed water bodies from natural lakes and rivers on basis of the used wetland area data sources. Both unmanged and managed water bodies are reported in the subcategory flooded land remaining flooded land. Organic soils of the wetlands category are reported in the subcategory "Other wetlands remaining other wetlands" and in subcategory "Peat extraction remaining peat extraction" depending if historic peat extraction occurred.

6.5.4 Methodological Issues

There are no key categories identified for the sub-categories of wetlands. Therefore, no significant pools are identified. The following table provides an overview of the methods and notation keys used.

Table 297 Overview of methods and notation keys used for the category wetlands

To	**Wetlands**					
From	living biomass	dead organic matter	mineral soil	organic soil	4(II) drained organic soils	4(IV) biomass burning
Forest land	T3	T3	NO	NO	NO	NO
Cropland	NO	NO	NO	NO	NO	NO
Grassland	T2	NO	NO	NO	NO	NO
Wetlands	NA,NO	NO,NA	NO	IE	T2	NA
Settlements	NO	NO	NO	NO	NO	NO
Other land	NO	NO	NO	NO	NO	NO

6.5.4.1 Wetlands remaining wetlands

6.5.4.1.1 Drainage of organic soils

Emissions due to historic drainage of organic soils occurs in all land use categories except other land. Emissions are included in category "4(II).D.1 Wetlands remaining wetlands". Emissions of drained organic soils are reported mainly in the category "Other wetlands remaining other wetlands". Furthermore, peat extraction occurred historically which is reported under "Peat extraction remaining peat extraction". In a dedicated project regarding extent, drainage status and resulting GHG-emissions of organic soils in Austria activity data and emission factors (Table 298) were estimated (Umweltbundesamt, 2025d). All estimates follow the guidance of chapter 2 of the 2013 Wetland Supplement (IPCC, 2014). Direct on-site emissions in the category "other wetlands" of CO_2, CH_4 and N_2O ("$CO_{2\ on\text{-}site}$," ," $EF_{CH4\_landc,n}$" and "$N_2O–N_{OS}$") are estimated based on a literature study on emission factors for Austrian conditions and constitute therefore tier 2 methodology. No specific wetland EF could be identified but grassland EF were judged as the most suitable. Off-site emissions from dissolved organic carbon (DOC) export ("$EF_{DOC\_drained}$") and CH_4 emissions from drainage ditches ("EF_{CH4_ditch}" including $Frac_{ditch}$) have a minor contribution and are therefore estimated using the default values from table 2.2 and 2.4 of the wetland supplement. Also EF from peat extraction have a minor contribution and are therefore estimated using the default values of tables 2.1, 2.4 and 2.5 of the 2013 wetland supplement. Information on AD is available in 6.1.3.1.1.

Table 298: Wetlands EF of drained organic soils

GHG	Unit	EF	95% confidence interval		Source
Other wetlands					
$CO_{2\ on\text{-}site}$	t CO_2-C ha^{-1} a^{-1}	8.63	6.35	10.91	Umweltbundesamt 2025d
$EF_{DOC\_drained}$	t C $ha^{-1}a^{-1}$	0.31	0.19	0.46	2013 Wetland Supplement, Table 2.2
$EF_{CH4\_landc,n}$	kg CH_4 ha^{-1} a^{-1}	1.57	-2.32	5.47	Umweltbundesamt 2025d
EF_{CH4_ditch}	kg CH_4 ha^{-1} a^{-1}	217	41	393	2013 Wetland Supplement, Table 2.4
$N_2O–N_{OS}$	kg N_2O-N ha^{-1} a^{-1}	3.65	0.63	6.68	Umweltbundesamt 2025d
Peat extraction					
$CO_{2\ on\text{-}site}$	t CO_2-C ha^{-1} a^{-1}	2.8	1.1	4.2	2013 Wetland Supplement, Table 2.1
$EF_{DOC\_drained}$	t C $ha^{-1}a^{-1}$	0.31	0.19	0.46	2013 Wetland Supplement, Table 2.2
$EF_{CH4\_landc,n}$	kg CH_4 ha^{-1} a^{-1}	6.1	1.6	11	2013 Wetland Supplement, Table 2.3
EF_{CH4_ditch}	kg CH_4 ha^{-1} a^{-1}	542	102	981	2013 Wetland Supplement, Table 2.4
$N_2O–N_{OS}$	kg N_2O-N ha^{-1} a^{-1}	0.3	-0.03	0.64	2013 Wetland Supplement, Table 2.5

Estimation of CO_2 emissions follows equation 2.2. The respective EFs are provided in Table 298 wheras no burning of drained organic soils is recorded to occur in Austria.

Estimation of CH_4 emissions follows equation 2.6. The respective EFs are provided in Table 298.

Estimation of N_2O emissions follows equation 2.7. The respective EF is provided in Table 298.

6.5.4.1.2 Flooded lands

Flooded Lands are defined as water bodies where human activities have caused changes in the amount of surface area covered by water (e.g. reservoirs for hydro-electricity). It is currently not possible to distinguish the areas of managed water bodies from natural lakes and rivers on basis of the used wetland area data sources. Nonetheless, this does not affect the GHG emission/removal calculations as the IPCC 2006 GL do not provide methodologies for Flooded land remaining flooded land.

6.5.4.1.3 Biomass burning

The emissions caused by biomass burning due to wildfires in the reed belts are included in category *4(IV)D.1 Wetlands remaining Wetlands*. This category is included since a major wildfire incident occurred in the reed belt of lake Neusiedlersee in 2020. Estimates of emissions of CH_4 and N_2O from this category are reported. Based on the IPCC 2006 Guidelines, equation (2.27) following a Tier 2 method was applied.

$$L_{fire}\ (t\ GHG) = A * M_B * C_f * G_{ef} * 10^{-3}$$

A area burnt (ha)
M_B mass of available fuel, t dm ha^{-1} (Table 2.4)
C_f combustion factor
G_{ef} emission factor, g kg^{-1} dm (Table 2.5)

Data on the area affected by wildfires is based on the Forest Fire Database ("Waldbrand-Datenbank Österreich") of the Institute of Silviculture, BOKU (BOKU, 2023). This database covers all wildfires and therefore also includes yearly data on reed belt burnings back to 2003. Moreover, results of a research project especially aimed at fire dynamic and emissions of air pollutants at lake Neusiedl (Project BraMaSchi) were included, in which reed biomass and combustion efficiency was studied. According to the study, the dry mass of the biomass (M_B) of reed is 20.33 t ha^{-1} and the combustion factor C_f is 0.33 (Umweltbundesamt, 2024, unpublished). The default emission factors (G_{ef}) for N_2O and CH_4 are derived from table 2.5 of the IPCC 2006 Guidelines.

The total wetland area affected by fires varies greatly from year to year, with an average for the whole time series of 54 ha. Therefore, the amounts of N_2O and CH_4 emissions caused by wildfires are negligible, with annual sum of N_2O and CH_4 emissions ranging between zero and 0.61 kt CO_2 equivalents. Due to the negligible GHG emission contribution in the years, for which the areas of such fires were recorded (since 2003), it is considered appropriate to report the emissions for the years before with "not estimated".

6.5.4.2 Land use changes to Wetlands (4.D.2)

The increase of wetland area occurs mainly due to the building of water reservoirs e.g. for water power stations or quarry ponds as well as the reconstruction from natural courses of rivers. Therefore the land-use changes to wetland occur in the subcategory land to flooded lands. Land-use changes in the other wetlands subcategories are not occurring. Chapter 0 describes the methods and spatially-explicit data used to estimate the respective land-use changes: Forest land converted to wetlands and Grassland converted to wetlands.

For lands converted Wetlands, carbon stock changes in biomass occur for conversions from Forest land and Grassland, while changes (losses) in deadwood and litter occur for conversions from Forest land only.

Since a previous review finding, mineral soil carbon stock changes due to conversions to Wetlands (i.e. flooded lands) are assumed not occuring. In submissions before 2014, Wetlands (flooded land) were assumed to have a soil C stock of zero t C ha^{-1}. Using the 2006 IPCC GL approach of calculating the C stock change over a transition period of 20 years led to unrealistic annual C stock losses in mineral soils for such conversions. Consequently, and due to a lack of information in the literature, no C-stock changes in mineral soil are assumed for land converted to Wetlands. As such, the regional split in conversion areas to Wetlands are irrelevant for this category.

6.5.4.2.1 Forest Land converted to Wetlands (4.D.2.1)

The methodology and activity data are described in Chapters 6.2.2 and 6.2.4.2.

The area in conversion from Forest land to Wetlands for a time period of 20 years ranges from 1 630 ha to 3 991 ha between the years 1990 and 2023. Due to the resulting changes in biomass and loss of forest deadwood and litter, these conversions cause annual emission rates ranging from 18 kt CO_2 to 67 kt CO_2.

For the calculation of the annual change of biomass and deadwood carbon stocks, an IPCC Tier 3 approach is used. Tier 2 is used for litter and soil carbon stock changes.

It should be noted that the areas of the annual LUCs to and from forests show stepwise changes between NFI observation periods while they remain constant within the NFI observation periods (for explanation see chapter 6.2.2.2). These stepwise LUC area changes have implications on the emissions/removals of Forest land to Wetland, which also change in a stepwise fashion for certain pools (e.g. biomass, dead wood, litter). Any interpolation across was considered unsuitable and is therefore not carried out.

6.5.4.2.2 Grassland converted to Wetland (4.D.2.3)

Changes in carbon stocks in biomass of grassland converted to wetland

For the calculation of the annual change in carbon stocks of living biomass in Grassland converted to wetlands the following equation was applied (equation 7.10 in 2006 IPCC GL)

Annual change in carbon stocks of living biomass in land converted to wetland (tonnes $C.a^{-1}$):

$$\Delta C_{LW\,flood} = (Sum\ A_i * (B_{after} - B_{before}))$$

A_i = *annual area of land currently converted to flooded land from original land use. ha*

B_{before} = *living biomass in land immediately before conversion to wetland = for grassland 4.7 t C ha.a^{-1}(see Chapter 6.4.4.2.2)*

B_{after} = *living biomass in land immediately after conversion to wetland (default = 0 t C ha.a^{-1})*

The area in conversion status from Grassland to Wetlands for a time period of 20 years ranges from 7 801 ha to 22 920 ha between the years 1990 and 2023 causing annual emission rates due to the loss of biomass from 3.0 kt CO_2 to 42.32 kt CO_2.

6.5.5 Uncertainty Assessment

The following uncertainties of the activity data were used: Annual LUC area FL to WL – see Chapter 6.2.5, Table 274; annual LUC area GL to WL: ±20%. The uncertainty of these LUCs were estimated by assessing the minimum and maximum potential of available areas that could contribute to such LUCs on basis of the area consistency with other related land use change subcategories and their uncertainties.

The uncertainties of the emission factors for the subcategories FL to WL and GL to WL are given in Chapter 6.2.5 (Table 275) and Chapter 6.3.5. (Table 287).

The uncertainties of the area of drained organic wetland soils and emission factors from such soils were taken from the related study (Umweltbundesamt, 2025d). The uncertainties of the area of drained organic wetland soils was defined as a triangle distribution with a minimum of 0.68 kha and a maximum of 0.72 kha. The uncertainties of the emission factors from drained organic wetland soils are consistent with those of drained grassland soils, because the same emission factors are used (see chapter 6.4.5). The uncertainties for the used default emission factors for ditches and peat extraction were taken from the IPCC 2013 Wetland Supplement (IPCC, 2014).

The uncertainties of the total wetland emissions/removals range between ±14 and ±51 kt CO_2eq and between ±26 and ±52% of the total category emissions in the single years. The low absolute uncertainty reflects the low LUC activity in this subcategory.

6.5.6 Category-specific QA/QC

The calculation of the data for category 4.D is embedded in the overall QA/QC-system of the Austrian GHG inventory (see Chapter 6.1.4).

6.5.7 Recalculations

For area consistency reasons a minor adjustment of the total *Wetland* area was carried out. The grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes involving *Grassland* and consequently have an impact on the results of the land-use change category *Grassland* to *Wetlands*. On basis of the national study on organic soils (Umweltbundesamt, 2025d), drained organic soils in *Wetlands* and areas of historic peat extraction were identified, for which emissions for the whole time series are estimated for the first time. Activity data for the biomass burning subcategory has been revised due to the availability of a new data source from the BraMaSchi Project. These improvements caused revisions of the annual net emissions for the whole time series of the *Wetlands* category in the range of +12 to +22 kt CO_2e per year compared to the last submission in 2024.

6.5.8 Planned improvements

There are currently no planned improvements.

6.6 Settlements (CRT Category 4.E)

6.6.1 Category description

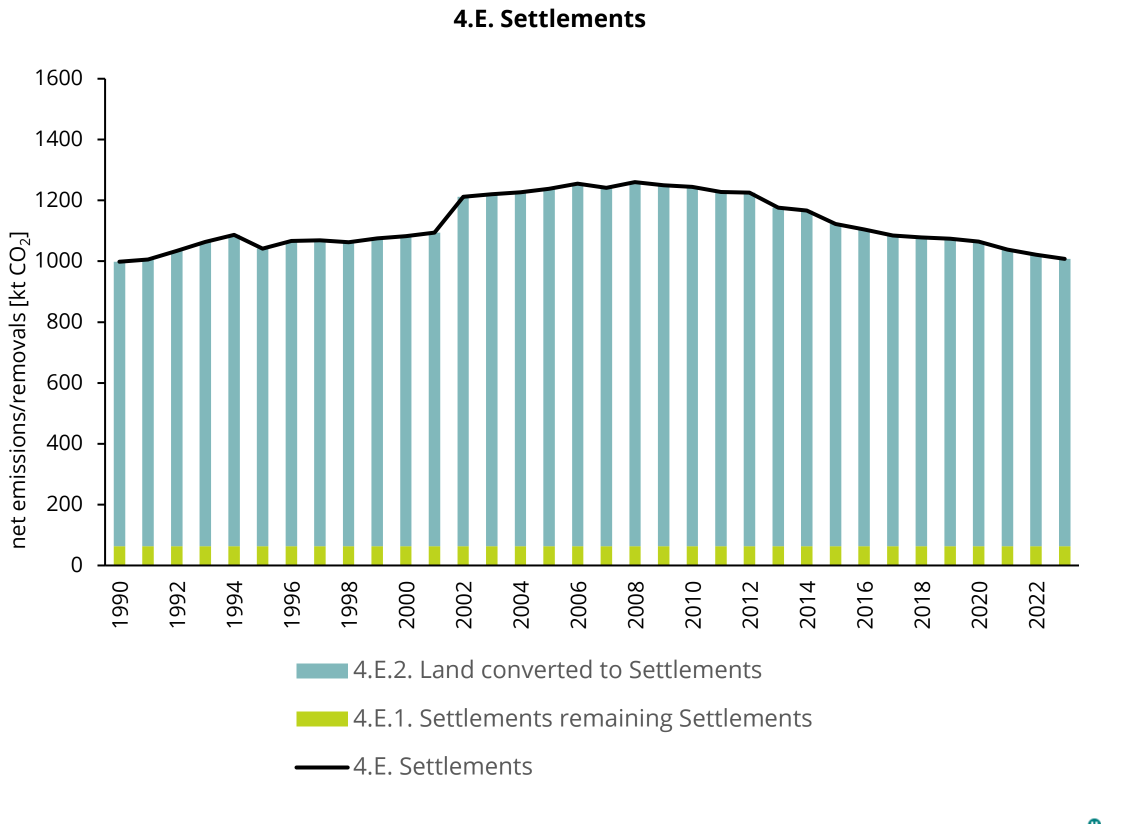
According to 2023 area estimates, about 7% (0.56 million ha) of Austria's surface can be allocated to the IPCC land use category Settlements. Along the time series a steady increase in settlement areas is observed. Previously, only emissions/removals from the subcategories Land converted to settlements were considered, assuming that the carbon pools of Settlements remaining settlements were either in equilibrium or are not occurring. However, improvements in estimation of drained organic soils with spatially-explicit data sources that overlap with the mapped Settlement area, mean that this emission source under Settlements remaining settlements is now estimated in this 2025 submission. Total GHG emissions from drained organic soils in Settlements remaining settlements are estimated at 69 kt CO_2eq per year over the time series.

The area in conversion status from Land converted to settlements for a time period of 20 years ranges from 125 557 ha to 145 929 ha between the years 1990 and 2023. Due to C stock changes in biomass, dead organic matter and soils, these conversions cause carbon dioxide net emissions ranging from 935 kt CO_2 to 1 197 kt CO_2. The conversions from Forest land and Grassland are the main sources of emissions in this subcategory.

Under Land converted to settlements, only conversions from Forest Land, Cropland and Grassland are considered to occur. The proportions of these categories vary between the years, which cause variations in the GHG emissions, implied emission factors and implied carbon stock change factors of this subcategory. Consequently, the trend in total emissions from Settlements does not strictly mirror the trend in the total settlement area.

Figure 45 and Table 300 show the land use changes and removals/emissions from LUC to settlements for the period 1990 to 2023. In total, category emissions range from 1 110 to 1 382 kt CO_2eq per year across the time series.

Figure 45: Emissions/removals (+/-) from land use changes to settlements (1990–2023) in kt CO_2.



Source: Umweltbundesamt

Table 299: Total areas and land use change areas for the subcategory settlements 4.E for the period 1990 to 2023 in ha.

	4.E Total Settlements	4.E.1. Settlements remaining settlements	4.E.2. Land converted to settlements	4.E.2.a Forest Land converted to settlements	4.E.2.b Cropland converted to settlements	4.E.2.c Grassland converted to settlements	4.E.2.d Wetland converted to settlements	4.E.2.e Other land converted to settlements
1990	359 931	217 372	142 559	9 792	114 907	17 860	NO	NO
1995	392 146	248 025	144 121	11 180	86 065	46 877	NO	NO
2000	424 361	282 385	141 977	10 689	68 692	62 595	NO	NO
2005	456 755	316 042	140 713	11 414	53 725	75 573	NO	NO
2010	493 979	349 610	144 369	10 976	49 287	84 106	NO	NO
2011	501 167	356 361	144 806	10 896	54 673	79 237	NO	NO
2012	509 041	363 112	145 929	10 816	60 992	74 120	NO	NO
2013	514 804	369 863	144 940	10 736	65 518	68 686	NO	NO
2014	520 993	376 614	144 378	10 656	70 351	63 371	NO	NO
2015	525 755	383 115	142 639	10 784	72 897	58 959	NO	NO
2016	530 063	389 616	140 446	10 912	71 671	57 863	NO	NO
2017	534 774	396 117	138 657	11 040	67 239	60 377	NO	NO

	4.E Total Settlements	4.E.1. Settlements remaining settlements	4.E.2. Land converted to settlements	4.E.2.a Forest Land converted to settlements	4.E.2.b Cropland converted to settlements	4.E.2.c Grassland converted to settlements	4.E.2.d Wetland converted to settlements	4.E.2.e Other land converted to settlements
2018	539 485	402 618	136 867	11 168	64 839	60 860	NO	NO
2019	544 327	409 119	135 208	11 296	62 426	61 486	NO	NO
2020	549 169	415 620	133 548	11 423	61 325	60 800	NO	NO
2021	552 931	422 121	130 810	11 551	60 073	59 186	NO	NO
2022	556 694	428 511	128 183	11 313	58 317	58 554	NO	NO
2023	560 457	434 900	125 557	11 075	56 264	58 218	NO	NO

Table 300: Emissions/removals (+/-) from land use changes to settlement for the period 1990 to 2023 in kt CO_2, CH_4 and N_2O emissions in CO_2eq.

	4.E Total Settlements_CO_2	4.E.1. Settlements remaining settlements	4.E.2. Land converted to settlements	4.E.2.a Forest land converted to settlements	4.E.2.b Cropland converted to settlements	4.E.2.c Grassland converted to settlements	4.E.2.d Wetland converted to settlements	4.E.2.e Other Land converted to settlements	4(II)E1_CO_2_Drained organic soils in CO_2	4(II)E1_CH_4_Drained organic soils CH_4 in CO_2eq	4(II)E1_N_2O_Drained organic soisl N_2O in CO_2eq	4(III)E2_N_2O_Direct and indirect N_2O emissions due to C losses in managed soils N_2O in CO_2eq	4.E Total Settlements_CO_2eq
1990	999	IE	935	267	518	150	NO	NO	63	3	3	106	1 110
1995	1 041	IE	978	220	388	370	NO	NO	63	3	3	112	1 159
2000	1 082	IE	1 019	216	310	493	NO	NO	63	3	3	113	1 202
2005	1 238	IE	1 175	333	256	586	NO	NO	63	3	3	115	1 359
2010	1 245	IE	1 181	258	263	660	NO	NO	63	3	3	119	1 370
2011	1 228	IE	1 165	257	299	608	NO	NO	63	3	3	119	1 353
2012	1 226	IE	1 163	257	342	564	NO	NO	63	3	3	119	1 351
2013	1 176	IE	1 112	256	336	520	NO	NO	63	3	3	117	1 299
2014	1 167	IE	1 104	255	374	474	NO	NO	63	3	3	116	1 289
2015	1 123	IE	1 059	257	356	446	NO	NO	63	3	3	113	1 242
2016	1 104	IE	1 041	259	340	442	NO	NO	63	3	3	112	1 222
2017	1 085	IE	1 021	260	275	486	NO	NO	63	3	3	111	1 202
2018	1 079	IE	1 015	262	265	488	NO	NO	63	3	3	109	1 194
2019	1 074	IE	1 011	263	255	493	NO	NO	63	3	3	108	1 189
2020	1 064	IE	1 001	264	251	486	NO	NO	63	3	3	107	1 177
2021	1 038	IE	975	266	247	463	NO	NO	63	3	3	104	1 149
2022	1 022	IE	958	263	241	454	NO	NO	63	3	3	102	1 130
2023	1 008	IE	945	261	232	452	NO	NO	63	3	3	100	1 114

6.6.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The Austrian system for land representation, in particular the methods for estimating settlement areas, was updated in the 2024 submission and has been further improved for this 2025 submission.

In previous submissions, the basis for the settlement area was the regional information derived from the Real Estate Database (BEV, 2024c). This database covers the whole area of Austria and gathers the land uses of real estate within the municipalities in digital cadastral maps. It is provided by the Austrian Federal Office of Metrology and Surveying (Bundesamt für Eich- und Vermessungswesen, BEV) and is updated since 2005 every year. Before 2005, the Real Estate Database was updated less frequently and in previous submissions respective stable mean annual increases were applied to certain parts of the time series pre-2005 to extrapolate the time series back to 1971. These spatially-explicit data source, processed in the *LU Area Statistics* element, still inform the estimates of Settlement areas and are used for extrapolating purposes. However, as part of the improved Austrian system for land representation, settlement areas for recent years are estimated based integrating different national sources of spatially-explicit land use data.

As part of the *LULUC Mapping* element (6.1.3.1) of the Austrian system for land representation, a spatially explicit quantification of Settlements is derived from the best-estimate 2022 baseline status layer. By integrating multiple national layers, in particular the 2022 DKM (BEV, 2024a), a complete and spatially-explicit estimate of total Settlement area for 2022 was derived. This estimate, together with LUC estimates from the other elements then feeds into the *LULUC Data Integration* element, where the annual time series of respective land-use changes to and from Settlements are used to extrapolate the annual Settlement area from 2022 back to 1970. Likewise, the areas for 2023 onwards are extrapolated forwards assuming the conversions between 2020 and 2022 have remained the same.

First of all, the 2022 Settlement area is extrapolated back to 2016 based on the 2017–2022 time series of all land-use changes to and from Settlements that were quantified from the change areas between the other 2016, 2018, 2020 and 2022 GIS layers. Likewise, the conversions derived from the 2020 and 2022 layers are assumed to have remained constant and are used to extrapolate settlement areas for the years 2023 onwards. The annual total area of Settlements are further extrapolated back to 1970 using the respective spatially-explicit Real Estate Database described above. This is done by seperately normalising the entire Settlement area time series by the respective 2016 value to create time series of proportional area changes (relative to 2016 total areas). Multiplying these 1970–2015 time series of relative changes by the 2016 total areas derived from the spatial datasets allows for the final time series of annual total Settlement area for 1970 onwards to be compiled.

After compiling the final time series of total settlemet area for 1970 onwards, the changes in area over time (increase) have to be balanced by respective land-use changes to and from this category. In Austria the increase in Settlement area is mainly due to conversions from agricultural land (Cropland and Grassland). Conversions between Forest land and Settlements also occur. Land use conversions to/from Settlements involving Wetlands and Other land are considered to be not occurring in Austria.

Conversions between Settlements and Forest land are quantified by the *NFI* element (see 6.2.2.2). By accounting for these conversions, a residual net change in settlement area is calculated and this is assumed to be explained completely by conversions of agricultural land to Settlements. The above assumption was verified by the net conversion of agricultural land to Settlements derived from analysis of the 2016, 2018, 2020 and 2022 LU layers. The split between conversions from Cropland and conversions from Grassland for the years 2017 onwards are based on the analysis of LUCs across the 2016, 2018, 2020 and 2022 LU layers. First the net conversions from Cropland are quantified, with the final residual net increase in Settlement area inferred as conversions from Grassland. For the years 1971-2016, the split between conversions from Cropland and conversions from Grassland are based on the net change in the Cropland area over time and the potential Cropland area available for conversion to Settlements. To estimate pre-2017 Cropland conversion to Settlements, the annual Cropland area derived from *LU Area Statistics* element is taken to derive the net annual change in Cropland area over time (see 6.3.2). After taking into account conversions to and from Forest land (*NFI* element) and conversions to and from Grassland (*IACS (CL<->GL)* element), a residual net change in Cropland remains that is quantified as Cropland conversion to Settlements. The Cropland area and net change are however first subject to iterative adjustments to ensure consistency with the 2010 and 2020 comprehesive farm structure surveys. This yields a final residual net change (decrease) in Cropland that is quantified 1:1 as Cropland conversion to Settlements. After quantifiying and accounting for Cropland conversions to Settlements, the remaining residual net change in settlement area pre-2017 is quantified as Grassland conversion to settlements. For further details on these calculation steps in the *LULUC Data Integration* element, the reader is referred to chapter 6.1.3.1 and Annex 5.2.

Finally, the total conversion areas from Cropland and Grassland to Settlements are multiplied by proportional regional splits to derive respective conversion areas per ecoregion for soil carbon stock estimates. The proportional splits for 2017 onwards are based on combining the LU 2016-2022 layers with a respective raster dataset of the BFW forest growth regions (BFW, 2024d). The proportional splits for 1971-2016 are based on an intersection of the above forest growth regions and the 1990, 2000, 2006, 2012 and 2018 EEA CLMS CORINE Land Cover status layers (EEA, 2020b). The merging of these datasets (*LULUC Mapping*) and subsequent processing (*LULUC Data Integration*) are described in further detail in chapter 6.1.3.1 and Annex 5.2.

6.6.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The settlement area in correspondence to the LULUCF category comprises the following subcategories of the national classification system:

- building land – sealed, partly sealed and unsealed area,
- parks and gardens,
- roads, railway tracks,
- industrial and business areas,
- mining areas, dumps, landfills,
- other, not further differentiated settlement area.

6.6.4 Methodological Issues

The following table provides an overview of the IPCC Tier methodology applied per category and pool in settlements, including the significant pools (in grey) for the year 2023. Land converted to Settlements is identified as key category for CO_2.

Table 301: Overview of IPCC tiers applied per pool in the settlements category. Significant pools of key categories are highlighted in grey and are based on the assessment of the year 2023

To	Settlements				
From	living biomass	dead organic matter	mineral soil	organic soil	4(II) drained organic soils
Forest land	T3	T3	T2	NO	NO
Cropland	T2	NO	T2	NO	NO
Grassland	T2	NO	T2	NO	NO
Wetlands	NO	NO	NO	NO	NO
Settlements	NA	NO	NA	IE	T2
Other land	NO	NO	NO	NO	NO

6.6.4.1 Settlements remaining settlements (4.E.1)

6.6.4.1.1 Drainage of organic soils

Emissions due to historic drainage of organic soils occurs in all land use categories except other land. CO_2 , CH_4 and N_2O emissions are included in category "4(II).E.1 Settlements remaining settlements". In a dedicated project regarding extent, drainage status and resulting GHG-emissions of organic soils in Austria activity data and emission factors (Table 302) were estimated (Umweltbundesamt, 2025d). All estimates follow the guidance of chapter 2 of the 2013 Wetland Supplement (IPCC, 2014). Direct on-site emissions of CO_2, CH_4 and N_2O ("$CO_{2\ on\text{-}site}$," ," $EF_{CH4\_landc,n}$" and "$N_2O–N_{OS}$") are estimated based on a literature study on emission factors for Austrian conditions and constitute therefore tier 2 methodology. Off-site emissions from dissolved organic carbon (DOC) export("$EF_{DOC\_drained}$") and CH_4 emissions from drainage ditches ("EF_{CH4_ditch}" including $Frac_{ditch}$) have a minor contribution and are therefore estimated using the default values from table 2.2 and 2.4 of the wetland supplement. Information on AD is available in 6.1.3.1.1.

Table 302: Settlement EF of drained organic soils

GHG	Unit	EF	95% confidence interval		Source
$CO_{2\ on\text{-}site}$	$t\ CO_2\text{-}C\ ha^{-1}\ a^{-1}$	8.63	6.35	10.91	(Umweltbundesamt, 2025d)
$EF_{DOC\_drained}$	$t\ C\ ha^{-1}a^{-1}$	0.31	0.19	0.46	2013 Wetland Supplement, Table 2.2
$EF_{CH4\_landc,n}$	$kg\ CH_4\ ha^{-1}\ a^{-1}$	1.57	-2.32	5.47	(Umweltbundesamt, 2025d)
EF_{CH4_ditch}	$kg\ CH_4\ ha^{-1}\ a^{-1}$	1165	335	1995	2013 Wetland Supplement, Table 2.4
$N_2O–N_{OS}$	$kg\ N_2O\text{-}N\ ha^{-1}\ a^{-1}$	3.65	0.63	6.68	(Umweltbundesamt, 2025d)

Estimation of CO_2 emissions follows equation 2.2. The respective EFs are provided in Table 302 wheras no burning of drained organic soils is recorded to occur in Austria.

Estimation of CH_4 emissions follows equation 2.6. The respective EFs are provided in Table 302.

Estimation of N_2O emissions follows equation 2.7. The respective EF is provided in Table 302.

6.6.4.2 Land use changes to settlement (4.E.2)

6.6.4.2.1 Biomass

Estimates for living biomass in settlement areas have been revised for this submission based on the results of a study carried out in 2023 in order to apply the Tier 2a method (eq. 8.2, 2006 IPCC Guidelines). In this study, the share of the crown cover of different vegetation classes was estimated for the settlement area in Austria by using the national, remote sensing dataset "BEV Land Cover" (BEV, 2023b). The dataset identifies six land cover classes in settlements based on an automated evaluation of orthophotos and air-borne laser scanning datasets (high vegetation/trees, bare soil/sealed soil, shrubs, buildings, water bodies and low vegetation). The following three vegetation classes were relevant for this analysis: trees (>5m height), shrubs (2–5m height) and low vegetation (<2m height). In addition, the national soil sealing layer 2022, which was prepared for the national land utilisation monitoring system (ÖROK, 2023) and provides information on the sealed areas in Settlements, was used to estimate the area of unsealed/sealed soil below the crown cover. With these data sources, a GIS-based analysis was conducted to obtain the crown cover shares of trees, shrubs and low vegetation in settlements (see Table 303).

In the same study, new emission factors for trees based on the analysis of tree cadastres of seven cities in Austria were developed. The following parameters were collected from the cadastres: Tree species, crown diameter, stem circumfence, tree height, number of trees and tree age. Based on the stem circumfence and the height, the stem volume was calculated with the form factors of (Pollanschütz, 1974). The branch and below-ground biomass was calculated by using the same expansion factors as for the biomass calculations of Forest land (see Table 263:). To obtain the carbon content, the biomass was multiplied with specific carbon contents: 0.48 for deciduous and 0.5 for coniferous trees). Finallly, a weighted average tree biomass carbon stock per hectare crown cover was calculated (see Table 303).

The calculation of the C accumulation rate was derived from the age-related linear increases in stem circumfence and height of the trees in the dataset. With these linear correlations, it was possible to obtain species-specific growth factors and apply them to all tree compartments. As a next step, the average growth rates per tree species were calculated. The crown cover area-based growth rates for tree species were then weighted by the species contribution to total urban crown cover to derive a representative, average carbon increment in tons per hectare crown cover (see Table 303).

Most trees in Settlements are first cultured in tree nurseries until they reach a certain size before they are planted. Therefore we determined the average size of newly planted trees based on the information from the tree cadastres and assumed that this amount of carbon was accumulated in a tree nursery which is considered in the perennial cropland subcategory. The average carbon stock of a newly planted tree amounts to 24.25 t C per ha crown cover. To avoid double counting, only the difference between this carbon stock at the time of plantation and the average biomass carbon stock in Settlements can be accounted for in the Settlements category. Therefore, when a land is converted to settlement, the trees accumulate carbon for 15 years to reach the average carbon stock with the calculated average increment rate.

For shrubs and low vegetation, the previously used study on the total living biomass for different ecological sub-systems in Vienna (Dörflinger, et al., 1995) was expanded upon by reviewing addtitional publications (Dörflinger, et al., 1996, Maier, et al., 1996). These studies complemented the existing information with additional area data on the different sub-systems. With these data it was possible to calculate the weighted average carbon stocks for shrubs and low vergetation per hectar crown cover/land cover of these vegetation types. For shrubs, it is assumed that it takes 20 years until the average, equilibrium carbon stock is reached (see Table 303). For low vegetation it is assumed that the average carbon stock is reached in the year of land use change and stays in equilibrium afterwards.

Table 303: Overview of emission factors and parameters used to calculate carbon stock changes for land converted to settlements.

	Trees	Shrubs	Low vegetation
Average carbon stock per area of crown cover (t C/ha crown cover)	65 t C/ha	30 t C/ha	6.7 t C/ha
Crown/land cover in settlements in 2022 (%)	11.4 %	3.3 %	42.1 %
Carbon accumulation time until average C stock is reached (years)	15 years	20 years	1 year
Annual carbon accumulation per area of crown cover (t C/ha/yr)	2.8 t C/ha/J	1.6 t C/ha/J	C accumulation only in the year of land use change
Annual carbon accumulation per area of settlement (t C/ha/yr)	0.32 t C/ha/J	0.052 t C/ha/J	2.82 t C/ha (= average C stock / area of settlement)

6.6.4.2.2 Litter and soil

For the calculation of the annual changes of carbon stocks in mineral soils of lands converted to settlement, the IPCC approach of 20 years discounting of soil C stock changes is used in combination with country-specific soil data. Areas with dead wood and litter stock losses (i.e. conversions from Forest land) and subsequent emissions are assumed to occur in the year of LUC.

The calculations of emissions from litter and mineral soils due to land use changes from forests to settlement are based on regionally stratified carbon stocks in litter and mineral soils of Forest land (see Chapter 6.2.4.2). These C stocks refer to a mineral soil depth of 0 to 50 cm. The carbon stock of the mineral soils in Settlements (when converted from or to forest) have been updated with the new sealing ratio as well. The share of sealed area was updated in this submission based on aforementioned BEV Land Cover dataset and the updated national soil monitoring data (ÖROK, 2023) which introduces a new data source and method to determine the share of sealed areas in the Settlements. Based on this assessment, the share of sealed areas in Settlements was estimated at 52.5% in 2022. As this assessment was only carried out for one single year so far, this value was applied over the whole time series. It is however foreseen, to investigate if the new method can be harmonised with the historical evaluation method to create a time series to estimate if the sealing fraction changes over time.

By expert judgement the carbon stocks on unsealed areas of settlement is estimated to be as high as in intensively managed grassland soils, which for a 0-50 cm depth and depending on the ecoregion have an average stock ranging from 75 to 100 t C ha^{-1}. Applying the above sealing fraction yields average settlement mineral soil carbon stocks ranging from 36 t C ha^{-1} in the Bohemian Massif to 47 t C ha^{-1} in the Calcareous Alps (Table 270).

6.6.4.2.3 Forest Land converted to Settlement (4.E.2.1)

The methodology and activity data are described in Chapters 6.2.2 and 6.2.4.2. The area in conversion status from Forest Land to Settlement for a time period of 20 years ranges from 9 792 ha to 11 565 ha between the years 1990 and 2023, causing annual emission rates from 215 kt CO_2 to 334 kt CO_2 due to the carbon losses from the biomass-, dead organic matter- and soil pools .

It should be noted that the areas of the annual LUCs to and from forests show stepwise changes between NFI observations while they remaining constant within each the NFI observation period (for explanation see chapter 6.2.2.2). These stepwise LUC area changes have implications on the emissions/removals of Forest land converted to settlements which also change in a stepwise fashion for certain pools (e.g. biomass, dead wood, litter). Any interpolation was considered unsuitable and is therefore not applied.

Changes in carbon stocks in biomass of forest land converted to settlement

The annual net emission rates due to loss of forest biomass and increase of settlement biomass range from 72 to 149 kt CO_2 in the years 1990 to 2023.

Changes in carbon stocks in dead organic matter and mineral soils of forest land converted to settlement

Loss of deadwood is estimated based on NFI measurements at deforestation areas. For the calculation of the annual change of carbon stocks in forest litter and mineral soils converted to Settlements, the IPCC Tier 2 approach is used. Emissions/removals were calculated by country-specific values for carbon stocks stratified according to five forest growth regions. The stratified LUC areas and C stocks according to these growth regions were used for the estimates. As mentioned above, both pre-conversion Forest land and post-conversion soil carbon stocks of Settlements are now stratified. The method is described in Chapter 6.2.4.2.

The annual emission rates due to C stock changes in dead organic matter range from 32 to 66 kt CO_2 in the years 1990–2023.

The annual emission rates due to C stock changes in mineral soil range from 101 to 121 kt CO_2 in the years 1990–2023.

6.6.4.2.4 Cropland converted to Settlement (4.E.2.2)

The area in conversion status from cropland to settlement for a time period of 20 years ranges from 47 158 to 114 907 ha in the years 1990–2023. In the years 1990 to 2023 net emissions range from 209 to 518 kt CO_2. Due to the methodological changes affecting the split between Cropland

and Grassland conversions to Settlements, as well as use of ecoregion-specific land-use change areas and mineral soil carbon stocks, the subcategory emissions differ substantially from the previous submission.

Changes in carbon stocks in biomass of cropland converted to settlement

For the calculation of the annual change in carbon stocks of living biomass in Cropland converted to settlement the IPCC Tier 2 approach is used. The method follows the approaches as described in Chapters 6.3.4.2.2 and 6.4.4.2.2 with the use of country-specific biomass data for annual cropland and settlements as described in Chapter 6.6.4.2.1. The average biomass stock for annual cropland biomass is higher than the average biomass stock of perennial cropland biomass (see Chapter 6.6.4.2.1). The share of annual cropland and perennial cropland which are converted to settlements is not known, but the use of the annual cropland biomass as loss due to LUCs from cropland to settlement represents a conservative estimate. The annual carbon stock gains of perennial plants, particularly trees, in the settlement areas are now estimated with a more refined method as described in Chapter 6.6.4.2.1.

Changes in carbon stocks in soil of cropland converted to settlement

As mentioned above, both pre-conversion Cropland and post-conversion soil carbon stocks of Settlements are now stratified.

Emissions/removals were calculated by ecoregion-specific values for carbon stocks in mineral soils of Cropland (annual cropland) and Settlements. Twenty-year conversion areas per ecoregion were multiplied by ecoregion-specific carbon stock change values derived from the respective category- and ecoregion-specific soil carbon stocks for mineral soils between 0 and 50 cm depth (Table 270).

According to the 2006 IPCC GL (Equation 2.25, IPCC 2006) annual rates of carbon stock change are estimated as the difference in stocks at two points in time divided by the time dependence of the stock change factors. For each ecoregion (e.g. *Foothills*), the equation is implemented as follows:

Annual change in carbon stock of mineral soils in Cropland converted to Settlements =
*$\Delta\ SOC_{20}$ * conversion area for a transition period of 20 years*

$$\Delta\ SOC = (SOC_0 - SOC_{0-T})/20 = -1.40\ t\ C\ ha^{-1}\ a^{-1}$$

$\Delta\ SOC_{20}$ average annual carbon stock change in soils of Cropland converted to Settlements (t C ha^{-1} a^{-1}) over a conversion transition period of 20 years

SOC_0 carbon stock in soils 20 years after conversion from Cropland (annual cropland) to Settlements (i.e. average C stock in 0–50 cm of Settlement soils in e.g. the ecoregion Foothills →37 t C ha^{-1}

SOC_{0-T} carbon stock in Austrian Cropland (annual cropland) soils before conversion (i.e. average C stock in 0 – 50 cm of annual cropland soils in e.g. the ecoregion Foothills → 65 t C ha^{-1}

The above calculuation is repeated for each ecoregion (Foothills, Bohemian Massif, Inner Alps, Calcareous Alps, and Alpine Ridge) and summed to give the total change in mineral soil carbon stocks caused by Cropland converted to Settlements.

Soil represents a source of net emissions during conversion of Cropland to Settlements (ranging from 243 to 589 kt CO_2).

6.6.4.2.5 Grassland converted to Settlement (4.E.2.3)

The area in conversion from grassland to settlement for a time period of 20 years ranges from 17 860 to 84 358 ha in the years 1990–2023 resulting in annual emission rates due to C stock changes of biomass and soils from 150 kt CO_2 to 670 kt CO_2. Due to the methodological changes affecting the split between Cropland and Grassland conversions to Settlements, as well as use of ecoregion-specific land-use change areas and mineral soil carbon stocks, the subcategory emissions differ substantially from the previous submission.

Changes in carbon stocks in biomass of grassland converted to settlement

For the calculation of the annual change in carbon stocks of living biomass in grassland converted to settlement the IPCC Tier 2 approach is used. The method is the same as described in the Chapters 6.3.4.2.2 and 6.4.4.2.2 with country specific biomass data for grasslands and settlements (see Chapter 6.6.4.2.1).

In the years 1990–2023 the annual net removals/emissions range from -70 to +10 kt CO_2.

Changes in carbon stocks in soils of grassland converted to settlement

As mentioned above, both pre-conversion Grassland and post-conversion soil carbon stocks of Settlements are now stratified.

Emissions/removals were calculated by ecoregion-specific values for carbon stocks in mineral soils of Grassland (intensive-use) and Settlements. Twenty-year conversion areas per ecoregion were multiplied by ecoregion-specific carbon stock change values derived from the respective category- and ecoregion-specific soil carbon stocks for mineral soils between 0 and 50 cm depth (Table 270).

According to the 2006 IPCC GL (Equation 2.25, IPCC 2006) annual rates of carbon stock change are estimated as the difference in stocks at two points in time divided by the time dependence of the stock change factors. For each ecoregion (e.g. *Foothills*), the equation is implemented as follows:

Annual change in carbon stock of mineral soils in Grassland converted to Settlements =
*ΔSOC_{20} * conversion area for a transition period of 20 years*

$$\Delta SOC = (SOC_0 - SOC_{0-T})/20 = -2.10\ t\ C\ ha^{-1}\ a^{-1}$$

ΔSOC_{20} — *average annual carbon stock change in soils of Grassland converted to Settlements (t C ha^{-1} a^{-1}) over a conversion transition period of 20 years*

SOC_0 — *carbon stock in soils 20 years after conversion from Cropland (annual cropland) to Settlements (i.e. average C stock in 0–50 cm of Settlement soils in e.g. the ecoregion Foothills →37 t C ha^{-1}*

SOC_{0-T} — *carbon stock in Austrian Grassland (intensive-use) soils before conversion (i.e. average C stock in 0 – 50 cm of Grassland (intensive-use) soils in e.g. the ecoregion Foothills → 79 t C ha^{-1}*

The above calculuation is repeated for each ecoregion (Foothills, Bohemian Massif, Inner Alps, Calcareous Alps, and Alpine Ridge) and summed to give the total change in mineral soil carbon stocks caused by Grassland converted to Settlements.

The annual emission rate due to loss of soil carbon ranges from 153 to 722 kt CO_2 in the years 1990–2023.

6.6.4.2.6 Direct and indirect N_2O emissions from N mineralization/immobilization associated with loss of soil organic matter in mineral soils resulting from land use changes to settlements (4(III))

These emissions were calculated for conversions to Settlements from Forest land, Cropland and Grassland because of related C losses in mineral soils. According to the key category analysis, N_2O emissions in the LULUCF sector are a key category. To estimate the associated N_2O emissions the tier 2 method as provided in the IPCC 2006 GL is applied (Eq.11.1).

To calculate the net annual amount of N mineralized (F_{SOM}, eq. 11.8) from the net carbon stock change (CSC) due to the land use change in the mineral soil, the CSC was divided by the country-specific, and land-use specific C/N ratios:

- for forest soils: 19 (source: BFW 1992),
- for cropland soils: 9 (source: GERZABEK et al, 2003)
- for grassland soils: 12 (source: see footnote 102).

Then the amount of N was multiplied by the default emission factor (EF_1) from Table11.1 in the IPCC 2006 GL. Then the result was converted from the amount of annual direct N_2O-N to N_2O emissions.

In addition to the direct N_2O emissions from managed soils, related indirect emissions also occur. The IPCC 2006 Guidelines provide the following tier 2 methodology in Chapter 11 (eq. 11.10). For $Frac_{LEACH}$ we use a country-specific factor of 0.15154 (Eder, et al., 2015) and for EF_5 we use the value provided in Table 11.3 of the IPCC 2006 Guidelines.

6.6.5 Uncertainty Assessment

The following uncertainties of the input data were used:

For the annual LUC area FL to SL see Chapter 6.2.5., Table 274. For the area of LUC from CL to SL and GL to SL an uncertainty of ±60% was assumed.

The uncertainties of the emission factors were given in the Chapter 6.2.5. (Table 275) and Chapter 6.3.5. (Table 287). For the settlement biomass growth rates ±75% based on expert judgement were used.

The uncertainties of the area of drained organic settlement soils and emission factors from such soils were taken from the related study (Umweltbundesamt, 2025d). The uncertainties of the area of drained organic settlement soils was defined as a triangle distribution with a minimum of 1.7 kha and a maximum of 2.2 kha. The uncertainties of the emission factors from drained organic wetland soils are consistent with those of drained grassland soils, because the same emission factors are used (see chapter 6.4.5). The uncertainties for the used default emission factors for ditches were taken from the IPCC 2013 Wetland Supplement (IPCC, 2014).

The uncertainty of the totals of the emissions/removals of the settlement category across the time series ranges from ±508 kt CO_2 to ±750 kt CO_2eq. With these values, the Settlement category contributes (after the forest land category and HWPs) the third highest share to the uncertainty of the total emissions/removals of the total LULUCF sector. Expressed in % of the total emissions of the settlement category, the uncertainty lies between ±42 and ±68% depending on the magnitude of the net emissions in the single years.

6.6.6 Category-specific QA/QC

The calculation of the data for category *4.E* is embedded in the overall QA/QC-system of the Austrian GHG inventory (see Chapter 6.1.4).

6.6.7 Recalculations

Since the last submission, the split of agricultural conversions to Settlements between Cropland and Grassland has been revised. For the years 2017 onwards the conversions of Cropland and Grassland to Settlements are now based directly on the spatial analysis of the 2016-2022 LU layers instead of being inferred from the Cropland statistics. Conversions from Cropland to Settlements for the years pre-2017 remain based on the inference from Cropland statistics; however, here also imporvements have been made to ensure consistency with the comprehensive Farm Structure Survey estimates (e.g. 2010 and 2020) and also correct an error affecting the pre-1990 time series. The above improvements affect both Cropland converted to Settlements and Grassland converted to Settlements. Furthermore, the Grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes involving Grassland and consequently have an impact on the results of the land-use change category Grassland to Settlement. With respect to soil carbon stock changes, improvements have been made to regionalize the Cropland and Grassland conversions to Settlements across five ecoregions (forest growth areas) to utilise ecoregion-specific soil carbon stocks for the pre- and post-conversion stocks. The stocks are moreover now for the depth 0-50 cm instead of the previously used 0-30 cm depth, ensuring consistency across all calculations of LUC-induced soil carbon stock changes e.g. Forest land conversions to Settlements. Forest land conversions to Settlements previously used 0-50 cm stocks and pre-conversion stocks stratified across the five ecoregions. Also here the methodology has been improved, implementing also post-conversion Settlement soil carbon stocks that are stratified too. Finally, on basis of a national study on organic soils, drained organic soils in Settlement were identified, for which emissions for the whole time series are estimated for the first time. These improvements caused upward revisions of the annual net emissions for the whole time series of the Settlement category in the range of 106 to 352 kt CO_2eq per year compared to the last submission in 2024.

6.6.8 Planned improvements

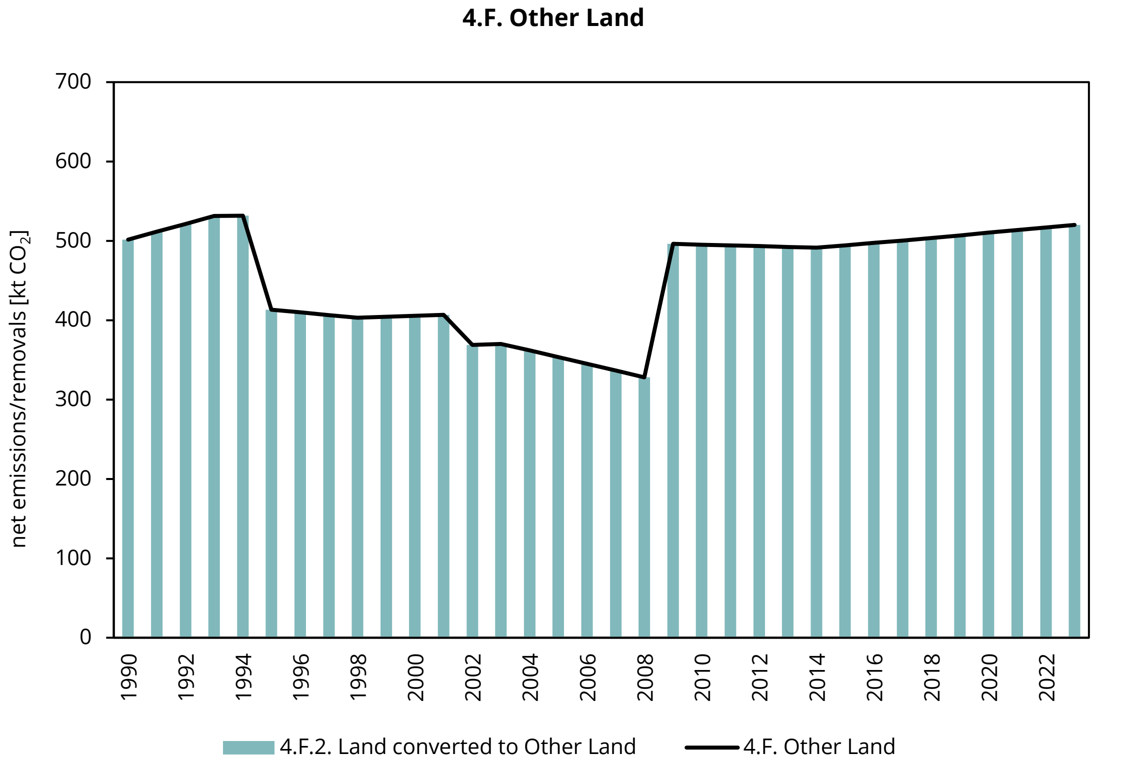
See Chapter 6.1.8.

6.7 Other Land (CRT Category 4.F)

6.7.1 Category description

Other land is a source of net GHG emissions due to conversions of Forest land to Other land. Over the 1990 to 2023 time series, annual Other land GHG emissions range from 339 to 546 kt CO_2e.

Figure 46: Emissions/removals (+/-) from land use changes to Other Land (1990–2023) in kt CO_2



Source: Umweltbundesamt

Table 304: Total areas and land-use change areas for the subcategory Other Land 4.F for the period 1990 to 2023 in ha.

	4.F Total Other Land	4.F.1. Other Land remaining other Land	4.F.2. Land converted to other Land	4.F.2.a Forest Land converted to other Land	4.F.2.b Cropland converted to other Land	4.F.2.c Grassland converted to other Land	4.F.2.d Wetland converted to ether Land	4.F.2.e Settlement converted to other Land
1990	687 093	668 959	18 134	18 134	NO	NO	NO	NO
1995	680 605	659 901	20 704	20 704	NO	NO	NO	NO
2000	675 790	655 994	19 796	19 796	NO	NO	NO	NO
2005	667 559	649 649	17 910	17 910	NO	NO	NO	NO

	4.F Total Other Land	4.F.1. Other Land remaining other Land	4.F.2. Land converted to other Land	4.F.2.a Forest Land converted to other Land	4.F.2.b Cropland converted to other Land	4.F.2.c Grassland converted to other Land	4.F.2.d Wetland converted to ether Land	4.F.2.e Settlement converted to other Land
2010	660 428	645 332	15 096	15 096	NO	NO	NO	NO
2011	659 589	644 431	15 158	15 158	NO	NO	NO	NO
2012	658 749	643 529	15 220	15 220	NO	NO	NO	NO
2013	657 910	642 628	15 282	15 282	NO	NO	NO	NO
2014	657 070	641 727	15 344	15 344	NO	NO	NO	NO
2015	656 231	640 440	15 791	15 791	NO	NO	NO	NO
2016	655 391	639 154	16 237	16 237	NO	NO	NO	NO
2017	654 552	637 867	16 684	16 684	NO	NO	NO	NO
2018	653 712	636 581	17 131	17 131	NO	NO	NO	NO
2019	652 873	635 295	17 578	17 578	NO	NO	NO	NO
2020	652 033	634 008	18 025	18 025	NO	NO	NO	NO
2021	651 194	632 722	18 472	18 472	NO	NO	NO	NO
2022	650 354	631 307	19 047	19 047	NO	NO	NO	NO
2023	649 514	629 891	19 623	19 623	NO	NO	NO	NO

Table 305: Emissions/removals (+/-) from land use changes to Other Land for the period 1990 to 2023 in kt CO_2, N_2O in kt CO_2eq.

	4.F Total Other land_CO_2	4.F.2. Land converted to other land	4.F.2.a Forest land converted to other land	4.F.2.b Cropland converted to other land	4.F.2.c Grassland converted to other land	4.F.2.d Wetland converted to other land	4.F.2.e Other Land converted to other land	4(III)F2_Direct and indirect N_2O emissions due to C losses in managed soils_N_2O in CO_2eq	4.F Total Other land_CO_2eq
1990	502	502	502	NO	NO	NO	NO	13	514
1995	413	413	413	NO	NO	NO	NO	14	428
2000	406	406	406	NO	NO	NO	NO	14	419
2005	353	353	353	NO	NO	NO	NO	13	366
2010	495	495	495	NO	NO	NO	NO	11	506
2011	494	494	494	NO	NO	NO	NO	11	505
2012	493	493	493	NO	NO	NO	NO	11	504
2013	492	492	492	NO	NO	NO	NO	11	503
2014	491	491	491	NO	NO	NO	NO	11	502
2015	494	494	494	NO	NO	NO	NO	11	505

	4.F Total Other land_CO_2	4.F.2. Land converted to other land	4.F.2.a Forest land converted to other land	4.F.2.b Cropland converted to other land	4.F.2.c Grassland converted to other land	4.F.2.d Wetland converted to other land	4.F.2.e Other Land converted to other land	4(III)F2_Direct and indirect N_2O emissions due to C losses in managed soils_N_2O in CO_2eq	4.F Total Other land_CO_2eq
2016	497	497	497	NO	NO	NO	NO	11	509
2017	501	501	501	NO	NO	NO	NO	11	512
2018	504	504	504	NO	NO	NO	NO	12	515
2019	507	507	507	NO	NO	NO	NO	12	519
2020	510	510	510	NO	NO	NO	NO	12	522
2021	514	514	514	NO	NO	NO	NO	12	526
2022	517	517	517	NO	NO	NO	NO	13	530
2023	520	520	520	NO	NO	NO	NO	13	533

6.7.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The total area of this category is estimated in accordance to the 2006 IPCC Guidelines to avoid double accounting or omission of area. Other land is quantified as the difference between the total area of the Austrian territory and the total estimated area of the previous five land use categories – Forest land, Cropland, Grassland, Wetlands and Settlements. Substantial improvements in the Austrian system for land representation (see 6.1.3.1), has thus led to revisions in the total Other land area; however, these improvements have not affected conversions from Forest land to Other land – the only subcategory causing carbon stock changes and emissions in Other land.

The Real Estate Database (BEV, 2024c) of Austria allows an assessment of the area of the category "Other land". This database covers the whole area of Austria and gathers the land uses of real estate within the municipalities in digital cadastral maps. It is provided by the Austrian Federal Office of Metrology and Surveying (Bundesamt für Eich- und Vermessungswesen, BEV) and is updated since 2005 every year. Before 2005, the Real Estate Database was updated less frequently and in previous submissions respective stable mean annual increases were applied to certain parts of the time series pre-2005 to extrapolate the time series back to 1971.

These statistics are processed in the *LU Statistics* element and feed into the *LULUC Data Integration* element for comparison purposes. For example,if the previous five land use category areas were summed together with the Other land areas according to the Real Estate Database, the resulting sum of annual areas of all land use categories would be 0.8% lower- to 0.1% higher than the total territorial area of Austria. From these small differences, we assume that the Austrian system for land representation gives an accurate picture of how the total Austrian area is distributed between the land use categories over time.

Only conversions from Forest land to Other land are considered to occur in Austria. These assumptions are base on the location for some parts of Forest land in extreme ecological conditions. Any change from other categories to other land would be geographically and/or rationally non-plausible (e.g. any reconversion of wetlands and settlements to other land is unlikely due to the steady increase of wetlands and settlements and the missing incentives for such conversions; Cropland occurs only in ecologically favorable conditions).

Conversions between Other land and Forest land are quantified by the *NFI* element (see 6.2.2.2) of the Austrian system for land representation.

6.7.3 Land-use definitions and the classification systems used and their correspondence to the LULUCF categories

The other land area is defined in correspondence to the LULUCF category and contains the following subcategories of the national classification system:

- rocks and screes,
- glaciers,
- unmanaged alpine dwarf shrub heaths.

6.7.4 Methodological Issues

The following table provides an overview of the IPCC Tier methodology applied per category and pool in other land, including the significant pools (in grey) for the year 2023. Land converted to Other land is identified as key category for CO2.Table 306 Overview of IPCC tiers applied per pool in the other land category. Significant pools of key categories are highlighted in grey and are based on the assessment of the year 2023.

Table 307: Overview of the IPCC Tier methodology applied per category and pool in other land

To	**Other land**			
From	living biomass	dead organic matter	mineral soil	organic soil
Forest land	T3	T3	T2	NO
Cropland	NO	NO	NO	NO
Grassland	NO	NO	NO	NO
Wetlands	NO	NO	NO	NO
Settlements	NO	NO	NO	NO
Other land	NA	NA	NA	NA

6.7.4.1 Land use changes to other land

6.7.4.1.1 Forest Land converted to Other Land (4.F.2.1)

The methodology and activity data are described in Chapters 6.2.2 and 6.2.4.2. The area in conversion from Forest land to Other land for a time period of 20 years ranges from 15 035 ha to 21 066 ha in the years 1990 to 2023 causing annual emission rates due to the loss of biomass and C stock changes in soil and litter from 328 kt CO_2 to 532 kt CO_2.

It should be noted that the areas of the annual LUCs to and from forests show stepwise changes between NFI observation periods while they remain constant within the NFI observation periods themselves (for explanation see chapter 6.2.2.2). These stepwise LUC area changes have implications on the emissions/removals of FL to OL which – as a consequence - also change stepwise for certain pools (e.g. biomass, dead wood, litter). Any interpolation across these steps was considered unsuitable and is therefore not carried out.

Changes in carbon stocks in biomass of forest land converted to other land

For the calculation of the annual change in carbon stocks of living biomass of forest land converted to other land the IPCC Tier 3 approach is used (see Chapter 6.2.4.2).

The annual net emission rates due to the loss of biomass on areas of land use change from forest land to other land range from 109 to 228 kt CO_2 in the years 1990–2023.

Changes in carbon stocks in dead organic matter and mineral soils of forest land converted to other land

Loss of deadwood is estimated on the basis of NFI measurements at deforestation areas.

For the calculation of the annual change of carbon stocks in forest litter and mineral soils converted to soils of Other land the IPCC Tier 2 approach is used. Emissions/removals were calculated by country specific values for carbon stocks stratified according to five forest growth regions. The stratified LUC areas and C stocks according to these growth regions were used for the estimates. The methods are described in Chapter 6.2.4.2.

The annual emission rates in the years 1990–2023 due to C stock changes in litter and deadwood range from 49 to 99 kt CO_2 and from 1.3 to 2.6 kt CO_2, respectively.

The annual emission rates due to C stock changes in mineral soils range from 162 to 220 kt CO_2 in the years 1990–2023.

6.7.4.1.2 Direct and indirect N_2O emissions from N mineralization/immobilization associated with loss of soil organic matter resulting from land use change on mineral soils (4(III))

Increases in available N due to soil C losses from human induced land use changes enhance the mineralisation of soil organic N and therefore cause N_2O emissions. These emissions were calculated for Forest land converted to Other land because of related C losses in mineral soils. According to the key category analysis, N_2O emissions in the LULUCF sector are a key category. To estimate the associated N_2O emissions the tier 2 method as provided in the IPCC 2006 GL is applied (Eq.11.1).

To calculate the net annual amount of N mineralized (F_{SOM}, eq. 11.8) from the net carbon stock change (CSC) due to the land use change in the mineral soil, the CSC was divided by the country specific C/N ratios:

- for forest soils: 19 (source: BFW 1992)

Then the amount of N was multiplied by the default emission factor (EF_1) from Table11.1 in the IPCC 2006 Gl. Then the result was converted from the amount of annual direct N_2O-N to N_2O emissions.

In addition to the direct N_2O emissions from managed soils, also related indirect emissions occur. The IPCC 2006 Guidelines provide the following tier 2 methodology in Chapter 11:

$$N_2O\text{-}N = F_{SOM} * Frac_{LEACH} * EF_5 \text{ (eq.11.10)}$$

Where:

...N_2O-N = annual amount of N_2O-N produced from leaching and runoff of N additions to managed soils, kg yr^{-1}

... F_{SOM} = the net annual amount of N mineralized in mineral soil associated with loss of soil C from soil organic matter as a result of changes in land use or management kg N yr^{-1}

... $Frac_{LEACH}$ = fraction of all N added to/mineralized in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff kg N per kg of N additions

$Frac_{LEACH}$ is a country specific factor of 0.15154 (Eder, et al., 2015) and EF_5 is provided in Table 11.3 of the IPCC 2006 Guidelines.

6.7.5 Uncertainty Assessment

The following uncertainties of the input data were used:

For the annual LUC area FL to OL see Chapter 6.2.5, Table 274.

The uncertainties of the emission factors and carbon stock change factors were given in the Chapter 6.2.5, Table 275.

The uncertainty of the totals of the emissions/removals of the for Other land ranges from ±261 kt CO_2 to ±607 kt CO_2eq. Expressed in % of the total emissions of the other land category, the uncertainty lies between ±62 and ±114%.

6.7.6 Category-specific QA/QC

The calculation of the data for category 4.E is embedded in the overall QA/QC-system of the Austrian GHG inventory (see Chapter 6.1.4).

6.7.7 Recalculations

GHG emissions and removals from Other land have not been revised since the 2024 submission. Improvements in the Austrian system for land representation have led to small revisions in the total Other land area; however, these improvements have not affected conversions from Forest land to Other land – the only subcategory causing carbon stock changes and GHG emissions in Other land.

6.7.8 Planned improvements

See Chapter 6.1.8.

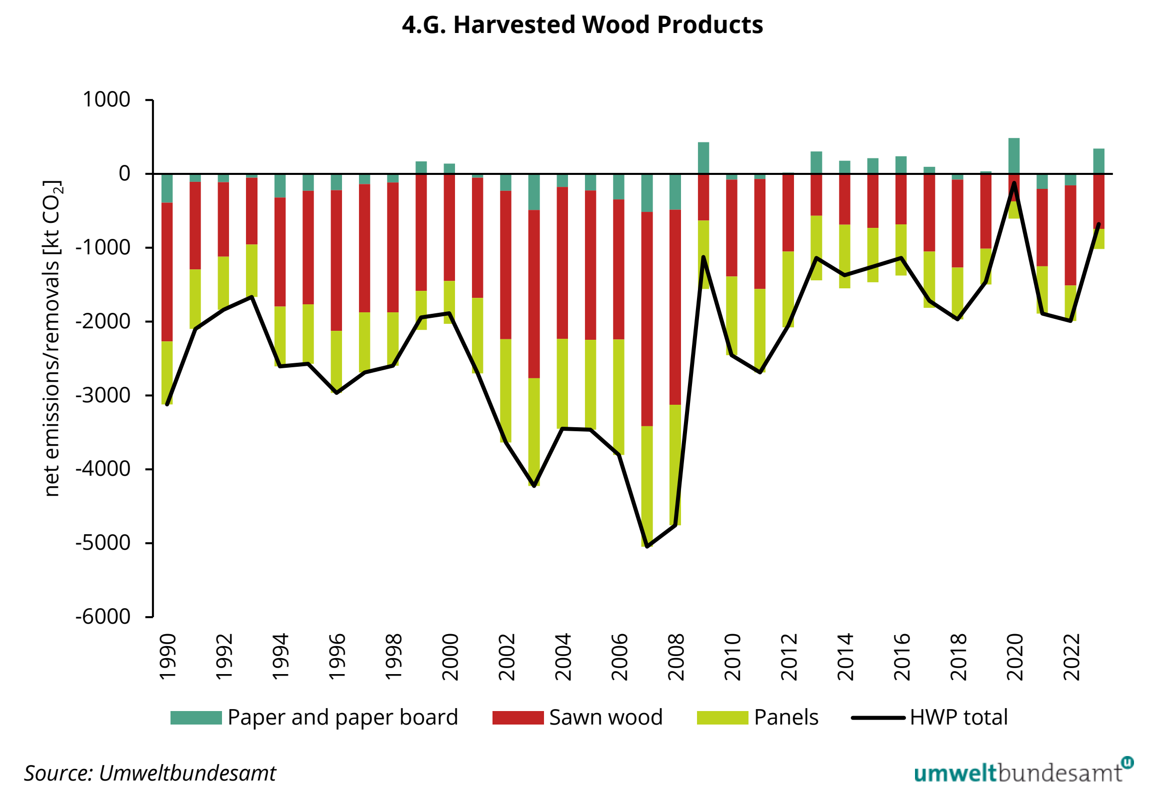
6.8 Harvested Wood Products (CRT Category 4.G)

6.8.1 Category description

The category Harvested Wood Products (HWP) is the second largest sink in Austria. In 2023 this category contributed to net removals with -678 kt CO_2 equivalent. The largest contribution results from the product category sawn wood, followed by wood panels and paper/paper products. Due to the nature of the input data and subsequent calculations, HWPs produced and exported are included in the same category as HWPs produced and consumed domestically. Disposal of HWP as solid waste is not occurring in Austria due to the restrictive landfill legislation.

HWP trend is driven by several factors. The general decreasing sink strength after 2008 stems from decreasing production of HWPs from domestic wood and increase in outflow due to the end of the life span of products from times of high HWP stock. Also the share of domestic harvest on overall production shows a decreasing trend which also impacts the HWP GHG result negatively. On top of that overall trend it can be seen that after the low domestic production and consequently exceptionally low HWP sink in 2020 (due to a huge amount of salvage logged wood in Central Europe from disturbances in the years before, as well as low wood prices and Corona pandemic influences), the net sink of the HWP category has increased in 2022 the second year in a row after returning to pre-2020 levels in 2021. In 2023 sinks decreased again due lower production in all product categories which lead especially in the product category "Paper and paperboard" to GHG net losses.

Figure 47: Emissions/removals from Harvested wood products for the period 1990 to 2023 by product category in kt CO_2.



Source: Umweltbundesamt

Table 308: Emissions/removals from Harvested wood products for the period 1990 to 2023 in kt CO_2.

	4.G Harvested wood products (produced and consumed domestically)	4.G.1.a Sawn wood	4.G.1.b Panels	4.G.2.a Paper and paper board	4.G.3 Harvested wood products (produced and exported)	4.G HWP in SWDS
1990	-3 122	-1 877	-854	-391	IE	NO
1995	-2 569	-1 537	-806	-227	IE	NO
2000	-1 889	-1 448	-581	140	IE	NO
2005	-3 461	-2 020	-1 216	-226	IE	NO
2010	-2 452	-1 311	-1 064	-77	IE	NO
2011	-2 687	-1 491	-1 128	-68	IE	NO
2012	-2 055	-1 052	-1 023	20	IE	NO
2013	-1 138	-566	-876	305	IE	NO
2014	-1 372	-687	-864	179	IE	NO
2015	-1 254	-729	-737	212	IE	NO
2016	-1 137	-683	-692	238	IE	NO
2017	-1 719	-1 050	-765	96	IE	NO
2018	-1 969	-1 189	-704	-77	IE	NO
2019	-1 462	-1 011	-486	35	IE	NO
2020	-122	-373	-233	484	IE	NO
2021	-1 889	-1 048	-640	-201	IE	NO
2022	-1 992	-1 355	-483	-154	IE	NO
2023	-678	-743	-275	341	IE	NO

6.8.2 Methodological Issues

Emissions/removals from HWPs are based on calculation of the stocks derived from domestic harvest by applying the production approach (or approach B) of the 2006 IPCC Guidelines. The HWP category is a key category in the Austrian inventory and it is estimated based on the Tier 2 method according to the 2006 IPCC Guidelines. Production data has been derived from the FAO Stat database on forestry production and trade statistics from 1961 onwards. Table 309 shows the domestic production of sawn wood, wood panels and paper/paper board as calculated from production and trade data from the FAO Stat database.

Table 309: Production of harvested wood products based on domestic harvest in Austria for the period 1990 to 2023 in cubic metres or tonnes calculated from FAO statistics.

	Sawn wood [1000 m³]	wood panels [1000 m³]	Paper and paper board [kt]
1990	5 616	1 326	1 701
1995	5 378	1 375	1 791
2000	5 496	1 251	1 639
2005	6 431	2 005	2 070
2010	5 812	2 049	2 201
2011	6 065	2 134	2 212

	Sawn wood [1000 m³]	wood panels [1000 m³]	Paper and paper board [kt]
2012	5 561	2 019	2 163
2013	4 998	1 915	1 954
2014	5 161	1 930	1 980
2015	5 233	1 830	1 919
2016	5 189	1 815	1 856
2017	5 647	1 906	1 908
2018	5 842	1 866	2 012
2019	5 645	1 666	1 948
2020	4 906	1 443	1 618
2021	5 734	1 828	2 008
2022	6 112	1 703	2 016
2023	5 396	1 524	1 694

As the original FAO production data does not differentiate the product categories between wood originating from domestic and imported harvest, the share for the domestic harvest needs to be obtained (equation 2.8.1 of chapter 2 of the IPCC (2014) KP supplement):

$$f_{IRW,i} = \frac{IRW_{p,i} - IRW_{ex,i}}{IRW_{p,i} + IRW_{im,i} - IRW_{ex,i}}$$

Where:

$f_{IRW,I}$ = share of wood from domestic harvest for year i, dimensionless
$IRW_{p,i}$ = Industrial roundwood production (wood in the rough) for year i, $m^3\ a^{-1}$
$IRW_{ex,i}$ = Industrial roundwood – export quantity for year i, $m^3\ a^{-1}$
$IRW_{im,i}$ = Industrial roundwood – import quantity for year i, $m^3\ a^{-1}$

In addition, the paper production on basis of domestic harvest is further adjusted by equation 2.8.2 of chapter 2 of the IPCC (2014) KP supplement which corrects for the paper production on basis of imported pulp:

$$f_{PULP,i} = \frac{PULP_{p,i} - PULP_{ex,i}}{PULP_{p,i} + PULP_{im,i} - PULP_{ex,i}}$$

Where:

$f_{PULP,I}$ = share of domestically produced pulp for the domestic production of paper and paperboard in year i
$PULP_{p,i}$ = production of wood pulp in year i, $t\ a^{-1}$
$PULP_{ex,i}$ = export of wood pulp in year i, $t\ a^{-1}$
$PULP_{im,i}$ = import of wood pulp in year i, $t\ a^{-1}$

The original FAO production data for the diverse wood products are then multiplied by the relevant $f_{IRW,I}$ and, in case of paper, additionally with the $f_{PULP,I}$ factors and aggregated to derive the production data on basis of domestic harvest presented in Table 309. For calculating the annual carbon stock inflow associated with the domestically produced wood products, the derived data are multipled by the respective C conversion factors in kt C m^{-3} or kt C t dm^{-1} (Table 310).

Table 310: Applied carbon conversion factors for HWP commodities.

HWP commodity	conversion factors t C/m^3 or t C/ t paper	Source
Sawnwood coniferous	0.225	IPCC (2014) KP Supplement, Tab. 2.8.1
Sawnwood non-coniferous	0.335	Rüter, 2011
Veneer Sheets	0.295	IPCC (2003) GPG, Tab. 3a.1.1
Plywood	0.240	IPCC (2003) GPG, Tab. 3a.1.1
Particle Board	0.290	Rüter, 2011
Fibreboard, Compressed	0.350	Rüter, 2011
Hardboard	0.417	Rüter, 2011
MDF	0.319	Rüter, 2011
Insulating Board	0.115	Rüter, 2011
Paper and Paperboard	0.450	IPCC (2006) GL, Tab. 12.4

The production approach requires a time series of C stock in domestically produced wood starting with year 1900 in order to reflect current emissions from HWPs which were harvested many decades ago. As the FAO statistics start from 1961, the annual carbon stock inflow from domestic wood production needs to be extrapolated backwards to obtain a full time series from the 1901 onwards. This is done by applying equation 12.6 of Vol 4, chapter 12 of the 2006 IPCC Guidelines separately to the sawn wood, wood panels and paper time series:

$$inflow_t = inflow_{1961} * e^{[U*(t-1961)]}$$

Where:

$inflow_t$	*= annual C inflow from production on basis of domestic harvest of aggregated sawn wood, wood panels, or paper for year t (pre 1961), kt C yr^{-1}*
t	*= year (pre 1961)*
$inflow_{1961}$	*= annual C inflow from production on basis of domestic harvest of aggregated sawn wood, wood panels, or paper for the year 1961, kt C yr^{-1}*
U	*= estimated continuous rate of change in industrial roundwood consumption for the region that includes the reporting country between 1900 and 1961 (Table 12.3 of Vol 4, chapter 12 of the 2006 IPCC Guidelines), 0.0151*

For each of the three wood product categories, an associated annual total C stock is calculated by starting in 1900, and applying the equation below (equation 12.1 of Vol 4, chapter 12 of the IPCC 2006 Guidelines) to each subsequent year up to the present:

$$C_i = e^{-k} * C_{i-1} + \left[\frac{(1-e^{-k})}{k}\right] * inflow_i$$

Where:

C_i = the carbon stock of the HWP pool for the year i, kt C

C_{i-1} = the carbon stock of the HWP pool for the previous year i, kt C

k = decay constant of first-order decay given in units, yr^{-1} (k = ln(2)/HL, where HL is half-life of the HWP pool in years. Tier 2 half-lives are used for sawn wood, wood panels and paper according to Table 2.8.2 of the KP supplement.

Finally, emissions/removals from the HWPs for a given year are calculated from the annual carbon stock change in the HWP pool ($\Delta C_i = C_i - C_{i-1}$).

6.8.3 Uncertainty Assessment

The methods follow closely the IPCC 2006 GL, therefore the uncertainty of ±50% as listed in the IPCC 2006 GL for this category was applied. This leads to absolute uncertainties in the range of ±60 to ±2 473 kt CO_2.

6.8.4 Recalculations

The *HWP* production figures for the year 2022 were updated in the most recent FAO statistics and very minor corrections were recorded in the years 2019-2021. Consequently, the HWP figures for this submission had to be updated accordingly. The recalculations in the *HWP* category led to lower removals of this subcategory of 118 kt CO_2e for 2022.

6.8.5 Planned Improvements

See Chapter 6.1.8.

7 WASTE (CRT SECTOR 5)

7.1 Sector overview

This chapter includes information on methods for estimating greenhouse gas emissions as well as references of activity data and emission factors concerning waste management and treatment activities reported under CRT Category 5 *Waste*: *Solid Waste Disposal (5.A)*, *Biological Treatment of Solid Waste (5.B)*, *Incineration and Open Burning of Waste (5.C)* and *Waste Water Treatment and Discharge (5.D)*.

Waste management and treatment activities are sources of methane (CH_4), carbon dioxide (CO_2) and nitrous oxide (N_2O) emissions.

7.1.1 Emission Trend

Overall greenhouse gas emissions from waste management and treatment activities in the year 2023 amounted to 1 295 kt CO_2 equivalent (1990: 4 565 kt CO_2 equivalent). These are about 1.9% of total greenhouse gas emissions in Austria in 2023 and 5.7% in 1990. In 2023, greenhouse gas emissions from the waste sector were 72% below the level of 1990.

Figure 48: GHG emissions from CRT 5 Waste.

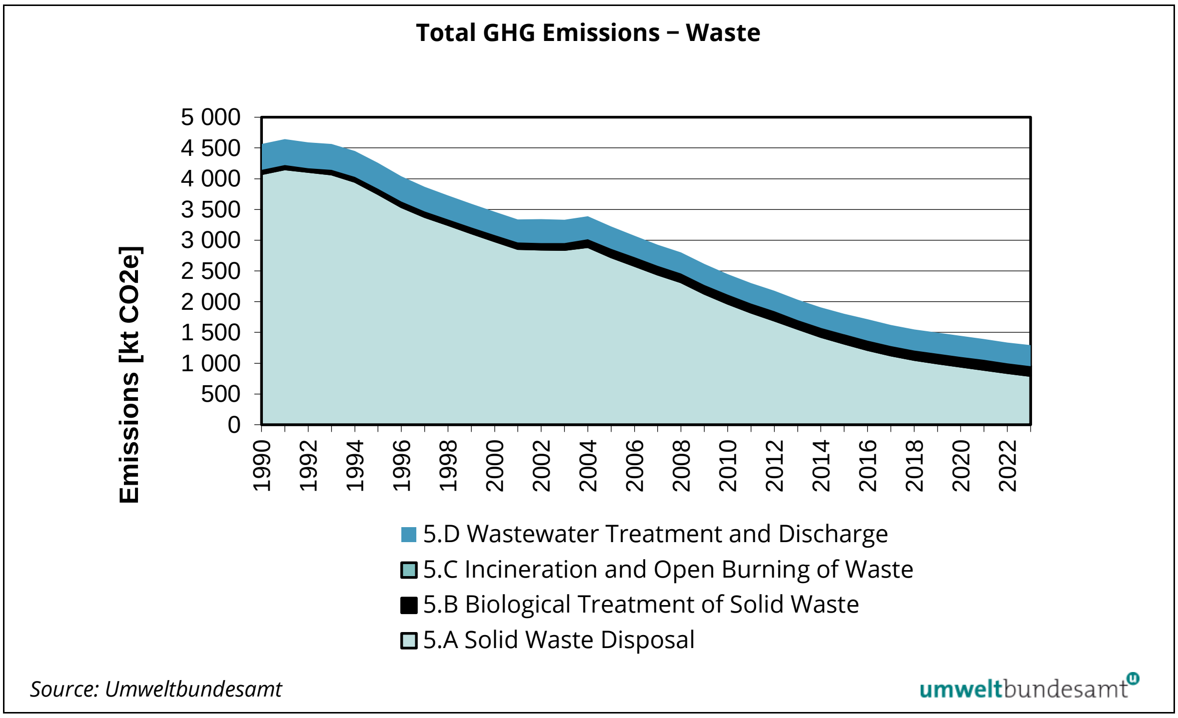


Table 311 presents the emission trend by gas. The major greenhouse gas emitted from this sector is CH_4, which represents 82% of all emissions from this sector in 2023, followed by N_2O (18%) and CO_2 (0.2%).

CH_4 emissions

CH_4 emissions from sector Waste amounted to 1 066 kt CO_2 equivalent in 2023; that is 76% below the level of 1990. CH_4 emissions originate from all sub-categories within this sector, but the largest source is *5.A Solid Waste Disposal*, contributing 75% to total CH_4 emissions from this sector, followed by *5.D Wastewater Treatment and Discharge* (18%).

The decrease of CH_4 emissions is a result of waste management policies. The amount of landfilled waste decreased significantly, the organic fraction within this waste decreased as well and methane recovery systems have increasingly been implemented during the period, reducing the amount of methane emitted. Furthermore, the decrease of inhabitants connected to septic tanks contributed to the reduction of CH_4 emissions.

N_2O emissions

N_2O emissions from sector Waste amounted to 227 kt CO_2 equivalent in 2023. Emissions increased by 114% since 1990.

68% of N_2O emissions originate from *5.D Wastewater Treatment and Discharge*, 32% are from *5.B Biological Treatment of Solid Waste*. In both categories emissions are increasing; waste incineration (municipal solid waste and waste oil) is a minor source of N_2O emissions.

CO_2 emissions

CO_2 emissions from sector Waste amounted to 2.1 kt CO_2 equivalent in 2023 and decreased by 93% compared to 1990.

CO_2 emissions originate from waste incineration (municipal solid waste, waste oil and hospital waste). The only plant incinerating municipal waste without energy recovery was shut down in 1991, which resulted in a drop of CO_2 emissions from 1991–1992. The decrease in emissions since 2005 is due to the waste incineration regulation specifying more stringent emission limits for all facilities to be complied by 2005 and thus reducing the number of facilities and thus waste incinerated.

Table 311: Greenhouse gas emissions from Waste sector by gas.

Year	CO_2	CH_4	N_2O	Total CRT 5
	[kt]	[kt CO_2e]	[kt CO_2e]	[kt CO_2e]
1990	28	4 430	106	4 565
1995	11	4 108	137	4 257
2000	12	3 285	166	3 463
2005	12	3 016	194	3 223
2010	2.1	2 244	205	2 450
2011	2.1	2 095	206	2 303
2012	2.1	1 966	208	2 176
2013	2.1	1 825	205	2 032
2014	2.1	1 696	207	1 906
2015	2.1	1 591	210	1 803
2016	2.1	1 497	216	1 715

Year	CO_2	CH_4	N_2O	Total CRT 5
	[kt]	[kt CO_2e]	[kt CO_2e]	[kt CO_2e]
2017	2.1	1 404	217	1 623
2018	2.1	1 329	217	1 548
2019	2.1	1 273	221	1 495
2020	2.1	1 220	222	1 445
2021	2.1	1 167	225	1 394
2022	2.1	1 111	225	1 337
2023	2.1	1 066	227	1 295
1990–2023	**-93%**	**-76%**	**+114%**	**-72%**

Table 312 presents the greenhouse gas emissions by sub-category. As can be seen, the dominant sub-category is *5.A Solid Waste Disposal*, contributing 62% (2023) to greenhouse gas emissions from sector Waste.

Table 312: Greenhouse gas emissions from Waste sector by subcategories.

Year	5.A	5.B	5.C	5.D	Total CRT 5
			[kt CO_2e]		
1990	4 081	35	29	420	4 565
1995	3 758	67	12	420	4 257
2000	2 987	81	13	383	3 463
2005	2 730	116	13	363	3 223
2010	1 978	134	2.2	336	2 450
2011	1 831	136	2.2	334	2 303
2012	1 701	140	2.2	332	2 176
2013	1 566	132	2.2	331	2 032
2014	1 435	138	2.2	330	1 906
2015	1 328	141	2.2	332	1 803
2016	1 221	146	2.2	345	1 715
2017	1 135	144	2.2	342	1 623
2018	1 060	144	2.2	342	1 548
2019	1 003	148	2.2	342	1 495
2020	950	150	2.2	343	1 445
2021	898	153	2.2	340	1 394
2022	846	149	2.2	340	1 337
2023	799	149	2.2	344	1 295
1990–2023	**-80%**	**+329%**	**-92%**	**-18%**	**-72%**

7.1.2 Key Categories

Methodology and results of the key category analysis is presented in Chapter 1.5.

7.1.3 Completeness

Table 313 gives an overview of the IPCC categories included in this chapter and presents the transformation matrix from SNAP categories. It also provides information on the status of emission estimates of all subcategories. A "✓" indicates that emissions from this sub-category have been estimated.

Table 313: Overview of subcategories of sector Waste: transformation into SNAP Codes and status of estimation.

IPCC Category	SNAP	CO_2	CH_4	N_2O
5.A SOLID WASTE DISPOSAL				
5.A.1 Managed waste disposal sites – Anaerobic (5.A.1.a)	090401 Solid Waste Disposal on Land	–	✓	–
5.A.2 Unmanaged waste disposal sites*)	090402 Unmanaged Waste Disposal	–	NO	–
5.A.3 Uncategorized waste disposal sites	090403 Other	–	NO	–
5.B BIOLOGICAL TREATMENT OF SOLID WASTE				
5.B.1 Composting	091005 Compost production	–	✓	✓
5.B.2 Anaerobic digestion at biogas facilities – Municipal Solid Waste (5.B.2.a)	091006 Biogas production	–	✓	NA**)
5.C INCINERATION AND OPEN BURNING OF WASTE				
5.C.1 Waste incineration	090201 Incineration of domestic or municipal waste	✓	✓	✓
	090207 Incineration of hospital wastes	✓	✓	✓
	090208 Incineration of waste oil	✓	NA	✓
5.C.2 Open burning of waste		NA	✓	✓
5.D WASTEWATER TREATMENT AND DISCHARGE				
5.D.1 Domestic wastewater	091002 Wastewater treatment in residential/commercial sect.	–	✓	✓
5.D.2 Industrial wastewater	091001 Wastewater treatment in industry	–	✓	✓
5.D.3 Other (please specify)		NO	NO	NO

*) *In Austria all waste disposal sites are managed.*

**) *According to the 2006 IPCC GL emissions are negligible (Vol. 5, p.4.4 and table 4.1); no EF provided in the 2006 IPCC GL*

7.1.4 Methodological Issues

For the emissions calculation of *CRT 5.A Solid Waste Disposal* the First Order Decay (FOD) Tier 2 method is applied. Data on the amounts of waste disposed at solid waste disposal sites – including also waste from industrial sources – is available on a yearly basis. Table 317 summarises the parameters used, which are partly country specific, partly IPCC defaults.

The calculation for *CRT 5.B Biological Treatment of Solid Waste* is based on the 2006 IPCC GL, but country-specific emission factors are applied (Tier 2). Emissions from composting and mechanical-biological treatment are calculated by multiplying waste quantities by emission factors taken from national studies. For the calculation of emissions from biogas plants the IPCC 2006 default EF of 5% CH_4/biogas produced is applied (Tier 1) until 2015. Since then a linear decline until 1% in 2030 is assumed (see chapter 7.3.2.2).

For *CRT 5.C.1 Waste Incineration* the CORINAIR methodology is applied: the quantity of waste is multiplied by an emission factor for CO_2, CH_4 and N_2O. For *CRT 5.C.2 Open Burning of Waste* a simple country specific method with country specific emission factors is applied for CH_4 and N_2O.

N_2O emissions from *CRT 5.D.1 Domestic Wastewater* are calculated using a country specific method (CS), based on the 2006 IPCC Guidelines, applying CS EF (direct N_2O) and IPCC defaults (indirect N_2O). Main differences to the default methodology are described in Chapter 7.5.2. Calculation of CH_4 emissions from this category follows the methodology of the 2019 IPCC Refinement. The EF are the IPCC 2019 defaults, but CS activity data and factors (K_{rem}) are used.

N_2O and CH_4 emissions from *CRT 5.D.2 Industrial Wastewater* are determined based on a study conducted in 2019 (UMWELTBUNDESAMT 2019c), applying a CS emission factor for the calculation of direct N_2O emissions and the default value for indirect N_2O emissions. For methane it is assumed that 1% of the gas generated in the anaerobic pre-treatment of waste water is actually emitted.

7.1.5 Quality Assurance and Quality Control (QA/QC)

In addition to the general QC activities described in Chapter 1.3.3, the following QA/QC activities are done on a regular basis:

- To ensure, that most up-to-date data and parameters (e.g. landfill gas recovery, connection rate etc.) are considered, national waste experts, mostly within the Umweltbundesamt are contacted. After finalisation of the calculation but prior to submission, the respective section of the NID is sent to relevant experts for a final check of descriptions and trend analysis.
- Activity data is checked for plausibility and time series consistency. If dips and jumps exceeding 20% compared to the year before are observed, other experts or data providers are consulted to either provide the explanation or to identify a possible inconsistency or an error.
- Recalculations are validated in detail by comparing several parameters and partial results over the whole time series. Explanations for recalculations are documented.
- In case of new or refined methods the calculation sheets are validated to ensure there are no transcription errors and are finally protected against accidental modification.

Further category-specific QA/QC steps and results are described in the respective subchapters.

7.2 Solid Waste Disposal (CRT Category 5.A)

Emissions: CH_4

Key Source: Yes (LA, TA)

7.2.1 Source category description

In 2023 emissions from *5.A Solid Waste Disposal* contributed 62% to greenhouse gas emissions from sector Waste and 1.2% to total greenhouse gas emissions in Austria. From 1990 to 2023 greenhouse gas emissions from this source decreased by 80% (see Table 312).

In the Austrian inventory two main categories of waste are distinguished: residual waste and non-residual waste. Residual waste refers only to the part of municipal solid waste[105] collected by the municipal system (mixed composition) that is directly deposited without any pre-treatment. Non-residual waste comprises among others municipal solid waste having been pre-treated, sludge from wastewater treatment and waste from industrial sources.

It has to be noted that from 2009 on no waste is allowed to be deposited any more without being pre-treated (due to the Landfill Ordinance[106]), so since 2009 no disposal of 'residual waste' is reported by landfill operators and therefore no new and additional amount of residual waste is taken into account in the inventory. Emissions from this subcategory are therefore only affected by waste deposited before 2009. Nevertheless 'residual waste' still has a notable contribution to total CH_4 generated (86% in 1990, 73% in 2005 and 43% in 2023). Waste from households and similar sources covered by the municipal waste collecting system but undergoing a pre-treatment before deposition is not included in this category, but in category 'non-residual waste' (sub-category 'sorting residues', among others from mechanical-biological treatment) and in sector 'energy' respectively, as incineration is a pre-treatment option too.

'Residual waste' corresponds to waste:

- originating from private households and similar sources (administrative facilities of commerce, industry and public administration, kindergartens, schools, hospitals, small enterprises, agriculture, market places and other generation points)
  - remaining after separation of paper, glass, plastic etc. at the source
  - covered by the municipal waste collecting system
  - directly landfilled without having passed any pre-treatment

Non residual waste':

- comprises pre-treated waste from households (e.g. sorting residues from mechanical-biological treatment) and waste with biodegradable lots from other sources, including industrial waste and sludge.

[105] i.e. waste from households as well as other waste which, because of its nature or composition, is similar to waste from household (Article 2 (b): Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste).

[106] Ordinance on Landfills (Landfill Ordinance 1996), Federal Law Gazette No 164/1996; Ordinance on Landfills (Landfill Ordinance 2008), Federal Law Gazette II No 39/2008.

- is divided into the categories wood, construction waste, paper, green waste, sludge, sorting residues/stabilized material, textiles and fats.

Stabilized material and sorting residues remaining after mechanical, biological and mechanical-biological treatment and bulky waste are the main fraction deposited. Other fractions deposited are sludge and construction waste. Bio waste, paper and wood are mainly composted, recycled or re-used (due to the implementation of the Waste Management Law), fat and textiles are not deposited any more (see Table 317). It has to be noted that from 2009 on no waste with high organic content is allowed to be deposited any more without being pre-treated (due to the Landfill Ordinance). Residues from MBT plants are exempted from this ordinance.

Table 314 presents a summary of all considered waste types and the corresponding identification numbers (list of waste).

Table 314: Considered types of waste (list of waste[107] pursuant to Article 1 (a) of Directive 75/442/EEC on waste).

Waste Identification No	Type of Waste	Waste Identification No	Type of Waste
0303	wastes from pulp, paper and cardboard production and processing	170903	other construction and demolition wastes (including mixed wastes) containing dangerous substances
1905	wastes from aerobic treatment of solid waste	170904	mixed construction and demolition waste
1908	wastes from wastewater treatment plants not otherwise specified	190805	sludge from treatment of urban wastewater
1909	wastes from the preparation of water intended for human consumption or water for industrial use	190809	grease and oil mixture from oil/water separation containing only edible oil and fats
1912	wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified	200101/ 200102	paper and cardboard
20303	waste from solvent extraction	200108	biodegradable kitchen and canteen waste
30105	Sawdust, shavings, cuttings, wood, particle board and veneer	200111	textiles
30304	de-inking sludge from paper recycling	200201	Bio-degradable wastes
30307	mechanically separated rejects from pulping of waste paper and cardboard	200302	waste from markets
30310	fibre rejects, fibre-, filler-, and coating sludge from mechanical separation	200307	bulky waste

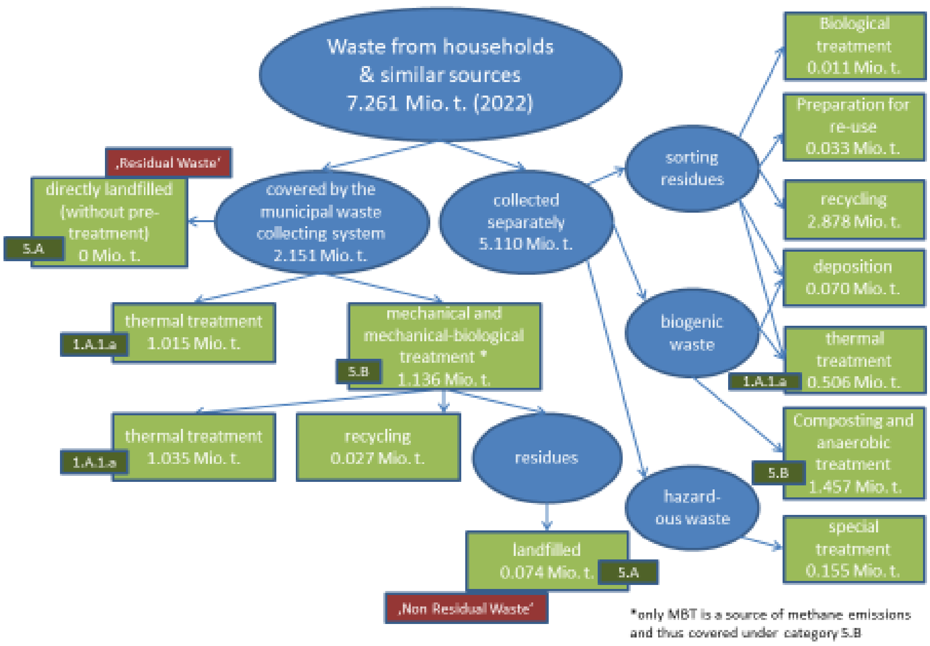
[107] Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste

Waste Identification No	Type of Waste	Waste Identification No	Type of Waste
40106	Sludge, in particular from on-site effluent treatment containing chromium	190811–14	sludge from treatment of industrial wastewater
40109	waste from dressing and finishing	200125	edible oil and fat
40221	wastes from unprocessed textile fibres	170201	wood
150103	wooden packaging		

Figure 49 below is only to inform about the waste management practices in Austria, and data presented herein is not used for the calculation of GHG emissions. The main streams of treatment and disposal of waste from households and similar sources are shown in Figure 49. It also aims to transparently show the distinction between residual and non-residual waste (with regard to municipal solid waste[108]) and to demonstrate that all relevant activity data are taken into account in the inventory.

Figure 49: Waste from households and similar sources – treatment and disposal routes 2022. Please note: This illustration only covers data from households and similar sources. Waste from industrial and similar sources (e.g. wastewater treatment plants) is not considered in this figure, but included in the inventory.

Waste treatment and disposal routes



Sources: Data: (BMK, 2024a), Chart: Umweltbundesamt

umweltbundesamt

[108] In fact non-residual waste also comprises waste from other (industrial) sources.

Almost 100% of waste from households and similar sources is incinerated, recycled or treated mechanical-biologically. Since 2009 only minor amounts of stabilized residues have been still directly deposited.

In Austria all waste disposal sites are managed sites. Only landfills for mass waste contain relevant organic material and are hence sources of CH_4 emissions. All other landfill types are not relevant for GHG emissions. According to the most recent information taken from the status report (BMK, 2024a) of the latest Federal Waste Management Plan (BMK, 2023), 26 mass waste landfills were in operation in 2022, compared to 61 sites in 2002.

In the inventory waste amounts deposited from 1950 onwards are taken into account. From 1950 till the end of the 1980s waste amounts were increasing, with a peak in 1989. The decrease after 1989 is partly due to the introduction of a landfill levy. This levy originates from an Austrian Law for cleaning up contaminated sites[109] with the objective to finance cleaning up and securing activities for contaminated site.

Figure 50: Waste ('residual waste' and 'non-residual waste') with a relevant share of degradable organic carbon (deposited on mass waste landfills), period 1950–2023.

Source: Umweltbundesamt

In 1990 waste management was for the first time regulated by law (Austrian Waste Management Law[110]). As a result, waste separation, reuse and recycling activities increased and the amounts of deposited waste decreased significantly until 1994.

The amount of deposited waste peaked once more in 2003 due to the remediation of contaminated sites, and then dropped as from the beginning of 2004 generally only pre-treated waste was

[109] Law on the Remediation of Contaminated Sites (1989), Federal Law Gazette No 299/1989

[110] Waste Management Act of 2002, Federal Law Gazette I No 102/2002

allowed to be deposited. This is due to the implementation of the Landfill Ordinance[111], which prohibits the disposal of untreated waste with relevant content of organic matter in Austria from 2004 on and therefore leads to reduced waste volumes as well as decreased carbon content in deposited waste. Under certain circumstances there were some exceptions to this pre-treatment-obligation granted to some Austrian provinces (regulated in § 76 Abs. 7 AWG 2002). In four of the nine Austrian provinces it was still allowed to deposit waste directly without any pre-treatment until the end of 2008.

Since the beginning of 2009 no waste with relevant content of organic matter is allowed to be deposited any more without being pre-treated due to theprovisions of the Landfill Ordinance[111]. Deposition of residual waste as well as paper, wood and green waste thus does no longer take place in Austria.

7.2.2 Methodological Issues

For the emissions calculation the First Order Decay (FOD) method is applied, assuming that the degradable organic carbon (DOC) in waste decays throughout a few decades. Good quality activity data on historical and current waste amounts is available. Parameters used are partly country-specific (e.g. landfill gas collection), partly default values. The method has therefore been characterized as a Tier 2 method.

7.2.2.1 Activity data

The quantities of 'residual waste' have been taken from the following sources:

- Data for 2008–2023 have been taken from the EDM[112], an electronic database administered by the BMLFUW and delivering data as input to the national Federal Waste Management Plan. Since the beginning of 2009 landfill operators are obliged to register their data directly and electronically (per upload) at the portal of http://edm.gv.at;
- Data for 1998–2007 were taken from a database for solid waste disposals called 'Deponiedatenbank' ('Austrian landfill database'), a database administered and maintained by the Umweltbundesamt until the end of 2008;
- Data for 1950–1997 on the amounts of deposited residual waste were taken from national studies (HACKL, A. & MAUSCHITZ, G., 1999, Umweltbundesamt, 2001a) and the respective Federal Waste Management Plans (BMLFUW, 1995, BMLFUW, 2001).

In the national study (HACKL, A. & MAUSCHITZ, G., 1999) as well as in the historical Federal Waste Management Plans the amounts of residual waste from administrative facilities of businesses and industries were not considered and therefore originally not included in the data of the years 1950 to 1999. Waste from these sources is however deposited and hence reported by the operators of

[111] Ordinance on Landfills 1996 ("Deponieverordnung" 1996), Federal Law Gazette No 164/1996, as amended by Federal Law Gazette II No 49/2004); Ordinance on Landfills 2008 ("Deponieverordnung" 2008), Federal Law Gazette II No 39/2008, as amended by Federal Law Gazette II No 144/2021)

[112] Electronic Data Management

landfill sites (therefore included in the Austrian landfill database as well as the EDM) and thus considered in the time series from 1998 onwards. To achieve a consistent time series, data of the two overlapping years[113] (1998 and 1999) were examined and the difference – which represents the residual waste from administrative facilities of industries and businesses – was calculated. This difference, relative to the change of residual waste from households, was then applied to the years 1950 to 1997 accordingly.

The quantities of 'non residual waste' of the years 1998–2007 were taken from the database for solid waste disposals ('Deponiedatenbank', 'Austrian landfill database'), data for 2008–2023 have been taken from the EDM (Electronic Data Management). Only the types of waste with biodegradable lots are considered. There are no data available for the years before 1998, thus extrapolation was done using the Austrian GDP (gross domestic product) per inhabitant (Kausel, 1998) as indicator. In order to get a more robust estimate, a 20 year average value was used.

Table 315 presents activity data and CH_4 emissions from managed waste disposal on land for the period 1990–2023.

Table 315: Activity data for 'residual waste' and 'non residual waste', greenhouse gas emissions and implied emission factors 1990–2023

Year	Non-Residual Waste	Residual Waste	Total Waste	CH_4 emissions	IEF*
		[t/a]			[t/t]
1990	648 702	1 995 747	2 644 448	145 756	0.06
1995	716 219	1 049 709	1 765 928	134 204	0.08
2000	826 874	1 052 061	1 878 935	106 674	0.07
2005	389 660	241 733	631 393	97 510	0.18
2010	244 969	0	244 969	70 637	0.33
2011	273 313	0	273 313	65 403	0.27
2012	166 263	0	166 263	60 766	0.41
2013	185 156	0	185 156	55 941	0.34
2014	174 500	0	174 500	51 251	0.33
2015	131 959	0	131 959	47 419	0.41
2016	132 182	0	132 182	43 618	0.37
2017	151 866	0	151 866	40 535	0.30
2018	163 663	0	163 663	37 863	0.26
2019	166 659	0	166 659	35 807	0.24
2020	165 576	0	165 576	33 927	0.23
2021	197 067	0	197 067	32 082	0.18
2022	138 940	0	138 940	30 208	0.24
2023	146 603	0	146 603	28 551	0.21

[113] Data available from the Federal Waste Management Plan (Bundesabfallwirtschaftsplan - BAWP) as well as from the Austrian landfill database.

* *IEF calculated on basis of gross CH_4 emissions: (CH_4 emissions + CH_4 recovery) / MSW. The smaller the annual amount of waste deposited, the larger the IEF and vice versa. E.g. in 1990, 2 644 kt waste were deposited resulting in an IEF of 0.06 t CH_4/t waste, whereas in 2023 only 147 kt were landfilled resulting in an IEF of 0.21 t CH_4/t waste. Fluctuations of the IEF are thus due to inter-annual fluctuations of annually reported waste amounts deposited at quite steadily declining emissions.*

Significant reductions of deposited waste volumes occurred 2003/2004 and 2008/2009, due to the restrictions pursuant to the Landfill Ordinance. The decrease 2011/2012 was caused by the shut-down of two bigger mechanical biological treatment plants resulting in lower depositions of residues from this pre-treatment. CH_4 emissions also declined, but quite steadily and not in the same extent as the volumes develop from year to year as these are also affected by historical DOC depositions (FOD). Since 1990, less than 10% of the annual emissions stem from the most recently deposited waste, and more than 90% from waste deposited in previous years.

Table 316: Mass of decomposable DOC deposited [kt], by waste type.

	Residual waste	Non-Residual waste							
	mixed MSW	wood	paper	sludges	sorting residues	bio-waste	textiles	construction waste	fats
	Decomposable DOC (DDOCm) deposited [kt]								
1990	239	3.0	6.9	7.8	36.1	1.9	0.4	1.5	0.0
1995	94	3.3	7.6	8.6	39.9	2.1	0.5	1.6	0.0
2000	81	1.7	5.2	6.2	53.7	1.3	1.0	2.7	0.0
2005	24	0.4	0.1	0.5	31.8	0.1	0.0	0.8	0.0
2010	0	0.0	0.0	0.1	21.3	0.0	0.0	0.0	0.0
2011	0	0.0	0.0	0.1	23.8	0.0	0.0	0.0	0.0
2012	0	0.0	0.0	0.2	14.3	0.0	0.0	0.0	0.0
2013	0	0.0	0.0	0.5	15.5	0.0	0.0	0.0	0.0
2014	0	0.0	0.0	0.4	14.8	0.0	0.0	0.0	0.0
2015	0	0.0	0.1	0.1	11.3	0.0	0.0	0.0	0.0
2016	0	0.0	0.0	0.3	11.1	0.0	0.0	0.0	0.0
2017	0	0.0	0.1	0.5	12.6	0.0	0.0	0.0	0.0
2018	0	0.0	0.1	0.4	13.7	0.0	0.0	0.0	0.0
2019	0	0.0	0.1	0.7	13.5	0.0	0.0	0.0	0.0
2020	0	0.0	0.1	0.8	13.4	0.0	0.0	0.0	0.0
2021	0	0.0	0.1	0.7	16.3	0.0	0.0	0.0	0.0
2022	0	0.0	0.0	0.4	11.6	0.0	0.0	0.0	0.0
2023	0	0.0	0.0	0.3	12.4	0.0	0.0	0.0	0.0

7.2.2.2 Emission Parameters

Where available, country specific parameters are used after they have been checked if they are in the range of the IPCC guidelines. If country specific parameters were not available IPCC default values are taken. The following table summarises the parameters used plus the corresponding references.

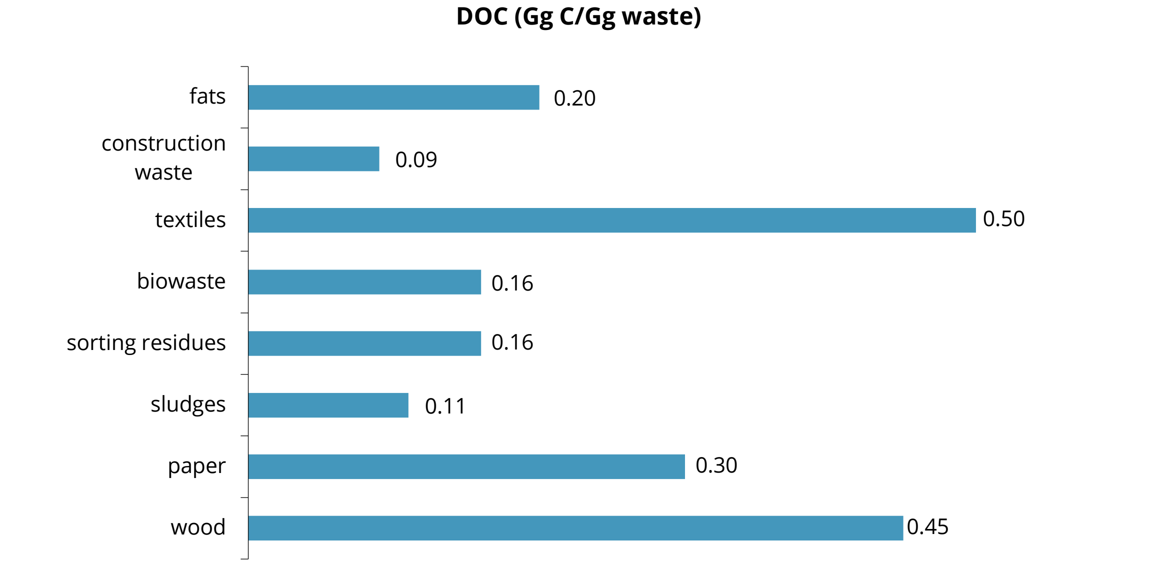
Table 317: Parameters for calculating CH_4 emissions from SWDS.

Waste category/ Parameters	residual waste	wood	paper	sludges	sorting residues	bio-waste	textiles	construction waste	fats
Methane correction factor (MCF)	1 IPCC default for managed SWDS								
Fraction of degradable organic carbon dissimilated (DOCF)	0.6	0.5	0.55	0.55	0.55	0.55	0.55	0.55	0.77
	national waste expertise (Umweltbundesamt, 2005)								
DOC (kt C/kt waste)	See Table 318	0.45	0.3	0.11	0.16	0.16	0.5	0.09	0.2
		(BAUMELER, et al., 1998), (Umweltbundesamt, 2005)							
Half life period ($t_{1/2}$)	7	25	15	7	20	10	15	20	4
	National waste experts	(GILBERG, 2005)	(GILBERG, 2005)	Assumption: same as residual waste	IPCC default slow decay	Assumption: similar to paper	Assumption: same as paper	IPCC default slow decay	(GILBERG, 2005)
Fraction of CH_4 in Landfill Gas (F)	From 2018 onwards: 0.5 (IPCC 2006) 2009–2018: linearly declining from 0.55 (2008) to 0.5 (2018) 1950–2008: 0.55 as cited in various Austrian and German literature (FLÖGL, 2002, ÖWAV, 2003, LFU, 1992, Umweltbundesamt, 2008b, Umweltbundesamt, 2014b)								
Methane Oxidation in the upper layer (OX)	10% IPCC default								
Landfill gas recovery (R)	see Figure 52 (Umweltbundesamt, 2004b, Umweltbundesamt, 2008b, Umweltbundesamt, 2014b, Umweltbundesamt, 2019a, Umweltbundesamt, 2019b, Umweltbundesamt, 2023a)								
Process start (M)	13 Delay time of 6 months, with an average residence time of 6 months (IPCC default)								

7.2.2.2.1 Biodegradable organic carbon (DOC)

Austria applies the waste composition modelling approach. The DOCs of the different waste categories under '**non residual waste**' are thus held constant for the entire time series, at the level shown in Table 317. These are clearly defined (wood, paper, sludge etc.) and quite 'homogenous'.

Figure 51: DOC of non-residual waste fractions.



Source: Umweltbundesamt

The DOC of '**residual waste'** however has changed over the years in accordance with its changing composition. The separate collection of biogenic waste, paper and cardboard, and glass, and the increase of food waste in recent years etc. have clearly influenced the trend of the DOC.

For the year 1990 a DOC content of 200 g/kg residual waste was taken (Umweltbundesamt, 2003b). For 2008, the last year in which this waste category has been deposited, the DOC was 169 g/kg waste. It was calculated on basis of updated information on the composition of residual waste published in the Annual update (2009) of the Federal Waste Management Plan 2006 (BMLFUW, 2006a), taking into account the different carbon content of the fractions as published in (Umweltbundesamt, 2003b). From 2009 on, only pre-treated waste, referred to as non-residual waste, is allowed to be deposited in Austria. Hence, only historical amounts are relevant and the DOC does not need to be updated any more.

Table 318: Bio-degradable organic carbon content of residual waste (mixed MSW, directly deposited).

Year	kg C/kg Residual Waste
1950–1990	0.20[1)]
1995	0.15[1)]
2000	0.13[*)]
2005	0.17[2)]
2008	0.17[3)]
2009–2023	n.r.[**)]

[1)] based on (Umweltbundesamt, 2003b)

[2)] based on (BMLFUW, 2006a)

[3)] calculated according to waste composition 2009 (annual update of (BMLFUW, 2006a)

[*)] interpolated

[**)] no deposition of residual waste any more

The intensified separate collection of organic and paper waste and the corresponding decreasing share of these materials in the residual waste fraction was the reason for the decrease of the DOC in residual waste during the 1990ies. The increase of the DOC of residual waste in 2000 and the following years is due to the increasing share of biogenic components especially of food waste in residual waste (as can be seen in Table 319).

Table 319: Composition of residual waste.

Residual waste	**1990[1)]**	**1993[1)]**	**1996[1)]**	**1999[1)]**	**2004[2)]**	**2008[3)]**
	[% of moist mass]	**[% of moist mass]**	**[% of moist mass]**	**[% of moist mass]**	**[% of moist mass]**	**[% of moist mass]**
Paper, cardboard	22	18	14	14	11	12
Glass	8	6	4	3	5	4
Metal	5	4	4.5	5	3	3
Plastic	10	9	11	15	10	10
Composite materials	11	11	14	–	8	10
Textiles	3	3	4	4	6	6
Hygiene materials	–	–	–	12	11	8
Biogenic components	30	34	30	18	37	40
Hazardous household waste	1	2	1	0.3	2	1
Mineral components	7	8	4	–	4	3
Wood, leather, rubber, other components	2	4	1	3	1	–
Residual fraction	–	–	14	27	2	2

[1)] *(Umweltbundesamt, 2003b)*

[2)] *(BMLFUW, 2006a)*

[3)] *Annual update (2009) of (BMLFUW, 2006a)*

7.2.2.2.2 DOCf

The DOCf values used for calculation are shown in Table 317.

Austria does not apply the bulk DOCf option of the IPCC 2006 GL as detailed information is available on the waste deposited (to be reported by landfill operators according to § 41 Landfill Ordinance). Based on this information the calculation is done separately for each waste fraction (wood, paper, sludges, sorting residues, bio waste, textiles, construction waste, fats, residual waste). The composition of the different landfilled waste fractions is well known, allowing for applying an appropriate DOCf accordingly (see (Umweltbundesamt, 2005). Higher DOCf values than the IPCC 2006 default (0.5) are applied for most of the waste types (except wood) as the composition data shows a low share of lignin in the waste deposited.

For 'residual waste', a calculation of the DOCf (0.6) was done based on waste analyses carried out in Austria in 2004[114] (BMLFUW, 2006a). Applying the default DOCf values presented in the 2019 Refinement to the 2006 IPCC GL, Table 3.0, our calculations for residual waste would result in a DOCf of 0.592. This value would be even slightly higher if the average value of 0.523 for moderately decomposable waste (indicated in the notes to Table 3.0) were used instead of the default value given of 0.5. The relatively high DOCf for Austria is mainly due to the high share of kitchen waste (about 37% of the total waste composition or almost 49% only regarding fractions with degradable organic substance).

A justification regarding the DOCf values of further waste fractions is given hereinafter:

- 'Sludges' do not contain lignin, therefore a slightly higher DOCf is in line with the GL.
- The default DOCf of green waste according to Table 3.0 of the 2019 Refinement to the 2006 IPCC GL is 0.7 and thus even higher than the value used in Austria. However in Austria the fraction 'biowaste' also includes branches, thus a slightly lower DOCf is appropriate.
- The waste category 'sorting residues' does not only include wood, but also compost like output from MBTs. Therefore a higher DOCf is justified.
- The decomposition of 'paper', even of newsprints, is higher than of 'wood' - again a higher DOCf is justified.

Also in (Bayard, et al.) the biodegradation of different waste streams was investigated showing typically higher DOCf values than the recommended DOCf of the IPCC GL 2006 of 0.5.

7.2.2.2.3 Fraction of CH4 in generated landfill gas (F)

For the historical years **1950–2008** Austria uses a country-specific value of 0.55 for the fraction of CH_4 in generated landfill gas (F), based on various literature, among others (Rettenberger, G. & Mezger, H., 1992, FLÖGL, 2002, ÖWAV, 2003, Umweltbundesamt, 2008b). This fraction is slightly higher than the default from the IPCC 2006 Guidelines (0.5) and based on the following considerations:

- The methane concentration in the generated landfill gas changes over time. After a few months already before the so called "stable methane phase" begins, the methane concentration rises to about 55%. During the stable methane phase (this phase lasts several years/decades) the CH_4-concentration typically is about 55% (Rettenberger, G. & Mezger, H., 1992).
- Further, the methane concentration in the landfill gas depends on the waste fractions deposited. Fats and proteins show substantially higher concentrations than carbohydrates (Weiland, 2001). In biogas plants, fats and oils show very high methane concentrations (about 68%), legumes show concentrations between 52% and 65%, food waste about 60% (LFL, 2017). Separately collected biowaste also contains proteins and fats, kitchen and canteen waste even higher proportions. In Austria it was allowed to landfill untreated waste until 2004, in some federal provinces until 2008, therefore a higher methane concentration in landfill gas is to be expected as not only cellulose and hemicellulose (with a theoretical methane concentration of about 50%) but also proteins and fats were deposited until 2008.

[114] The analysis of 2004 is used as since 2004 a ban of landfilling of untreated residual waste came into force (with exemptions until 2008).

From 2018 onwards, a value of 0.5 is applied, based on the IPCC 2006 GL.

For the years **2008–2018** a linear decline from 0.55 to 0.5 is assumed as the change of the methane concentration does not occur within one year.

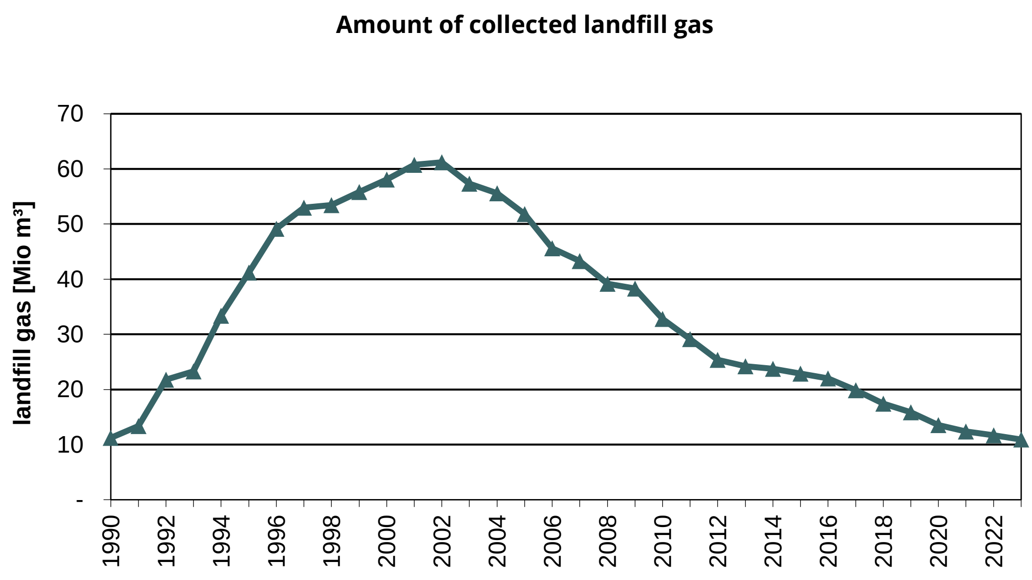
This approach is applied since the 2021 submission as, depending on the waste age, the amount of CO_2 absorbed in water increases (0.01% to 10% of CO_2 might be absorbed in water according to (Rettenberger, G. & Mezger, H., 1992). This was not reflected in the historical submissions, and addressed during the 2020 comprehensive ESD-Review (EEA, 2020a).

7.2.2.2.4 Landfill gas recovery

In 2004, Umweltbundesamt investigated the amount of annually collected landfill gas by questionnaires sent to landfill operators (Umweltbundesamt, 2004b) showing that in 2001 the amount of collected landfill gas was more than 5 times higher than in 1990. In 1990 only nine landfills were equipped with landfill gas wells, whereas in 2001 at all operating mass landfills landfill gas was collected.

In 2008, 2013, 2018 and 2023 further surveys were conducted (Umweltbundesamt, 2008b, Umweltbundesamt, 2014b, Umweltbundesamt, 2019a, Umweltbundesamt, 2023a) to get new data on collected landfill gas as well as information on its use from landfill operators. Landfill gas volumes and their treatment are thus surveyed in a 5-year cycle. The most recent survey covers the period 2018 – 2022. For the most current year 2023 an assumption had to be made on the collected gas quantities based on historical trends of data from the surveys in the federal provinces of Austria.

Figure 52: Amount of collected landfill gas 1990 to 2023.



Source: (Umweltbundesamt, 2004b, Umweltbundesamt, 2008b, Umweltbundesamt, 2014b, Umweltbundesamt, 2019a, Umweltbundesamt, 2023a)

From 2002 onwards, the amount of landfill gas collected decreased (despite a consistent recovery practice) as a consequence of:

- Reduced carbon content of deposited waste and consequently reduced landfill gas production
- Slightly decreasing methane concentration in recovered landfill gas – an effect that is due to the extensive capturing of landfill gas which can lead to the dilution of the landfill gas captured.

Compared to 2002 (maximum), the collected amount of landfill gas decreased by 82% by 2023.

7.2.3 Uncertainty Assessment

The Uncertainty Assessment is originally based on a national study (Winiwarter, Rypdal, 2001) and was improved and revised by expert judgement for the submission 2005. These values were confirmed in the latest uncertainty study (Winiwarter, 2007).

The uncertainties have been determined based on the following considerations

- IPCC Tier 2 method applied;
- Country-specific activity data taken from Austrian databases;
- Availability of data on landfill gas recovered on a regular basis.

Table 320: Uncertainty assessment for managed waste disposal on land.

	(Winiwarter, Rypdal, 2001)	Expert judgement 2005 (Winiwarter, 2007)
Activity data	25%	12%
Emission factor	35%	25%

7.2.4 Category-specific QA/QC

Beginning from the year 1998 until the end of the year 2007, activity data on deposited waste was reported annually by landfill operators to the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW, since 2020 the BMK – Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology). After a first check the reports were forwarded to the Umweltbundesamt, who in turn incorporated the reports into a landfill database. Landfill operators in default were prosecuted. In the course of the data collection and administration, a quality control of the incoming data was implemented: data was checked in terms of completeness and plausibility. To clarify any discrepancies landfill operators were contacted. Lists of landfill owners were sent to competent authorities of each province (responsible for licensing and controlling) in order to check if number and type of landfill facilities were correct. Last but not least, plausibility was gained by comparison of the data with previous reports.

Since the year 2008 landfill operators are obliged[115] to report their data directly and electronically at the portal of http://edm.gv.at (EDM: **E**lectronic **D**ata **M**anagement in environmental and waste

[115] According to § 41 (1) Landfill Ordinance.

management). Every person or installation collecting and treating waste is obliged to register in EDM and submit annually reports of each waste input and output (yearly balance of type, quantity, origin and destination of waste). In various meetings and training courses especially landfill operators were educated in using this new reporting tool. Responsible institution for administration of the EDM is the Federal Ministry BMK, since April 2025 named as BMLUK.. The former landfill database is not maintained any more, but its data were used for checking accurately whether all landfill operators have registered in EDM. Analysis and quality control of the data is carried out on an ongoing basis. Although the comparison with previous reports is an important tool, the advantage of having the landfill data embedded in the general input-output reports is obvious (counterchecking with the reports of partners).

In addition, supervisors appointed by the competent authority for each landfill are obliged to monitor regularly not only the landfill site itself but also each registration in EDM and the reporting of data. As there is a special tax on wastes being landfilled, another independent mechanism of control on landfills is realised by the ministry of finance (via former customs executives).

Input Data Audit 2014/2015

At the end of 2014/beginning 2015 a multi-step audit was conducted by the IBE sectoral waste experts at the BMLFUW (Department responsible for analysis and quality check of EDM data on landfilled waste) and the Umweltbundesamt (Expert Team responsible for data query on behalf of the BMLFUW). Aim was to get insight into collection, processing and quality control of data, i.e. waste amounts deposited, and clarify issues on transparency, accuracy, completeness, consistency, comparability and timely availability of data.

The audit showed a very strong commitment on quality. There is close cooperation with relevant data providers, in particular related to waste treating facilities. QA/QC takes place at different stages, and an improvement program ensures adaption of the system to changing requirements. Some recommendations on improvements have been given by the IBE, but mainly with regard to documentation and archiving.

Check IPCC 2019 Refinement

The new specifications of the IPCC 2019 Refinement (e.g. on the consideration of active aeration of landfills) were investigated but no need for adjustment of the OLI FAO model was identified as e.g. in-situ stabilisation is currently hardly practiced in Austria as a national study (Umweltbundesamt, 2023a) revealed.

7.2.5 Recalculations

No recalculations are reported in this years' submission.

7.2.6 Planned improvements

No improvements are currently planned.

7.3 Biological Treatment of Solid Waste (CRT Category 5.B)

Emissions: CH_4, N_2O

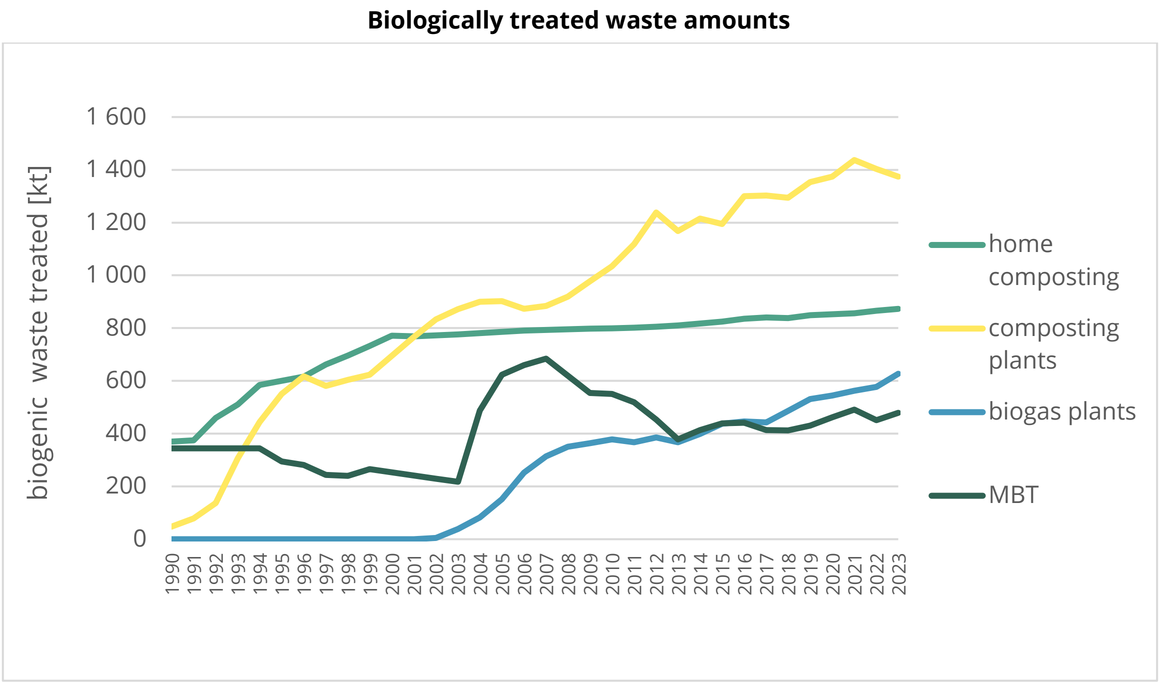
Key Source: no

7.3.1 Source category description

In this category biological treatment of solid waste is considered, including CH_4 and N_2O emissions from mechanical-biological treatment (MBT), composting and anaerobic digestion.

- mixed waste treated in Mechanical-Biological Treatment (MBT) plants, covering waste from households and similar sources covered by the municipal waste collecting system, but also significant amounts of waste from waste water treatment (e.g. sewage sludge) or smaller amounts of waste from industrial sources (e.g. residues from processing of recovered paper) are included.
- biogenic waste composted, covering centralised composting plants and home composting
- biogenic waste treated in biogas plants (anaerobic treatment)

Figure 53: Amounts of waste treated (mechanical-) biologically.



Source: Umweltbundesamt

Emissions increased by 329% since 1990 as the result of the increasing amount of composted waste, the construction of biogas plants and to a minor part to increased amounts of mechanical-biologically treated waste.

7.3.2 Methodological Issues

7.3.2.1 Composting (5.B.1)

Emissions from mechanical-biological treatment as well as composting are calculated by multiplying the quantity of waste by the corresponding emission factor, using Equation 4.1 respectively Equation 4.2 from the IPCC 2006 GL.

$$CH_4\ emissions = M_i * EF_i$$

$$N_2O\ emissions = M_i * EF_i$$

Where:

M_i … mass of organic waste treated by biological treatment type i (composting, MBT)

EF_i … emission factor for treatment i (MBT, composting)

7.3.2.2 Anaerobic digestion at biogas facilities (5.B.2)

Biogas plants became operational in Austria in 2002. For the years before (2001 and former years) 'NO' is reported as no anaerobic digestion of waste took place in Austria.

CH_4 emissions from biogas plants, i.e. emissions due to unintentional leakages during process disturbances or other unexpected events as well as from storage of fermentation residues, are calculated applying the IPCC 2006 default value of 5% CH_4 emissions of biogas produced[116]. From 2015 to 2030 it is assumed that the leakage gradually decreases to stabilise at a leakage rate of 1%. The reasoning for this continuous decrease is that gas-tight storage tanks are required for new biogas plants to obtain approval. As the average lifetime of a biogas plant is estimated with 15 years, it can be assumed that by 2030 only gas-tight biogas plants are in operation. But still a leakage of 1% will be assumed, also after 2030.

$$CH_4\ emissions = M * L_0 * F * CH_4\ density * EF$$

Where:

M … mass of organic waste treated by anaerobic treatment plants

L_0 … CH_4 generation potential

F … fraction of methane in biogas

EF … emission factor (% of CH_4 generated)

N_2O emissions for category 5.B.2 – Municipal Solid Waste are reported as 'NA' in CRT table 5.B from 2002 onwards as the 2006 IPCC Guidelines (vol. 5) (1) do not include a default methodology and EF and (2) N_2O emissions from anaerobic digestion of organic waste are assumed to be negligible (vol. 5, p.4.4 and table 4.1).

[116] The remaining 95% of the total methane generated and not emitted is included in the "Amount of CH_4 for energy recovery", covering flaring as well (reported as 'IE').

7.3.2.3 Activity data

The 'Electronic Data Management' (EDM) is the main data source for this category. The EDM is an information network operated by Umweltbundesamt. It is a central *eGovernment* initiative by the Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (www.edm.gv.at) enabling enterprises, waste collectors and conditioners as well as authorities to handle registration, notification and reporting obligations in the waste and environment sectors online. Waste amounts collected and treated (input-output records) have to be reported on an annual basis via this electronic tool.

Historical activity data were taken from national publications and regional sources.

- From 2009 onwards, data on **mechanical-biologically treated waste** is taken directly from the Electronic Data Management (EDM). For the years prior to 2009, several national studies provided the required activity (BAUMELER, et al., 1998, Angerer, T. & Fröhlich, M., 2002, Umweltbundesamt, 2008a).
- Data source for the waste amounts treated in **composting plants** is the EDM as well. Data for the first years of the time series were collected from the Austrian Federal Provinces (Amlinger, 2003b) data in-between interpolated. Regarding EDM data on composting plants, research by waste experts from Umweltbundesamt (2015) indicates higher amounts of waste being composted than covered by the EDM due to some minor exemptions in the EDM reporting requirements and in some cases missing reports. Based on a study conducted in 2015 on municipal green waste (Umweltbundesamt, 2016), it is assumed that in 2011 10% of waste volumes reported are additionally composted, whereas this additional share is expected to decrease linearly to 5% in 2014 as it is expected that reporting irregularities will be further decreased. The 5% assumption is continued from 2014 and onwards.
- Current **home composted amounts** are taken from the latest Federal Waste Management Plan (BMK, 2023). Historical amounts (2000 and earlier years) are available from a national study (Amlinger, et al., 2005). To create a time series, a per capita value was derived from both sources and an average per capita of 95 kg then applied to the population figures (Statistik Austria, 2024i).
  In submission 2023 the amounts of waste composted in private and community gardens have been entirely revised.[117] The reason is a change of the estimation method done in the course of the preparation of the Federal Waste Management Plan (BMK, 2023) in view of an upcoming reporting obligation regarding home-composted quantities to the European Commission[118]. Based on an estimated total volume of biogenic waste produced (covering food waste as well as grass, leaves, branches from green urban areas) the biogenic waste collected via municipal waste management system (residual waste) and via separate collection was deducted to get a value of biogenic waste potentially be composted in home and community gardens.
- **Biogas plants:** EDM data on waste treated anaerobically is available since 2011. For the years prior to 2011 an increase of activity from 2002 onwards in line with the increasing

[117] Until submission 2022 home composted amounts for the years 2010 ff were calculated based on a per-capita value of 215 kg/person/a, whereas for Vienna only 15% of the population was considered due to the lower number of gardens in this urban area. This approach was in line with the method applied for the BAWP (BMNT 2018a).

[118] In the future home composting will be included in the AT recycling rate for municipal waste.

feeding-in of renewable energy from biogas plants into the national grid is assumed. Anaerobic digestion started to become a treatment option in 2002 in Austria when the Green Electricity Act (Ökostromgesetz 2002; Federal Law Gazette No 149/2002) entered into force.

Table 321: Activity data for MBT and composting (5.B.1) as well as anaerobic treatment (5.B.2).

Year	Mechanical-Biological Treatment (MBT)	Composting plants	Home composting	Anaerobic treatment
		[kt]		
1990	345	48	370	NO
1995	295	551	600	NO
2000	254	695	772	NO
2005	623	903	786	152
2010	551	1 035	799	378
2011	519	1 118	802	367
2012	453	1 239	806	385
2013	379	1 168	811	367
2014	413	1 215	817	399
2015	439	1 194	825	438
2016	442	1 300	836	446
2017	414	1 303	841	443
2018	412	1 294	839	486
2019	430	1 353	849	532
2020	462	1 374	853	544
2021	492	1 437	856	563
2022	451	1 404	866	577
2023	478	1 375	873	627

7.3.2.4 Emission factors

Different references provide emission factors for mechanical-biologically treated waste, thus an average value was used. The emission factor for composted waste is taken from a national study. The emission factors are within the IPCC default range as presented in Table 4.1 of the IPCC 2006 GL.

Table 322: Emission factors used for 'Composting' (5.B.1).

	CH_4 [kg/t FS*]	N_2O [kg/t FS]	References
Mechanical-biological treatment (MBT)	0.6	0.1	(Amlinger, et al., 2005, Angerer, T. & Fröhlich, M., 2002, Doedens, et al., 1999, UBA Deutschland, 1999)
Composting (bio-waste, loppings, home composting)	0.75	0.1	(Amlinger, et al., 2005)

* *'Feuchtsubstanz' = 'Wet mass'*

The EFs provided here refer to the wet mass ('FS'-Feuchtsubstanz), the EFs in the CRT however refer to the dry mass. Accordingly, the IEF refers to the AD in dry matter. For the input material a moisture content of 60% was assumed. Furthermore it should be noted that in the CRT the IEF is calculated for MBT and for composting together, which has an impact to the total IEF of CH_4. However, the input to MBT is much smaller than the input to composting (only about 18% of the total input in *5.B.1* in 2023) and therefore the emission factor is dominated by the EF for composting.

For CH_4 the IEFs based on dry matter are as follows: MBT: 1.5 kg CH_4/t dry matter; Composting: 1.9 kg CH_4/t dry matter. Taking into account the respective treated amounts, a combined IEF of 1.81 kg CH_4/t dry matter can be derived for 2023.

For N_2O from MBT and Composting the IEF related to dry matter is 0.25 kg N_2O/t dry matter.

Table 323: Emission parameters used for 'Anaerobic digestion at biogas plants' (5.B.2).

	Parameter		**References**
L_0	CH_4 generation potential	110 m³/t	(Umweltbundesamt, 2011)
F	Fraction of CH_4 in biogas	0.6	(Umweltbundesamt, 2011)
$EF_{until\ 2015}$	EF (emitted CH_4)	5%	(IPCC 2006)
$EF_{2016\ onwards}$	EF (emitted CH_4)	See below	Expert judgement

The emission factor for CH_4 emitted is gradually decreasing from 2016 to 2030, as Austrian approval authorities require 'zero' leakage from new biogas plants. For this reason, the leakage of 5% is gradually decreasing to 1% in 2030, considering the average lifetime of a biogas plant with 15 years.

A CH_4 density (D) of 0.65 kg/m^3 is applied.

The 2006 IPCC GL do not provide an N_2O emission factor for 'anaerobic digestion', and emissions are assumed to be negligible (Volume 5, Chapter 4.1.3.1, Table 4.1). Hence Austria reports 'NA' for that source.[119]

7.3.3 Uncertainty Assessment

The following uncertainties are determined for that category:

Table 324: Uncertainty assessment for CRT 5.B Biological Treatment of Solid Waste.

	CH_4	**N_2O**
Activity data	20%	20%
Emission factor	50%	50%

[119] The UNFCCC Reporting Guidelines (Dec. 24/CP.19) state in footnote 6 to article 37 b (page 12), that "the notation key 'NE' could also be used – i.e. does not have to be used (no 'shall requirement') – when an activity occurs in the Party but the 2006 IPCC Guidelines do not provide methodologies to estimate the emissions/removals". Based on this paragraph, our understanding in this matter is that reporting of "NA" is valid in the absence of an IPCC default methodology and emission factor.

7.3.4 Category-specific QA/QC

See Chapter 7.1.5.

All QA/QC steps have been undertaken for this category. A comparison of EF with the IPCC defaults proved that these are in the range of the IPCC 2006 GL. In addition, the input data audit described under the CRT *5.A Solid Waste Disposal* to a large extent also considers this sub-category as the data basis (EDM) is the same.

7.3.4.1 Composted amounts

For the years 2011–2014 activity data on the input in **composting plants** reported via Electronic Data Management (EDM) were checked for accuracy and completeness. As according to current knowledge the EDM reporting obligation does not cover all potential composting plants in Austria, some waste amounts not reported via EDM have to be considered additionally to achieve time-series consistency, estimated to be 5% additionally to the reported waste amounts (Expert Judgement Umweltbundesamt).

Historical **home composted amounts of waste** in Austria are available from two different sources: The Federal Waste Management Plan (BMK, 2023), based on a calculation considering different national mass volumes, as well as a national study (Amlinger, et al., 2005) surveyed at the level of the federal provinces. A comparison has shown that the results coincide very well (0.096 t per capita versus 0.095 t per capita).

7.3.4.2 Verification – CH_4 from biogas plants

An alternative approach for calculation was considered, using the EF included in chapter 4.1.3.1 of the IPCC 2006 GL – corrigendum of July 2015 (0.8 kg CH_4/t waste treated) leading to lower CH_4 emissions (20 vs 39 kg CO_2e/t waste treated) than applying the IPCC default for CH_4 in terms of emissions per gas produced (as actually applied and included in chapter 4.1 of the IPCC 2006 GL). Due to the higher gas generation potential of biogenic waste fermented (mainly municipal biogenic and kitchen waste) the more conservative option was chosen for the Austrian inventory.

7.3.5 Recalculations

No recalculations are reported in this years' submission.

7.3.6 Planned improvements

No improvements are currently planned.

7.4 Incineration and Open Burning of Waste (CRT Category 5.C)

The Austrian Federal clean air act (Bundesluftreinhaltegesetz, BGBl. I Nr. 137/2002)[120] prohibits the burning of waste outside stationary combustion facilities with the general exception of fire grills, bonfires and barbecues as well as activities which need a specific permit (e.g. burning of agricultural residues).

7.4.1 Waste Incineration (5.C.1)

7.4.1.1 Source Category Description

Emissions: CO, CH_4, N_2O

Key source: No

In this category, emissions from incineration of waste oil are included as well as emissions from municipal waste incineration without energy recovery. All CO_2 emissions from waste are caused by waste incineration. The share of 5.C.1 in total emissions from waste is 0.6% for the year 1990 and 0.2% for the year 2023.

In Austria, waste oil has been incinerated in especially designed so called "USK-facilities" (**U**mwelt**s**chutz**k**omponenten GmbH). The emissions of waste oil combustion for energy recovery (e.g. in cement industry) are reported under fuel combustion. In 2002, the Austrian waste incineration regulation[121] came into force, introducing ambitious emission limits (from 2005 on[122]) for air pollution for all kind of waste incineration plants without any limit of size. The number of facilities, which do have the allowance for incineration of waste oil other than cement plants and large waste incineration plants, was only five since the year 2010.

In general, municipal, industrial and hazardous waste are combusted for energy recovery in district heating plants or in industrial sites and therefore the emissions are reported under fuel combustion. There is only one waste incineration plant without energy recovery which has been operated until 1991 with a capacity of 22 000 tons of municipal waste per year. This plant has been rebuilt as a district heating plant, starting operation in 1996. Therefore, the emissions since the re-opening of this plant are reported under fuel combustion from 1996 onwards.

Table 325: Greenhouse gas emissions from Category 5.C.1.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	27.92	0.0009	0.0004	28.06
1995	11.11	0.0003	0.0001	11.15
2000	12.40	0.0003	0.0001	12.44
2005	12.40	0.0003	0.0001	12.44

[120] https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20002155

[121] Abfallverbrennungs-(Sammel-)Verordnung (AVV; BGBl. II Nr. 389/2002 i. d. g. F.): Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft und des Bundesministers für Wirtschaft und Arbeit über die Verbrennung von Abfällen.

[122] Old facilities had to conform to the new regulation 2005 at the latest.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
2010 to 2023	2.05	0.0001	0.0000	2.06
1990–2023	**-93%**	**-94%**	**-96%**	**-93%**

7.4.1.2 Methodological Issues

A simple tier1 methodology is applied: the quantity of waste is multiplied by an emission factor for CO_2, CH_4 and N_2O.

Emission factors

National emission factors for CH_4 are derived from residual fuel oil VOC emission factors (Bundesministerium für wirtschaftliche Angelegenheiten, 1990, Bundesministerium für wirtschaftliche Angelegenheiten, 1996, Umweltbundesamt, 2001b). N_2O emission factors are taken from a national study (Orthofer et al., 1995a).

For municipal solid waste and clinical waste the CO_2 emission factor is calculated by means of IPCC GPG 2001 default assumptions for total carbon content and fossil carbon share. The selected calculation parameters are presented in Table 326. Because of the absence of plant specific data a combustion efficiency of 100% has been selected.

For waste oil, the same CO_2 emission factor (80 t CO_2/TJ) as for *1.A.1.a* heavy oil is used and a heating value of 40.3 GJ/t (source: Energy balance-residual fuel oil) is used to convert the emission factors from [t/TJ] to [kg/t].

Table 326: Emission factors and parameters of IPCC Category 5.C.1 Waste Incineration.

Waste Type	Carbon content	Share in fossil carbon	Combustion efficiency	CO_2 [kg/t]	CH_4 [g/t]	N_2O [g/t]
Municipal Waste	40%	40%	100%	586.67	0.2[(1)]	12.18
Clinical Waste	60%	40%	100%	880.00	100.00	12.00
Waste Oil	–	–	–	3 224.00	NA	24.18

[(1)] *IPCC 2006 Guidelines table 5-3, technology 'continuous incineration/stoker'.*

Activity data

For municipal solid waste, the capacity (22 000 tons of waste per year) of one operating waste incineration plant without energy recovery was used.

Waste oil activity data 1990 to 1999 were taken from (Umweltbundesamt, 1995). For 2000 to 2005 the activity data of 1999 was used. (Umweltbundesamt, 2001c) quotes that in 2001 total waste oil accumulation was about 37 500 t. Nevertheless, waste oil is mainly used for energy recovery in cement kilns or public power plants and it is consequently accounted for in the energy balance as *Industrial Waste*.

Activity data of clinical waste is determined by data interpretation of the waste flow database at the *Umweltbundesamt* considering the waste key number '971' („Abfälle aus dem medizinischen Bereich") for the years 1990 and 1994 and extrapolated for the remaining time series.

Since 2005, the Austrian waste incineration regulation gives ambitious emission limits for air pollution for all kind of waste incineration without any limit of quantity. Since then, all operators which do have an allowance for incineration of a specific type of waste, needs to be registered in a federal database. The number of waste incineration plants which are not considered under sector *1.A* is:

- Waste oil: 8
- Clinical waste: 1
- Municipal solid waste: None

At current there is one facility which has the permit to incinerate hazardous waste (including hospital waste) in larger amounts which is allocated in *1.A.1.a*. Additionally there is one hospital with a permit to incinerate waste (capacity < 2 t/h) but it is not known if and how the energy is used. Assuming a capacity of 1 t/hour of plastics waste and 500 hours yearly operating time it was estimated to be 500 t/year. However, waste experts at the Umweltbundesamt doubt if this hospital makes use of the permit. Thus from the expert view this is rather an over- than an underestimate.

Under the new waste regulation 8 companies have the permit to incinerate waste oil although it is not known if they make use of their permit in reality. These companies are mostly road transport companies or car dealers which are considered not to use the energy. Each of the 8 companies is assumed to have installations with a capacity of 60.8 t waste oil/year (Umweltbundesamt, 2001c). This is the same average capacity that has been used for estimating the waste oil quantity for 1990 to 2005. This results in a rounded value of 500 t waste oil/year. Activity data for the years 2006–2009 has been interpolated. Activity data for clinical waste and waste oil has been kept constant since the year 2010 because the number of facilities with a permit did not change.

Table 327: Activity data for IPCC Category 5.C Waste Incineration.

Year	Municipal Waste [Mg]	Clinical Waste [Mg]	Waste Oil [Mg]
1990	22 000	9 000	2 200
1991	22 000	7 525	1 500
1992	NO	6 050	1 800
1993	NO	4 575	2 100
1994	NO	3 100	2 500
1995	NO	3 100	2 600
1996	NO	3 100	2 700
1997	NO	3 100	2 800
1998	NO	3 100	2 900
1999–2005	NO	3 100	3 000
2006	NO	2 500	2 500
2007	NO	2 000	2 000
2008	NO	1 500	1 500
2009	NO	1 000	1 000
2010–2023	NO	500	500

The following table shows activity data of waste incineration with energy recovery.

Table 328: Activity data for waste incineration with energy recovery.

Year	1.A.1.a Public Electricity and Heat[1]			1.A.2 Industrial waste		1.A.2 Manuf. Industries[3]
	MSW [t]	hazardous waste [t][4]	sewage sludge [t]	Industrial waste [t]	of which waste oil [t]	Ind. Waste [TJ]
1990	299 256	80 000	55 000	59 422	11 716	3 220
1995	441 502	71 337	60 672	86 998	28 675	5 270
2000	528 365	70 513	80 406	169 888	27 794	6 250
2005	944 948	103 058	58 979	338 491	27 028	7 891
2010	1 418 176	109 772	57 002	359 589	21 911	11 210
2011	1 456 520	108 220	164 636	393 857	19 597	11 941
2012	1 438 921	98 227	176 809	388 235	12 662	11 401
2013	1 516 986	143 848	173 637	428 759	10 365	11 264
2014	1 774 538	168 985	177 894	462 892	11 963	11 022
2015	1 850 216	114 110	201 061	481 311	15 370	10 966
2016	1 783 095	399 848	197 201	478 954	20 396	11 929
2017	1 895 859	104 892	201 374	476 084	18 267	11 836
2018	1 842 933	101 684	182 822	513 896	19 782	12 142
2019	1 910 989	99 344	180 179	487 055	22 070	11 028
2020	2 077 348	86 853	168 996	470 651	18 756	11 645
2021	2 081 197	97 521	97 824	481 066	18 628	11 413
2022	2 023 033	101 177	94 853	480 875	18 411	13 086
2023	2 159 005	97 928	102 605	441 555	13 479	11 355

[1] *UMWELTBUNDESAMT, (IEA/EUROSTAT JQ, 2024).*

[2] *(Hackl, Mauschitz, 1995, 1997, 2001, 2003, 2007, Mauschitz, 2004, 2009, 2010-2023), From 2005 onwards ETS data is used*

[3] *1.A.2.f other fuels – activity data*

[4] *including waste oil and clinical waste*

7.4.1.3 Recalculations

No recalculations were carried out in this years' submission.

7.4.1.4 Planned improvements

No improvements are currently planned.

7.4.2 Open Burning of Waste (5.C.2)

7.4.2.1 Source Category Description

Emissions from the open burning of wood residues from vineyards are calculated in the Agriculture sector but reported in the Waste sector under category *5.C.2.1.b Open Burning of Waste* – Biogenic –

Other. In response to the ESR Review 2023, biogenic CO_2 emissions were added to this source category.

7.4.2.2 Methodological Issues

A simple country specific method with country specific emission factors is applied for estimation of CH_4 and N_2O emissions. For the calculation of biogenic CO_2, the simple Tier 1 methodology of the 2006 IPCC GL (Volume 5, Chapter 5, equation 5.1) is used.

Activity data

For activity data, the planted vineyard area of the national vineyard surveys (Weingartengrunderhebungen) for the years 2009, 2015 and 2020 (Statistik Austria, 2011), (Statistik Austria, 2016) and (Statistik Austria, 2021c) was used, as these explicitly comprise the vineyard area planted with vine stems. For time series consistency, the areas of vineyards between 2009, 2015 and 2020 were interpolated. For 2021, 2022 and 2023, the value of 2020 has been taken as no more recent data is currently available. According to the EU legislation, these surveys have to be carried out every 5 years. So, in 2025 the next survey will be conducted. Land use areas are harmonized with sector Land Use, Land Use Change and Forestry (LULUCF) of Austria's GHG inventory to be consistent within the Austrian Inventory and across all sectors. Further details are given in chapter 6.3 *Cropland (Category 4.B).*

According to an expert judgement from the *Federal Association of Viniculture* (Bundesweinbauverband Österreich) in 2001 the amount of residual wood per hectare viniculture was 1.5 to 2.5 t residual wood and the part of it that is burnt was estimated to be 1 to 3%. For the calculations the upper limits (3% of 2.5 t/ha) were used, resulting in a factor of 0.075 t burnt residual wood per hectare viniculture area. Based on recent information from the *Federal Association of Viniculture*, the area of vineyards with open burning activities has decreased over time and is assessed to be no more than 1% of the total vineyard areas for the years from 2010 onwards. The burning of vine is either prohibited or only permitted to a very limited extent in the relevant federal provinces. The areas of vineyards with open burning activities between 2001 and 2010 were determined by linear interpolation between the two, respective expert judgement estimates. The value of 2010 (1%) is used for the subsequent years.

Table 329: Activity data for the open burning of wood residues from vineyards 1990–2023.

Year	Viniculture Area [ha]	Burnt Residual Wood [t]
1990	58 364	4 377
1995	55 627	4 172
2000	50 304	3 773
2005	46 892	2 475
2010	45 517	1 138
2011	45 502	1 138
2012	45 486	1 137
2013	45 470	1 137
2014	45 454	1 136

Year	Viniculture Area [ha]	Burnt Residual Wood [t]
2015	45 439	1 136
2016	45 584	1 140
2017	45 729	1 143
2018	45 874	1 147
2019	46 020	1 150
2020	46 165	1 154
2021	46 165	1 154
2022	46 165	1 154
2023	46 165	1 154

Emissions factors

The emission factors (4 828 g CH_4/t and 49.7 g N_2O/t burnt wood) were calculated by multiplying the emission factors of 7 kg N_2O/TJ and 680 g CH_4/TJ (Stanzel, et al., 1995) with a calorific value of 7.1 MJ/kg burnt wood which corresponds to burning wood logs in poor operation furnace systems.

For biogenic CO_2, the default parameters (fraction of carbon in the dry matter, oxidation factor) were taken from Table 2.4 and Table 5.2 (IPCC 2006), Volume 5, Chapter 2 and Chapter 5).

7.4.2.3 Recalculations

No recalculations were carried out in this years' submission.

7.4.2.4 Planned improvements

As the Austrian National Inventory requires a homogeneous allocation of activities and emission sources for both greenhouse gases and air pollutants and Austria is confronted with two contradictory recommendations in the reporting under the UNFCCC (UNFCCC, 2023) and under the UNECE / EU NEC Directive (NEC Review 2022), Austria decided not to change its reporting in the current submission, but plans to further analyse these findings.

7.5 Wastewater Treatment and Discharge (CRT Category 5.D)

Emissions: CH_4, N_2O
Key Source: yes, 5.D CH_4 (LA, TA)

7.5.1 Source category description

This category covers CH_4 and N_2O emissions from domestic and industrial wastewater treatment.

Domestic wastewater treatment in Austria covers the following treatment systems:

- Centralised, aerobic wastewater treatment plants (WWTP)
- Small domestic wastewater treatment plants (4 PE to 50 PE)
- Septic tanks
- Anaerobic sludge digestion

Centralised, aerobic wastewater treatment plants (WWTP) are aerobic treatment plants for carbon and nutrients removal (nitrogen and phosphorus). Two categories of centralised WWTP are distinguished:

- Centralised, aerobic WWTP for carbon removal (typically have low sludge age), referred to as 'C-plants' in further text
- Centralised, aerobic WWTP for nutrient removal (typically have long sludge age), referred to as 'CNP-plants' in further text

Small domestic wastewater treatment plants (4 PE to 50 PE) are used to treat the wastewater of one or more households. This type of treatment plants is not connected to the public sewer system and is mainly used for primary treatment, although subsequent aerobic treatment can take place as well. However, in order to simplify the calculation, the assumption has been made that this type of wastewater treatment carry out primary treatment only. Clarified wastewater is discharged directly to receiving water. These plants are referred to as 'primary treatment' in further text. *Septic tanks* are closed tanks without overflow where the retention time of solids can remain for several months or years. In this system the whole wastewater is collected in sealed pits and pumped out at regular intervals and transported to municipal treatment plants. *Anaerobic sludge digestion* is subsequent sludge treatment (primary and secondary sludge, after mechanical and biological treatment purification) in anaerobic digesters on-site.

N_2O emissions that are related to domestic wastewater collection and treatment mainly originate from aerobic processes in wastewater treatment plants, in specific from the nitrification and denitrification processes in the aeration tank. The precondition for the N_2O building are aerobic processes. CH_4 emissions that are related to domestic wastewater collection and treatment mainly originate from anaerobic processes in wastewater collection and treatment.

Table 330: Reporting of N_2O and CH_4 emissions under 5.D.1 - Overview

	CH_4 emissions	**N_2O emissions**
Centralised WWTP for carbon removal	yes	yes
Centralised WWTP for nutrient removal	yes	yes
Small domestic WWTP	yes	no
Septic tanks	yes	no
Anaerobic sludge digestion	yes	no
Indirect emissions from effluent	yes	yes

In the year 2023, greenhouse gas emissions from *5.D Wastewater treatment and discharge* contributed 27% to greenhouse gas emissions from sector *5 Waste* and 0.5% to total national greenhouse gas emissions in Austria. From 1990 to 2023, greenhouse gas emissions from this category decreased by 18%. This is due to the decrease of CH_4 emissions *from 5.D.1 Domestic wastewater* (-44%), mainly affected by the declining number of people disposing their wastewater into septic systems. On the other hand, N_2O emissions from domestic wastewater strongly increased (+79%) in line with the growing number of inhabitants connected to modern centralized wastewater treatment plants. GHG emissions from *5.D.2 Industrial wastewater* contribute only minor to GHG emissions from sub-category *5.D* (1.2% in 2023).

Table 331: CH_4 emissions from wastewater treatment

	Domestic wastewater (5.D.1)						Industrial wastewater (5.D.2)	
	septic tanks	primary treatment	Centralised WWTP (aerobic treatment)	sludge treatment	discharge	total	plants	total
	[t CH_4]	[t CH_4]	[t CH_4]	[t CH_4]	[t CH_4]	[t CO_2e]	[t CH_4]	[t CO_2e]
1990	7 578	336	1 165	1 932	887	**333 168**	34	**942**
1995	6 571	173	1 592	2 255	830	**319 754**	42	**1 180**
2000	4 190	94	1 925	2 743	378	**261 260**	52	**1 461**
2005	2 564	85	2 241	2 683	560	**227 690**	105	**2 944**
2010	1 721	37	2 185	2 598	316	**191 996**	109	**3 061**
2011	1 642	36	2 186	2 606	303	**189 619**	105	**2 950**
2012	1 564	34	2 187	2 614	290	**187 283**	108	**3 022**
2013	1 502	33	2 193	2 612	294	**185 751**	110	**3 069**
2014	1 442	31	2 200	2 611	297	**184 272**	111	**3 103**
2015	1 427	31	2 201	2 615	293	**183 908**	109	**3 055**
2016	1 416	31	2 370	2 813	312	**194 377**	116	**3 255**
2017	1 314	28	2 344	2 778	304	**189 532**	124	**3 479**
2018	1 209	26	2 385	2 815	311	**188 902**	134	**3 752**
2019	1 200	26	2 368	2 786	316	**187 487**	134	**3 751**
2020	1 191	26	2 380	2 816	302	**188 026**	130	**3 634**
2021	1 167	25	2 348	2 768	305	**185 187**	131	**3 663**
2022	1 151	25	2 342	2 777	288	**184 324**	125	**3 504**
2023	1 151	25	2 382	2 825	291	**186 883**	104	**2 915**
1990-2023	-6 427	-311	+1 217	+893	-596	**-146 285**	+70	**+1 974**
1990-2023	-85%	-93%	+104%	+46%	-67%	**-44%**	+210%	**+210%**

Table 332: N_2O emissions from wastewater treatment

	Domestic wastewater (5.D.1)				Industrial wastewater (5.D.2)	
	Centralised WWTP	effluent WWTP	Effluent population	total	plants	total
	[t N_2O]	[t N_2O]	[t N_2O]	[t CO_2e]	[t N_2O]	[t CO_2e]
1990	0	205	117	85 433	1.4	363
1995	77	215	79	98 421	1.6	419

	Domestic wastewater (5.D.1)				Industrial wastewater (5.D.2)	
	Centralised WWTP	effluent WWTP	Effluent population	total	plants	total
	[t N_2O]	[t N_2O]	[t N_2O]	[t CO_2e]	[t N_2O]	[t CO_2e]
2000	266	138	47	119 327	2.1	544
2005	363	101	34	131 986	2.4	637
2010	437	75	19	140 792	2.1	545
2011	440	74	18	140 960	2.2	570
2012	443	73	17	141 278	2.3	600
2013	447	70	17	141 478	2.8	745
2014	452	68	16	141 908	2.4	642
2015	457	70	16	143 901	2.4	643
2016	463	75	16	146 874	2.6	678
2017	468	77	15	148 114	2.7	728
2018	472	76	13	148 674	3.0	797
2019	474	78	13	149 970	3.3	875
2020	477	74	13	149 541	6.2	1 655
2021	479	74	13	150 056	5.9	1 567
2022	485	73	13	151 130	5.0	1 331
2023	489	77	13	153 309	4.9	1 296
1990-2023	489	-128	-105	67 876	3.5	933
1990-2023		-63%	-89%	79%	257%	257%

7.5.2 Methodological Issues

7.5.2.1 Domestic wastewater treatment

CH_4 emissions that are related to domestic wastewater treatment are calculated applying a Tier 2 method following the IPCC 2019 Refinement (IPCC 2019), using the default emission factors for B_o and MCF from (IPCC 2019) expressed as Chemical Oxygen Demand (COD). For the calculation of direct and indirect CH_4 emissions from centralised aerobic wastewater treatment plants as well as the subsequent anaerobic digestion at these plants, country specific COD data are available taken from a national emissions register (EMREG) covering inflow and outflow freights to and from those plants. Also data on K_{rem} and S_{mass} – necessary for the calculation of COD removed as sludge (Sj) – are country specific and are based on national sources (Parravicini, et al., 2015, Parravicini, et al., 2020). For the calculation of CH_4 emissions from small domestic wastewater treatment plants (with primary treatment only) and septic tanks, the TOW is calculated based on connection rates and COD population equivalents (120 g COD per person and day).

N_2O emissions from the treatment of domestic and commercial wastewater (including industrial sources – 'co-dischargers') in centralised wastewater treatment plants are calculated applying a country-specific method (and emission factor) based on (Parravicini, et al., 2015), as described in chapter 7.5.2.2. For calculation of N_2O emissions from the effluent (indirect emissions) the method and default emission factor from the IPCC 2006 GL is applied, using largely country specific N data from EMREG.

Connection degree to different discharge pathways

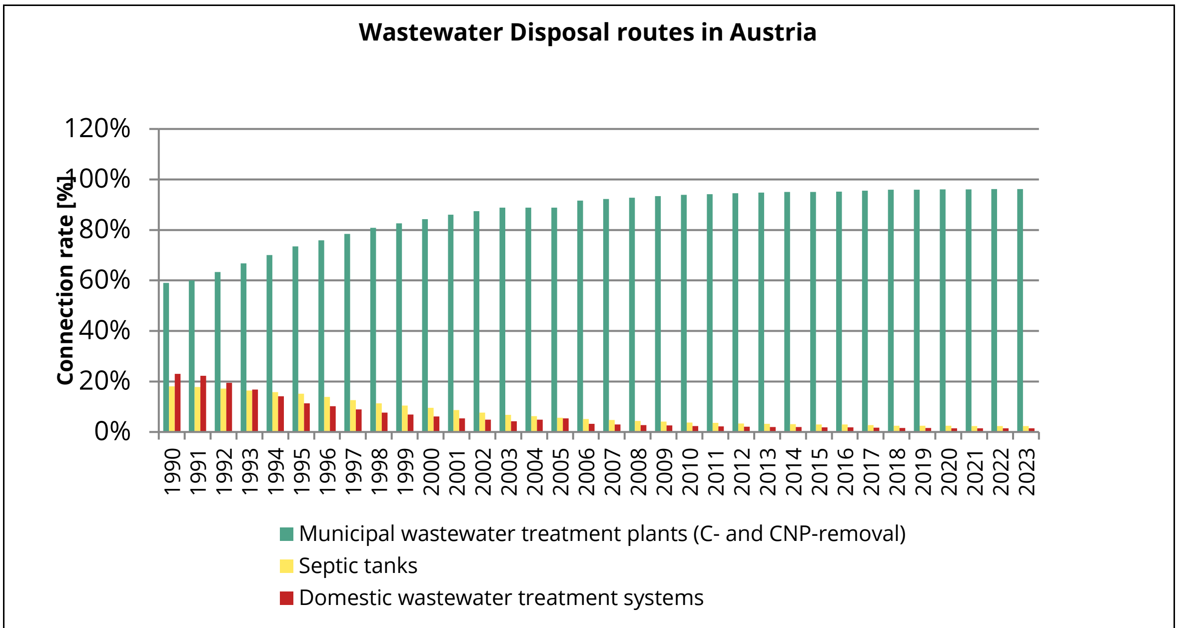
Most wastewater in Austria is treated in centralised wastewater treatment plants. From 1990 to 2023 the connection rate to those plants increased from 59.0% to 96.3%. Aerobic municipal wastewater treatment plants in Austria cover facilities with carbon removal ('C plants') and facilities with removal of carbon, nitrogen and phosphor ('CNP plants'); since 2010 all plants in Austria are classified as CNP-plants.

Table 333: Discharge pathways of domestic wastewater in Austria

	Distribution over discharge pathways							
Waste Type	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2023**
Small, domestic plants	23.0%	11.4%	6.1%	5.4%	2.3%	1.9%	1.5%	1.4%
Centralised plants with C-removal	59.0%	56.0%	24.7%	9.5%	0.0%	0.0%	0.0%	0.0%
Centralised plants with CNP-removal	0.0%	17.5%	59.6%	79.4%	93.9%	95.1%	96.0%	96.3%
Septic tanks	18.0%	15.1%	9.6%	5.7%	3.8%	3.0%	2.4%	2.3%

There are only some sparsely populated areas that are not connected to the public sewage system, but where septic tanks or small domestic plants, i.e. small aerobic wastewater treatment plants for one or two households, are used. Septic tanks account for only 2.3% in 2023, compared to 18% in 1990. Domestic wastewater treatment plants, contribute 1.4% to Austria's wastewater disposal (2023), compared to 23% in 1990 (see Table 333).

Figure 54: Disposal routes of domestic wastewater in Austria.



Source: Umweltbundesamt

Data on the Austrian **population (P)** are taken from national statistics (Statistik Austria, 2024j). Data on the **connection rates** to the public sewage system are available for the years 1971, 1981, 1991, 1995, 1998, 2001, 2003, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020 and 2022 (missing data interpolated) and were taken from the Austrian reports on water pollution control (Gewässerschutzberichte – (BMLFUW, 2002b) and previous reports) and situation reports on municipal wastewater (BMLFUW, 2006b, BMLFUW, 2008b, BMLFUW, 2010, BMLFUW, 2012, BMLFUW, 2014, BMLFUW, 2016, BMNT, 2018, BMLRT, 2020, BML, 2022a, BML, 2024b). For 2023 the connection rate was derived based on the current population data (Statistik Austria, 2024j), with an increase compared to 2022 only considered for the share of population connected to wastewater treatment plans. The number of inhabitants using septic tanks and small domestic wastewater treatment plants is expected to remain unchanged compared to 2022.

Until 1998, detailed statistics on wastewater disposal routes were available: in addition to wastewater treated in municipal plants, also domestic wastewater handling systems, septic tanks and 'unspecified disposal routes' were covered. However, data availability has changed in the early 2000s and since then only the share of 'population connected' and the share of 'population not connected' to waste water treatment plants is provided, but no further split. For this reason, a derived mean value based on historical data is used for determining the share of the not connected population using septic tanks for the years from 2001 onwards.

Sewage sludge

In order to prevent uncontrolled putrefaction, sewage sludge is further stabilized. In smaller facilities such stabilization is usually carried out aerobically (open pool with oxygen input) and only a negligible amount of methane is produced. In bigger plants (typically > 30 000 pe) stabilization is carried out in an anaerobic digester. Methane gas that is produced during anaerobic digestion is used for energy recovery in combined heat/power generation systems (CHP).[123] Related emissions are covered in CRT sector *1.A* fuel combustion and are thus reported as 'IE' in CRT Table *5.D*.[124].

In 2023 about 43% of the sewage sludge was incinerated (included in *1.A*) and 26% was applied on agricultural soils (included in *3.D*). The remaining part was treated another way, in Austria mainly in composting and to a minor part in mechanical-biological treatment plants (included in *5.B*) (Umweltbundesamt, 2024c).

7.5.2.1.1 CH_4 emissions

CH_4 emissions from domestic wastewater treatment occur mainly under anaerobic conditions. The following treatment and disposal paths are considered:

- Direct emissions from small domestic plants (with primary treatment), C-plants (with carbon removal) and CNP-plants (with carbon and nutrients removal) due to wastewater collection and treatment;
- Indirect emissions from small domestic plants, C-plants and CNP-plants due to discharge to aquatic environments
- Direct emissions from septic tanks

[123] Only if technical disruptions or overloads occur, the methane gas is flared off.

[124] The 'NA' reported under category 5.D.1 in CRT table 5.D only refers to the emissions source 'cesspools', where no recovery and no flaring takes place.

- Emissions from subsequent sludge treatment (anaerobic digestion and composting)
- For emissions calculation, the following equation from the IPCC 2019 Refinement (Equation 6.1) is applied:

$$CH_4\ Emissions_j = (TOW_j - S_j) * EF_j - R_j$$

Where:

CH_4 Emissions$_j$ = *CH_4 emissions from treatment/discharge pathway/system j (in kg CH_4/yr)*
TOW_j = *total organics in wastewater of treatment/discharge pathway/system j (in kg COD/yr)*
S_j = *organic component removed from wastewater in the form of sludge from treatment/discharge pathway/system j (in kg COD/yr)*
EF_j = *emission factor for treatment/discharge pathway/system j (in kg CH_4/kg COD)*
Rj = *amount of CH_4 recovered or flared from treatment/discharge pathway/system j (in kg CH_4/yr)*

The application of this equation for the different treatment paths, including data and parameters used, is described as follows.

Total organics in wastewater (TOW) and TOW removal

For centralised aerobic wastewater treatment plants, data on quantities of organics in wastewater ('TOW' – inflow and effluent) expressed in Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) in the wastewater are available for the years 2006-2023 from the Electronic Emission Register of Surface Water Bodies ('Emissionsregister – Oberflächenwasserkörper', abbreviated 'EMREG-OW'[125]). TOW data for the years before could partly be retrieved from the Austrian reports on water pollution control, missing data were inter- and extrapolated. EMREG is an electronic register of material emissions to surface water from point sources, especially municipal sewage treatment plant administered by the Federal Ministry of Agriculture, Forestry, Regions and Water Management and serves the collection of information for the National Water Management Plan and for management plans for international river catchment areas. EMREG covers inflow as well as effluent carbon data, so CS information on carbon removal is available as well.

Small domestic plants with primary treatment and septic systems are not covered by the EMREG reporting obligation, so the amounts of COD need to be calculated based on population data, connection rates and a COD generation rate of 120 g COD/capita/day. The COD effluent of domestic plants is calculated by applying the default removal fraction (TOW_{REM}) for mechanical treatment plants (primary treatment) of 0.40 from the IPCC 2019 Refinement (Table 6.6B (New)). For septic tanks no COD removal in the form of sludge and no disposal to aquatic environment takes place. In this system the whole wastewater is collected in sealed pits and pumped out at regular intervals and transported to municipal treatment plants. For the calculation of the TOW from primary treatment and septic tanks the following formula from IPCC 2019 (Equation 6.3) is applied:

$$TOW = P * cd_{septic\ tanks} * COD * 365 * 0.001$$

$$TOW = P * cd_{primary\ treatment} * COD * 365 * 0.001$$

[125] BGBl. II Nr. 2017/207: Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über ein elektronisches Register zur Erfassung aller wesentlichen Belastungen von Oberflächenwasserkörpern durch Emissionen von Stoffen aus Punktquellen (EmRegV-OW)

Where:

TOW = total organics in wastewater in inventory year, kg COD/yr

P = country population in inventory year, (person)

cd = connection degree to septic tanks and to primary treatment in small domestic plants

COD = specific COD load per capita = 120 g/PE/day

0.001 = conversion from grams COD to kg COD

The COD effluent from small domestic plants is calculated by applying Equation 6.3D of (IPCC 2019) and the default removal fraction (TOW_{REM}) for mechanical treatment plants (primary treatment) of 0.40 taken from (IPCC 2019) Table 6.6B:

$$TOW_{effluent\text{-}primary\ treatment} = \Sigma\ [TOW * cd_{primary\ treatment} * (1-TOW_{REM})]$$

Where:

TOW = total organics treated in small domestic wastewater treatment (primary treatment)

cd = connecton degree to small domestic wastewater treatment plants

TOW_{REM} = fraction of total wastwater organics removed during wastewater treatment = 0.4 for primary treatment according to Table 6.6B (IPCC 2019)

In septic tanks no COD removal in the form of sludge and no disposal to aquatic environment takes place, thus total TOW in septic tanks is subject to direct CH_4 emissions.

Table 334: TOW freights for each treatment pathway, in t COD/yr

	Centralised aerobic wastewater treatment plants		**Small domestic wastewater treatment plants**		**Septic tanks**
Year	**$COD_{influent}$**	**$COD_{effluent}$**	**$COD_{influent}$**	**$COD_{effluent}$**	**$COD_{influent}$**
			[t COD/yr]		
1990	367 043	55 056	77 255	46 353	60 624
1995	473 353	71 003	39 687	23 812	52 568
2000	566 786	30 269	21 569	12 941	33 523
2005	593 722	52 280	19 480	11 688	20 510
2010	573 760	30 923	8 569	5 141	13 771
2011	574 749	29 697	8 174	4 904	13 136
2012	575 737	28 470	7 786	4 672	12 513
2013	576 428	29 076	7 477	4 486	12 016
2014	577 119	29 682	7 177	4 306	11 534
2015	577 792	29 265	7 104	4 262	11 417
2016	621 965	31 426	7 048	4 229	11 327
2017	614 615	30 832	6 541	3 925	10 513
2018	624 112	31 914	6 019	3 612	9 674
2019	618 659	32 475	5 975	3 585	9 602
2020	623 555	30 966	5 928	3 557	9 528
2021	614 001	31 410	5 809	3 486	9 336
2022	614 116	29 460	5 731	3 439	9 211
2023	624 722	29 807	5 731	3 439	9 211

	Centralised aerobic wastewater treatment plants		Small domestic wastewater treatment plants		Septic tanks
Year	$COD_{influent}$	$COD_{effluent}$	$COD_{influent}$	$COD_{effluent}$	$COD_{influent}$
1990-2023	*257 679*	*-25 249*	*-71 524*	*-42 914*	*-51 413*

The CH_4 emission factors were calculated in accordance with (IPCC 2019) Equation 6.2 as follows:

$$EF_j = B_o * MCF_j$$

Where:

EF_j = *emission factor, kg CH_4/kg COD*
j = *each treatment/discharge pathway or system*
B_o = *maximum CH_4 producing capacity (kg CH_4/kg COD) = 0.25 kg CH_4/kg COD (IPCC 2019, Table 6.2)*
$MCF_{aerobic}$ = *methane correction factor (fraction) as proposed in IPCC 2019, Table 6.3*

For aerobic municipal and domestic wastewater treatement plants the MCF of 0.03 was taken, for septic tanks the MCF of 0.5 was used. For the discharge of treated wastewater the Tier 2 factor for the discharge to aquatic environments other than reservoirs, lakes and estuaries (0.035) were taken as in Austria only a minor quantity of treated wastewater is discharged to stagnant water.

Calculation of direct emissions from aerobic treatment plants:

For the calculation of emissions from aerobic wastewater treatment plants, i.e. C-plants, CNP-plants and small domestic wastewater treatment plants, the equation from the IPCC 2019 Refinement (Equation 6.1) is applied, using the default EF of 0.0075 kg CH_4/kg COD (Table 6.3 of IPCC 2019). Data on organics in wastewater treated (TOW) and discharged ($TOW_{EFFtreat}$) is largely available from the Austrian EMREG, the Electronic Emission Register of Surface Water Bodies. The TOW of small domestic plants is calculated based on population data and a specific COD load per capita of 120 g/person/day (see Table 334 and introductory text).

The organic component removed from wastewater in the form of sludge ($\mathbf{S_{aerobic}}$) is calculated using Equation 6.3B (IPCC 2019) by multiplying the amount of raw sludge removed from wastewater treatment as dry mass (S_{mass}) with an sludge factor (K_{rem}).

$$S_{aerobic} = S_{mass} * K_{rem}$$

Where:

$S_{aerobic}$ = *organic component removed from wastewater in the form of sludge in aerobic treatment plants (t COD/yr)*
S_{mass} = *amount of raw sludge removed as dry mass (tonnes/yr)*
K_{rem} = *sludge factor (kg COD/kg sludge)*

The $\mathbf{S_{mass}}$ was calculated from a COD balance based on DWA-A 131 and (Parravicini, et al., 2022), resulting in a factor of 0.59 for short sludge age, and a factor of 0.51 for long sludge age (see Annex 5.3).

Table 335: Sludge removed from aerobic wastewater treatment – mass (S_{mass}) and organic component ($S_{aerobic}$)

Year	C- and CNP-WWTP	Small domestic WWTP (primary treatment)	All plants
	t sludge (dm)	**t sludge (dm)**	**t COD/yr**
1990	184 072	25 958	244 130
1995	231 754	13 335	277 799
2000	290 959	7 247	319 194
2005	285 069	6 545	303 134
2010	279 496	2 879	286 025
2011	280 506	2 746	286 736
2012	281 514	2 616	287 448
2013	281 448	2 512	287 132
2014	281 383	2 411	286 819
2015	281 899	2 387	287 261
2016	303 443	2 368	308 911
2017	299 797	2 198	304 832
2018	303 942	2 023	308 595
2019	300 832	2 007	305 420
2020	304 096	1 992	308 662
2021	298 922	1 952	303 353
2022	299 937	1 926	304 294
2023	305 185	1 926	309 559

For K_{rem}, country specific values based on COD measurements of sludge in real wastewater treatment plans are available for C- and CNP-plants, obtained in the course of a measurement programm at Austrian wastewater plants (Parravicini, et al., 2015):

- primary sludge: 1.25 kg COD/kg sludge (dm)
- secondary sludge, short sludge age ('C plants'): 1.15 kg COD/kg sludge (dm)
- secondary sludge, long sludge age ('CNP plants'): 1 kg COD/kg sludge (dm)

During the aerobic treatment no recovery of methane takes place, thus factor **R** was set to 0.

Calculation of indirect CH_4 emissions

For the calculation of indirect emissions from the effluent from aerobic wastewater treatment plants, i.e. C-plants, CNP-plants and small domestic wastewater treatment plants, the equation from the IPCC 2019 Refinement (Equation 6.1) is applied, using the default EF of 0.009 kg CH_4/kg COD (Table 6.3 of IPCC 2019).

Data on organics in wastewater effluent ($TOW_{EFFtreat}$), i.e. in wastewater after treatment, is for C- and CNP-plants available from the Austrian EMREG, the Electronic Emission Register of Surface Water Bodies. For small domestic wastewater treatment plants the organics in treated wastewater effluent discharged to aquatic environments is calculated based on Equation 6.3D of (IPCC 2019), using the default value for TOW_{rem} related to primary treatment (0.4) as provided in Table 6.6B of (IPCC 2019).

Data on TOW effluents from all treatment paths is shown in Table 334.

For wastewater discharged to aquatic environments, there is no sludge removal (Sj = 0) and no CH_4 recovery (Rj = 0).

Calculation of CH_4 emissions from septic tanks

For the calculation of emissions from septic tanks, the equation from the IPCC 2019 Refinement (Equation 6.1) is applied, using the default EF of 0.125 kg CH_4/kg COD (Table 6.3 of IPCC 2019).

The organic load (TOW), expressed as COD, entering this tanks is calculated based on population data and a specific COD load per capita of 120 g/person/day (see Table 334 and introductory text). For wastewater collected in septic tanks there is no sludge removal (Sj = 0) and no CH_4 recovery (Rj = 0).

Calculation of CH_4 emissions from sludge treatment

CH_4 emissions from the treatment of raw sludge are calculated using Equation 4.1 from (IPCC 2006) (Volume 5, Chapter 4) and the default emission factors from Table 4.1:

$$CH_4\ Emissions_i = M_i * EF_i$$

Where:

CH_4 Emissions$_i$ = total CH_4 emissions from treatment of sludge
M_i = mass of sludge treated by biological treatment type I - S_{mass}, see Table 335
EF_i = emission factor for treatment i (g CH_4/kg sludge treated)

Most of the raw sludge is treated anaerobically in anaerobic digesters (85% in 2023), only some minor amounts are treated aerobically (5%) or another way (e.g. by drying – 5%). Anaerobic digestion have become the main treatment type of sludge in Austria since it contributes to energy recovery and carbon neutrality. The emission factor of 9.2 kg CH_4/tonnes sludge treated, applied on the total mass of sludge produced (S_{mass}) from wastewater treatment (see Table 335), has been derived as follows:

Table 336: Sludge treatment pathways and corresponding CH_4 emission factors

Sludge treatment	Share of treatment	Emission factor
	[%]	kg CH_4/ton sludge dm)
Composting	5%	10
Anaerobic treatment	85%	10
Other treatment	5%	0
unknown	5%	4
Overall EF		**9.2**

For both, composting and anaerobic digestion an EF of 10 g CH_4/kg raw sludge treated (dry weight) is applied. For anaerobic digestion the IPCC 2006 GL provide a default factor of 2, with the range between 0 and 20. However, when applying this lower default factor (2), CH_4 emissions resulting from anaerobic sludge digestion would be much lower than the direct CH_4 emissions from the aerobic treatment in wastewater treatment plants, although CH_4 emissions resulting from anaerobic digestion are generally expected to be much higher than emissions from different WWTP treatment steps. For this reason it was decided to use the higher emission factor of 10 kg CH_4/kg sludge for GHG inventory reporting on sludge digestion. This is in accordance with an alternative approach for emission calculation provided by (IPCC 2006) in Volume 5, based on biogas generated (see chapter 7.5.4.3).

Resulting CH_4 emissions from anaerobic digestion are slightly higher in comparison to direct emissions of the wastewater treatment plants, which is in good agreement with (Tauber, Parravicini, V. & Svardal, K. 2021).

It has to be noted, that category 5.D.1 only includes emissions from the biological treatment of raw sludge removed in the course of the mechanical and biological wastewater treatment. Emissions from the treatment of stabilised sewage sludge – i.e. the sludge already undergone a pre-treatment – are considered in other categories of the inventory (3.D agricultural soils, 5.B biological treatment, 5.A solid waste disposal, 1.A incineration).

7.5.2.1.2 N_2O emissions

N_2O emissions from *CRT 5.D.1.Wastewater Treatment and Discharge* are calculated using a country specific method. Emissions are calculated separately for N_2O from effluent (indirect emissions) and N_2O from advanced centralized wastewater treatment plants (i.e. plants with removal of carbon, nitrogen and phosphor 'CNP-plants'), hereinafter referred to as 'plants', (direct emissions), and are then summed up.

$$N_2O\ emissions = N_2O_{PLANTS} + N_2O_{EFFLUENT}$$

N_2O emissions = *total N_2O emissions from wastewater handling and discharge*
N_2O_{PLANTS} = *N_2O from advanced wastewater treatment plants, referred to as CNP-plants*
$N_2O_{EFFLUENT}$ = *N_2O from plant effluent + N_2O from effluent of the population not connected to plants*

The main differences to the default methodology of the IPCC 2006 GL are as follows:

- In the Austrian approach the different nitrogen flows (nitrogen influent to plants, nitrogen effluent from plants and nitrogen effluent from wastewater of the population not connected to plants) are considered separately and related emissions are then summed up.
- Instead of estimating $N_{EFFLUENT}$ based on protein consumption and co-discharged fractions (IPCC 2006 GL), measured/reported values (country-specific N) are used, based on EMREG ($N_{EFFLUENT\ PLANTS}$) and Zessner, M. & Lindtner, S., 2005 ($N_{EFFLUENT\ POPULATION}$).
- For the calculation of direct emissions from wastewater treatment plants a country-specific EF, based on measurements at Austrian wastewater treatment plants (2013/2014) is used. Only the population connected to plants with controlled nitrification and denitrification ('modern/advanced plants') is considered.

Direct N_2O emissions from plants (N_2O_{PLANTS})

N_2O emissions from wastewater treatment plants are based on a national measurement programme delivering results (EF) for 2013 (Parravicini, et al., 2015). Emissions for the whole time series (except for 2013) are calculated based on the EF derived and applying Equation 6.9 of the IPCC 2006 GL:

$$N_2O_{PLANTS} = P * T_{CNP\text{-}PLANTS} * F_{IND\text{-}COM} * EF_{PLANT}$$

N_2O_{PLANTS} = N_2O emissions from modern wastewater treatment plants
P = Austrian population
$T_{CNP\text{-}PLANTS}$ = connection rate to modern, centralized wastewater treatment plants (CS), referred to as CNP-plants
$F_{IND\text{–}COM}$ = fraction of industrial and commercial co-discharge (CS)
EF_{PLANT} = emission factor for Austrian wastewater treatment plants (CS)

Activity data

Data on the Austrian **population (P)** is provided by (Statistik Austria, 2024i). Information on the **connection rate** to the public sewage system are regularly updated and published in the Austrian reports on water pollution control (see chapter 7.5.2.1).

As only modern wastewater treatment plants with controlled nitrification and denitrification steps are relevant for N_2O emissions, only these so-called 'CND-plants' are considered in the calculation. Since 2010 all municipal wastewater treatment plants are classified as CNP-plants, due to the high overall denitrification rate in Austria (80% in 2010). In 2023 the denitrification rate reached a level of 80.8% (Umweltbundesamt, 2024f). Minor fluctuations are mainly due to the changing waste water temperature. On the contrary, until 1994 there was almost no plant with nitrification and denitrification in Austria and nitrogen removal has largely taken place as sludge removal (10%). It is assumed that between 1994 and 2010 their share was rising, in line with the N-removal. The $\mathbf{T_{CNP\text{-}PLANTS}}$ was calculated on basis of connection rates to the public sewage system (national statistics) and the assessed share of CNP-plants in Austria.

Table 337: Activity data for calculation of direct N_2O emissions (plants).

	Population	$T_{CNP\text{-}PLANTS}$		Denitrification rate
		connection rate plants	share CNP-plants	
	no.	[%]	[%]	[%]
1990	7 677 850	59.0%	0.0%	10.0%
1995	7 948 278	73.5%	23.8%	26.7%
2000	8 011 566	84.3%	70.7%	59.5%
2005	8 225 278	88.9%	89.3%	72.5%
2010	8 361 069	93.9%	100.0%	80.0%
2011	8 388 534	94.2%	100.0%	80.0%
2012	8 426 311	94.5%	100.0%	80.0%
2013	8 477 230	94.8%	100.0%	80.8%
2014	8 543 932	95.0%	100.0%	81.5%
2015	8 629 519	95.1%	100.0%	81.1%
2016	8 739 806	95.2%	100.0%	80.6%
2017	8 795 073	95.6%	100.0%	80.3%

	Population	$T_{CNP-PLANTS}$		Denitrification rate
		connection rate plants	share CNP-plants	
	no.	[%]	[%]	[%]
2018	8 837 707	95.9%	100.0%	80.9%
2019	8 877 637	96.0%	100.0%	80.5%
2020	8 916 845	96.0%	100.0%	81.0%
2021	8 951 520	96.1%	100.0%	81.0%
2022	9 052 856	96.2%	100.0%	81.2%
2023	9 130 697	96.3%	100.0%	80.8%

$F_{IND-COM}$: It is assumed that 30% of total nitrogen influent to wastewater treatment plants is attributable to commercial and industrial sources (Orthofer, et al., 1995b).

Emission Factor (EF_{PLANT})

The country specific EF used for modern wastewater treatment plants (**EF_{PLANT}**) is 43 g N_2O/population equivalent/year and is derived from a national measuring programme 2013/2014, measuring and analyzing N_2O emissions from 24 field measurements at 8 representative wastewater treatment plants in Austria (Parravicini, et al., 2015) . The EF considers current operational conditions, in particular nitrogen removal (denitrification) at Austrian wastewater treatment plants. The waste water emission ordinance for municipal wastewater treatment plants with an organic design capacity larger than 5 000 population equivalents forces a minimum reduction rate of 70% of total nitrogen. The objective of N-removal is to reduce the risk of eutrophication of surface waters.

Indirect N_2O emissions from wastewater effluent ($N_2O_{EFFLUENT}$)

For the calculation of indirect N_2O emissions Equation 6.7 from the IPCC 2006 GL is applied:

$$N_2O_{EFFLUENT} = N_{EFFLUENT} * EF_{EFFLUENT} * 44/28$$

$N_2O_{EFFLUENT}$ = N_2O emissions from effluent to surface water bodies
$N_{EFFLUENT}$ = $N_{EFFLUENT\ PLANTS} + N_{EFFLUENT\ POPULATION}$ (CS)
$EF_{EFFLUENT}$ = emission factor for wastewater discharge (IPCC 2006)

Activity data

$N_{EFFLUENT}$ includes nitrogen effluent from the population not connected to the public sewage system ($N_{EFFLUENT\ POPULATION}$) as well as nitrogen effluent from wastewater treatment plants ($N_{EFFLUENT\ PLANTS}$). Both are country specific values and thus did not need to be calculated based on protein intake statistics (as provided for Equation 6.8 of the IPCC 2006 GL).

Data on $N_{EFFLUENT\ PLANTS}$ are retrieved from the EMREG, and is so far available for the years 2001, 2004, 2006, 2008, 2010, 2012, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 and 2023 (Umweltbundesamt, 2024f). Data for the years in between had to be interpolated. For the years before 2001 the $N_{effluent}$ plants were derived taking the connected population as well as the denitrification rate into account.

$N_{EFFLUENT\ POPULATION}$ is based on investigations made by (Zessner, M. & Lindtner, S., 2005), assessing specific N loads from households in Austria to be within the range 11–13 g N/inhabitant/d. Based on the higher value of this range (13 g) and the Austrian statistics on population the $N_{EFFLUENT\ POPULATION}$ was calculated.

Table 338: Activity data for calculation of N_2O from wastewater effluent.

	$N_{EFFLUENT\ PLANTS}$	$N_{EFFLUENT\ POPULATION}$	$N_{EFFLUENT\ TOTAL}$
	[t N/yr]	**[t N/yr]**	**[t N/yr]**
1990	26 094	14 937	41 031
1995	27 420	9 994	37 415
2000	17 507	5 968	23 475
2005	12 804	4 332	17 136
2010	9 578	2 420	11 998
2011	9 409	2 309	11 718
2012	9 240	2 199	11 440
2013	8 933	2 112	11 045
2014	8 625	2 027	10 652
2015	8 966	2 006	10 972
2016	9 604	1 991	11 595
2017	9 738	1 848	11 585
2018	9 632	1 700	11 332
2019	9 965	1 687	11 653
2020	9 475	1 674	11 150
2021	9 460	1 641	11 101
2022	9 247	1 619	10 866
2023	9 743	1 619	11 361

Emission Factor ($EF_{EFFLUENT}$)

The default emission factor for N_2O emissions from domestic wastewater nitrogen effluent of the IPCC 2006 GL is applied: 0.005 kg N_2O-N/kg N.

7.5.2.2 Industrial wastewater treatment (on site)

CH_4 and N_2O emissions from sub-category *5.D.2* (see Table 331 and Table 332) are estimated on the basis of a study conducted in 2019 (Umweltbundesamt, 2019b), investigating the practice of wastewater handling in industrial plants in Austria, covering the following industrial branches:

- Paper and pulp
- Food and beverages, covering
  - dairy processing
  - breweries
  - fruit juice production
  - starch production

- sugar production
- meat production
- vegetable oils
- pet food production
- rendering

CH_4 emissions

The IPCC 2006 GL state that only industrial wastewater with significant carbon loading that is treated under intended or unintended anaerobic conditions will produce CH_4. Accordingly, all relevant industrial plants in Austria in the area of food production and pulp and paper – i.e. with significant carbon loading – were contacted in the framework of a national study (Umweltbundesamt, 2019b), to get information on:

- their wastewater treatment practice (on-site treatment/indirect discharge, aerob/anaerob treatment, sludge digestion, gas recovery, etc.)
- bottom-up data on gas generated in the pre-treatment of waste water and methane concentration (based on measurements).

It turned out that anaerobic wastewater pre-treatment only partially takes place in individual industrial sectors – such as the paper industry, breweries, starch, sugar and fruit juice production. All plants with anaerobic pre-treament have gas collection with subsequent energy recovery. For industrial wastewater treatment plants practicing no anaerobic wastewater pre-treatment on-site – e.g. in the milk and meat production – a MCF of zero is assumed in accordance with the IPCC 2006 Guidelines as they are well managed in Austria.

In addition most of the industrial plants do not have anaerobic treatment of the sludge. The sludge is incinerated on-site or off-site or transferred to external treaters (biogas plants, domestic waste water treatment plants). The few plants with an anaerobic treatment of sludge use the biogas produced for energy prodution.

Nevertheless, emission of methane can occur as diffuse emissions e.g. during the subsequent aerobic treatment of the anaerobic pre-treated waste water (partly stripping of methane if methane is included in the pre-treated waste water). For this reason, an EF of 1% of the methane generated was applied for all plants with an anaerobic pre-treatment.

The assumption of 1% fugitive methane emission is also supported in (IFEU, 2008), where a fugitive emission of 1% is assumed for biogas plants.

Emissions data for 1990–2018 were taken directly from the study (Umweltbundesamt, 2019b), data for subsequent years were extrapolated mainly using production data for primary and secondary pulp (Austropapier, 2023), as the paper industry is the main source of CH_4 emissions from this subcategory (share of 78% in *5.D.2*).

N_2O emissions

N_2O is produced, if modern waste water treatment is applied (N–removal by nitrification/ denitrification). However, industrial waste water often shows only small nitrogen concentrations and therefore direct N_2O emissions are low. Furthermore indirect N_2O emissions are caused by the N-load in the effluent emitted to the receiving waters.

Indirect N_2O emissions are calculated by using measured N-loads from industrial direct discharges reported annually in the EMREG Register (Umweltbundesamt, 2024f) and applying the emission factor for wastewater discharge of 0.005 kg N_2O-N/kg N (IPCC 2006).

7.5.3 Uncertainty Assessment

The uncertainty, originally based on ORTHOFER et al (1995), was re-evaluated and adapted for the N_2O EF based on an expert judgement by Umweltbundesamt (2015). The compared to the previous estimate higher EF uncertainty is due to the relatively low uncertainty assessment of previous submissions, the very large uncertainty associated with the default EF for indirect N_2O emissions (IPCC 2006 GL) as well as the wide dispersion of the individual measurement results influencing the EF for wastewater treatment plants (Expert judgement by Umweltbundesamt (2015)). Also fluctuating nitrogen flows and removals affects the uncertainty of the applied CS EF.

The uncertainty for CH_4 was completely revised compared to the previous submission as new emission sources were considered for the first time (wastewater treatment plants, raw sludge treatment, discharge to aquatic environments). The lower uncertainty for activity data can be explained by the use of the data from Austrian national emissions register for surface water (EMREG-OW). In Austria all WWTP > 2 000 PE report to EMREG-OW. These treatment plants cover 96% of the total load. The operators are responsible for the collecting and reporting of the data. These data are subjected to external monitoring as well. After entering the data in EMREG-OW quality check of the data is performed on regular base ensuring very low uncertainty of the data.

The uncertainty of the CH_4 EF was adjusted to consider all sources covered under 5.D.1, and is based on the uncertainty ranges as included in the IPCC 2019 Refinement (Table 6.7 of Volume 5, Table 4.1 of Volume 5, Chapter 4).

Table 339: Uncertainty assessment for CRT 5.D.1 Wastewater Treatment and Discharge (2023).

	CH_4	N_2O
Activity data	5%	5%
Emission factor	16%	100%

7.5.4 Category-specific QA/QC

7.5.4.1 CH_4 from centralised aerobic wastewater treatment plants (Verification)

For verification purpose, a comparison of the inventory results with literature data on CH_4 emissions from wastewater treatment plants was made. Deriving an emission factor for C- and CNP-plants, based on the current inventory but related to PE (population equivalents), results in 399 g CH_4/PE.a for 1990 and 383 g CH_4/PE.a for 2023. This is well in the range of emission values as published for wastewater treatment plants in international literature, e.g. (e.g. (Daelman, et al., STOWA 2010). In summary, literature data accounts for 76 to 588 g CH_4/PE/a for WWTPs, including emissions from the digestion process (Tauber, Parravicini, V. & Svardal, K. 2021).

7.5.4.2 Sludge amount (Verification)

The amount of the raw sludge removed in C-plants and CNP-pants has been calculated using country specific data on S_{mass} and $COD_{removed}$ (see chapter 7.5.2.1.1). It is well known that degradation of dry solid sludge during anaerobic digestion ranges between 30% and 35%.

According to our inventory calculation 305 185 t of raw sludge was produced in C- and CNP-plants during 2023 (see Table 335). Assuming 35% degradation, the amount of the stabilised sludge would degrade to **198 370 t** after anaerobic digestion. According to an evaluation of sewage sludge generation and utilization in Austria (Umweltbundesamt, 2024c), made for the 'Bundesabfallwirtschaftsplan' (Austrian Waste Management Plan) in 2023 approximately **197 269 t** of stabilised sludge has been generated, which is in very good agreement with the sludge amount that has been calculated.

7.5.4.3 CH_4 from anaerobic sludge treatment (Verification)

To verify the CH_4 emissions from anaerobic sludge treatment (GHG inventory result) calculated as described in chapter 7.5.2.1.1, an alternative approach, based on biogas production, was applied. In Volume 5 of (IPCC 2006) it is stated that emissions of CH_4 from anaerobic digestion will generally be between 0 and 10 percent of the amount of CH_4 generated due to unintentional leakages during process disturbances or other unexpected events. This methodology was applied as an alternative approach as follows:

Based on a COD mass balance, biogas has a content of 35 g COD/PE.d. Methane production on Austrian WWTP > 20 000 PE corresponds approximately to 12 L CH_4/PE,d (Lindtner, 2008). Under the assumption that under standard conditions, 22.4 liters of gas correspond to one mole of the gas, following calculation can be made for 2023:

Assumptions:

- 35 g COD in biogas
- 12 L CH_4/PE,d (specific CH_4 production on Austrian WWTPs)
- 14.3 PE (average PE load in 2023 for Austrian WWTP based on COD)
- 5 % CH_4 default value for methane emissions (IPPC, Vol5)

Calculation:

12 L CH_4/PE,d / 22.4 L *(12 g + 4 g) *365 = 3 129 g CH_4/PE,a

3 129 g CH_4/PE,a * 14.3 PE = 44 739 t/CH_4/a * 5 % = **2 237 t CH_4/a**

Result:

Total CH_4 from sludge treatment in 2023, determined for the GHG inventory (using the EF as shown in Table 336) amounts to **2 825 t CH_4/a** (see Table 331), which is very near to the calculation result based on biogas production and an 5% methane loss assumption as described above (2 237 t CH_4/a). This confirms the assumption that for Austria the EF for anaerobic digestion has to be set much higher than the default EF of 2 g CH_4/kg waste digested as provided in Table 4.1 (Volume 5) of the IPCC 2006 Guidelines.

7.5.4.4 N_2O from domestic wastewater treatment (5.D.1)

An extensive QA/QC on the methodology has been conducted in 2014/2015 to best adapt the method for estimating N_2O emissions from wastewater to the IPCC 2006 GL. In this context different options were considered and discussed with other wastewater experts. Results for the year 2013 range from 122 t N_2O to 757 t N_2O (using no country-specific data at all). The currently applied option was chosen as it delivers the most accurate emissions result, considering actual nitrogen flows and a CS emission factor reflecting up-to-date operating conditions at Austrian wastewater treatment plants.

Results of the measurement program (RelaKO) were presented to a wide range of national stakeholders at two events organised by the Austrian Water and Waste Management Association ('ÖWAV'; PARRAVICINI & SVARDAL 2015) and published as a scientific article in Energy Procedia (PARRAVICINI ET AL 2016) as well as in the JOURNAL OF ENVIRONMENTAL MANAGEMENT 279 (2021).

Verification EF_{PLANTS}

As a QA and verification measure Austria regularly evaluates plant specific N flows (influent to and effluent from wastewater treatment plants) and take this data for extrapolation of plant specific N_2O emissions – as determined by the national measuring programme 2013/2014 RelaKO ((Parravicini, et al., 2015)BMLFUW 2015) – to national N_2O emissions from wastewater treatment plants on basis of the regression equation of the RelaKO project. This way, changing operating conditions at wastewater treatment plants can be considered and emissions (or the EF_{PLANT}) adjusted accordingly, if necessary.

7.5.5 Recalculations

In this years' submission CH_4 emissions from the treatment of domestic wastewater in municipal wastewater treatment plants, domestic wastewater treatment plants as well as from the disposal of treated wastewater to aquatic environments were considered for the first time leading to higher emissions from this sub-category over the entire time series (+164 kt CO_2e in 2022).

For *5.D.2 industrial wastewater* recalculations are reported for 2021 and 2022 (–0.4 kt CO_2e) as updated information on primary and secondary pulp production became available from the latest industry reports 2022 and 2023 (Austropapier, 2023).

7.5.6 Planned improvements

No improvements are currently planned.

8 OTHER (CRT SECTOR 6)

Austria does not report any emissions under CRT Sector 6.

9 INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS

According to decision 18/CMA.1, annex, para. 52. Parties may report indirect CO_2 from the atmospheric oxidation of CH_4, CO and NMVOCs as well as indirect emissions of N_2O from sources other than agriculture and LULUCF.

Austria does not separately report any indirect CO_2 emissions from the atmospheric oxidation of CH_4, CO and NMVOCs in CRT Table 6, but has partly covered these emissions in categories *1.A* and *2.D.3* as described below.

Table 340: Indirect emissions as reported in CRT Table 6 for the year 2023.

Greenhouse Gas Source and Sink Categories	Indirect Emissions	
	CO_2	**N_2O**
1. Energy	IE,NE	NE
2. Industrial Processes and Product Use	IE	NE
3. Agriculture	NO	NO
4. LULUCF	NO	NO
5. Waste	NA	NA
6. Other (please specify)	NO	NO

The reasons for the notation keys reported in CRT Table 6 are:

1. Energy

CO_2 emissions reported in category 1.A consider total carbon of fossil fuels and thus also covers all potential indirect CO_2 emissions (reported as 'IE' in CRT Table 6)

CO_2 emissions from carbon included in fugitive CH_4 emissions reported in category 1.B are not estimated (reported as 'NE' in CRT Table 6)

2. Industrial processes and product use:

Indirect CO_2 emissions from solvent use (from NMVOC) are reported under 2.D.3 Solvent Use in CRT Table2(I).A-Hs2 ('IE')

As indirect CO_2 emissions from the atmospheric oxidation of CH_4, CO and NMVOCs are covered in categories *1.A* and *2.D.3* information on methodological issues, uncertainty assessment, category specific QA/QC, recalculations and planned improvements can be found in the relevant category chapters.

10 RECALCULATIONS AND IMPROVEMENTS

Recalculations of previously submitted inventory data are performed with the purpose to improve the GHG inventory. This chapter shows the changes in emissions for all greenhouse gases compared to the previous submission. Recalculations of the whole time-series per category can be found in Annex 7 to the NID.

10.1 Explanations and justifications for recalculations, including in response to the review process

Compiling an emission inventory includes data collecting, data transfer and data processing. Data has to be collected from different sources, for instance national statistics, plant operators, studies, personal information or other publications. The provided data must be transferred from different data formats and units into a unique electronic format to be processed further. The calculation of emissions by applying methodologies on the collected data and the final computing of time series into a predefined format (CRT) are further steps in the preparation of the final submission. Finally the submission must be delivered in due time. Even though a QA/QC system gives assistance so that potential error sources are minimized it is sometimes necessary to make some revisions (called recalculations) under the following circumstances:

An emission source was not considered in the previous inventory.

A source/data supplier has delivered new data. The causes might be: Previous data were preliminary data only (by estimation, extrapolation), improvements in methodology.

Occurrence of errors in data transfer or processing: wrong data, unit-conversion, software errors etc.

Methodological changes: a new methodology must be applied to fulfil the reporting obligations caused by one of the following reasons:

- to decrease uncertainties.
- an emission source becomes a key source.
- consistent input data needed for applying the methodology is no longer accessible.
- input data for more detailed methodology is now available.
- the methodology is no longer appropriate.

Detailed information on recalculations and their justifications can be found in the following subchapters as well as the corresponding Sector-specific Chapters *3 Energy – 7 Waste*, in which all methodological changes and activity data updates that led to recalculations of emissions with respect to the previous submission are listed.

10.1.1 Energy (CRT Sector 1)

10.1.1.1 Stationary sources

Update/Improvement of activity data

Revision of the energy balance

The federal statistics office 'Statistik Austria' revised the energy balance (mainly for the year 2022) with the following **main implications** for energy consumption as used in the inventory and the corresponding CO_2 emissions:

- Natural gas 2022: Gross inland consumption was not revised. The transformation input was revised downwards by 3.7 PJ (−170 kt CO_2 for *1.A.1.a* and −38 kt CO_2 for *1.A.2*) and shifted to final energy consumption. The final energy consumption of *1.A.4.a* and *1.A.4.b* was revised downwards by 0.2 PJ (−13 kt CO_2) and final energy consumption of manufacturing industries was revised upwards by +4.0 PJ (+220 kt CO_2 for *1.A.2*)
- Gas oil 2022: Gross inland consumption was not revised. Around 0.4 PJ (31 kt CO_2) were shifted from the commercial/institutional (*1.A.4.a*) and the residential sector (*1.A.4.b*) to public power and district heating plants (*1.A.1.a*).
- Liquefied natural gas 2022: Around 0.5 PJ (32 kt CO_2) were shifted from manufacturing industries to "non-energy consumption".
- Solid biomass 2022: Final energy consumption was corrected by +5.0 PJ, most of which was allocated to *1.A.4.b*.

Methodological changes

- Natural gas consumption of gas supply companies (reported as transformation input for district heating and already included in public district heating plants *1.A.1.a*) was moved from sector *1.A.1.c* to sector *1.A.2.g* since the year 2011 (approx. 130 kt CO_2 from natural gas in 2022), as the offset quantity had previously been deducted from this sector. This improved consistency with the energy balance at the sector level.
- The revision of process-related CO_2 emissions from steel production (*2.C.1*) for 2022 shifted 134 kt CO_2 from sector *1.A.2.a* to sector *2.C.1*.

1.A.2.g.7 Off-road Industry

Revision 2022: −46.0 kt CO_2e

Update of the stock of non-road mobile machinery (NRMM) in construction and industry from 2016 onwards according to the production index by the federal statistics office 'Statistik Austria'. For 2016 to 2021, this resulted in an average increase in energy consumption of 2.7% per year; for 2022 in a reduction of 3.1%.

Methodological changes

For 1990 to 2022, minor changes in greenhouse gas emissions (CH_4 emissions) of sub-categories *1.A.4.a commercial/institutional* and *1.A.4.b residential* occur because of updated heating stock data and newly allocated shares of combustion technologies per energy carrier (updated energy demand model for space heating).

10.1.1.2 Mobile sources

1.A.3.b Road transport

Revision 2022: +53.2 kt CO_2e

Update/Improvement of activity data

Revision of the energy balance

Update of natural gas and liquefied petroleum gas consumption for the years 2021 and 2022 due to revisions in the current national energy balance by the federal statistics office 'Statistik Austria'.

Update of correction factor (CF) for real-world fuel consumption PC (passenger cars)

The real-world consumption correction factors - when switching from NEDC (New European Driving Cycle) to WLTP (Worldwide harmonized Light vehicles Test Procedure) standard values - have been updated in the NEMO emissions calculation model for PC. The revision with minor adjustments from 2019 onwards and a solid update from 2021 onwards is based on the national CO_2 monitoring data and data from the new version 5.1 of the Handbook of emission factors (not published yet).

- CO_2-CF for gasoline PC from 2021 onwards = 20%
- CO_2-CF for diesel PC from 2021 onwards = 18%

Methodological changes

Assumptions of specific mileage for **inland/domestic** road transport activity

Starting with the submission 2020 growth rates of the automatic permanent counting stations on the high-level road network were no longer used to annually extrapolate specific mileage from the previous year's level. Instead, data from the central annual "sticker check" (ZBD; in accordance with §57a KFG) have been used for all inland road transport (Austrian and foreign vehicles being operated on the Austrian road network).

Although comparisons with the mileage resulting from the replaced method showed similar results for 2020, an increasing gap in mileage became obvious between the two methods from the pandemic year 2020 onwards. The mileage of foreign vehicles in Austria is obviously growing faster than that of domestic vehicles in Austria. Conversely, this means that by giving priority to the information from the ZBD (only for vehicles registered in Austria), the total mileage on the Austrian road network was systematically underestimated in the recent submissions and too high fuel quantities were attributed to fuel exports.

The finding for this submission and for the future is that it is not permissible to use the specific mileage according to the ZBD for all motor vehicle traffic on Austria's roads.

The method has been changed now back to the previous approach and means a shift in fuel consumption and emissions from fuel exports to domestic consumption for the whole time-series. Total fuel sales have not been revised.

1.A.5 Military

Revision 2022: +0.8 kt CO_2e

The kerosene consumption of military air traffic was updated using actual data for the years 2016, 2017 and 2018 as reported by the Austrian Ministry of Defense. This was done in response to the UNFCCC Review 2023. In previous submissions linear interpolation was necessary. Consequently, the time-series back to 1999 also changed noticeably.

10.1.1.3 Fugitive Emissions

1.B.2.a.2 Oil production

In previous submissions, emissions from *oil exploration* (*1.B.2.a.1*) and *oil production* (*1.B.2.a.2)* were included in *1.B.2.b.2 Natural gas production* as there is a combined production of oil and gas (incl. oil gas) in Austria. From this years' submission onwards however, oil production, including oil exploration, is reported separately under *1.B.2.a.2*. leading to higher emissions from this sub-category (e.g. 2022: +38 *kt CO_2e).* This is thus a partly shift in emissions from *1.B.2.b.2* to *1.B.2.a.2* done in response to the UNFCCC Review 2023 (UNFCCC, 2024).

1.B.2.b.2 Natural gas production

The revision of the whole emission time series in this years' submission (2022: −30 *kt CO_2e*) is due to separate reporting of oil and gas production data, as mentioned above, done in response to the UNFCCC Review 2023 (ARR 2023, E.2). Moreover for this years' submission activity data (gas produced) was taken from the (more complete) Mineral Oil Repor, leading to higher emissions for 2022 (+8 *kt CO_2e).*

1.B.2.b.4 Natural gas transmission and storage

Emissions of CH_4 were revised over the whole time series due to the consideration of new study results on fugitive emissions from gas transmission, storage and distribution in Austria, conducted by Forschung Burgenland based on a survey among Austrian gas companies (Wartha, 2024). Moreover, verified emissions data on gas transmission became available from the IMEO reporting within the scope of OGMP 2.0 from 2022[126] onwards. Also CrO_2 emissions from gas storage were reported for the first time based on the study results (Wartha, 2024). Overall, emissions were revised by −52 *kt CO_2e* in this subsector for 2022, −33 *kt CO_2e* of which can be attributed to gas transmission and −19 *kt CO_2e* to gas storage.

1.B.2.b.5 Natural gas distribution

Emissions were updated over the whole time series (2022: −7.4 *kt CO_2e*) based on the new study on fugitive emissions from the Austrian gas network, covering gas transmission, storage and distribution (Wartha, 2024).

[126] UNEP – United Nations Environment Programme (2023): An Eye on Methane. The road to radical transparency: International Methane Emissions Observatory 2023. Nairobi.

1.B.2.b.6.1 Natural gas post-meter

This sub-category was reported for the first time in this years' submission based on the IPCC 2019 Refinement, covering emissions from natural-gas appliances and natural-gas-powered vehicles. This resulted in +176 *kt CO_2e* for 2022 and to a similar extent for the rest of the time series (see Annex 7).

10.1.2 Industrial Processes and Other Product Use (CRT Sector 2)

Consideration of additional sources/processes

2.G.4.a Fireworks

CO_2 emissions from fireworks are estimated for the first time in this years' submission (+0.05 kt CO_2 in 2022).

2.G.3.a Medical N_2O use

Additional technical use was identified, emissions are reported together with medical use due to confidentiality reasons (+8.90 kt CO_2equ in 2022).

Allocation of emissions between subcategories

2.B.1 Ammonia production / 2.D.3.d other - Urea used as a catalyst

Updated urea amounts used in road traffic for 2005 onwards led to a redistribution of minor amounts between these two categories (+/−1.25 kt CO_2 in 2022).

Methodological improvements

2.A.4.b Other uses of soda ash

As up-to-date input data for the previously applied methodology for estimating soda ash use is not available, a new methodology was applied for the whole time series. Emissive uses are now estimated directly (previously an indirect approach was applied where non-emissive uses were subtracted from total use). The main source is use in tungsten production, and here tungsten production and a CS value for soda use in tungsten production is used for estimating soda ash use. This results in recalculations of the whole time series (−1.07 kt CO_2 in 2022).

2.C.3.a Aluminium production

For transparency reasons official data for aluminium production is now used as AD (previously confidential data was used and reported as "C"). The methodology for CO_2 emissions was reassessed, and the general level of emissions was verified. The change in methodology resulted in minor recalculations over the whole time series (−0.4 kt CO_2 in 2022).

2.D.3.a Solvent use

The methodology for estimating emissions from *Solvent Use* was reassessed for industrial and commercial applications and data on domestic use was updated. This resulted in recalculations of the time series from 1996 onwards, with higher emissions for the years 2000 − 2022 (+6.39 kt CO_2 of *2.D.3.1* emissions in 2022).

2.F Refrigeration and Air Conditioning

Compared to last year, several major improvements in Category *2.F* were implemented (details are given below). The total effect of all recalculations over the time series 1990-2022 is −0.3% of total F-Gas emissions reported now compared to last year's submission. The overall trend and the peak of F-Gases in 2018 remained the same. For the years before 2018, emissions reported now are lower than estimated last year, which is mainly due to the re-assessment of total imports and the allocation to sub sectors as well as the implementation of an updated emission factor for commercial refrigeration. Emissions from 2020 onwards are higher, which is mainly due to the revision of lifetime of refrigeration equipment leading to a shift of emissions from decommissioning to later years.

A short description of the recalculations is given below for each sub-category. Additionally, the total consumption of F-gases and the allocation to sub sectors was re-assessed, which affected input data for commercial and industrial refrigeration (input data for these two sub-categories are residual amounts not consumed by the other categories for which consumption is estimated bottom up).

2.F.1.a Commercial Refrigeration and 2.F.1.c Industrial Refrigeration

Emission factors and lifetime of equipment applied were updated based on actual data from about 1000 units in commercial and industrial refrigeration. The data showed that the applied emission factor for commercial refrigeration other than supermarkets previously was overestimated, and it was changed from 15% for all years to 7.5% in 2020 (interpolated in years in between). This results in lower emissions especially for recent years, but − as a result on the methodology which has refrigerant consumption as the main input parameter − on the other hand increases the stock as less amounts are needed for refilling, so more amounts are left for new installations. Also the updating of the second relevant parameter - lifetime of equipment - had an increasing effect on stock: data showed that the lifetime of equipment was previously underestimated (14 years was changed to 20 years for commercial and from 10 to 20 years for industrial refrigeration). Also, this resulted in a delay of emissions from decommissioning. Overall, the update of the two parameters roughly counterbalanced each other for ex-post emissions.

Also, emissions from commercial refrigeration other than supermarkets are now calculated based on emissions from every refrigerant separately (previously refrigerants were grouped according their GWP), as expected, the deviation of the two approaches is small (about 1%).

The implemented improvements concerning total refrigerant consumption described above, and the improvements made for MACs described below lowered the amounts of refrigerants attributed to the industrial and commercial sector, particularly for the 2010s.

For 2022, emissions from commercial refrigeration are now 18.95 kt CO_2e higher than in the last submission, and those from industrial refrigeration 18.49 kt CO_2e higher.

2.F.1.e Mobile Air Conditioning

In the course of the QA/QC plan an in-depth re-assessment of the methodology for this source category was made, leading to several improvements which resulted in an increase of emissions from this subcategory (+51.72 kt CO_2e for 2022):

- The applied default value for emissions from busses (15%) was updated using data from a sample of about 1 000 buses, which had an average of 25% leakage per year.

- The assumption on average filling of MACs was revised (previously emissions from MACs were calculated based on the assumption that the average filling is only 70% of the nominal filling, which would imply that about half of the MAC units, which need a minimum filling of about 60% to work properly, would not work during their lifetime; now the average filling is assumed to be 90% of the nominal filling and stock). As this increased emissions, this also resulted in an increase of F-Gas need for refilling, which reduces the residual amount assigned to commercial and industrial refrigeration.

Update of activity or emissions data

2.C.1.a Steel

The approach of disaggregation of total emissions from iron and steel production in Austria to Energy and IPPU was corrected for 2022 (one carbon flow was incorrectly transferred to the calculation file), resulting in +134.45 kt CO_2 in *2.C.1.a* in 2022. Additionally one rounded value of 2014 was replaced with the actual value.

2.E Electronics industry

Reported data was corrected by the producer from 2020 onwards (−0.68 kt CO_2e in 2022).

2.F.1.d Transport refrigeration

For this year's submission, additional data reported for 2020 was incorporated also affecting 2021 and 2022 emissions (+0.69 kt CO_2e in 2022).

2.F.1.f Stationary Air Conditioning

Data was recalculated for 2020 as shares of the different refrigerant used in the different appliances was updated (−0.36 kg CO_2e in 2022).

2.F.3 Fire Protection

Amounts previously reported as refilling (= emissions) in 2022 actually corresponded to new fillings and this was corrected (−1.23 kt CO_2e in 2022).

2.F.4.b Aerosols

The methodology from technical aerosols was reviewed in the course of the QA/QC plan, leading to the correction of a transcription error (+0.13 kt CO_2e in 2022).

2.G.1 Other product manufacture and use - Electrical Equipment

The emission factor for 2022 was corrected (was 2%, should be 1% like in other years; −2.76 kt CO_2e in 2022).

10.1.3 Agriculture (CRT Sector 3)

Update of activity data

3.A Enteric fermentation, 3.B Manure management, 3.D Agricultural soils

AWMS data – new survey 'TIHALO III'

The research project 'Animal husbandry and manure management systems in Austria' ('TIHALO I', (Amon, et al., 2007a) and 'TIHALO II', (Pöllinger, et al., 2018)) has been followed-up by a new investigation ('TIHALO III', (Pöllinger, et al., 2025). In this project, as in its predecessors, a comprehensive survey of the agricultural practices in Austria has been carried out. The results of this study (data on livestock feeding, management systems and practices, application techniques for 2023) were used as the basis for the calculation of Austria's emission inventory in submission 2025 resulting in revisions for CH_4 and N_2O emissions in all animal related emission sources.

The most significant impact to Austria's GHG inventory was the introduction of the manure management system 'pit storage below animal confinements'. The system 'slurry separation' was also implemented as a new manure management system for cattle and swine, mainly affecting ammonia emissions.

Background data for feeding and nutrition of cattle

Due to the updated proportions of grazing for all cattle categories according to the new 'TIHALO III' study as described above, the net energy for activity was revised. The net energy for pregnancy of breeding heifers at 1-2 years of age was also recalculated, as more accurate data on the calving age and days in gestation were used for the entire time series instead of using constant values. These improvements led to revisions of the gross energy intake (GE), $N_{excretion}$ and $VS_{excretion}$ for breeding heifers at 1-2 years of age for the entire time series and for the remaining cattle categories between 2018 and 2022.

Updated feeding and nutrition for sheep, goats, horses, poultry, deer and rabbits

For the non-key livestock categories sheep, goats, horses, poultry, deer and rabbits available feeding and nutrition data was gathered and analysed. Based on that information, Tier 2 methodologies according to the 2019 IPCC Refinement were applied. Consequently, country-specific GE-intake values and updated $VS_{excretion}$ and $N_{excretion}$ values have been generated according to IPCC (2019).

Livestock data – horses and deer

For 2023 new livestock numbers for horses became available (BML, 2024a). The years 2018-2022 were determined by interpolation. For deer, the entire time series was revised: data from IACS (INVEKOS)[127] available from 2000 onwards was taken (BML 2024) instead of the numbers previously used based on the farm structure surveys 2010 and 2020. IACS provides annual and more complete data for deer compared to the farm structure surveys. Animal numbers for the years 1990-1999 were determined by trend extrapolation.

[127] Integrated Administration and Control System (IACS): tool for transparency and accountability in funding payments

Livestock data – rabbits

Rabbits were included for the first time in the inventory as a new animal category. Rabbit livestock numbers based on IACS (INVEKOS) for the years from 2000 onwards were taken as activity data (BML, 2024a). Animal numbers for the years 1990-1999 were determined by trend extrapolation. Emissions of CH_4 and N_2O from rabbits are for the first time recorded in the source categories *Enteric Fermentation* (*3.A.4.h.i.*), *Manure Management* (*3.B.4.h.i.*) and *Animal manure applied to soils (3.D.1.b.i.)*.

Biogas plants

Updated figures for biogas plants for 2018-2022 (E-CONTROL 2024)[128] resulted in slightly revised CH_4 and N_2O emissions with an impact on the source categories *3.B Manure Management, 3.D.1.b.i. Animal manure applied to soils* and *3.D.1.b.iii. Other organic fertilizers applied to* soils for 2018-2022.

Other legumes

Activity data from other legumes, lupines, lentils, chickpeas and vetches were included under source category *3.D.1.d. Crop residues* for the first time.

Organic soils (i.e. histosols)

In previous submissions, organic soils were only reported in the grassland category. In 2024, a new national study on organic soils (Umweltbundesamt, 2025d) was finalized and updated activity data on organic soils became available. According to the study results, organic soils occur on both grassland and arable land. More information is included in 10.1.4.

3.D.a.2.c Other organic fertilisers

Based on the updated activity data for biogas plants (see above), the N_2O emissions for the years 2018-2022 were slightly revised (+0.00003 kt N_2O for 2022).

3.D.1.e. Mineralization/immobilization associated with loss/gain of soil organic matter (N_2O)

Revisions of activity data in cropland remaining cropland categories (for more information see chapter 6.3.7 on LULUCF) resulted in revised N_2O emissions for the entire time series (+0.01 kt N_2O for 2022).

Improvements of methodologies and emission factors

3.A Enteric fermentation (CH_4)

For sheep, goats, horses, poultry, deer and rabbits, for the first time emissions were calculated based on the Tier 2 methodology according to IPCC 2019 and country-specific EFs (equation 10.21) using updated activity and nutrition data (AWMS data, feeding and nutrition, livestock data, new emission source rabbits– see above). The improvements resulted in overall higher emission amounts for the entire time series (+1.7 kt CH_4 for 2022).

[128] E-CONTROL (2024): Herkunftsnachweisdatenbank der E-Control gem. Erneuerbaren Ausbau Gesetz (EAG), § 81 Abs 9. https://anlagenregister.at/. Accessed in December 2024.

3.B Manure management (CH_4, direct and indirect N_2O)

Methane and N_2O emissions have been revised by using new and updated activity (AWMS data, feeding and nutrition, livestock data, new emissions source of rabbits, biogas - see above) and the 2019 Refinement of the IPCC GL for all livestock categories. In particular, the implementation of the manure management system 'pit storage below animal confinements' resulted in higher CH_4 emissions over the entire time series.

Revisions of the ammonia inventory showed an increasing effect on emission levels of indirect N_2O emissions. The update of the total ammoniacal nitrogen (TAN) values for liquid and solid manure of cattle and swine resulting in higher ammonia emissions had the most significant impact. TAN values used in previous submissions taken from (Schechtner, 1991) were amongst the lowest in European countries. Revised values were derived from measurement data from PÖTSCH (2019)[129] and adjusted with the N-losses provided in the German and Swiss inventories.

In total, the entire time series of 3*.B Manure Management* was revised upwards (+5.7 kt CH_4 for 2022, +0.4 kt N_2O total for 2022).

3.D Agricultural Soils (N_2O)

3.D.1.b.i Animal manure applied to soils

Due to revised methodologies and activity data used for emission calculations in categories *3.A* and *3.B* (see above) the quantities of animal manure applied to soils were revised for the entire time series. Higher ammonia emissions from manure management resulted in lower N amounts available for application on soils and thus to lower N_2O emissions for the entire time series (-0.2 kt N_2O for 2022).

3.D.1.c. Urine and dung deposited by grazing animals

Livestock related updates (livestock numbers, N excretion values) as well as new data on Austrian agricultural practices from the new TIHALO III-survey as already described before, led to recalculated N_2O emissions from grazed animals. Additionally, updated EFs according to the 2019 IPCC Refinement were applied, resulting in revisions for the entire time series (-0.2 kt N_2O for 2022).

3.D.1.d. Crop residues

In addition to the updated activity data for other legumes (see above), methodological improvements were made in the calculations of cover crops. The above-ground residue dry matter value was taken from a recent national study (Erhart, et al., 2021b). The 2019 IPCC default values of grass-clover mix were used for the calculations. These improvements resulted in an overall increase in N_2O emissions for the entire time series (+0.3 kt N_2O for 2022).

3.D.1.f. Cultivation of organic soils (i.e. histosols)

In addition to the updated activity data for organic soils (see above) methodological improvements have been carried out by using the emission factors according to (Umweltbundesamt, 2025d). Detailed information is provided in chapter 10.1.4 on LULUCF. The revisions affected the entire time series (-0.02 kt N_2O for 2022).

[129] PÖTSCH, E. (2019): Personal communication. Documented in (HÖRTENHUBER 2025)

3.D.b Agricultural soils (indirect soil emissions – N_2O)

Atmospheric deposition: reasons for revised estimates are the updated activity data (see above) and the improvements made within the ammonia inventory (esp. the updated TAN values for cattle and swine). Furthermore, NH_3-emissions from crop residues were calculated for the first time contributing to the indirect N_2O-Emisisons from atmospheric deposition. As a result, the indirect N_2O emissions from atmospheric deposition have been revised upwards for the entire time series (+0.1 kt N_2O for 2022).

N leaching and run-off: updated activity data and methodological improvements affected revised N amounts from animal manure applied to soils, grazing, crop residues and mineralisation resulting in revised emissions for the entire time series (+0.3 kt N_2O for 2022).

10.1.4 LULUCF (CRT Sector 4)

4.A Forest land

The increment, drain and dead wood results for recent years were updated on basis of an analysis of intermediate results of the ongoing NFI cycle 2022/27. These new results caused a significant change of the biomass and dead wood results of the most recent years since 2019, but resulted also in minor (before 2009) and intermediate (2009 to 2018) revised biomass and dead wood results of previous years. The forest soil C stock changes were recalculated for the complete time series based on the intermediate results of the ongoing NFI 2022/27 cycle, as well as improved calibration- and spin-up procedures of the model. A detailed and comprehensive study was finalized in 2024 (Umweltbundesamt, 2025d), where the area of organic soils in Austria, their land use and drainage status and related emission factors were analysed on basis of various geographic, historic and other data sources. Based on this study, drained organic soils in *Forest land* were identified, for which emissions for the whole time series are estimated for the first time. Together, these improvements caused changes of the annual net removals for the whole time series of the *Forest land* category in the range of -4 903 to +7 071 kt CO_2e per year compared to the last submission in 2024.

4.B Cropland

For area consistency reasons a minor adjustment of the total *Cropland* area was carried out. The *Grassland* biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes involving *Grassland* and consequently have an impact on the results of the land-use change category *Grassland* to *Cropland*. The land-use changes between all categories are meanwhile estimated on basis of a regionalized assessment of related activity data in five ecological regions and related specific soil carbon stocks for these regions and all land-use categories. In addition, the soil carbon stock changes of all land-use change categories are since current submission 2025 based on the soil carbon stocks for the depth of 0-50 cm instead of 0-30 cm (in previous submission changes in soil carbon stocks between 0 and 50 cm were carried out just for the land-use change categories involving *Forest land*). On basis of the organic soils study (see in chapter 6 for *Forest land*), drained organic soils in *Cropland* were identified, for which emissions for the whole time series are estimated for the first time. These improvements caused upward revisions of the annual net emissions for the whole time series of the *Cropland* category in the range of +155 to +204 kt CO_2e per year compared to the last submission in 2024.

4.C Grassland

For area consistency reasons, a minor adjustment of the total *Grassland* area was carried out. The *Grassland* biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes to *Grassland* and consequently have an impact on the results of the *Grassland* category. The land-use changes between all categories are meanwhile estimated on basis of a regionalized assessment of related activity data in five ecological regions and related specific soil carbon stocks for these regions and all land-use categories. In addition, the soil carbon stock changes of all land-use change categories are since current submission 2025 based on the soil carbon stocks for the depth of 0-50 cm instead of 0-30 cm (in previous submission changes in soil carbon stocks between 0 and 50 cm were carried out just for the land-use change categories involving *Forest land*). On basis of the organic soils study (see in chapter 6 for *Forest land*), the area of drained organic soils in *Grassland* and the related emissions were slightly revised. These improvements caused upward revisions of the annual net emissions for the whole time series of the *Grassland* category in the range of +85 to +149 kt CO_2e per year compared to the last submission in 2024.

4.D Wetlands

For area consistency reasons a minor adjustment of the total *Wetland* area was carried out. The grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes involving *Grassland* and consequently have an impact on the results of the land-use change category *Grassland* to *Wetlands*. On basis of the organic soils study (see in chapter 6 for *Forest land*), drained organic soils in *Wetlands* and areas of historic peat extraction were identified, for which emissions for the whole time series are estimated for the first time. Activity data for the biomass burning subcategory has been revised due to the availability of a new data source from the BraMaSchi Project. These improvements caused revisions of the annual net emissions for the whole time series of the *Wetlands* category in the range of +12 to +22 kt CO_2e per year compared to the last submission in 2024.

4.E Settlements

Since the last submission, the split of agricultural conversions to Settlements between Cropland and Grassland has been revised. For the years 2017 onwards the conversions of Cropland and Grassland to Settlements are now based directly on the spatial analysis of the 2016-2022 LU layers instead of being inferred from the Cropland statistics. Conversions from Cropland to Settlements for the years pre-2017 remain based on the inference from Cropland statistics; however, here also imporvements have been made to ensure consistency with the comprehensive Farm Structure Survey estimates (e.g. 2010 and 2020) and also correct an error affecting the pre-1990 time series. The above improvements affect both Cropland converted to Settlements and Grassland converted to Settlements. Furthermore, the Grassland biomass stock was updated based on new results for root, stubble and aboveground biomass. These biomass values are used for land-use changes involving Grassland and consequently have an impact on the results of the land-use change category Grassland to Settlement. With respect to soil carbon stock changes, improvements have been made to regionalize the Cropland and Grassland conversions to Settlements across five ecoregions (forest growth areas) to utilise ecoregion-specific soil carbon stocks for the pre- and post-conversion stocks. The stocks are moreover now for the depth 0-50 cm instead of the previously used 0-30 cm depth, ensuring consistency across all calculations of LUC-induced soil carbon stock changes e.g. Forest land conversions to Settlements. Forest land conversions to Settlements previously used

0-50 cm stocks and pre-conversion stocks stratified across the five ecoregions. Also here the methodology has been improved, implementing also post-conversion Settlement soil carbon stocks that are stratified too. Finally, on basis of a national study on organic soils, drained organic soils in Settlement were identified, for which emissions for the whole time series are estimated for the first time. These improvements caused upward revisions of the annual net emissions for the whole time series of the Settlement category in the range of 106 to 352 kt CO_2eq per year compared to the last submission in 2024.

4.F Other land

GHG emissions and removals from *Other land* have not been revised since the 2024 submission. Improvements in the Austrian system for land representation have led to small revisions in the total Other land area; however, these improvements have not affected conversions from Forest land to Other land – the only subcategory causing carbon stock changes and GHG emissions in Other land.

4.G HWPs

The *HWP* production figures for the year 2022 were updated in the most recent FAO statistics and very minor corrections were recorded in the years 2019-2021. Consequently, the HWP figures for this submission had to be updated accordingly. The recalculations in the *HWP* category led to lower removals of this subcategory of 118 kt CO_2e for 2022.

10.1.5 Waste (CRT Sector 5)

Consideration of additional sources

5.D.1 Domestic wastewater treatment

In this years' submission CH_4 emissions from the treatment of domestic wastewater in municipal wastewater treatment plants, domestic wastewater treatment plants as well as from the disposal of treated wastewater to aquatic environments were considered for the first time leading to higher emissions from this sub-category over the entire time series (+164 kt CO_2e in 2022).

Update of activity data

5.D.2 Industrial Wastewater Treatment and Discharge

For *5.D.2 industrial wastewater* recalculations are reported for 2021 and 2022 (–0.003 kt CO_2e) as updated information on primary and secondary pulp production became available from the latest industry reports 2022 and 2023 (Austropapier, 2023).

10.2 Implications for emission and removal levels

As a result of the continuous improvement of Austria's GHG inventory, emissions of some sources have been recalculated on the basis of updated data or revised methodologies. Thus GHG emission data for 1990 to 2022 submitted this year differ slightly from data reported last year.

The national total (excl. LULUCF) for the base year is 0.68% (+539 kt CO_2e) higher, the national total (excl. LULUCF) for 2022 is 0.92% (+671 kt CO_2e) higher than the values submitted last year.

Table 341: Recalculation difference of Austria's greenhouse gas emissions compared to the previous submission by sector

	OLI 2024		**OLI 2023**		**Recalculation Difference**	
THG	**1990**	**2022**	**1990**	**2022**	**1990**	**2022**
	[kt CO_2e]		**[kt CO_2e]**		**[kt CO_2e]**	
Total*	79 621	73 515	79 083	72 844	+539	+671
1. Energy	52 835	48 434	52 666	48 464	+169	-30
2. IPPU	13 641	16 170	13 633	15 929	+ 7.9	+240
3. Agriculture	8 581	7 573	8 416	7 277	+164	+297
4. LULUCF	−13 756	−206	−11 682	−4 474	−2 074	+4 267
5. Waste	4 565	1 337	4 367	1 174	+197	+164

* *without LULUCF*

National total emissions (excluding LULUCF) for **1990** were revised upwards since last years' submission (+539 kt CO_2e), mainly due to upward revisions in the sectors *1 Energy*, *3 Agriculture and 5 Waste*. Under *1 Energy,* a new emission source has been included in the inventory (*1.B.2.b.6 gas post-meter*) leading to higher emissions from this sector over almost the entire time-series. Recalculations for *3 Agriculture* are mainly attributable to the consideration of a recently completed study on livestock feeding, management systems and practices in Austria (Pöllinger, et al., 2025) affecting emissions from all animal related categories. Furthermore, the 2019 Refinement (IPCC 2019) was applied for the non-key animal categories in *3.A Enteric Fermentation* and for all livestock categories in *3.B Manure Management* having a partly upwards effect on the 1990 emission level. The upward revision in sector *Waste* is due to consideration of the updated methodology of the IPCC 2019 Refinement for category *5.D wastewater treatment and discharge*, in particular first-time reporting on CH_4 emissions from wastewater treatment plants and effluent under sub-category *5.D.1 domestic wastewater*.

Emissions for **2022** (without LULUCF) are higher (+671 kt CO_2e) than the values reported in the previous submission, mainly due to revised estimates in the sectors *3 Agriculture, 2 IPPU and 5 Waste*. In sector *3 Agriculture* a new study (Pöllinger, et al., 2025) was considered, resulting in revised emission data for CH_4 and N_2O in all animal related emission sources. Additionally, the implementation of the 2019 Refinement (IPCC 2019) in the sectors *3.A Enteric Fermentation* (for the non-key animal categories) and *3.B Manure Management (*for all livestock categories) had a partly upwards effect on absolute emissions 2022. In the sector *2 IPPU* the approach of disaggregation of total emissions from iron and steel production in Austria to *1 Energy* and *2 IPPU* was corrected for 2022 resulting in higher emissions reported under *2 IPPU (2.C.1.q)* and lower emissions reported under *1 Energy (1.A.2.a)*. Furthermore, several major improvements in category *2.F* were implemented in this years' inventory, leading to higher emissions for the previous years. The consideration of additional sources of CH_4 emissions in sub-category *5.D.1 domestic wastewater* in implementation of the IPCC 2019 Refinement ist the reason for higher emissions from sector *5 Waste* compared to the previous submission.

The following tables present the recalculation difference with respect to last years' submission for each gas (positive values indicate that this years' estimate is higher).

Table 342: Recalculation difference of Austria's greenhouse gas emissions compared to the previous submission by gas.

	1990 (Base year)	2022
	Recalculation Difference [kt CO_2e]	
Total	539	671
CO_2	7.5	−35
CH_4	442	506
N_2O	89	108
HFC, PFC, SF_6, NF_3	–	92

without LULUCF

For the year 1990 emissions of all gases (CO_2, CH_4 and N_2O) were revised upwards except for the F-Gases. CH_4 shows the strongest increase.

For 2022, emissions of CH_4 and N_2O were revised upwards as well, with methane showing the strongest revision (+506 kt CO_2e) followed by nitrous oxide (+108 kt CO_2e). Emissions of CO_2 however were revised downwards mainly due to energy balance revisions. Revisions in the sector *3 Agriculture* contribute most to the recalculations of the non-CO_2 gas emissions, but also the inclusion of a new emission source category – *1.B.2.b.6 gas post-meter* – in *1.B Fugitive emissions from fuels* and the reporting on methane emissions from wastewater treatment plants and effluent under *5.D.1 domestic wastewater* for the first time in this submission, have a notable effect on recalculations by increasing CH_4 emissions over the whole time series (see Annex 7).

10.3 Implications for emission and removal trends, including time-series consistency

The 1990–2022 trend of total national emissions (excluding LULUCF) of the present submission shows a reduction of about 7.7 %, while the emission reduction based on the previous inventory submission (2024) amounted to 7.9%.

Table 343 presents the recalculation differences of national total GHG emissions for all years.

Table 343: Recalculations of Austria's GHG emissions compared to the previous submission.

	National Total GHG emissions without LULUCF			
	OLI 2024	**OLI 2023**	**Recalculation Difference**	
	[kt CO_2e]	**[kt CO_2e]**	**[kt CO_2e]**	**[%]**
1990	79 621	79 083	539	0.68%
1995	80 570	79 986	584	0.73%

	National Total GHG emissions without LULUCF			
	OLI 2024	OLI 2023	Recalculation Difference	
	[kt CO_2e]	[kt CO_2e]	[kt CO_2e]	[%]
2000	81 389	80 640	748	0.93%
2005	93 341	92 605	736	0.79%
2010	85 442	84 793	649	0.77%
2011	83 251	82 607	644	0.78%
2012	80 487	79 889	598	0.75%
2013	80 868	80 310	558	0.69%
2014	77 215	76 721	494	0.64%
2015	79 359	78 935	424	0.54%
2016	80 319	79 863	456	0.57%
2017	82 635	82 195	440	0.54%
2018	79 441	78 903	538	0.68%
2019	80 641	80 058	582	0.73%
2020	74 679	74 030	649	0.88%
2021	78 073	77 360	713	0.92%
2022	73 515	72 844	671	0.92%

Also the 1990-2022 trend of LULUCF is similar to the previous submission (−98% in the current submission compared to –62% in submission 2024), with basically the same fluctuations over the time series.

A description of all recalculations by each sector is given in Chapter 10.1 as well as the relevant sectoral methodological chapters. Recalculation differences at sub-category level for the whole time-series 1990–2022 are provided in Annex 7.

10.4 Areas of improvement in response to the review process

The Umweltbundesamt is responsible for the management of the improvement programme. It is supported by the QA/QC programme based on the international standard EN ISO/IEC 17020:2012.

The overall goal is to produce emission inventories which are fully consistent with the UNFCCC reporting guidelines and the IPCC 2006 Guidelines and achieve the quality objectives set. To meet this goal, an improvement programme has been established that is driven by the results of various review processes, as e.g. internal reviews and audits (see chapter 1.5.6), the review under the UNFCCC and/or under the Kyoto Protocol as well as other international and European reviews, e.g. under the European Union Monitoring Mechanism ("Effort Sharing Decision Review") or under CLRTAP. The Improvement programme requires the establishment of improvement plans set up and maintained for each sector as well as for general issues (incl. improvement of the Quality Management System), that are updated every year after the results from the UNFCCC review process become available and are carefully monitored.

10.4.1 Planned improvements

Source specific planned improvements are presented in the respective subchapters of Chapters 3–7. Planned improvements attributable to the last UNFCCC Review conducted in 2023 are summarized below:

Table 344: Planned improvements made in response to the UNFCCC Review.

Finding	Reference*	Improvement planned
Other (Comparability) Present the national totals with and without indirect CO_2 in the CRF tables and in the NIR, in accordance with paragraph 29 of the UNFCCC Annex I inventory reporting guidelines.	ARR 2023 G.2	Options for implementation of this recommendation are under discussion. Separate reporting of indirect CO_2 from 2.D.3.a would result in inconsistencies with other sectors' reporting (in particular Energy where indirect CO_2 is included in reported (direct) CO_2). The separate reporting of indirect CO_2 from Energy is also challenging because of the different conversion factors of the ETS methodology and the IPCC 2006 default value (please refer to ARR 2023, E.6). Indirect CO_2 emissions have not yet been estimated for other sectors either (e.g. 1.B and other IPPU categories). More time is therefore needed to clarify this issue.
Comparison with international data – liquid biomass – CO_2, CH_4 and N_2O The ERT encourages the Party to follow up with Statistics Austria to explore the differences between the liquid biomass consumption data used for the national energy balance and the data submitted to IEA, and report any findings and recalculations in the NIR.	ARR 2023 E.5	Implementation needs further clarification from Statistics Austria why biofuels are reported differently in the IEA/EEA Joint Questionnaires and national statistics.
1.A Fuel combustion – sectoral approach – liquid, solid, gaseous, biomass, other fossil fuels – CO_2 The ERT recommends that the Party, for those EU ETS operators that do not report CO_2 emissions based on direct measurements, collect AD and subsequently apply default or country-specific EFs to the relevant fuel consumption, thereby mitigating potential discrepancies resulting from use of different carbon conversion factors under the EU ETS (3.664 t CO_2/t C) and the 2006 IPCC Guidelines (vol. 2, chap. 1, table 1.4, p.23), which require converting the carbon EF to a CO_2 EF using a factor of 44/12 = 3.667 t CO_2/t C).	ARR 2023 E.6	More time is needed for implementation of this recommendation.

Finding	Reference*	Improvement planned
3.F.5 Other (field burning of agricultural residues) – CH4 and NO2 The ERT recommends that the Party report CH_4 and N_2O emissions from burning of woody perennial crops, including biomass from viticulture, under burning of agricultural residues and provide in the NIR a detailed explanation for the recalculation, including information on the impact of the recalculations on the trend in emissions at the category, sector and national level, as appropriate.	ARR 2023 A.5	Emissions from the open burning of biogenic waste have not yet been reallocated to the agricultural sector. However, additional information is included in the NID. Since the national inventory requires a homogeneous allocation of activities and emission sources for greenhouse gases and air pollutants (UNFCCC and UNECE reporting) to ensure consistency, further analyses of this finding is planned. Refer to Chapter 7.4.2

** Annual Review Report (UNFCCC, 2024)*

10.4.2 Improvements made in response to the review process

In 2023, Austria was reviewed by the UNFCCC. Results of this review – conducted as a desk review – are published in an Annual Review Report (ARR, UNFCCC 2024).

Table 345: Improvements made in response to the UNFCCC Review.

Finding	Reference*	Improvement made	Chapter
General			
CRF tables – N_2O The ERT recommends that the Party correct the reporting of indirect N_2O emissions for the LULUCF sector in CRF table 6 (i.e. by reporting those emissions as "NO"), ensuring consistency with the reporting of NO_X emissions.	ARR 2023 G.3	Indirect N_2O emissions for the LULUCF sector are now correctly reported as 'NO' in CRT Table 6.	Chapter 9 CRT Table 6
Energy			
1.A.5.b Mobile – liquid fuels – CO_2, CH_4 and N_2O (Accuracy) Make efforts to improve the accuracy of the estimates by developing more efficient cooperation with the Austrian Ministry of Defence to resolve confidentiality issues. If linear extrapolation continues to be used for the estimates, demonstrate the validity of the trend in the NIR.	ARR 2023 E.1	#1 Fuel consumption data for military ground operations have been submitted by the Austrian Ministry of Defence in autumn 2023, and considered already in the 2024 submission. #2 Data on kerosene consumption for military aviation could also be obtained from the Austrian Ministry of Defence (2024) for the years 2016, 2017 and 2018 and the time series was adapted accordingly for the 2025 submission.	Chapter 3.2.15

Finding	Reference*	Improvement made	Chapter
1.B.2 Oil, natural gas and other emissions from energy production – oil and natural gas – CH_4 – Transparency Make efforts to report the emissions for category 1.B.2 disaggregated into categories 1.B.2.a.i and 1.B.2.b.i.	ARR 2023 E.2	Emissions are reported separately for oil production (incl. exploration) and gas production (incl. exploration) from submission 2025 onwards. According to the IPCC 2006 GL oil gas has been allocated to 1.B.2.b.ii Natural gas.	Chapter 3.3.3.2
Fuel combustion – reference approach – liquid fuels – CO_2 The ERT recommends that the Party update CRF table 1.A(c) with the recalculated value for total apparent consumption (excluding NEU, reductants and feedstocks) for liquid fuels by subtracting the NEU value for naphtha, and explain the reason for, and impact of, the recalculation in the NIR.	ARR 2023 E.4	In the 2024 submission, total apparent consumption (excluding NEU, reductants and feedstocks) for liquid fuels has been revised by subtracting the non energy use of naphtha, which is about 37 PJ for 2022.	Chapter 3.2.1.2
1.A.1.a Public electricity and heat production – other fossil fuels – CO_2 The ERT recommends that the Party correctly allocate the non-fossil share of AD for MSW under public electricity and heat production (biomass) (category 1.A.1.a). The ERT encourages the Party to include additional information on waste incineration with energy recovery included as biomass and fossil fuels under the information item on MSW fossil and non-fossil shares in CRF table 1.A(a).	ARR 2023 E.7	The non renewable part of MSW has been allocated to 1.A.1.a other fossil fuels and the renewable part to 1.A.1.a biomass in this 2024 submission.	Chapter 3.2.9.2
1.A.1.a Public electricity and heat production – other fossil fuels – CO_2, CH_4 and N_2O The ERT recommends that the Party provide a detailed explanation in the NIR regarding how calorific values for MSW non-biomass and biomass fractions are derived for the GHG inventory and specify which carbon EFs are used to calculate CO_2 emissions for each fraction. The ERT also recommends that the Party review the methodology for determining MSW non-biomass and biomass fractions to assess whether using a weighted or normal average could enhance the accuracy of estimates and, if revisions are deemed necessary, recalculate emissions accordingly and describe the recalculations in the NIR.	ARR 2023 E.8	This issue is addressed in the NID 2024.	Chapter 3.2.9.2
1.A.1.a Public electricity and heat production – biomass – CO_2, CH_4 and N_2O The ERT recommends that Austria include in the NIR a clear explanation of the biomass fuel mix (AD and CO_2, CH_4 and N_2O EFs for the different biomass types) in public electricity and heat production to allow a better understanding of the difference in trends before 2004 and after 2005.	ARR 2023 E.9	The fluctuations in the trends of 1.A.1.a biomass CO_2, CH_4 and N_2O implied emission factors are explained in Annex 3.1.	Chapter 3.2.10.1 NID Annex 3.1

Finding	Reference*	Improvement made	Chapter
1.A.3.b.iii Heavy-duty trucks and buses – gaseous fuels – CO_2, CH_4 and N_2O The ERT recommends that the Party provide in the NIR a detailed explanation for any recalculations performed for road transportation, including information on the impact of the recalculations on the trend in emissions at the category, sector and national total level, as appropriate.	ARR 2023 E.10	Austria added detailed explanations for the recalculations performed for road transportation in the 2024 submission, including a discussion on the impact of the recalculations on the trend in emissions at the category, sector and national total level, as appropriate.	Chapter 3.2.13.2
1.A.3.c Railways – liquid and other fossil fuels, biomass – CO_2, CH_4 and N_2O The ERT recommends that the Party report the reasons for any recalculations for CO_2, CH_4 and N_2O emissions from railways and the impact of these recalculations in the NIR, including on the trend in emissions at the category, sector and national total level, as appropriate.	ARR 2023 E.11	Austria added detailed explanations for the recalculations performed for road transportation in the 2024 submission, including a discussion on the impact of the recalculations on the trend in emissions at the category, sector and national total level, as appropriate	Chapter 3.2.13.3
IPPU			
2.C.1 Iron and steel production – CO_2 – Transparency Review and, if necessary, revise the title of NIR table 138 (section 4.4.1.2, p.246) to make it consistent with the table's content.	ARR 2023 I.7	Title of table was corrected (CH_4 added).	Chapter 4.4.1.2, Table 148
2.C.1 Iron and steel production – CO_2 – Transparency Provide accurate information and data (e.g. detailed carbon balances and carbon contents) in the NIR (section 4.4.1) to enhance the transparency of the reporting on carbon flows for iron and steel production activities related to the IPPU and energy sectors.	ARR 2023 I.8	Information on the confidentiality of detailed carbon balances is included.	Chapter 4.4.1.2
2.F.1 Refrigeration and air conditioning – HFC-134a (Accuracy) Revise the estimate of HFC-134a emissions from manufacturing, stocks and disposal for the bus and construction vehicle classes of category 2.F.1.e (mobile air conditioning), using appropriate default EFs provided in the 2006 IPCC Guidelines (vol. 3, chap. 7, p.7.52) for the estimations if more accurate EFs are not available.	ARR 2023 I.11	Emissions from stocks for construction vehicles are estimated and reported.	Chapter 4.7.2.1 Chapter 4.7.5
2.F.1 Refrigeration and air conditioning – HFC-134a (Transparency) Transparently document any assumptions about vehicle AD.	ARR 2023 I.12	This information is included in the NID chapter on MAC.	Chapter 4.7.2.1
2.C.1 Iron and steel production – CH_4 The ERT recommends that the Party include in CRF table 9 the explanation for the use of "IE" for reporting of CH_4 emissions from sinter.	ARR 2023 I.13	The notation key 'IE' is explained in CRT Table 9.	CRT Table 9

Finding	Reference*	Improvement made	Chapter
2.F.3 Fire protection, 2.F.4 Aerosols – HFCs The ERT recommends that Austria correct NIR table 167 to ensure that the emission data presented therein are consistent with the data reported in CRF table 2(II)B-H.	ARR 2023 I.14	The table has been corrected.	Chapter 4.7.1, Table 155
2.G.3 N2O from product uses – N_2O The ERT recommends that Austria include in the NIR the relevant explanations and justification regarding the use of a single value for AD and N_2O emissions for the whole time series.	ARR 2023 I.15	Information has been included in the NID.	Chapter 4.8.2.3
Agriculture			
3 General (agriculture) – CH_4 and N_2O The ERT recommends that Austria increase transparency in the NIR by including additional information on mules and asses, including the data source references, the assumptions used and the related uncertainty of emissions estimated using the different data sources available.	ARR 2023 A.1	Information has been included in the NID.	Chapter 5.1.7
3 General (agriculture) – CH_4 and N_2O The ERT recommends that the Party collect data on its annual horse population since 2017 to improve the accuracy of the estimation of CH_4 emissions from enteric fermentation and CH_4 and N_2O emissions from manure management.	ARR 2023 A.2	For 2023 new livestock numbers for horses became available (BML 2024). The years 2018-2022 were determined by interpolation.	Chapter 5.2.2
3.B Manure management – CH_4 The ERT recommends that the Party provide in the NIR relevant information to demonstrate that the MCF values for liquid manure management for the full time series are not biased, taking into account the annual temperature variation and the trend from 1990 to the present.	ARR 2023 A.3	Information has been included in the NID.	Chapter 5.3.2.1
3.D.a.5 Mineralization/immobilization associated with loss/gain of soil organic matter – N_2O The ERT recommends that the Party include in the agriculture section of the NIR transparent documentation of the respective contribution of all subdivisions of cropland remaining cropland (category 4.B.1) (for example perennial converted to annual, annual remaining annual and perennial remaining perennial) that are losing soil carbon and hence contributing to the emissions under category 3.D.a.5.	ARR 2023 A.4	Information has been included in the NID.	Chapter 5.4.2.1.5
LULUCF			

Finding	Reference*	Improvement made	Chapter
4 General (LULUCF) – CO_2 The ERT recommends that the Party explain in the NIR how consistency is ensured in estimates for all land-use categories when applying SOC values from different soil depths (e.g. 0–50 cm carbon stock changes for all land-use conversions but 0–30 cm stock depths for cropland remaining cropland and grassland remaining grassland).	ARR 2023 L.3	The consistency of using soil carbon stocks of the same soil depth in single land-use change categories is more transprarently described.	Chapter 6.1.3.2
4 General (LULUCF) – CO_2 The ERT recommends that the Party include in the NIR a description of the methodology used to identify organic soils.	ARR 2023 L.4	The methodology to identify organic soils is described.	Chapter 6, 6.1.3.1.1
4 General (LULUCF) – CO_2 The ERT recommends that the Party provide transparent information in the NIR to demonstrate the accuracy of the estimates of soil carbon stock changes in cropland and grassland remaining in the same land-use categories, taking into consideration the SOC gains and losses due to changes in management practices.	ARR 2023 L.5	The accuracy of the estimates of soil carbon stock changes in the remaining cropland and grassland subcategories is more transparently described.	Chapters 6.3.4.1.4, 6.4.4.1.2
4.A.1 Forest land remaining forest land – CO_2 The ERT encourages the Party to continue collecting data to enable carbon stock changes in mineral soils for forests not in yield to be estimated in the future. The ERT also encourages the Party to include in the NIR the justification for applying a tier 1 methodology for carbon stock changes in mineral soils for forests not in yield.	ARR 2023 L.6	A justification for applying a tier 1 methodology for the mineral soils of forests not in yield is provided.	Chapter 6.2.4.1.3
4.A.1 Forest land remaining forest land – CO_2 The ERT recommends that the Party provide in CRF table 4.A estimates of the carbon stock change in biomass losses for forests not in yield or provide an explanation for the reporting of biomass losses as "IE" in CRF table 9 and in the NIR.	ARR 2023 L.7	An explanation for reporting biomass losses in forests not in yield as "IE" is provided.	Chapter 6.2.4.1.1
4.B Cropland – CO_2 The ERT recommends that the Party explain in the NIR where all perennial cropland types (including areas with a rotation period of up to 30 years, 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) are accounted for in the GHG inventory.	ARR 2023 L.8	Perennial cropland was more precise and complete defined.	Chapters 6.3.3, 6.3.4.1.1

Finding	Reference*	Improvement made	Chapter
4.B.1 Cropland remaining cropland – CO_2 The ERT recommends that the Party explain in its NIR how it developed the weighted average biomass carbon stock change factor for the living biomass pool and demonstrate that basing the factor for conversions to and from perennial cropland only on vineyards and orchards allows for accurate estimates of emissions and removals from living biomass.	ARR 2023 L.9	The rationale for the use of weighted means of the vineyard and orchard biomass representative for perennial cropland biomass at related conversion areas was given.	Chapter 6.3.4.1.1
4.C.1 Grassland remaining grassland – CO_2 The ERT recommends that the Party explain, in the NIR, the correction applied to the areas of grassland remaining grassland from the original source data (the national statistics) and for use in the inventory. The ERT encourages the Party to report in the NIR on the progress of the project that aims to improve the quantification of the total grassland area with spatially explicit data sets.	ARR 2023 L.10	The derivation of the grassland area data was described in detail.	Chapters 6.4.2, 6.1.3.1
4.C.1 Grassland remaining grassland – CO_2 The ERT recommends that the Party report the soil carbon stock, management factors, assumptions and data sources and corresponding areas for grassland remaining grassland in the NIR., referring to the current or the potential update based on the national research project on management measures to maintain and enhance SOC stocks in grassland mineral soils.	ARR 2023 L.11	The rationale for changing the approach of estimating mineral soil carbon stock changes in grassland remaining grassland was explained.	Chapter 6.4.4.1.2
4.D Wetlands The ERT recommends that the Party demonstrate in the NIR that the current assumption that the area of drained peatlands has remained constant since 1990 accurately reflects the national circumstances, or if this is not possible, revise the areas using the best available information or a splicing technique from the 2006 IPCC Guidelines (vol.1, chap. 5) and explain any recalculation in the NIR.	ARR 2023 L.12	A project on the distribution and management of organic soils was finalised in 2024 and has improved the estimates for organic soils for submission 2025.	Chapter 6.1.8
4.D.1 Wetlands remaining wetlands – CO_2 The ERT recommends that Austria provide an explanation for the reporting of "NE" for CO2 emissions from other wetlands remaining other wetlands and flooded land remaining flooded land in CRF table 9 and in the NIR.	ARR 2023 L.13	An explanation was provided in the NID and in CRT 9.	Chapter 6.5.4.1, CRT Table 9

Finding	Reference*	Improvement made	Chapter
4.G HWP – CO_2 The ERT encourages the Party to report the factors used to convert from product units to carbon in the NIR. Further, the ERT encourages the Party to report these factors in CRF table 4.G and/or include a reference to the NIR in the documentation box.	ARR 2023 L.14	These factors are reported in the NID.	Chapter 6.8.2, Table 310
WASTE			
5.D.1 Domestic wastewater – CH_4 (Convention reporting adherence) Provide consistent information in CRF table 5.D and the NIR (either estimates or the correct notation key for the recovered and flared CH_4 from domestic wastewater).	ARR 2023 W.2	The notation key 'IE' for 5.D.1 is added in CRT 5.D and the NID text adapted accordingly.	Chapter 7.5.2.1, CRT Table 5.D
5 General (waste) – CH_4 The ERT recommends that the Party demonstrate clearly in the NIR that deposition of paper, wood and green waste has not taken place since 2009, for example by citing the relevant legislation. The ERT encourages the Party to report the notation key "NO" for the annual change in total long-term carbon storage in HWP waste for the years in which this activity does not occur, in the memo item in CRF table 5.	ARR 2023 W.3	Reference to the Landfill Ordinance (Federal Law Gazette II No 39/2008) is included and information, that due to that deposition of paper, wood and green waste no longer takes place in Austria, is now more clearly stated in the NIR/NID. In CRT Table 5 'NO' is reported for the annual change in total long-term carbon storage in HWP waste (5.F.3).	Chapter 7.2.1, CRT Table 5
5.A Solid waste disposal on land – CH_4 The ERT recommends that Austria review the assumptions regarding landfill gas collection for 2018 onward, taking into consideration, as appropriate, the results of the survey conducted among the landfill operators on the landfill gas recovered and utilized in 2023 and covering 2018–2022, to ensure its reporting is consistent with the 2006 IPCC Guidelines (vol. 5, chap. 3, p.3.19).	ARR 2023 W.4	The results of the most recent survey on landfill gas recovery and utilization (Umweltbundesamt 2023b) have been considered in the Austrian inventory.	Chapter 7.2.2.2.4
5.B.2 Anaerobic digestion at biogas facilities – CH_4 The ERT recommends that the Party report separately CH_4 flared and CH_4 recovered for MSW combustion. It also recommends that, if the Party cannot report these emissions separately and continues to report CH_4 flared as "IE", including those emissions under the amount of CH_4 for energy recovery, the Party provide an explanation in CRF table 9 and in the NIR to clarify where the CH_4 flared is reported.	ARR 2023 W.5	An explanation on where 'CH_4 flared' is included is provided in the NID as well as in CRT Table 9.	Chapter 7.3.2.2 (see footnote) CRT Table 9

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11 ABBREVIATIONS

General

AMA.................................... Agrarmarkt Austria

AECM .... Agri-environment-climate Measures

AWMS .... Animal Waste Management System (see also MMS)

BAWP .... Bundes-Abfallwirtschaftsplan/Federal Waste Management Plan

BFW.................................... Bundesamt und Forschungszentrum für Wald/Austrian Federal Office and Research Centre for Forest

BMK.................................... Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation & Technologie/Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology) (formerly BMNT, from April 2025 onwards: BMLUK)

BMLFUW............................ Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft/Federal Ministry of Agriculture, Forestry, Environment and Water Management

BMLRT................................ Bundesministerium für Landwirtschaft, Regionen und Tourismus; Federal Ministry of Agriculture, Regions and Tourism (formerly BMNT)

BML .... Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft/Federal Ministry of Agriculture, Forestry, Regions and Water Management (formerly BMLRT, from April 2025 onwards: BMLUK)

BMLUK .... Bundesministerium für Land- und Forstwirtschaft, Klima- und Umweltschutz, Regionen und Wasserwirtschaft/ Federal Ministry of Agriculture and Forestry, Climate and En-vironmental Protection, Regions and Water Management (formerly BMK and BML)

BMNT .... Bundesministerium für Nachhaltigkeit und Tourismus/Federal Ministry for Sustainability and Tourism (formerly BMLFUW)

BMWA .... Bundesministerium für Wirtschaft und Arbeit/Federal Ministry for Economic Affairs and Labour (renamed as BMWFJ, from April 2025 onwards: BMWET)

BMWET .... Bundesministerium für Wirtschaft, Energie und Tourismus/Federal Ministry for Economy, Energy and Tourism

BMWFJ .... Bundesministerium für Wirtschaft, Familie und Jugend/Federal Ministry of Economy, Family and Youth (formerly BMWA)

CAN .... Calcium Ammonium Nitrate (Fertilizer)

COP .... Conference of the Parties

CORINAIR .... Core Inventory Air

CORINE .... Coordination d´information Environmentale

CRF .... Common Reporting Format (until submission 2023)

CRT .... Common Reporting Tables (from submission 2024 onwards)

DKDB................................. Dampfkesseldatenbank/Austrian annual steam boiler inventory

DOC.................................. Degradable Organic Carbon

EC .... European Community

EDM.................................. Electronic Data Management

EEA .... European Environment Agency

EF...................................... Emission Factor

EFTA .... European Free Trade Association

EIONET.............................. European Environment Information and Observation NETwork

EMEP .... Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe

EMREG .... Electronic Emission Register of Surface Water Bodies

EN..................................... European Norm

EPER................................. European Pollutant Emission Register

ETC/AE .... European Topic Centre on Air Emissions

ETF.................................... Enhanced Transpareny Framework

EU..................................... European Union

ERT .... Expert Review Team (in context of the UNFCCC review process)

EZG................................... Emissionszertifikategesetz

FAME .... Fatty Acid Methyl Ester (Fettsäuremethylester, Biodiesel)

FAO .... Food and Agricultural Organisation of the United Nations

GHG .... Greenhouse Gas

GLOBEMI .... Globale Modellbildung für Emissions- und Verbrauchsszenarien im Verkehrssektor/Global Modelling for Emission- and Fuel consumption Scenarios of the Transport Sector)

GPG.................................. Good Practice Guidance

GWP .... Global Warming Potential

HDV................................... Heavy Duty Vehicle

IMEO .... International Methane Emissions Observatory

IPCC.................................. Intergovernmental Panel on Climate Change

ICR.................................... In-Country Review (by the UNFCCC)

IEA .... International Energy Agency

ISO.................................... International Standards Organisation

LDV................................... Light Duty Vehicle

LTO................................... Landing/Take-Off cycle

LULUCF............................. Land Use, Land-Use Change and Forestry – IPCC-CRT Category 4

MMS................................. Manure Management System (see also AWMS)

MPGs................................ Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement-NACENomenclature des activites economiques de la Communaute Europeenne

ND .... Natural Disturbances

NEMO .... Network Emission Model

NFI.................................... National Forest Inventory

NFR................................... Nomenclature for Reporting (Format of Reporting under the UNECE/CLRTAP Convention)

NISA .... National Inventory System Austria

NPK .... Nitrogen (N) Phosphorus (P) and Potassium (K) (Fertilizer)

NRMM............................... Non-Road Mobile Machinery

OECD................................ Organisation for Economic Co-operation and Development

OGMP .... Oil and Gas Methane Partnership

OLI.................................... Österreichische Luftschadstoff Inventur / Austrian Air Emission Inventory

OMV .... Österreichische Mineralölverwaltung / Austrian Mineraloil Company

PC .... Passenger cars

PRTR................................. Pollutant Release and Transfer Register

QA/QC.............................. Quality Assurance/Quality Control

QMS .... Quality Management System

RWA.................................. Raiffeisen Ware Austria (see www.rwa.at)

SNAP .... Selected Nomenclature on Air Pollutants

SWDS .... Solid Waste Disposal Sites

TERT .... Technical Expert Review Team (under the EU Monitoring Mechanism)

UNECE/CLRTAP................. United Nations Economic Commission for Europe,
Convention on Long-range Transboundary Air Pollution

UNFCCC .... United Nations Framework Convention on Climate Change

WWPT .... Wastewater Treatment Plants

Notation Keys

According to the revised UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention (FCCC/CP/2013/10/Add.32002/8, Decision 24/CP.19).

"NO" (not occurring)	for categories or processes, including recovery, under a particular source or sink category that do not occur within a Party;
"NE" (not estimated)	for AD and/or emissions by sources and removals by sinks of GHGs which have not been estimated but for which a corresponding activity may occur within a Party. Where "NE" is used in an inventory to report emissions or removals of CO2, N2O, CH4, HFCs, PFCs, SF6 and NF3 the Party shall indicate in both the NIR and the CRT completeness table why emissions or removals have not been estimated. Furthermore the Party should provide justifications for exclusion in terms of the likely level of emissions
"NA" (not applicable)	for activities under a given source/sink category that do occur within the Party but do not result in emissions or removals of a specific gas. If the cells for categories in the CRT tables for which "NA" is applicable are shaded, they do not need to be filled in.
"IE" (included elsewhere)	for emissions by sources and removals by sinks of GHGs estimated but included elsewhere in the inventory instead of the expected source/sink category. Where "IE" is used in an inventory, the Annex I Party should indicate, in the CRT completeness table, where in the inventory the emissions or removals from the displaced source/sink category have been included, and the Annex I Party should explain such a deviation from the inclusion under the expected category, especially if it is due to confidentiality.
"C" (confidential)	for emissions by sources and removals by sinks of GHGs which the reporting could lead to the disclosure of confidential information, given the provisions of paragraph 27 of above

Chemical Symbols – Greenhouse gases

CH_4 .... Methane

CO_2 .... Carbon Dioxide

N_2O.................................... Nitrous Oxide

HFCs.................................. Hydroflurocarbons

PFCs .... Perfluorocarbons

SF_6 .... Sulphur hexafluoride

NF_3..................................... Nitrogen trifluoride

Further chemical compounds

CO .... Carbon Monoxide

Cd .... Cadmium

NH_3 .... Ammonia

Hg .... Mercury

NO_x .... Nitrogen Oxides (NO plus NO_2)

NO_2 .... Nitrogen Dioxide

NMVOC .... Non-Methane Volatile Organic Compounds

PAH .... Polycyclic Aromatic Hydrocarbons

Pb .... Lead

POP .... Persistent Organic Pollutants

SO_2 .... Sulfur Dioxide

SO_x .... Sulfur Oxides

Units and Metric Symbols

UNIT	Name	Unit for
g	gram	mass
t	ton	mass
W	watt	power
J	joule	calorific value
m	meter	length

Mass Unit Conversion		
1g		
1kg	= 1 000 g	
1t	= 1 000 kg	= 1 Mg
1kt	= 1 000 t	= 1 Kt
1Mt	= 1 Mio t	= 1 Tg

Metric Symbol	Prefix	Factor
P	peta	1015
T	tera	1012
G	giga	109
M	mega	106
k	kilo	103
h	hecto	102
da	deca	101
d	deci	10-1
c	centi	10-2
m	milli	10-3
µ	micro	10-6
n	nano	10-9

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umweltbundesamt
ENVIRONMENT AGENCY AUSTRIA

AUSTRIA'S NATIONAL INVENTORY DOCUMENT 2025 – ANNEX

Submission under the UNFCCC and under the Paris Agreement

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ANNEX
REP-0964

VIENNA 2025

Since 23 December 2005 the Umweltbundesamt has been accredited as Inspection Body for emission inventories, Type A (ID No. 241), in accordance with EN ISO/IEC 17020 and the Austrian Accreditation Law (AkkG), by decree of Accreditation Austria (first decree, No. BMWA-92.715/0036-I/12/2005, issued by Accreditation Austria / Federal Ministry of Economics and Labour on 19 January 2006).

The accreditation scope of the IBE is listed on: akkreditierung-austria.gv.at/overview. The specific underlying standards for the results presented in this report are outlined in Chapter 1.5 of this report.

Akkreditierung Austria
0241
ISO/IEC 17020

ANNEX 1: KEY CATEGORIES

Annex 1.1 – Description of methodology for identification of key categories

The method used to identify key source categories follows the Approach 1 method – quantitative approach described in the IPCC 2006 GL (Volume 1), Chapter 4 *Methodological Choice and Identification of Key Categories.* In addition, the Approach 2 method was applied.

The analysis includes all greenhouse gases reported under the UNFCCC: CO_2, CH_4, N_2O, HFC, PFC, SF_6 and NF_3. All IPCC categories are included.

Key categories were first identified for the inventory excluding LULUCF and then the key category analysis was repeated for the full inventory including LULUCF categories.

The identification of key categories consists of six steps:

- Identifying categories
- Level Assessment excluding LULUCF (Approach 1 and Approach 2)
- Trend Assessment excluding LULUCF (Approach 1 and Approach 2)
- Level Assessment including LULUCF (Approach 1 and Approach 2)
- Trend Assessment including LULUCF (Approach 1 and Approach 2)
- Qualitative considerations

Annex 1.2 – Information on the level of disaggregation

Level of disaggregation and identification of key categories

To identify key categories, the key category analysis (KCA) was applied to a selected subcategory-gas resolution consisting of 311 subcategory-gas combinations for which emissions (or removals) occur in Austria. Table A 15 presents the 311 source/sink categories (incl. LULUCF) considered in the Austrian key category analysis, and their greenhouse gas emissions expressed in CO_2 equivalent emissions for the years 1990 to 2023. In total 81 individual categories were identified as key categories, with twelve of the 81 categories identified via the approach 2 KCA taking into account uncertainty contributions to the level and trend assessments.

Further details and a list of the source/sink categories and key categories for each sector are given in the corresponding subchapters *3 Energy – 8 Waste* in the NID.

Level Assessment excluding LULUCF

For the Level Assessment the contribution of GHG emissions (expressed in CO_2 equivalent emissions) of each category to national total emissions was calculated. The calculation was performed for the years 1990 and 2023 according to Equation 4.1 of the IPCC 2006 GL. Then the sources were ranked in descending order of magnitude according to the results of the level assessment and finally a cumulative total was calculated.

In total 43 individual categories were identified as key categories according to the approach 1 level assessment (LA) of 2023 emissions excluding LULUCF, with 50 categories identified by the repective KCA on 1990 emissions. The result of each level assessment is presented in Tables A 1 and A 2.

Trend Assessment excluding LULUCF

The trend assessment (TA) identifies source categories that have a significant influence on the overall trend of the overall inventory. For the TA, emissions of the year 2023 were compared with 1990.

The calculation was performed according to Equation 4.2 of the IPCC 2006 GL. For sources with zero current year emissions Equation 4.3 of the IPCC 2006 GL was used to calculate the trend. The results were ranked in descending order of magnitude and a cumulative total was calculated. Those sources that make up > 95% of the total trend were identified as key categories. In total, 51 categories were identified as key categories in the approach 1 trend assessment of emissions excluding LULUCF according to Approach 1. Results are presented in Table A 3.

Level Assessment including LULUCF

The approach 1 level assessment was repeated for the full inventory including the LULUCF categories for the years 1990 and 2023 according to Equation 5.4.1 of the GPG-LULUCF. The result of each level assessment is presented in Tables A 4 and A 5.

Trend Assessment including LULUCF

The approach 1 trend assessment was repeated for the full inventory including the LULUCF categories for the years 1990 and 2023 according to Equation 5.4.2 of the GPG-LULUCF (Equation 5.4.3 for zero current year emissions). The result of the trend assessment Approach 1 is presented in Table A 6.

Approach 2 KCA

The above level and trend assessments (with and without LULUCF) were complemented by respective approach 2 KCA that considers also the impact on level and trend uncertainties. Together, the approach 2 analyses led to a further 12 categories being identified as key categories. The results of these individual level and trend assessments are shown in Tables A 7 – A 12.

Qualitative criteria

Qualitative criteria considered were:

- categories that are close to the 95% criteria, but are not included in all years, e.g. due to fluctuating emissions/removals
- mitigation techniques,
- high expected growth of emissions/removals
- unexpected low or high emissions/removals.

No additional key source categories were identified applying these qualitative criteria.

Identification of key categories

Any category meeting the 95% (Approach 1) respectively 90% (Approach 2) threshold in any year of the level assessment or in the trend assessment and meeting the qualitative criteria as described above is considered a key category. The full results of the approach 1 and approach 2 KCA with and without LULUCF are synthesised in Table A 15.

Consequences of key category selection:

Whenever a method used for the estimation of emissions/removals of a key category is not consistent with the requirements of the IPCC 2006 Guidelines, the method will have to be improved in order to reduce uncertainty, which is considered in the emission inventory improvement programme.

Annex 1.3 – Results of the Key Category Analysis

Results are presented for the level assessments for the years 1990 and 2023, and for the trend assessment 1990-2023, both for the key category analysis excluding and including LULUCF. Furthermore, key categories identified including their ranking in the level and trend assessments and emission sources and removal sinks in the level of aggregation as used for the key category analysis together with emissions/removals from 1990 to 2023 for these categories are included.

Table A 1: Approach 1 – Level Assessment of the KCA excluding LULUCF for 1990.

IPCC Code and Category	GHG	Year 1990 Estimate $E_{x,t}$ [kt CO_2-e units]	Level Assessment $L_{x,t}$ [%]	Cumulative Total of $L_{x,t}$ [%]
1.A.3.b. Road transportation - Gasoline	CO_2	7896	9.9	9.9
2.C.1. Iron and steel production	CO_2	6840	8.6	18.5
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6247	7.8	26.4
1.A.4.b. Residential - Liquid Fuels	CO_2	5633	7.1	33.4
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358	6.7	40.2
3.A.1. Cattle	CH_4	4871	6.1	46.3
5.A. Solid waste disposal	CH_4	4081	5.1	51.4
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294	4.1	55.5
1.A.4.b. Residential - Solid Fuels	CO_2	2511	3.2	58.7
2.A.1. Cement production	CO_2	2033	2.6	61.2
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	1958	2.5	63.7
1.A.4.b. Residential - Gaseous Fuels	CO_2	1856	2.3	66
3.D.1. Direct N_2O emissions from managed soils	N_2O	1606	2	68.1
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1420	1.8	69.8
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	1229	1.5	71.4
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1180	1.5	72.9
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1107	1.4	74.3
2.C.3. Aluminium production	PFCs	1032	1.3	75.5
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1014	1.3	76.8
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	943	1.2	78
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	853	1.1	79.1
2.B.2. Nitric acid production	N_2O	780	1	80.1
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	698	0.9	80.9

IPCC Code and Category	GHG	Year 1990 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $L_{x,t}$ [%]	Cumulative Total of $L_{x,t}$ [%]
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	650	0.8	81.7
1.A.2.g.viii Other - Liquid Fuels	CO_2	610	0.8	82.5
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	559	0.7	83.2
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	535	0.7	83.9
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	519	0.7	84.5
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	508	0.6	85.2
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	507	0.6	85.8
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	506	0.6	86.4
3.B.1. Cattle	CH_4	482	0.6	87.1
2.A.4.c. Non-metallurgical magnesium production	CO_2	481	0.6	87.7
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467	0.6	88.2
2.B.1. Ammonia production	CO_2	467	0.6	88.8
2.A.2. Lime production	CO_2	456	0.6	89.4
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	437	0.5	90
3.B.1. Cattle	N_2O	404	0.5	90.5
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	398	0.5	91
1.B.2.b. Natural gas	CH_4	375	0.5	91.4
1.B.1.a. Coal mining and handling	CH_4	373	0.5	91.9
2.D. Non-energy products from fuels and solvent use	CO_2	349	0.4	92.3
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	345	0.4	92.8
5.D. Wastewater treatment and discharge	CH_4	334	0.4	93.2
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286	0.4	93.6
1.A.4.b. Residential - Biomass	CH_4	264	0.3	93.9
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252	0.3	94.2
2.C.4. Magnesium production	SF_6	235	0.3	94.5
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	224	0.3	94.8
1.A.4.b. Residential - Solid Fuels	CH_4	224	0.3	95.1

Table A 2: Approach 1 – Level Assessment of the KCA excluding LULUCF for 2023

IPCC Code and Category	GHG	Year 2023 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $L_{x,t}$ [%]	Cumulative Total of $L_{x,t}$ [%]
1.A.3.b. Road transportation - Diesel Oil	CO_2	14667	21.4	21.4
2.C.1. Iron and steel production	CO_2	10188	14.8	36.2
1.A.3.b. Road transportation - Gasoline	CO_2	4625	6.7	42.9
3.A.1. Cattle	CH_4	4024	5.9	48.8
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3206	4.7	53.4
1.A.4.b. Residential - Gaseous Fuels	CO_2	2736	4	57.4
1.A.4.b. Residential - Liquid Fuels	CO_2	2261	3.3	60.7
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	2252	3.3	64
2.A.1. Cement production	CO_2	1543	2.2	66.2
3.D.1. Direct N_2O emissions from managed soils	N_2O	1402	2	68.3
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	1365	2	70.3
2.F.1. Refrigeration and air-conditioning	HFCs	1350	2	72.2
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1270	1.8	74.1
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	1101	1.6	75.7
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	1094	1.6	77.3
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	1075	1.6	78.8
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	957	1.4	80.2

IPCC Code and Category	GHG	Year 2023 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $L_{x,t}$ [%]	Cumulative Total of $L_{x,t}$ [%]
5.A. Solid waste disposal	CH_4	799	1.2	81.4
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	793	1.2	82.6
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	791	1.2	83.7
3.B.1. Cattle	CH_4	665	1	84.7
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	635	0.9	85.6
1.A.2.a. Iron and steel - Solid Fuels	CO_2	632	0.9	86.5
2.A.2. Lime production	CO_2	588	0.9	87.4
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	554	0.8	88.2
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	506	0.7	88.9
2.B.1. Ammonia production	CO_2	447	0.7	89.6
3.D.2. Indirect N_2O emissions from managed soils	N_2O	376	0.5	90.1
2.A.4.c. Non-metallurgical magnesium production	CO_2	339	0.5	90.6
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	327	0.5	91.1
2.G.2. SF_6 and PFCs from other product use	SF_6	306	0.4	91.5
1.B.2.b. Natural gas	CH_4	290	0.4	92
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	278	0.4	92.4
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	260	0.4	92.7
3.B.1. Cattle	N_2O	253	0.4	93.1
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	216	0.3	93.4
1.A.4.b. Residential - Biomass	CH_4	196	0.3	93.7
1.A.3.b. Road transportation - Diesel Oil	N_2O	191	0.3	94
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	190	0.3	94.3
5.D. Wastewater treatment and discharge	CH_4	190	0.3	94.5
2.D. Non-energy products from fuels and solvent use	CO_2	162	0.2	94.8
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	155	0.2	95
5.D. Wastewater treatment and discharge	N_2O	155	0.2	95.2

Table A 3: Approach 1 – Trend Assessment of the KCA excluding LULUCF for the trend 1990–2023.

IPCC Code and Category	GHG	Base Year (1990) Estimate $E_{x,0}$ [kt CO_2-e units]	Latest Year (2023) Estimate Ex,t [kt CO_2-e units]	Trend Assessment $T_{x,t}$	% Contribution to Trend	Cumulative Total of $T_{x,t}$ [%]
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358	14667	0.1262	20.4	20.4
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6247	0	0.0677	10.9	31.3
2.C.1. Iron and steel production	CO_2	6840	10188	0.0538	8.7	40.1
5.A. Solid waste disposal	CH_4	4081	799	0.0342	5.5	45.6
1.A.4.b. Residential - Liquid Fuels	CO_2	5633	2261	0.0326	5.3	50.9
1.A.3.b. Road transportation - Gasoline	CO_2	7896	4625	0.0275	4.4	55.3
1.A.4.b. Residential - Solid Fuels	CO_2	2511	27	0.0269	4.3	59.6
2.F.1. Refrigeration and air-conditioning	HFCs	0	1350	0.017	2.7	62.4
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252	1365	0.0144	2.3	64.7
1.A.4.b. Residential - Gaseous Fuels	CO_2	1856	2736	0.0143	2.3	67
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1420	216	0.0127	2	69.1
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	1229	147	0.0115	1.9	70.9
2.C.3. Aluminium production	PFCs	1032	0	0.0112	1.8	72.7

IPCC Code and Category	GHG	Base Year (1990) Estimate $E_{x,0}$ [kt CO_2-e units]	Latest Year (2023) Estimate Ex,t [kt CO_2-e units]	Trend Assessment $T_{x,t}$	% Contribution to Trend	Cumulative Total of $T_{x,t}$ [%]
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286	1094	0.0106	1.7	74.5
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	853	39	0.0087	1.4	75.9
2.B.2. Nitric acid production	N_2O	780	27	0.0081	1.3	77.2
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	1958	2252	0.0071	1.1	78.3
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	650	1075	0.0065	1	79.4
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	519	957	0.0064	1	80.4
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	67	554	0.0062	1	81.4
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1014	1270	0.005	0.8	82.2
1.A.2.g.viii Other - Liquid Fuels	CO_2	610	137	0.0049	0.8	83
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294	3206	0.0046	0.7	83.8
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	535	128	0.0042	0.7	84.4
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1107	632	0.0041	0.7	85.1
1.B.1.a. Coal mining and handling	CH_4	373	0	0.004	0.7	85.7
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	398	49	0.0037	0.6	86.3
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	943	1101	0.0036	0.6	86.9
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	506	155	0.0035	0.6	87.5
3.B.1. Cattle	CH_4	482	665	0.0031	0.5	88
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	508	190	0.0031	0.5	88.5
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1180	791	0.0029	0.5	89
2.A.1. Cement production	CO_2	2033	1543	0.0027	0.4	89.4
2.C.4. Magnesium production	SF_6	235	2	0.0025	0.4	89.8
2.G.2. SF_6 and PFCs from other product use	SF_6	124	306	0.0025	0.4	90.2
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	507	635	0.0025	0.4	90.6
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	75	260	0.0025	0.4	91
2.A.2. Lime production	CO_2	456	588	0.0024	0.4	91.4
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	698	793	0.0024	0.4	91.8
1.A.4.b. Residential - Solid Fuels	CH_4	224	2	0.0024	0.4	92.2
1.A.3.b. Road transportation - Diesel Oil	N_2O	11	191	0.0023	0.4	92.5
3.A.1. Cattle	CH_4	4871	4024	0.0022	0.4	92.9
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	125	278	0.0021	0.3	93.3
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	224	25	0.0021	0.3	93.6
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	345	148	0.0019	0.3	93.9
2.D. Non-energy products from fuels and solvent use	CO_2	349	162	0.0017	0.3	94.2
2.C.3. Aluminium production	CO_2	150	5	0.0016	0.3	94.4
5.D. Wastewater treatment and discharge	CH_4	334	190	0.0012	0.2	94.6
3.B.1. Cattle	N_2O	404	253	0.0012	0.2	94.8
5.D. Wastewater treatment and discharge	N_2O	86	155	0.001	0.2	95
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	91	0	0.001	0.2	95.2

Table A 4: Approach 1 – Level Assessment of the KCA including LULUCF for 1990.

IPCC Code and Category	GHG	Year 1990 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $L_{x,t}$ [%]	Cumulative Total of $L_{x,t}$ [%]
4.A.1. Forest land remaining forest land	CO_2	-10624	10.7	10.7

IPCC Code and Category	GHG	Year 1990 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $L_{x,t}$ [%]	Cumulative Total of $L_{x,t}$ [%]
1.A.3.b. Road transportation - Gasoline	CO_2	7896	8	18.7
2.C.1. Iron and steel production	CO_2	6840	6.9	25.5
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6247	6.3	31.8
1.A.4.b. Residential - Liquid Fuels	CO_2	5633	5.7	37.5
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358	5.4	42.9
3.A.1. Cattle	CH_4	4871	4.9	47.8
5.A. Solid waste disposal	CH_4	4081	4.1	51.9
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294	3.3	55.2
4.G. Harvested wood products	CO_2	-3122	3.1	58.4
4.A.2. Land converted to forest land	CO_2	-2959	3	61.4
1.A.4.b. Residential - Solid Fuels	CO_2	2511	2.5	63.9
2.A.1. Cement production	CO_2	2033	2	65.9
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	1958	2	67.9
1.A.4.b. Residential - Gaseous Fuels	CO_2	1856	1.9	69.8
3.D.1. Direct N_2O emissions from managed soils	N_2O	1606	1.6	71.4
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1420	1.4	72.8
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	1229	1.2	74.1
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1180	1.2	75.3
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1107	1.1	76.4
2.C.3. Aluminium production	PFCs	1032	1	77.4
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1014	1	78.4
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	943	0.9	79.4
4.E.2. Land converted to settlements	CO_2	935	0.9	80.3
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	853	0.9	81.2
2.B.2. Nitric acid production	N_2O	780	0.8	82
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	698	0.7	82.7
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	650	0.7	83.3
1.A.2.g.viii Other - Liquid Fuels	CO_2	610	0.6	83.9
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	559	0.6	84.5
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	535	0.5	85
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	519	0.5	85.6
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	508	0.5	86.1
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	507	0.5	86.6
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	506	0.5	87.1
4.F.2. Land converted to other land	CO_2	502	0.5	87.6
3.B.1. Cattle	CH_4	482	0.5	88.1
2.A.4.c. Non-metallurgical magnesium production	CO_2	481	0.5	88.6
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467	0.5	89
2.B.1. Ammonia production	CO_2	467	0.5	89.5
2.A.2. Lime production	CO_2	456	0.5	90
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	437	0.4	90.4
4.C.2. Land converted to grassland	CO_2	421	0.4	90.8
3.B.1. Cattle	N_2O	404	0.4	91.3
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	398	0.4	91.7
1.B.2.b. Natural gas	CH_4	375	0.4	92
1.B.1.a. Coal mining and handling	CH_4	373	0.4	92.4
4.C.1. Grassland remaining grassland	CO_2	371	0.4	92.8
2.D. Non-energy products from fuels and solvent use	CO_2	349	0.4	93.1
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	345	0.3	93.5
5.D. Wastewater treatment and discharge	CH_4	334	0.3	93.8

IPCC Code and Category	GHG	Year 1990 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $L_{x,t}$ [%]	Cumulative Total of $L_{x,t}$ [%]
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286	0.3	94.1
1.A.4.b. Residential - Biomass	CH_4	264	0.3	94.4
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252	0.3	94.6
2.C.4. Magnesium production	SF_6	235	0.2	94.9
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	224	0.2	95.1

Table A 5: Approach 1 – Level Assessment of the KCA including LULUCF for 2023.

IPCC Code and Category	GHG	Year 2023 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $L_{x,t}$ [%]	Cumulative Total of $L_{x,t}$ [%]
1.A.3.b. Road transportation - Diesel Oil	CO_2	14667	18.2	18.2
2.C.1. Iron and steel production	CO_2	10188	12.7	30.9
4.A.1. Forest land remaining forest land	CO_2	6763	8.4	39.3
1.A.3.b. Road transportation - Gasoline	CO_2	4625	5.8	45.1
3.A.1. Cattle	CH_4	4024	5	50.1
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3206	4	54.1
1.A.4.b. Residential - Gaseous Fuels	CO_2	2736	3.4	57.5
1.A.4.b. Residential - Liquid Fuels	CO_2	2261	2.8	60.3
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	2252	2.8	63.1
2.A.1. Cement production	CO_2	1543	1.9	65
3.D.1. Direct N_2O emissions from managed soils	N_2O	1402	1.7	66.8
4.A.2. Land converted to forest land	CO_2	-1402	1.7	68.5
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	1365	1.7	70.2
2.F.1. Refrigeration and air-conditioning	HFCs	1350	1.7	71.9
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1270	1.6	73.5
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	1101	1.4	74.8
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	1094	1.4	76.2
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	1075	1.3	77.5
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	957	1.2	78.7
4.E.2. Land converted to settlements	CO_2	945	1.2	79.9
5.A. Solid waste disposal	CH_4	799	1	80.9
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	793	1	81.9
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	791	1	82.9
4.G. Harvested wood products	CO_2	-678	0.8	83.7
3.B.1. Cattle	CH_4	665	0.8	84.5
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	635	0.8	85.3
1.A.2.a. Iron and steel - Solid Fuels	CO_2	632	0.8	86.1
2.A.2. Lime production	CO_2	588	0.7	86.8
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	554	0.7	87.5
4.F.2. Land converted to other land	CO_2	520	0.6	88.2
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	506	0.6	88.8
2.B.1. Ammonia production	CO_2	447	0.6	89.4
3.D.2. Indirect N_2O emissions from managed soils	N_2O	376	0.5	89.8
4.C.1. Grassland remaining grassland	CO_2	371	0.5	90.3
2.A.4.c. Non-metallurgical magnesium production	CO_2	339	0.4	90.7
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	327	0.4	91.1
2.G.2. SF_6 and PFCs from other product use	SF_6	306	0.4	91.5
1.B.2.b. Natural gas	CH_4	290	0.4	91.9
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	278	0.3	92.2

IPCC Code and Category	GHG	Year 2023 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $L_{x,t}$ [%]	Cumulative Total of $L_{x,t}$ [%]
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	260	0.3	92.5
4.B.1. Cropland remaining cropland	CO_2	256	0.3	92.9
3.B.1. Cattle	N_2O	253	0.3	93.2
4.C.2. Land converted to grassland	CO_2	222	0.3	93.4
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	216	0.3	93.7
1.A.4.b. Residential - Biomass	CH_4	196	0.2	94
1.A.3.b. Road transportation - Diesel Oil	N_2O	191	0.2	94.2
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	190	0.2	94.4
5.D. Wastewater treatment and discharge	CH_4	190	0.2	94.7
4.B.2. Land converted to cropland	CO_2	172	0.2	94.9
4. Land use, land-use change and forestry	N_2O	169	0.2	95.1

Table A 6: Approach 1 – Trend Assessment of the KCA including LULUCF for the trend 1990–2023.

IPCC Code and Category	GHG	Base Year (1990) Estimate $E_{x,0}$ [kt CO_2-e units]	Latest Year (2023) Estimate Ex,t [kt CO_2-e units]	Trend Assessment $T_{x,t}$	% Contribution to Trend	Cumulative Total of $T_{x,t}$ [%]
4.A.1. Forest land remaining forest land	CO_2	-10624	6763	0.1583	20.2	20.2
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358	14667	0.0853	10.9	31.1
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6247	0	0.0728	9.3	40.4
1.A.3.b. Road transportation - Gasoline	CO_2	7896	4625	0.0455	5.8	46.2
1.A.4.b. Residential - Liquid Fuels	CO_2	5633	2261	0.0429	5.5	51.7
5.A. Solid waste disposal	CH_4	4081	799	0.0395	5	56.7
1.A.4.b. Residential - Solid Fuels	CO_2	2511	27	0.029	3.7	60.4
2.C.1. Iron and steel production	CO_2	6840	10188	0.0229	2.9	63.3
4.G. Harvested wood products	CO_2	-3122	-678	0.0197	2.5	65.9
3.A.1. Cattle	CH_4	4871	4024	0.0163	2.1	67.9
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1420	216	0.0144	1.8	69.8
2.F.1. Refrigeration and air-conditioning	HFCs	0	1350	0.0136	1.7	71.5
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	1229	147	0.0128	1.6	73.1
2.C.3. Aluminium production	PFCs	1032	0	0.012	1.5	74.7
4.A.2. Land converted to forest land	CO_2	-2959	-1402	0.011	1.4	76.1
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252	1365	0.0108	1.4	77.5
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	853	39	0.0095	1.2	78.7
2.B.2. Nitric acid production	N_2O	780	27	0.0088	1.1	79.8
2.A.1. Cement production	CO_2	2033	1543	0.0082	1	80.8
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286	1094	0.0077	1	81.8
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1107	632	0.0065	0.8	82.7
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294	3206	0.0061	0.8	83.4
1.A.4.b. Residential - Gaseous Fuels	CO_2	1856	2736	0.0059	0.8	84.2
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1180	791	0.0058	0.7	84.9
1.A.2.g.viii Other - Liquid Fuels	CO_2	610	137	0.0057	0.7	85.7
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	535	128	0.0049	0.6	86.3
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	67	554	0.0048	0.6	86.9
3.D.1. Direct N_2O emissions from managed soils	N_2O	1606	1402	0.0046	0.6	87.5

IPCC Code and Category	GHG	Base Year (1990) Estimate $E_{x,0}$ [kt CO_2-e units]	Latest Year (2023) Estimate Ex,t [kt CO_2-e units]	Trend Assessment $T_{x,t}$	% Contribution to Trend	Cumulative Total of $T_{x,t}$ [%]
1.B.1.a. Coal mining and handling	CH_4	373	0	0.0044	0.6	88.1
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	506	155	0.0043	0.6	88.6
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	398	49	0.0041	0.5	89.1
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	508	190	0.004	0.5	89.6
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	519	957	0.0036	0.5	90.1
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	650	1075	0.0033	0.4	90.5
2.C.4. Magnesium production	SF_6	235	2	0.0027	0.3	90.9
4.C.2. Land converted to grassland	CO_2	421	222	0.0027	0.3	91.2
1.A.4.b. Residential - Solid Fuels	CH_4	224	2	0.0026	0.3	91.5
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	345	148	0.0025	0.3	91.9
2.D. Non-energy products from fuels and solvent use	CO_2	349	162	0.0024	0.3	92.2
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	224	25	0.0024	0.3	92.5
2.A.4.c. Non-metallurgical magnesium production	CO_2	481	339	0.0022	0.3	92.8
3.B.1. Cattle	N_2O	404	253	0.0022	0.3	93
5.D. Wastewater treatment and discharge	CH_4	334	190	0.002	0.3	93.3
1.A.3.b. Road transportation - Diesel Oil	N_2O	11	191	0.0018	0.2	93.5
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	437	327	0.0018	0.2	93.7
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	75	260	0.0017	0.2	94
2.C.3. Aluminium production	CO_2	150	5	0.0017	0.2	94.2
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467	376	0.0017	0.2	94.4
2.G.2. SF_6 and PFCs from other product use	SF_6	124	306	0.0016	0.2	94.6
1.B.2.b. Natural gas	CH_4	375	290	0.0014	0.2	94.8
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	559	506	0.0014	0.2	95
4.E.2. Land converted to settlements	CO_2	935	945	0.0014	0.2	95.1

Table A 7: Approach 2 – Level Assessment of the KCA excluding LULUCF for 1990.

IPCC Code and Category	GHG	Year 1990 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $LU_{x,t}$ [%]	Cumulative Total of $LU_{x,t}$ [%]
3.D.1. Direct N_2O emissions from managed soils	N_2O	1606	2	29
5.A. Solid waste disposal	CH_4	4081	5.1	39.2
3.A.1. Cattle	CH_4	4871	6.1	49
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467	0.6	57.5
2.C.3. Aluminium production	PFCs	1032	1.3	62.2
3.B.1. Cattle	N_2O	404	0.5	65.8
1.A.3.b. Road transportation - Gasoline	CO_2	7896	9.9	68.8
3.B.5. Indirect N_2O emissions	N_2O	123	0.2	71.1
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358	6.7	73.1
1.B.1.a. Coal mining and handling	CH_4	373	0.5	74.8
1.B.2.b. Natural gas	CH_4	375	0.5	76.3
2.C.1. Iron and steel production	CO_2	6840	8.6	77.6
1.A.4.b. Residential - Biomass	CH_4	264	0.3	78.8
2.D. Non-energy products from fuels and solvent use	CO_2	349	0.4	79.9
1.A.4.b. Residential - Solid Fuels	CH_4	224	0.3	81
3.B.3. Swine	N_2O	111	0.1	82
2.A.1. Cement production	CO_2	2033	2.6	82.9

IPCC Code and Category	GHG	Year 1990 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $LU_{x,t}$ [%]	Cumulative Total of $LU_{x,t}$ [%]
3.B.1. Cattle	CH_4	482	0.6	83.9
1.A.4.b. Residential - Gaseous Fuels	CO_2	1856	2.3	84.8
5.D. Wastewater treatment and discharge	N_2O	86	0.1	85.5
5.D. Wastewater treatment and discharge	CH_4	334	0.4	86.2
2.G.2. SF_6 and PFCs from other product use	SF_6	124	0.2	86.8
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294	4.1	87.4
1.A.4.b. Residential - Liquid Fuels	CO_2	5633	7.1	88
1.A.3.b. Road transportation - Gasoline	N_2O	83	0.1	88.5
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286	0.4	89
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1014	1.3	89.4
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	943	1.2	89.9
2.A.2. Lime production	CO_2	456	0.6	90.3

Table A 8: Approach 2 – Level Assessment of the KCA excluding LULUCF for 2023.

IPCC Code and Category	GHG	Year 2023 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $LU_{x,t}$ [%]	Cumulative Total of $LU_{x,t}$ [%]
3.D.1. Direct N_2O emissions from managed soils	N_2O	1402	2	30.2
3.A.1. Cattle	CH_4	4024	5.9	38.8
3.D.2. Indirect N_2O emissions from managed soils	N_2O	376	0.5	46.9
2.F.1. Refrigeration and air-conditioning	HFCs	1350	2	54.3
1.A.3.b. Road transportation - Diesel Oil	CO_2	14667	21.4	61
3.B.1. Cattle	N_2O	253	0.4	63.7
3.B.5. Indirect N_2O emissions	N_2O	117	0.2	66.2
5.A. Solid waste disposal	CH_4	799	1.2	68.6
1.A.3.b. Road transportation - Gasoline	CO_2	4625	6.7	70.7
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	1094	1.6	72.6
2.G.2. SF_6 and PFCs from other product use	SF_6	306	0.4	74.4
5.D. Wastewater treatment and discharge	N_2O	155	0.2	76.1
1.A.4.b. Residential - Gaseous Fuels	CO_2	2736	4	77.6
3.B.1. Cattle	CH_4	665	1	79
1.B.2.b. Natural gas	CH_4	290	0.4	80.4
1.A.4.b. Residential - Biomass	CH_4	196	0.3	81.5
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	554	0.8	82.5
2.C.1. Iron and steel production	CO_2	10188	14.8	83.3
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1270	1.8	84
2.D. Non-energy products from fuels and solvent use	CO_2	162	0.2	84.6
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	1365	2	85.2
1.A.3.b. Road transportation - Diesel Oil	N_2O	191	0.3	85.9
3.B.3. Swine	N_2O	57	0.1	86.5
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	1101	1.6	87.1
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	1075	1.6	87.6
2.G.1. Electrical equipment	SF_6	51	0.1	88.2
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	278	0.4	88.7
3.G. Liming	CO_2	95	0.1	89.2
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	957	1.4	89.8
5.B. Biological treatment of solid waste	CH_4	77	0.1	90.2

Table A 9: Approach 2 – Trend Assessment of the KCA excluding LULUCF for the trend 1990–2023.

IPCC Code and Category	GHG	Base Year (1990) Estimate $E_{x,0}$ [kt CO_2-e units]	Latest Year (2023) Estimate Ex,t [kt CO_2-e units]	Trend Assessment $TU_{x,t}$	% Contribution to Trend	Cumulative Total of $TU_{x,t}$ [%]
5.A. Solid waste disposal	CH_4	4081	799	0.0342	16.2	16.2
2.F.1. Refrigeration and air-conditioning	HFCs	0	1350	0.017	14.8	31
2.C.3. Aluminium production	PFCs	1032	0	0.0112	9.6	40.6
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358	14667	0.1262	9.2	49.7
1.B.1.a. Coal mining and handling	CH_4	373	0	0.004	3.5	53.2
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286	1094	0.0106	2.9	56.1
2.G.2. SF_6 and PFCs from other product use	SF_6	124	306	0.0025	2.4	58.5
1.A.4.b. Residential - Solid Fuels	CH_4	224	2	0.0024	2	60.5
3.B.1. Cattle	N_2O	404	253	0.0012	2	62.5
1.A.3.b. Road transportation - Gasoline	CO_2	7896	4625	0.0275	2	64.5
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	67	554	0.0062	1.9	66.5
5.D. Wastewater treatment and discharge	N_2O	86	155	0.001	1.7	68.2
1.A.4.b. Residential - Gaseous Fuels	CO_2	1856	2736	0.0143	1.2	69.4
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467	376	0.0003	1.2	70.6
1.A.3.b. Road transportation - Diesel Oil	N_2O	11	191	0.0023	1.2	71.8
2.D. Non-energy products from fuels and solvent use	CO_2	349	162	0.0017	1.1	72.8
3.B.1. Cattle	CH_4	482	665	0.0031	1.1	73.9
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252	1365	0.0144	1	75
1.A.3.b. Road transportation - Gasoline	N_2O	83	7	0.0008	1	75.9
2.G.1. Electrical equipment	SF_6	11	51	0.0005	0.9	76.8
3.B.3. Swine	N_2O	111	57	0.0005	0.8	77.6
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6247	0	0.0677	0.8	78.5
3.A.1. Cattle	CH_4	4871	4024	0.0022	0.8	79.2
5.B. Biological treatment of solid waste	CH_4	15	77	0.0008	0.7	80
3.D.1. Direct N_2O emissions from managed soils	N_2O	1606	1402	0.0002	0.7	80.7
1.A.1.a. Public electricity and heat production - Biomass	N_2O	3	64	0.0008	0.7	81.3
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	125	278	0.0021	0.7	82
2.C.1. Iron and steel production	CO_2	6840	10188	0.0538	0.7	82.7
5.B. Biological treatment of solid waste	N_2O	20	72	0.0007	0.6	83.3
1.A.4.b. Residential - Liquid Fuels	CO_2	5633	2261	0.0326	0.6	83.9
3.G. Liming	CO_2	46	95	0.0007	0.6	84.5
2.C.3. Aluminium production	CO_2	150	5	0.0016	0.6	85.1
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	650	1075	0.0065	0.6	85.6
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	519	957	0.0064	0.5	86.2
1.A.4.b. Residential - Solid Fuels	CO_2	2511	27	0.0269	0.5	86.7
3.B.5. Indirect N_2O emissions	N_2O	123	117	0.0001	0.4	87.1
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1014	1270	0.005	0.4	87.5
1.B.2.a. Oil	CH_4	92	43	0.0005	0.4	87.9
2.B.2. Nitric acid production	N_2O	780	27	0.0081	0.4	88.3
1.A.3.b. Road transportation - Gasoline	CH_4	77	7	0.0008	0.4	88.7
5.D. Wastewater treatment and discharge	CH_4	334	190	0.0012	0.4	89.1
3.B.4. Other livestock	N_2O	11	26	0.0002	0.3	89.4
1.A.4.b. Residential - Biomass	CH_4	264	196	0.0004	0.3	89.8
3.A.4. Other livestock	CH_4	41	103	0.0008	0.3	90.1

Table A 10: Approach 2 – Level Assessment of the KCA including LULUCF for 1990.

IPCC Code and Category	GHG	Year 1990 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $LU_{x,t}$ [%]	Cumulative Total of $LU_{x,t}$ [%]
4.A.1. Forest land remaining forest land	CO_2	-10624	10.7	18.8
3.D.1. Direct N_2O emissions from managed soils	N_2O	1606	1.6	33.8
4.A.2. Land converted to forest land	CO_2	-2959	3	47.4
4.G. Harvested wood products	CO_2	-3122	3.1	54.6
5.A. Solid waste disposal	CH_4	4081	4.1	59.9
3.A.1. Cattle	CH_4	4871	4.9	65
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467	0.5	69.4
4.F.2. Land converted to other land	CO_2	502	0.5	72
2.C.3. Aluminium production	PFCs	1032	1	74.4
4.E.2. Land converted to settlements	CO_2	935	0.9	76.5
3.B.1. Cattle	N_2O	404	0.4	78.4
4.C.2. Land converted to grassland	CO_2	421	0.4	80.3
1.A.3.b. Road transportation - Gasoline	CO_2	7896	8	81.8
3.B.5. Indirect N_2O emissions	N_2O	123	0.1	83
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358	5.4	84.1
1.B.1.a. Coal mining and handling	CH_4	373	0.4	84.9
1.B.2.b. Natural gas	CH_4	375	0.4	85.7
2.C.1. Iron and steel production	CO_2	6840	6.9	86.4
1.A.4.b. Residential - Biomass	CH_4	264	0.3	87
4. Land use, land-use change and forestry	N_2O	180	0.2	87.6
2.D. Non-energy products from fuels and solvent use	CO_2	349	0.4	88.2
1.A.4.b. Residential - Solid Fuels	CH_4	224	0.2	88.7
3.B.3. Swine	N_2O	111	0.1	89.3
2.A.1. Cement production	CO_2	2033	2	89.8
3.B.1. Cattle	CH_4	482	0.5	90.3

Table A 11: Approach 2 – Level Assessment of the KCA including LULUCF for 2023.

IPCC Code and Category	GHG	Year 2023 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $LU_{x,t}$ [%]	Cumulative Total of $LU_{x,t}$ [%]
3.D.1. Direct N_2O emissions from managed soils	N_2O	1402	1.7	19.7
4.A.1. Forest land remaining forest land	CO_2	6763	8.4	37.4
3.A.1. Cattle	CH_4	4024	5	43
3.D.2. Indirect N_2O emissions from managed soils	N_2O	376	0.5	48.3
2.F.1. Refrigeration and air-conditioning	HFCs	1350	1.7	53.1
4.E.2. Land converted to settlements	CO_2	945	1.2	57.9
1.A.3.b. Road transportation - Diesel Oil	CO_2	14667	18.2	62.2
4.A.2. Land converted to forest land	CO_2	-1402	1.7	65.5
4.F.2. Land converted to other land	CO_2	520	0.6	68
4.G. Harvested wood products	CO_2	-678	0.8	70.3
3.B.1. Cattle	N_2O	253	0.3	72.1
3.B.5. Indirect N_2O emissions	N_2O	117	0.1	73.7
5.A. Solid waste disposal	CH_4	799	1	75.3
1.A.3.b. Road transportation - Gasoline	CO_2	4625	5.8	76.6
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	1094	1.4	77.9
2.G.2. SF_6 and PFCs from other product use	SF_6	306	0.4	79.1

IPCC Code and Category	GHG	Year 2023 Estimate$E_{x,t}$ [kt CO_2-e units]	Level Assessment $LU_{x,t}$ [%]	Cumulative Total of $LU_{x,t}$ [%]
5.D. Wastewater treatment and discharge	N_2O	155	0.2	80.1
4. Land use, land-use change and forestry	N_2O	169	0.2	81.2
1.A.4.b. Residential - Gaseous Fuels	CO_2	2736	3.4	82.2
3.B.1. Cattle	CH_4	665	0.8	83.1
1.B.2.b. Natural gas	CH_4	290	0.4	84
4.B.1. Cropland remaining cropland	CO_2	256	0.3	84.9
4.C.2. Land converted to grassland	CO_2	222	0.3	85.6
4.C.1. Grassland remaining grassland	CO_2	371	0.5	86.4
1.A.4.b. Residential - Biomass	CH_4	196	0.2	87.1
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	554	0.7	87.8
2.C.1. Iron and steel production	CO_2	10188	12.7	88.3
4.B.2. Land converted to cropland	CO_2	172	0.2	88.7
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1270	1.6	89.2
2.D. Non-energy products from fuels and solvent use	CO_2	162	0.2	89.6
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	1365	1.7	90

Table A 12: Approach 2 – Trend Assessment of the KCA including LULUCF for the trend 1990–2023.

IPCC Code and Category	GHG	Base Year (1990) Estimate $E_{x,0}$ [kt CO_2-e units]	Latest Year (2023) Estimate Ex,t [kt CO_2-e units]	Trend Assessment $TU_{x,t}$	% Contributi on to Trend	Cumulative Total of $TU_{x,t}$ [%]
4.A.1. Forest land remaining forest land	CO_2	-10624	6763	0.1583	40.4	40.4
5.A. Solid waste disposal	CH_4	4081	799	0.0395	7.5	47.9
4.G. Harvested wood products	CO_2	-3122	-678	0.0197	6.6	54.5
3.D.1. Direct N_2O emissions from managed soils	N_2O	1606	1402	0.0046	6.3	60.8
2.F.1. Refrigeration and air-conditioning	HFCs	0	1350	0.0136	4.7	65.5
2.C.3. Aluminium production	PFCs	1032	0	0.012	4.1	69.6
4.A.2. Land converted to forest land	CO_2	-2959	-1402	0.011	2.5	72.1
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358	14667	0.0853	2.5	74.6
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467	376	0.0017	2.3	76.8
3.A.1. Cattle	CH_4	4871	4024	0.0163	2.2	79.1
1.B.1.a. Coal mining and handling	CH_4	373	0	0.0044	1.5	80.6
3.B.1. Cattle	N_2O	404	253	0.0022	1.5	82
1.A.3.b. Road transportation - Gasoline	CO_2	7896	4625	0.0455	1.3	83.3
1.A.4.b. Residential - Solid Fuels	CH_4	224	2	0.0026	0.9	84.2
4.C.2. Land converted to grassland	CO_2	421	222	0.0027	0.9	85.1
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286	1094	0.0077	0.8	85.9
4.E.2. Land converted to settlements	CO_2	935	945	0.0014	0.7	86.6
2.G.2. SF_6 and PFCs from other product use	SF_6	124	306	0.0016	0.6	87.2
2.D. Non-energy products from fuels and solvent use	CO_2	349	162	0.0024	0.6	87.8
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	67	554	0.0048	0.6	88.4
3.B.3. Swine	N_2O	111	57	0.0007	0.5	88.9
1.B.2.b. Natural gas	CH_4	375	290	0.0014	0.4	89.3
1.A.3.b. Road transportation - Gasoline	N_2O	83	7	0.0009	0.4	89.8
1.A.4.b. Residential - Biomass	CH_4	264	196	0.0011	0.4	90.1

Table A 13: Key categories identified including their ranking in the level and trend assessment for approach 1 and approach 2 KCA excluding LULUCF.

		Approach 1			Approach 2					
IPCC Category	**GHG**	**LA 1990**	**LA 2023**	**TA 1990–2023**	**LA 1990**	**LA 2023**	**TA 1990–2023**	**1990 [kt CO_2-e units]**	**2023 [kt CO_2-e units]**	**Share 2023 [%]**
1.A.1.a. Public electricity and heat production - Biomass	N_2O						26	3	64	0.1
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	8	5	23	23			3294	3206	4.7
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	15		12				1229	147	0.2
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	45	15	14	26	10	6	286	1094	1.6
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	3		2			22	6247	NO	NO
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	37	30					437	327	0.5
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	11	8	17				1958	2252	3.3
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	31	42	29				506	155	0.2
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	24	16	18		25	33	650	1075	1.6
1.A.2.a. Iron and steel - Solid Fuels	CO_2	17	23	25				1107	632	0.9
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2		34	37				75	260	0.4
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	28	17	19		29	34	519	957	1.4
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2		33	43		27	27	125	278	0.4
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	20	14	28	28	24		943	1101	1.6
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	21		15				853	39	0.1
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	39		27				398	49	0.1
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	30	22	36				507	635	0.9
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	43		45				345	148	0.2
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	26	26					559	506	0.7
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	29	39	31				508	190	0.3
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2		25	20		17	11	67	554	0.8
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	27		24				535	128	0.2
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	47	11	9		21	18	252	1365	2
1.A.2.g.viii Other - Gaseous Fuels	CO_2	19	13	21	27	19	37	1014	1270	1.8
1.A.2.g.viii Other - Liquid Fuels	CO_2	25		22				610	137	0.2
1.A.3.b. Road transportation - Diesel Oil	CO_2	5	1	1	9	5	4	5358	14667	21.4
1.A.3.b. Road transportation - Diesel Oil	N_2O		38	41		22	15	11	191	0.3
1.A.3.b. Road transportation - Gasoline	CH_4						40	77	7	0
1.A.3.b. Road transportation - Gasoline	CO_2	1	3	6	7	9	10	7896	4625	6.7
1.A.3.b. Road transportation - Gasoline	N_2O				25		19	83	7	0
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	49		44				224	25	0
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	23	19	39				698	793	1.2
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	14	36	11				1420	216	0.3
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2			51				91	NO	NO
1.A.4.b. Residential - Biomass	CH_4	46	37		13	16	43	264	196	0.3
1.A.4.b. Residential - Gaseous Fuels	CO_2	12	6	10	19	13	13	1856	2736	4
1.A.4.b. Residential - Liquid Fuels	CO_2	4	7	5	24		30	5633	2261	3.3
1.A.4.b. Residential - Solid Fuels	CH_4	50		40	15		8	224	2	0
1.A.4.b. Residential - Solid Fuels	CO_2	9		7			35	2511	27	0
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	16	20	32				1180	791	1.2
1.B.1.a. Coal mining and handling	CH_4	41		26	10		5	373	NO	NO
1.B.2.a. Oil	CH_4						38	92	43	0.1
1.B.2.b. Natural gas	CH_4	40	32		11	15		375	290	0.4

		Approach 1			Approach 2					
IPCC Category	GHG	LA 1990	LA 2023	TA 1990–2023	LA 1990	LA 2023	TA 1990–2023	1990 [kt CO_2-e units]	2023 [kt CO_2-e units]	Share 2023 [%]
2.A.1. Cement production	CO_2	10	9	33	17			2033	1543	2.2
2.A.2. Lime production	CO_2	36	24	38	29			456	588	0.9
2.A.4.c. Non-metallurgical magnesium production	CO_2	33	29					481	339	0.5
2.B.1. Ammonia production	CO_2	35	27					467	447	0.7
2.B.2. Nitric acid production	N_2O	22		16			39	780	27	0
2.C.1. Iron and steel production	CO_2	2	2	3	12	18	28	6840	10188	14.8
2.C.3. Aluminium production	CO_2			47			32	150	5	0
2.C.3. Aluminium production	PFCs	18		13	5		3	1032	NO	NO
2.C.4. Magnesium production	SF_6	48		34				235	2	0
2.D. Non-energy products from fuels and solvent use	CO_2	42	41	46	14	20	16	349	162	0.2
2.F.1. Refrigeration and air-conditioning	HFCs		12	8		4	2	NO	1350	2
2.G.1. Electrical equipment	SF_6					26	20	11	51	0.1
2.G.2. SF_6 and PFCs from other product use	SF_6		31	35	22	11	7	124	306	0.4
3.A.1. Cattle	CH_4	6	4	42	3	2	23	4871	4024	5.9
3.A.4. Other livestock	CH_4						44	41	103	0.1
3.B.1. Cattle	CH_4	32	21	30	18	14	17	482	665	1
3.B.1. Cattle	N_2O	38	35	49	6	6	9	404	253	0.4
3.B.3. Swine	N_2O				16	23	21	111	57	0.1
3.B.4. Other livestock	N_2O						42	11	26	0
3.B.5. Indirect N_2O emissions	N_2O				8	7	36	123	117	0.2
3.D.1. Direct N_2O emissions from managed soils	N_2O	13	10		1	1	25	1606	1402	2
3.D.2. Indirect N_2O emissions from managed soils	N_2O	34	28		4	3	14	467	376	0.5
3.G. Liming	CO_2					28	31	46	95	0.1
5.A. Solid waste disposal	CH_4	7	18	4	2	8	1	4081	799	1.2
5.B. Biological treatment of solid waste	CH_4					30	24	15	77	0.1
5.B. Biological treatment of solid waste	N_2O						29	20	72	0.1
5.D. Wastewater treatment and discharge	CH_4	44	40	48	21		41	334	190	0.3
5.D. Wastewater treatment and discharge	N_2O		43	50	20	12	12	86	155	0.2
							∑	**77049**	**66866**	**97.3**

Table A 14: Key categories identified including their ranking in the level and trend assessment for approach 1 and approach 2 KCA including LULUCF.

		Approach 1			Approach 2					
IPCC Category	GHG	LA 1990	LA 2023	TA 1990–2023	LA 1990	LA 2023	TA 1990–2023	1990 [kt CO_2-e units]	2023 [kt CO_2-e units]	Share 2023 [%]
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	9	6	22				3294	3206	4.2
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	18		13				1229	147	0.2
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	52	17	20		15	16	286	1094	1.4
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	4		3				6247	NO	NO
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	42	36	45				437	327	0.4
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	14	9					1958	2252	3
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	35		30				506	155	0.2
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	28	18	34				650	1075	1.4
1.A.2.a. Iron and steel - Solid Fuels	CO_2	20	27	21				1107	632	0.8
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2		40	46				75	260	0.3

IPCC Category	GHG	Approach 1 LA 1990	Approach 1 LA 2023	Approach 1 TA 1990–2023	Approach 2 LA 1990	Approach 2 LA 2023	Approach 2 TA 1990–2023	1990 [kt CO_2-e units]	2023 [kt CO_2-e units]	Share 2023 [%]
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	32	19	33				519	957	1.3
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2		39					125	278	0.4
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	23	16					943	1101	1.4
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	25		17				853	39	0.1
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	45		31				398	49	0.1
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	34	26					507	635	0.8
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	50		38				345	148	0.2
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	30	31	51				559	506	0.7
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	33	47	32				508	190	0.2
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2		29	27		26	20	67	554	0.7
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	31		26				535	128	0.2
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	54	13	16		31		252	1365	1.8
1.A.2.g.viii Other - Gaseous Fuels	CO_2	22	15			29		1014	1270	1.7
1.A.2.g.viii Other - Liquid Fuels	CO_2	29		25				610	137	0.2
1.A.3.b. Road transportation - Diesel Oil	CO_2	6	1	2	15	7	8	5358	14667	19.2
1.A.3.b. Road transportation - Diesel Oil	N_2O		46	44				11	191	0.3
1.A.3.b. Road transportation - Gasoline	CO_2	2	4	4	13	14	13	7896	4625	6.1
1.A.3.b. Road transportation - Gasoline	N_2O						23	83	7	0
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	56		40				224	25	0
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	27	22					698	793	1
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	17	44	11				1420	216	0.3
1.A.4.b. Residential - Biomass	CH_4	53	45		19	25	24	264	196	0.3
1.A.4.b. Residential - Gaseous Fuels	CO_2	15	7	23		19		1856	2736	3.6
1.A.4.b. Residential - Liquid Fuels	CO_2	5	8	5				5633	2261	3
1.A.4.b. Residential - Solid Fuels	CH_4			37	22		14	224	2	0
1.A.4.b. Residential - Solid Fuels	CO_2	12		7				2511	27	0
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	19	23	24				1180	791	1
1.B.1.a. Coal mining and handling	CH_4	47		29	16		11	373	NO	NO
1.B.2.b. Natural gas	CH_4	46	38	50	17	21	22	375	290	0.4
2.A.1. Cement production	CO_2	13	10	19	24			2033	1543	2
2.A.2. Lime production	CO_2	41	28					456	588	0.8
2.A.4.c. Non-metallurgical magnesium production	CO_2	38	35	41				481	339	0.4
2.B.1. Ammonia production	CO_2	40	32					467	447	0.6
2.B.2. Nitric acid production	N_2O	26		18				780	27	0
2.C.1. Iron and steel production	CO_2	3	2	8	18	27		6840	10188	13.4
2.C.3. Aluminium production	CO_2			47				150	5	0
2.C.3. Aluminium production	PFCs	21		14	9		6	1032	NO	NO
2.C.4. Magnesium production	SF_6	55		35				235	2	0
2.D. Non-energy products from fuels and solvent use	CO_2	49		39	21	30	19	349	162	0.2
2.F.1. Refrigeration and air-conditioning	HFCs		14	12		5	5	NO	1350	1.8
2.G.2. SF_6 and PFCs from other product use	SF_6		37	49		16	18	124	306	0.4
3.A.1. Cattle	CH_4	7	5	10	6	3	10	4871	4024	5.3
3.B.1. Cattle	CH_4	37	25		25	20		482	665	0.9
3.B.1. Cattle	N_2O	44	42	42	11	11	12	404	253	0.3
3.B.3. Swine	N_2O				23		21	111	57	0.1
3.B.5. Indirect N_2O emissions	N_2O				14	12		123	117	0.2
3.D.1. Direct N_2O emissions from managed soils	N_2O	16	11	28	2	1	4	1606	1402	1.8
3.D.2. Indirect N_2O emissions from managed soils	N_2O	39	33	48	7	4	9	467	376	0.5
4. Land use, land-use change and forestry	N_2O		50		20	18		180	169	0.2
4.A.1. Forest land remaining forest land	CO_2	1	3	1	1	2	1	-10624	6763	8.9

		Approach 1			Approach 2					
IPCC Category	**GHG**	**LA 1990**	**LA 2023**	**TA 1990–2023**	**LA 1990**	**LA 2023**	**TA 1990–2023**	**1990 [kt CO_2-e units]**	**2023 [kt CO_2-e units]**	**Share 2023 [%]**
4.A.2. Land converted to forest land	CO_2	11	12	15	3	8	7	-2959	-1402	-1.8
4.B.1. Cropland remaining cropland	CO_2		41			22		201	256	0.3
4.B.2. Land converted to cropland	CO_2		49			28		173	172	0.2
4.C.1. Grassland remaining grassland	CO_2	48	34			24		371	371	0.5
4.C.2. Land converted to grassland	CO_2	43	43	36	12	23	15	421	222	0.3
4.E.2. Land converted to settlements	CO_2	24	20	52	10	6	17	935	945	1.2
4.F.2. Land converted to other land	CO_2	36	30		8	9		502	520	0.7
4.G. Harvested wood products	CO_2	10	24	9	4	10	3	-3122	-678	-0.9
5.A. Solid waste disposal	CH_4	8	21	6	5	13	2	4081	799	1
5.D. Wastewater treatment and discharge	CH_4	51	48	43				334	190	0.2
5.D. Wastewater treatment and discharge	N_2O					17		86	155	0.2
							∑	**62720**	**73668**	**96.6**

Table A 15: Source/sink categories and emissions/removals (kt CO_2eq) for the 311 subcategory-gas combinations used for the key category analysis.

IPCC Code and Category	GHG	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
1.A.1.a. Public electricity and heat production - Biomass	CH_4	1	2	3	6	17	18	18	19	18	18
1.A.1.a. Public electricity and heat production - Biomass	N_2O	3	6	11	22	61	64	65	68	67	64
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CH_4	2	2	2	3	3	2	2	2	2	2
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294	3439	3472	5277	5233	3626	4224	4467	4330	3206
1.A.1.a. Public electricity and heat production - Gaseous Fuels	N_2O	2	2	2	3	3	2	2	2	2	2
1.A.1.a. Public electricity and heat production - Liquid Fuels	CH_4	1	2	1	1	1	0	0	0	0	0
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	1229	1561	1184	1111	672	255	65	126	236	147
1.A.1.a. Public electricity and heat production - Liquid Fuels	N_2O	2	3	2	2	1	1	0	0	0	0
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CH_4	1	1	1	2	4	4	4	4	4	4
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286	282	288	495	886	1083	1016	1049	1028	1094
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	N_2O	4	3	3	6	12	14	13	13	13	14
1.A.1.a. Public electricity and heat production - Solid Fuels	CH_4	2	1	1	2	1	1	0	NO	NO	NO
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6247	4529	4824	5844	3870	2335	356	NO	NO	NO
1.A.1.a. Public electricity and heat production - Solid Fuels	N_2O	24	18	20	24	16	10	2	NO	NO	NO
1.A.1.b. Petroleum refining - Gaseous Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	437	421	362	516	499	341	497	533	300	327
1.A.1.b. Petroleum refining - Gaseous Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.1.b. Petroleum refining - Liquid Fuels	CH_4	1	1	1	2	2	2	2	2	1	2
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	1958	2169	1852	2311	2226	2463	2235	2217	1955	2252
1.A.1.b. Petroleum refining - Liquid Fuels	N_2O	2	2	2	3	3	4	4	3	2	3
1.A.1.c. Manufacture of solid fuels and other energy industries - Biomass	CH_4	1	1	1	1	1	1	1	1	1	1
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	506	611	281	392	238	231	160	178	210	155
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CH_4	0	0	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CO_2	4	0	NO	NO	NO	NO	NO	NO	NO	NO
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	N_2O	0	0	NO	NO	NO	NO	NO	NO	NO	NO

IPCC Code and Category	GHG	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
1.A.2.a. Iron and steel - Biomass	CH_4	NO	NO	NO	NO	0	0	0	0	0	0
1.A.2.a. Iron and steel - Biomass	N_2O	NO	NO	NO	NO	0	0	0	0	0	0
1.A.2.a. Iron and steel - Gaseous Fuels	CH_4	0	0	1	1	1	1	1	1	1	1
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	650	757	1022	1090	1101	1116	1081	1013	1047	1075
1.A.2.a. Iron and steel - Gaseous Fuels	N_2O	0	0	0	1	1	1	1	0	0	1
1.A.2.a. Iron and steel - Liquid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.a. Iron and steel - Liquid Fuels	CO_2	76	83	73	59	32	6	7	20	18	9
1.A.2.a. Iron and steel - Liquid Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.a. Iron and steel - Solid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1107	497	180	695	142	284	715	760	708	632
1.A.2.a. Iron and steel - Solid Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Biomass	CH_4	NO	NO	NO	NO	NO	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Biomass	N_2O	NO	NO	NO	NO	NO	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	75	205	128	172	209	252	246	280	287	260
1.A.2.b. Non-ferrous metals - Gaseous Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Liquid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Liquid Fuels	CO_2	35	41	47	33	20	29	8	9	9	9
1.A.2.b. Non-ferrous metals - Liquid Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CH_4	NO	NO	NO	NO	NO	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CO_2	NO	NO	NO	NO	NO	1	1	0	1	1
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	N_2O	NO	NO	NO	NO	NO	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Solid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.b. Non-ferrous metals - Solid Fuels	CO_2	22	10	18	13	7	14	13	5	12	12
1.A.2.b. Non-ferrous metals - Solid Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.c. Chemicals - Biomass	CH_4	1	0	1	1	1	1	1	1	1	1
1.A.2.c. Chemicals - Biomass	N_2O	3	2	4	2	3	2	3	3	4	3
1.A.2.c. Chemicals - Gaseous Fuels	CH_4	0	0	0	1	1	1	1	1	1	0
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	519	572	874	1019	1014	1013	1131	1242	1023	957
1.A.2.c. Chemicals - Gaseous Fuels	N_2O	0	0	0	0	0	0	1	1	0	0
1.A.2.c. Chemicals - Liquid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.c. Chemicals - Liquid Fuels	CO_2	97	102	64	74	142	57	75	36	48	41
1.A.2.c. Chemicals - Liquid Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.c. Chemicals - Other Fossil Fuels	CH_4	1	1	1	0	1	1	1	1	1	1
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	125	161	153	106	315	222	245	231	308	278
1.A.2.c. Chemicals - Other Fossil Fuels	N_2O	2	2	2	2	4	3	3	3	4	4

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1.A.2.c. Chemicals - Solid Fuels	CH_4	0	0	1	0	0	0	0	0	0	0
1.A.2.c. Chemicals - Solid Fuels	CO_2	106	150	250	149	76	103	42	34	52	22
1.A.2.c. Chemicals - Solid Fuels	N_2O	0	1	1	1	0	0	0	0	0	0
1.A.2.d. Pulp, paper and print - Biomass	CH_4	3	5	3	5	4	4	5	4	5	5
1.A.2.d. Pulp, paper and print - Biomass	N_2O	15	22	17	24	22	22	23	22	25	27
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CH_4	0	1	1	1	1	1	1	1	1	1
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	943	1361	1763	1709	1906	1378	1480	1607	1385	1101
1.A.2.d. Pulp, paper and print - Gaseous Fuels	N_2O	0	1	1	1	1	1	1	1	1	1
1.A.2.d. Pulp, paper and print - Liquid Fuels	CH_4	1	1	0	0	0	0	0	0	0	0
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	853	523	171	139	72	42	13	15	24	39
1.A.2.d. Pulp, paper and print - Liquid Fuels	N_2O	2	1	0	0	0	0	0	0	0	0
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CH_4	0	0	NO	0	0	0	0	0	0	0
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CO_2	15	36	NO	7	8	25	9	2	2	18
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	N_2O	0	1	NO	0	0	0	0	0	0	0
1.A.2.d. Pulp, paper and print - Solid Fuels	CH_4	1	1	1	1	1	1	1	1	0	0
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	398	381	446	438	326	384	298	210	130	49
1.A.2.d. Pulp, paper and print - Solid Fuels	N_2O	2	2	2	2	1	2	1	1	1	0
1.A.2.e. Food processing, beverages and tobacco - Biomass	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.e. Food processing, beverages and tobacco - Biomass	N_2O	0	0	0	0	1	0	0	0	0	1
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	507	583	694	704	749	888	749	756	800	635
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	345	342	166	242	201	68	29	35	94	148
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	N_2O	1	1	0	0	0	0	0	0	0	0
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CH_4	NO	NO	NO	NO	0	0	0	NO	0	0
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CO_2	NO	NO	NO	NO	0	0	0	NO	0	0
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	N_2O	NO	NO	NO	NO	0	0	0	NO	0	0
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0

IPCC Code and Category	GHG	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CO_2	18	6	22	13	15	23	12	13	17	16
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.f. Non-metallic minerals - Biomass	CH_4	NO	NO	NO	0	1	1	1	1	1	1
1.A.2.f. Non-metallic minerals - Biomass	N_2O	NO	NO	NO	2	3	4	4	4	5	4
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	559	615	641	659	602	625	699	665	593	506
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH_4	1	0	0	0	0	0	0	0	0	0
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	508	348	198	296	195	159	79	147	160	190
1.A.2.f. Non-metallic minerals - Liquid Fuels	N_2O	1	1	0	1	0	0	0	0	0	0
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CH_4	0	1	1	2	2	2	2	3	3	2
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	67	122	197	327	419	555	566	616	616	554
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	N_2O	1	2	4	5	5	8	8	8	8	7
1.A.2.f. Non-metallic minerals - Solid Fuels	CH_4	2	1	1	1	1	1	1	1	1	0
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	535	435	503	373	312	266	311	253	209	128
1.A.2.f. Non-metallic minerals - Solid Fuels	N_2O	2	2	2	2	1	1	1	1	1	1
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	CH_4	NO	NO	NO	0	0	0	0	0	0	0
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	N_2O	NO	NO	NO	1	3	3	2	2	2	3
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CH_4	0	0	1	0	0	0	0	0	0	0
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252	353	543	801	1065	1056	1263	1356	1398	1365
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	N_2O	24	35	59	62	48	38	36	38	39	38
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CO_2	4	5	8	8	8	8	9	10	10	10
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.2.g.vii. Off-road vehicles and other machinery - Other Fossil Fuels	CO_2	NO	NO	NO	0	4	4	4	4	5	5
1.A.2.g.viii Other - Biomass	CH_4	1	1	3	5	7	7	5	6	6	5
1.A.2.g.viii Other - Biomass	N_2O	4	2	9	18	24	27	19	21	22	20
1.A.2.g.viii Other - Gaseous Fuels	CH_4	1	1	1	1	1	1	1	1	1	1
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1014	1423	1070	1292	1548	1247	1364	1535	1511	1270
1.A.2.g.viii Other - Gaseous Fuels	N_2O	0	1	1	1	1	1	1	1	1	1
1.A.2.g.viii Other - Liquid Fuels	CH_4	1	1	1	1	0	0	0	0	0	0
1.A.2.g.viii Other - Liquid Fuels	CO_2	610	791	605	713	506	259	150	150	101	137
1.A.2.g.viii Other - Liquid Fuels	N_2O	1	1	1	1	1	0	0	0	0	0
1.A.2.g.viii Other - Other Fossil Fuels	CH_4	0	0	0	1	1	0	0	0	0	0
1.A.2.g.viii Other - Other Fossil Fuels	CO_2	3	50	33	44	45	28	32	32	29	31

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1.A.2.g.viii Other - Other Fossil Fuels	N_2O	0	1	0	2	2	0	1	0	1	0
1.A.2.g.viii Other - Solid Fuels	CH_4	0	0	0	0	NO	0	0	0	0	0
1.A.2.g.viii Other - Solid Fuels	CO_2	91	18	30	35	NO	0	0	3	2	0
1.A.2.g.viii Other - Solid Fuels	N_2O	0	0	0	0	NO	0	0	0	0	0
1.A.3.a. Domestic aviation - Aviation Gasoline	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.3.a. Domestic aviation - Aviation Gasoline	CO_2	8	7	6	9	9	8	6	6	5	5
1.A.3.a. Domestic aviation - Aviation Gasoline	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.3.a. Domestic aviation - Jet Kerosene	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.3.a. Domestic aviation - Jet Kerosene	CO_2	31	46	61	58	54	42	18	18	24	25
1.A.3.a. Domestic aviation - Jet Kerosene	N_2O	0	1	1	1	1	1	0	0	0	0
1.A.3.b. Road transportation - Biomass	CH_4	NO	NO	NO	0	1	1	1	1	1	1
1.A.3.b. Road transportation - Biomass	N_2O	NO	NO	NO	1	12	24	13	14	13	15
1.A.3.b. Road transportation - Diesel Oil	CH_4	4	4	4	5	4	6	11	12	13	13
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358	7756	11897	17625	16215	16739	16204	16819	15685	14667
1.A.3.b. Road transportation - Diesel Oil	N_2O	11	21	44	78	112	159	190	202	195	191
1.A.3.b. Road transportation - Gaseous Fuels	CH_4	NO	NO	NO	0	0	0	0	0	0	0
1.A.3.b. Road transportation - Gaseous Fuels	CO_2	NO	NO	NO	1	25	40	44	42	40	36
1.A.3.b. Road transportation - Gaseous Fuels	N_2O	NO	NO	NO	0	0	0	0	0	0	0
1.A.3.b. Road transportation - Gasoline	CH_4	77	50	29	24	15	11	8	7	7	7
1.A.3.b. Road transportation - Gasoline	CO_2	7896	7397	6092	6393	5284	4781	3962	4213	4389	4625
1.A.3.b. Road transportation - Gasoline	N_2O	83	96	71	54	25	12	7	7	7	7
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CO_2	26	32	43	60	57	36	8	7	8	5
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	N_2O	0	0	1	1	0	0	0	0	0	0
1.A.3.b. Road transportation - Other Fossil Fuels	CO_2	NO	NO	NO	13	69	85	56	58	55	54
1.A.3.c. Railways - Biomass	CH_4	NO	NO	NO	0	0	0	0	0	0	0
1.A.3.c. Railways - Biomass	N_2O	NO	NO	NO	0	1	0	0	0	0	0
1.A.3.c. Railways - Liquid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.3.c. Railways - Liquid Fuels	CO_2	171	143	133	160	142	86	81	80	80	73
1.A.3.c. Railways - Liquid Fuels	N_2O	16	13	13	15	11	5	4	4	4	4
1.A.3.c. Railways - Other Fossil Fuels	CO_2	NO	NO	NO	0	1	0	0	0	0	0
1.A.3.c. Railways - Solid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.3.c. Railways - Solid Fuels	CO_2	7	6	3	1	0	0	0	0	0	0
1.A.3.c. Railways - Solid Fuels	N_2O	0	0	0	0	0	0	0	0	0	0

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1.A.3.d. Domestic navigation - Biomass	CH_4	NO	NO	NO	0	0	0	0	0	0	0
1.A.3.d. Domestic navigation - Biomass	N_2O	NO	NO	NO	0	0	0	0	0	0	0
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CO_2	18	25	33	46	47	58	17	29	62	63
1.A.3.d. Domestic navigation - Gas/Diesel Oil	N_2O	2	3	4	5	5	5	1	2	5	5
1.A.3.d. Domestic navigation - Gasoline	CH_4	1	1	1	1	0	0	0	0	0	0
1.A.3.d. Domestic navigation - Gasoline	CO_2	10	9	9	9	8	7	7	7	7	6
1.A.3.d. Domestic navigation - Gasoline	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.3.d. Domestic navigation - Other Fossil Fuels	CO_2	NO	NO	NO	0	0	0	0	0	0	0
1.A.3.e. Other transportation - Biomass	CH_4	NO	NO	NO	0	0	0	0	0	0	0
1.A.3.e. Other transportation - Biomass	N_2O	NO	NO	NO	0	0	0	0	0	0	0
1.A.3.e. Other transportation - Gaseous Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	224	227	338	359	459	586	475	378	152	25
1.A.3.e. Other transportation - Gaseous Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.3.e. Other transportation - Liquid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.3.e. Other transportation - Liquid Fuels	CO_2	5	7	9	11	11	10	6	7	11	12
1.A.3.e. Other transportation - Liquid Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.3.e. Other transportation - Other Fossil Fuels	CO_2	NO	NO	NO	0	0	0	0	0	0	0
1.A.4.a. Commercial/institutional - Biomass	CH_4	8	6	6	4	6	3	4	4	3	2
1.A.4.a. Commercial/institutional - Biomass	N_2O	2	2	4	3	4	3	4	4	3	2
1.A.4.a. Commercial/institutional - Gaseous Fuels	CH_4	2	4	3	3	2	2	2	2	2	2
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	698	1623	1311	1283	952	838	842	970	724	793
1.A.4.a. Commercial/institutional - Gaseous Fuels	N_2O	0	1	1	1	0	0	0	0	0	0
1.A.4.a. Commercial/institutional - Liquid Fuels	CH_4	5	4	3	3	1	1	1	1	1	0
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1420	1316	1338	1986	682	446	447	581	491	216
1.A.4.a. Commercial/institutional - Liquid Fuels	N_2O	3	2	3	4	1	1	1	1	1	0
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CO_2	83	39	42	81	4	6	0	0	0	0
1.A.4.a. Commercial/institutional - Other Fossil Fuels	N_2O	1	1	1	1	0	0	0	0	0	0
1.A.4.a. Commercial/institutional - Solid Fuels	CH_4	0	0	0	0	0	0	NO	NO	NO	NO
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	91	60	105	68	21	0	NO	NO	NO	NO
1.A.4.a. Commercial/institutional - Solid Fuels	N_2O	0	0	0	0	0	0	NO	NO	NO	NO
1.A.4.b. Residential - Biomass	CH_4	264	270	240	219	260	228	212	251	203	196
1.A.4.b. Residential - Biomass	N_2O	62	66	64	62	80	77	75	91	77	74
1.A.4.b. Residential - Gaseous Fuels	CH_4	5	6	7	9	9	8	8	9	8	7
1.A.4.b. Residential - Gaseous Fuels	CO_2	1856	2453	2709	3640	3627	3156	3339	3617	3013	2736

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1.A.4.b. Residential - Gaseous Fuels	N_2O	1	1	1	2	2	2	2	2	1	1
1.A.4.b. Residential - Liquid Fuels	CH_4	22	19	17	13	8	6	5	5	5	4
1.A.4.b. Residential - Liquid Fuels	CO_2	5633	5844	5602	4934	4311	3347	3076	3212	2767	2261
1.A.4.b. Residential - Liquid Fuels	N_2O	18	19	18	16	13	9	8	8	7	6
1.A.4.b. Residential - Other Fossil Fuels	CO_2	NO	NO	NO	0	0	0	0	0	0	0
1.A.4.b. Residential - Peat	CH_4	0	0	0	0	0	0	NO	NO	NO	NO
1.A.4.b. Residential - Peat	CO_2	0	0	0	0	0	0	NO	NO	NO	NO
1.A.4.b. Residential - Peat	N_2O	0	0	0	0	0	0	NO	NO	NO	NO
1.A.4.b. Residential - Solid Fuels	CH_4	224	147	76	33	22	8	5	3	3	2
1.A.4.b. Residential - Solid Fuels	CO_2	2511	1651	851	372	244	86	55	39	33	27
1.A.4.b. Residential - Solid Fuels	N_2O	11	7	4	2	1	0	0	0	0	0
1.A.4.c. Agriculture/forestry/fishing - Biomass	CH_4	34	38	42	48	54	58	53	62	59	57
1.A.4.c. Agriculture/forestry/fishing - Biomass	N_2O	4	5	5	7	10	10	9	10	9	9
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CO_2	20	27	30	43	47	34	50	54	47	26
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CH_4	7	5	5	4	2	2	1	1	1	1
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1180	926	999	952	803	788	828	808	799	791
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	N_2O	68	68	77	76	54	39	34	32	30	29
1.A.4.c. Agriculture/forestry/fishing - Other Fossil Fuels	CO_2	NO	NO	NO	0	3	3	2	2	2	3
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CH_4	5	3	1	1	0	0	0	0	0	0
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CO_2	51	37	17	12	5	2	2	1	1	1
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	N_2O	0	0	0	0	0	0	0	0	0	0
1.A.5. Other (not specified elsewhere) - Biomass	CH_4	NO	NO	NO	0	0	0	0	0	0	0
1.A.5. Other (not specified elsewhere) - Biomass	N_2O	NO	NO	NO	0	0	0	0	0	0	0
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CH_4	0	0	0	0	0	0	0	0	0	0
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CO_2	37	34	41	37	29	22	28	28	28	27
1.A.5. Other (not specified elsewhere) - Liquid Fuels	N_2O	1	1	1	1	1	0	1	1	1	0
1.A.5. Other (not specified elsewhere) - Other Fossil Fuels	CO_2	NO	NO	NO	0	0	0	0	0	0	0
1.B.1.a. Coal mining and handling	CH_4	373	41	30	0	NO	NO	NO	NO	NO	NO
1.B.2.a. Oil	CH_4	92	85	80	72	72	71	52	50	44	43
1.B.2.a. Oil	CO_2	0	0	0	0	0	0	0	0	0	0
1.B.2.b. Natural gas	CH_4	375	418	431	418	432	390	339	333	311	290
1.B.2.b. Natural gas	CO_2	102	127	165	160	184	162	109	84	80	74
2.A.1. Cement production	CO_2	2033	1631	1712	1797	1622	1701	1821	1889	1832	1543
2.A.2. Lime production	CO_2	456	452	556	618	604	609	579	653	624	588

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2.A.3. Glass production	CO_2	39	42	36	35	40	40	39	36	35	35
2.A.4.a. Ceramics	CO_2	116	149	116	128	81	91	106	96	100	48
2.A.4.b. Other uses of soda ash	CO_2	13	8	16	15	12	11	9	9	9	9
2.A.4.c. Non-metallurgical magnesium production	CO_2	481	410	339	310	314	301	282	357	317	339
2.B.1. Ammonia production	CH_4	2	2	2	3	2	3	2	1	1	2
2.B.1. Ammonia production	CO_2	467	509	491	462	476	502	491	501	419	447
2.B.10. Other	CH_4	9	9	10	10	10	10	11	11	12	9
2.B.10. Other	CO_2	139	134	135	146	157	136	146	144	138	110
2.B.2. Nitric acid production	N_2O	780	733	813	234	54	42	47	41	23	27
2.B.5. Carbide production	CO_2	38	32	43	38	37	46	40	44	43	33
2.B.8. Petrochemical and carbon black production	CH_4	29	29	29	29	42	42	42	42	42	42
2.C.1. Iron and steel production	CH_4	6	7	7	7	3	4	4	4	5	7
2.C.1. Iron and steel production	CO_2	6840	7564	8420	9764	10388	10787	9482	11002	10414	10188
2.C.2. Ferroalloys production	CO_2	21	21	19	19	20	20	17	17	17	16
2.C.3. Aluminium production	CO_2	150	1	2	1	4	8	5	6	5	5
2.C.3. Aluminium production	PFCs	1032	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C.3. Aluminium production	SF_6	14	14	NO	NO	0	0	NO	NO	NO	NO
2.C.4. Magnesium production	SF_6	235	422	37	5	NO	2	5	5	2	2
2.C.5. Lead production	CO_2	5	4	4	5	5	5	5	5	5	5
2.D. Non-energy products from fuels and solvent use	CO_2	349	234	217	182	171	144	159	170	178	162
2.E.1. Integrated circuit or semiconductor	HFCs	2	9	4	4	2	2	3	3	2	1
2.E.1. Integrated circuit or semiconductor	NF_3	NO	6	10	26	4	13	14	15	16	18
2.E.1. Integrated circuit or semiconductor	PFCs	31	75	79	145	71	45	27	23	24	26
2.E.1. Integrated circuit or semiconductor	SF_6	100	422	327	166	68	43	13	12	13	13
2.F.1. Refrigeration and air-conditioning	HFCs	NO	40	392	901	1388	1645	1647	1503	1452	1350
2.F.1. Refrigeration and air-conditioning	PFCs	NO	NO	NO	0	0	0	0	0	0	0
2.F.2. Foam blowing agents	HFCs	NO	275	267	146	35	15	15	14	14	14
2.F.3. Fire protection	HFCs	NO	NO	0	6	11	12	11	12	11	11
2.F.4. Aerosols	HFCs	NO	4	25	38	20	24	24	23	27	24
2.F.5. Solvents	HFCs	NO	NO	0	NO	NO	NO	NO	NO	NO	NO
2.G. Other product manufacture and use	CO_2	0	0	0	0	0	0	0	0	0	0
2.G. Other product manufacture and use	N_2O	117	117	117	67	47	37	41	39	41	41
2.G.1. Electrical equipment	SF_6	11	15	18	23	30	37	45	47	46	51
2.G.2. SF_6 and PFCs from other product use	SF_6	124	262	211	315	248	236	391	304	301	306
2.G.4 Other	HFCs	NO	NO	NO	0	NO	NO	NO	NO	NO	NO
2.G.4 Other	PFCs	NO	NO	1	5	NO	NO	NO	NO	NO	NO

IPCC Code and Category	GHG	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
3.A.1. Cattle	CH_4	4871	4794	4498	4216	4239	4174	4027	4040	4058	4024
3.A.2. Sheep	CH_4	82	97	90	87	95	94	105	108	107	105
3.A.3. Swine	CH_4	88	84	76	74	74	68	68	68	64	61
3.A.4. Other livestock	CH_4	41	56	61	67	78	87	99	101	102	103
3.B.1. Cattle	CH_4	482	463	429	398	471	547	609	630	654	665
3.B.1. Cattle	N_2O	404	388	370	354	341	325	282	275	265	253
3.B.2. Sheep	CH_4	2	3	2	2	3	2	3	3	3	2
3.B.2. Sheep	N_2O	8	9	9	8	9	9	10	10	10	9
3.B.3. Swine	CH_4	184	169	147	136	129	118	120	121	116	111
3.B.3. Swine	N_2O	111	100	85	77	69	60	60	61	59	57
3.B.4. Other livestock	CH_4	12	14	13	14	15	17	19	19	19	19
3.B.4. Other livestock	N_2O	11	15	16	18	20	23	25	26	26	26
3.B.5. Indirect N_2O emissions	N_2O	123	124	117	116	120	120	119	120	119	117
3.D.1. Direct N_2O emissions from managed soils	N_2O	1606	1518	1579	1511	1408	1523	1476	1480	1438	1402
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467	434	429	404	388	414	397	398	386	376
3.F. Field burning of agricultural residues	CH_4	1	1	1	1	1	0	0	NO	NO	NO
3.F. Field burning of agricultural residues	N_2O	0	0	0	0	0	0	0	NO	NO	NO
3.G. Liming	CO_2	46	36	43	54	69	83	99	99	99	95
3.H. Urea application	CO_2	10	20	19	22	29	35	25	23	26	30
3.I. Other carbon-containing fertilizers	CO_2	31	29	27	20	15	27	25	27	24	22
4. Land use, land-use change and forestry	CH_4	37	37	37	37	37	37	37	37	38	37
4. Land use, land-use change and forestry	N_2O	180	188	182	182	187	180	175	173	171	169
4.A.1. Forest land remaining forest land	CO_2	-10624	-15487	-16370	-12468	-10199	-3983	-2193	-2911	311	6763
4.A.2. Land converted to forest land	CO_2	-2959	-2977	-2322	-2086	-1875	-1585	-1468	-1444	-1423	-1402
4.B.1. Cropland remaining cropland	CO_2	201	182	28	-82	-84	-13	183	271	305	256
4.B.2. Land converted to cropland	CO_2	173	148	147	157	146	135	175	176	170	172
4.C.1. Grassland remaining grassland	CO_2	371	371	371	371	371	371	371	371	371	371
4.C.2. Land converted to grassland	CO_2	421	203	211	463	292	315	226	213	214	222
4.D.1. Wetlands remaining wetlands	CO_2	21	21	21	21	21	21	21	21	21	21
4.D.2. Land converted to wetlands	CO_2	44	31	36	47	82	74	70	69	69	69
4.E.1. Settlements remaining settlements	CO_2	63	63	63	63	63	63	63	63	63	63
4.E.2. Land converted to settlements	CO_2	935	978	1019	1175	1181	1059	1001	975	958	945
4.F.2. Land converted to other land	CO_2	502	413	406	353	495	494	510	514	517	520
4.G. Harvested wood products	CO_2	-3122	-2569	-1889	-3461	-2452	-1254	-122	-1889	-1992	-678
5.A. Solid waste disposal	CH_4	4081	3758	2987	2730	1978	1328	950	898	846	799
5.B. Biological treatment of solid waste	CH_4	15	29	35	55	70	76	78	79	77	77

IPCC Code and Category	GHG	1990	1995	2000	2005	2010	2015	2020	2021	2022	2023
5.B. Biological treatment of solid waste	N_2O	20	38	46	61	63	65	71	74	72	72
5.C. Incineration and open burning of waste	CH_4	1	1	1	0	0	0	0	0	0	0
5.C. Incineration and open burning of waste	CO_2	28	11	12	12	2	2	2	2	2	2
5.C. Incineration and open burning of waste	N_2O	0	0	0	0	0	0	0	0	0	0
5.D. Wastewater treatment and discharge	CH_4	334	321	263	231	195	187	192	189	188	190
5.D. Wastewater treatment and discharge	N_2O	86	99	120	133	141	145	151	152	152	155

ANNEX 2: UNCERTAINTY ASSESSMENT

A consistent assessment of uncertainties of the Austrian greenhouse gas inventory requires a detailed understanding of the uncertainties of the respective input parameters. Since the first detailed uncertainty evaluation (WINIWARTER & ORTHOFER 2000, WINIWARTER & RYPDAL 2001), the Austrian inventory compilers have spent considerable effort to also obtain uncertainties from individual contributors to the inventory. This leads to a situation where national information or at least national expert knowledge directly from the stage of inventory development may flow into the assessment of uncertainties.

The respective sectoral uncertainties are documented in detail in the sectoral chapters of this report. Specific uncertainty estimates are e.g. available for agricultural soil, for enteric fermentation from animal husbandry, for F-gases, for transport, and for land-use change and forestry.

Annex 2.1 – Description of methodology used for identifying uncertainties

Theoretical background

The assessment and propagation of uncertainties in emission inventories has been described in detail by IPCC (IPCC 2000, IPCC 2006). Principally, two different pathways may be taken to arrive at a total uncertainty, and to develop an inventory uncertainty. The approach 1 is based on error propagation: assuming input information is available in form of normal distribution, and input uncertainties are statistically independent, the approach allows for reliable assessment of inventory uncertainty. More flexibility is possible in the method for approach 2. The Monte-Carlo approach allows any probability distribution of input parameters, and it also enables to define statistical dependencies between parameters. The most obvious dependency is a full dependency. This occurs when two values are based on the identical set of measurements. A variation or error in one value would then be fully reflected also in the other value. While "full dependency" theoretically can also be covered in error propagation, this is normally not done and only in a very limited way possible in the IPCC spreadsheets.

The general properties of error propagation allow to combine (add up) information in a way that the relative uncertainty (as percentage of the mean value) of the combination becomes lower than the relative uncertainty of any of the input parameters. This advantage of going into detail is often implicitly taken advantage of, when a problem is disassembled into sub-problems and the sub-results are being recombined. Nevertheless it is not always the most detailed level that yields results of lowest uncertainty. If measurements or assessments at the most detailed level are difficult, a more comprehensive level of information may provide the lower overall uncertainty.

As a consequence, optimizing the approach requires collecting input information at the most detailed level an inventory is prepared at. Attaching uncertainty data then may be done at a level where greatest confidence can be expected on the data. This may be the most detailed level, but more often uncertainty data will not be available, or a "balance" approach (energy balance, solvent balance) will allow more reliability at a more aggregated level.

Procedure

For the update of the uncertainty assessment of the Austrian greenhouse gas inventory, the most detailed level of the inventory system was used as the base level. This "base level" of the inventory facilitates compilation of emission data for different purposes. Reporting on air pollution (according to UN-ECE or European Commission requirements) is performed by agglomerating the details in basically the same way as it is done for the GHG inventory according to UNFCCC procedures.

This approach of starting at the most detailed level the inventory offers facilitated an assessment of emission uncertainty at any level that the most reasonable uncertainty data are available. Very detailed information can be entered directly, for aggregate information the same uncertainty (as a statistically dependent entity) is applied for all input entries concerned.

Uncertainty information was taken from national studies, from international information (as e.g. in the IPCC reports) from variation presented in literature, and by contacting national experts. Structured interviews were not held, but information collected previously in structured interviews still could be used.

In all input and output parameters, uncertainty has been expressed as normal or lognormal probability density function. In line with the IPCC requirements, the uncertainty range is presented as the range with 95% probability of a given value being within its boundaries. Thus the boundaries were given as the 2.5 and 97.5-percentiles of the respective distribution. For a normal distribution, this is +/- 2 standard deviations from the mean.

Random uncertainty vs. systematic uncertainty

In a previous study, random and systematic uncertainties were strictly separated. Systematic uncertainty was seen as composed of the errors contained and discovered in the national inventory during the analysis (WINIWARTER & RYPDAL 2001). As systematic uncertainty by the definition above is unknown at the time it occurs, its true magnitude can not be known. Previously, this magnitude of the errors still undiscovered was expected to be of similar magnitude as those identified. Such an assessment obviously refers to the inventory as a whole, and not to a single sector, as one should not expect an error always occurring in the same sector. Furthermore, it is highly questionable that the assumption, an error remaining relates to the error discovered already, can be sustained during all stages of inventory development.

Consequently here we did not perform a specific assessment of systematic uncertainty.

Data origin

Many of the uncertainties included in the calculations have already been covered in the previous submissions. Nevertheless it is worthwhile to consider some of the input uncertainties in detail – especially those that contribute more to the overall uncertainty.

Activities: According to information from the Austrian statistical agency, the Austrian energy balance is strongly affected by inexact reporting, reporting errors or omissions/double counting due to difficult attribution of responsibilities. Detailed statistics are therefore not very reliable, but on the total energy level a number of additional plausibility checks are performed. This procedure allows to expect high quality data of low uncertainty at a rather high level of detail, to be presented separately by the specified fuel types (coal/oil/gas, and also biomass but at a higher uncertainty). Consequently, separate (independent) assessment of energy data has been applied to power plants, other combustion including industry, and transport. Within each of these ranges of sectors the specific uncertainty has been applied, but is considered statistically dependent.

Some very special fuels are also treated separately (landfill gas, black liquor). Additionally, large industrial plants are considered separately, as long as they remain sufficiently separate of the energy input. Iron and steel industry is considered dependent of energy. Non-energy sectors are assessed using the specific Austrian studies already mentioned above. These studies contain specific information on agricultural soil, enteric fermentation from animal husbandry, F-gases, transport, and on land-use change and forestry.

Activity related uncertainties for base year and target year are considered to be the same in all cases, but statistically independent. There are reports, e.g. on the solvent sector, which assume lower uncertainty for more recent data. As the solvent balance is strongly dependent on the trade statistics, which suffered heavily from the relaxation of reporting requirements after Austria's accession to the EU in 1995, such improvement was not considered.

Carbon dioxide (CO_2): The emission factor of CO_2 is in most cases well contained due to the carbon content of fuels or of raw materials. Still it is basically one set of measurements that is applied uniformly. A large number of single data have been applied to arrive at a reliable carbon content and consequently emission factor, but this is already factored-in in the magnitude of the uncertainty. Consequently, all energy related carbon contents by fuel type are here considered identical for all energy related activities. We assume independence of uncertainties between fuel types only. Some more independent uncertainty figures are available for source categories like solvents, chemical industry, land use change.

Methane (CH_4): Methane emissions are derived from a large variety of individual measurements of total hydrocarbon (HC) or total volatile organic compound emissions. But only the smaller part of uncertainties derives from these measurements. The larger part is caused by assumptions on the fraction of CH_4 in the HC mix, which ranges from 10% (coal fired large plants) to 75% (gas combustion). Therefore statistically independent numbers are no more than the CH_4 fractions considered separately. Such separate data is available only in combustion generally, in power plants, and in transport. Consequently we have here a very similar pattern as in activities.

Agricultural methane (enteric fermentation and manure treatment) has been assessed for Austria in specific studies, which also reported the uncertainty involved in emission factors (AMON et al. 2002, GEBETSROITHER et al. 2002). This uncertainty estimate could be applied here.

Nitrous oxide (N_2O): Very limited measurement data are available on nitrous oxide emissions. When trying to trace emission factors back to their origin, the large Austrian data collection on emission factors from combustion (STANZEL et al. 1995) refers virtually all N_2O factors back to GEMIS. In line with an earlier assessment done in an Austrian N_2O balance (ORTHOFER et al. 1994), uncertainties by fuel in general and uncertainties in the domestic heating sector were considered independent. Also transport was considered independently, even separated between Diesel fuel and gasoline (as only the latter is equipped with catalysts, which are responsible for the larger share of emissions).

In addition to the definition of statistically independent parameters, some of the uncertainty attributions had to be adapted. Uncertainty figures in the energy sector refer to measurements done around 1990 (VITOVEC 1991). Changes in fuel quality or in combustion equipment are not at all reflected, leading to enhanced uncertainty which we here take from international data. Furthermore (and most importantly, see below), the uncertainty estimate on N_2O from soils used previously (NIR 2006) could not be sustained. A detailed investigation revealed that the source of the 48% uncertainty presented was a statement in an IPCC report (IPCC 2000) referring to a measurement uncertainty. Here we have to deal with an emission factor uncertainty, which is estimated much higher, at an order of magnitude in the latest IPCC emission inventory guidelines (IPCC 2006). This higher number which we adopt now is still much smaller than the two orders of magnitude recommended by IPCC previously (IPCC 2000), and also smaller than a previous estimate for Austria (WINIWARTER & RYPDAL 2001). The latter was considered in part systematic uncertainty, however (the random uncertainty was considered smaller than the range now used) – this is still in part true, but only reflects our lack of knowledge on soil processes. Choosing to apply a quasi-standardized value conforms to the claim of (WINIWARTER 2007) that application of similar parameters between countries allows for a smaller error in an inter-comparison, even if the difference to a "true value" might be larger.

Fluorinated gases: The uncertainties related to emissions of fluorinated gases (PFC, HFC and SF_6) have been investigated within the emission assessment (NIR 2006). Basically, emissions in areas where substances are specifically brought in, e.g. as solvents, are considered well understood, those that refer to release (refrigeration, electrodes during Al-production) are considered highly uncertain.

Annex 2.2 – Results of the Uncertainty Assessment

Table A 16: Approach 1 Uncertainty Analysis for 1990 – excluding LULUCF

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert \frac{D}{\sum C} \right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.1.a. Public electricity and heat production - Biomass	CH_4	0.86	17.75	5.00	50.00	50.25	0.00000	0.00021	0.00022	0.01068	0.00158	0.00012
1.A.1.a. Public electricity and heat production - Biomass	N_2O	2.95	64.42	5.00	50.00	50.25	0.00000	0.00078	0.00081	0.03885	0.00572	0.00154
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CH_4	1.66	1.61	2.00	50.00	50.04	0.00000	0.00000	0.00002	0.00011	0.00006	0.00000
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294.25	3206.44	2.00	0.20	2.01	0.00692	0.00457	0.04027	0.00091	0.11390	0.01297
1.A.1.a. Public electricity and heat production - Gaseous Fuels	N_2O	1.58	1.53	2.00	50.00	50.04	0.00000	0.00000	0.00002	0.00011	0.00005	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CH_4	1.31	0.16	0.50	50.00	50.00	0.00000	0.00001	0.00000	0.00061	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	1228.70	147.01	0.50	0.50	0.71	0.00012	0.01147	0.00185	0.00573	0.00131	0.00003
1.A.1.a. Public electricity and heat production - Liquid Fuels	N_2O	2.48	0.31	0.50	50.00	50.00	0.00000	0.00002	0.00000	0.00115	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CH_4	1.18	4.45	10.00	50.00	50.99	0.00000	0.00004	0.00006	0.00216	0.00079	0.00001
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286.45	1093.80	10.00	15.00	18.03	0.00421	0.01063	0.01374	0.15950	0.19428	0.06318
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	N_2O	3.71	14.05	10.00	50.00	50.99	0.00001	0.00014	0.00018	0.00681	0.00250	0.00005
1.A.1.a. Public electricity and heat production - Solid Fuels	CH_4	1.72	0.00	0.50	50.00	50.00	0.00000	0.00002	0.00000	0.00093	0.00000	0.00000

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6246.94	0.00	0.50	0.50	0.71	0.00308	0.06764	0.00000	0.03382	0.00000	0.00114
1.A.1.a. Public electricity and heat production - Solid Fuels	N_2O	24.41	0.00	0.50	50.00	50.00	0.00023	0.00026	0.00000	0.01322	0.00000	0.00017
1.A.1.b. Petroleum refining - Gaseous Fuels	CH_4	0.22	0.16	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00002	0.00001	0.00000
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	436.66	327.09	2.00	0.20	2.01	0.00012	0.00062	0.00411	0.00012	0.01162	0.00014
1.A.1.b. Petroleum refining - Gaseous Fuels	N_2O	0.21	0.16	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00002	0.00001	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CH_4	1.26	1.74	0.50	50.00	50.00	0.00000	0.00001	0.00002	0.00041	0.00002	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	1957.67	2252.50	0.50	0.50	0.71	0.00030	0.00707	0.02829	0.00354	0.02000	0.00041
1.A.1.b. Petroleum refining - Liquid Fuels	N_2O	1.90	2.87	0.50	50.00	50.00	0.00000	0.00002	0.00004	0.00077	0.00003	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Biomass	CH_4	0.87	0.85	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00007	0.00008	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CH_4	0.26	0.08	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00009	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	506.07	154.69	2.00	0.20	2.01	0.00016	0.00354	0.00194	0.00071	0.00550	0.00003
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	N_2O	0.24	0.07	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00008	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CH_4	0.01	0.00	0.50	50.00	50.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CO_2	3.94	0.00	0.50	0.50	0.71	0.00000	0.00004	0.00000	0.00002	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	N_2O	0.01	0.00	0.50	50.00	50.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	CH_4	0.00	0.01	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	N_2O	0.00	0.02	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CH_4	0.33	0.54	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00016	0.00005	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	649.84	1074.99	5.00	0.20	5.00	0.00167	0.00646	0.01350	0.00129	0.09547	0.00912
1.A.2.a. Iron and steel - Gaseous Fuels	N_2O	0.31	0.51	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00015	0.00005	0.00000

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.a. Iron and steel - Liquid Fuels	CH_4	0.07	0.01	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CO_2	76.32	8.56	1.00	0.50	1.12	0.00000	0.00072	0.00011	0.00036	0.00015	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	N_2O	0.13	0.02	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CH_4	0.35	0.21	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1106.72	631.81	1.00	0.50	1.12	0.00024	0.00406	0.00794	0.00203	0.01122	0.00013
1.A.2.a. Iron and steel - Solid Fuels	N_2O	0.34	0.21	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00005	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	CH_4	0.00	0.01	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	N_2O	0.00	0.05	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00003	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CH_4	0.04	0.13	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	74.96	260.46	5.00	0.20	5.00	0.00002	0.00246	0.00327	0.00049	0.02313	0.00054
1.A.2.b. Non-ferrous metals - Gaseous Fuels	N_2O	0.04	0.12	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CH_4	0.02	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CO_2	35.04	9.06	1.00	0.50	1.12	0.00000	0.00027	0.00011	0.00013	0.00016	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	N_2O	0.03	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CO_2	0.00	0.56	5.00	15.00	15.81	0.00000	0.00001	0.00001	0.00011	0.00005	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	N_2O	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CH_4	0.06	0.03	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CO_2	21.90	11.92	1.00	0.50	1.12	0.00000	0.00009	0.00015	0.00004	0.00021	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	N_2O	0.08	0.05	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	CH_4	0.81	0.92	10.00	50.00	50.99	0.00000	0.00000	0.00001	0.00014	0.00016	0.00000
1.A.2.c. Chemicals - Biomass	N_2O	3.07	3.43	10.00	50.00	50.99	0.00000	0.00001	0.00004	0.00049	0.00061	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CH_4	0.26	0.48	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00016	0.00004	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	518.79	956.76	5.00	0.20	5.00	0.00106	0.00639	0.01202	0.00128	0.08497	0.00722
1.A.2.c. Chemicals - Gaseous Fuels	N_2O	0.25	0.46	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00015	0.00004	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CH_4	0.11	0.05	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CO_2	96.99	41.34	1.00	0.50	1.12	0.00000	0.00053	0.00052	0.00027	0.00073	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.c. Chemicals - Liquid Fuels	N_2O	0.20	0.09	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00005	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CH_4	0.56	1.26	10.00	50.00	50.99	0.00000	0.00001	0.00002	0.00049	0.00022	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	125.22	277.98	10.00	15.00	18.03	0.00080	0.00213	0.00349	0.03202	0.04937	0.00346
1.A.2.c. Chemicals - Other Fossil Fuels	N_2O	1.77	3.97	10.00	50.00	50.99	0.00000	0.00003	0.00005	0.00153	0.00070	0.00000
1.A.2.c. Chemicals - Solid Fuels	CH_4	0.30	0.07	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00012	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CO_2	106.09	22.34	1.00	0.50	1.12	0.00000	0.00087	0.00028	0.00043	0.00040	0.00000
1.A.2.c. Chemicals - Solid Fuels	N_2O	0.43	0.09	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00018	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Biomass	CH_4	2.96	5.47	10.00	50.00	50.99	0.00000	0.00004	0.00007	0.00183	0.00097	0.00000
1.A.2.d. Pulp, paper and print - Biomass	N_2O	14.97	26.99	10.00	50.00	50.99	0.00009	0.00018	0.00034	0.00883	0.00479	0.00010
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CH_4	0.48	0.55	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00009	0.00005	0.00000
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	942.60	1101.05	5.00	0.20	5.00	0.00351	0.00361	0.01383	0.00072	0.09778	0.00956
1.A.2.d. Pulp, paper and print - Gaseous Fuels	N_2O	0.45	0.52	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00009	0.00005	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CH_4	0.92	0.04	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00047	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	852.62	38.96	1.00	0.50	1.12	0.00014	0.00875	0.00049	0.00437	0.00069	0.00002
1.A.2.d. Pulp, paper and print - Liquid Fuels	N_2O	1.73	0.08	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00089	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CH_4	0.06	0.05	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CO_2	14.50	18.20	10.00	15.00	18.03	0.00001	0.00007	0.00023	0.00107	0.00323	0.00001
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	N_2O	0.20	0.17	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00003	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CH_4	1.16	0.15	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00053	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	398.35	49.43	1.00	0.50	1.12	0.00003	0.00370	0.00062	0.00185	0.00088	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	N_2O	1.64	0.21	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00076	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	CH_4	0.10	0.29	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00012	0.00005	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	N_2O	0.14	0.54	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00027	0.00010	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CH_4	0.26	0.32	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00003	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	506.71	635.42	5.00	0.20	5.00	0.00101	0.00249	0.00798	0.00050	0.05643	0.00318
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	N_2O	0.24	0.30	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00003	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CH_4	0.36	0.15	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00010	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	344.93	147.91	1.00	0.50	1.12	0.00002	0.00188	0.00186	0.00094	0.00263	0.00001
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	N_2O	0.69	0.28	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00019	0.00001	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CH_4	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CO_2	0.00	0.03	10.00	15.00	18.03	0.00000	0.00000	0.00000	0.00001	0.00001	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	N_2O	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CH_4	0.05	0.04	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CO_2	18.13	16.19	1.00	0.50	1.12	0.00000	0.00001	0.00020	0.00000	0.00029	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	N_2O	0.07	0.06	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	CH_4	0.00	1.13	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00071	0.00020	0.00000
1.A.2.f. Non-metallic minerals - Biomass	N_2O	0.00	4.29	10.00	50.00	50.99	0.00000	0.00005	0.00005	0.00269	0.00076	0.00001
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH_4	0.28	0.25	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00002	0.00000
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	558.71	505.70	5.00	0.20	5.00	0.00123	0.00030	0.00635	0.00006	0.04491	0.00202
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N_2O	0.27	0.24	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00002	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH_4	0.52	0.15	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00019	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	508.08	189.91	1.00	0.50	1.12	0.00005	0.00312	0.00239	0.00156	0.00337	0.00001

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.f. Non-metallic minerals - Liquid Fuels	N_2O	0.98	0.27	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00036	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CH_4	0.44	2.34	10.00	50.00	50.99	0.00000	0.00002	0.00003	0.00123	0.00042	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	67.25	554.09	10.00	15.00	18.03	0.00023	0.00623	0.00696	0.09345	0.09842	0.01842
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	N_2O	1.39	7.38	10.00	50.00	50.99	0.00000	0.00008	0.00009	0.00388	0.00131	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	CH_4	1.59	0.37	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00063	0.00001	0.00000
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	535.09	128.32	1.00	0.50	1.12	0.00006	0.00419	0.00161	0.00209	0.00228	0.00001
1.A.2.f. Non-metallic minerals - Solid Fuels	N_2O	2.26	0.53	1.00	50.00	50.01	0.00000	0.00002	0.00001	0.00089	0.00001	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	CH_4	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	N_2O	0.00	2.54	5.00	50.00	50.25	0.00000	0.00003	0.00003	0.00159	0.00023	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CH_4	0.33	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00009	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252.19	1364.90	3.00	3.00	4.24	0.00018	0.01441	0.01714	0.04323	0.07273	0.00716
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	N_2O	23.85	37.50	3.00	30.00	30.15	0.00008	0.00021	0.00047	0.00638	0.00200	0.00004
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CH_4	0.03	0.08	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CO_2	3.62	9.90	3.00	3.00	4.24	0.00000	0.00009	0.00012	0.00026	0.00053	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	N_2O	0.02	0.06	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Other Fossil Fuels	CO_2	0.00	4.64	5.00	15.00	15.81	0.00000	0.00006	0.00006	0.00087	0.00041	0.00000
1.A.2.g.viii Other - Biomass	CH_4	1.25	5.39	10.00	50.00	50.99	0.00000	0.00005	0.00007	0.00271	0.00096	0.00001
1.A.2.g.viii Other - Biomass	N_2O	3.60	20.39	10.00	50.00	50.99	0.00001	0.00022	0.00026	0.01086	0.00362	0.00013
1.A.2.g.viii Other - Gaseous Fuels	CH_4	0.51	0.64	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00012	0.00006	0.00000
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1013.80	1270.47	5.00	0.20	5.00	0.00406	0.00497	0.01596	0.00099	0.11283	0.01273

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.g.viii Other - Gaseous Fuels	N_2O	0.48	0.61	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00012	0.00005	0.00000
1.A.2.g.viii Other - Liquid Fuels	CH_4	0.57	0.11	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00024	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CO_2	610.41	136.60	1.00	0.50	1.12	0.00007	0.00490	0.00172	0.00245	0.00243	0.00001
1.A.2.g.viii Other - Liquid Fuels	N_2O	1.03	0.19	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00044	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CH_4	0.02	0.14	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00008	0.00003	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CO_2	3.45	31.25	10.00	15.00	18.03	0.00000	0.00036	0.00039	0.00533	0.00555	0.00006
1.A.2.g.viii Other - Other Fossil Fuels	N_2O	0.05	0.45	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00025	0.00008	0.00000
1.A.2.g.viii Other - Solid Fuels	CH_4	0.25	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00013	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CO_2	90.88	0.04	1.00	0.50	1.12	0.00000	0.00098	0.00000	0.00049	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	N_2O	0.35	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00019	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CH_4	0.00	0.00	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CO_2	7.84	5.43	3.00	3.00	4.24	0.00000	0.00002	0.00007	0.00005	0.00029	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	N_2O	0.06	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CH_4	0.06	0.03	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CO_2	30.57	24.98	3.00	3.00	4.24	0.00000	0.00002	0.00031	0.00005	0.00133	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	N_2O	0.50	0.18	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00009	0.00001	0.00000
1.A.3.b. Road transportation - Biomass	CH_4	0.00	1.34	5.00	50.00	50.25	0.00000	0.00002	0.00002	0.00084	0.00012	0.00000
1.A.3.b. Road transportation - Biomass	N_2O	0.00	14.72	5.00	50.00	50.25	0.00000	0.00018	0.00018	0.00925	0.00131	0.00009
1.A.3.b. Road transportation - Diesel Oil	CH_4	4.42	13.34	3.00	30.00	30.15	0.00000	0.00012	0.00017	0.00359	0.00071	0.00001
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358.15	14667.22	3.00	3.00	4.24	0.08152	0.12607	0.18421	0.37820	0.78155	0.75385
1.A.3.b. Road transportation - Diesel Oil	N_2O	10.72	190.74	3.00	30.00	30.15	0.00002	0.00228	0.00240	0.06838	0.01016	0.00478
1.A.3.b. Road transportation - Gaseous Fuels	CH_4	0.00	0.20	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00013	0.00001	0.00000
1.A.3.b. Road transportation - Gaseous Fuels	CO_2	0.00	36.24	3.00	3.00	4.24	0.00000	0.00046	0.00046	0.00137	0.00193	0.00001
1.A.3.b. Road transportation - Gaseous Fuels	N_2O	0.00	0.13	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00008	0.00001	0.00000
1.A.3.b. Road transportation - Gasoline	CH_4	77.50	7.12	3.00	30.00	30.15	0.00086	0.00075	0.00009	0.02251	0.00038	0.00051
1.A.3.b. Road transportation - Gasoline	CO_2	7895.66	4625.41	3.00	3.00	4.24	0.17701	0.02744	0.05809	0.08232	0.24647	0.06752

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.3.b. Road transportation - Gasoline	N_2O	82.83	6.94	3.00	70.00	70.06	0.00531	0.00081	0.00009	0.05672	0.00037	0.00322
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CH_4	0.23	0.01	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00012	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CO_2	26.46	5.06	3.00	3.00	4.24	0.00000	0.00022	0.00006	0.00067	0.00027	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	N_2O	0.32	0.01	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00017	0.00000	0.00000
1.A.3.b. Road transportation - Other Fossil Fuels	CO_2	0.00	53.92	5.00	15.00	15.81	0.00000	0.00068	0.00068	0.01016	0.00479	0.00013
1.A.3.c. Railways - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.c. Railways - Biomass	N_2O	0.00	0.25	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00016	0.00002	0.00000
1.A.3.c. Railways - Liquid Fuels	CH_4	0.24	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CO_2	171.35	72.85	3.00	3.00	4.24	0.00008	0.00094	0.00092	0.00283	0.00388	0.00002
1.A.3.c. Railways - Liquid Fuels	N_2O	15.83	3.67	3.00	30.00	30.15	0.00004	0.00013	0.00005	0.00377	0.00020	0.00001
1.A.3.c. Railways - Other Fossil Fuels	CO_2	0.00	0.25	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00005	0.00002	0.00000
1.A.3.c. Railways - Solid Fuels	CH_4	0.01	0.00	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CO_2	6.62	0.28	3.00	3.00	4.24	0.00000	0.00007	0.00000	0.00020	0.00001	0.00000
1.A.3.c. Railways - Solid Fuels	N_2O	0.13	0.01	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	CH_4	0.00	0.02	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	N_2O	0.00	0.33	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00021	0.00003	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CH_4	0.03	0.06	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CO_2	18.37	62.58	3.00	3.00	4.24	0.00000	0.00059	0.00079	0.00176	0.00333	0.00001
1.A.3.d. Domestic navigation - Gas/Diesel Oil	N_2O	2.17	5.01	3.00	30.00	30.15	0.00000	0.00004	0.00006	0.00118	0.00027	0.00000
1.A.3.d. Domestic navigation - Gasoline	CH_4	0.95	0.23	3.00	30.00	30.15	0.00000	0.00001	0.00000	0.00022	0.00001	0.00000
1.A.3.d. Domestic navigation - Gasoline	CO_2	9.63	6.34	3.00	3.00	4.24	0.00000	0.00002	0.00008	0.00007	0.00034	0.00000
1.A.3.d. Domestic navigation - Gasoline	N_2O	0.04	0.03	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.d. Domestic navigation - Other Fossil Fuels	CO_2	0.00	0.21	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00004	0.00002	0.00000
1.A.3.e. Other transportation - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.3.e. Other transportation - Biomass	N_2O	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CH_4	0.11	0.01	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00005	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	224.37	24.64	2.00	0.20	2.01	0.00003	0.00212	0.00031	0.00042	0.00088	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	N_2O	0.11	0.01	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00005	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CH_4	0.01	0.01	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CO_2	4.83	11.56	3.00	3.00	4.24	0.00000	0.00009	0.00015	0.00028	0.00062	0.00000
1.A.3.e. Other transportation - Liquid Fuels	N_2O	0.01	0.13	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00010	0.00001	0.00000
1.A.3.e. Other transportation - Other Fossil Fuels	CO_2	0.00	0.04	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.4.a. Commercial/institutional - Biomass	CH_4	7.75	2.27	10.00	50.00	50.99	0.00002	0.00006	0.00003	0.00277	0.00040	0.00001
1.A.4.a. Commercial/institutional - Biomass	N_2O	2.11	2.11	10.00	50.00	50.99	0.00000	0.00000	0.00003	0.00018	0.00038	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CH_4	1.76	2.00	5.00	50.00	50.25	0.00000	0.00001	0.00003	0.00030	0.00018	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	697.87	793.45	5.00	0.20	5.00	0.00192	0.00240	0.00997	0.00048	0.07047	0.00497
1.A.4.a. Commercial/institutional - Gaseous Fuels	N_2O	0.33	0.38	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00003	0.00000
1.A.4.a. Commercial/institutional - Liquid Fuels	CH_4	4.80	0.25	1.00	50.00	50.01	0.00001	0.00005	0.00000	0.00244	0.00000	0.00001
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1419.50	216.05	1.00	0.50	1.12	0.00040	0.01267	0.00271	0.00633	0.00384	0.00005
1.A.4.a. Commercial/institutional - Liquid Fuels	N_2O	2.77	0.45	1.00	50.00	50.01	0.00000	0.00002	0.00001	0.00122	0.00001	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CH_4	0.37	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00020	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CO_2	83.25	0.33	10.00	15.00	18.03	0.00036	0.00090	0.00000	0.01347	0.00006	0.00018
1.A.4.a. Commercial/institutional - Other Fossil Fuels	N_2O	1.18	0.01	10.00	50.00	50.99	0.00000	0.00001	0.00000	0.00063	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CH_4	0.27	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00015	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	91.11	0.00	1.00	0.50	1.12	0.00000	0.00099	0.00000	0.00049	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	N_2O	0.38	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00021	0.00000	0.00000
1.A.4.b. Residential - Biomass	CH_4	263.62	196.10	10.00	50.00	50.99	0.02850	0.00039	0.00246	0.01968	0.03483	0.00160
1.A.4.b. Residential - Biomass	N_2O	61.80	74.13	10.00	50.00	50.99	0.00157	0.00026	0.00093	0.01306	0.01317	0.00034
1.A.4.b. Residential - Gaseous Fuels	CH_4	4.69	6.89	5.00	50.00	50.25	0.00001	0.00004	0.00009	0.00179	0.00061	0.00000
1.A.4.b. Residential - Gaseous Fuels	CO_2	1855.69	2736.44	5.00	0.20	5.00	0.01360	0.01426	0.03437	0.00285	0.24302	0.05907

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.4.b. Residential - Gaseous Fuels	N_2O	0.89	1.30	5.00	50.00	50.25	0.00000	0.00001	0.00002	0.00034	0.00012	0.00000
1.A.4.b. Residential - Liquid Fuels	CH_4	21.91	3.93	1.00	50.00	50.01	0.00019	0.00019	0.00005	0.00941	0.00007	0.00009
1.A.4.b. Residential - Liquid Fuels	CO_2	5633.32	2260.84	1.00	0.50	1.12	0.00626	0.03263	0.02839	0.01631	0.04016	0.00188
1.A.4.b. Residential - Liquid Fuels	N_2O	17.83	6.20	1.00	50.00	50.01	0.00013	0.00012	0.00008	0.00576	0.00011	0.00003
1.A.4.b. Residential - Other Fossil Fuels	CO_2	0.00	0.20	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00004	0.00002	0.00000
1.A.4.b. Residential - Peat	CH_4	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.b. Residential - Peat	CO_2	0.47	0.00	10.00	15.00	18.03	0.00000	0.00001	0.00000	0.00008	0.00000	0.00000
1.A.4.b. Residential - Peat	N_2O	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.b. Residential - Solid Fuels	CH_4	223.59	2.43	1.00	50.00	50.01	0.01972	0.00239	0.00003	0.11961	0.00004	0.01431
1.A.4.b. Residential - Solid Fuels	CO_2	2510.58	27.33	1.00	0.50	1.12	0.00124	0.02685	0.00034	0.01343	0.00049	0.00018
1.A.4.b. Residential - Solid Fuels	N_2O	10.58	0.12	1.00	50.00	50.01	0.00004	0.00011	0.00000	0.00566	0.00000	0.00003
1.A.4.c. Agriculture/forestry/fishing - Biomass	CH_4	33.66	57.28	10.00	50.00	50.99	0.00046	0.00035	0.00072	0.01773	0.01017	0.00042
1.A.4.c. Agriculture/forestry/fishing - Biomass	N_2O	4.25	9.20	10.00	50.00	50.99	0.00001	0.00007	0.00012	0.00348	0.00163	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CH_4	0.05	0.07	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00001	0.00000
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CO_2	20.22	25.97	5.00	0.20	5.00	0.00000	0.00011	0.00033	0.00002	0.00231	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	N_2O	0.01	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CH_4	6.53	1.31	1.00	50.00	50.01	0.00002	0.00005	0.00002	0.00271	0.00002	0.00001
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1180.04	790.59	1.00	0.50	1.12	0.00027	0.00286	0.00993	0.00143	0.01404	0.00020
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	N_2O	68.26	29.35	1.00	50.00	50.01	0.00184	0.00037	0.00037	0.01855	0.00052	0.00034
1.A.4.c. Agriculture/forestry/fishing - Other Fossil Fuels	CO_2	0.00	2.56	5.00	15.00	15.81	0.00000	0.00003	0.00003	0.00048	0.00023	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CH_4	4.58	0.06	1.00	50.00	50.01	0.00001	0.00005	0.00000	0.00244	0.00000	0.00001
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CO_2	51.00	0.71	1.00	0.50	1.12	0.00000	0.00054	0.00001	0.00027	0.00001	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	N_2O	0.22	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00012	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	N_2O	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CH_4	0.04	0.02	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert \frac{D}{\sum C} \right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CO_2	37.35	27.40	1.00	0.50	1.12	0.00000	0.00006	0.00034	0.00003	0.00049	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	N_2O	0.96	0.50	1.00	50.00	50.01	0.00000	0.00000	0.00001	0.00021	0.00001	0.00000
1.A.5. Other (not specified elsewhere) - Other Fossil Fuels	CO_2	0.00	0.01	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.B.1.a. Coal mining and handling	CH_4	373.21	0.00	5.00	50.00	50.25	0.05548	0.00404	0.00000	0.20220	0.00000	0.04088
1.B.2.a. Oil	CH_4	92.12	42.61	0.50	50.00	50.00	0.00335	0.00046	0.00054	0.02315	0.00038	0.00054
1.B.2.a. Oil	CO_2	0.00	0.00	0.50	0.50	0.71	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.B.2.b. Natural gas	CH_4	374.71	290.43	20.00	40.00	44.72	0.04430	0.00041	0.00365	0.01651	0.10317	0.01092
1.B.2.b. Natural gas	CO_2	102.19	73.84	20.00	0.20	20.00	0.00066	0.00018	0.00093	0.00004	0.02623	0.00069
2.A.1. Cement production	CO_2	2033.41	1542.56	5.00	2.00	5.39	0.01891	0.00266	0.01937	0.00532	0.13699	0.01880
2.A.2. Lime production	CO_2	456.20	588.12	10.00	2.00	10.20	0.00341	0.00244	0.00739	0.00489	0.10446	0.01094
2.A.3. Glass production	CO_2	38.51	34.66	5.00	2.00	5.39	0.00001	0.00002	0.00044	0.00004	0.00308	0.00001
2.A.4.a. Ceramics	CO_2	116.48	47.75	5.00	2.00	5.39	0.00006	0.00066	0.00060	0.00132	0.00424	0.00002
2.A.4.b. Other uses of soda ash	CO_2	12.57	8.76	30.00	2.00	30.07	0.00002	0.00003	0.00011	0.00005	0.00467	0.00002
2.A.4.c. Non-metallurgical magnesium production	CO_2	481.23	339.15	2.00	2.00	2.83	0.00029	0.00096	0.00426	0.00191	0.01205	0.00015
2.B.1. Ammonia production	CH_4	1.74	2.17	2.00	10.00	10.20	0.00000	0.00001	0.00003	0.00008	0.00008	0.00000
2.B.1. Ammonia production	CO_2	467.34	446.65	2.00	5.00	5.39	0.00100	0.00055	0.00561	0.00273	0.01587	0.00026
2.B.10. Other	CH_4	9.39	8.71	2.00	2.00	2.83	0.00000	0.00001	0.00011	0.00002	0.00031	0.00000
2.B.10. Other	CO_2	138.56	110.16	2.00	2.00	2.83	0.00002	0.00012	0.00138	0.00024	0.00391	0.00002
2.B.2. Nitric acid production	N_2O	779.63	27.26	2.00	2.00	2.83	0.00077	0.00810	0.00034	0.01621	0.00097	0.00026
2.B.5. Carbide production	CO_2	37.78	32.59	1.00	5.00	5.10	0.00001	0.00000	0.00041	0.00000	0.00058	0.00000
2.B.8. Petrochemical and carbon black production	CH_4	29.40	42.00	20.00	10.00	22.36	0.00007	0.00021	0.00053	0.00209	0.01492	0.00023
2.C.1. Iron and steel production	CH_4	6.45	6.91	2.00	20.00	20.10	0.00000	0.00002	0.00009	0.00034	0.00025	0.00000
2.C.1. Iron and steel production	CO_2	6840.44	10187.63	2.00	0.50	2.06	0.03137	0.05378	0.12795	0.02689	0.36190	0.13170
2.C.2. Ferroalloys production	CO_2	20.81	16.32	5.00	25.00	25.50	0.00004	0.00002	0.00020	0.00051	0.00145	0.00000
2.C.3. Aluminium production	CO_2	150.26	4.61	2.00	5.00	5.39	0.00010	0.00157	0.00006	0.00785	0.00016	0.00006

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
2.C.3. Aluminium production	PFCs	1032.32	0.00	2.00	50.00	50.04	0.42092	0.01118	0.00000	0.55924	0.00000	0.31275
2.C.3. Aluminium production	SF_6	14.10	0.00	2.00	50.00	50.04	0.00008	0.00015	0.00000	0.00764	0.00000	0.00006
2.C.4. Magnesium production	SF_6	235.00	2.27	5.00	5.00	7.07	0.00044	0.00252	0.00003	0.01259	0.00020	0.00016
2.C.5. Lead production	CO_2	4.70	5.40	5.00	50.00	50.25	0.00001	0.00002	0.00007	0.00084	0.00048	0.00000
2.D. Non-energy products from fuels and solvent use	CO_2	348.94	161.96	20.00	30.00	36.06	0.02497	0.00175	0.00203	0.05241	0.05753	0.00606
2.E.1. Integrated circuit or semiconductor	HFCs	2.04	1.50	5.00	10.00	11.18	0.00000	0.00000	0.00002	0.00003	0.00013	0.00000
2.E.1. Integrated circuit or semiconductor	NF_3	0.00	17.84	5.00	10.00	11.18	0.00000	0.00022	0.00022	0.00224	0.00158	0.00001
2.E.1. Integrated circuit or semiconductor	PFCs	30.62	25.91	5.00	10.00	11.18	0.00002	0.00001	0.00033	0.00006	0.00230	0.00001
2.E.1. Integrated circuit or semiconductor	SF_6	100.39	13.16	5.00	10.00	11.18	0.00020	0.00092	0.00017	0.00923	0.00117	0.00009
2.F.1. Refrigeration and air-conditioning	HFCs	0.00	1350.37	10.00	50.00	50.99	0.00000	0.01696	0.01696	0.84800	0.23985	0.77663
2.F.1. Refrigeration and air-conditioning	PFCs	0.00	0.20	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00012	0.00004	0.00000
2.F.2. Foam blowing agents	HFCs	0.00	14.15	20.00	100.00	101.98	0.00000	0.00018	0.00018	0.01778	0.00503	0.00034
2.F.3. Fire protection	HFCs	0.00	11.24	10.00	20.00	22.36	0.00000	0.00014	0.00014	0.00282	0.00200	0.00001
2.F.4. Aerosols	HFCs	0.00	24.44	20.00	10.00	22.36	0.00000	0.00031	0.00031	0.00307	0.00868	0.00008
2.F.5. Solvents	HFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.G. Other product manufacture and use	CO_2	0.07	0.05	0.00	20.00	20.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.G. Other product manufacture and use	N_2O	117.27	41.07	0.00	20.00	20.00	0.00087	0.00075	0.00052	0.01510	0.00000	0.00023
2.G.1. Electrical equipment	SF_6	11.13	50.52	5.00	100.00	100.12	0.00020	0.00051	0.00063	0.05139	0.00449	0.00266
2.G.2. SF_6 and PFCs from other product use	SF_6	124.44	306.36	25.00	50.00	55.90	0.00763	0.00250	0.00385	0.12496	0.13604	0.03412
2.G.4 Other	HFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.G.4 Other	PFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3.A.1. Cattle	CH_4	4870.97	4023.56	10.00	20.00	22.36	1.87130	0.00225	0.05053	0.04494	0.71466	0.51275
3.A.2. Sheep	CH_4	82.00	104.87	10.00	20.00	22.36	0.00053	0.00043	0.00132	0.00857	0.01863	0.00042
3.A.3. Swine	CH_4	87.78	60.94	10.00	20.00	22.36	0.00061	0.00019	0.00077	0.00372	0.01082	0.00013
3.A.4. Other livestock	CH_4	41.21	102.78	10.00	20.00	22.36	0.00013	0.00084	0.00129	0.01689	0.01826	0.00062
3.B.1. Cattle	CH_4	482.20	664.85	10.00	20.00	22.36	0.01834	0.00312	0.00835	0.06250	0.11809	0.01785

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G\bullet D)^2}{(\sum D)^2}$	Note B	$\left\vert\frac{D}{\sum C}\right\vert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
3.B.1. Cattle	N_2O	403.52	253.03	10.00	100.00	100.50	0.25941	0.00119	0.00318	0.11945	0.04494	0.01629
3.B.2. Sheep	CH_4	2.15	2.46	10.00	30.00	31.62	0.00000	0.00001	0.00003	0.00023	0.00044	0.00000
3.B.2. Sheep	N_2O	8.03	9.34	10.00	100.00	100.50	0.00010	0.00003	0.00012	0.00302	0.00166	0.00001
3.B.3. Swine	CH_4	184.45	111.35	10.00	20.00	22.36	0.00268	0.00060	0.00140	0.01200	0.01978	0.00054
3.B.3. Swine	N_2O	110.65	56.61	10.00	100.00	100.50	0.01951	0.00049	0.00071	0.04880	0.01006	0.00248
3.B.4. Other livestock	CH_4	12.42	19.19	10.00	30.00	31.62	0.00002	0.00011	0.00024	0.00319	0.00341	0.00002
3.B.4. Other livestock	N_2O	11.44	26.03	10.00	100.00	100.50	0.00021	0.00020	0.00033	0.02029	0.00462	0.00043
3.B.5. Indirect N_2O emissions	N_2O	123.43	116.51	5.00	200.00	200.06	0.09619	0.00013	0.00146	0.02515	0.01035	0.00074
3.D.1. Direct N_2O emissions from managed soils	N_2O	1605.91	1402.09	5.00	200.00	200.06	16.28236	0.00021	0.01761	0.04154	0.12452	0.01723
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467.48	375.87	5.00	200.00	200.06	1.37976	0.00034	0.00472	0.06899	0.03338	0.00587
3.F. Field burning of agricultural residues	CH_4	0.91	0.00	100.00	40.00	107.70	0.00000	0.00001	0.00000	0.00040	0.00000	0.00000
3.F. Field burning of agricultural residues	N_2O	0.22	0.00	100.00	50.00	111.80	0.00000	0.00000	0.00000	0.00012	0.00000	0.00000
3.G. Liming	CO_2	45.67	95.29	5.00	50.00	50.25	0.00083	0.00070	0.00120	0.03510	0.00846	0.00130
3.H. Urea application	CO_2	9.60	30.07	5.00	50.00	50.25	0.00004	0.00027	0.00038	0.01369	0.00267	0.00019
3.I. Other carbon-containing fertilizers	CO_2	30.66	22.15	5.00	50.00	50.25	0.00037	0.00005	0.00028	0.00270	0.00197	0.00001
5.A. Solid waste disposal	CH_4	4081.16	799.44	12.00	25.00	27.73	2.02039	0.03417	0.01004	0.85415	0.17039	0.75860
5.B. Biological treatment of solid waste	CH_4	14.57	76.83	20.00	50.00	53.85	0.00010	0.00081	0.00096	0.04035	0.02729	0.00237
5.B. Biological treatment of solid waste	N_2O	20.21	72.24	20.00	50.00	53.85	0.00019	0.00069	0.00091	0.03441	0.02566	0.00184
5.C. Incineration and open burning of waste	CH_4	0.62	0.16	0.00	7.00	7.00	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
5.C. Incineration and open burning of waste	CO_2	27.92	2.05	7.00	20.00	21.19	0.00006	0.00028	0.00003	0.00554	0.00026	0.00003
5.C. Incineration and open burning of waste	N_2O	0.17	0.02	0.00	7.00	7.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
5.D. Wastewater treatment and discharge	CH_4	334.11	189.80	15.00	16.00	21.93	0.00847	0.00124	0.00238	0.01979	0.05057	0.00295
5.D. Wastewater treatment and discharge	N_2O	85.80	154.60	15.00	100.00	101.12	0.01187	0.00101	0.00194	0.10120	0.04119	0.01194
Total		**79621.24**	**68695.92**				**22.96**					**3.77**

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivi ty	Type B sensitiv ity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
Total Uncertainties						**Uncertainty in total inventory %:**	**4.79**				**Trend uncertainty %:**	**1.94**

Table A 17: Approach 1 Uncertainty Analysis for 2023 – excluding LULUCF

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivi ty	Type B sensitiv ity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.1.a. Public electricity and heat production - Biomass	CH_4	0.86	17.75	5.00	50.00	50.25	0.00017	0.00021	0.00022	0.01068	0.00158	0.00012
1.A.1.a. Public electricity and heat production - Biomass	N_2O	2.95	64.42	5.00	50.00	50.25	0.00222	0.00078	0.00081	0.03885	0.00572	0.00154
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CH_4	1.66	1.61	1.00	50.00	50.01	0.00000	0.00000	0.00002	0.00011	0.00003	0.00000
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294.25	3206.44	1.00	0.20	1.02	0.00227	0.00457	0.04027	0.00091	0.05695	0.00324
1.A.1.a. Public electricity and heat production - Gaseous Fuels	N_2O	1.58	1.53	1.00	50.00	50.01	0.00000	0.00000	0.00002	0.00011	0.00003	0.00000

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.1.a. Public electricity and heat production - Liquid Fuels	CH_4	1.31	0.16	0.50	50.00	50.00	0.00000	0.00001	0.00000	0.00061	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	1228.70	147.01	0.50	0.50	0.71	0.00000	0.01147	0.00185	0.00573	0.00131	0.00003
1.A.1.a. Public electricity and heat production - Liquid Fuels	N_2O	2.48	0.31	0.50	50.00	50.00	0.00000	0.00002	0.00000	0.00115	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CH_4	1.18	4.45	5.00	50.00	50.25	0.00001	0.00004	0.00006	0.00216	0.00040	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286.45	1093.80	5.00	15.00	15.81	0.06338	0.01063	0.01374	0.15950	0.09714	0.03488
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	N_2O	3.71	14.05	5.00	50.00	50.25	0.00011	0.00014	0.00018	0.00681	0.00125	0.00005
1.A.1.a. Public electricity and heat production - Solid Fuels	CH_4	1.72	0.00	0.50	50.00	50.00	0.00000	0.00002	0.00000	0.00093	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6246.94	0.00	0.50	0.50	0.71	0.00000	0.06764	0.00000	0.03382	0.00000	0.00114
1.A.1.a. Public electricity and heat production - Solid Fuels	N_2O	24.41	0.00	0.50	50.00	50.00	0.00000	0.00026	0.00000	0.01322	0.00000	0.00017
1.A.1.b. Petroleum refining - Gaseous Fuels	CH_4	0.22	0.16	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	436.66	327.09	1.00	0.20	1.02	0.00002	0.00062	0.00411	0.00012	0.00581	0.00003
1.A.1.b. Petroleum refining - Gaseous Fuels	N_2O	0.21	0.16	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CH_4	1.26	1.74	0.50	50.00	50.00	0.00000	0.00001	0.00002	0.00041	0.00002	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	1957.67	2252.50	0.50	0.50	0.71	0.00054	0.00707	0.02829	0.00354	0.02000	0.00041
1.A.1.b. Petroleum refining - Liquid Fuels	N_2O	1.90	2.87	0.50	50.00	50.00	0.00000	0.00002	0.00004	0.00077	0.00003	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Biomass	CH_4	0.87	0.85	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00007	0.00008	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CH_4	0.26	0.08	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00009	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	506.07	154.69	1.00	0.20	1.02	0.00001	0.00354	0.00194	0.00071	0.00275	0.00001

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G\bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	N_2O	0.24	0.07	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00008	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CH_4	0.01	0.00	0.50	50.00	50.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CO_2	3.94	0.00	0.50	0.50	0.71	0.00000	0.00004	0.00000	0.00002	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	N_2O	0.01	0.00	0.50	50.00	50.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	CH_4	0.00	0.01	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	N_2O	0.00	0.02	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CH_4	0.33	0.54	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00016	0.00005	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	649.84	1074.99	5.00	0.20	5.00	0.00613	0.00646	0.01350	0.00129	0.09547	0.00912
1.A.2.a. Iron and steel - Gaseous Fuels	N_2O	0.31	0.51	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00015	0.00005	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CH_4	0.07	0.01	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CO_2	76.32	8.56	1.00	0.50	1.12	0.00000	0.00072	0.00011	0.00036	0.00015	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	N_2O	0.13	0.02	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CH_4	0.35	0.21	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1106.72	631.81	1.00	0.50	1.12	0.00011	0.00406	0.00794	0.00203	0.01122	0.00013
1.A.2.a. Iron and steel - Solid Fuels	N_2O	0.34	0.21	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00005	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	CH_4	0.00	0.01	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	N_2O	0.00	0.05	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00003	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CH_4	0.04	0.13	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	74.96	260.46	5.00	0.20	5.00	0.00036	0.00246	0.00327	0.00049	0.02313	0.00054
1.A.2.b. Non-ferrous metals - Gaseous Fuels	N_2O	0.04	0.12	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CH_4	0.02	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CO_2	35.04	9.06	1.00	0.50	1.12	0.00000	0.00027	0.00011	0.00013	0.00016	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	N_2O	0.03	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivi ty	Type B sensitiv ity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CO_2	0.00	0.56	5.00	15.00	15.81	0.00000	0.00001	0.00001	0.00011	0.00005	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	N_2O	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CH_4	0.06	0.03	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CO_2	21.90	11.92	1.00	0.50	1.12	0.00000	0.00009	0.00015	0.00004	0.00021	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	N_2O	0.08	0.05	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	CH_4	0.81	0.92	10.00	50.00	50.99	0.00000	0.00000	0.00001	0.00014	0.00016	0.00000
1.A.2.c. Chemicals - Biomass	N_2O	3.07	3.43	10.00	50.00	50.99	0.00001	0.00001	0.00004	0.00049	0.00061	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CH_4	0.26	0.48	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00016	0.00004	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	518.79	956.76	5.00	0.20	5.00	0.00486	0.00639	0.01202	0.00128	0.08497	0.00722
1.A.2.c. Chemicals - Gaseous Fuels	N_2O	0.25	0.46	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00015	0.00004	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CH_4	0.11	0.05	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CO_2	96.99	41.34	1.00	0.50	1.12	0.00000	0.00053	0.00052	0.00027	0.00073	0.00000
1.A.2.c. Chemicals - Liquid Fuels	N_2O	0.20	0.09	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00005	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CH_4	0.56	1.26	10.00	50.00	50.99	0.00000	0.00001	0.00002	0.00049	0.00022	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	125.22	277.98	10.00	15.00	18.03	0.00532	0.00213	0.00349	0.03202	0.04937	0.00346
1.A.2.c. Chemicals - Other Fossil Fuels	N_2O	1.77	3.97	10.00	50.00	50.99	0.00001	0.00003	0.00005	0.00153	0.00070	0.00000
1.A.2.c. Chemicals - Solid Fuels	CH_4	0.30	0.07	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00012	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CO_2	106.09	22.34	1.00	0.50	1.12	0.00000	0.00087	0.00028	0.00043	0.00040	0.00000
1.A.2.c. Chemicals - Solid Fuels	N_2O	0.43	0.09	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00018	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Biomass	CH_4	2.96	5.47	10.00	50.00	50.99	0.00002	0.00004	0.00007	0.00183	0.00097	0.00000
1.A.2.d. Pulp, paper and print - Biomass	N_2O	14.97	26.99	10.00	50.00	50.99	0.00040	0.00018	0.00034	0.00883	0.00479	0.00010
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CH_4	0.48	0.55	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00009	0.00005	0.00000
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	942.60	1101.05	5.00	0.20	5.00	0.00643	0.00361	0.01383	0.00072	0.09778	0.00956
1.A.2.d. Pulp, paper and print - Gaseous Fuels	N_2O	0.45	0.52	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00009	0.00005	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CH_4	0.92	0.04	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00047	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	852.62	38.96	1.00	0.50	1.12	0.00000	0.00875	0.00049	0.00437	0.00069	0.00002
1.A.2.d. Pulp, paper and print - Liquid Fuels	N_2O	1.73	0.08	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00089	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\vert\frac{D}{\sum C}\right\vert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CH_4	0.06	0.05	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CO_2	14.50	18.20	10.00	15.00	18.03	0.00002	0.00007	0.00023	0.00107	0.00323	0.00001
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	N_2O	0.20	0.17	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00003	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CH_4	1.16	0.15	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00053	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	398.35	49.43	1.00	0.50	1.12	0.00000	0.00370	0.00062	0.00185	0.00088	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	N_2O	1.64	0.21	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00076	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	CH_4	0.10	0.29	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00012	0.00005	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	N_2O	0.14	0.54	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00027	0.00010	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CH_4	0.26	0.32	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00003	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	506.71	635.42	5.00	0.20	5.00	0.00214	0.00249	0.00798	0.00050	0.05643	0.00318
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	N_2O	0.24	0.30	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00003	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CH_4	0.36	0.15	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00010	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	344.93	147.91	1.00	0.50	1.12	0.00001	0.00188	0.00186	0.00094	0.00263	0.00001
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	N_2O	0.69	0.28	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00019	0.00001	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CH_4	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CO_2	0.00	0.03	10.00	15.00	18.03	0.00000	0.00000	0.00000	0.00001	0.00001	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	N_2O	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CH_4	0.05	0.04	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CO_2	18.13	16.19	1.00	0.50	1.12	0.00000	0.00001	0.00020	0.00000	0.00029	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	N_2O	0.07	0.06	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	CH_4	0.00	1.13	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00071	0.00020	0.00000
1.A.2.f. Non-metallic minerals - Biomass	N_2O	0.00	4.29	10.00	50.00	50.99	0.00001	0.00005	0.00005	0.00269	0.00076	0.00001
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH_4	0.28	0.25	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00002	0.00000
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	558.71	505.70	5.00	0.20	5.00	0.00136	0.00030	0.00635	0.00006	0.04491	0.00202
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N_2O	0.27	0.24	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00002	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH_4	0.52	0.15	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00019	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	508.08	189.91	1.00	0.50	1.12	0.00001	0.00312	0.00239	0.00156	0.00337	0.00001
1.A.2.f. Non-metallic minerals - Liquid Fuels	N_2O	0.98	0.27	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00036	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CH_4	0.44	2.34	10.00	50.00	50.99	0.00000	0.00002	0.00003	0.00123	0.00042	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	67.25	554.09	10.00	15.00	18.03	0.02114	0.00623	0.00696	0.09345	0.09842	0.01842
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	N_2O	1.39	7.38	10.00	50.00	50.99	0.00003	0.00008	0.00009	0.00388	0.00131	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	CH_4	1.59	0.37	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00063	0.00001	0.00000
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	535.09	128.32	1.00	0.50	1.12	0.00000	0.00419	0.00161	0.00209	0.00228	0.00001
1.A.2.f. Non-metallic minerals - Solid Fuels	N_2O	2.26	0.53	1.00	50.00	50.01	0.00000	0.00002	0.00001	0.00089	0.00001	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	CH_4	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	N_2O	0.00	2.54	5.00	50.00	50.25	0.00000	0.00003	0.00003	0.00159	0.00023	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CH_4	0.33	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00009	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252.19	1364.90	3.00	3.00	4.24	0.00711	0.01441	0.01714	0.04323	0.07273	0.00716
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	N_2O	23.85	37.50	3.00	30.00	30.15	0.00027	0.00021	0.00047	0.00638	0.00200	0.00004

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert \frac{D}{\sum C} \right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CH_4	0.03	0.08	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CO_2	3.62	9.90	3.00	3.00	4.24	0.00000	0.00009	0.00012	0.00026	0.00053	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	N_2O	0.02	0.06	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Other Fossil Fuels	CO_2	0.00	4.64	5.00	15.00	15.81	0.00000	0.00006	0.00006	0.00087	0.00041	0.00000
1.A.2.g.viii Other - Biomass	CH_4	1.25	5.39	10.00	50.00	50.99	0.00002	0.00005	0.00007	0.00271	0.00096	0.00001
1.A.2.g.viii Other - Biomass	N_2O	3.60	20.39	10.00	50.00	50.99	0.00023	0.00022	0.00026	0.01086	0.00362	0.00013
1.A.2.g.viii Other - Gaseous Fuels	CH_4	0.51	0.64	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00012	0.00006	0.00000
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1013.80	1270.47	5.00	0.20	5.00	0.00856	0.00497	0.01596	0.00099	0.11283	0.01273
1.A.2.g.viii Other - Gaseous Fuels	N_2O	0.48	0.61	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00012	0.00005	0.00000
1.A.2.g.viii Other - Liquid Fuels	CH_4	0.57	0.11	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00024	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CO_2	610.41	136.60	1.00	0.50	1.12	0.00000	0.00490	0.00172	0.00245	0.00243	0.00001
1.A.2.g.viii Other - Liquid Fuels	N_2O	1.03	0.19	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00044	0.00000	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CH_4	0.02	0.14	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00008	0.00003	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CO_2	3.45	31.25	10.00	15.00	18.03	0.00007	0.00036	0.00039	0.00533	0.00555	0.00006
1.A.2.g.viii Other - Other Fossil Fuels	N_2O	0.05	0.45	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00025	0.00008	0.00000
1.A.2.g.viii Other - Solid Fuels	CH_4	0.25	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00013	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CO_2	90.88	0.04	1.00	0.50	1.12	0.00000	0.00098	0.00000	0.00049	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	N_2O	0.35	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00019	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CH_4	0.00	0.00	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CO_2	7.84	5.43	3.00	3.00	4.24	0.00000	0.00002	0.00007	0.00005	0.00029	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	N_2O	0.06	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CH_4	0.06	0.03	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CO_2	30.57	24.98	3.00	3.00	4.24	0.00000	0.00002	0.00031	0.00005	0.00133	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	N_2O	0.50	0.18	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00009	0.00001	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G\bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.3.b. Road transportation - Biomass	CH_4	0.00	1.34	5.00	50.00	50.25	0.00000	0.00002	0.00002	0.00084	0.00012	0.00000
1.A.3.b. Road transportation - Biomass	N_2O	0.00	14.72	5.00	50.00	50.25	0.00012	0.00018	0.00018	0.00925	0.00131	0.00009
1.A.3.b. Road transportation - Diesel Oil	CH_4	4.42	13.34	3.00	30.00	30.15	0.00003	0.00012	0.00017	0.00359	0.00071	0.00001
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358.15	14667.22	3.00	3.00	4.24	0.82055	0.12607	0.18421	0.37820	0.78155	0.75385
1.A.3.b. Road transportation - Diesel Oil	N_2O	10.72	190.74	3.00	30.00	30.15	0.00701	0.00228	0.00240	0.06838	0.01016	0.00478
1.A.3.b. Road transportation - Gaseous Fuels	CH_4	0.00	0.20	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00013	0.00001	0.00000
1.A.3.b. Road transportation - Gaseous Fuels	CO_2	0.00	36.24	3.00	3.00	4.24	0.00001	0.00046	0.00046	0.00137	0.00193	0.00001
1.A.3.b. Road transportation - Gaseous Fuels	N_2O	0.00	0.13	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00008	0.00001	0.00000
1.A.3.b. Road transportation - Gasoline	CH_4	77.50	7.12	3.00	30.00	30.15	0.00001	0.00075	0.00009	0.02251	0.00038	0.00051
1.A.3.b. Road transportation - Gasoline	CO_2	7895.66	4625.41	3.00	3.00	4.24	0.08160	0.02744	0.05809	0.08232	0.24647	0.06752
1.A.3.b. Road transportation - Gasoline	N_2O	82.83	6.94	3.00	70.00	70.06	0.00005	0.00081	0.00009	0.05672	0.00037	0.00322
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CH_4	0.23	0.01	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00012	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CO_2	26.46	5.06	3.00	3.00	4.24	0.00000	0.00022	0.00006	0.00067	0.00027	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	N_2O	0.32	0.01	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00017	0.00000	0.00000
1.A.3.b. Road transportation - Other Fossil Fuels	CO_2	0.00	53.92	5.00	15.00	15.81	0.00015	0.00068	0.00068	0.01016	0.00479	0.00013
1.A.3.c. Railways - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.c. Railways - Biomass	N_2O	0.00	0.25	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00016	0.00002	0.00000
1.A.3.c. Railways - Liquid Fuels	CH_4	0.24	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CO_2	171.35	72.85	3.00	3.00	4.24	0.00002	0.00094	0.00092	0.00283	0.00388	0.00002
1.A.3.c. Railways - Liquid Fuels	N_2O	15.83	3.67	3.00	30.00	30.15	0.00000	0.00013	0.00005	0.00377	0.00020	0.00001
1.A.3.c. Railways - Other Fossil Fuels	CO_2	0.00	0.25	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00005	0.00002	0.00000
1.A.3.c. Railways - Solid Fuels	CH_4	0.01	0.00	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CO_2	6.62	0.28	3.00	3.00	4.24	0.00000	0.00007	0.00000	0.00020	0.00001	0.00000
1.A.3.c. Railways - Solid Fuels	N_2O	0.13	0.01	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G\bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.3.d. Domestic navigation - Biomass	CH_4	0.00	0.02	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	N_2O	0.00	0.33	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00021	0.00003	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CH_4	0.03	0.06	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CO_2	18.37	62.58	3.00	3.00	4.24	0.00001	0.00059	0.00079	0.00176	0.00333	0.00001
1.A.3.d. Domestic navigation - Gas/Diesel Oil	N_2O	2.17	5.01	3.00	30.00	30.15	0.00000	0.00004	0.00006	0.00118	0.00027	0.00000
1.A.3.d. Domestic navigation - Gasoline	CH_4	0.95	0.23	3.00	30.00	30.15	0.00000	0.00001	0.00000	0.00022	0.00001	0.00000
1.A.3.d. Domestic navigation - Gasoline	CO_2	9.63	6.34	3.00	3.00	4.24	0.00000	0.00002	0.00008	0.00007	0.00034	0.00000
1.A.3.d. Domestic navigation - Gasoline	N_2O	0.04	0.03	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.d. Domestic navigation - Other Fossil Fuels	CO_2	0.00	0.21	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00004	0.00002	0.00000
1.A.3.e. Other transportation - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	N_2O	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CH_4	0.11	0.01	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00005	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	224.37	24.64	1.00	0.20	1.02	0.00000	0.00212	0.00031	0.00042	0.00044	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	N_2O	0.11	0.01	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00005	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CH_4	0.01	0.01	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CO_2	4.83	11.56	3.00	3.00	4.24	0.00000	0.00009	0.00015	0.00028	0.00062	0.00000
1.A.3.e. Other transportation - Liquid Fuels	N_2O	0.01	0.13	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00010	0.00001	0.00000
1.A.3.e. Other transportation - Other Fossil Fuels	CO_2	0.00	0.04	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.4.a. Commercial/institutional - Biomass	CH_4	7.75	2.27	10.00	50.00	50.99	0.00000	0.00006	0.00003	0.00277	0.00040	0.00001
1.A.4.a. Commercial/institutional - Biomass	N_2O	2.11	2.11	10.00	50.00	50.99	0.00000	0.00000	0.00003	0.00018	0.00038	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CH_4	1.76	2.00	5.00	50.00	50.25	0.00000	0.00001	0.00003	0.00030	0.00018	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	697.87	793.45	5.00	0.20	5.00	0.00334	0.00240	0.00997	0.00048	0.07047	0.00497
1.A.4.a. Commercial/institutional - Gaseous Fuels	N_2O	0.33	0.38	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00003	0.00000
1.A.4.a. Commercial/institutional - Liquid Fuels	CH_4	4.80	0.25	1.00	50.00	50.01	0.00000	0.00005	0.00000	0.00244	0.00000	0.00001
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1419.50	216.05	1.00	0.50	1.12	0.00001	0.01267	0.00271	0.00633	0.00384	0.00005
1.A.4.a. Commercial/institutional - Liquid Fuels	N_2O	2.77	0.45	1.00	50.00	50.01	0.00000	0.00002	0.00001	0.00122	0.00001	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CH_4	0.37	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00020	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CO_2	83.25	0.33	10.00	15.00	18.03	0.00000	0.00090	0.00000	0.01347	0.00006	0.00018
1.A.4.a. Commercial/institutional - Other Fossil Fuels	N_2O	1.18	0.01	10.00	50.00	50.99	0.00000	0.00001	0.00000	0.00063	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CH_4	0.27	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00015	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	91.11	0.00	1.00	0.50	1.12	0.00000	0.00099	0.00000	0.00049	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	N_2O	0.38	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00021	0.00000	0.00000
1.A.4.b. Residential - Biomass	CH_4	263.62	196.10	10.00	50.00	50.99	0.02119	0.00039	0.00246	0.01968	0.03483	0.00160
1.A.4.b. Residential - Biomass	N_2O	61.80	74.13	10.00	50.00	50.99	0.00303	0.00026	0.00093	0.01306	0.01317	0.00034
1.A.4.b. Residential - Gaseous Fuels	CH_4	4.69	6.89	5.00	50.00	50.25	0.00003	0.00004	0.00009	0.00179	0.00061	0.00000
1.A.4.b. Residential - Gaseous Fuels	CO_2	1855.69	2736.44	5.00	0.20	5.00	0.03973	0.01426	0.03437	0.00285	0.24302	0.05907
1.A.4.b. Residential - Gaseous Fuels	N_2O	0.89	1.30	5.00	50.00	50.25	0.00000	0.00001	0.00002	0.00034	0.00012	0.00000
1.A.4.b. Residential - Liquid Fuels	CH_4	21.91	3.93	1.00	50.00	50.01	0.00001	0.00019	0.00005	0.00941	0.00007	0.00009
1.A.4.b. Residential - Liquid Fuels	CO_2	5633.32	2260.84	1.00	0.50	1.12	0.00135	0.03263	0.02839	0.01631	0.04016	0.00188
1.A.4.b. Residential - Liquid Fuels	N_2O	17.83	6.20	1.00	50.00	50.01	0.00002	0.00012	0.00008	0.00576	0.00011	0.00003
1.A.4.b. Residential - Other Fossil Fuels	CO_2	0.00	0.20	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00004	0.00002	0.00000
1.A.4.b. Residential - Peat	CH_4	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.b. Residential - Peat	CO_2	0.47	0.00	10.00	15.00	18.03	0.00000	0.00001	0.00000	0.00008	0.00000	0.00000
1.A.4.b. Residential - Peat	N_2O	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.b. Residential - Solid Fuels	CH_4	223.59	2.43	1.00	50.00	50.01	0.00000	0.00239	0.00003	0.11961	0.00004	0.01431
1.A.4.b. Residential - Solid Fuels	CO_2	2510.58	27.33	1.00	0.50	1.12	0.00000	0.02685	0.00034	0.01343	0.00049	0.00018
1.A.4.b. Residential - Solid Fuels	N_2O	10.58	0.12	1.00	50.00	50.01	0.00000	0.00011	0.00000	0.00566	0.00000	0.00003
1.A.4.c. Agriculture/forestry/fishing - Biomass	CH_4	33.66	57.28	10.00	50.00	50.99	0.00181	0.00035	0.00072	0.01773	0.01017	0.00042
1.A.4.c. Agriculture/forestry/fishing - Biomass	N_2O	4.25	9.20	10.00	50.00	50.99	0.00005	0.00007	0.00012	0.00348	0.00163	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CH_4	0.05	0.07	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00001	0.00000
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CO_2	20.22	25.97	5.00	0.20	5.00	0.00000	0.00011	0.00033	0.00002	0.00231	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	N_2O	0.01	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CH_4	6.53	1.31	1.00	50.00	50.01	0.00000	0.00005	0.00002	0.00271	0.00002	0.00001
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1180.04	790.59	1.00	0.50	1.12	0.00017	0.00286	0.00993	0.00143	0.01404	0.00020
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	N_2O	68.26	29.35	1.00	50.00	50.01	0.00046	0.00037	0.00037	0.01855	0.00052	0.00034
1.A.4.c. Agriculture/forestry/fishing - Other Fossil Fuels	CO_2	0.00	2.56	5.00	15.00	15.81	0.00000	0.00003	0.00003	0.00048	0.00023	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CH_4	4.58	0.06	1.00	50.00	50.01	0.00000	0.00005	0.00000	0.00244	0.00000	0.00001
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CO_2	51.00	0.71	1.00	0.50	1.12	0.00000	0.00054	0.00001	0.00027	0.00001	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	N_2O	0.22	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00012	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	N_2O	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CH_4	0.04	0.02	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CO_2	37.35	27.40	1.00	0.50	1.12	0.00000	0.00006	0.00034	0.00003	0.00049	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	N_2O	0.96	0.50	1.00	50.00	50.01	0.00000	0.00000	0.00001	0.00021	0.00001	0.00000
1.A.5. Other (not specified elsewhere) - Other Fossil Fuels	CO_2	0.00	0.01	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.B.1.a. Coal mining and handling	CH_4	373.21	0.00	5.00	50.00	50.25	0.00000	0.00404	0.00000	0.20220	0.00000	0.04088
1.B.2.a. Oil	CH_4	92.12	42.61	0.50	50.00	50.00	0.00096	0.00046	0.00054	0.02315	0.00038	0.00054
1.B.2.a. Oil	CO_2	0.00	0.00	0.50	0.50	0.71	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.B.2.b. Natural gas	CH_4	374.71	290.43	20.00	40.00	44.72	0.03575	0.00041	0.00365	0.01651	0.10317	0.01092
1.B.2.b. Natural gas	CO_2	102.19	73.84	20.00	0.20	20.00	0.00046	0.00018	0.00093	0.00004	0.02623	0.00069
2.A.1. Cement production	CO_2	2033.41	1542.56	1.00	2.00	2.24	0.00252	0.00266	0.01937	0.00532	0.02740	0.00078
2.A.2. Lime production	CO_2	456.20	588.12	5.00	2.00	5.39	0.00213	0.00244	0.00739	0.00489	0.05223	0.00275
2.A.3. Glass production	CO_2	38.51	34.66	1.00	2.00	2.24	0.00000	0.00002	0.00044	0.00004	0.00062	0.00000
2.A.4.a. Ceramics	CO_2	116.48	47.75	1.00	2.00	2.24	0.00000	0.00066	0.00060	0.00132	0.00085	0.00000
2.A.4.b. Other uses of soda ash	CO_2	12.57	8.76	30.00	2.00	30.07	0.00001	0.00003	0.00011	0.00005	0.00467	0.00002
2.A.4.c. Non-metallurgical magnesium production	CO_2	481.23	339.15	2.00	2.00	2.83	0.00019	0.00096	0.00426	0.00191	0.01205	0.00015
2.B.1. Ammonia production	CH_4	1.74	2.17	2.00	10.00	10.20	0.00000	0.00001	0.00003	0.00008	0.00008	0.00000

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivi ty	Type B sensitiv ity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
2.B.1. Ammonia production	CO_2	467.34	446.65	2.00	5.00	5.39	0.00123	0.00055	0.00561	0.00273	0.01587	0.00026
2.B.10. Other	CH_4	9.39	8.71	2.00	2.00	2.83	0.00000	0.00001	0.00011	0.00002	0.00031	0.00000
2.B.10. Other	CO_2	138.56	110.16	2.00	2.00	2.83	0.00002	0.00012	0.00138	0.00024	0.00391	0.00002
2.B.2. Nitric acid production	N_2O	779.63	27.26	2.00	2.00	2.83	0.00000	0.00810	0.00034	0.01621	0.00097	0.00026
2.B.5. Carbide production	CO_2	37.78	32.59	1.00	5.00	5.10	0.00001	0.00000	0.00041	0.00000	0.00058	0.00000
2.B.8. Petrochemical and carbon black production	CH_4	29.40	42.00	20.00	10.00	22.36	0.00019	0.00021	0.00053	0.00209	0.01492	0.00023
2.C.1. Iron and steel production	CH_4	6.45	6.91	0.50	20.00	20.01	0.00000	0.00002	0.00009	0.00034	0.00006	0.00000
2.C.1. Iron and steel production	CO_2	6840.44	10187.63	0.50	0.50	0.71	0.01100	0.05378	0.12795	0.02689	0.09048	0.00891
2.C.2. Ferroalloys production	CO_2	20.81	16.32	5.00	25.00	25.50	0.00004	0.00002	0.00020	0.00051	0.00145	0.00000
2.C.3. Aluminium production	CO_2	150.26	4.61	20.00	5.00	20.62	0.00000	0.00157	0.00006	0.00785	0.00164	0.00006
2.C.3. Aluminium production	PFCs	1032.32	0.00	2.00	50.00	50.04	0.00000	0.01118	0.00000	0.55924	0.00000	0.31275
2.C.3. Aluminium production	SF_6	14.10	0.00	2.00	50.00	50.04	0.00000	0.00015	0.00000	0.00764	0.00000	0.00006
2.C.4. Magnesium production	SF_6	235.00	2.27	5.00	5.00	7.07	0.00000	0.00252	0.00003	0.01259	0.00020	0.00016
2.C.5. Lead production	CO_2	4.70	5.40	5.00	50.00	50.25	0.00002	0.00002	0.00007	0.00084	0.00048	0.00000
2.D. Non-energy products from fuels and solvent use	CO_2	348.94	161.96	20.00	30.00	36.06	0.00723	0.00175	0.00203	0.05241	0.05753	0.00606
2.E.1. Integrated circuit or semiconductor	HFCs	2.04	1.50	5.00	10.00	11.18	0.00000	0.00000	0.00002	0.00003	0.00013	0.00000
2.E.1. Integrated circuit or semiconductor	NF_3	0.00	17.84	5.00	10.00	11.18	0.00001	0.00022	0.00022	0.00224	0.00158	0.00001
2.E.1. Integrated circuit or semiconductor	PFCs	30.62	25.91	5.00	10.00	11.18	0.00002	0.00001	0.00033	0.00006	0.00230	0.00001
2.E.1. Integrated circuit or semiconductor	SF_6	100.39	13.16	5.00	10.00	11.18	0.00000	0.00092	0.00017	0.00923	0.00117	0.00009
2.F.1. Refrigeration and air-conditioning	HFCs	0.00	1350.37	10.00	50.00	50.99	1.00466	0.01696	0.01696	0.84800	0.23985	0.77663
2.F.1. Refrigeration and air-conditioning	PFCs	0.00	0.20	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00012	0.00004	0.00000
2.F.2. Foam blowing agents	HFCs	0.00	14.15	20.00	100.00	101.98	0.00044	0.00018	0.00018	0.01778	0.00503	0.00034
2.F.3. Fire protection	HFCs	0.00	11.24	10.00	20.00	22.36	0.00001	0.00014	0.00014	0.00282	0.00200	0.00001
2.F.4. Aerosols	HFCs	0.00	24.44	20.00	10.00	22.36	0.00006	0.00031	0.00031	0.00307	0.00868	0.00008
2.F.5. Solvents	HFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.G. Other product manufacture and use	CO_2	0.07	0.05	0.00	20.00	20.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
2.G. Other product manufacture and use	N_2O	117.27	41.07	0.00	20.00	20.00	0.00014	0.00075	0.00052	0.01510	0.00000	0.00023
2.G.1. Electrical equipment	SF_6	11.13	50.52	5.00	100.00	100.12	0.00542	0.00051	0.00063	0.05139	0.00449	0.00266
2.G.2. SF_6 and PFCs from other product use	SF_6	124.44	306.36	25.00	50.00	55.90	0.06215	0.00250	0.00385	0.12496	0.13604	0.03412
2.G.4 Other	HFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.G.4 Other	PFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3.A.1. Cattle	CH_4	4870.97	4023.56	1.00	20.00	20.02	1.37564	0.00225	0.05053	0.04494	0.07147	0.00713
3.A.2. Sheep	CH_4	82.00	104.87	10.00	20.00	22.36	0.00117	0.00043	0.00132	0.00857	0.01863	0.00042
3.A.3. Swine	CH_4	87.78	60.94	4.00	20.00	20.40	0.00033	0.00019	0.00077	0.00372	0.00433	0.00003
3.A.4. Other livestock	CH_4	41.21	102.78	10.00	20.00	22.36	0.00112	0.00084	0.00129	0.01689	0.01826	0.00062
3.B.1. Cattle	CH_4	482.20	664.85	1.00	20.00	20.02	0.03756	0.00312	0.00835	0.06250	0.01181	0.00405
3.B.1. Cattle	N_2O	403.52	253.03	1.00	100.00	100.00	0.13569	0.00119	0.00318	0.11945	0.00449	0.01429
3.B.2. Sheep	CH_4	2.15	2.46	10.00	30.00	31.62	0.00000	0.00001	0.00003	0.00023	0.00044	0.00000
3.B.2. Sheep	N_2O	8.03	9.34	10.00	100.00	100.50	0.00019	0.00003	0.00012	0.00302	0.00166	0.00001
3.B.3. Swine	CH_4	184.45	111.35	4.00	20.00	20.40	0.00109	0.00060	0.00140	0.01200	0.00791	0.00021
3.B.3. Swine	N_2O	110.65	56.61	4.00	100.00	100.08	0.00680	0.00049	0.00071	0.04880	0.00402	0.00240
3.B.4. Other livestock	CH_4	12.42	19.19	10.00	30.00	31.62	0.00008	0.00011	0.00024	0.00319	0.00341	0.00002
3.B.4. Other livestock	N_2O	11.44	26.03	10.00	100.00	100.50	0.00145	0.00020	0.00033	0.02029	0.00462	0.00043
3.B.5. Indirect N_2O emissions	N_2O	123.43	116.51	5.00	200.00	200.06	0.11513	0.00013	0.00146	0.02515	0.01035	0.00074
3.D.1. Direct N_2O emissions from managed soils	N_2O	1605.91	1402.09	5.00	200.00	200.06	16.67338	0.00021	0.01761	0.04154	0.12452	0.01723
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467.48	375.87	5.00	200.00	200.06	1.19824	0.00034	0.00472	0.06899	0.03338	0.00587
3.F. Field burning of agricultural residues	CH_4	0.91	0.00	100.00	40.00	107.70	0.00000	0.00001	0.00000	0.00040	0.00000	0.00000
3.F. Field burning of agricultural residues	N_2O	0.22	0.00	100.00	50.00	111.80	0.00000	0.00000	0.00000	0.00012	0.00000	0.00000
3.G. Liming	CO_2	45.67	95.29	5.00	50.00	50.25	0.00486	0.00070	0.00120	0.03510	0.00846	0.00130
3.H. Urea application	CO_2	9.60	30.07	5.00	50.00	50.25	0.00048	0.00027	0.00038	0.01369	0.00267	0.00019
3.I. Other carbon-containing fertilizers	CO_2	30.66	22.15	5.00	50.00	50.25	0.00026	0.00005	0.00028	0.00270	0.00197	0.00001
5.A. Solid waste disposal	CH_4	4081.16	799.44	12.00	25.00	27.73	0.10414	0.03417	0.01004	0.85415	0.17039	0.75860

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G\bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
5.B. Biological treatment of solid waste	CH_4	14.57	76.83	20.00	50.00	53.85	0.00363	0.00081	0.00096	0.04035	0.02729	0.00237
5.B. Biological treatment of solid waste	N_2O	20.21	72.24	20.00	50.00	53.85	0.00321	0.00069	0.00091	0.03441	0.02566	0.00184
5.C. Incineration and open burning of waste	CH_4	0.62	0.16	0.00	7.00	7.00	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
5.C. Incineration and open burning of waste	CO_2	27.92	2.05	7.00	20.00	21.19	0.00000	0.00028	0.00003	0.00554	0.00026	0.00003
5.C. Incineration and open burning of waste	N_2O	0.17	0.02	0.00	7.00	7.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
5.D. Wastewater treatment and discharge	CH_4	334.11	189.80	5.00	16.00	16.76	0.00215	0.00124	0.00238	0.01979	0.01686	0.00068
5.D. Wastewater treatment and discharge	N_2O	85.80	154.60	5.00	100.00	100.12	0.05078	0.00101	0.00194	0.10120	0.01373	0.01043
Total		**79621.24**	**68695.92**				**21.97**					**3.06**
Total Uncertainties						**Uncertainty in total inventory %:**	**4.69**				**Trend uncertainty %:**	**1.75**

Table A 18: Approach 1 Uncertainty Analysis for 1990 – including LULUCF

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.1.a. Public electricity and heat production - Biomass	CH_4	0.86	17.75	5.00	50.00	50.25	0.00000	0.00025	0.00027	0.01272	0.00191	0.00017
1.A.1.a. Public electricity and heat production - Biomass	N_2O	2.95	64.42	5.00	50.00	50.25	0.00001	0.00093	0.00098	0.04631	0.00692	0.00219
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CH_4	1.66	1.61	2.00	50.00	50.04	0.00000	0.00000	0.00002	0.00024	0.00007	0.00000
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294.25	3206.44	2.00	0.20	2.01	0.01011	0.00920	0.04868	0.00184	0.13769	0.01896
1.A.1.a. Public electricity and heat production - Gaseous Fuels	N_2O	1.58	1.53	2.00	50.00	50.04	0.00000	0.00000	0.00002	0.00022	0.00007	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CH_4	1.31	0.16	0.50	50.00	50.00	0.00000	0.00002	0.00000	0.00103	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	1228.70	147.01	0.50	0.50	0.71	0.00017	0.01935	0.00223	0.00968	0.00158	0.00010
1.A.1.a. Public electricity and heat production - Liquid Fuels	N_2O	2.48	0.31	0.50	50.00	50.00	0.00000	0.00004	0.00000	0.00195	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CH_4	1.18	4.45	10.00	50.00	50.99	0.00000	0.00005	0.00007	0.00235	0.00096	0.00001
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286.45	1093.80	10.00	15.00	18.03	0.00615	0.01157	0.01661	0.17360	0.23485	0.08529
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	N_2O	3.71	14.05	10.00	50.00	50.99	0.00001	0.00015	0.00021	0.00741	0.00302	0.00006
1.A.1.a. Public electricity and heat production - Solid Fuels	CH_4	1.72	0.00	0.50	50.00	50.00	0.00000	0.00003	0.00000	0.00151	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6246.94	0.00	0.50	0.50	0.71	0.00450	0.10966	0.00000	0.05483	0.00000	0.00301
1.A.1.a. Public electricity and heat production - Solid Fuels	N_2O	24.41	0.00	0.50	50.00	50.00	0.00034	0.00043	0.00000	0.02144	0.00000	0.00046

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.1.b. Petroleum refining - Gaseous Fuels	CH_4	0.22	0.16	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00007	0.00001	0.00000
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	436.66	327.09	2.00	0.20	2.01	0.00018	0.00271	0.00497	0.00054	0.01405	0.00020
1.A.1.b. Petroleum refining - Gaseous Fuels	N_2O	0.21	0.16	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00007	0.00001	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CH_4	1.26	1.74	0.50	50.00	50.00	0.00000	0.00000	0.00003	0.00021	0.00002	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	1957.67	2252.50	0.50	0.50	0.71	0.00044	0.00020	0.03420	0.00010	0.02418	0.00058
1.A.1.b. Petroleum refining - Liquid Fuels	N_2O	1.90	2.87	0.50	50.00	50.00	0.00000	0.00001	0.00004	0.00051	0.00003	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Biomass	CH_4	0.87	0.85	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00011	0.00009	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CH_4	0.26	0.08	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00017	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	506.07	154.69	2.00	0.20	2.01	0.00024	0.00654	0.00235	0.00131	0.00664	0.00005
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	N_2O	0.24	0.07	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00016	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CH_4	0.01	0.00	0.50	50.00	50.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CO_2	3.94	0.00	0.50	0.50	0.71	0.00000	0.00007	0.00000	0.00003	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	N_2O	0.01	0.00	0.50	50.00	50.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	CH_4	0.00	0.01	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	N_2O	0.00	0.02	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CH_4	0.33	0.54	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00012	0.00006	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	649.84	1074.99	5.00	0.20	5.00	0.00244	0.00490	0.01632	0.00098	0.11541	0.01332
1.A.2.a. Iron and steel - Gaseous Fuels	N_2O	0.31	0.51	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00012	0.00006	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CH_4	0.07	0.01	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CO_2	76.32	8.56	1.00	0.50	1.12	0.00000	0.00121	0.00013	0.00061	0.00018	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	N_2O	0.13	0.02	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00011	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CH_4	0.35	0.21	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00015	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert \frac{D}{\sum C} \right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1106.72	631.81	1.00	0.50	1.12	0.00035	0.00985	0.00959	0.00493	0.01357	0.00021
1.A.2.a. Iron and steel - Solid Fuels	N_2O	0.34	0.21	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00014	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	CH_4	0.00	0.01	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	N_2O	0.00	0.05	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00003	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CH_4	0.04	0.13	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00007	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	74.96	260.46	5.00	0.20	5.00	0.00003	0.00264	0.00395	0.00053	0.02796	0.00078
1.A.2.b. Non-ferrous metals - Gaseous Fuels	N_2O	0.04	0.12	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CH_4	0.02	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CO_2	35.04	9.06	1.00	0.50	1.12	0.00000	0.00048	0.00014	0.00024	0.00019	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	N_2O	0.03	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CO_2	0.00	0.56	5.00	15.00	15.81	0.00000	0.00001	0.00001	0.00013	0.00006	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	N_2O	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CH_4	0.06	0.03	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CO_2	21.90	11.92	1.00	0.50	1.12	0.00000	0.00020	0.00018	0.00010	0.00026	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	N_2O	0.08	0.05	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	CH_4	0.81	0.92	10.00	50.00	50.99	0.00000	0.00000	0.00001	0.00001	0.00020	0.00000
1.A.2.c. Chemicals - Biomass	N_2O	3.07	3.43	10.00	50.00	50.99	0.00001	0.00000	0.00005	0.00009	0.00074	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CH_4	0.26	0.48	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00014	0.00005	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	518.79	956.76	5.00	0.20	5.00	0.00155	0.00541	0.01453	0.00108	0.10271	0.01055
1.A.2.c. Chemicals - Gaseous Fuels	N_2O	0.25	0.46	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00013	0.00005	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CH_4	0.11	0.05	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CO_2	96.99	41.34	1.00	0.50	1.12	0.00000	0.00108	0.00063	0.00054	0.00089	0.00000
1.A.2.c. Chemicals - Liquid Fuels	N_2O	0.20	0.09	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00011	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CH_4	0.56	1.26	10.00	50.00	50.99	0.00000	0.00001	0.00002	0.00046	0.00027	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	125.22	277.98	10.00	15.00	18.03	0.00117	0.00202	0.00422	0.03030	0.05969	0.00448
1.A.2.c. Chemicals - Other Fossil Fuels	N_2O	1.77	3.97	10.00	50.00	50.99	0.00000	0.00003	0.00006	0.00146	0.00085	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.c. Chemicals - Solid Fuels	CH_4	0.30	0.07	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00022	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CO_2	106.09	22.34	1.00	0.50	1.12	0.00000	0.00152	0.00034	0.00076	0.00048	0.00000
1.A.2.c. Chemicals - Solid Fuels	N_2O	0.43	0.09	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00031	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Biomass	CH_4	2.96	5.47	10.00	50.00	50.99	0.00001	0.00003	0.00008	0.00155	0.00117	0.00000
1.A.2.d. Pulp, paper and print - Biomass	N_2O	14.97	26.99	10.00	50.00	50.99	0.00013	0.00015	0.00041	0.00733	0.00579	0.00009
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CH_4	0.48	0.55	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00000	0.00006	0.00000
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	942.60	1101.05	5.00	0.20	5.00	0.00513	0.00015	0.01672	0.00003	0.11821	0.01397
1.A.2.d. Pulp, paper and print - Gaseous Fuels	N_2O	0.45	0.52	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00000	0.00006	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CH_4	0.92	0.04	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00077	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	852.62	38.96	1.00	0.50	1.12	0.00021	0.01439	0.00059	0.00719	0.00084	0.00005
1.A.2.d. Pulp, paper and print - Liquid Fuels	N_2O	1.73	0.08	1.00	50.00	50.01	0.00000	0.00003	0.00000	0.00146	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CH_4	0.06	0.05	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00002	0.00001	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CO_2	14.50	18.20	10.00	15.00	18.03	0.00002	0.00002	0.00028	0.00032	0.00391	0.00002
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	N_2O	0.20	0.17	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00005	0.00004	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CH_4	1.16	0.15	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00090	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	398.35	49.43	1.00	0.50	1.12	0.00005	0.00625	0.00075	0.00312	0.00106	0.00001
1.A.2.d. Pulp, paper and print - Solid Fuels	N_2O	1.64	0.21	1.00	50.00	50.01	0.00000	0.00003	0.00000	0.00128	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	CH_4	0.10	0.29	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00013	0.00006	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	N_2O	0.14	0.54	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00029	0.00012	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CH_4	0.26	0.32	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00002	0.00003	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	506.71	635.42	5.00	0.20	5.00	0.00148	0.00074	0.00965	0.00015	0.06822	0.00465
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	N_2O	0.24	0.30	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00002	0.00003	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CH_4	0.36	0.15	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00020	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	344.93	147.91	1.00	0.50	1.12	0.00003	0.00381	0.00225	0.00191	0.00318	0.00001
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	N_2O	0.69	0.28	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00039	0.00001	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CH_4	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CO_2	0.00	0.03	10.00	15.00	18.03	0.00000	0.00000	0.00000	0.00001	0.00001	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	N_2O	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CH_4	0.05	0.04	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CO_2	18.13	16.19	1.00	0.50	1.12	0.00000	0.00007	0.00025	0.00004	0.00035	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	N_2O	0.07	0.06	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	CH_4	0.00	1.13	10.00	50.00	50.99	0.00000	0.00002	0.00002	0.00086	0.00024	0.00000
1.A.2.f. Non-metallic minerals - Biomass	N_2O	0.00	4.29	10.00	50.00	50.99	0.00000	0.00007	0.00007	0.00325	0.00092	0.00001
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH_4	0.28	0.25	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00005	0.00003	0.00000
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	558.71	505.70	5.00	0.20	5.00	0.00180	0.00214	0.00768	0.00043	0.05429	0.00295
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N_2O	0.27	0.24	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00005	0.00003	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH_4	0.52	0.15	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00034	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	508.08	189.91	1.00	0.50	1.12	0.00007	0.00604	0.00288	0.00302	0.00408	0.00003
1.A.2.f. Non-metallic minerals - Liquid Fuels	N_2O	0.98	0.27	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00065	0.00001	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CH_4	0.44	2.34	10.00	50.00	50.99	0.00000	0.00003	0.00004	0.00139	0.00050	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	67.25	554.09	10.00	15.00	18.03	0.00034	0.00723	0.00841	0.10846	0.11897	0.02592
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	N_2O	1.39	7.38	10.00	50.00	50.99	0.00000	0.00009	0.00011	0.00438	0.00158	0.00002

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.f. Non-metallic minerals - Solid Fuels	CH_4	1.59	0.37	1.00	50.00	50.01	0.00000	0.00002	0.00001	0.00112	0.00001	0.00000
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	535.09	128.32	1.00	0.50	1.12	0.00008	0.00745	0.00195	0.00373	0.00276	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	N_2O	2.26	0.53	1.00	50.00	50.01	0.00000	0.00003	0.00001	0.00158	0.00001	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	CH_4	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	N_2O	0.00	2.54	5.00	50.00	50.25	0.00000	0.00004	0.00004	0.00193	0.00027	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CH_4	0.33	0.04	3.00	30.00	30.15	0.00000	0.00001	0.00000	0.00016	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252.19	1364.90	3.00	3.00	4.24	0.00026	0.01629	0.02072	0.04887	0.08792	0.01012
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	N_2O	23.85	37.50	3.00	30.00	30.15	0.00012	0.00015	0.00057	0.00451	0.00242	0.00003
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CH_4	0.03	0.08	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CO_2	3.62	9.90	3.00	3.00	4.24	0.00000	0.00009	0.00015	0.00026	0.00064	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	N_2O	0.02	0.06	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Other Fossil Fuels	CO_2	0.00	4.64	5.00	15.00	15.81	0.00000	0.00007	0.00007	0.00106	0.00050	0.00000
1.A.2.g.viii Other - Biomass	CH_4	1.25	5.39	10.00	50.00	50.99	0.00000	0.00006	0.00008	0.00300	0.00116	0.00001
1.A.2.g.viii Other - Biomass	N_2O	3.60	20.39	10.00	50.00	50.99	0.00001	0.00025	0.00031	0.01232	0.00438	0.00017
1.A.2.g.viii Other - Gaseous Fuels	CH_4	0.51	0.64	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00004	0.00007	0.00000
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1013.80	1270.47	5.00	0.20	5.00	0.00593	0.00148	0.01929	0.00030	0.13639	0.01860
1.A.2.g.viii Other - Gaseous Fuels	N_2O	0.48	0.61	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00003	0.00007	0.00000
1.A.2.g.viii Other - Liquid Fuels	CH_4	0.57	0.11	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00042	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CO_2	610.41	136.60	1.00	0.50	1.12	0.00011	0.00865	0.00207	0.00433	0.00293	0.00003
1.A.2.g.viii Other - Liquid Fuels	N_2O	1.03	0.19	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00076	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.g.viii Other - Other Fossil Fuels	CH_4	0.02	0.14	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00009	0.00003	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CO_2	3.45	31.25	10.00	15.00	18.03	0.00000	0.00041	0.00047	0.00621	0.00671	0.00008
1.A.2.g.viii Other - Other Fossil Fuels	N_2O	0.05	0.45	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00030	0.00010	0.00000
1.A.2.g.viii Other - Solid Fuels	CH_4	0.25	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00022	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CO_2	90.88	0.04	1.00	0.50	1.12	0.00000	0.00160	0.00000	0.00080	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	N_2O	0.35	0.00	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00031	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CH_4	0.00	0.00	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CO_2	7.84	5.43	3.00	3.00	4.24	0.00000	0.00006	0.00008	0.00017	0.00035	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	N_2O	0.06	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CH_4	0.06	0.03	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CO_2	30.57	24.98	3.00	3.00	4.24	0.00000	0.00016	0.00038	0.00047	0.00161	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	N_2O	0.50	0.18	3.00	30.00	30.15	0.00000	0.00001	0.00000	0.00018	0.00001	0.00000
1.A.3.b. Road transportation - Biomass	CH_4	0.00	1.34	5.00	50.00	50.25	0.00000	0.00002	0.00002	0.00102	0.00014	0.00000
1.A.3.b. Road transportation - Biomass	N_2O	0.00	14.72	5.00	50.00	50.25	0.00000	0.00022	0.00022	0.01118	0.00158	0.00013
1.A.3.b. Road transportation - Diesel Oil	CH_4	4.42	13.34	3.00	30.00	30.15	0.00000	0.00012	0.00020	0.00375	0.00086	0.00001
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358.15	14667.22	3.00	3.00	4.24	0.11912	0.12843	0.22269	0.38530	0.94477	1.04106
1.A.3.b. Road transportation - Diesel Oil	N_2O	10.72	190.74	3.00	30.00	30.15	0.00002	0.00271	0.00290	0.08123	0.01229	0.00675
1.A.3.b. Road transportation - Gaseous Fuels	CH_4	0.00	0.20	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00016	0.00001	0.00000
1.A.3.b. Road transportation - Gaseous Fuels	CO_2	0.00	36.24	3.00	3.00	4.24	0.00000	0.00055	0.00055	0.00165	0.00233	0.00001
1.A.3.b. Road transportation - Gaseous Fuels	N_2O	0.00	0.13	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00010	0.00001	0.00000
1.A.3.b. Road transportation - Gasoline	CH_4	77.50	7.12	3.00	30.00	30.15	0.00126	0.00125	0.00011	0.03761	0.00046	0.00141
1.A.3.b. Road transportation - Gasoline	CO_2	7895.66	4625.41	3.00	3.00	4.24	0.25866	0.06843	0.07023	0.20528	0.29794	0.13091
1.A.3.b. Road transportation - Gasoline	N_2O	82.83	6.94	3.00	70.00	70.06	0.00776	0.00135	0.00011	0.09449	0.00045	0.00893
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CH_4	0.23	0.01	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00020	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CO_2	26.46	5.06	3.00	3.00	4.24	0.00000	0.00039	0.00008	0.00116	0.00033	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	N_2O	0.32	0.01	3.00	50.00	50.09	0.00000	0.00001	0.00000	0.00027	0.00000	0.00000
1.A.3.b. Road transportation - Other Fossil Fuels	CO_2	0.00	53.92	5.00	15.00	15.81	0.00000	0.00082	0.00082	0.01228	0.00579	0.00018
1.A.3.c. Railways - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.c. Railways - Biomass	N_2O	0.00	0.25	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00019	0.00003	0.00000
1.A.3.c. Railways - Liquid Fuels	CH_4	0.24	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00011	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CO_2	171.35	72.85	3.00	3.00	4.24	0.00012	0.00190	0.00111	0.00571	0.00469	0.00005
1.A.3.c. Railways - Liquid Fuels	N_2O	15.83	3.67	3.00	30.00	30.15	0.00005	0.00022	0.00006	0.00668	0.00024	0.00004
1.A.3.c. Railways - Other Fossil Fuels	CO_2	0.00	0.25	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00006	0.00003	0.00000
1.A.3.c. Railways - Solid Fuels	CH_4	0.01	0.00	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CO_2	6.62	0.28	3.00	3.00	4.24	0.00000	0.00011	0.00000	0.00034	0.00002	0.00000
1.A.3.c. Railways - Solid Fuels	N_2O	0.13	0.01	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	CH_4	0.00	0.02	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	N_2O	0.00	0.33	5.00	50.00	50.25	0.00000	0.00001	0.00001	0.00025	0.00004	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CH_4	0.03	0.06	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CO_2	18.37	62.58	3.00	3.00	4.24	0.00000	0.00063	0.00095	0.00188	0.00403	0.00002
1.A.3.d. Domestic navigation - Gas/Diesel Oil	N_2O	2.17	5.01	3.00	30.00	30.15	0.00000	0.00004	0.00008	0.00114	0.00032	0.00000
1.A.3.d. Domestic navigation - Gasoline	CH_4	0.95	0.23	3.00	30.00	30.15	0.00000	0.00001	0.00000	0.00040	0.00001	0.00000
1.A.3.d. Domestic navigation - Gasoline	CO_2	9.63	6.34	3.00	3.00	4.24	0.00000	0.00007	0.00010	0.00022	0.00041	0.00000
1.A.3.d. Domestic navigation - Gasoline	N_2O	0.04	0.03	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Other Fossil Fuels	CO_2	0.00	0.21	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00005	0.00002	0.00000
1.A.3.e. Other transportation - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	N_2O	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CH_4	0.11	0.01	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00009	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	224.37	24.64	2.00	0.20	2.01	0.00005	0.00357	0.00037	0.00071	0.00106	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	N_2O	0.11	0.01	2.00	50.00	50.04	0.00000	0.00000	0.00000	0.00009	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.3.e. Other transportation - Liquid Fuels	CH_4	0.01	0.01	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CO_2	4.83	11.56	3.00	3.00	4.24	0.00000	0.00009	0.00018	0.00027	0.00074	0.00000
1.A.3.e. Other transportation - Liquid Fuels	N_2O	0.01	0.13	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00012	0.00001	0.00000
1.A.3.e. Other transportation - Other Fossil Fuels	CO_2	0.00	0.04	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.4.a. Commercial/institutional - Biomass	CH_4	7.75	2.27	10.00	50.00	50.99	0.00004	0.00010	0.00003	0.00509	0.00049	0.00003
1.A.4.a. Commercial/institutional - Biomass	N_2O	2.11	2.11	10.00	50.00	50.99	0.00000	0.00001	0.00003	0.00025	0.00045	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CH_4	1.76	2.00	5.00	50.00	50.25	0.00000	0.00000	0.00003	0.00003	0.00021	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	697.87	793.45	5.00	0.20	5.00	0.00281	0.00022	0.01205	0.00004	0.08518	0.00726
1.A.4.a. Commercial/institutional - Gaseous Fuels	N_2O	0.33	0.38	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00001	0.00004	0.00000
1.A.4.a. Commercial/institutional - Liquid Fuels	CH_4	4.80	0.25	1.00	50.00	50.01	0.00001	0.00008	0.00000	0.00403	0.00001	0.00002
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1419.50	216.05	1.00	0.50	1.12	0.00058	0.02166	0.00328	0.01083	0.00464	0.00014
1.A.4.a. Commercial/institutional - Liquid Fuels	N_2O	2.77	0.45	1.00	50.00	50.01	0.00000	0.00004	0.00001	0.00210	0.00001	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CH_4	0.37	0.00	10.00	50.00	50.99	0.00000	0.00001	0.00000	0.00033	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CO_2	83.25	0.33	10.00	15.00	18.03	0.00052	0.00146	0.00001	0.02187	0.00007	0.00048
1.A.4.a. Commercial/institutional - Other Fossil Fuels	N_2O	1.18	0.01	10.00	50.00	50.99	0.00000	0.00002	0.00000	0.00103	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CH_4	0.27	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00024	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	91.11	0.00	1.00	0.50	1.12	0.00000	0.00160	0.00000	0.00080	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	N_2O	0.38	0.00	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00034	0.00000	0.00000
1.A.4.b. Residential - Biomass	CH_4	263.62	196.10	10.00	50.00	50.99	0.04165	0.00165	0.00298	0.08273	0.04211	0.00862
1.A.4.b. Residential - Biomass	N_2O	61.80	74.13	10.00	50.00	50.99	0.00229	0.00004	0.00113	0.00198	0.01592	0.00026
1.A.4.b. Residential - Gaseous Fuels	CH_4	4.69	6.89	5.00	50.00	50.25	0.00001	0.00002	0.00010	0.00111	0.00074	0.00000
1.A.4.b. Residential - Gaseous Fuels	CO_2	1855.69	2736.44	5.00	0.20	5.00	0.01988	0.00894	0.04155	0.00179	0.29378	0.08631
1.A.4.b. Residential - Gaseous Fuels	N_2O	0.89	1.30	5.00	50.00	50.25	0.00000	0.00000	0.00002	0.00021	0.00014	0.00000
1.A.4.b. Residential - Liquid Fuels	CH_4	21.91	3.93	1.00	50.00	50.01	0.00028	0.00033	0.00006	0.01627	0.00008	0.00026
1.A.4.b. Residential - Liquid Fuels	CO_2	5633.32	2260.84	1.00	0.50	1.12	0.00914	0.06460	0.03433	0.03230	0.04854	0.00340
1.A.4.b. Residential - Liquid Fuels	N_2O	17.83	6.20	1.00	50.00	50.01	0.00018	0.00022	0.00009	0.01095	0.00013	0.00012

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert \frac{D}{\sum C} \right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.4.b. Residential - Other Fossil Fuels	CO_2	0.00	0.20	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00005	0.00002	0.00000
1.A.4.b. Residential - Peat	CH_4	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.b. Residential - Peat	CO_2	0.47	0.00	10.00	15.00	18.03	0.00000	0.00001	0.00000	0.00012	0.00000	0.00000
1.A.4.b. Residential - Peat	N_2O	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.b. Residential - Solid Fuels	CH_4	223.59	2.43	1.00	50.00	50.01	0.02882	0.00389	0.00004	0.19458	0.00005	0.03786
1.A.4.b. Residential - Solid Fuels	CO_2	2510.58	27.33	1.00	0.50	1.12	0.00182	0.04368	0.00041	0.02184	0.00059	0.00048
1.A.4.b. Residential - Solid Fuels	N_2O	10.58	0.12	1.00	50.00	50.01	0.00006	0.00018	0.00000	0.00921	0.00000	0.00008
1.A.4.c. Agriculture/forestry/fishing - Biomass	CH_4	33.66	57.28	10.00	50.00	50.99	0.00068	0.00028	0.00087	0.01391	0.01230	0.00034
1.A.4.c. Agriculture/forestry/fishing - Biomass	N_2O	4.25	9.20	10.00	50.00	50.99	0.00001	0.00007	0.00014	0.00325	0.00198	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CH_4	0.05	0.07	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CO_2	20.22	25.97	5.00	0.20	5.00	0.00000	0.00004	0.00039	0.00001	0.00279	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	N_2O	0.01	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CH_4	6.53	1.31	1.00	50.00	50.01	0.00002	0.00009	0.00002	0.00474	0.00003	0.00002
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1180.04	790.59	1.00	0.50	1.12	0.00040	0.00873	0.01200	0.00436	0.01698	0.00031
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	N_2O	68.26	29.35	1.00	50.00	50.01	0.00269	0.00075	0.00045	0.03768	0.00063	0.00142
1.A.4.c. Agriculture/forestry/fishing - Other Fossil Fuels	CO_2	0.00	2.56	5.00	15.00	15.81	0.00000	0.00004	0.00004	0.00058	0.00028	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CH_4	4.58	0.06	1.00	50.00	50.01	0.00001	0.00008	0.00000	0.00398	0.00000	0.00002
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CO_2	51.00	0.71	1.00	0.50	1.12	0.00000	0.00089	0.00001	0.00044	0.00002	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	N_2O	0.22	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00019	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	N_2O	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CH_4	0.04	0.02	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CO_2	37.35	27.40	1.00	0.50	1.12	0.00000	0.00024	0.00042	0.00012	0.00059	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	N_2O	0.96	0.50	1.00	50.00	50.01	0.00000	0.00001	0.00001	0.00047	0.00001	0.00000
1.A.5. Other (not specified elsewhere) - Other Fossil Fuels	CO_2	0.00	0.01	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.B.1.a. Coal mining and handling	CH_4	373.21	0.00	5.00	50.00	50.25	0.08107	0.00656	0.00000	0.32786	0.00000	0.10749
1.B.2.a. Oil	CH_4	92.12	42.61	0.50	50.00	50.00	0.00489	0.00097	0.00065	0.04858	0.00046	0.00236
1.B.2.a. Oil	CO_2	0.00	0.00	0.50	0.50	0.71	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.B.2.b. Natural gas	CH_4	374.71	290.43	20.00	40.00	44.72	0.06473	0.00217	0.00441	0.08697	0.12472	0.02312
1.B.2.b. Natural gas	CO_2	102.19	73.84	20.00	0.20	20.00	0.00096	0.00067	0.00112	0.00013	0.03171	0.00101
2.A.1. Cement production	CO_2	2033.41	1542.56	5.00	2.00	5.39	0.02764	0.01230	0.02342	0.02461	0.16560	0.02803
2.A.2. Lime production	CO_2	456.20	588.12	10.00	2.00	10.20	0.00499	0.00091	0.00893	0.00183	0.12628	0.01595
2.A.3. Glass production	CO_2	38.51	34.66	5.00	2.00	5.39	0.00001	0.00015	0.00053	0.00030	0.00372	0.00001
2.A.4.a. Ceramics	CO_2	116.48	47.75	5.00	2.00	5.39	0.00009	0.00132	0.00073	0.00264	0.00513	0.00003
2.A.4.b. Other uses of soda ash	CO_2	12.57	8.76	30.00	2.00	30.07	0.00003	0.00009	0.00013	0.00018	0.00564	0.00003
2.A.4.c. Non-metallurgical magnesium production	CO_2	481.23	339.15	2.00	2.00	2.83	0.00043	0.00331	0.00515	0.00661	0.01456	0.00026
2.B.1. Ammonia production	CH_4	1.74	2.17	2.00	10.00	10.20	0.00000	0.00000	0.00003	0.00002	0.00009	0.00000
2.B.1. Ammonia production	CO_2	467.34	446.65	2.00	5.00	5.39	0.00146	0.00143	0.00678	0.00715	0.01918	0.00042
2.B.10. Other	CH_4	9.39	8.71	2.00	2.00	2.83	0.00000	0.00003	0.00013	0.00007	0.00037	0.00000
2.B.10. Other	CO_2	138.56	110.16	2.00	2.00	2.83	0.00004	0.00076	0.00167	0.00152	0.00473	0.00002
2.B.2. Nitric acid production	N_2O	779.63	27.26	2.00	2.00	2.83	0.00112	0.01328	0.00041	0.02657	0.00117	0.00071
2.B.5. Carbide production	CO_2	37.78	32.59	1.00	5.00	5.10	0.00001	0.00017	0.00049	0.00084	0.00070	0.00000
2.B.8. Petrochemical and carbon black production	CH_4	29.40	42.00	20.00	10.00	22.36	0.00010	0.00012	0.00064	0.00121	0.01804	0.00033
2.C.1. Iron and steel production	CH_4	6.45	6.91	2.00	20.00	20.10	0.00000	0.00001	0.00010	0.00017	0.00030	0.00000
2.C.1. Iron and steel production	CO_2	6840.44	10187.63	2.00	0.50	2.06	0.04584	0.03445	0.15467	0.01722	0.43748	0.19169
2.C.2. Ferroalloys production	CO_2	20.81	16.32	5.00	25.00	25.50	0.00006	0.00012	0.00025	0.00295	0.00175	0.00001
2.C.3. Aluminium production	CO_2	150.26	4.61	2.00	5.00	5.39	0.00015	0.00257	0.00007	0.01285	0.00020	0.00017
2.C.3. Aluminium production	PFCs	1032.32	0.00	2.00	50.00	50.04	0.61510	0.01814	0.00000	0.90679	0.00000	0.82226
2.C.3. Aluminium production	SF_6	14.10	0.00	2.00	50.00	50.04	0.00011	0.00025	0.00000	0.01239	0.00000	0.00015
2.C.4. Magnesium production	SF_6	235.00	2.27	5.00	5.00	7.07	0.00064	0.00409	0.00003	0.02047	0.00024	0.00042
2.C.5. Lead production	CO_2	4.70	5.40	5.00	50.00	50.25	0.00001	0.00000	0.00008	0.00003	0.00058	0.00000

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
2.D. Non-energy products from fuels and solvent use	CO_2	348.94	161.96	20.00	30.00	36.06	0.03649	0.00367	0.00246	0.11016	0.06955	0.01697
2.E.1. Integrated circuit or semiconductor	HFCs	2.04	1.50	5.00	10.00	11.18	0.00000	0.00001	0.00002	0.00013	0.00016	0.00000
2.E.1. Integrated circuit or semiconductor	NF_3	0.00	17.84	5.00	10.00	11.18	0.00000	0.00027	0.00027	0.00271	0.00192	0.00001
2.E.1. Integrated circuit or semiconductor	PFCs	30.62	25.91	5.00	10.00	11.18	0.00003	0.00014	0.00039	0.00145	0.00278	0.00001
2.E.1. Integrated circuit or semiconductor	SF_6	100.39	13.16	5.00	10.00	11.18	0.00029	0.00156	0.00020	0.01564	0.00141	0.00025
2.F.1. Refrigeration and air-conditioning	HFCs	0.00	1350.37	10.00	50.00	50.99	0.00000	0.02050	0.02050	1.02510	0.28994	1.13490
2.F.1. Refrigeration and air-conditioning	PFCs	0.00	0.20	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00015	0.00004	0.00000
2.F.2. Foam blowing agents	HFCs	0.00	14.15	20.00	100.00	101.98	0.00000	0.00021	0.00021	0.02149	0.00608	0.00050
2.F.3. Fire protection	HFCs	0.00	11.24	10.00	20.00	22.36	0.00000	0.00017	0.00017	0.00341	0.00241	0.00002
2.F.4. Aerosols	HFCs	0.00	24.44	20.00	10.00	22.36	0.00000	0.00037	0.00037	0.00371	0.01049	0.00012
2.F.5. Solvents	HFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.G. Other product manufacture and use	CO_2	0.07	0.05	0.00	20.00	20.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
2.G. Other product manufacture and use	N_2O	117.27	41.07	0.00	20.00	20.00	0.00127	0.00144	0.00062	0.02874	0.00000	0.00083
2.G.1. Electrical equipment	SF_6	11.13	50.52	5.00	100.00	100.12	0.00029	0.00057	0.00077	0.05715	0.00542	0.00330
2.G.2. SF_6 and PFCs from other product use	SF_6	124.44	306.36	25.00	50.00	55.90	0.01115	0.00246	0.00465	0.12324	0.16445	0.04223
2.G.4 Other	HFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.G.4 Other	PFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3.A.1. Cattle	CH_4	4870.97	4023.56	10.00	20.00	22.36	2.73457	0.02448	0.06109	0.48962	0.86391	0.98607
3.A.2. Sheep	CH_4	82.00	104.87	10.00	20.00	22.36	0.00077	0.00015	0.00159	0.00303	0.02252	0.00052
3.A.3. Swine	CH_4	87.78	60.94	10.00	20.00	22.36	0.00089	0.00062	0.00093	0.01234	0.01308	0.00032
3.A.4. Other livestock	CH_4	41.21	102.78	10.00	20.00	22.36	0.00020	0.00084	0.00156	0.01673	0.02207	0.00077
3.B.1. Cattle	CH_4	482.20	664.85	10.00	20.00	22.36	0.02680	0.00162	0.01009	0.03243	0.14275	0.02143
3.B.1. Cattle	N_2O	403.52	253.03	10.00	100.00	100.50	0.37908	0.00325	0.00384	0.32482	0.05433	0.10846
3.B.2. Sheep	CH_4	2.15	2.46	10.00	30.00	31.62	0.00000	0.00000	0.00004	0.00001	0.00053	0.00000
3.B.2. Sheep	N_2O	8.03	9.34	10.00	100.00	100.50	0.00015	0.00000	0.00014	0.00006	0.00200	0.00000
3.B.3. Swine	CH_4	184.45	111.35	10.00	20.00	22.36	0.00392	0.00155	0.00169	0.03100	0.02391	0.00153

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
3.B.3. Swine	N_2O	110.65	56.61	10.00	100.00	100.50	0.02850	0.00108	0.00086	0.10846	0.01216	0.01191
3.B.4. Other livestock	CH_4	12.42	19.19	10.00	30.00	31.62	0.00004	0.00007	0.00029	0.00219	0.00412	0.00002
3.B.4. Other livestock	N_2O	11.44	26.03	10.00	100.00	100.50	0.00030	0.00019	0.00040	0.01941	0.00559	0.00041
3.B.5. Indirect N_2O emissions	N_2O	123.43	116.51	5.00	200.00	200.06	0.14057	0.00040	0.00177	0.07998	0.01251	0.00655
3.D.1. Direct N_2O emissions from managed soils	N_2O	1605.91	1402.09	5.00	200.00	200.06	23.79376	0.00693	0.02129	1.38562	0.15052	1.94259
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467.48	375.87	5.00	200.00	200.06	2.01628	0.00251	0.00571	0.50144	0.04035	0.25307
3.F. Field burning of agricultural residues	CH_4	0.91	0.00	100.00	40.00	107.70	0.00000	0.00002	0.00000	0.00064	0.00000	0.00000
3.F. Field burning of agricultural residues	N_2O	0.22	0.00	100.00	50.00	111.80	0.00000	0.00000	0.00000	0.00020	0.00000	0.00000
3.G. Liming	CO_2	45.67	95.29	5.00	50.00	50.25	0.00121	0.00064	0.00145	0.03222	0.01023	0.00114
3.H. Urea application	CO_2	9.60	30.07	5.00	50.00	50.25	0.00005	0.00029	0.00046	0.01440	0.00323	0.00022
3.I. Other carbon-containing fertilizers	CO_2	30.66	22.15	5.00	50.00	50.25	0.00055	0.00020	0.00034	0.01012	0.00238	0.00011
4. Land use, land-use change and forestry	CH_4	37.47	37.33	0.00	42.80	42.80	0.00059	0.00009	0.00057	0.00392	0.00000	0.00002
4. Land use, land-use change and forestry	N_2O	180.20	169.36	0.00	71.14	71.14	0.03788	0.00060	0.00257	0.04233	0.00000	0.00179
4.A.1. Forest land remaining forest land	CO_2	-10623.78	6763.48	0.00	37.62	37.62	36.82817	0.28982	0.10269	10.90432	0.00000	118.90412
4.A.2. Land converted to forest land	CO_2	-2959.14	-1401.95	0.00	97.65	97.65	19.24624	0.03072	-0.02129	3.00004	0.00000	9.00023
4.B.1. Cropland remaining cropland	CO_2	201.17	256.25	0.00	38.56	38.56	0.01387	0.00036	0.00389	0.01372	0.00000	0.00019
4.B.2. Land converted to cropland	CO_2	173.39	172.48	0.00	32.66	32.66	0.00739	0.00043	0.00262	0.01397	0.00000	0.00020
4.C.1. Grassland remaining grassland	CO_2	371.06	371.06	0.00	27.90	27.90	0.02471	0.00089	0.00563	0.02472	0.00000	0.00061
4.C.2. Land converted to grassland	CO_2	421.02	221.64	0.00	96.02	96.02	0.37675	0.00403	0.00337	0.38720	0.00000	0.14992
4.D.1. Wetlands remaining wetlands	CO_2	20.63	20.63	0.00	24.55	24.55	0.00006	0.00005	0.00031	0.00121	0.00000	0.00000
4.D.2. Land converted to wetlands	CO_2	44.12	69.20	0.00	69.27	69.27	0.00215	0.00028	0.00105	0.01907	0.00000	0.00036
4.E.1. Settlements remaining settlements	CO_2	63.34	63.34	0.00	0.00	0.00	0.00000	0.00015	0.00096	0.00000	0.00000	0.00000
4.E.2. Land converted to settlements	CO_2	935.18	944.74	0.00	46.26	46.26	0.43136	0.00209	0.01434	0.09659	0.00000	0.00933
4.F.2. Land converted to other land	CO_2	501.55	520.29	0.00	109.88	109.88	0.70005	0.00091	0.00790	0.10034	0.00000	0.01007
4.G. Harvested wood products	CO_2	-3122.27	-677.87	0.00	49.02	49.02	5.39896	0.04459	-0.01029	2.18563	0.00000	4.77700
5.A. Solid waste disposal	CH_4	4081.16	799.44	12.00	25.00	27.73	2.95244	0.05953	0.01214	1.48837	0.20598	2.25766

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
5.B. Biological treatment of solid waste	CH_4	14.57	76.83	20.00	50.00	53.85	0.00014	0.00091	0.00117	0.04553	0.03299	0.00316
5.B. Biological treatment of solid waste	N_2O	20.21	72.24	20.00	50.00	53.85	0.00027	0.00074	0.00110	0.03708	0.03102	0.00234
5.C. Incineration and open burning of waste	CH_4	0.62	0.16	0.00	7.00	7.00	0.00000	0.00001	0.00000	0.00006	0.00000	0.00000
5.C. Incineration and open burning of waste	CO_2	27.92	2.05	7.00	20.00	21.19	0.00008	0.00046	0.00003	0.00919	0.00031	0.00008
5.C. Incineration and open burning of waste	N_2O	0.17	0.02	0.00	7.00	7.00	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
5.D. Wastewater treatment and discharge	CH_4	334.11	189.80	15.00	16.00	21.93	0.01238	0.00299	0.00288	0.04782	0.06113	0.00602
5.D. Wastewater treatment and discharge	N_2O	85.80	154.60	15.00	100.00	101.12	0.01735	0.00084	0.00235	0.08398	0.04979	0.00953
Total		**65865.20**	**76225.91**				**96.62**					**142.42**
Total Uncertainties						**Uncertainty in total inventory %:**	**9.83**				**Trend uncertainty %:**	**11.93**

Table A 19: Approach 1 Uncertainty Analysis 2023 – including LULUCF

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.1.a. Public electricity and heat production - Biomass	CH_4	0.86	17.75	5.00	50.00	50.25	0.00014	0.00025	0.00027	0.01272	0.00191	0.00017
1.A.1.a. Public electricity and heat production - Biomass	N_2O	2.95	64.42	5.00	50.00	50.25	0.00180	0.00093	0.00098	0.04631	0.00692	0.00219
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CH_4	1.66	1.61	1.00	50.00	50.01	0.00000	0.00000	0.00002	0.00024	0.00003	0.00000
1.A.1.a. Public electricity and heat production - Gaseous Fuels	CO_2	3294.25	3206.44	1.00	0.20	1.02	0.00184	0.00920	0.04868	0.00184	0.06885	0.00474
1.A.1.a. Public electricity and heat production - Gaseous Fuels	N_2O	1.58	1.53	1.00	50.00	50.01	0.00000	0.00000	0.00002	0.00022	0.00003	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CH_4	1.31	0.16	0.50	50.00	50.00	0.00000	0.00002	0.00000	0.00103	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Liquid Fuels	CO_2	1228.70	147.01	0.50	0.50	0.71	0.00000	0.01935	0.00223	0.00968	0.00158	0.00010
1.A.1.a. Public electricity and heat production - Liquid Fuels	N_2O	2.48	0.31	0.50	50.00	50.00	0.00000	0.00004	0.00000	0.00195	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CH_4	1.18	4.45	5.00	50.00	50.25	0.00001	0.00005	0.00007	0.00235	0.00048	0.00001
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	CO_2	286.45	1093.80	5.00	15.00	15.81	0.05148	0.01157	0.01661	0.17360	0.11743	0.04392
1.A.1.a. Public electricity and heat production - Other Fossil Fuels	N_2O	3.71	14.05	5.00	50.00	50.25	0.00009	0.00015	0.00021	0.00741	0.00151	0.00006
1.A.1.a. Public electricity and heat production - Solid Fuels	CH_4	1.72	0.00	0.50	50.00	50.00	0.00000	0.00003	0.00000	0.00151	0.00000	0.00000
1.A.1.a. Public electricity and heat production - Solid Fuels	CO_2	6246.94	0.00	0.50	0.50	0.71	0.00000	0.10966	0.00000	0.05483	0.00000	0.00301
1.A.1.a. Public electricity and heat production - Solid Fuels	N_2O	24.41	0.00	0.50	50.00	50.00	0.00000	0.00043	0.00000	0.02144	0.00000	0.00046

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivi ty	Type B sensitiv ity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.1.b. Petroleum refining - Gaseous Fuels	CH_4	0.22	0.16	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00007	0.00000	0.00000
1.A.1.b. Petroleum refining - Gaseous Fuels	CO_2	436.66	327.09	1.00	0.20	1.02	0.00002	0.00271	0.00497	0.00054	0.00702	0.00005
1.A.1.b. Petroleum refining - Gaseous Fuels	N_2O	0.21	0.16	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00007	0.00000	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CH_4	1.26	1.74	0.50	50.00	50.00	0.00000	0.00000	0.00003	0.00021	0.00002	0.00000
1.A.1.b. Petroleum refining - Liquid Fuels	CO_2	1957.67	2252.50	0.50	0.50	0.71	0.00044	0.00020	0.03420	0.00010	0.02418	0.00058
1.A.1.b. Petroleum refining - Liquid Fuels	N_2O	1.90	2.87	0.50	50.00	50.00	0.00000	0.00001	0.00004	0.00051	0.00003	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Biomass	CH_4	0.87	0.85	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00011	0.00009	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CH_4	0.26	0.08	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00017	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	CO_2	506.07	154.69	1.00	0.20	1.02	0.00000	0.00654	0.00235	0.00131	0.00332	0.00001
1.A.1.c. Manufacture of solid fuels and other energy industries - Gaseous Fuels	N_2O	0.24	0.07	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00016	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CH_4	0.01	0.00	0.50	50.00	50.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	CO_2	3.94	0.00	0.50	0.50	0.71	0.00000	0.00007	0.00000	0.00003	0.00000	0.00000
1.A.1.c. Manufacture of solid fuels and other energy industries - Liquid Fuels	N_2O	0.01	0.00	0.50	50.00	50.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	CH_4	0.00	0.01	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.a. Iron and steel - Biomass	N_2O	0.00	0.02	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CH_4	0.33	0.54	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00012	0.00006	0.00000
1.A.2.a. Iron and steel - Gaseous Fuels	CO_2	649.84	1074.99	5.00	0.20	5.00	0.00498	0.00490	0.01632	0.00098	0.11541	0.01332
1.A.2.a. Iron and steel - Gaseous Fuels	N_2O	0.31	0.51	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00012	0.00006	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CH_4	0.07	0.01	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	CO_2	76.32	8.56	1.00	0.50	1.12	0.00000	0.00121	0.00013	0.00061	0.00018	0.00000
1.A.2.a. Iron and steel - Liquid Fuels	N_2O	0.13	0.02	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00011	0.00000	0.00000
1.A.2.a. Iron and steel - Solid Fuels	CH_4	0.35	0.21	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00015	0.00000	0.00000

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.a. Iron and steel - Solid Fuels	CO_2	1106.72	631.81	1.00	0.50	1.12	0.00009	0.00985	0.00959	0.00493	0.01357	0.00021
1.A.2.a. Iron and steel - Solid Fuels	N_2O	0.34	0.21	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00014	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	CH_4	0.00	0.01	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Biomass	N_2O	0.00	0.05	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00003	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CH_4	0.04	0.13	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00007	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Gaseous Fuels	CO_2	74.96	260.46	5.00	0.20	5.00	0.00029	0.00264	0.00395	0.00053	0.02796	0.00078
1.A.2.b. Non-ferrous metals - Gaseous Fuels	N_2O	0.04	0.12	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00006	0.00001	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CH_4	0.02	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	CO_2	35.04	9.06	1.00	0.50	1.12	0.00000	0.00048	0.00014	0.00024	0.00019	0.00000
1.A.2.b. Non-ferrous metals - Liquid Fuels	N_2O	0.03	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	CO_2	0.00	0.56	5.00	15.00	15.81	0.00000	0.00001	0.00001	0.00013	0.00006	0.00000
1.A.2.b. Non-ferrous metals - Other Fossil Fuels	N_2O	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CH_4	0.06	0.03	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	CO_2	21.90	11.92	1.00	0.50	1.12	0.00000	0.00020	0.00018	0.00010	0.00026	0.00000
1.A.2.b. Non-ferrous metals - Solid Fuels	N_2O	0.08	0.05	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000
1.A.2.c. Chemicals - Biomass	CH_4	0.81	0.92	10.00	50.00	50.99	0.00000	0.00000	0.00001	0.00001	0.00020	0.00000
1.A.2.c. Chemicals - Biomass	N_2O	3.07	3.43	10.00	50.00	50.99	0.00001	0.00000	0.00005	0.00009	0.00074	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CH_4	0.26	0.48	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00014	0.00005	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CO_2	518.79	956.76	5.00	0.20	5.00	0.00394	0.00541	0.01453	0.00108	0.10271	0.01055
1.A.2.c. Chemicals - Gaseous Fuels	N_2O	0.25	0.46	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00013	0.00005	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CH_4	0.11	0.05	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	CO_2	96.99	41.34	1.00	0.50	1.12	0.00000	0.00108	0.00063	0.00054	0.00089	0.00000
1.A.2.c. Chemicals - Liquid Fuels	N_2O	0.20	0.09	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00011	0.00000	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CH_4	0.56	1.26	10.00	50.00	50.99	0.00000	0.00001	0.00002	0.00046	0.00027	0.00000
1.A.2.c. Chemicals - Other Fossil Fuels	CO_2	125.22	277.98	10.00	15.00	18.03	0.00432	0.00202	0.00422	0.03030	0.05969	0.00448
1.A.2.c. Chemicals - Other Fossil Fuels	N_2O	1.77	3.97	10.00	50.00	50.99	0.00001	0.00003	0.00006	0.00146	0.00085	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.c. Chemicals - Solid Fuels	CH_4	0.30	0.07	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00022	0.00000	0.00000
1.A.2.c. Chemicals - Solid Fuels	CO_2	106.09	22.34	1.00	0.50	1.12	0.00000	0.00152	0.00034	0.00076	0.00048	0.00000
1.A.2.c. Chemicals - Solid Fuels	N_2O	0.43	0.09	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00031	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Biomass	CH_4	2.96	5.47	10.00	50.00	50.99	0.00001	0.00003	0.00008	0.00155	0.00117	0.00000
1.A.2.d. Pulp, paper and print - Biomass	N_2O	14.97	26.99	10.00	50.00	50.99	0.00033	0.00015	0.00041	0.00733	0.00579	0.00009
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CH_4	0.48	0.55	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00000	0.00006	0.00000
1.A.2.d. Pulp, paper and print - Gaseous Fuels	CO_2	942.60	1101.05	5.00	0.20	5.00	0.00522	0.00015	0.01672	0.00003	0.11821	0.01397
1.A.2.d. Pulp, paper and print - Gaseous Fuels	N_2O	0.45	0.52	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00000	0.00006	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CH_4	0.92	0.04	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00077	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Liquid Fuels	CO_2	852.62	38.96	1.00	0.50	1.12	0.00000	0.01439	0.00059	0.00719	0.00084	0.00005
1.A.2.d. Pulp, paper and print - Liquid Fuels	N_2O	1.73	0.08	1.00	50.00	50.01	0.00000	0.00003	0.00000	0.00146	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CH_4	0.06	0.05	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00002	0.00001	0.00000
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	CO_2	14.50	18.20	10.00	15.00	18.03	0.00002	0.00002	0.00028	0.00032	0.00391	0.00002
1.A.2.d. Pulp, paper and print - Other Fossil Fuels	N_2O	0.20	0.17	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00005	0.00004	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CH_4	1.16	0.15	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00090	0.00000	0.00000
1.A.2.d. Pulp, paper and print - Solid Fuels	CO_2	398.35	49.43	1.00	0.50	1.12	0.00000	0.00625	0.00075	0.00312	0.00106	0.00001
1.A.2.d. Pulp, paper and print - Solid Fuels	N_2O	1.64	0.21	1.00	50.00	50.01	0.00000	0.00003	0.00000	0.00128	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	CH_4	0.10	0.29	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00013	0.00006	0.00000
1.A.2.e. Food processing, beverages and tobacco - Biomass	N_2O	0.14	0.54	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00029	0.00012	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CH_4	0.26	0.32	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00002	0.00003	0.00000
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	CO_2	506.71	635.42	5.00	0.20	5.00	0.00174	0.00074	0.00965	0.00015	0.06822	0.00465
1.A.2.e. Food processing, beverages and tobacco - Gaseous Fuels	N_2O	0.24	0.30	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00002	0.00003	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\vert\frac{D}{\sum C}\right\vert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CH_4	0.36	0.15	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00020	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	CO_2	344.93	147.91	1.00	0.50	1.12	0.00000	0.00381	0.00225	0.00191	0.00318	0.00001
1.A.2.e. Food processing, beverages and tobacco - Liquid Fuels	N_2O	0.69	0.28	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00039	0.00001	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CH_4	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	CO_2	0.00	0.03	10.00	15.00	18.03	0.00000	0.00000	0.00000	0.00001	0.00001	0.00000
1.A.2.e. Food processing, beverages and tobacco - Other Fossil Fuels	N_2O	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CH_4	0.05	0.04	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	CO_2	18.13	16.19	1.00	0.50	1.12	0.00000	0.00007	0.00025	0.00004	0.00035	0.00000
1.A.2.e. Food processing, beverages and tobacco - Solid Fuels	N_2O	0.07	0.06	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Biomass	CH_4	0.00	1.13	10.00	50.00	50.99	0.00000	0.00002	0.00002	0.00086	0.00024	0.00000
1.A.2.f. Non-metallic minerals - Biomass	N_2O	0.00	4.29	10.00	50.00	50.99	0.00001	0.00007	0.00007	0.00325	0.00092	0.00001
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH_4	0.28	0.25	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00005	0.00003	0.00000
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO_2	558.71	505.70	5.00	0.20	5.00	0.00110	0.00214	0.00768	0.00043	0.05429	0.00295
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N_2O	0.27	0.24	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00005	0.00003	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH_4	0.52	0.15	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00034	0.00000	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO_2	508.08	189.91	1.00	0.50	1.12	0.00001	0.00604	0.00288	0.00302	0.00408	0.00003
1.A.2.f. Non-metallic minerals - Liquid Fuels	N_2O	0.98	0.27	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00065	0.00001	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CH_4	0.44	2.34	10.00	50.00	50.99	0.00000	0.00003	0.00004	0.00139	0.00050	0.00000
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	CO_2	67.25	554.09	10.00	15.00	18.03	0.01717	0.00723	0.00841	0.10846	0.11897	0.02592
1.A.2.f. Non-metallic minerals - Other Fossil Fuels	N_2O	1.39	7.38	10.00	50.00	50.99	0.00002	0.00009	0.00011	0.00438	0.00158	0.00002

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.f. Non-metallic minerals - Solid Fuels	CH_4	1.59	0.37	1.00	50.00	50.01	0.00000	0.00002	0.00001	0.00112	0.00001	0.00000
1.A.2.f. Non-metallic minerals - Solid Fuels	CO_2	535.09	128.32	1.00	0.50	1.12	0.00000	0.00745	0.00195	0.00373	0.00276	0.00002
1.A.2.f. Non-metallic minerals - Solid Fuels	N_2O	2.26	0.53	1.00	50.00	50.01	0.00000	0.00003	0.00001	0.00158	0.00001	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	CH_4	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Biomass	N_2O	0.00	2.54	5.00	50.00	50.25	0.00000	0.00004	0.00004	0.00193	0.00027	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CH_4	0.33	0.04	3.00	30.00	30.15	0.00000	0.00001	0.00000	0.00016	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	CO_2	252.19	1364.90	3.00	3.00	4.24	0.00577	0.01629	0.02072	0.04887	0.08792	0.01012
1.A.2.g.vii. Off-road vehicles and other machinery - Diesel Oil	N_2O	23.85	37.50	3.00	30.00	30.15	0.00022	0.00015	0.00057	0.00451	0.00242	0.00003
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CH_4	0.03	0.08	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	CO_2	3.62	9.90	3.00	3.00	4.24	0.00000	0.00009	0.00015	0.00026	0.00064	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Gasoline	N_2O	0.02	0.06	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000
1.A.2.g.vii. Off-road vehicles and other machinery - Other Fossil Fuels	CO_2	0.00	4.64	5.00	15.00	15.81	0.00000	0.00007	0.00007	0.00106	0.00050	0.00000
1.A.2.g.viii Other - Biomass	CH_4	1.25	5.39	10.00	50.00	50.99	0.00001	0.00006	0.00008	0.00300	0.00116	0.00001
1.A.2.g.viii Other - Biomass	N_2O	3.60	20.39	10.00	50.00	50.99	0.00019	0.00025	0.00031	0.01232	0.00438	0.00017
1.A.2.g.viii Other - Gaseous Fuels	CH_4	0.51	0.64	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00004	0.00007	0.00000
1.A.2.g.viii Other - Gaseous Fuels	CO_2	1013.80	1270.47	5.00	0.20	5.00	0.00696	0.00148	0.01929	0.00030	0.13639	0.01860
1.A.2.g.viii Other - Gaseous Fuels	N_2O	0.48	0.61	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00003	0.00007	0.00000
1.A.2.g.viii Other - Liquid Fuels	CH_4	0.57	0.11	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00042	0.00000	0.00000
1.A.2.g.viii Other - Liquid Fuels	CO_2	610.41	136.60	1.00	0.50	1.12	0.00000	0.00865	0.00207	0.00433	0.00293	0.00003
1.A.2.g.viii Other - Liquid Fuels	N_2O	1.03	0.19	1.00	50.00	50.01	0.00000	0.00002	0.00000	0.00076	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.2.g.viii Other - Other Fossil Fuels	CH_4	0.02	0.14	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00009	0.00003	0.00000
1.A.2.g.viii Other - Other Fossil Fuels	CO_2	3.45	31.25	10.00	15.00	18.03	0.00005	0.00041	0.00047	0.00621	0.00671	0.00008
1.A.2.g.viii Other - Other Fossil Fuels	N_2O	0.05	0.45	10.00	50.00	50.99	0.00000	0.00001	0.00001	0.00030	0.00010	0.00000
1.A.2.g.viii Other - Solid Fuels	CH_4	0.25	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00022	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	CO_2	90.88	0.04	1.00	0.50	1.12	0.00000	0.00160	0.00000	0.00080	0.00000	0.00000
1.A.2.g.viii Other - Solid Fuels	N_2O	0.35	0.00	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00031	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CH_4	0.00	0.00	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	CO_2	7.84	5.43	3.00	3.00	4.24	0.00000	0.00006	0.00008	0.00017	0.00035	0.00000
1.A.3.a. Domestic aviation - Aviation Gasoline	N_2O	0.06	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CH_4	0.06	0.03	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	CO_2	30.57	24.98	3.00	3.00	4.24	0.00000	0.00016	0.00038	0.00047	0.00161	0.00000
1.A.3.a. Domestic aviation - Jet Kerosene	N_2O	0.50	0.18	3.00	30.00	30.15	0.00000	0.00001	0.00000	0.00018	0.00001	0.00000
1.A.3.b. Road transportation - Biomass	CH_4	0.00	1.34	5.00	50.00	50.25	0.00000	0.00002	0.00002	0.00102	0.00014	0.00000
1.A.3.b. Road transportation - Biomass	N_2O	0.00	14.72	5.00	50.00	50.25	0.00009	0.00022	0.00022	0.01118	0.00158	0.00013
1.A.3.b. Road transportation - Diesel Oil	CH_4	4.42	13.34	3.00	30.00	30.15	0.00003	0.00012	0.00020	0.00375	0.00086	0.00001
1.A.3.b. Road transportation - Diesel Oil	CO_2	5358.15	14667.22	3.00	3.00	4.24	0.66644	0.12843	0.22269	0.38530	0.94477	1.04106
1.A.3.b. Road transportation - Diesel Oil	N_2O	10.72	190.74	3.00	30.00	30.15	0.00569	0.00271	0.00290	0.08123	0.01229	0.00675
1.A.3.b. Road transportation - Gaseous Fuels	CH_4	0.00	0.20	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00016	0.00001	0.00000
1.A.3.b. Road transportation - Gaseous Fuels	CO_2	0.00	36.24	3.00	3.00	4.24	0.00000	0.00055	0.00055	0.00165	0.00233	0.00001
1.A.3.b. Road transportation - Gaseous Fuels	N_2O	0.00	0.13	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00010	0.00001	0.00000
1.A.3.b. Road transportation - Gasoline	CH_4	77.50	7.12	3.00	30.00	30.15	0.00001	0.00125	0.00011	0.03761	0.00046	0.00141
1.A.3.b. Road transportation - Gasoline	CO_2	7895.66	4625.41	3.00	3.00	4.24	0.06628	0.06843	0.07023	0.20528	0.29794	0.13091
1.A.3.b. Road transportation - Gasoline	N_2O	82.83	6.94	3.00	70.00	70.06	0.00004	0.00135	0.00011	0.09449	0.00045	0.00893
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CH_4	0.23	0.01	3.00	50.00	50.09	0.00000	0.00000	0.00000	0.00020	0.00000	0.00000
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	CO_2	26.46	5.06	3.00	3.00	4.24	0.00000	0.00039	0.00008	0.00116	0.00033	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.3.b. Road transportation - Liquefied Petroleum Gases (LPG)	N_2O	0.32	0.01	3.00	50.00	50.09	0.00000	0.00001	0.00000	0.00027	0.00000	0.00000
1.A.3.b. Road transportation - Other Fossil Fuels	CO_2	0.00	53.92	5.00	15.00	15.81	0.00013	0.00082	0.00082	0.01228	0.00579	0.00018
1.A.3.c. Railways - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.c. Railways - Biomass	N_2O	0.00	0.25	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00019	0.00003	0.00000
1.A.3.c. Railways - Liquid Fuels	CH_4	0.24	0.04	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00011	0.00000	0.00000
1.A.3.c. Railways - Liquid Fuels	CO_2	171.35	72.85	3.00	3.00	4.24	0.00002	0.00190	0.00111	0.00571	0.00469	0.00005
1.A.3.c. Railways - Liquid Fuels	N_2O	15.83	3.67	3.00	30.00	30.15	0.00000	0.00022	0.00006	0.00668	0.00024	0.00004
1.A.3.c. Railways - Other Fossil Fuels	CO_2	0.00	0.25	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00006	0.00003	0.00000
1.A.3.c. Railways - Solid Fuels	CH_4	0.01	0.00	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.c. Railways - Solid Fuels	CO_2	6.62	0.28	3.00	3.00	4.24	0.00000	0.00011	0.00000	0.00034	0.00002	0.00000
1.A.3.c. Railways - Solid Fuels	N_2O	0.13	0.01	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00006	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	CH_4	0.00	0.02	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Biomass	N_2O	0.00	0.33	5.00	50.00	50.25	0.00000	0.00001	0.00001	0.00025	0.00004	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CH_4	0.03	0.06	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Gas/Diesel Oil	CO_2	18.37	62.58	3.00	3.00	4.24	0.00001	0.00063	0.00095	0.00188	0.00403	0.00002
1.A.3.d. Domestic navigation - Gas/Diesel Oil	N_2O	2.17	5.01	3.00	30.00	30.15	0.00000	0.00004	0.00008	0.00114	0.00032	0.00000
1.A.3.d. Domestic navigation - Gasoline	CH_4	0.95	0.23	3.00	30.00	30.15	0.00000	0.00001	0.00000	0.00040	0.00001	0.00000
1.A.3.d. Domestic navigation - Gasoline	CO_2	9.63	6.34	3.00	3.00	4.24	0.00000	0.00007	0.00010	0.00022	0.00041	0.00000
1.A.3.d. Domestic navigation - Gasoline	N_2O	0.04	0.03	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.d. Domestic navigation - Other Fossil Fuels	CO_2	0.00	0.21	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00005	0.00002	0.00000
1.A.3.e. Other transportation - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.e. Other transportation - Biomass	N_2O	0.00	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CH_4	0.11	0.01	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00009	0.00000	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	CO_2	224.37	24.64	1.00	0.20	1.02	0.00000	0.00357	0.00037	0.00071	0.00053	0.00000
1.A.3.e. Other transportation - Gaseous Fuels	N_2O	0.11	0.01	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00009	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.3.e. Other transportation - Liquid Fuels	CH_4	0.01	0.01	3.00	30.00	30.15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.e. Other transportation - Liquid Fuels	CO_2	4.83	11.56	3.00	3.00	4.24	0.00000	0.00009	0.00018	0.00027	0.00074	0.00000
1.A.3.e. Other transportation - Liquid Fuels	N_2O	0.01	0.13	3.00	70.00	70.06	0.00000	0.00000	0.00000	0.00012	0.00001	0.00000
1.A.3.e. Other transportation - Other Fossil Fuels	CO_2	0.00	0.04	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.4.a. Commercial/institutional - Biomass	CH_4	7.75	2.27	10.00	50.00	50.99	0.00000	0.00010	0.00003	0.00509	0.00049	0.00003
1.A.4.a. Commercial/institutional - Biomass	N_2O	2.11	2.11	10.00	50.00	50.99	0.00000	0.00001	0.00003	0.00025	0.00045	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CH_4	1.76	2.00	5.00	50.00	50.25	0.00000	0.00000	0.00003	0.00003	0.00021	0.00000
1.A.4.a. Commercial/institutional - Gaseous Fuels	CO_2	697.87	793.45	5.00	0.20	5.00	0.00271	0.00022	0.01205	0.00004	0.08518	0.00726
1.A.4.a. Commercial/institutional - Gaseous Fuels	N_2O	0.33	0.38	5.00	50.00	50.25	0.00000	0.00000	0.00001	0.00001	0.00004	0.00000
1.A.4.a. Commercial/institutional - Liquid Fuels	CH_4	4.80	0.25	1.00	50.00	50.01	0.00000	0.00008	0.00000	0.00403	0.00001	0.00002
1.A.4.a. Commercial/institutional - Liquid Fuels	CO_2	1419.50	216.05	1.00	0.50	1.12	0.00001	0.02166	0.00328	0.01083	0.00464	0.00014
1.A.4.a. Commercial/institutional - Liquid Fuels	N_2O	2.77	0.45	1.00	50.00	50.01	0.00000	0.00004	0.00001	0.00210	0.00001	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CH_4	0.37	0.00	10.00	50.00	50.99	0.00000	0.00001	0.00000	0.00033	0.00000	0.00000
1.A.4.a. Commercial/institutional - Other Fossil Fuels	CO_2	83.25	0.33	10.00	15.00	18.03	0.00000	0.00146	0.00001	0.02187	0.00007	0.00048
1.A.4.a. Commercial/institutional - Other Fossil Fuels	N_2O	1.18	0.01	10.00	50.00	50.99	0.00000	0.00002	0.00000	0.00103	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CH_4	0.27	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00024	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	CO_2	91.11	0.00	1.00	0.50	1.12	0.00000	0.00160	0.00000	0.00080	0.00000	0.00000
1.A.4.a. Commercial/institutional - Solid Fuels	N_2O	0.38	0.00	1.00	50.00	50.01	0.00000	0.00001	0.00000	0.00034	0.00000	0.00000
1.A.4.b. Residential - Biomass	CH_4	263.62	196.10	10.00	50.00	50.99	0.01721	0.00165	0.00298	0.08273	0.04211	0.00862
1.A.4.b. Residential - Biomass	N_2O	61.80	74.13	10.00	50.00	50.99	0.00246	0.00004	0.00113	0.00198	0.01592	0.00026
1.A.4.b. Residential - Gaseous Fuels	CH_4	4.69	6.89	5.00	50.00	50.25	0.00002	0.00002	0.00010	0.00111	0.00074	0.00000
1.A.4.b. Residential - Gaseous Fuels	CO_2	1855.69	2736.44	5.00	0.20	5.00	0.03227	0.00894	0.04155	0.00179	0.29378	0.08631
1.A.4.b. Residential - Gaseous Fuels	N_2O	0.89	1.30	5.00	50.00	50.25	0.00000	0.00000	0.00002	0.00021	0.00014	0.00000
1.A.4.b. Residential - Liquid Fuels	CH_4	21.91	3.93	1.00	50.00	50.01	0.00001	0.00033	0.00006	0.01627	0.00008	0.00026
1.A.4.b. Residential - Liquid Fuels	CO_2	5633.32	2260.84	1.00	0.50	1.12	0.00110	0.06460	0.03433	0.03230	0.04854	0.00340
1.A.4.b. Residential - Liquid Fuels	N_2O	17.83	6.20	1.00	50.00	50.01	0.00002	0.00022	0.00009	0.01095	0.00013	0.00012

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\|\frac{D}{\sum C}\right\|$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.A.4.b. Residential - Other Fossil Fuels	CO_2	0.00	0.20	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00005	0.00002	0.00000
1.A.4.b. Residential - Peat	CH_4	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.b. Residential - Peat	CO_2	0.47	0.00	10.00	15.00	18.03	0.00000	0.00001	0.00000	0.00012	0.00000	0.00000
1.A.4.b. Residential - Peat	N_2O	0.00	0.00	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.b. Residential - Solid Fuels	CH_4	223.59	2.43	1.00	50.00	50.01	0.00000	0.00389	0.00004	0.19458	0.00005	0.03786
1.A.4.b. Residential - Solid Fuels	CO_2	2510.58	27.33	1.00	0.50	1.12	0.00000	0.04368	0.00041	0.02184	0.00059	0.00048
1.A.4.b. Residential - Solid Fuels	N_2O	10.58	0.12	1.00	50.00	50.01	0.00000	0.00018	0.00000	0.00921	0.00000	0.00008
1.A.4.c. Agriculture/forestry/fishing - Biomass	CH_4	33.66	57.28	10.00	50.00	50.99	0.00147	0.00028	0.00087	0.01391	0.01230	0.00034
1.A.4.c. Agriculture/forestry/fishing - Biomass	N_2O	4.25	9.20	10.00	50.00	50.99	0.00004	0.00007	0.00014	0.00325	0.00198	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CH_4	0.05	0.07	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	CO_2	20.22	25.97	5.00	0.20	5.00	0.00000	0.00004	0.00039	0.00001	0.00279	0.00001
1.A.4.c. Agriculture/forestry/fishing - Gaseous Fuels	N_2O	0.01	0.01	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CH_4	6.53	1.31	1.00	50.00	50.01	0.00000	0.00009	0.00002	0.00474	0.00003	0.00002
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	CO_2	1180.04	790.59	1.00	0.50	1.12	0.00013	0.00873	0.01200	0.00436	0.01698	0.00031
1.A.4.c. Agriculture/forestry/fishing - Liquid Fuels	N_2O	68.26	29.35	1.00	50.00	50.01	0.00037	0.00075	0.00045	0.03768	0.00063	0.00142
1.A.4.c. Agriculture/forestry/fishing - Other Fossil Fuels	CO_2	0.00	2.56	5.00	15.00	15.81	0.00000	0.00004	0.00004	0.00058	0.00028	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CH_4	4.58	0.06	1.00	50.00	50.01	0.00000	0.00008	0.00000	0.00398	0.00000	0.00002
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	CO_2	51.00	0.71	1.00	0.50	1.12	0.00000	0.00089	0.00001	0.00044	0.00002	0.00000
1.A.4.c. Agriculture/forestry/fishing - Solid Fuels	N_2O	0.22	0.00	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00019	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	CH_4	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Biomass	N_2O	0.00	0.00	5.00	50.00	50.25	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CH_4	0.04	0.02	1.00	50.00	50.01	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	CO_2	37.35	27.40	1.00	0.50	1.12	0.00000	0.00024	0.00042	0.00012	0.00059	0.00000
1.A.5. Other (not specified elsewhere) - Liquid Fuels	N_2O	0.96	0.50	1.00	50.00	50.01	0.00000	0.00001	0.00001	0.00047	0.00001	0.00000
1.A.5. Other (not specified elsewhere) - Other Fossil Fuels	CO_2	0.00	0.01	5.00	15.00	15.81	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

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		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
1.B.1.a. Coal mining and handling	CH_4	373.21	0.00	5.00	50.00	50.25	0.00000	0.00656	0.00000	0.32786	0.00000	0.10749
1.B.2.a. Oil	CH_4	92.12	42.61	0.50	50.00	50.00	0.00078	0.00097	0.00065	0.04858	0.00046	0.00236
1.B.2.a. Oil	CO_2	0.00	0.00	0.50	0.50	0.71	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.B.2.b. Natural gas	CH_4	374.71	290.43	20.00	40.00	44.72	0.02904	0.00217	0.00441	0.08697	0.12472	0.02312
1.B.2.b. Natural gas	CO_2	102.19	73.84	20.00	0.20	20.00	0.00038	0.00067	0.00112	0.00013	0.03171	0.00101
2.A.1. Cement production	CO_2	2033.41	1542.56	1.00	2.00	2.24	0.00205	0.01230	0.02342	0.02461	0.03312	0.00170
2.A.2. Lime production	CO_2	456.20	588.12	5.00	2.00	5.39	0.00173	0.00091	0.00893	0.00183	0.06314	0.00399
2.A.3. Glass production	CO_2	38.51	34.66	1.00	2.00	2.24	0.00000	0.00015	0.00053	0.00030	0.00074	0.00000
2.A.4.a. Ceramics	CO_2	116.48	47.75	1.00	2.00	2.24	0.00000	0.00132	0.00073	0.00264	0.00103	0.00001
2.A.4.b. Other uses of soda ash	CO_2	12.57	8.76	30.00	2.00	30.07	0.00001	0.00009	0.00013	0.00018	0.00564	0.00003
2.A.4.c. Non-metallurgical magnesium production	CO_2	481.23	339.15	2.00	2.00	2.83	0.00016	0.00331	0.00515	0.00661	0.01456	0.00026
2.B.1. Ammonia production	CH_4	1.74	2.17	2.00	10.00	10.20	0.00000	0.00000	0.00003	0.00002	0.00009	0.00000
2.B.1. Ammonia production	CO_2	467.34	446.65	2.00	5.00	5.39	0.00100	0.00143	0.00678	0.00715	0.01918	0.00042
2.B.10. Other	CH_4	9.39	8.71	2.00	2.00	2.83	0.00000	0.00003	0.00013	0.00007	0.00037	0.00000
2.B.10. Other	CO_2	138.56	110.16	2.00	2.00	2.83	0.00002	0.00076	0.00167	0.00152	0.00473	0.00002
2.B.2. Nitric acid production	N_2O	779.63	27.26	2.00	2.00	2.83	0.00000	0.01328	0.00041	0.02657	0.00117	0.00071
2.B.5. Carbide production	CO_2	37.78	32.59	1.00	5.00	5.10	0.00000	0.00017	0.00049	0.00084	0.00070	0.00000
2.B.8. Petrochemical and carbon black production	CH_4	29.40	42.00	20.00	10.00	22.36	0.00015	0.00012	0.00064	0.00121	0.01804	0.00033
2.C.1. Iron and steel production	CH_4	6.45	6.91	0.50	20.00	20.01	0.00000	0.00001	0.00010	0.00017	0.00007	0.00000
2.C.1. Iron and steel production	CO_2	6840.44	10187.63	0.50	0.50	0.71	0.00893	0.03445	0.15467	0.01722	0.10937	0.01226
2.C.2. Ferroalloys production	CO_2	20.81	16.32	5.00	25.00	25.50	0.00003	0.00012	0.00025	0.00295	0.00175	0.00001
2.C.3. Aluminium production	CO_2	150.26	4.61	20.00	5.00	20.62	0.00000	0.00257	0.00007	0.01285	0.00198	0.00017
2.C.3. Aluminium production	PFCs	1032.32	0.00	2.00	50.00	50.04	0.00000	0.01814	0.00000	0.90679	0.00000	0.82226
2.C.3. Aluminium production	SF_6	14.10	0.00	2.00	50.00	50.04	0.00000	0.00025	0.00000	0.01239	0.00000	0.00015
2.C.4. Magnesium production	SF_6	235.00	2.27	5.00	5.00	7.07	0.00000	0.00409	0.00003	0.02047	0.00024	0.00042
2.C.5. Lead production	CO_2	4.70	5.40	5.00	50.00	50.25	0.00001	0.00000	0.00008	0.00003	0.00058	0.00000

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
2.D. Non-energy products from fuels and solvent use	CO_2	348.94	161.96	20.00	30.00	36.06	0.00587	0.00367	0.00246	0.11016	0.06955	0.01697
2.E.1. Integrated circuit or semiconductor	HFCs	2.04	1.50	5.00	10.00	11.18	0.00000	0.00001	0.00002	0.00013	0.00016	0.00000
2.E.1. Integrated circuit or semiconductor	NF_3	0.00	17.84	5.00	10.00	11.18	0.00001	0.00027	0.00027	0.00271	0.00192	0.00001
2.E.1. Integrated circuit or semiconductor	PFCs	30.62	25.91	5.00	10.00	11.18	0.00001	0.00014	0.00039	0.00145	0.00278	0.00001
2.E.1. Integrated circuit or semiconductor	SF_6	100.39	13.16	5.00	10.00	11.18	0.00000	0.00156	0.00020	0.01564	0.00141	0.00025
2.F.1. Refrigeration and air-conditioning	HFCs	0.00	1350.37	10.00	50.00	50.99	0.81597	0.02050	0.02050	1.02510	0.28994	1.13490
2.F.1. Refrigeration and air-conditioning	PFCs	0.00	0.20	10.00	50.00	50.99	0.00000	0.00000	0.00000	0.00015	0.00004	0.00000
2.F.2. Foam blowing agents	HFCs	0.00	14.15	20.00	100.00	101.98	0.00036	0.00021	0.00021	0.02149	0.00608	0.00050
2.F.3. Fire protection	HFCs	0.00	11.24	10.00	20.00	22.36	0.00001	0.00017	0.00017	0.00341	0.00241	0.00002
2.F.4. Aerosols	HFCs	0.00	24.44	20.00	10.00	22.36	0.00005	0.00037	0.00037	0.00371	0.01049	0.00012
2.F.5. Solvents	HFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.G. Other product manufacture and use	CO_2	0.07	0.05	0.00	20.00	20.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
2.G. Other product manufacture and use	N_2O	117.27	41.07	0.00	20.00	20.00	0.00012	0.00144	0.00062	0.02874	0.00000	0.00083
2.G.1. Electrical equipment	SF_6	11.13	50.52	5.00	100.00	100.12	0.00440	0.00057	0.00077	0.05715	0.00542	0.00330
2.G.2. SF_6 and PFCs from other product use	SF_6	124.44	306.36	25.00	50.00	55.90	0.05048	0.00246	0.00465	0.12324	0.16445	0.04223
2.G.4 Other	HFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.G.4 Other	PFCs	0.00	0.00	0.00	0.00	0.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
3.A.1. Cattle	CH_4	4870.97	4023.56	1.00	20.00	20.02	1.11727	0.02448	0.06109	0.48962	0.08639	0.24719
3.A.2. Sheep	CH_4	82.00	104.87	10.00	20.00	22.36	0.00095	0.00015	0.00159	0.00303	0.02252	0.00052
3.A.3. Swine	CH_4	87.78	60.94	4.00	20.00	20.40	0.00027	0.00062	0.00093	0.01234	0.00523	0.00018
3.A.4. Other livestock	CH_4	41.21	102.78	10.00	20.00	22.36	0.00091	0.00084	0.00156	0.01673	0.02207	0.00077
3.B.1. Cattle	CH_4	482.20	664.85	1.00	20.00	20.02	0.03051	0.00162	0.01009	0.03243	0.01428	0.00126
3.B.1. Cattle	N_2O	403.52	253.03	1.00	100.00	100.00	0.11020	0.00325	0.00384	0.32482	0.00543	0.10554
3.B.2. Sheep	CH_4	2.15	2.46	10.00	30.00	31.62	0.00000	0.00000	0.00004	0.00001	0.00053	0.00000
3.B.2. Sheep	N_2O	8.03	9.34	10.00	100.00	100.50	0.00015	0.00000	0.00014	0.00006	0.00200	0.00000
3.B.3. Swine	CH_4	184.45	111.35	4.00	20.00	20.40	0.00089	0.00155	0.00169	0.03100	0.00956	0.00105

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
3.B.3. Swine	N_2O	110.65	56.61	4.00	100.00	100.08	0.00552	0.00108	0.00086	0.10846	0.00486	0.01179
3.B.4. Other livestock	CH_4	12.42	19.19	10.00	30.00	31.62	0.00006	0.00007	0.00029	0.00219	0.00412	0.00002
3.B.4. Other livestock	N_2O	11.44	26.03	10.00	100.00	100.50	0.00118	0.00019	0.00040	0.01941	0.00559	0.00041
3.B.5. Indirect N_2O emissions	N_2O	123.43	116.51	5.00	200.00	200.06	0.09351	0.00040	0.00177	0.07998	0.01251	0.00655
3.D.1. Direct N_2O emissions from managed soils	N_2O	1605.91	1402.09	5.00	200.00	200.06	13.54193	0.00693	0.02129	1.38562	0.15052	1.94259
3.D.2. Indirect N_2O emissions from managed soils	N_2O	467.48	375.87	5.00	200.00	200.06	0.97320	0.00251	0.00571	0.50144	0.04035	0.25307
3.F. Field burning of agricultural residues	CH_4	0.91	0.00	100.00	40.00	107.70	0.00000	0.00002	0.00000	0.00064	0.00000	0.00000
3.F. Field burning of agricultural residues	N_2O	0.22	0.00	100.00	50.00	111.80	0.00000	0.00000	0.00000	0.00020	0.00000	0.00000
3.G. Liming	CO_2	45.67	95.29	5.00	50.00	50.25	0.00395	0.00064	0.00145	0.03222	0.01023	0.00114
3.H. Urea application	CO_2	9.60	30.07	5.00	50.00	50.25	0.00039	0.00029	0.00046	0.01440	0.00323	0.00022
3.I. Other carbon-containing fertilizers	CO_2	30.66	22.15	5.00	50.00	50.25	0.00021	0.00020	0.00034	0.01012	0.00238	0.00011
4. Land use, land-use change and forestry	CH_4	37.47	37.33	0.00	41.95	41.95	0.00042	0.00009	0.00057	0.00384	0.00000	0.00001
4. Land use, land-use change and forestry	N_2O	180.20	169.36	0.00	89.26	89.26	0.03933	0.00060	0.00257	0.05311	0.00000	0.00282
4.A.1. Forest land remaining forest land	CO_2	-10623.78	6763.48	0.00	37.39	37.39	11.00620	0.28982	0.10269	10.83634	0.00000	117.42625
4.A.2. Land converted to forest land	CO_2	-2959.14	-1401.95	0.00	33.08	33.08	0.37005	0.03072	-0.02129	1.01617	0.00000	1.03260
4.B.1. Cropland remaining cropland	CO_2	201.17	256.25	0.00	50.68	50.68	0.02902	0.00036	0.00389	0.01804	0.00000	0.00033
4.B.2. Land converted to cropland	CO_2	173.39	172.48	0.00	38.64	38.64	0.00764	0.00043	0.00262	0.01653	0.00000	0.00027
4.C.1. Grassland remaining grassland	CO_2	371.06	371.06	0.00	27.92	27.92	0.01847	0.00089	0.00563	0.02474	0.00000	0.00061
4.C.2. Land converted to grassland	CO_2	421.02	221.64	0.00	47.02	47.02	0.01869	0.00403	0.00337	0.18959	0.00000	0.03595
4.D.1. Wetlands remaining wetlands	CO_2	20.63	20.63	0.00	24.49	24.49	0.00004	0.00005	0.00031	0.00121	0.00000	0.00000
4.D.2. Land converted to wetlands	CO_2	44.12	69.20	0.00	47.21	47.21	0.00184	0.00028	0.00105	0.01300	0.00000	0.00017
4.E.1. Settlements remaining settlements	CO_2	63.34	63.34	0.00	0.00	0.00	0.00000	0.00015	0.00096	0.00000	0.00000	0.00000
4.E.2. Land converted to settlements	CO_2	935.18	944.74	0.00	71.73	71.73	0.79046	0.00209	0.01434	0.14979	0.00000	0.02244
4.F.2. Land converted to other land	CO_2	501.55	520.29	0.00	67.93	67.93	0.21496	0.00091	0.00790	0.06203	0.00000	0.00385
4.G. Harvested wood products	CO_2	-3122.27	-677.87	0.00	49.01	49.01	0.18992	0.04459	-0.01029	2.18513	0.00000	4.77479
5.A. Solid waste disposal	CH_4	4081.16	799.44	12.00	25.00	27.73	0.08458	0.05953	0.01214	1.48837	0.20598	2.25766

IPCC Code and Category	GHG	Base year emissions or removals	Year x emissions or removals	Activity data uncertaint	Emission factor / estimation parameter uncertaint	Combined uncertainty	Contribution to variance by category in year x	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
		input data	input data	input data Note A	input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	I*F Note C	J*E*sqrt(2) Note D	K^2 + L^2
5.B. Biological treatment of solid waste	CH_4	14.57	76.83	20.00	50.00	53.85	0.00295	0.00091	0.00117	0.04553	0.03299	0.00316
5.B. Biological treatment of solid waste	N_2O	20.21	72.24	20.00	50.00	53.85	0.00260	0.00074	0.00110	0.03708	0.03102	0.00234
5.C. Incineration and open burning of waste	CH_4	0.62	0.16	0.00	7.00	7.00	0.00000	0.00001	0.00000	0.00006	0.00000	0.00000
5.C. Incineration and open burning of waste	CO_2	27.92	2.05	7.00	20.00	21.19	0.00000	0.00046	0.00003	0.00919	0.00031	0.00008
5.C. Incineration and open burning of waste	N_2O	0.17	0.02	0.00	7.00	7.00	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
5.D. Wastewater treatment and discharge	CH_4	334.11	189.80	5.00	16.00	16.76	0.00174	0.00299	0.00288	0.04782	0.02038	0.00270
5.D. Wastewater treatment and discharge	N_2O	85.80	154.60	5.00	100.00	100.12	0.04124	0.00084	0.00235	0.08398	0.01660	0.00733
Total		**65865.20**	**76225.91**				**30.53**					**131.82**
Total Uncertainties						**Uncertainty in total inventory %:**	**5.53**				**Trend uncertainty %:**	**11.48**

ANNEX 3: DETAILED DESCRIPTION OF THE REFERENCE APPROACH, INCLUDING NATIONAL ENERGY BALANCE

Annex 3.1 – CRT 1.A Fuel Combustion

This Annex includes detailed information about category *1.A Fuel Combustion* (trend information by sub-category), a description of the national energy balance (including fuel and fuel categories) and a description of the methodology applied to extract activity data from the energy balance for the calculation of emissions for category *1.A Fuel Combustion* (e.g. correspondence of categories of the energy balance to IPCC categories). Activity data used for estimating emissions in the sectoral approach as taken from the energy balance is also presented.

Furthermore, the revision of the national energy balance as well as the implication of this revision on activity data are described.

1.A.1.a – Biomass – implied emission factors for CO_2. N_2O and CH_4

Following a recommendation of the UNFCCC 2023 review, the fluctuations in the trend of 1.A.1.a biomass CO_2, CH_4 and N_2O implied emission factors are explained.

The following table shows fuel consumption and of solid biomass and biogas of category 1.A.1.a and the calculated implied emission factors which are consistent with CRT Table1.A(a)s1.

CO_2, CH_4 and N_2O emission factors for the year 2005 are lower than for 2004 because biogas consumption increases, which has lower emission factors than solid biomass. Emissions factors are provided in the NID chapter for category 1.A.1.a.

Table A 20: 1.A.1.a - Biomass - implied emission factors for CO_2. N_2O and CH_4

	Fuel consumption (TJ)			**CH_4 IEF**	**CH_4 emissions**			**N_2O IEF**	**N_2O emissions**			**CO_2 IEF**	**CO_2 emissions**		
	Total	Solid	Biogas		Total	Solid	Biogas		Total	Solid	Biogas		Total	Solid	Biogas
1990	2 785	2 785	0	10.97	0.031	0.031	0.000	4.00	0.011	0.011	0.000	110.6	308	308	0
1995	3 962	3 962	0	10.80	0.043	0.043	0.000	4.00	0.016	0.016	0.000	110.8	439	439	0
2000	4 672	4 672	0	10.80	0.050	0.050	0.000	4.00	0.019	0.019	0.000	110.8	518	518	0
2001	4 923	4 923	0	10.82	0.053	0.053	0.000	4.00	0.020	0.020	0.000	110.7	545	545	0
2002	5 226	5 226	0	10.78	0.056	0.056	0.000	4.00	0.021	0.021	0.000	110.8	579	579	0
2003	5 897	5 858	39	10.65	0.063	0.063	0.000	3.97	0.023	0.023	0.000	110.5	652	650	2
2004	8 405	8 343	62	10.53	0.088	0.088	0.000	3.97	0.033	0.033	0.000	110.6	930	927	3
2005	8 494	8 411	83	10.52	0.089	0.089	0.000	3.96	0.034	0.034	0.000	110.5	939	934	5
2006	9 101	9 019	82	10.48	0.095	0.095	0.000	3.96	0.036	0.036	0.000	110.6	1 007	1 002	4
2007	8 738	8 720	18	10.57	0.092	0.092	0.000	3.99	0.035	0.035	0.000	111.0	970	969	1
2008	10 272	10 174	98	10.40	0.107	0.107	0.000	3.96	0.041	0.041	0.000	110.7	1 137	1 132	5
2009	13 311	13 202	109	10.36	0.138	0.138	0.000	3.97	0.053	0.053	0.000	111.0	1 477	1 471	6
2010	15 480	15 381	99	10.30	0.159	0.159	0.000	3.97	0.062	0.062	0.000	111.1	1 720	1 714	5
2011	16 823	16 533	290	10.23	0.172	0.172	0.000	3.93	0.066	0.066	0.000	110.4	1 858	1 842	16
2012	19 359	19 109	250	10.37	0.201	0.201	0.000	3.95	0.076	0.076	0.000	110.5	2 140	2 126	14
2013	24 679	21 100	3 578	9.09	0.224	0.221	0.004	3.43	0.085	0.084	0.000	103.1	2 544	2 349	195
2014	35 018	29 535	5 484	8.93	0.313	0.307	0.005	3.39	0.119	0.118	0.001	102.5	3 589	3 289	299
2015	42 365	36 551	5 814	9.03	0.383	0.377	0.006	3.46	0.147	0.146	0.001	103.7	4 393	4 076	317
2016	49 483	43 378	6 105	9.13	0.452	0.446	0.006	3.52	0.174	0.174	0.001	104.5	5 173	4 840	333
2017	53 410	48 073	5 337	9.37	0.500	0.495	0.005	3.61	0.193	0.192	0.001	105.8	5 653	5 362	291
2018	62 196	56 984	5 212	9.49	0.590	0.585	0.005	3.67	0.228	0.228	0.001	106.8	6 643	6 359	285
2019	63 089	57 601	5 489	9.48	0.598	0.593	0.005	3.66	0.231	0.230	0.001	106.6	6 726	6 426	300
2020	67 466	60 827	6 640	9.37	0.632	0.625	0.007	3.62	0.244	0.243	0.001	106.0	7 150	6 787	363
2021	66 157	60 091	6 066	9.43	0.624	0.618	0.006	3.64	0.241	0.240	0.001	106.3	7 036	6 704	331
2022	66 981	57 139	9 842	8.96	0.600	0.591	0.010	3.43	0.230	0.229	0.001	103.1	6 907	6 370	537
2023	70 625	60 475	10 150	9.00	0.636	0.625	0.010	3.44	0.243	0.242	0.001	103.3	7 296	6 741	554

Trend information by sub category

1.A.1.a Public Electricity and Heat Production

Table A 21: Greenhouse gas emissions from Category 1.A.1.a

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	11 056	0.24	0.13	11 098
1995	9 812	0.27	0.12	9 852
2000	9 768	0.30	0.14	9 814
2005	12 726	0.50	0.22	12 798
2010	10 661	0.88	0.35	10 778
2011	10 248	0.89	0.36	10 368
2012	8 805	0.90	0.36	8 925
2013	7 804	0.87	0.35	7 922
2014	6 309	0.84	0.33	6 419
2015	7 299	0.90	0.34	7 415
2016	7 109	0.90	0.33	7 221
2017	7 784	0.92	0.33	7 898
2018	6 872	0.88	0.32	6 982
2019	6 947	0.86	0.31	7 054
2020	5 661	0.87	0.31	5 768
2021	5 642	0.90	0.32	5 751
2022	5 595	0.89	0.31	5 703
2023	4 447	0.86	0.30	4 552
Trend 1990–2023	**-59.8%**	**256.4%**	**128.6%**	**-59.0%**

Solid fossil fuels and natural gas are dominant compared to other fuel types. Since 2007 liquid fossil fuels became less important. The share in CO_2 emissions from waste incineration in district heating plants which are reported as 'other fuels' increased from 3% in 1990 to 18% in 2020. Solid fuels 2020 decreased due to the phase-out of coal-fired power generation.

Table A 22: Share of fuel types on total CO_2 emissions from Category 1.A.1.a

	Liquid	Solid	Gaseous	Other
1990	11%	57%	30%	3%
1995	16%	46%	35%	3%
2000	12%	49%	36%	3%
2005	9%	46%	41%	4%
2010	6%	36%	49%	8%
2011	4%	41%	45%	9%
2012	3%	39%	47%	11%
2013	2%	42%	43%	13%
2014	2%	37%	44%	17%
2015	3%	32%	50%	15%
2016	5%	22%	56%	16%
2017	3%	17%	66%	14%
2018	1%	20%	64%	15%
2019	1%	17%	68%	15%
2020	1%	6%	75%	18%
2021	2%	0%	79%	19%
2022	4%	0%	77%	18%
2023	3%	0%	72%	25%

1.A.1.b Petroleum Refining

Table A 23: Greenhouse gas emissions from Category 1.A.1.b.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	2 394	0.05	0.01	2 398
1995	2 590	0.06	0.01	2 594
2000	2 214	0.06	0.01	2 218
2005	2 827	0.08	0.01	2 833
2010	2 724	0.07	0.01	2 730
2011	2 768	0.07	0.01	2 774
2012	2 836	0.08	0.01	2 842
2013	2 827	0.08	0.02	2 833
2014	2 713	0.08	0.01	2 719
2015	2 804	0.09	0.02	2 811
2016	2 784	0.09	0.02	2 791
2017	2 739	0.08	0.01	2 745
2018	2 824	0.08	0.02	2 831
2019	2 791	0.08	0.01	2 797
2020	2 732	0.08	0.01	2 738
2021	2 750	0.08	0.01	2 755
2022	2 255	0.06	0.01	2 259
2023	2 580	0.07	0.01	2 585
Trend 1990–2023	**7.7%**	**28.2%**	**43.6%**	**7.8%**

Table A 24 presents the share of CO_2 emissions on the different fuel types.

Table A 24: Share of fuel types on total CO_2 emissions from Category 1.A.1.b.

	Liquid	Gaseous
1990	82%	18%
1995	84%	16%
2000	84%	16%
2005	82%	18%
2010	82%	18%
2011	82%	18%
2012	85%	15%
2013	87%	13%
2014	88%	12%
2015	88%	12%
2016	88%	12%
2017	86%	14%
2018	83%	17%
2019	82%	18%
2020	82%	18%
2021	81%	19%
2022	87%	13%
2023	87%	13%

1.A.1.c Manufacture of Solid Fuels and Other Energy Industries

Table A 25: Greenhouse gas emissions from Category 1.A.1.c.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	510	0.04	0.0010	511
1995	611	0.04	0.0011	613
2000	281	0.04	0.0005	282
2005	392	0.04	0.0007	394

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
2010	238	0.04	0.0004	239
2011	211	0.04	0.0004	212
2012	205	0.05	0.0004	207
2013	217	0.04	0.0004	218
2014	214	0.04	0.0004	216
2015	231	0.05	0.0004	232
2016	226	0.05	0.0004	227
2017	208	0.04	0.0004	209
2018	188	0.04	0.0003	189
2019	183	0.04	0.0003	184
2020	160	0.04	0.0003	161
2021	178	0.04	0.0003	180
2022	210	0.04	0.0004	211
2023	155	0.03	0.0003	156
Trend 1990–2023	**-69.7%**	**-17.5%**	**-70.7%**	**-69.6%**

Almost all emissions of category 1.A.1.c originate from natural gas combustion.

Table A 26: Share of fuel types on total CO_2 emissions from Category 1.A.1.c.

	Liquid	Gaseous
1990	1%	99%
1995	0%	100%
2000	NO	100%
2005	NO	100%
2010	NO	100%
2011	NO	100%
2012	NO	100%
2013	NO	100%
2014	NO	100%
2015	NO	100%
2016	NO	100%
2017	NO	100%
2018	NO	100%
2019	NO	100%
2020	NO	100%
2021	NO	100%
2022	NO	100%
2023	NO	100%

1.A.2.a Iron and Steel

Table A 27: Greenhouse gas emissions from Category 1.A.2.a.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	1 833	0.03	0.003	1 834
1995	1 338	0.02	0.003	1 339
2000	1 275	0.02	0.003	1 277
2005	1 845	0.03	0.003	1 846
2010	1 275	0.02	0.003	1 277
2011	1 446	0.03	0.003	1 447
2012	1 483	0.03	0.003	1 485
2013	1 606	0.03	0.003	1 608
2014	1 496	0.03	0.003	1 497
2015	1 406	0.02	0.002	1 407
2016	1 577	0.03	0.003	1 578
2017	1 658	0.03	0.003	1 660

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
2018	1 771	0.03	0.003	1 773
2019	1 805	0.03	0.003	1 806
2020	1 803	0.03	0.003	1 805
2021	1 793	0.03	0.003	1 794
2022	1 773	0.03	0.003	1 775
2023	1 715	0.03	0.003	1 717
Trend 1990–2023	**-6.4%**	**1.7%**	**-3.8%**	**-6.4%**

CO_2 emissions from category *1.A.2.a (without blast furnaces)* mainly arise from gaseous fuels.

Table A 28: Share of fuel types in total CO_2 emissions from Category 1.A.2.a.

	Liquid	Solid	Gaseous
1990	4.2%	60.4%	35.5%
1995	6.2%	37.1%	56.6%
2000	5.8%	14.1%	80.1%
2005	3.2%	37.7%	59.1%
2010	2.5%	11.2%	86.4%
2011	1.9%	12.4%	85.8%
2012	1.3%	13.0%	85.7%
2013	0.5%	17.4%	82.1%
2014	0.4%	9.8%	89.8%
2015	0.4%	20.2%	79.4%
2016	0.5%	31.7%	67.8%
2017	0.4%	33.2%	66.4%
2018	0.4%	33.1%	66.5%
2019	0.3%	36.2%	63.5%
2020	0.4%	39.7%	60.0%
2021	1.1%	42.4%	56.5%
2022	1.0%	39.9%	59.0%
2023	0.5%	36.8%	62.7%

1.A.2.b Non-Ferrous Metals

Table A 29: Greenhouse gas emissions from Category 1.A.2.b.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	132	0.004	0.001	132
1995	255	0.006	0.001	255
2000	193	0.006	0.001	193
2005	218	0.005	0.001	218
2010	236	0.005	0.001	236
2011	248	0.005	0.001	249
2012	241	0.005	0.001	241
2013	271	0.012	0.003	272
2014	289	0.008	0.001	289
2015	295	0.007	0.001	296
2016	305	0.007	0.001	305
2017	297	0.007	0.001	297
2018	325	0.007	0.001	325
2019	301	0.007	0.001	301
2020	268	0.006	0.001	268
2021	295	0.006	0.001	295
2022	309	0.007	0.001	309
2023	282	0.007	0.001	282
Trend 1990–2023	**113.8%**	**52.1%**	**48.7%**	**113.7%**

CO_2 emissions from category *1.A.2.b* mainly arise from gaseous fuels.

Table A 30: Share of fuel types in total CO_2 emissions from Category 1.A.2.b

	Liquid	Solid	Gaseous	Other
1990	27%	17%	57%	0.0%
1995	16%	4%	80%	0.0%
2000	24%	9%	66%	0.0%
2005	15%	6%	79%	0.0%
2010	8%	3%	89%	0.0%
2011	9%	3%	88%	0.0%
2012	9%	3%	89%	0.0%
2013	13%	5%	81%	0.4%
2014	11%	6%	83%	0.3%
2015	10%	5%	85%	0.4%
2016	7%	5%	88%	0.4%
2017	6%	4%	90%	0.4%
2018	2%	3%	95%	0.2%
2019	3%	4%	93%	0.4%
2020	3%	5%	92%	0.3%
2021	3%	2%	95%	0.1%
2022	3%	4%	93%	0.2%
2023	3%	4%	92%	0.2%

1.A.2.c Chemicals

Table A 31: Greenhouse gas emissions from Category 1.A.2.c.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	847	0.07	0.02	855
1995	986	0.07	0.02	993
2000	1 341	0.11	0.03	1 352
2005	1 348	0.07	0.02	1 355
2010	1 547	0.11	0.03	1 559
2011	1 487	0.10	0.03	1 498
2012	1 486	0.11	0.03	1 497
2013	1 384	0.09	0.03	1 394
2014	1 418	0.10	0.03	1 427
2015	1 394	0.09	0.02	1 403
2016	1 550	0.10	0.03	1 559
2017	1 627	0.10	0.03	1 637
2018	1 471	0.10	0.03	1 481
2019	1 462	0.09	0.03	1 472
2020	1 493	0.10	0.03	1 503
2021	1 543	0.09	0.03	1 552
2022	1 431	0.11	0.03	1 443
2023	1 298	0.10	0.03	1 309
Trend 1990–2023	**53.3%**	**35.5%**	**40.4%**	**53.2%**

In 2023, natural gas was still the main source of CO_2 emissions from category *1.A.2.c* while CO_2 emissions from solid and liquid fossil fuel combustion got less important.

Table A 32: Share of fuel types in total CO_2 emissions from Category 1.A.2.c

	Liquid	Solid	Gaseous	Other
1990	11%	13%	61%	15%
1995	10%	15%	58%	16%
2000	5%	19%	65%	11%
2005	5%	11%	76%	8%
2010	9%	5%	66%	20%
2011	8%	5%	68%	19%
2012	7%	5%	69%	19%
2013	6%	6%	72%	16%
2014	4%	9%	71%	16%
2015	4%	7%	73%	16%
2016	4%	7%	73%	16%
2017	3%	13%	70%	14%
2018	3%	8%	75%	14%
2019	3%	4%	81%	12%
2020	5%	3%	76%	16%
2021	2%	2%	81%	15%
2022	3%	4%	72%	22%
2023	3%	2%	74%	21%

1.A.2.d Pulp, Paper and Print

Table A 33: Greenhouse gas emissions from Category 1.A.2.d.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv.[kt]
1990	2 208	0.20	0.07	2 233
1995	2 301	0.25	0.10	2 334
2000	2 379	0.20	0.08	2 405
2005	2 293	0.26	0.10	2 327
2010	2 312	0.23	0.09	2 343
2011	2 264	0.23	0.09	2 295
2012	2 023	0.23	0.10	2 055
2013	1 899	0.23	0.10	1 931
2014	1 741	0.22	0.09	1 772
2015	1 829	0.22	0.09	1 859
2016	1 774	0.22	0.09	1 805
2017	1 776	0.22	0.09	1 807
2018	1 883	0.23	0.10	1 915
2019	1 970	0.24	0.10	2 004
2020	1 800	0.22	0.09	1 831
2021	1 833	0.21	0.09	1 863
2022	1 541	0.22	0.10	1 574
2023	1 208	0.22	0.11	1 242
Trend 1990–2023	**-45.3%**	**12.3%**	**47.2%**	**-44.4%**

Natural gas combustion is the main source of CO_2 emissions from category *1.A.2.d*. liquid fuel consumption decreased since 1990 whereas the share of solid fuels in total CO_2 emissions is rather constant.

Table A 34: Share of fuel types in total CO_2 emissions from Category 1.A.2.d.

	Liquid	Solid	Gaseous	Other
1990	39%	18%	43%	1%
1995	23%	17%	59%	2%
2000	7%	19%	74%	0%
2005	6%	19%	75%	0%

	Liquid	Solid	Gaseous	Other
2010	3%	14%	82%	0%
2011	2%	16%	82%	0%
2012	2%	17%	81%	0%
2013	3%	19%	76%	1%
2014	2%	21%	76%	1%
2015	2%	21%	75%	1%
2016	2%	21%	77%	1%
2017	1%	22%	76%	1%
2018	1%	20%	78%	1%
2019	1%	19%	80%	0%
2020	1%	17%	82%	1%
2021	1%	11%	88%	0%
2022	2%	8%	90%	0%
2023	3%	4%	91%	2%

1.A.2.e Food Processing, Beverages and Tobacco

Table A 35: Greenhouse gas emissions from Category 1.A.2.e.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	870	0.03	0.004	872
1995	931	0.03	0.004	933
2000	882	0.02	0.004	884
2005	960	0.03	0.005	962
2010	966	0.03	0.005	968
2011	962	0.03	0.005	964
2012	942	0.03	0.005	944
2013	827	0.02	0.003	828
2014	922	0.02	0.003	924
2015	980	0.02	0.003	981
2016	816	0.02	0.003	817
2017	803	0.02	0.003	804
2018	769	0.02	0.003	771
2019	759	0.02	0.003	761
2020	790	0.02	0.003	791
2021	804	0.02	0.002	806
2022	911	0.02	0.004	912
2023	800	0.03	0.004	802
Trend 1990–2023	**-8.1%**	**3.9%**	**4.7%**	**-8.0%**

The share of natural gas consumption is increasing and is the main source of CO_2 emissions from category *1.A.2.e*. The share of liquid fossil fuel in total CO_2 emissions strongly decreased since 1990.

Table A 36: Share of fuel types in total CO_2 emissions from Category 1.A.2.e.

	Liquid	Solid	Gaseous	Other
1990	40%	2%	58%	0.00%
1995	37%	1%	63%	0.00%
2000	19%	2%	79%	0.00%
2005	25%	1%	73%	0.00%
2010	21%	2%	78%	0.03%
2011	21%	2%	78%	0.03%
2012	17%	2%	82%	0.03%
2013	9%	2%	89%	0.01%
2014	9%	2%	88%	0.00%
2015	7%	2%	91%	0.00%

	Liquid	Solid	Gaseous	Other
2016	7%	2%	91%	0.00%
2017	6%	2%	92%	0.00%
2018	5%	2%	94%	0.05%
2019	5%	2%	94%	0.00%
2020	4%	2%	95%	0.01%
2021	4%	2%	94%	0.00%
2022	10%	2%	88%	0.00%
2023	18%	2%	79%	0.00%

1.A.2.f Non-Metallic Minerals

Table A 37: Greenhouse gas emissions from Category 1.A.2.f.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	1 669	0.10	0.02	1 677
1995	1 520	0.09	0.02	1 528
2000	1 540	0.11	0.02	1 550
2005	1 656	0.14	0.04	1 669
2010	1 528	0.14	0.04	1 542
2011	1 546	0.14	0.04	1 560
2012	1 530	0.15	0.04	1 545
2013	1 552	0.15	0.04	1 567
2014	1 613	0.16	0.05	1 630
2015	1 605	0.17	0.05	1 623
2016	1 631	0.16	0.05	1 648
2017	1 636	0.17	0.05	1 654
2018	1 694	0.18	0.05	1 713
2019	1 664	0.17	0.05	1 682
2020	1 654	0.17	0.05	1 672
2021	1 682	0.18	0.05	1 701
2022	1 579	0.17	0.05	1 598
2023	1 378	0.15	0.05	1 395
Trend 1990–2023	**-17.4%**	**49.9%**	**159.7%**	**-16.8%**

Natural gas and other fossil fuel (Industrial waste) combustion is the main source of CO_2 emissions from category *1.A.2.f*. The share of other fossil fuel increased while liquid and solid fuels decreased.

Table A 38: Share of fuel types in total CO_2 emissions from category 1.A.2.f

	Liquid	Solid	Gaseous	Other
1990	30%	32%	33%	4%
1995	23%	29%	40%	8%
2000	13%	33%	42%	13%
2005	18%	23%	40%	20%
2010	13%	20%	39%	27%
2011	13%	18%	40%	29%
2012	11%	19%	38%	32%
2013	11%	17%	41%	32%
2014	10%	17%	39%	34%
2015	10%	17%	39%	35%
2016	10%	14%	40%	37%
2017	8%	13%	41%	38%
2018	8%	14%	40%	39%
2019	6%	14%	42%	37%
2020	5%	19%	42%	34%
2021	9%	15%	40%	37%

	Liquid	Solid	Gaseous	Other
2022	10%	13%	38%	39%
2023	14%	9%	37%	40%

1.A.2.g.7 Manufacturing Industries and Construction – Mobile sources

Table A 39: Greenhouse gas emissions from Category 1.A.2.g.7.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	256	0.01	0.09	280
1995	358	0.02	0.13	393
2000	551	0.02	0.22	610
2005	810	0.02	0.23	873
2010	1 077	0.01	0.19	1 129
2011	1 082	0.01	0.19	1 132
2012	1 119	0.01	0.18	1 167
2013	1 128	0.01	0.17	1 174
2014	1 102	0.01	0.16	1 146
2015	1 068	0.01	0.15	1 109
2016	1 103	0.01	0.15	1 143
2017	1 184	0.01	0.15	1 224
2018	1 262	0.01	0.15	1 303
2019	1 334	0.01	0.16	1 375
2020	1 276	0.005	0.14	1 314
2021	1 371	0.005	0.15	1 412
2022	1 413	0.005	0.16	1 454
2023	1 379	0.004	0.15	1 420
Trend 1990–2023	**439.2%**	**-66.3%**	**68.0%**	**406.9%**

All emissions from mobile machinery of industry arise from liquid fuels (diesel, gasoline) and biofuels.

1.A.2.g.8 Manufacturing Industries and Construction – Other – stationary sources

Table A 40: Greenhouse gas emissions from Category 1.A.2.g.8.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	1 719	0.09	0.02	1 727
1995	2 282	0.10	0.02	2 290
2000	1 738	0.15	0.04	1 753
2005	2 083	0.26	0.08	2 112
2010	2 099	0.31	0.10	2 136
2011	1 967	0.33	0.11	2 006
2012	2 045	0.34	0.12	2 087
2013	1 954	0.31	0.11	1 992
2014	1 651	0.29	0.11	1 688
2015	1 534	0.29	0.11	1 570
2016	1 695	0.26	0.09	1 727
2017	1 700	0.26	0.09	1 732
2018	1 617	0.23	0.08	1 645
2019	1 567	0.21	0.07	1 592
2020	1 546	0.23	0.08	1 574
2021	1 721	0.23	0.08	1 750
2022	1 644	0.25	0.09	1 675
2023	1 438	0.22	0.08	1 466
Trend 1990-2023	**-16.3%**	**142.3%**	**292.6%**	**-15.1%**

Natural gas and liquid fossil fuel combustion is the main source of CO_2 emissions from category *1.A.2.g.8*.

Table A 41: Share of fuel types on total CO_2 emissions from Category 1.A.2.g.8

	Liquid	Solid	Gaseous	Other
1990	36%	5%	59%	0%
1995	35%	1%	62%	2%
2000	35%	2%	62%	2%
2005	34%	2%	62%	2%
2010	24%	0%	74%	2%
2011	27%	0%	71%	2%
2012	28%	0%	70%	2%
2013	16%	0%	83%	2%
2014	16%	0%	82%	1%
2015	17%	0%	81%	2%
2016	15%	0%	83%	2%
2017	13%	0%	85%	2%
2018	10%	0%	88%	2%
2019	13%	0%	85%	2%
2020	10%	0%	88%	2%
2021	9%	0%	89%	2%
2022	6%	0%	92%	2%
2023	9%	0%	88%	2%

1.A.3.e.i Other Transportation – Pipeline Compressors

Table A 42: Greenhouse gas emissions from Category 1.A.3.e.i

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	224	0.004	0.0004	225
1995	227	0.004	0.0004	227
2000	338	0.006	0.0006	338
2005	359	0.006	0.0006	359
2010	459	0.008	0.0008	459
2011	568	0.010	0.0010	569
2012	458	0.008	0.0008	458
2013	607	0.011	0.0011	607
2014	505	0.009	0.0009	505
2015	585	0.011	0.0011	586
2016	561	0.010	0.0010	562
2017	634	0.011	0.0011	635
2018	587	0.011	0.0011	588
2019	547	0.010	0.0010	548
2020	475	0.009	0.0009	476
2021	378	0.007	0.0007	378
2022	152	0.003	0.0003	152
2023	24	0.000	0.0000	24
Trend 1990–2023	**-89.2%**	**-89.2%**	**-89.2%**	**-89.2%**

All emissions from pipeline compressors arise from gaseous fuels.

1.A.4 Other sectors

Table A 43: Greenhouse gas emissions from Category 1.A.4.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	13 543	20.49	0.64	14 287
1995	13 976	17.98	0.65	14 652

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
2000	13 005	14.27	0.67	13 582
2005	13 371	12.14	0.65	13 883
2010	10 700	13.05	0.62	11 231
2011	9 519	11.86	0.60	10 011
2012	9 051	12.32	0.58	9 551
2013	9 305	12.56	0.58	9 810
2014	8 369	10.98	0.54	8 819
2015	8 705	11.26	0.54	9 162
2016	9 007	11.47	0.54	9 472
2017	9 107	11.63	0.53	9 573
2018	8 385	10.57	0.49	8 812
2019	8 644	10.52	0.50	9 071
2020	8 642	10.41	0.50	9 065
2021	9 285	12.15	0.56	9 773
2022	7 879	10.14	0.49	8 292
2023	6 854	9.74	0.47	7 250
Trend 1990–2023	**-49.4%**	**-52.5%**	**-27.7%**	**-49.3%**

As can be seen from Table A 44 liquid fossil fuels are the main source of CO_2 emissions from category *1.A.4* with a quite constant share over time series. Since 1990 solid fossil fuels became less important whereas the share of CO_2 emissions from natural gas combustion more than doubled.

Table A 44: Share of fuel types on total CO_2 emissions from Category 1.A.4.

	Liquid	Solid	Gaseous	Other
1990	61%	20%	19%	1%
1995	58%	13%	29%	0%
2000	61%	7%	31%	0%
2005	59%	3%	37%	1%
2010	54%	3%	43%	0%
2011	55%	2%	43%	0%
2012	52%	2%	47%	0%
2013	52%	1%	46%	0%
2014	54%	1%	45%	0%
2015	53%	1%	46%	0%
2016	51%	1%	48%	0%
2017	52%	1%	47%	0%
2018	51%	1%	48%	0%
2019	50%	1%	49%	0%
2020	50%	1%	49%	0%
2021	50%	0%	50%	0%
2022	52%	0%	48%	0%
2023	48%	0%	52%	0%

1.A.4 Other sectors – stationary sources

Table A 45: Greenhouse gas emissions from Category 1.A.4 Other sectors – stationary sources.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	12 601	19.88	0.37	13 254
1995	13 054	17.43	0.37	13 534
2000	12 054	13.80	0.35	12 453
2005	12 373	11.75	0.34	12 726
2010	9 799	12.83	0.39	10 190
2011	8 556	11.66	0.37	8 915
2012	8 157	12.15	0.38	8 529
2013	8 434	12.41	0.39	8 816
2014	7 426	10.83	0.34	7 760

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
2015	7 831	11.12	0.36	8 178
2016	8 074	11.34	0.37	8 427
2017	8 232	11.51	0.38	8 591
2018	7 507	10.45	0.35	7 835
2019	7 726	10.41	0.36	8 055
2020	7 717	10.30	0.36	8 043
2021	8 382	12.05	0.43	8 767
2022	6 983	10.04	0.36	7 306
2023	5 969	9.63	0.34	6 277
Trend 1990–2023	**-52.6%**	**-51.6%**	**-6.9%**	**-52.6%**

Liquid fossil fuels are the main stationary source of CO_2 emissions from category *1.A.4* until 2011 with a quite constant share over time. Since 1990 solid fossil fuels became less important whereas the share of CO_2 emissions from natural gas combustion more than doubled.

Table A 46: Share of fuel types in total CO_2 emissions from Category 1.A.4 stationary sources.

	Liquid	Solid	Gaseous	Other
1990	58%	21%	20%	0.7%
1995	55%	13%	31%	0.3%
2000	58%	8%	34%	0.3%
2005	56%	4%	40%	0.7%
2010	50%	3%	47%	0.1%
2011	50%	2%	48%	0.1%
2012	46%	2%	52%	0.0%
2013	48%	2%	51%	0.1%
2014	48%	1%	50%	0.1%
2015	47%	1%	51%	0.1%
2016	45%	1%	53%	0.1%
2017	47%	1%	52%	0.1%
2018	45%	1%	54%	0.1%
2019	44%	1%	55%	0.1%
2020	44%	1%	55%	0.0%
2021	44%	0%	55%	0.0%
2022	45%	0%	54%	0.0%
2023	40%	0%	60%	0.1%

1.A.4.a.1 Commercial/Institutional – stationary sources

Table A 47: Greenhouse gas emissions from Category 1.A.4.a.1 Commercial/Institutional- stationary sources.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	2 292	0.53	0.03	2 313
1995	3 038	0.51	0.02	3 059
2000	2 797	0.43	0.03	2 817
2005	3 418	0.40	0.03	3 437
2010	1 660	0.34	0.02	1 675
2011	1 487	0.28	0.02	1 499
2012	1 361	0.23	0.01	1 371
2013	1 387	0.23	0.01	1 398
2014	1 247	0.18	0.01	1 255
2015	1 289	0.22	0.01	1 299
2016	1 224	0.19	0.01	1 232
2017	1 420	0.23	0.02	1 431
2018	1 362	0.24	0.02	1 374
2019	1 368	0.24	0.02	1 380

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
2020	1 290	0.23	0.02	1 301
2021	1 551	0.26	0.02	1 564
2022	1 215	0.21	0.02	1 226
2023	1 010	0.16	0.01	1 017
Trend 1990–2023	**-55.9%**	**-69.8%**	**-56.6%**	**-56.0%**

1.A.4.b.1 Residential – stationary sources

Table A 48: Greenhouse gas emissions from Category 1.A.4.b.1 Residential – stationary sources.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	9 827	17.93	0.32	10 414
1995	9 776	15.42	0.33	10 294
2000	8 999	11.80	0.30	9 409
2005	8 791	9.57	0.28	9 134
2010	8 049	10.56	0.34	8 436
2011	6 996	9.53	0.32	7 348
2012	6 736	9.92	0.34	7 102
2013	6 977	9.98	0.35	7 349
2014	6 105	8.62	0.30	6 427
2015	6 469	8.83	0.32	6 801
2016	6 763	9.03	0.33	7 103
2017	6 734	9.05	0.33	7 075
2018	6 075	8.20	0.30	6 385
2019	6 285	8.29	0.31	6 600
2020	6 364	8.18	0.31	6 676
2021	6 764	9.55	0.37	7 130
2022	5 711	7.72	0.32	6 010
2023	4 924	7.42	0.30	5 212
Trend 1990–2023	**-49.9%**	**-58.6%**	**-5.7%**	**-50.0%**

1.A.4.c.1 Agriculture/Forestry/Fisheries – stationary sources

The following table presents greenhouse gas emissions from 1.A.4.c.1 Agriculture/ Forestry/ Fisheries – stationary sources.

Table A 49: Greenhouse gas emissions from Category 1.A.4.c.1 Agriculture/Forestry/Fisheries – stationary sources.

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
1990	482	1.42	0.02	527
1995	240	1.49	0.02	287
2000	258	1.57	0.02	308
2005	165	1.78	0.02	221
2010	91	1.94	0.03	152
2011	74	1.86	0.02	133
2012	60	2.01	0.03	124
2013	70	2.20	0.03	139
2014	75	2.03	0.03	138
2015	73	2.08	0.03	139
2016	88	2.13	0.03	155
2017	78	2.23	0.03	148
2018	69	2.02	0.03	133
2019	73	1.87	0.02	132
2020	63	1.89	0.03	123
2021	67	2.23	0.03	138

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 equiv. [kt]
2022	57	2.11	0.03	124
2023	36	2.05	0.03	100
Trend 1990–2023	**-92.6%**	**44.2%**	**36.3%**	**-81.0%**

Activity Data Recalculations

Updates of activity data and NCVs follow the updates of the IEA-compliant energy balance compiled by the federal statistics authority Statistik Austria.

Table A 50: 1.A activity data recalculations by sub categories with respect to previous submission.

	Fuel Consumption [PJ]								
	1990			2020			2022		
IPCC Category / Fuel Group	**Subm. 2025**	**Subm. 2024**	**Differen-ce**	**Subm. 2025**	**Subm. 2024**	**Differen-ce**	**Subm. 2025**	**Subm. 2024**	**Differen-ce**
1 A FUEL COMBUSTION ACTIVITIES	790.39	790.39	-	958.95	948.83	10.12	943.23	931.25	11.99
1 A liquid	368.39	368.39	-	383.17	383.16	0.00	381.02	381.58	-0.57
1 A solid	113.46	113.46	-	19.25	19.25	0.00	12.32	13.77	-1.45
1 A gaseous	203.98	203.98	-	294.64	294.64	-	278.11	278.11	-
1 A other	7.83	7.72	0.12	24.72	23.68	1.04	26.33	25.32	1.01
1 A peat	0.00	0.00	-	NO	NO	-	NO	NO	-
1 A biomass	96.73	96.85	-0.12	227.60	228.10	-0.50	236.15	232.46	3.70
1 A 1 Energy Industries	187.35	187.35	-	212.23	205.03	7.20	206.81	202.38	4.43
1 A 1 liquid	43.15	43.15	-	30.40	30.40	-	30.27	30.27	-
1 A 1 solid	61.40	61.40	-	3.86	3.86	-	NO	NO	-
1 A 1 gaseous	76.48	76.48	-	87.79	90.17	-2.38	87.07	92.53	-5.46
1 A 1 other	3.50	3.39	0.12	12.29	11.25	1.04	12.47	11.46	1.01
1 A 1 peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 biomass	2.82	2.93	-0.12	68.31	69.35	-1.04	67.70	68.11	-0.42
1 A 1 a Public Electricity and Heat Production	142.78	142.78	-	170.80	161.28	9.52	170.43	163.59	6.84
1 A 1 a liquid	15.63	15.63	-	0.83	0.83	-	3.11	3.11	-
1 A 1 a solid	61.40	61.40	-	3.86	3.86	-	NO	NO	-
1 A 1 a gaseous	59.46	59.46	-	75.97	76.03	-0.06	77.88	80.93	-3.05
1 A 1 a other	3.50	3.39	0.12	12.29	11.25	1.04	12.47	11.46	1.01
1 A 1 a peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 a biomass	2.79	2.90	-0.12	68.27	69.31	-1.04	67.66	68.08	-0.42
1 A 1 b Petroleum refining	35.34	35.34	-	38.51	38.51	-	32.57	32.57	-
1 A 1 b liquid	27.46	27.46	-	29.57	29.57	-	27.16	27.16	-
1 A 1 b solid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 b gaseous	7.88	7.88	-	8.94	8.94	-	5.40	5.40	-
1 A 1 b other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 b peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 b biomass	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c Manufacture of Solid fuels and Other Energy Industries	9.23	9.23	-	2.92	5.24	-2.32	3.81	6.23	-2.41
1 A 1 c liquid	0.06	0.06	-	NO	NO	-	NO	NO	-
1 A 1 c solid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c gaseous	9.13	9.13	-	2.88	5.20	-2.32	3.78	6.19	-2.41
1 A 1 c other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c biomass	0.03	0.03	-	0.04	0.04	-	0.03	0.03	-
1 A 1 c 1 Manufacture of Solid Fuels	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 1 liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 1 solid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 1 gaseous	NO	NO	-	NO	NO	-	NO	NO	-

	Fuel Consumption [PJ]								
	1990			2020			2022		
IPCC Category / Fuel Group	Subm. 2025	Subm. 2024	Differen-ce	Subm. 2025	Subm. 2024	Differen-ce	Subm. 2025	Subm. 2024	Differen-ce
1 A 1 c 1 other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 1 peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 1 biomass	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 2 Oil and gas extraction	6.73	6.73	-	0.01	2.34	-2.32	0.53	2.95	-2.41
1 A 1 c 2 liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 2 solid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 2 gaseous	6.73	6.73	-	0.01	2.34	-2.32	0.53	2.95	-2.41
1 A 1 c 2 other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 2 peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 2 biomass	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 3 Other Energy Industries	2.50	2.50	-	2.91	2.91	-	3.28	3.28	-
1 A 1 c 3 liquid	0.06	0.06	-	NO	NO	-	NO	NO	-
1 A 1 c 3 solid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 3 gaseous	2.41	2.41	-	2.86	2.86	-	3.24	3.24	-
1 A 1 c 3 other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 3 peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 1 c 3 biomass	0.03	0.03	-	0.04	0.04	-	0.03	0.03	-
1 A 2 Manufacturing Industries and Construction	169.63	169.63	-	233.36	229.97	3.39	239.76	237.10	2.66
1 A 2 liquid	36.10	36.10	-	21.85	21.34	0.51	24.73	25.56	-0.83
1 A 2 solid	23.87	23.87	-	14.79	14.79	-	11.96	13.40	-1.44
1 A 2 gaseous	76.99	76.99	-	121.39	119.07	2.32	119.55	113.86	5.69
1 A 2 other	3.22	3.22	-	11.65	11.64	0.00	13.09	13.09	-0.00
1 A 2 peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 biomass	29.45	29.45	-	63.67	63.11	0.56	70.43	71.19	-0.76
1 A 2 a Iron and Steel	24.44	24.44	-	27.10	27.10	-	26.61	28.47	-1.86
1 A 2 a liquid	1.01	1.01	-	0.09	0.09	-	0.24	0.65	-0.41
1 A 2 a solid	11.69	11.69	-	7.54	7.54	-	7.47	8.89	-1.42
1 A 2 a gaseous	11.73	11.73	-	19.45	19.45	-	18.83	18.86	-0.03
1 A 2 a other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 a peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 a biomass	NO	NO	-	0.01	0.01	-	0.07	0.07	-0.00
1 A 2 b Non-Ferrous Metals	2.08	2.08	-	4.73	4.73	-	5.47	5.34	0.14
1 A 2 b liquid	0.51	0.51	-	0.13	0.13	-	0.14	0.14	-0.00
1 A 2 b solid	0.21	0.21	-	0.13	0.13	-	0.11	0.14	-0.02
1 A 2 b gaseous	1.35	1.35	-	4.42	4.42	-	5.17	5.01	0.16
1 A 2 b other	NO	NO	-	0.01	0.01	-	0.01	0.01	-
1 A 2 b peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 b biomass	NO	NO	-	0.04	0.04	-	0.05	0.05	0.00
1 A 2 c Chemicals	16.29	16.29	-	28.19	28.19	-	27.60	27.01	0.59
1 A 2 c liquid	1.27	1.27	-	0.99	0.99	-	0.64	0.64	-0.00
1 A 2 c solid	1.09	1.09	-	0.44	0.44	-	0.55	0.55	-
1 A 2 c gaseous	9.36	9.36	-	20.35	20.35	-	18.41	17.82	0.59
1 A 2 c other	1.67	1.67	-	3.24	3.24	-	4.10	4.10	-
1 A 2 c peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 c biomass	2.90	2.90	-	3.17	3.17	-	3.91	3.91	0.00
1 A 2 d Pulp, Paper and Print	55.31	55.31	-	67.42	67.42	-	66.18	65.94	0.24
1 A 2 d liquid	10.94	10.94	-	0.17	0.17	-	0.31	0.31	-0.00
1 A 2 d solid	4.13	4.13	-	3.31	3.31	-	1.47	1.47	-
1 A 2 d gaseous	17.01	17.01	-	26.61	26.61	-	24.91	24.67	0.24
1 A 2 d other	0.19	0.19	-	0.09	0.09	-	0.02	0.02	-
1 A 2 d peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 d biomass	23.03	23.03	-	37.23	37.23	-	39.47	39.47	0.00
1 A 2 e Food Processing, Beverages and Tobacco	13.91	13.91	-	14.46	14.46	-	16.35	15.90	0.45
1 A 2 e liquid	4.45	4.45	-	0.41	0.41	-	1.27	0.99	0.28

	Fuel Consumption [PJ]								
	1990			2020			2022		
IPCC Category / Fuel Group	Subm. 2025	Subm. 2024	Differen-ce	Subm. 2025	Subm. 2024	Differen-ce	Subm. 2025	Subm. 2024	Differen-ce
1 A 2 e solid	0.18	0.18	-	0.11	0.11	-	0.16	0.16	-
1 A 2 e gaseous	9.15	9.15	-	13.46	13.46	-	14.39	13.96	0.43
1 A 2 e other	NO	NO	-	0.00	0.00	-	0.00	0.00	-
1 A 2 e peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 e biomass	0.13	0.13	-	0.48	0.48	-	0.53	0.79	-0.26
1 A 2 f Non-Metallic Minerals	23.34	23.34	-	27.24	27.24	-	26.73	26.73	-0.00
1 A 2 f liquid	6.26	6.26	-	0.88	0.88	-	1.75	1.75	-
1 A 2 f solid	5.69	5.69	-	3.27	3.27	-	2.18	2.18	-
1 A 2 f gaseous	10.09	10.09	-	12.57	12.57	-	10.66	10.66	-
1 A 2 f other	1.31	1.31	-	7.17	7.17	-	7.73	7.73	-
1 A 2 f peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 f biomass	NO	NO	-	3.35	3.35	-	4.41	4.41	-0.00
1 A 2 g Other (please specify)	34.27	34.27	-	64.23	60.84	3.39	70.81	67.71	3.11
1 A 2 g liquid	11.65	11.65	-	19.18	18.67	0.51	20.38	21.08	-0.70
1 A 2 g solid	0.88	0.88	-	0.00	0.00	-	0.02	0.02	-0.00
1 A 2 g gaseous	18.30	18.30	-	24.53	22.21	2.32	27.18	22.88	4.31
1 A 2 g other	0.05	0.05	-	1.13	1.13	0.00	1.24	1.24	-0.00
1 A 2 g peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 g biomass	3.39	3.39	-	19.39	18.83	0.56	21.99	22.48	-0.50
1 A 2 g 7 Off-road vehicles and other machinery	3.45	3.45	-	18.08	17.53	0.54	20.06	20.69	-0.64
1 A 2 g 7 gasoline	0.05	3.45	-3.40	0.12	16.58	-16.45	0.14	19.53	-19.39
1 A 2 g 7 diesel oil	3.40	NO	3.40	16.97	NO	16.97	18.79	NO	18.79
1 A 2 g 7 LPG	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 g 7 other liquid	NO	NO	-	NO	0.05	-0.05	NO	0.06	-0.06
1 A 2 g 7 gaseous	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 g 7 other	NO	NO	-	0.05	0.91	-0.85	0.06	1.10	-1.04
1 A 2 g 7 biomass	NO			0.93			1.07		
1 A 2 g 8 Other Manufacturing Industries	30.82	30.82	-	46.15	43.30	2.85	50.76	47.01	3.74
1 A 2 g 8 liquid	8.20	8.20	-	2.09	2.09	-	1.46	1.56	-0.10
1 A 2 g 8 solid	0.88	0.88	-	0.00	0.00	-	0.02	0.02	-0.00
1 A 2 g 8 gaseous	18.30	18.30	-	24.53	22.21	2.32	27.18	22.88	4.31
1 A 2 g 8 other	0.05	0.05	-	1.08	1.08	-	1.18	1.18	-
1 A 2 g 8 peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 2 g 8 biomass	3.39	3.39	-	18.45	17.92	0.53	20.92	21.38	-0.46
1 A 3 Transport	183.58	183.58	0.00	296.21	296.70	-0.48	289.22	288.57	0.64
1 A 3 liquid	179.46	179.46	0.00	272.17	272.68	-0.51	271.23	270.60	0.63
1 A 3 solid	0.07	0.07	-	0.00	0.00	-	0.00	0.00	-
1 A 3 gaseous	4.05	4.05	-	9.35	9.29	0.06	3.45	3.46	-0.01
1 A 3 other	NO	NO	-	0.75	0.75	-0.00	0.73	0.73	0.00
1 A 3 biomass	NO	NO	-	13.95	13.97	-0.03	13.79	13.77	0.02
1 A 3 a Domestic Aviation	0.52	0.52	-	0.32	0.32	-	0.41	0.41	-
1 A 3 a aviation gasoline	0.10	0.10	-	0.08	0.08	-	0.07	0.07	-
1 A 3 a jet kerosene	0.42	0.42	-	0.24	0.24	-	0.33	0.33	-
1 A 3 a biomass	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b Road Transportation	176.19	176.19	0.00	285.77	286.32	-0.54	283.81	283.17	0.65
1 A 3 b gasoline	103.53	103.53	-	52.49	52.49	-0.00	57.79	57.79	0.00
1 A 3 b diesel oil	72.25	72.25	0.00	217.75	218.26	-0.51	210.77	210.16	0.61
1 A 3 b LPG	0.41	0.41	-	0.13	0.13	-	0.12	0.11	0.02
1 A 3 b other liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b gaseous	NO	NO	-	0.80	0.80	-	0.71	0.72	-0.01
1 A 3 b other	NO	NO	-	0.74	0.74	-0.00	0.73	0.73	0.00
1 A 3 b biomass	NO	NO	-	13.87	13.90	-0.03	13.68	13.66	0.02
1 A 3 b 1 Cars	117.06	116.88	0.18	158.21	157.88	0.33	168.33	165.69	2.64
1 A 3 b 1 gasoline	97.28	97.28	-0.00	49.84	49.84	-0.00	55.23	55.27	-0.04
1 A 3 b 1 diesel oil	19.39	19.20	0.18	100.34	100.02	0.32	104.76	102.23	2.52

	Fuel Consumption [PJ]								
	1990			2020			2022		
IPCC Category / Fuel Group	Subm. 2025	Subm. 2024	Differen-ce	Subm. 2025	Subm. 2024	Differen-ce	Subm. 2025	Subm. 2024	Differen-ce
1 A 3 b 1 LPG	0.39	0.39	0.00	0.12	0.12	0.00	0.12	0.10	0.02
1 A 3 b 1 other liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 1 gaseous	NO	NO	-	0.07	0.07	0.00	0.08	0.07	0.01
1 A 3 b 1 other	NO	NO	-	0.31	0.31	0.00	0.33	0.32	0.01
1 A 3 b 1 biomass	NO	NO	-	7.53	7.51	0.02	7.82	7.69	0.13
1 A 3 b 2 Light duty trucks	13.64	13.64	-0.00	22.40	22.40	-0.00	24.51	23.88	0.63
1 A 3 b 2 gasoline	3.35	3.35	0.00	0.62	0.62	0.00	0.66	0.61	0.05
1 A 3 b 2 diesel oil	10.28	10.28	-	20.62	20.62	-0.00	22.56	21.98	0.59
1 A 3 b 2 LPG	0.01	0.01	-0.00	0.00	0.00	-0.00	0.00	0.00	0.00
1 A 3 b 2 other liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 2 gaseous	NO	NO	-	0.02	0.02	-	0.01	0.05	-0.04
1 A 3 b 2 other	NO	NO	-	0.06	0.06	-	0.07	0.07	0.00
1 A 3 b 2 biomass	NO	NO	-	1.08	1.08	-	1.20	1.17	0.03
1 A 3 b 3 Heavy duty trucks and buses	44.66	44.84	-0.18	103.03	103.91	-0.87	88.98	91.60	-2.63
1 A 3 b 3 gasoline	2.07	2.07	0.00	NO	NO	-	NO	NO	-
1 A 3 b 3 diesel oil	42.58	42.77	-0.18	96.79	97.62	-0.83	83.45	85.95	-2.50
1 A 3 b 3 LPG	0.01	0.01	-0.00	0.00	0.00	-0.00	0.00	0.00	0.00
1 A 3 b 3 other liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 3 gaseous	NO	NO	-	0.71	0.71	-0.00	0.62	0.60	0.02
1 A 3 b 3 other	NO	NO	-	0.37	0.37	-0.00	0.32	0.33	-0.01
1 A 3 b 3 biomass	NO	NO	-	5.17	5.21	-0.04	4.58	4.72	-0.14
1 A 3 b 4 Motorcycles	0.84	0.84	-	2.13	2.13	-	1.99	1.99	-
1 A 3 b 4 gasoline	0.84	0.84	-	2.03	2.03	-	1.91	1.91	-
1 A 3 b 4 diesel oil	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 4 LPG	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 4 other liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 4 gaseous	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 4 other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 4 biomass	NO	NO	-	0.10	0.10	-	0.08	0.08	-
1 A 3 b 5 Other (please specify)	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 5 gasoline	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 5 diesel oil	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 5 LPG	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 5 other liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 5 gaseous	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 5 other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 b 5 biomass	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 c Railways	2.38	2.38	-	1.15	1.15	-	1.14	1.14	-
1 A 3 c liquid	2.31	2.31	-	1.09	1.09	-	1.07	1.07	-
1 A 3 c solid	0.07	0.07	-	0.00	0.00	-	0.00	0.00	-
1 A 3 c gaseous	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 c other	NO	NO	-	0.00	0.00	-	0.00	0.00	-
1 A 3 c biomass	NO	NO	-	0.05	0.05	-	0.06	0.06	-
1 A 3 d Domestic Navigation	0.37	0.37	-	0.33	0.33	-0.00	0.97	0.97	-0.00
1 A 3 d residual oil	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 d gas/diesel oil	0.25	0.25	-	0.22	0.22	-	0.83	0.83	-0.00
1 A 3 d gasoline	0.13	0.13	-	0.09	0.09	0.00	0.09	0.09	0.00
1 A 3 d other liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 d gaseous	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 d other	NO	NO	-	0.00	0.00	-	0.00	0.00	-
1 A 3 d biomass	NO	NO	-	0.02	0.02	-0.00	0.05	0.05	-0.00
1 A 3 e Other Transportation	4.11	4.11	-	8.64	8.58	0.06	2.89	2.89	-0.00
1 A 3 e liquid	0.06	0.06	-	0.09	0.09	-	0.15	0.15	-
1 A 3 e solid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 e gaseous	4.05	4.05	-	8.55	8.49	0.06	2.73	2.74	-0.00
1 A 3 e other	NO	NO	-	0.00	0.00	-	0.00	0.00	-

	Fuel Consumption [PJ]								
	1990			2020			2022		
IPCC Category / Fuel Group	**Subm. 2025**	**Subm. 2024**	**Differen-ce**	**Subm. 2025**	**Subm. 2024**	**Differen-ce**	**Subm. 2025**	**Subm. 2024**	**Differen-ce**
1 A 3 e biomass	NO	NO	-	0.00	0.00	-	0.01	0.01	-
1 A 3 e 1 Pipeline Transport	4.05	4.05	-	8.55	8.49	0.06	2.73	2.73	-0.00
1 A 3 e 1 liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 e 1 solid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 e 1 gaseous	4.05	4.05	-	8.55	8.49	0.06	2.73	2.73	-0.00
1 A 3 e 1 other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 e 1 biomass	NO	NO	-	NO	NO	-	NO	NO	-
1 A 3 e 2 Other (please specify)	0.06	0.06	-	0.09	0.09	-	0.16	0.16	-
1 A 3 e 2 gasoline	0.01		0.01	0.01		0.01			-
1 A 3 e 2 diesel oil	0.06	0.06	-0.01	0.08	0.09	-0.01	0.13	0.15	-0.01
1 A 3 e 2 LPG	NO	NO	-	NO	0.00	-0.00	NO	0.01	-0.01
1 A 3 e 2 other liquid	NO	NO	-	NO	0.00	-0.00	NO	0.00	-0.00
1 A 3 e 2 solid	NO	NO	-	NO	0.00	-0.00	NO	0.01	-0.01
1 A 3 e 2 gaseous	NO			0.00			0.01		
1 A 3 e 2 other	NO			0.00			0.00		
1 A 3 e 2 biomass	NO			0.00			0.01		
1 A 4 Other Sectors	249.32	249.32	-	216.76	216.75	0.01	207.08	202.83	4.25
1 A 4 liquid	109.16	109.16	-	58.35	58.35	0.00	54.40	54.78	-0.38
1 A 4 solid	28.12	28.12	-	0.60	0.60	0.00	0.36	0.37	-0.01
1 A 4 gaseous	46.46	46.46	-	76.11	76.11	-	68.05	68.26	-0.21
1 A 4 other	1.11	1.11	-	0.04	0.04	-	0.04	0.04	-
1 A 4 peat	0.00	0.00	-	NO	NO	-	NO	NO	-
1 A 4 biomass	64.46	64.46	-	81.67	81.66	0.01	84.23	79.38	4.85
1 A 4 a Commercial/Institutional	35.39	35.39	-	25.13	25.13	-	23.72	23.18	0.54
1 A 4 a liquid	18.66	18.66	-	6.00	6.00	-	6.59	6.65	-0.06
1 A 4 a solid	0.96	0.96	-	NO	NO	-	NO	NO	-
1 A 4 a gaseous	12.60	12.60	-	15.15	15.15	-	13.02	12.91	0.10
1 A 4 a other	1.11	1.11	-	0.01	0.01	-	0.01	0.01	-
1 A 4 a peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 4 a biomass	2.06	2.06	-	3.97	3.97	-	4.11	3.62	0.49
1 A 4 a 1 Stationary combustion	35.39	35.39	-	25.13	25.13	-	23.72	23.18	0.54
1 A 4 a 1 liquid	18.66	18.66	-	6.00	6.00	-	6.59	6.65	-0.06
1 A 4 a 1 solid	0.96	0.96	-	NO	NO	-	NO	NO	-
1 A 4 a 1 gaseous	12.60	12.60	-	15.15	15.15	-	13.02	12.91	0.10
1 A 4 a 1 other	1.11	1.11	-	0.01	0.01	-	0.01	0.01	-
1 A 4 a 1 peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 4 a 1 biomass	2.06	2.06	-	3.97	3.97	-	4.11	3.62	0.49
1 A 4 b Residential	193.30	193.30	-	172.68	172.68	0.00	164.13	161.37	2.76
1 A 4 b liquid	74.79	74.79	-	41.20	41.20	0.00	37.06	37.38	-0.32
1 A 4 b solid	26.62	26.62	-	0.58	0.58	0.00	0.35	0.36	-0.01
1 A 4 b gaseous	33.50	33.50	-	60.05	60.05	-	54.19	54.52	-0.34
1 A 4 b other	NO	NO	-	0.00	0.00	-	0.00	0.00	-
1 A 4 b peat	0.00	0.00	-	NO	NO	-	NO	NO	-
1 A 4 b biomass	58.40	58.40	-	70.85	70.85	-0.00	72.53	69.11	3.43
1 A 4 b 1 Stationary combustion	191.02	191.02	-	171.20	171.20	0.00	162.69	159.93	2.76
1 A 4 b 1 liquid	72.50	72.50	-	39.80	39.80	-	35.68	36.01	-0.32
1 A 4 b 1 solid	26.62	26.62	-	0.58	0.58	0.00	0.35	0.36	-0.01
1 A 4 b 1 gaseous	33.50	33.50	-	60.05	60.05	-	54.19	54.52	-0.34
1 A 4 b 1 other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 4 b 1 peat	0.00	0.00	-	NO	NO	-	NO	NO	-
1 A 4 b 1 biomass	58.40	58.40	-	70.78	70.78	-	72.46	69.04	3.43
1 A 4 b 2 Mobile combustion	2.29	2.29	-	1.48	1.48	-	1.44	1.44	0.00
1 A 4 b 2 liquid	2.29	2.29	-	1.41	1.41	0.00	1.37	1.37	0.00
1 A 4 b 2 solid	NO	NO	-	NO	0.00	-0.00	NO	0.00	-0.00
1 A 4 b 2 gaseous	NO	NO	-	NO	0.07	-0.07	NO	0.07	-0.07
1 A 4 b 2 other	NO			0.00			0.00		

	Fuel Consumption [PJ]								
	1990			2020			2022		
IPCC Category / Fuel Group	Subm. 2025	Subm. 2024	Differen-ce	Subm. 2025	Subm. 2024	Differen-ce	Subm. 2025	Subm. 2024	Differen-ce
1 A 4 b 2 biomass	NO			0.07			0.07		
1 A 4 c Agriculture/Forestry/Fishing	20.63	20.63	-	18.95	18.94	0.01	19.23	18.28	0.95
1 A 4 c liquid	15.71	15.71	-	11.14	11.14	0.00	10.75	10.75	-0.00
1 A 4 c solid	0.55	0.55	-	0.02	0.02	-	0.01	0.01	-0.00
1 A 4 c gaseous	0.37	0.37	-	0.91	0.91	-	0.85	0.83	0.02
1 A 4 c other	NO	NO	-	0.03	0.03	-	0.03	0.03	-
1 A 4 c peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 4 c biomass	4.01	4.01	-	6.85	6.84	0.01	7.59	6.66	0.93
1 A 4 c 1 Stationary combustion	10.26	10.26	-	7.35	7.35	0.01	8.00	7.06	0.95
1 A 4 c 1 liquid	5.34	5.34	-	0.17	0.17	-	0.14	0.15	-0.00
1 A 4 c 1 solid	0.55	0.55	-	0.02	0.02	-	0.01	0.01	-0.00
1 A 4 c 1 gaseous	0.37	0.37	-	0.91	0.91	-	0.85	0.83	0.02
1 A 4 c 1 other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 4 c 1 peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 4 c 1 biomass	4.01	4.01	-	6.26	6.26	0.01	7.01	6.08	0.93
1 A 4 c 2 Mobile combustion	10.37	10.37	-	11.59	11.59	0.00	11.22	11.22	0.00
1 A 4 c 2 gasoline	0.42	0.42	-	0.36	0.36	0.00	0.38	0.38	0.00
1 A 4 c 2 diesel oil	9.95	9.95	-	10.62	10.62	-	10.23	10.22	0.00
1 A 4 c 2 LPG	NO	NO	-	NO	NO	-	NO	NO	-
1 A 4 c 2 other liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 4 c 2 gaseous	NO	NO	-	NO	NO	-	NO	NO	-
1 A 4 c 2 other	NO	NO	-	0.03	0.03	-	0.03	0.03	-
1 A 4 c 2 biomass	NO	NO	-	0.58	0.58	-0.00	0.58	0.58	-0.00
1 A 5 Other	0.51	0.51	-0.00	0.39	0.39	0.00	0.38	0.37	0.01
1 A 5 liquid	0.51	0.51	-0.00	0.39	0.39	0.00	0.38	0.37	0.01
1 A 5 solid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 gaseous	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 other	NO	NO	-	0.00	0.00	-	0.00	0.00	-
1 A 5 peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 biomass	NO	NO	-	0.00	0.00	0.00	0.00	0.00	-
1 A 5 a Stationary combustion	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 a liquid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 a solid	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 a gaseous	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 a other	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 a peat	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 a biomass	NO	NO	-	NO	NO	-	NO	NO	-
1 A 5 b Mobile combustion - Military	0.51	0.51	-0.00	0.39	0.39	0.00	0.38	0.37	0.01
1 A 5 b liquid	0.51	0.51	-0.00	0.39	0.39	0.00	0.38	0.37	0.01
1 A 5 b biomass	NO	NO	-	NO	0.00	-0.00	NO	0.00	-0.00
Memo - International Aviation	12.10	12.10	-	14.38	14.38	-	27.04	27.04	-
aviation gasoline	NO	NO	-	NO	NO	-	NO	NO	-
jet kerosene	12.10	12.10	-	14.38	14.38	-	27.04	27.04	-
biomass	NO	NO	-	NO	NO	-	NO	NO	-
Memo - International Navigation	0.62	0.62	-	0.57	0.57	-	0.43	0.43	-
residual oil	NO	NO	-	NO	NO	-	NO	NO	-
gas/diesel oil	0.62	0.62	-	0.57	0.57	-	0.43	0.43	-

A "-" indicates that no recalculations were carried out or recalculations are lower than ± 0.005 TJ (mostly due to rounding) .

Methodology

CO_2 emissions from *1.A Fuel Combustion* have been calculated using the IPCC Tier 2 methodology while for N_2O and CH_4 emissions the Tier 1 methodology has been applied. The fuel consumption based on the energy balance is multiplied with source specific emission factors for CO_2, CH_4 and N_2O. Sector specific considerations and emission factors are described in the related sub chapters of Chapter *3 Energy* of the NID.

Activity data is taken from the national energy balance as described in the following sub chapters. Data of the national energy balance is presented in Annex 3.4.

The National Energy Balance

There are five different IEA questionnaires for each of: oil; natural gas; coal; renewable fuels; electricity and heat. Table A 51 shows the unified categories of the IEA questionnaires with ISIC codes and the corresponding SNAP and IPCC categories to which the fuel consumption is assigned to.

Data of the national energy balance is presented in Annex 3.4.

Table A 51: Categories of the national energy balance (JQ) and their correspondence to IPCC categories.

IEA-Category and ISIC Codes[(2)]	Comments	SNAP	IPCC-Category
Production			Reference Approach: Production
Imports			Reference Approach: Import
Exports			Reference Approach: Export
Bunkers	No consumption [(1)]		
Stock Changes			Reference Approach: Stock Change
Refinery Fuel		0103	1 A 1 b Petroleum Refining
Transformation Sector, of which:			
Public Electricity plants Public CHP plants Public Heat plants	In the inventory plant specific data are considered.	0101 0102	1 A 1 a Public Electricity and Heat Production
Auto Producer Electricity plants Auto Producer CHP plants Auto Producer Heat plants	For autoproducers by sectors see table below.		
Coke Ovens	Transformation from *Coking Coal* to *Coke Oven Coke*.		
Blast furnaces	Coke Oven Coke.	030326	1 A 2 a Iron and Steel
Gas Works	Transformation of *Other Oil Products* to *Gas Works Gas*.		
Petrochemical Industry	No consumption [(1)]		
Patent Fuel Plants	No consumption [(1)]		
Not Elsewhere Specified	No consumption [(1)]		
Energy Sector, of which (ISIC 10, 11, 12, 23, 40):			
Coal Mines	No consumption [(1)]		
Oil and Gas Extraction		0105	1 A 1 c Manufacture of Solid fuels and Other Energy Industries
Inputs to oil refineries		0103	1 A 1 b Petroleum Refining
Coke Ovens	*Coke Oven Gas* and *Blast Furnace Gas*.	0301	1 A 2 a Iron and Steel
Blast furnaces	*Coke Oven Coke*.	030326	1 A 2 a Iron and Steel
Gas Works	*Natural Gas. Other liquid fuels*.	0105	1 A 1 c Manufacture of Solid fuels and Other Energy Industries
Electricity, CHP and Heat Plants		0101	1 A 1 a Public Electricity and Heat Production
Liquefaction Plants	No consumption [(1)]		
Not Elsewhere Specified	No consumption [(1)]		
Distribution Losses	Includes statistical differences and therefore it may be less than zero.		
Final Energy Consumption			
Total Transport, of which (ISIC 60, 61, 62):			
Domestic Air Transport			

IEA-Category and ISIC Codes[(2)]	Comments	SNAP	IPCC-Category
Road Rail Inland Waterways	Division to SNAP categories is performed by means of studies.	07 08 0201	1 A 2 f Manuf. Ind. and Constr. -Other 1 A 3 Transport 1 A 4 b Residential 1 A 4 c Agriculture/ Forestry/ Fisheries
Pipeline Transport	*Natural Gas*.	010506	1 A 3 e Transport-Other
Non Specified	*Other biofuels* and *Lubricants*.	0201	1 A 4 a Commercial/ Institutional
Total Industry, of which:			
Iron and Steel (ISIC 271, 2731)		0301 030301 030326	1 A 2 a Iron and Steel
Chemical incl.Petro-Chemical (ISIC 24)		0301	1 A 2 c Chemicals
Non ferrous Metals (ISIC 272, 2732)		0301	1 A 2 b Non-ferrous Metals
Non metallic Mineral Products (ISIC 26)		0301 030311 030317 030319	1 A 2 Non-metallic minerals
Transportation Equipment (ISIC 34, 35)		0301	1 A 2 g Manuf. Ind. and Constr. –Other
Machinery (ISIC 28, 29, 30, 31, 32)		0301	1 A 2 g Manuf. Ind. and Constr. –Other
Mining and Quarrying (ISIC 13, 14)		0105	1 A 2 g Manuf. Ind. and Constr. –Other
Food, Beverages and Tobacco (ISIC 15, 16)		0301	1 A 2 e Food Processing, Beverages and Tobacco
Pulp, Paper and Printing (ISIC 21, 22)		0301	1 A 2 d Pulp, Paper and Print
Wood and Wood Products (ISIC 20)		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Construction (ISIC 45)		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Textiles and Leather (ISIC 17, 18, 19)		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Non Specified (ISIC 25, 33, 36, 37)		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Total Other sectors, of which:			
Commercial and Public Services (ISIC 41, 50, 51, 52, 55, 63, 64, 65, 66, 67, 70, 71, 72, 73, 74, 75, 80, 85, 90, 91, 92, 93, 99)		0201	1 A 4 a Commercial/ Institutional
Residential (ISIC 95)		0202	1 A 4 b Residential
Agriculture (ISIC 01, 02, 05)		0203	1 A 4 c Agriculture/Forestry/ Fisheries
Non Specified	No consumption [(1)]		

[(1)] *Indicates that no fuel consumption is reported in the energy balance for the specific category. In some cases this may be interpreted as "included elsewhere" if the energy statistic has lack of detailed sectoral data.*

[(2)] *Sector names may differ to original IEA questionnaire naming convention. Note that the ISIC Revised 4 codes cited in this table are consistent with the NACE Revison 2 nomenclature.*

Table A 52: Categories of the national energy balance (since 2013) and their correspondence to IPCC categories: Autoproducers by sector.

Auto Producers (Electricity + CHP + Heat), of which:			
Energy Sector, of which:			
Coal Mines	No consumption [(1)]		
Oil and Gas Extraction		0105	1 A 1 c Manufacture of Solid fuels and Other Energy Industries
Inputs to oil refineries		0103	1 A 1 b Petroleum Refining
Coke Ovens	No consumption [(1)]		
Gas Works	No consumption [(1)]		
Liquefaction Plants	No consumption [(1)]		
Not Elsewhere Specified	No consumption [(1)]		
Industrie, of which:			

Auto Producers (Electricity + CHP + Heat), of which:			
Iron and Steel		030326	1 A 2 a Iron and Steel
Chemical (incl.Petro-Chemical)		0301	1 A 2 c Chemicals
Non ferrous Metals		0301	1 A 2 b Non-ferrous Metals
Non metallic Mineral Products		0301	1 A 2 f Non-metallic minerals
Transportation Equipment		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Machinery		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Mining and Quarrying		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Food, Beverages and Tobacco		0301	1 A 2 e Food Processing, Beverages and Tobacco
Pulp, Paper and Printing		0301	1 A 2 d Pulp, Paper and Print
Wood and Wood Products		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Construction		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Textiles and Leather		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Non Specified (Industry)		0301	1 A 2 g Manuf. Ind. and Constr. -Other
Total Transport, of which			
Pipeline Transport	No consumption (1)		
Non Specified	No consumption (1)		
Other Sectors, of which			
Commercial and Public Services		0201	1 A 4 a Commercial/ Institutional
Residential	No consumption (1)		
Agriculture	No consumption (1)		
Non Specified	No consumption (1)		

(1) *Indicates that no fuel consumption is reported in the energy balance for the specific category. In some cases this may be interpreted as "included elsewhere" if the energy statistic has lack of detailed sectoral data.*

Fuels and Fuel Categories

The units used in the national fuel statistics are: *ton* for solid or liquid fuels and *cubic meter* for gaseous fuels. To convert these units into the caloric unit *Joule* the calorific value of each fuel category has to be quantified. These calorific values are specified in the unit *Joule per Mass or Volume Unit,* e.g. MJ/kg, MJ/m³ gas.

Each fuel has chemical and physical characteristics which influence its burning performance e.g. calorific value or carbon and sulphur content. Fuel categories are formed to pool fuels of the same characteristics in fuel groups. Limitations are given by the fuel categories of the energy balance. A list of the inventory fuel categories and their correspondence to IPCC-fuel categories is shown in Table A 53.

Table A 53: Fuel categories used for the inventory and correspondence to IPCC fuel categories.

	Inventory Fuel Category	**IEA Fuel Category**		**IPCC Fuel Category (3)**
Code (1)	**Category**	**Category**	**Average Net Calorific Value (2)**	
102 A	Hard Coal	Bituminous Coal and Anthracite	30.16	Solid (coal)
104 A	Hard Coal Briquettes	Patent Fuel	31.00	Solid (coal)
105 A	Brown Coal	Lignite/Brown Coal	21.75	Solid (coal)
106 A	Brown Coal Briquettes	BKB/PB	19.80	Solid (coal)
107 A	Coke	Coke Oven Coke	28.50	Solid (coal)
113 A	Peat	Peat	0.00	Solid
304 A	Coke Oven Gas	Coke Oven Gas	17.33	Solid
305 A	Blast Furnace Gas	Blast Furnace Gas	3.59	Solid
110 A	Petrol Coke	Petrol Coke	30.28	Liquid
203 B	Light Fuel Oil Sulphur Content < 0,2 %		42.40	
203 C	Medium Fuel Oil Sulphur Content < 0,4%	Residual Fuel Oil		Liquid (residual oil)
203 D	Heavy Fuel Oil Sulphur Content >= 1%			

	Inventory Fuel Category	IEA Fuel Category		IPCC Fuel Category[3]
Code [1]	Category	Category	Average Net Calorific Value[2]	
204 A	Gasoil	Heating and other Gasoil	43.37	Liquid (gas/diesel oil)
205 0	Diesel	Transport Diesel	42.37	Liquid (diesel oil; gas/diesel oil)
206 A	Petroleum	Other Kerosene	43.35	Liquid
206 B	Kerosene	Kerosene Type Jet Fuel	43.30	Liquid (jet kerosene)
207 A	Aviation Gasoline	Gasoline Type Jet Fuel	44.10	Liquid (aviation gasoline)
208 0	Motor Gasoline	Motor Gasoline	40.82	Liquid (gasoline)
224 A	Other Petroleum Products	Other Products	46.18	Liquid
303 A	Liquified Petroleum Gas (LPG)	LPG	46.12	Liquid
308 A	Refinery Gas	Refinery Gas	33.76	Liquid
301 A	Natural Gas	Natural Gas	37.16	Gaseous (natural gas)
114 B	Municipal Waste	Municipal Solid Waste- Renewable	[4]10.24	Other Fuels
		Municipal Solid Waste-Non Renewable	[4]10.63	Biomass
115 A	Industrial Waste	Industrial Wastes	16.14	Other Fuels
111 A	Fuel Wood	*Wood/Wood wastes/Other Solid Wastes, of which:* Wood	14.31	Biomass
112 A	Char Coal	Char coal	29.50	Biomass
116 A	Wood Wastes, Wood Chips, Pellets, Straw.	*Wood/Wood wastes/Other Solid Wastes, of which:* Other vegetal materials and waste (including straw, sawdust, wood chips)	6.37	Biomass
118 A	Sewage Sludge (dry substance)	*Wood/Wood wastes/Other Solid Wastes, of which:* Other vegetal materials and waste (including straw, sawdust, wood chips)	12.00	Biomass
215 A	Black Liquor	*Wood/Wood wastes/Other Solid Wastes, of which:* Black Liquor	[4]8.86	Biomass
309 A	Biogas	Biogas	[4]24.62	Biomass
309 B	Sewage Sludge Gas	Sewage Sludge Gas	[4]24.86	Biomass
310 A	Landfill Gas	Landfill Gas	[4]17.28	Biomass

[1] *First three digits are based on CORINAIR / NAPFUE 94–Code*

[2] *Units: [MJ / kg] or [MJ / m^3 Gas] respectively, for the Year 2023. Note that for some fuels sector specific calorific values are taken. The energy balance reports some fuels (e.g. renewables) in [TJ] so that unit conversion by means of calorific values is not necessary.*

[3] *Fuel subcategories are shown in parenthesis*

[4] *Heating value of transformation input.*

Energy Consumption and CO_2 Emissions by Sectors and Fuel Types

The following tables show detailed data on fuel consumption and CO_2 emissions for each fuel type and each sector of *1 A Fuel Combustion* for certain years. For information on completeness, in particular on CO_2 emissions included elsewhere, please refer to the documentation boxes of the CRT and to Chapter 3.2.8 chapter *Completeness* of the NID.

Table A 54: 2023 energy consumption and CO_2 emissions from category 1 A Fuel Combustion by fuel type and sector.

		Consumption (PJ)					CO_2 emissions (Mt)				
		1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A	1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A
		Energy Ind.	Industry	Trans-port	Other Sectors	Total	Energy Ind.	Industry	Trans-port	Other Sectors	Total
	Total Solid		**9.02**	**0.00**	**0.30**	**9.32**		**0.86**	**0.00**	**0.03**	**0.89**
102A	Hard Coal		1.07	0.00	0.00	1.07		0.10	0.00	0.00	0.10
104A	Hard Coal Briquettes				0.07	0.07				0.01	0.01
105A	Brown Coal		1.03		0.01	1.04		0.10		0.00	0.10
106A	Brown Coal Briquettes				0.10	0.10				0.01	0.01
107A	Coke		0.35		0.11	0.46		0.04		0.01	0.05
113A	Peat										
304A	Coke Oven Gas		6.58			6.58		0.62			0.62
	Total Liquid	**33.16**	**25.55**	**260.93**	**43.83**	**363.47**	**2.40**	**1.95**	**19.51**	**3.27**	**27.12**
110A	Petrol Coke	1.66	1.58			3.24	0.17	0.17			0.34
203B	Light Fuel Oil	0.21	0.38		0.00	0.59	0.02	0.03		0.00	0.05
203C	Medium Fuel Oil										
203D	Heavy Fuel Oil	0.33	0.29			0.62	0.03	0.02			0.05
204A	Gasoil	1.40	3.27		30.71	35.38	0.10	0.25		2.30	2.65
2050	Diesel	0.00	18.34	199.08	10.92	228.34	0.00	1.37	14.81	0.81	16.99
206A	Other Kerosene										
206B	Jet Kerosene			0.70		0.70			0.05		0.05
207A	Aviation Gasoline			0.07		0.07			0.01		0.01
2080	Motor Gasoline		0.13	61.00	0.92	62.05		0.01	4.63	0.07	4.71
224A	Other Petroleum Products	13.72	0.09			13.81	1.07	0.01			1.08
303A	Liquified Petroleum Gas (LPG)	1.84	1.46	0.08	1.28	4.66	0.12	0.09	0.01	0.08	0.30
308A	Refinery Gas	14.00				14.00	0.90				0.90
301A	**Total Gaseous (Natural Gas)**	**66.33**	**104.40**	**1.10**	**63.95**	**235.79**	**3.69**	**5.80**	**0.06**	**3.56**	**13.11**
	Total Other Fuel	**13.26**	**11.36**	**0.72**	**0.04**	**25.38**	**1.09**	**0.89**	**0.05**	**0.00**	**2.04**
114A	MSW non renewable	11.77				11.77	0.98				0.98
115A	Industrial Waste	1.49	11.29		0.01	12.79	0.11	0.88		0.00	0.99
225A	FAME		0.06	0.72	0.04	0.82		0.00	0.05	0.00	0.06
	Total Biomass[(1)]	**65.56**	**77.95**	**16.32**	**80.62**	**240.45**	**(5.85)**	**(7.65)**	**(1.16)**	**(8.94)**	**(23.59)**
111A	Fuel Wood				52.47	52.47				5.88	5.88
112A	Char Coal	0.03			0.34	0.37				0.04	0.04
114C	MSW renewable	10.84				10.84					
116A	Wood Wastes	49.46	36.24		26.05	111.75	5.54	4.06		2.92	12.52
118A	Sewage Sludge	0.36	0.66			1.02	0.04	0.07			0.11
215A	Black Liquor		30.84			30.84		2.94			2.94
250A	Liquid Biofuels		1.18	16.30	0.75	18.23		0.08	1.15	0.05	1.29
309A	Biogas	4.71	7.50	0.02	0.31	12.53	0.26	0.41	0.00	0.02	0.68
309B	Sewage Sludge Gas	0.11	1.53		0.68	2.32	0.01	0.08		0.04	0.13
310A	Landfill Gas	0.06			0.03	0.09	0.00			0.00	0.01
	Total[(1)]	**178.32**	**228.29**	**279.06**	**188.74**	**874.40**	**7.18**	**9.50**	**19.62**	**6.85**	**43.16**

[(1)] CO_2 emissions of Biomass are not included in Total.

Table A 55: 2022 energy consumption and CO_2 emissions from category 1 A Fuel Combustion by fuel type and sector.

		Consumption (PJ)					CO_2 emissions (Mt)				
		1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A	1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A
		Energy Ind.	**Industry**	**Trans-port**	**Other Sectors**	**Total**	**Energy Ind.**	**Industry**	**Trans-port**	**Other Sectors**	**Total**
	Total Solid		**11.96**	**0.00**	**0.36**	**12.32**		**1.13**	**0.00**	**0.03**	**1.17**
102A	Hard Coal		2.76	0.00	0.01	2.77		0.25	0.00	0.00	0.25
104A	Hard Coal Briquettes				0.06	0.06				0.01	0.01
105A	Brown Coal		1.46		0.01	1.47		0.14		0.00	0.14
106A	Brown Coal Briquettes				0.16	0.16				0.02	0.02
107A	Coke		0.36		0.11	0.47		0.04		0.01	0.05
113A	Peat										
304A	Coke Oven Gas		7.39			7.39		0.70			0.70
	Total Liquid	**30.27**	**24.73**	**271.62**	**54.40**	**381.02**	**2.19**	**1.86**	**20.30**	**4.06**	**28.41**
110A	Petrol Coke	1.73	1.58			3.31	0.17	0.15			0.32
203B	Light Fuel Oil	0.22	1.08		0.00	1.30	0.02	0.08		0.00	0.10
203C	Medium Fuel Oil										
203D	Heavy Fuel Oil	0.49	0.28			0.78	0.04	0.02			0.06
204A	Gasoil	2.40	1.47		40.94	44.81	0.18	0.11		3.07	3.36
2050	Diesel	0.00	18.79	212.83	11.02	242.65	0.00	1.40	15.84	0.82	18.06
206A	Other Kerosene										
206B	Jet Kerosene			0.70		0.70			0.05		0.05
207A	Aviation Gasoline			0.07		0.07			0.01		0.01
2080	Motor Gasoline		0.14	57.89	0.96	58.99		0.01	4.40	0.07	4.48
224A	Other Petroleum Products	10.89	0.10			10.99	0.85	0.01			0.86
303A	Liquified Petroleum Gas (LPG)	2.64	1.30	0.12	1.47	5.53	0.17	0.08	0.01	0.09	0.35
308A	Refinery Gas	11.89				11.89	0.76				0.76
301A	**Total Gaseous (Natural Gas)**	**87.07**	**119.55**	**3.45**	**68.05**	**278.11**	**4.84**	**6.65**	**0.19**	**3.78**	**15.46**
	Total Other Fuel	**12.47**	**13.09**	**0.73**	**0.04**	**26.33**	**1.03**	**0.96**	**0.06**	**0.00**	**2.05**
114A	MSW non renewable	10.96				10.96	0.91				0.91
115A	Industrial Waste	1.52	13.03		0.01	14.55	0.11	0.96		0.00	1.07
225A	FAME		0.06	0.73	0.04	0.83		0.00	0.06	0.00	0.06
	Total Biomass(1)	**67.70**	**70.43**	**13.80**	**84.23**	**236.15**	**(6.19)**	**(7.23)**	**(0.98)**	**(9.35)**	**(23.75)**
111A	Fuel Wood				54.19	54.19				6.07	6.07
112A	Char Coal	0.03			0.36	0.39				0.04	0.04
114C	MSW renewable	10.09				10.09					
116A	Wood Wastes	52.66	37.59		28.04	118.29	5.90	4.21		3.14	13.25
118A	Sewage Sludge	0.33	0.62			0.95	0.04	0.07			0.11
215A	Black Liquor		28.93			28.93		2.76			2.76
250A	Liquid Biofuels		1.07	13.77	0.65	15.49		0.08	0.97	0.05	1.10
309A	Biogas	4.42	0.78	0.03	0.30	5.53	0.24	0.04	0.00	0.02	0.30
309B	Sewage Sludge Gas	0.11	1.44		0.66	2.21	0.01	0.08		0.04	0.12
310A	Landfill Gas	0.06			0.03	0.09	0.00			0.00	0.00
	Total(1)	**197.51**	**239.76**	**289.60**	**207.08**	**933.94**	**8.06**	**10.60**	**20.55**	**7.88**	**47.09**

(1) CO_2 emissions of Biomass are not included in Total.

Table A 56: 2020 energy consumption and CO_2 emissions from category 1 A Fuel Combustion by fuel type and sector.

		Consumption (PJ)					CO_2 emissions (Mt)				
		1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A	1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A
		Energy Ind.	Industry	Trans-port	Other Sectors	Total	Energy Ind.	Industry	Trans-port	Other Sectors	Total
	Total Solid	**3.86**	**14.79**	**0.00**	**0.60**	**19.25**	**0.36**	**1.39**	**0.00**	**0.06**	**1.80**
102A	Hard Coal	3.86	5.67	0.00	0.08	9.61	0.36	0.52	0.00	0.01	0.88
104A	Hard Coal Briquettes				0.03	0.03				0.00	0.00
105A	Brown Coal		1.35		0.03	1.38		0.13		0.00	0.13
106A	Brown Coal Briquettes				0.20	0.20				0.02	0.02
107A	Coke		0.32		0.25	0.58		0.03		0.02	0.06
113A	Peat										
304A	Coke Oven Gas		7.46			7.46		0.71			0.71
	Total Liquid	**30.40**	**21.85**	**272.56**	**58.35**	**383.17**	**2.30**	**1.63**	**20.34**	**4.35**	**28.62**
110A	Petrol Coke	2.25	0.63			2.88	0.23	0.06			0.29
203B	Light Fuel Oil	0.57	1.55		0.01	2.13	0.04	0.12		0.00	0.17
203C	Medium Fuel Oil										
203D	Heavy Fuel Oil	0.13	0.28			0.41	0.01	0.02			0.03
204A	Gasoil	0.14	1.08		44.23	45.45	0.01	0.08		3.32	3.41
2050	Diesel	0.00	16.97	219.16	11.41	247.54	0.00	1.26	16.31	0.85	18.42
206A	Other Kerosene										
206B	Jet Kerosene			0.61		0.61			0.04		0.04
207A	Aviation Gasoline			0.08		0.08			0.01		0.01
2080	Motor Gasoline		0.12	52.59	0.97	53.68		0.01	3.97	0.07	4.05
224A	Other Petroleum Products	18.48	0.09			18.57	1.44	0.01			1.45
303A	Liquified Petroleum Gas (LPG)	0.21	1.13	0.13	1.73	3.20	0.01	0.07	0.01	0.11	0.20
308A	Refinery Gas	8.61				8.61	0.55				0.55
301A	**Total Gaseous (Natural Gas)**	**87.79**	**121.39**	**9.35**	**76.11**	**294.64**	**4.88**	**6.75**	**0.52**	**4.23**	**16.38**
	Total Other Fuel	**12.29**	**11.65**	**0.75**	**0.04**	**24.72**	**1.02**	**0.86**	**0.06**	**0.00**	**1.93**
114A	MSW non renewable	11.23				11.23	0.94				0.94
115A	Industrial Waste	1.05	11.59		0.01	12.65	0.08	0.85		0.00	0.93
225A	FAME		0.05	0.75	0.04	0.83		0.00	0.06	0.00	0.06
	Total Biomass[(1)]	**68.31**	**63.67**	**13.95**	**81.67**	**227.60**	**(6.10)**	**(6.51)**	**(0.99)**	**(9.09)**	**(22.69)**
111A	Fuel Wood		0.01		57.52	57.54		0.00		6.44	6.44
112A	Char Coal	0.04			0.45	0.49				0.05	0.05
114C	MSW renewable	10.34				10.34					
116A	Wood Wastes	50.49	31.13		22.56	104.18	5.65	3.49		2.53	11.67
118A	Sewage Sludge	0.59	0.81			1.40	0.07	0.09			0.16
215A	Black Liquor		29.20			29.20		2.78			2.78
250A	Liquid Biofuels		0.93	13.93	0.65	15.52		0.07	0.99	0.05	1.10
309A	Biogas	6.73	0.75	0.01	0.29	7.78	0.37	0.04	0.00	0.02	0.43
309B	Sewage Sludge Gas	0.08	0.84		0.17	1.09	0.00	0.05		0.01	0.06
310A	Landfill Gas	0.03			0.01	0.05	0.00			0.00	0.00
	Total[(1)]	**202.65**	**233.36**	**296.61**	**216.76**	**949.37**	**8.55**	**10.63**	**20.91**	**8.64**	**48.74**

[(1)] CO_2 emissions of Biomass are not included in Total.

Table A 57: 2015 energy consumption and CO_2 emissions from category 1 A Fuel Combustion by fuel type and sector.

		Consumption (PJ)					CO_2 emissions (Mt)				
		1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A	1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A
		Energy Ind.	Industry	Trans-port	Other Sectors	Total	Energy Ind.	Industry	Trans-port	Other Sectors	Total
	Total Solid	**24.98**	**11.47**	**0.00**	**0.94**	**37.39**	**2.34**	**1.07**	**0.00**	**0.09**	**3.50**
102A	Hard Coal	24.98	6.25	0.00	0.06	31.29	2.34	0.57	0.00	0.01	2.91
104A	Hard Coal Briquettes				0.21	0.21				0.02	0.02
105A	Brown Coal		1.89		0.04	1.93		0.18		0.00	0.19
106A	Brown Coal Briquettes				0.20	0.20				0.02	0.02
107A	Coke		0.44		0.42	0.86		0.05		0.04	0.09
113A	Peat				0.00	0.00				0.00	0.00
304A	Coke Oven Gas		2.90			2.90		0.27			0.27
	Total Liquid	**35.91**	**22.16**	**291.99**	**61.32**	**411.38**	**2.72**	**1.68**	**21.79**	**4.58**	**30.77**
110A	Petrol Coke	1.86	1.48			3.34	0.19	0.14			0.33
203B	Light Fuel Oil	0.12	3.02		0.90	4.04	0.01	0.24		0.07	0.31
203C	Medium Fuel Oil										
203D	Heavy Fuel Oil	2.99	1.65			4.64	0.24	0.13			0.37
204A	Gasoil	0.12	0.29		47.38	47.79	0.01	0.02		3.55	3.58
2050	Diesel	0.00	14.20	227.18	10.49	251.87	0.00	1.06	16.89	0.78	18.73
206A	Other Kerosene										
206B	Jet Kerosene			0.85		0.85			0.06		0.06
207A	Aviation Gasoline			0.11		0.11			0.01		0.01
2080	Motor Gasoline		0.11	63.29	1.20	64.60		0.01	4.79	0.09	4.89
224A	Other Petroleum Products	21.64	0.30			21.94	1.69	0.02			1.71
303A	Liquified Petroleum Gas (LPG)	0.76	1.11	0.56	1.35	3.78	0.05	0.07	0.04	0.09	0.24
308A	Refinery Gas	8.42				8.42	0.54				0.54
301A	**Total Gaseous (Natural Gas)**	**75.77**	**117.66**	**11.29**	**72.71**	**277.43**	**4.20**	**6.52**	**0.63**	**4.03**	**15.37**
	Total Other Fuel	**13.30**	**10.97**	**1.13**	**0.12**	**25.52**	**1.08**	**0.83**	**0.09**	**0.01**	**2.01**
114A	MSW non renewable	10.07				10.07	0.84				0.84
115A	Industrial Waste	3.23	10.92		0.08	14.23	0.24	0.83		0.01	1.08
225A	FAME		0.05	1.13	0.04	1.22		0.00	0.09	0.00	0.09
	Total Biomass[(1)]	**70.67**	**68.48**	**18.35**	**83.15**	**240.64**	**(6.29)**	**(7.03)**	**(1.30)**	**(9.25)**	**(23.88)**
111A	Fuel Wood	0.03	0.00		60.59	60.63	0.00	0.00		6.79	6.79
112A	Char Coal	0.04			0.43	0.47				0.05	0.05
114C	MSW renewable	9.27				9.27					
116A	Wood Wastes	50.44	36.46		20.90	107.80	5.65	4.08		2.34	12.07
118A	Sewage Sludge	0.72	0.53			1.25	0.08	0.06			0.14
215A	Black Liquor		28.40			28.40		2.71			2.71
250A	Liquid Biofuels		0.96	18.33	0.76	20.05		0.07	1.30	0.05	1.42
309A	Biogas	9.94	0.79	0.02	0.28	11.04	0.54	0.04	0.00	0.02	0.60
309B	Sewage Sludge Gas	0.11	1.34		0.09	1.54	0.01	0.07		0.00	0.08
310A	Landfill Gas	0.09			0.09	0.19	0.01			0.01	0.01
	Total[(1)]	**220.63**	**230.74**	**322.76**	**218.23**	**992.36**	**10.33**	**10.11**	**22.50**	**8.70**	**51.65**

(1) CO_2 emissions of Biomass are not included in Total.

Table A 58: 2010 energy consumption and CO_2 emissions from category 1 A Fuel Combustion by fuel type and sector.

		Consumption (PJ)					CO_2 emissions (Mt)				
		1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A	1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A
		Energy Ind.	**Industry**	**Trans-port**	**Other Sectors**	**Total**	**Energy Ind.**	**Industry**	**Trans-port**	**Other Sectors**	**Total**
	Total Solid	**41.47**	**9.39**	**0.00**	**2.89**	**53.75**	**3.87**	**0.88**	**0.00**	**0.27**	**5.02**
102A	Hard Coal	41.47	6.07	0.00	0.28	47.82	3.87	0.56	0.00	0.03	4.45
104A	Hard Coal Briquettes				0.40	0.40				0.04	0.04
105A	Brown Coal		1.57		0.10	1.68		0.15		0.01	0.16
106A	Brown Coal Briquettes				0.59	0.59				0.06	0.06
107A	Coke		0.35		1.51	1.86		0.04		0.14	0.18
113A	Peat				0.00	0.00				0.00	0.00
304A	Coke Oven Gas		1.40			1.40		0.13			0.13
	Total Liquid	**38.90**	**29.66**	**292.87**	**77.98**	**439.41**	**2.90**	**2.24**	**21.86**	**5.80**	**32.79**
110A	Petrol Coke	1.75	1.44			3.20	0.18	0.14			0.32
203B	Light Fuel Oil	0.15	4.91		1.79	6.86	0.01	0.38		0.14	0.53
203C	Medium Fuel Oil	1.79				1.79	0.14				0.14
203D	Heavy Fuel Oil	6.43	3.03			9.46	0.51	0.24			0.75
204A	Gasoil	0.11	3.21		59.67	62.98	0.01	0.24		4.47	4.72
2050	Diesel	0.00	14.37	221.34	10.70	246.40	0.00	1.07	16.42	0.79	18.27
206A	Other Kerosene		0.01			0.01		0.00			0.00
206B	Jet Kerosene			1.12		1.12			0.08		0.08
207A	Aviation Gasoline			0.12		0.12			0.01		0.01
2080	Motor Gasoline		0.11	69.40	1.38	70.88		0.01	5.29	0.11	5.41
224A	Other Petroleum Products	15.34	0.52			15.85	1.20	0.04			1.23
303A	Liquified Petroleum Gas (LPG)	1.30	2.07	0.89	4.45	8.71	0.08	0.13	0.06	0.28	0.56
308A	Refinery Gas	12.02				12.02	0.77				0.77
301A	**Total Gaseous (Natural Gas)**	**107.75**	**128.69**	**8.74**	**83.50**	**328.68**	**5.97**	**7.13**	**0.48**	**4.63**	**18.21**
	Total Other Fuel	**10.97**	**11.21**	**0.92**	**0.10**	**23.20**	**0.89**	**0.79**	**0.07**	**0.01**	**1.75**
114A	MSW non renewable	7.49				7.49	0.62				0.62
115A	Industrial Waste	3.48	11.16		0.06	14.70	0.26	0.79		0.00	1.05
225A	FAME		0.05	0.92	0.04	1.01		0.00	0.07	0.00	0.08
	Total Biomass(1)	**62.23**	**66.51**	**15.76**	**86.53**	**231.04**	**(5.89)**	**(6.88)**	**(1.12)**	**(9.64)**	**(23.53)**
111A	Fuel Wood	0.04	0.65		69.13	69.82	0.00	0.07		7.74	7.82
112A	Char Coal	0.04			0.37	0.41				0.04	0.04
114C	MSW renewable	6.89				6.89					
116A	Wood Wastes	49.83	34.77		15.93	100.53	5.58	3.89		1.78	11.26
118A	Sewage Sludge	0.22	0.69			0.92	0.03	0.08			0.10
215A	Black Liquor		28.53			28.53		2.72			2.72
250A	Liquid Biofuels		0.80	15.76	0.66	17.22		0.06	1.12	0.05	1.22
309A	Biogas	4.78	0.51	0.00	0.10	5.39	0.26	0.03	0.00	0.01	0.29
309B	Sewage Sludge Gas	0.32	0.55		0.27	1.13	0.02	0.03		0.01	0.06
310A	Landfill Gas	0.12			0.07	0.19	0.01			0.00	0.01
	Total(1)	**261.32**	**245.46**	**318.29**	**251.00**	**1 076.07**	**13.62**	**11.04**	**22.41**	**10.70**	**57.77**

(1) CO_2 emissions of Biomass are not included in Total.

Table A 59: 2005 energy consumption and CO_2 emissions from category 1 A Fuel Combustion by fuel type and sector.

		Consumption (PJ)					CO_2 emissions (Mt)				
		1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A	1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A
		Energy Ind.	**Industry**	**Trans-port**	**Other Sectors**	**Total**	**Energy Ind.**	**Industry**	**Trans-port**	**Other Sectors**	**Total**
	Total Solid	**61.63**	**18.43**	**0.01**	**4.81**	**84.88**	**5.84**	**1.72**	**0.00**	**0.45**	**8.01**
102A	Hard Coal	51.51	7.65	0.01	1.37	60.54	4.81	0.71	0.00	0.13	5.64
104A	Hard Coal Briquettes				0.03	0.03				0.00	0.00
105A	Brown Coal	10.12	2.54		0.16	12.82	1.04	0.22		0.02	1.27
106A	Brown Coal Briquettes		0.00		1.01	1.01		0.00		0.10	0.10
107A	Coke		1.15		2.23	3.38		0.12		0.21	0.32
113A	Peat				0.00	0.00				0.00	0.00
304A	Coke Oven Gas		7.09			7.09		0.67			0.67
	Total Liquid	**45.18**	**30.94**	**326.88**	**105.60**	**508.59**	**3.42**	**2.37**	**24.41**	**7.87**	**38.07**
110A	Petrol Coke	2.07	2.05			4.12	0.21	0.19			0.40
203B	Light Fuel Oil	0.17	7.14		9.23	16.53	0.01	0.56		0.71	1.28
203C	Medium Fuel Oil	2.29	0.00			2.29	0.18	0.00			0.18
203D	Heavy Fuel Oil	11.39	4.14			15.53	0.90	0.32			1.23
204A	Gasoil	0.19	4.94		77.61	82.73	0.01	0.37		5.82	6.21
2050	Diesel	0.01	10.80	240.59	11.74	263.14	0.00	0.80	17.84	0.87	19.52
206A	Other Kerosene		0.02			0.02		0.00			0.00
206B	Jet Kerosene			1.28		1.28			0.09		0.09
207A	Aviation Gasoline			0.12		0.12			0.01		0.01
2080	Motor Gasoline		0.11	83.96	1.65	85.72		0.01	6.40	0.13	6.54
224A	Other Petroleum Products	17.28	0.17			17.45	1.35	0.01			1.36
303A	Liquified Petroleum Gas (LPG)	2.29	1.56	0.93	5.37	10.15	0.15	0.10	0.06	0.34	0.65
308A	Refinery Gas	9.49				9.49	0.61				0.61
301A	**Total Gaseous (Natural Gas)**	**111.65**	**119.95**	**6.49**	**89.65**	**327.73**	**6.19**	**6.65**	**0.36**	**4.97**	**18.16**
	Total Other Fuel	**6.07**	**7.89**	**0.17**	**1.08**	**15.22**	**0.49**	**0.48**	**0.01**	**0.08**	**1.07**
114A	MSW non renewable	4.62				4.62	0.39				0.39
115A	Industrial Waste	1.45	7.88		1.07	10.41	0.11	0.48		0.08	0.67
225A	FAME		0.01	0.17	0.01	0.18		0.00	0.01	0.00	0.01
	Total Biomass(1)	**24.71**	**58.24**	**2.20**	**67.64**	**152.79**	**(2.08)**	**(6.00)**	**(0.16)**	**(7.55)**	**(15.79)**
111A	Fuel Wood	0.04	1.14		57.69	58.87	0.00	0.13		6.46	6.59
112A	Char Coal	0.03			0.36	0.39				0.04	0.04
114C	MSW renewable	4.26				4.26					
116A	Wood Wastes	16.55	29.10		9.09	54.74	1.85	3.26		1.02	6.13
118A	Sewage Sludge	0.25	0.04			0.29	0.03	0.00			0.03
215A	Black Liquor		26.65			26.65		2.54			2.54
250A	Liquid Biofuels		0.10	2.20	0.11	2.40		0.01	0.16	0.01	0.17
309A	Biogas	2.85	0.43		0.14	3.42	0.16	0.02		0.01	0.19
309B	Sewage Sludge Gas	0.69	0.64		0.06	1.39	0.04	0.04		0.00	0.08
310A	Landfill Gas	0.04	0.15		0.19	0.38	0.00	0.01		0.01	0.02
	Total(1)	**249.25**	**235.44**	**335.74**	**268.77**	**1 089.21**	**15.95**	**11.21**	**24.78**	**13.37**	**65.31**

(1) CO_2 emissions of Biomass are not included in Total.

Table A 60: 2000 energy consumption and CO_2 emissions from category 1 A Fuel Combustion by fuel type and sector.

		Consumption (PJ)					CO_2 emissions (Mt)				
		1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A	1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A
		Energy Ind.	Industry	Trans-port	Other Sectors	Total	Energy Ind.	Industry	Trans-port	Other Sectors	Total
	Total Solid	**49.16**	**15.21**	**0.03**	**10.33**	**74.72**	**4.82**	**1.45**	**0.00**	**0.97**	**7.25**
102A	Hard Coal	37.36	10.31	0.03	2.16	49.85	3.53	0.97	0.00	0.20	4.70
104A	Hard Coal Briquettes				0.12	0.12				0.01	0.01
105A	Brown Coal	11.80	1.90		0.64	14.34	1.29	0.18		0.07	1.55
106A	Brown Coal Briquettes		0.00		2.06	2.06		0.00		0.20	0.20
107A	Coke		1.19		5.35	6.54		0.12		0.49	0.62
113A	Peat				0.00	0.00				0.00	0.00
304A	Coke Oven Gas		1.81			1.81		0.17			0.17
	Total Liquid	**41.55**	**24.71**	**244.93**	**106.01**	**417.20**	**3.04**	**1.88**	**18.32**	**7.94**	**31.18**
110A	Petrol Coke	1.63	0.81			2.44	0.16	0.08			0.25
203B	Light Fuel Oil	1.81	5.52		15.69	23.02	0.14	0.43		1.21	1.78
203C	Medium Fuel Oil				1.47	1.47				0.11	0.11
203D	Heavy Fuel Oil	13.04	6.59		0.14	19.77	1.04	0.51		0.01	1.56
204A	Gasoil	0.01	1.61		71.98	73.59	0.00	0.12		5.40	5.52
2050	Diesel	0.04	7.32	162.80	11.06	181.22	0.00	0.54	12.07	0.82	13.44
206A	Other Kerosene				0.26	0.26				0.02	0.02
206B	Jet Kerosene			1.36		1.36			0.10		0.10
207A	Aviation Gasoline			0.08		0.08			0.01		0.01
2080	Motor Gasoline		0.11	80.02	1.72	81.84		0.01	6.10	0.13	6.24
224A	Other Petroleum Products	9.74	0.21			9.96	0.76	0.01			0.77
303A	Liquified Petroleum Gas (LPG)	0.94	2.54	0.67	3.70	7.85	0.06	0.16	0.04	0.24	0.50
308A	Refinery Gas	14.33				14.33	0.87				0.87
301A	**Total Gaseous (Natural Gas)**	**74.27**	**111.77**	**6.10**	**73.11**	**265.25**	**4.11**	**6.19**	**0.34**	**4.05**	**14.69**
	Total Other Fuel	**3.24**	**6.25**		**0.56**	**10.05**	**0.29**	**0.38**		**0.04**	**0.71**
114A	MSW non renewable	2.42				2.42	0.23				0.23
115A	Industrial Waste	0.82	6.25		0.56	7.63	0.06	0.38		0.04	0.49
225A	FAME										
	Total Biomass[(1)]	**10.30**	**40.83**		**69.27**	**120.41**	**(0.90)**	**(4.13)**		**(7.73)**	**(12.76)**
111A	Fuel Wood		0.95		59.22	60.17		0.11		6.63	6.74
112A	Char Coal	0.03			0.31	0.34				0.03	0.03
114C	MSW renewable	2.23				2.23					
116A	Wood Wastes	7.67	15.15		9.24	32.05	0.86	1.70		1.03	3.59
118A	Sewage Sludge	0.28				0.28	0.03				0.03
215A	Black Liquor		24.06			24.06		2.29			2.29
250A	Liquid Biofuels										
309A	Biogas	0.00	0.31		0.05	0.36	0.00	0.02		0.00	0.02
309B	Sewage Sludge Gas	0.08	0.36		0.03	0.47	0.00	0.02		0.00	0.03
310A	Landfill Gas	0.01			0.43	0.44	0.00			0.02	0.02
	Total[(1)]	**178.52**	**198.78**	**251.06**	**259.28**	**887.64**	**12.26**	**9.90**	**18.66**	**13.01**	**53.83**

(1) CO_2 emissions of Biomass are not included in Total.

Table A 61: 1995 energy consumption and CO_2 emissions from category 1 A Fuel Combustion by fuel type and sector.

		Consumption (PJ)					CO_2 emissions (Mt)				
		1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A	1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A
		Energy Ind.	Industry	Trans-port	Other Sectors	Total	Energy Ind.	Industry	Trans-port	Other Sectors	Total
	Total Solid	**45.49**	**15.72**	**0.06**	**18.59**	**79.86**	**4.53**	**1.50**	**0.01**	**1.75**	**7.78**
102A	Hard Coal	29.90	7.45	0.06	4.11	41.52	2.82	0.70	0.01	0.38	3.91
104A	Hard Coal Briquettes										
105A	Brown Coal	15.58	2.29		1.14	19.00	1.71	0.22		0.12	2.05
106A	Brown Coal Briquettes		0.28		3.05	3.32		0.03		0.30	0.32
107A	Coke		0.78		10.30	11.08		0.08		0.95	1.03
113A	Peat				0.00	0.00				0.00	0.00
304A	Coke Oven Gas		4.93			4.93		0.47			0.47
	Total Liquid	**46.34**	**33.87**	**205.75**	**107.92**	**393.87**	**3.73**	**2.59**	**15.46**	**8.09**	**29.86**
110A	Petrol Coke	1.87	0.37			2.24	0.19	0.04			0.23
203B	Light Fuel Oil	1.39	11.55		17.79	30.73	0.11	0.90		1.37	2.38
203C	Medium Fuel Oil	0.11	0.00		2.32	2.43	0.01	0.00		0.18	0.19
203D	Heavy Fuel Oil	17.70	13.77		0.46	31.93	1.41	1.07		0.04	2.52
204A	Gasoil	0.09	0.20		70.50	70.80	0.01	0.02		5.29	5.31
2050	Diesel	0.28	4.82	106.98	10.61	122.69	0.02	0.36	7.93	0.79	9.10
206A	Other Kerosene				0.26	0.26				0.02	0.02
206B	Jet Kerosene			1.05		1.05			0.08		0.08
207A	Aviation Gasoline			0.09		0.09			0.01		0.01
2080	Motor Gasoline		0.07	97.13	1.80	99.00		0.01	7.41	0.14	7.55
224A	Other Petroleum Products	8.88	0.21		0.01	9.10	0.69	0.01		0.00	0.71
303A	Liquified Petroleum Gas (LPG)	1.06	2.88	0.49	4.18	8.61	0.07	0.18	0.03	0.27	0.55
308A	Refinery Gas	14.95				14.95	1.23				1.23
301A	**Total Gaseous (Natural Gas)**	**80.70**	**99.58**	**4.09**	**74.06**	**258.43**	**4.47**	**5.52**	**0.23**	**4.10**	**14.32**
	Total Other Fuel	**3.25**	**5.27**		**0.52**	**9.04**	**0.28**	**0.37**		**0.04**	**0.69**
114A	MSW non renewable	2.04				2.04	0.19				0.19
115A	Industrial Waste	1.22	5.27		0.52	7.01	0.09	0.37		0.04	0.50
225A	FAME										
	Total Biomass[(1)]	**5.93**	**35.65**		**69.85**	**111.43**	**(0.45)**	**(3.63)**		**(7.79)**	**(11.86)**
111A	Fuel Wood		1.07		66.28	67.35		0.12		7.42	7.54
112A	Char Coal	0.03			0.28	0.31				0.03	0.03
114C	MSW renewable	1.87				1.87					
116A	Wood Wastes	3.77	13.04		2.63	19.44	0.42	1.46		0.29	2.18
118A	Sewage Sludge	0.21				0.21	0.02				0.02
215A	Black Liquor		21.39			21.39		2.04			2.04
250A	Liquid Biofuels										
309A	Biogas		0.04			0.04		0.00			0.00
309B	Sewage Sludge Gas	0.01	0.00		0.61	0.62	0.00	0.00		0.03	0.03
310A	Landfill Gas	0.03	0.12		0.05	0.20	0.00	0.01		0.00	0.01
	Total[(1)]	**181.70**	**190.09**	**209.90**	**270.95**	**852.64**	**13.01**	**9.97**	**15.69**	**13.98**	**52.65**

(1) CO_2 emissions of Biomass are not included in Total.

Table A 62: 1990 energy consumption and CO_2 emissions from category 1 A Fuel Combustion by fuel type and sector.

		Consumption (PJ)					CO_2 emissions (Mt)				
		1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A	1 A 1	1 A 2	1 A 3 + 1 A 5	1 A 4	1 A
		Energy Ind.	**Industry**	**Trans-port**	**Other Sectors**	**Total**	**Energy Ind.**	**Industry**	**Trans-port**	**Other Sectors**	**Total**
	Total Solid	**61.40**	**23.87**	**0.07**	**28.13**	**113.46**	**6.25**	**2.28**	**0.01**	**2.65**	**11.18**
102A	Hard Coal	38.44	7.17	0.07	5.28	50.96	3.85	0.67	0.01	0.49	5.03
104A	Hard Coal Briquettes										
105A	Brown Coal	22.73	2.19		2.36	27.28	2.37	0.21		0.26	2.84
106A	Brown Coal Briquettes	0.23	1.24		4.45	5.91	0.02	0.12		0.43	0.57
107A	Coke		1.66		16.04	17.69		0.17		1.48	1.65
113A	Peat				0.00	0.00				0.00	0.00
304A	Coke Oven Gas		11.61			11.61		1.10			1.10
	Total Liquid	**43.15**	**36.10**	**179.98**	**109.16**	**368.39**	**3.19**	**2.78**	**13.56**	**8.23**	**27.76**
110A	Petrol Coke	1.96	0.96			2.92	0.20	0.10			0.29
203B	Light Fuel Oil	1.61	10.99		33.54	46.14	0.13	0.86		2.58	3.57
203C	Medium Fuel Oil	0.29	0.01		4.47	4.77	0.02	0.00		0.35	0.37
203D	Heavy Fuel Oil	13.67	17.40		1.63	32.71	1.08	1.36		0.13	2.56
204A	Gasoil	0.00	0.06		52.94	53.00	0.00	0.00		3.97	3.97
2050	Diesel	0.01	3.40	74.93	10.80	89.14	0.00	0.25	5.56	0.80	6.61
206A	Other Kerosene				0.74	0.74				0.06	0.06
206B	Jet Kerosene			0.87		0.87			0.06		0.06
207A	Aviation Gasoline			0.10		0.10			0.01		0.01
2080	Motor Gasoline		0.05	103.66	1.85	105.56		0.00	7.91	0.14	8.05
224A	Other Petroleum Products	6.93	0.24		0.87	8.03	0.54	0.02		0.06	0.61
303A	Liquified Petroleum Gas (LPG)	0.41	2.99	0.41	2.32	6.14	0.03	0.19	0.03	0.15	0.39
308A	Refinery Gas	18.28				18.28	1.20				1.20
301A	**Total Gaseous (Natural Gas)**	**76.48**	**76.99**	**4.05**	**46.46**	**203.98**	**4.24**	**4.27**	**0.22**	**2.57**	**11.30**
	Total Other Fuel	**3.50**	**3.22**		**1.11**	**7.83**	**0.29**	**0.21**		**0.08**	**0.58**
114A	MSW non renewable	1.26				1.26	0.12				0.12
115A	Industrial Waste	2.25	3.22		1.11	6.58	0.17	0.21		0.08	0.46
225A	FAME										
	Total Biomass[(1)]	**2.82**	**29.45**		**64.46**	**96.73**	**(0.18)**	**(3.00)**		**(7.22)**	**(10.40)**
111A	Fuel Wood		0.66		62.46	63.12		0.07		7.00	7.07
112A	Char Coal	0.03			0.22	0.25				0.02	0.02
114C	MSW renewable	1.16				1.16					
116A	Wood Wastes	1.44	10.99		1.79	14.22	0.16	1.23		0.20	1.59
118A	Sewage Sludge	0.19				0.19	0.02				0.02
215A	Black Liquor		17.80			17.80		1.70			1.70
250A	Liquid Biofuels										
309A	Biogas										
309B	Sewage Sludge Gas										
310A	Landfill Gas										
	Total[(1)]	**187.35**	**169.63**	**184.10**	**249.32**	**790.39**	**13.96**	**9.53**	**13.79**	**13.54**	**50.83**

[(1)] CO_2 emissions of Biomass are not included in Total.

Annex 3.3 – CO_2 Reference Approach

This annex presents the results, methodology and detailed data for the CO_2 reference approach.

Methodology

The default methodology is applied.

Emission factors

Carbon emission factors

For estimation of emissions that arise from combustion of fossil fuels, the default carbon emission factors described in chapter 1.4.1.1 of the IPCC 1996 Reference Manual have been used (IPCC Workbook 1.6 table 1-2) except for natural gas and coal, where country specific values have been used.

Fraction of carbon oxidised

Default values of table 1-6 of the IPCC 1996 Reference Manual have been used for coal and biomass. For liquid fuels and natural gas 100% combustion efficiency is assumed. Selected values are presented Table A 67.

Activity data

Production, Imports, Exports, Stock Change

Activity data are taken from the national energy balance (IEA JQ 2024) (see Annex 3.1 and Annex 3.4). The reference approach requires more detailed fuel categories than provided in the national energy balance. Some fuel categories are aggregations of the detailed fuel categories the reference approach asks for. The following fuel types are included elsewhere:

- Ethane is included in Refinery Feedstocks.

Conversion factors

For the most important solid and liquid fuels country specific conversion factors in the unit TJ/Gg are selected. Selected values are presented below.

International Bunkers

International bunkers are relevant for aviation and international navigation on rivers (mostly Danube), the Neusiedler Lake and the Lake Constance.

Fuel consumption of international bunkers is consistent with memo item international bunkers as described in the relevant chapter for Category 1.A.3.

Carbon Stored (C excluded)

A high amount of residual fuel oil is considered as a reductant in blast furnaces (CRT 2.C.1).

Naphta is used as feedstock for ethylen production in petrochemical plants.

Non-energy use of Bitumen is considered to be 100% stored (e.g. as Asphalt concrete).

The share of Petroleum coke which is used for calcium carbide production is considered to be 100% stored.

Non energy use of other oil products is considered to be 100% stored.

A high amount of other bituminous coal is considered as a reductant in blast furnaces (CRT 2.C.1).

A high amount of Coke oven coke is considered as a reductant in blast furnaces (CRT 2.C.1).

Coal tar imports are considered as a reductant in blast furnaces (CRT 2.C.1).

Natural gas used for Ammonia production is excluded from the RA and emissions are reported under CRT 2.B.1

A share of waste plastics are considered as a reductant in blast furnaces (CRT 2.C.1).

In the Sectoral Approach, the release of stored carbon as emissions is considered as quoted in the NID, chapter *3.4 Feedstock*.

Recalculations

Activity data

Imports, Exports and Production are updated according to the new version of the energy balance (IEA JQ 2024). Changes of activity data are based on energy balance recalculations.

Revised Methodology

Since submission 2021, the reference approach considers energy balance data of pure fossil diesel and gasoline while in previous submissions blended biofuels were included in those fuel data.

Because of the exclusion of blended biofuels from motor diesel and gasoline, these fuels are now included in 'liquid biomass'.

The carbon content of waste non-biomass fraction in the reference approach has been harmonized with the sectoral approach.

Results of the Reference Approach

Table A 63 to Table A 68 present calculation results, apparent fuel consumption, carbon stored, international bunker fuels, conversion factors, carbon emission factors and the fraction of carbon oxidised for all fuel types of the Reference Approach.

Table A 63 presents the calculation results for each fuel type of the Reference Approach for selected years.

Table A 63: Actual CO_2 emissions (kt CO_2) for selected years.

Fuel Type	1990	2000	2005	2010	2015	2019	2020	2021	2022	2023
Crude Oil	24 784	25 694	27 249	24 056	27 591	28 438	25 456	25 690	17 505	25 002
Orimulsion	0	0	0	0	0	0	0	0	0	0
Natural Gas Liquids	110	287	209	360	141	43	39	31	30	25
Gasoline	-248	488	910	1 012	-349	-1 054	-1 097	-1 082	399	100
Jet Kerosene	-846	-1 588	-1 737	-1 398	-1 920	-2 683	-1 062	-1 023	-1 297	-2 142
Other Kerosene	-44	16	-2	-1	-1	-1	-1	0	-1	-1
Shale Oil	0	0	0	0	0	0	0	0	0	0
Gas / Diesel Oil	1 755	7 093	13 476	12 954	10 676	11 585	10 727	11 763	14 929	10 281

Fuel Type	1990	2000	2005	2010	2015	2019	2020	2021	2022	2023
Residuel Fuel Oil	650	399	-373	-539	-1 494	-1 124	-1 214	-978	-866	-1 236
LPG	249	398	329	296	-163	-152	-140	-189	41	-108
Ethane	0	0	0	0	0	0	0	0	0	0
Naphtha	-1 357	-1 828	-1 474	-2 257	-2 974	-3 155	-3 296	-3 410	-2 577	-2 472
Bitumen	-907	-1 207	-1 234	-986	-979	-1 332	-1 431	-1 483	-794	-1 348
Lubricants	155	-173	-216	-182	55	53	48	74	98	81
Petroleum Coke	97	82	207	140	149	95	64	141	172	183
Refinery Feedstocks	3 019	1 620	873	357	-211	978	358	398	1 181	-17
OtherOil	432	-26	-193	-620	43	36	-49	-48	-5	-51
Liquid Fossil Totals	27 849	31 254	38 023	33 193	30 564	31 727	28 402	29 883	28 816	28 298
Anthracite	40	7	12	8	10	55	57	73	5	2
Coking Coal	7 004	5 626	5 625	4 709	4 615	4 631	4 617	4 640	4 693	4 603
Other Bit. Coal	4 713	4 809	5 808	4 559	2 984	1 682	1 001	308	168	132
Sub- Bit. Coal	0	79	137	141	171	138	124	113	133	92
Lignite	2 729	1 319	1 205	13	11	3	5	7	6	7
Oil Shale	0	0	0	0	0	0	0	0	0	0
BKB & Patent Fuel	548	198	96	78	31	21	22	24	19	13
Coke Oven / Gas Coke	-3 269	-3 383	-3 565	-3 923	-3 664	-3 269	-3 484	-3 807	-3 527	-3 332
Coal Tar	0	-143	-1	-2	-140	-122	-83	-129	-129	-111
Solid Fossil Totals	11 766	8 512	9 318	5 583	4 018	3 139	2 260	1 230	1 365	1 406
Gaseous Fossil	11 417	14 791	18 293	18 365	15 522	17 349	16 546	17 497	15 619	13 271
Waste (non-biomass fraction)	580	714	1 059	1 678	1 919	1 879	1 870	1 931	1 985	1 976
Peat	0	0	0	0	0	0	0	0	0	0
Fossil Totals	51 612	55 270	66 693	58 819	52 024	54 094	49 078	50 540	47 785	44 951
Biomass Totals	9 270	11 550	14 694	22 203	23 125	21 832	21 736	23 823	22 792	23 450
Solid Biomass	9 197	11 254	13 584	19 354	19 035	18 640	18 823	21 040	20 065	19 523
Liquid Biomass	19	51	382	1 775	2 286	1 735	1 471	1 530	1 411	1 788
Gas Biomass	0	140	544	730	1 353	985	963	740	816	1 598
Other non-fossil fuels (biogenic waste)	55	105	184	344	450	472	479	513	501	541

Table A 64 presents the apparent fuel consumption for each fuel type of the Reference Approach.

Table A 64: Apparent Consumption (TJ) for selected years.

Fuel Type	1990	2000	2005	2010	2015	2019	2020	2021	2022	2023
Crude Oil	337 960	350 367	371 572	328 037	376 237	387 788	347 127	350 323	238 710	340 935
Orimulsion	0	0	0	0	0	0	0	0	0	0
Natural Gas Liquids	1 743	4 550	3 315	5 711	2 238	684	615	488	473	404
Gasoline	-3 203	7 140	13 229	14 663	-4 992	-15 170	-15 774	-15 565	5 802	1 478
Jet Kerosene	-11 826	-22 204	-24 294	-19 558	-26 852	-37 521	-14 858	-14 304	-18 135	-29 961
Other Kerosene	-610	217	110	50	24	24	13	21	20	17
Shale Oil	0	0	0	0	0	0	0	0	0	0
Gas / Diesel Oil	23 699	95 763	181 950	174 902	144 138	156 411	144 823	158 814	201 564	138 804
Residuel Fuel Oil	13 243	14 769	4 898	1 420	-18 355	-14 532	-15 696	-12 639	-11 190	-15 981
LPG	3 943	6 307	5 210	4 696	-1 420	-1 740	-1 521	-2 339	2 093	-661
Ethane	0	0	0	0	0	0	0	0	0	0
Naphtha	90	0	1 230	89	-6 515	190	-65	-253	474	9
Bitumen	11 328	10 643	7 878	7 219	5 993	4 326	977	860	6 210	-909
Lubricants	5 506	-84	-1 278	-972	1 506	1 432	1 317	2 005	2 671	2 217
Petroleum Coke	2 881	2 069	3 313	3 246	1 918	1 188	637	1 434	2 268	2 091
Refinery Feedstocks	41 163	22 090	11 900	4 873	-2 876	13 332	4 882	5 427	16 103	-235
OtherOil	6 646	393	-1 487	-7 462	2 449	2 612	1 430	1 416	1 180	1 094
Liquid Fossil Totals	432 562	492 018	577 546	516 913	473 493	499 025	453 907	475 687	448 243	439 301
Anthracite	448	84	142	99	131	612	605	784	72	38
Coking Coal	67 937	54 564	55 252	53 630	51 356	50 979	50 608	50 953	51 482	51 667
Other Bit. Coal	50 568	51 604	62 304	53 439	55 150	39 020	30 408	28 447	23 191	19 729
Sub- Bit. Coal	0	844	1 451	1 499	1 811	1 465	1 320	1 197	1 409	974

Fuel Type	1990	2000	2005	2010	2015	2019	2020	2021	2022	2023
Lignite	27 294	13 188	11 861	132	114	30	49	68	57	70
Oil Shale	0	0	0	0	0	0	0	0	0	0
BKB & Patent Fuel	5 912	2 134	1 032	838	333	226	237	259	200	146
Coke Oven / Gas Coke	19 304	30 110	36 977	33 751	29 222	29 943	22 107	27 411	28 990	29 358
Coal Tar	0	-1 810	91	36	-1 759	-1 409	-1 038	-1 586	-1 512	-1 365
Solid Fossil Totals	171 462	150 718	169 112	143 424	136 357	120 865	104 296	107 533	103 889	100 618
Gaseous Fossil	219 239	275 836	338 534	340 091	289 239	321 403	306 427	323 717	288 460	246 722
Waste (non-biomass fraction)	8 073	10 509	16 654	25 649	27 899	26 372	27 981	27 618	28 936	28 122
Peat	4	4	4	4	4	0	0	0	0	0
Fossil Totals	831 340	929 086	1 101 850	1 026 082	926 992	967 666	892 611	934 556	869 528	814 763
Biomass Totals	96 503	120 409	153 723	236 337	246 781	232 789	231 233	253 413	242 567	249 017
Solid Biomass	95 324	116 649	140 804	200 603	197 301	193 204	195 104	218 084	207 976	202 355
Liquid Biomass	262	720	4 882	23 313	29 600	22 701	19 327	19 997	18 764	23 025
Gas Biomass	0	1 275	4 961	6 663	12 341	8 983	8 787	6 753	7 445	14 580
Other non-fossil fuels (biogenic waste)	917	1 765	3 076	5 758	7 540	7 901	8 016	8 578	8 383	9 057

Table A 65 presents the carbon stored for each fuel type of the Reference Approach.

Table A 65: Carbon Stored (kt C) for selected years

Fuel Type	1990	2000	2005	2010	2015	2019	2020	2021	2022	2023
Crude Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orimulsion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natural Gas Liquids	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gasoline	7.05	1.79	1.75	1.18	0.88	0.81	0.95	0.85	0.83	0.76
Jet Kerosene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Kerosene	0.00	0.00	2.60	1.13	0.70	0.65	0.44	0.55	0.53	0.49
Shale Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas / Diesel Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residuel Fuel Oil	102.08	202.84	204.95	177.08	20.12	0.00	0.00	0.00	0.00	0.00
LPG	0.00	0.00	0.00	0.00	20.15	11.61	11.96	11.45	24.90	17.97
Ethane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Naphtha	372.01	498.58	426.63	617.38	680.87	864.19	897.48	924.92	712.19	674.30
Bitumen	496.58	563.27	509.96	427.64	398.92	458.37	411.66	423.42	353.28	347.53
Lubricants	67.90	45.56	33.44	30.26	15.00	14.29	13.17	20.05	26.71	22.17
Petroleum Coke	52.82	34.51	34.69	50.98	12.07	6.67	0.16	1.05	15.37	7.49
Refinery Feedstocks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OtherOil	15.05	15.05	23.01	19.92	37.13	42.45	41.93	41.36	24.96	35.80
Liquid Fossil Totals	1 113.49	1 361.59	1 237.04	1 325.57	1 185.85	1 399.04	1 377.76	1 423.65	1 158.76	1 106.51
Anthracite	0.75	0.38	0.36	0.35	0.65	1.20	0.42	0.61	0.65	0.48
Coking Coal	37.10	29.59	56.04	51.63	37.94	25.98	24.83	23.18	21.84	48.21
Other Bit. Coal	0.00	0.00	0.00	116.01	597.08	535.10	500.08	644.51	541.79	478.42
Sub- Bit. Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lignite	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oil Shale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BKB & Patent Fuel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coke Oven / Gas Coke	1 474.97	1 823.38	2 066.73	2 092.32	1 903.61	1 822.25	1 643.37	1 889.33	1 855.41	1 813.50
Coal Tar	0.00	0.00	2.31	1.40	0.17	2.88	0.20	0.98	2.63	0.94
Solid Fossil Totals	1 512.83	1 853.35	2 123.13	2 260.30	2 539.28	2 384.54	2 168.69	2 557.62	2 419.69	2 340.62
Gaseous Fossil	198.77	133.78	125.93	129.72	136.83	142.20	133.97	136.78	114.47	121.94
Waste (non-biomass fraction)	0.00	0.00	0.00	51.06	30.81	19.40	30.31	32.20	30.17	28.58
Peat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fossil Totals	2 825.08	3 348.72	3 486.10	3 715.58	3 861.96	3 925.77	3 680.43	4 118.04	3 692.93	3 569.06
Biomass Totals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solid Biomass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liquid Biomass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Fuel Type	1990	2000	2005	2010	2015	2019	2020	2021	2022	2023
Gas Biomass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other non-fossil fuels (biogenic waste)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A 66 presents international bunker fuels for the relevant fuel types of the Reference Approach.

Table A 66: International Bunkers [kt fuel].

Fuel Type	1990	2000	2005	2010	2015	2019	2020	2021	2022	2023
Jet Kerosene	279	538	622	650	675	923	331	390	624	836
Diesel	15	21	24	21	15	14	13	19	10	10

Table A 67 presents conversion factors, carbon emission factors and the fraction of carbon oxidised for all fuel types of the Reference Approach. Country specific values are provided only were relevant.

Table A 67: Conversion factor, carbon emission factor and fraction of carbon oxidised for the year 2023.

	Conversion Factor [TJ/kt]		Carbon emission factor [t C/TJ]		
Fuel Type	**Default value**	**Country specific value 2023**	**Default value**	**Country specific value 2021**	**Fraction of carbon oxidised [t C/t C]**
Crude Oil	42.75	42.50	20.00	-	1.00
Natural Gas Liquids	45.22	42.50	17.20	-	1.00
Gasoline	44.80	41.51	18.90	-	1.00
Jet Kerosene	44.59	43.30	19.50	-	1.00
Other Kerosene	44.75	43.30	19.60	-	1.00
Gas / Diesel Oil	43.33	42.37	20.20	-	1.00
Residuel Fuel Oil	40.19	41.56	21.10	-	1.00
LPG	47.31	46.12	17.20	-	1.00
Ethane	-	-	-	-	1.00
Naphtha	45.01	45.01	20.00	-	1.00
Bitumen	40.19	41.80	22.00	-	1.00
Lubricants	40.19	41.80	20.00	-	1.00
Petroleum Coke	31.00	30.28	27.50	-	1.00
Refinery Feedstocks	42.50	41.70	20.00	-	1.00
OtherOil	40.19	46.18	20.00	-	1.00
Anthracite	28.00	28.00	26.80	-	0.98
Coking Coal	28.00	30.19	25.80	25.73	0.98
Other Bit. Coal	28.00	30.16	25.80	26.11	0.98
Sub- Bit. Coal	22.20	22.02	26.20	-	0.98
Lignite	10.90	18.54	27.60	26.97	0.98
BKB & Patent Fuel	19.30	19.30	25.80	-	0.98
Coke Oven / Gas Coke	28.20	28.50	29.50	30.19	0.98
Coal Tar		37.01	22.01	-	0.98
Natural Gas	-	-	15.30	15.16	1.00
Waste (non-biomass fraction)	-	-		20.18	1.00
Peat	8.80	-	28.90	-	1.00
Solid Biomass	-	-	29.90	29.90	0.88
Liquid Biomass	-	36.85	-	21.18	1.00
Gas Biomass	-	-	29.90	29.90	1.00
Other non-fossil fuels (biogenic waste)	-	-	27.30	16.29	1.00

Table A 68 presents selected country specific conversion factors. From 2007 on the conversion factor of lignite is higher because indigenous production and use of lignite with a comparable low calorific value (high water content) has been suspended.

Table A 68: Country specific conversion factors for selected fuels [TJ/kt]

Fuel Type	1990	2000	2005	2010	2015	2019	2020	2021	2022	2023
Other Bit. Coal	28.00	27.99	29.10	28.15	28.85	28.93	28.46	28.97	29.90	30.16
Sub Bit. Coal	22.20	22.20	22.18	21.84	22.08	22.23	21.83	21.90	21.79	22.02
Lignite	10.90	9.82	9.83	9.80	9.70	16.16	14.14	15.09	16.51	18.54
Coke	28.50	28.67	28.88	28.75	28.84	28.73	28.77	28.48	28.22	28.50

Annex 3.4 – National Energy Balance

The following tables present the data of the national energy balance by IEA categories. Calorific values for unit conversion are presented at the end of this Annex. Data was submitted to the Umweltbundesamt by STATISTIK AUSTRIA in November 2024.

Please note that for reasons of confidentiality energy consumption of autoproducers by sub sectors are not public available and therefore not presented in this ANNEX.

Annex 3.4.1 – Coal

Table A 69: National Energy Balance 1990–2023. Coking Coal [1000 tons].

101A Coking Coal	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	2 376	1 778	1 738	2 063	1 907	1 689	1 797	1 751	1 760	1 837	1 732	1 711	1 688	1 807
Total Exports (Balance)	0	0	0	0	0	5	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	-39	130	139	-164	-69	48	19	12	-16	-79	16	28	33	-95
Gross Inland Deliveries (Obs.)	2 337	1 908	1 877	1 899	1 838	1 731	1 816	1 764	1 745	1 758	1 748	1 739	1 721	1 712
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	2 337	1 908	1 877	1 899	1 838	1 731	1 816	1 764	1 745	1 758	1 748	1 739	1 721	1 712
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	2 337	1 908	1 877	1 899	1 838	1 731	1 816	1 764	1 745	1 758	1 748	1 739	1 721	1 712
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0

101A Coking Coal	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 70: National Energy Balance 1990–2023. Bituminous Coal & Anthracite [1000 tons].

102A Bitominous Coal & Anthracite (hard coal)	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	1 233	1 216	1 671	2 260	1 727	1 339	1 485	1 636	1 327	1 241	976	1 060	792	650
Total Exports (Balance)	0	1	0	3	1	6	0	1	3	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	589	268	176	-111	176	583	230	-17	159	129	114	-50	-14	5
Gross Inland Deliveries (Obs.)	1 822	1 484	1 847	2 146	1 902	1 916	1 715	1 617	1 484	1 370	1 090	1 010	778	656
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	1 421	1 082	1 422	1 885	1 576	967	675	584	622	532	196	34	11	3
Public Electricity	964	550	1 203	1 694	1 396	718	438	363	421	313	59	0	0	0
Public Combined Heat and Power	409	518	161	148	144	207	195	176	153	179	97	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	10	7	0	0	0	0	0	0	0	3	0	0
Auto Producers for CHP	48	14	48	36	36	41	43	45	47	40	40	31	11	3
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	33	0	143	750	806	838	676	702	705	818	681	617
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	143	750	806	838	676	702	705	818	681	617

102A Bitominous Coal & Anthracite (hard coal)	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	33	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	399	401	391	260	181	197	231	192	183	133	187	157	85	34
Total Transport	3	0	1	0	0	0	0	0	0	0	0	0	0	0
Rail	3	0	1	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	208	252	313	213	171	195	226	183	173	123	184	155	84	34
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	7	45	57	35	20	31	28	40	34	5	12	12	14	5
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	199	164	170	86	56	32	20	23	28	30	86	49	28	11
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	2	43	86	87	94	132	178	121	111	88	85	94	42	18
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	188	149	77	47	10	2	5	9	10	10	3	2	0	0
Commerce - Public Services	11	10	8	9	0	0	0	0	0	0	0	0	0	0
Residential	176	137	69	38	9	2	5	8	10	10	3	2	0	0
Agriculture	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	2	1	1	1	1	2	3	3	3	3	1	2	2	1

Table A 71: National Energy Balance 1990–2023. Patent Fuel [1000 tons].

104A Patent Fuel (hard coal briquettes)	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	0	0	4	1	13	7	4	4	28	2	2	1	2	2
Total Exports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross Inland Deliveries (Obs.)	0	0	4	1	13	7	4	4	28	2	2	1	2	2
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0

104A Patent Fuel (hard coal briquettes)	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	0	0	4	1	13	7	4	4	28	2	2	1	2	2
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	0	0	0	0	0	0	0	0	26	1	1	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	26	1	1	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	0	0	4	1	13	7	4	4	2	1	1	1	2	2
Commerce - Public Services	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	3	1	13	7	4	4	2	1	1	1	2	2
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 72: National Energy Balance 1990–2023. Lignite and Brown Coal [1000 tons].

105A Lignite and brown coal	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	2 448	1 297	1 249	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	36	29	54	113	90	94	79	76	80	68	64	59	68	48
Total Exports (Balance)	3	0	0	0	8	0	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	23	417	78	1 158	0	0	0	0	0	0	0	0	0	0
Gross Inland Deliveries (Obs.)	2 503	1 743	1 381	1 272	82	94	79	76	79	68	64	59	68	48
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	2 133	1 524	1 230	1 136	0	0	0	0	0	0	0	0	0	0
Public Electricity	1 182	1 081	1 168	1 068	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	881	339	26	48	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	16	9	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	54	95	35	20	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

105A Lignite and brown coal	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	6	0	2	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	6	0	2	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	364	219	149	136	82	94	79	76	79	68	63	59	68	48
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	147	115	105	126	77	92	78	74	78	66	61	58	68	48
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	11	4	39	70	77	92	78	74	78	66	61	58	68	47
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	132	111	66	56	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	217	104	43	10	5	2	1	2	1	1	1	1	1	0
Commerce - Public Services	9	5	3	1	0	0	0	0	0	0	0	0	0	0
Residential	208	99	41	9	5	2	1	2	1	1	1	1	1	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Table A 73: National Energy Balance 1990–2023. Brown Coal Briquettes [1000 tons].

106A BKB-PB	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	295	173	95	53	31	10	9	14	13	10	10	12	8	5
Total Exports (Balance)	0	1	0	2	0	0	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	12	1	11	2	0	0	0	0	0	0	0	0	0	0
Gross Inland Deliveries (Obs.)	306	172	107	52	31	10	9	13	13	10	10	12	8	5
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	12	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	7	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

106A BKB-PB	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	295	172	107	52	31	10	9	13	13	10	10	12	8	5
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	64	14	0	0	0	0	0	0	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	63	14	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	230	158	107	52	31	10	9	13	13	10	10	12	8	5
Commerce - Public Services	8	6	34	17	8	0	0	0	0	0	0	0	0	0
Residential	214	146	70	32	22	10	9	13	12	10	10	12	8	5
Agriculture	8	6	3	4	1	0	0	1	1	0	1	1	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 74: National Energy Balance 1990–2023. Coke Oven Coke [1000 tons].

107A Coke Oven Coke	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	1 725	1 448	1 385	1 404	1 381	1 329	1 352	1 355	1 316	1 316	1 327	1 319	1 271	1 288
Total Imports (Balance)	815	718	981	1 402	1 252	1 004	929	1 167	823	951	816	921	1 043	1 006
Total Exports (Balance)	1	1	1	4	3	1	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	-136	189	71	-117	-75	10	-20	9	-43	91	-48	42	-16	24
Gross Inland Deliveries (Obs.)	2 402	2 354	2 435	2 684	2 555	2 343	2 260	2 530	2 095	2 359	2 095	2 281	2 298	2 318
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	623	711	909	1 162	1 200	1 214	1 177	1 276	1 069	1 136	1 084	1 220	1 128	1 082
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

107A Coke Oven Coke	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	623	711	909	1 162	1 200	1 214	1 177	1 276	1 069	1 136	1 084	1 220	1 128	1 082
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	913	1 076	1 076	1 167	1 067	856	828	972	810	936	716	863	923	950
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	913	1 076	1 076	1 167	1 067	856	828	972	810	936	716	863	923	950
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	853	557	436	339	268	244	237	230	182	255	264	143	212	258
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	290	196	247	262	215	229	223	218	173	245	255	140	208	253
Iron and Steel	235	178	207	229	206	217	213	209	167	236	247	136	199	242
Chemical (incl.Petro-Chemical)	14	6	15	9	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	7	3	6	4	4	4	5	3	3	4	4	2	4	5
Non metallic Mineral Products	23	4	10	14	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	5	2	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Food, Beverages and Tobacco	5	2	7	6	5	7	5	6	4	4	4	2	5	5
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	563	361	190	77	53	15	15	11	8	11	9	3	4	5
Commerce - Public Services	13	9	6	4	2	0	0	0	0	0	0	0	0	0
Residential	537	345	180	72	50	14	14	11	8	10	9	3	4	5
Agriculture	12	8	4	2	1	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	13	10	14	16	20	28	18	52	34	31	30	54	36	29

Table A 75: National Energy Balance 1990–2023. Peat [1000 tons].

113A Peat	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Total Imports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Exports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross Inland Deliveries (Obs.)	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0

113A Peat	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Commerce - Public Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 76: National Energy Balance 1990–2023. Coke Oven Gas [TJ].

304A Coke Oven Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	13 117	10 906	10 466	10 854	10 716	10 337	9 954	10 154	10 321	10 428	10 217	10 250	9 721	9 888
Total Imports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Exports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross Inland Deliveries (Obs.)	13 117	10 906	10 466	10 854	10 716	10 337	9 954	10 154	10 321	10 428	10 217	10 250	9 721	9 888
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	3 385	6 228	3 592	2 332	2 584	4 328	3 352	3 367	3 165	2 961	3 290	3 045	2 461	2 452
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0

304A Coke Oven Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Auto Producers of Electricity	0	0	3 256	2 127	2 346	4 013	3 063	3 105	2 953	2 744	3 020	2 773	2 195	2 252
Auto Producers for CHP	3 385	6 228	286	205	238	315	289	262	213	217	270	272	266	200
Auto Producer Heat Plants	0	0	50	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	4 136	3 439	3 300	4 944	4 799	3 515	3 156	3 074	3 920	3 917	4 100	3 272	3 762	3 981
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	1 072	892	856	316	536	382	2 048	1 661	2 342	1 771	2 050	1 358	1 958	2 310
Blast Furnaces (Energy)	3 064	2 547	2 444	4 628	4 264	3 133	1 108	1 414	1 577	2 146	2 050	1 914	1 804	1 671
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	5 596	1 239	3 574	3 514	3 266	2 476	3 439	3 704	3 230	3 540	2 815	3 925	3 488	3 435
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	5 596	1 239	3 574	3 514	3 266	2 476	3 439	3 704	3 230	3 540	2 815	3 925	3 488	3 435
Iron and Steel	5 596	1 239	3 574	3 514	3 266	2 476	3 439	3 704	3 230	3 540	2 815	3 925	3 488	3 435
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 77: National Energy Balance 1990–2023. Blast Furnace Gas [TJ].

305A Blast Furnace Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	17 094	19 503	25 385	32 220	33 119	33 626	32 631	35 082	28 633	31 341	29 429	34 082	31 240	30 313
Total Imports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Exports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross Inland Deliveries (Obs.)	17 094	19 503	25 385	32 220	33 119	33 626	32 631	35 082	28 633	31 341	29 429	34 082	31 240	30 313
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	4 822	6 213	6 014	12 095	14 468	15 529	14 552	17 051	14 473	15 709	14 540	17 036	15 254	15 276
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0

305A Blast Furnace Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	5 011	11 292	13 502	14 584	13 640	15 595	13 580	14 351	12 918	15 311	13 603	13 634
Auto Producers for CHP	4 822	6 213	1 003	802	966	945	912	1 456	893	1 358	1 622	1 725	1 651	1 642
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	9 682	11 685	15 254	16 723	16 002	15 979	16 049	16 175	12 646	14 203	13 546	15 307	14 525	13 686
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	2 391	2 641	3 675	4 169	3 442	3 378	4 468	4 954	3 964	3 320	2 911	3 460	3 006	2 644
Blast Furnaces (Energy)	7 291	9 044	11 579	12 554	12 560	12 601	11 581	11 222	8 681	10 883	10 634	11 847	11 519	11 043
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BKB (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum refineries	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	2 590	1 605	4 117	836	1 262	1 145	1 089	1 054	783	828	871	1 152	1 003	951
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	2 590	1 605	4 117	836	1 262	1 145	1 089	1 054	783	828	871	1 152	1 003	951
Iron and Steel	2 590	1 605	4 117	836	1 262	1 145	1 089	1 054	783	828	871	1 152	1 003	951
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Annex 3.4.2 – Oil

Table A 78: National Energy Balance 1990–2023. Crude Oil [1000 tons].

201A Crude Oil	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	1 149	1 035	971	855	903	854	786	698	670	634	548	550	505	456
Refinery Losses	254	177	157	36	97	139	169	158	116	111	166	157	125	312

201A Crude Oil	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Intake (Calculated)	7 952	8 619	8 240	8 743	7 719	8 853	8 184	8 064	8 970	9 124	8 168	8 243	5 617	8 022
Refinery Intake (Observed)	7 952	8 619	8 240	8 743	7 719	8 853	8 184	8 064	8 970	9 124	8 168	8 243	5 617	8 022
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	6 797	7 590	7 314	7 833	6 795	8 079	7 332	7 219	8 333	8 592	7 610	7 567	5 138	7 568
Total Exports (Balance)	0	0	61	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	6	-6	16	55	20	-80	66	148	-34	-102	10	125	-26	-2
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 79: National Energy Balance 1990–2023. Natural Gas Liquids [1000 tons].

302A Natural Gas Liquids	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	41	43	101	78	134	21	6	37	18	16	14	11	11	10
Refinery Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Intake (Calculated)	41	43	107	78	134	53	6	37	18	16	14	11	11	10
Refinery Intake (Observed)	41	43	107	78	134	53	6	37	18	16	14	11	11	10
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	0	0	6	0	0	31	0	0	0	0	0	0	0	0
Total Exports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 80: National Energy Balance 1990–2023. Refinery Feedstocks [1000 tons].

217A Refinery Feedstocks	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Intake (Calculated)	1 069	582	540	362	325	371	531	552	293	501	421	268	658	519
Refinery Intake (Observed)	1 069	582	540	362	325	371	531	552	293	501	421	268	658	519
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	1 009	600	627	265	218	63	204	296	101	224	143	186	428	95
Total Exports (Balance)	0	39	125	18	2	47	39	52	95	64	30	44	40	75
Stock Change (National Territory)	-26	-28	-10	35	-101	-131	156	-61	-4	118	-25	-55	-45	-64

Table A 81: National Energy Balance 1990–2023. Residual Fuel Oil [1000 tons].

203X; Residual Fuel Oil	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	1 913	1 596	1 075	1 360	934	1 154	898	839	710	735	737	645	778	1 019
Refinery Fuel	131	233	133	186	143	60	42	73	88	76	41	29	147	162
Total Imports (Balance)	602	532	261	182	173	11	16	68	65	44	67	32	38	2
Total Exports (Balance)	185	38	152	72	244	525	576	437	467	455	471	370	266	391
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	-94	-100	247	7	102	67	119	71	17	56	24	33	-40	4
Gross Inland Deliveries (Obs.)	2 155	1 757	1 298	1 237	823	397	344	275	188	218	222	244	156	171
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	725	721	611	506	390	243	194	177	140	164	187	203	127	157
Public Electricity	28	88	109	84	32	10	1	11	0	0	2	1	1	0
Public Combined Heat and Power	253	316	162	174	144	37	78	35	1	1	5	3	12	9
Public Heat Plants	99	70	87	81	35	30	30	26	24	10	10	8	4	4
Auto Producers of Electricity	0	0	5	72	38	1	12	8	50	44	64	107	2	0
Auto Producers for CHP	227	97	15	95	140	166	73	97	66	110	105	83	108	144
Auto Producer Heat Plants	1	1	1	0	2	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	117	149	232	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0

203X; Residual Fuel Oil	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	421	345	83	54	73	88	76	41	29	147	162
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	235	202	23	12	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	1 430	1 036	687	496	231	131	138	98	47	53	36	41	29	14
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	517	549	277	263	187	110	100	81	39	53	35	41	29	14
Iron and Steel	19	23	21	15	8	2	2	1	1	0	0	1	1	0
Chemical (incl.Petro-Chemical)	23	27	11	13	30	14	15	14	7	5	10	7	5	3
Non ferrous Metals	4	7	9	6	5	5	2	1	0	0	0	0	0	0
Non metallic Mineral Products	115	135	51	45	39	23	21	16	7	19	11	10	4	2
Transportation Equipment	13	17	4	5	2	1	2	1	1	0	0	0	1	0
Machinery	29	32	30	32	23	12	11	9	5	6	3	6	4	2
Mining and Quarrying	6	7	12	12	4	2	2	2	1	1	0	1	0	0
Food, Beverages and Tobacco	78	89	38	42	31	16	13	10	5	5	3	5	5	2
Pulp, Paper and Printing	126	108	41	39	18	9	7	4	3	3	2	2	3	1
Wood and Wood Products	15	21	9	13	6	7	7	6	3	3	1	1	0	0
Construction	32	22	16	16	4	13	13	12	6	8	4	5	6	3
Textiles and Leather	27	25	12	11	7	2	2	1	0	0	0	0	0	0
Non Specified (Industry)	30	36	23	15	9	4	3	3	1	2	1	3	1	0
Total Other Sectors	913	487	410	233	44	22	38	17	8	1	0	0	0	0
Commerce - Public Services	315	240	118	92	5	13	27	15	8	1	0	0	0	0
Residential	471	194	232	112	30	0	0	0	0	0	0	0	0	0
Agriculture	127	53	60	29	8	8	11	2	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 82: National Energy Balance 1990–2023. Heating and Oher Gas Oil [1000 tons].

204A Heating and Other Gas Oil	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	1 239	1 454	1 062	997	795	642	635	662	581	476	592	387	261	369
Refinery Fuel	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Total Imports (Balance)	0	165	533	926	725	592	580	597	555	599	722	571	644	589
Total Exports (Balance)	0	0	1	20	14	31	12	10	10	13	15	17	7	10
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	5	39	125	59	12	23	-49	-9	20	25	-106	258	153	-40
Gross Inland Deliveries (Obs.)	1 244	1 658	1 719	1 933	1 471	1 113	1 085	1 152	1 041	1 044	1 061	1 160	1 033	816
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	2	0	5	4	3	1	3	4	3	4	28	38	35
Public Electricity	0	0	0	1	0	1	0	1	1	1	0	1	1	1
Public Combined Heat and Power	0	2	0	3	1	1	0	2	2	2	2	2	1	2
Public Heat Plants	0	0	0	1	1	1	0	0	0	0	0	23	32	30
Auto Producers of Electricity	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Auto Producers for CHP	0	0	0	0	0	1	1	0	0	1	1	1	2	2
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0

204A Heating and Other Gas Oil	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	1 244	1 656	1 719	1 928	1 468	1 109	1 084	1 149	1 038	1 040	1 058	1 133	995	781
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	1	5	38	115	75	7	7	7	21	25	25	15	52	74
Iron and Steel	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Chemical (incl.Petro-Chemical)	0	0	2	2	1	0	0	0	3	5	5	2	6	8
Non ferrous Metals	0	0	2	1	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	1	2	6	6	1	2	2	5	6	8	3	5	7
Transportation Equipment	0	0	0	1	1	0	0	0	0	0	0	0	1	1
Machinery	0	1	5	13	9	1	1	1	2	2	2	2	5	5
Mining and Quarrying	0	0	1	4	1	1	1	1	1	1	1	1	1	1
Food, Beverages and Tobacco	0	1	10	29	26	1	1	1	3	3	3	2	18	30
Pulp, Paper and Printing	0	0	1	2	1	0	0	0	1	1	1	1	4	7
Wood and Wood Products	0	0	1	7	1	0	0	0	1	1	1	0	1	1
Construction	0	1	10	41	23	1	1	1	3	3	3	2	7	10
Textiles and Leather	0	0	1	4	2	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	2	6	3	0	0	0	1	1	1	1	2	3
Total Other Sectors	1 243	1 651	1 682	1 813	1 393	1 103	1 077	1 142	1 017	1 016	1 033	1 118	944	707
Commerce - Public Services	26	92	264	474	150	122	101	159	142	137	132	173	145	63
Residential	1 216	1 558	1 416	1 337	1 241	980	975	982	873	878	900	943	798	643
Agriculture	1	1	1	1	1	1	1	1	3	1	1	1	1	1
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 83: National Energy Balance 1990–2023. Diesel [1000 tons].

2050 Diesel	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	1 531	1 920	2 662	2 931	2 741	3 453	3 166	3 319	3 472	3 703	3 202	3 329	1 883	2 942
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	576	937	2 075	4 129	4 428	3 949	4 477	4 511	4 509	4 577	4 201	4 256	4 779	3 812
Total Exports (Balance)	3	83	415	889	858	861	829	954	998	1 064	1 003	1 246	636	929
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	-7	112	-59	89	46	-42	-67	70	5	-185	-154	156	90	-7
Gross Inland Deliveries (Obs.)	2 097	2 886	4 263	6 260	6 228	6 499	6 748	6 945	6 989	7 030	6 245	6 494	6 116	5 819
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	8	1	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	6	0	0	0	0	0	0	0	0	0	0	0	0

2050 Diesel	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	2 096	2 877	4 262	6 260	6 228	6 499	6 748	6 945	6 989	7 030	6 245	6 494	6 116	5 819
Total Transport	1 766	2 507	3 830	5 651	5 638	6 017	6 296	6 467	6 504	6 546	5 796	6 036	5 621	5 315
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	1 691	2 436	3 757	5 562	5 550	5 951	6 227	6 394	6 435	6 473	5 747	5 977	5 560	5 257
Rail	54	45	42	52	52	32	32	35	33	33	29	29	29	27
Inland Waterways	20	26	31	38	36	34	36	38	36	40	19	29	31	31
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	81	113	172	345	323	219	197	220	228	230	204	209	246	247
Iron and Steel	0	0	0	6	7	8	8	7	7	7	6	7	7	7
Chemical (incl.Petro-Chemical)	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	1	1	1	4	4	4	4	4	4	4	1	1
Transportation Equipment	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Machinery	0	0	0	0	0	7	6	6	7	7	6	6	2	2
Mining and Quarrying	2	2	3	4	4	4	4	5	5	5	4	4	5	4
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	1	1	1	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	1	1	1	1	6	3	3	3	3	3	3	3	3
Construction	77	108	165	331	308	189	171	194	201	203	180	184	227	229
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	250	257	260	264	268	263	256	258	256	254	246	250	249	258
Commerce - Public Services	9	13	19	27	35	32	26	30	30	30	30	30	30	42
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	241	245	241	237	233	231	230	228	226	225	216	220	219	215
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 84: National Energy Balance 1990–2023. Other Kerosene [1000 tons].

206A Other Kerosene	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	31	8	1	1	3	28	21	15	26	15	13	9	27	26
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	14	4	5	3	1	1	0	1	1	1	0	1	1	0
Total Exports (Balance)	21	6	0	0	0	0	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0

206A Other Kerosene	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Stock Change (National Territory)	-7	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross Inland Deliveries (Obs.)	17	6	6	3	2	1	1	1	1	1	1	1	1	1
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	17	6	6	0	0	0	0	0	0	0	0	0	0	0
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	17	6	6	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	17	6	6	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	3	1	1	1	1	1	1	1	1	1	1

Table A 85: National Energy Balance 1990–2023. Kerosene Type Jet Fuel [1000 tons].

206B Kerosene Type Jet Fuel	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	291	420	544	592	476	648	651	613	760	893	362	344	404	708
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	13	23	35	85	193	109	137	144	83	50	53	39	217	129
Total Exports (Balance)	5	0	5	2	6	37	24	29	19	29	9	5	2	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	0	4	-5	-22	12	-17	1	11	7	37	-56	26	-10	15
Gross Inland Deliveries (Obs.)	299	447	569	653	675	703	765	739	831	951	322	404	610	852
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	299	447	569	653	675	703	765	739	831	951	322	404	610	852
Total Transport	299	447	569	653	675	703	765	739	831	951	322	404	610	852
International Civil Aviation	281	421	537	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	18	26	32	653	675	703	765	739	831	951	322	404	610	852
Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

206B Kerosene Type Jet Fuel	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 86: National Energy Balance 1990–2023. Gasoline Type Jet Fuel [1000 tons].

207A Gasoline Type Jet Fuel	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	3	4	3	6	4	4	3	4	1	2	1	1	1	1
Total Exports (Balance)	0	0	1	3	2	1	1	1	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	0	-2	0	0	0	0	1	-1	1	0	0	0	0	0
Gross Inland Deliveries (Obs.)	3	2	2	3	3	3	3	2	2	2	2	2	2	2
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	3	2	2	3	3	3	3	2	2	2	2	2	2	2
Total Transport	3	2	2	3	3	3	3	2	2	2	2	2	2	2
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	3	2	2	3	3	3	3	2	2	2	2	2	2	2
Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

207A Gasoline Type Jet Fuel	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total Other Sectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A 87: National Energy Balance 1990–2023. Motor Gasoline [1000 tons].

2080 Motor Gasoline	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	2 631	2 276	1 815	1 798	1 589	1 812	1 759	1 782	2 030	2 075	1 805	1 870	1 389	1 764
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	271	710	680	1 107	873	844	822	771	730	671	566	570	821	721
Total Exports (Balance)	281	596	473	770	665	976	875	865	1 060	978	984	996	606	698
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	-53	18	-32	-14	106	29	-36	-13	49	-56	48	42	-61	36
Gross Inland Deliveries (Obs.)	2 567	2 409	1 990	2 121	1 872	1 661	1 659	1 639	1 678	1 669	1 396	1 463	1 520	1 717
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	2 549	2 399	1 985	2 117	1 869	1 659	1 657	1 637	1 676	1 667	1 394	1 461	1 518	1 715
Total Transport	2 546	2 393	1 979	2 109	1 859	1 652	1 650	1 631	1 670	1 661	1 388	1 454	1 510	1 708
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	3	3	2	3	3	3	3	2	2	2	2	2	2	2
Road	2 540	2 387	1 974	2 103	1 854	1 647	1 644	1 627	1 665	1 656	1 383	1 450	1 506	1 704
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	3	3	3	3	2	2	2	2	2	2	2	2	2	2
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	2	1	2	3	5	1	2	2	3	3	2	2	2	2
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	1	1	1	0	0	0	0	0	1	1	1	1	2	2
Machinery	0	0	0	0	0	0	1	1	1	1	1	1	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2080 Motor Gasoline	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	1	3	5	1	1	1	1	1	1	1	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	2	5	4	4	5	6	5	4	4	4	4	5	5	5
Commerce - Public Services	0	0	0	0	1	1	0	0	0	0	0	0	0	1
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	2	4	4	4	4	4	5	4	4	4	4	5	5	4
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	18	10	4	4	3	2	3	2	2	2	2	2	2	2

Table A 88: National Energy Balance 1990–2023. Lubricants [1000 tons].

219A Lubricants	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	31	73	111	111	96	0	0	0	0	0	0	0	0	0
Refinery Fuel	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	177	51	57	53	45	73	110	141	144	121	97	93	92	72
Total Exports (Balance)	32	41	58	85	71	37	69	96	109	86	65	45	30	24
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	-12	4	-1	1	2	0	0	0	0	-1	-1	0	2	4
Gross Inland Deliveries (Obs.)	164	86	109	80	72	36	41	45	34	34	31	48	64	53
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	18	9	12	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	5	3	4	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	2	1	1	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	9	5	6	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	146	77	97	0	0	0	0	0	0	0	0	0	0	0
Total Transport	67	35	44	0	0	0	0	0	0	0	0	0	0	0
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	66	34	43	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Total Industry	76	40	51	0	0	0	0	0	0	0	0	0	0	0
Iron and Steel	15	9	9	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	6	3	4	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	2	1	2	0	0	0	0	0	0	0	0	0	0	0

219A Lubricants	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non metallic Mineral Products	10	5	7	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	2	1	1	0	0	0	0	0	0	0	0	0	0	0
Machinery	3	2	2	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	3	2	2	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	10	5	7	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	8	4	5	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	3	1	2	0	0	0	0	0	0	0	0	0	0	0
Construction	2	1	1	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	4	2	3	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	8	4	6	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	3	2	2	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	3	2	2	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	164	86	109	80	72	36	41	45	34	34	31	48	64	53

Table A 89: National Energy Balance 1990–2023. White Spirit [1000 tons].

220A White Spirit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	0	5	0	0	70	0	0	0	0	0	0	0	0	0
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	11	8	7	11	12	19	19	19	18	18	16	17	15	14
Total Exports (Balance)	0	0	0	0	65	1	1	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	0	-1	0	0	-3	0	0	0	0	0	0	0	0	0
Gross Inland Deliveries (Obs.)	11	12	7	12	15	18	18	18	18	17	16	17	15	14
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	11	12	7	7	12	16	16	16	16	15	13	15	13	12
Total Transport	0	1	1	4	7	13	13	14	13	13	11	12	10	9
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	4	7	13	13	14	13	13	11	12	10	9
Rail	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0

220A White Spirit	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	11	11	6	3	5	1	2	2	3	3	2	2	2	2
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	11	10	4	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	1	1	0	0	0	0	0	1	1	1	1	2	2
Machinery	0	0	0	0	0	0	1	1	1	1	1	1	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	1	3	5	1	1	1	1	1	1	1	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	0	0	0	0	1	1	0	0	0	0	0	0	0	1
Commerce - Public Services	0	0	0	0	1	1	0	0	0	0	0	0	0	1
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	11	11	5	4	3	2	3	2	2	2	2	2	2	2

Table A 90: National Energy Balance 1990–2023. Bitumen [1000 tons].

222A Bitumen	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	269	254	343	366	292	290	333	306	369	395	424	440	236	400
Refinery Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	284	187	292	335	346	271	278	289	313	304	290	262	284	209
Total Exports (Balance)	1	5	45	147	182	131	145	144	187	201	239	240	135	232
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	-12	4	-3	0	10	3	0	-4	0	0	-28	-2	0	1
Gross Inland Deliveries (Obs.)	540	440	587	555	465	434	467	447	495	498	448	460	384	378
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	540	440	587	0	0	0	0	0	0	0	0	0	0	0
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0

222A Bitumen	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	540	440	587	0	0	0	0	0	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	540	440	587	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	540	440	587	555	465	434	467	447	495	498	448	460	384	378

Table A 91: National Energy Balance 1990–2022. Other Oil Products [1000 tons].

224A Other Oil Products	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	7	29	15	87	172	19	26	27	21	23	45	46	26	42
Refinery Fuel	70	0	0	6	8	0	0	0	0	0	0	0	0	0
Total Imports (Balance)	182	29	149	54	33	45	50	41	46	41	13	17	15	8
Total Exports (Balance)	3	39	139	96	144	3	3	1	6	1	1	1	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	-31	36	-8	-5	-12	-1	2	-2	0	-1	3	-2	-4	3
Gross Inland Deliveries (Obs.)	35	15	18	35	40	60	74	66	62	62	60	60	37	52
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	22	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	22	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	6	8	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0

224A Other Oil Products	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	0	0	0	4	11	3	3	3	2	3	2	2	2	2
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	0	0	0	4	11	3	3	3	2	3	2	2	2	2
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	4	11	3	3	3	2	3	2	2	2	2
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	13	15	18	31	29	57	71	63	60	59	58	58	35	50

Table A 92: National Energy Balance 1990–2023. LPG [1000 tons].

303A LPG	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	47	60	34	107	87	139	122	102	111	137	117	150	106	138
Refinery Fuel	0	0	20	49	28	16	25	21	6	18	5	17	57	40
Total Imports (Balance)	97	149	159	133	114	54	53	62	62	61	64	64	96	66
Total Exports (Balance)	14	42	17	20	11	83	68	62	86	89	92	110	64	84
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	2	20	-5	0	-1	-3	-2	3	1	-9	-5	-4	13	4
Gross Inland Deliveries (Obs.)	133	186	150	171	161	91	80	83	83	81	80	82	94	84
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	1	3	0	0	0	0	0	0	0	0	0	0	0	0
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	1	3	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers for CHP	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	8	19	20	49	28	16	25	21	6	18	5	17	57	40
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0

303A LPG	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	124	163	150	171	161	66	64	75	69	67	65	67	63	61
Total Transport	9	11	15	20	19	12	11	11	7	5	3	2	3	2
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	9	11	15	20	19	12	11	11	7	5	3	2	3	2
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	65	62	55	34	45	24	24	26	26	25	25	25	28	32
Iron and Steel	4	3	1	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Non ferrous Metals	8	6	4	4	1	1	0	0	2	2	3	3	3	3
Non metallic Mineral Products	12	23	15	3	9	2	2	2	2	1	1	1	1	5
Transportation Equipment	1	3	1	2	1	1	1	1	1	1	1	1	1	0
Machinery	11	13	14	10	12	9	10	11	11	10	9	10	11	10
Mining and Quarrying	1	1	1	1	1	2	2	2	1	2	2	1	1	1
Food, Beverages and Tobacco	3	3	4	5	7	4	4	4	4	3	4	4	5	6
Pulp, Paper and Printing	1	1	2	1	1	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	1	1	2	2	1	1	1	1	1	1	1	0
Construction	23	9	13	6	9	4	4	3	4	3	4	4	5	5
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	1	0	0	1	0	0	0	0	1	0	0	0	0
Total Other Sectors	50	90	80	117	97	30	29	39	36	37	37	40	32	28
Commerce - Public Services	32	61	24	69	60	3	3	7	6	7	7	8	6	2
Residential	16	26	51	43	33	24	24	29	27	27	28	29	24	23
Agriculture	2	3	5	4	3	2	2	3	3	3	3	3	2	2
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	25	16	8	14	15	15	14	31	23

Table A 93: National Energy Balance 1990–2023. Refinery Gas [1000 tons].

308A Refinery Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Refinery Gross Output	373	305	312	309	392	282	218	262	281	316	284	296	389	415
Refinery Fuel	373	305	310	277	356	250	94	110	108	277	245	191	349	379
Total Imports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Exports (Balance)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Marine Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change (National Territory)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross Inland Deliveries (Obs.)	0	0	2	32	35	32	124	152	173	39	39	105	40	35
Statistical Difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Transformation Sector	0	0	0	30	31	31	124	152	173	39	39	105	40	35
Public Electricity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Combined Heat and Power	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Public Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Auto Producers of Electricity	0	0	0	0	0	0	17	10	72	11	15	62	0	0
Auto Producers for CHP	0	0	0	30	31	31	108	142	101	28	24	43	40	35
Auto Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0

308A Refinery Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non Specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Energy Sector	0	0	0	277	356	250	94	110	108	277	245	191	349	379
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Consumption	0	0	2	2	4	0	0	0	0	0	0	0	0	0
Total Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
International Civil Aviation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Air Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inland Waterways	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Industry	0	0	2	2	4	0	0	0	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (incl.Petro-Chemical)	0	0	2	2	4	0	0	0	0	0	0	0	0	0
Non ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non metallic Mineral Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation Equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulp, Paper and Printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Industry)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Other Sectors	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commerce - Public Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Specified (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Annex 3.4.3 – Natural Gas

Table A 94: National Energy Balance 1990–2023. Natural Gas [PJ NCV].

301A Natural Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	46.4	53.3	64.8	55.7	58.5	43.4	40.8	43.7	36.0	32.2	26.5	23.7	22.4	19.9
Total Imports (Balance)	187.9	229.1	222.8	299.4	256.0	210.0	260.5	293.7	271.8	394.8	224.9	165.1	430.1	250.7
Total Exports (Balance)	0.0	0.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stock Change (National Territory)	-15.1	-12.3	-11.3	-16.6	25.6	35.8	2.0	-11.8	0.5	-105.7	55.1	134.8	-164.1	-23.9
Gross Inland Deliveries (Obs.)	219.2	269.6	275.8	338.5	340.1	289.2	303.2	325.6	308.3	321.4	306.4	323.7	288.5	246.7
Statistical Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Transformation Sector	74.7	95.8	83.3	115.2	113.7	75.2	82.5	102.4	91.2	96.2	87.4	93.1	85.9	64.7
Public Electricity	28.1	21.7	25.4	46.7	35.2	16.0	15.9	38.6	25.8	31.7	22.1	14.8	24.6	12.6
Public Combined Heat and Power	23.8	30.8	27.7	39.2	48.9	37.9	45.2	41.7	43.9	45.3	46.6	57.1	47.5	38.6
Public Heat Plants	7.6	9.6	9.2	9.1	10.2	11.3	11.1	12.1	9.1	7.6	7.1	8.3	5.6	6.2
Auto Producers of Electricity	9.6	21.2	12.0	9.0	7.5	2.7	2.9	2.8	5.5	4.6	4.8	5.5	1.5	1.4
Auto Producers for CHP	5.7	12.5	8.6	10.6	11.9	6.9	6.9	7.2	6.5	6.9	6.7	7.5	6.6	5.8
Auto Producer Heat Plants	0.0	0.0	0.4	0.6	0.1	0.4	0.5	0.1	0.4	0.1	0.1	0.1	0.0	0.1
Gas Works (Transformation)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

301A Natural Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Coke Ovens (Transformation)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blast Furnaces (Transformation)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conversion to Liquids	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non Specified (Transformation)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Energy Sector	15.8	18.8	11.9	14.7	12.0	9.0	8.4	8.8	10.4	10.5	9.0	10.2	7.9	7.7
Coal Mines	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil and Gas Extraction	6.6	10.8	4.3	6.8	3.8	3.6	3.4	3.1	2.9	2.6	2.5	2.9	3.4	2.2
Inputs to Oil Refineries	6.8	7.6	6.5	5.5	5.8	3.6	3.4	3.8	4.7	5.2	4.8	5.2	3.0	3.4
Coke Ovens (Energy)	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.2	0.3	0.3	0.2	0.2	0.2	0.2
Blast furnace (Energy)	0.0	0.0	0.8	2.0	2.1	1.6	1.3	1.5	2.2	2.0	1.3	1.5	1.1	1.6
Gas Works (Energy)	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Power Plants	0.0	0.0	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.2
Non Specified (Energy)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distribution Losses	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Final Consumption	113.5	144.2	167.3	195.4	198.5	191.0	198.0	200.4	194.9	199.7	195.8	206.5	182.3	161.5
Total Transport	4.1	4.1	6.1	6.5	8.7	11.3	10.9	12.2	11.3	10.5	9.3	7.5	3.5	1.1
Road	0.0	0.0	0.0	0.0	0.5	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7
Pipeline Transport	4.1	4.1	6.1	6.5	8.3	10.6	10.1	11.5	10.6	9.7	8.5	6.7	2.7	0.4
Non Specified (Transport)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Industry	69.0	73.5	88.3	99.2	106.3	107.0	109.3	110.7	112.2	113.5	111.0	116.4	111.1	96.6
Iron and Steel	10.5	11.2	13.5	14.1	14.6	17.7	17.0	17.6	17.7	17.6	17.2	15.8	17.3	17.0
Chemical (incl.Petro-Chemical)	7.7	8.3	14.4	16.0	16.5	16.7	18.6	19.1	18.4	19.5	18.8	20.7	17.1	15.9
Non ferrous Metals	1.4	2.2	2.3	3.1	3.8	4.5	4.9	4.8	5.6	5.0	4.4	5.0	5.2	4.7
Non metallic Mineral Products	10.1	11.1	11.6	14.0	13.5	14.3	14.9	15.3	15.1	15.0	16.4	18.9	16.8	13.8
Transportation Equipment	1.5	2.6	1.3	2.2	1.9	1.3	1.5	1.7	1.8	1.6	1.7	1.8	2.0	1.1
Machinery	4.3	6.1	4.8	6.5	8.8	6.1	6.3	6.0	6.2	6.2	6.0	6.7	6.4	5.6
Mining and Quarrying	2.6	2.5	2.3	2.8	2.0	5.6	6.2	7.2	6.7	6.0	5.9	4.1	4.0	2.4
Food, Beverages and Tobacco	8.9	9.4	11.4	11.5	12.4	13.3	12.4	12.1	11.9	12.1	12.8	13.2	14.0	11.1
Pulp, Paper and Printing	12.9	9.8	19.5	20.3	24.2	20.9	20.5	20.1	21.8	23.8	21.7	23.1	20.7	16.9
Wood and Wood Products	1.7	2.0	1.7	3.3	2.9	2.4	2.3	2.5	2.6	2.3	2.1	2.5	2.4	3.0
Construction	0.7	1.5	1.4	1.6	1.8	1.2	1.3	1.2	1.4	1.3	1.2	1.1	2.0	2.0
Textiles and Leather	3.5	3.4	2.9	2.1	1.8	1.4	1.7	1.4	1.4	1.6	1.4	1.6	1.4	1.3
Non Specified (Industry)	3.1	3.4	1.2	1.6	2.0	1.6	1.6	1.7	1.6	1.6	1.5	1.8	1.9	1.7
Total Other Sectors	40.4	66.6	72.9	89.6	83.5	72.6	77.8	77.5	71.4	75.8	75.5	82.6	67.8	63.9
Commerce - Public Services	6.5	21.9	23.4	23.2	17.2	15.0	14.3	15.0	14.2	15.2	14.5	16.6	12.7	14.2
Residential	33.5	44.3	48.9	65.7	65.5	57.0	62.8	61.5	56.3	59.5	60.0	65.0	54.2	49.2
Agriculture	0.4	0.5	0.5	0.8	0.8	0.6	0.7	1.0	0.9	1.1	0.9	1.0	0.8	0.5
Non Specified (Others)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Non-Energy Use	14.9	10.5	13.3	13.2	15.8	13.9	14.3	13.8	11.6	14.9	14.2	13.8	12.3	12.8

Annex 3.4.4 – Renewable Fuels

Table A 95: National Energy Balance 1990–2023. Fuel Wood [PJ].

111A Fuel Wood	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	61.40	65.76	58.63	56.30	63.02	52.35	55.54	56.73	50.06	52.71	55.23	65.99	52.08	49.51
Total Imports (Balance)	2.30	1.62	1.80	3.50	7.87	8.55	6.83	5.76	7.01	5.07	2.55	2.20	2.34	3.18
Total Exports (Balance)	0.04	0.22	0.18	0.84	0.98	0.17	0.15	0.18	0.27	0.23	0.14	0.17	0.15	0.15
Stock Change (National Territory)	-0.55	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Inland Deliveries (Obs.)	63.12	67.35	60.25	58.95	69.91	60.73	62.22	62.31	56.80	57.54	57.64	68.03	54.27	52.54
Statistical Difference	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Transformation Sector	0.00	0.00	0.08	0.13	0.13	0.14	0.14	0.09	0.10	0.10	0.10	0.10	0.08	0.08
Public Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Public Combined Heat and Power	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Public Heat Plants	0.00	0.00	0.00	0.04	0.04	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00

111A Fuel Wood	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Auto Producers of Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Auto Producers for CHP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Auto Producer Heat Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Energy Sector	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Patent Fuel Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coke Ovens (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blast Furnaces (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas Works (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BKB (Transformation)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distribution Losses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Final Consumption	63.12	67.35	60.17	58.82	69.78	60.59	62.08	62.22	56.71	57.44	57.54	67.92	54.19	52.47
Total Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inland Waterways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Transport)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Industry	0.66	1.07	0.95	1.14	0.65	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
Iron and Steel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chemical (incl.Petro-Chemical)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non ferrous Metals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non metallic Mineral Products	0.05	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machinery	0.05	0.06	0.03	0.06	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food, Beverages and Tobacco	0.12	0.09	0.02	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pulp, Paper and Printing	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wood and Wood Products	0.23	0.30	0.71	0.36	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.29	0.11	0.27	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textiles and Leather	0.02	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Industry)	0.19	0.25	0.08	0.36	0.02	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
Total Other Sectors	62.46	66.28	59.22	57.69	69.13	60.59	62.07	62.21	56.69	57.43	57.52	67.92	54.19	52.47
Commerce - Public Services	1.33	1.17	0.34	0.59	0.60	0.10	0.09	0.21	0.19	0.21	0.21	0.24	0.19	0.04
Residential	57.50	61.25	55.38	53.04	64.46	56.91	58.30	58.32	53.15	53.82	53.92	63.67	50.80	49.31
Agriculture	3.63	3.86	3.49	4.06	4.06	3.59	3.68	3.68	3.35	3.40	3.40	4.01	3.20	3.11
Non Specified (Others)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A 96: National Energy Balance 1990-2023. Wood Waste [PJ].

116A Wood waste and other biomass	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	14.34	19.78	35.70	61.63	101.12	109.68	108.00	113.23	109.52	109.23	113.17	122.08	124.25	119.99
Total Imports (Balance)	2.14	2.49	3.14	7.41	12.83	8.47	8.31	8.80	7.98	7.35	8.14	8.80	6.92	5.26
Total Exports (Balance)	2.08	2.62	6.51	13.84	12.95	10.29	11.15	12.38	14.09	14.72	15.08	15.54	13.03	13.31
Stock Change (National Territory)	0.00	0.00	0.00	0.00	1.16	0.31	0.25	-0.33	0.04	0.34	-1.24	0.34	0.78	0.77
Gross Inland Deliveries (Obs.)	14.41	19.65	32.34	55.20	102.16	108.18	105.41	109.32	103.45	102.19	105.00	115.69	118.93	112.71
Statistical Difference	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Transformation Sector	3.19	10.12	12.50	20.71	58.00	59.90	58.02	60.43	59.39	56.81	59.49	61.96	61.42	59.07
Public Electricity	0.00	0.00	0.01	2.86	10.86	9.15	7.24	7.18	6.67	4.71	5.24	3.96	5.61	5.10
Public Combined Heat and Power	0.00	0.00	0.35	4.10	17.27	18.06	16.25	17.51	17.62	17.96	16.97	17.56	17.71	16.28
Public Heat Plants	1.63	3.98	7.59	9.81	21.92	23.96	25.38	26.91	26.42	25.95	28.88	31.86	29.67	28.43
Auto Producers of Electricity	0.00	0.19	1.51	1.32	2.99	2.16	1.38	1.42	2.53	2.68	2.79	2.56	2.08	2.77
Auto Producers for CHP	1.56	5.95	2.96	2.60	4.88	6.52	7.68	7.29	6.06	5.43	5.55	5.93	6.25	6.33
Auto Producer Heat Plants	0.00	0.00	0.08	0.02	0.08	0.06	0.09	0.11	0.09	0.08	0.07	0.10	0.10	0.15
Total Energy Sector	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Patent Fuel Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

116A Wood waste and other biomass	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Coke Ovens (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blast Furnaces (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas Works (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BKB (Transformation)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distribution Losses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Final Consumption	11.22	9.53	19.84	34.49	44.16	48.28	47.39	48.89	44.06	45.21	45.34	53.70	57.48	53.62
Total Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inland Waterways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Transport)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Industry	9.43	6.90	11.62	25.52	28.61	27.39	26.39	26.13	22.29	22.82	22.78	24.84	29.46	27.64
Iron and Steel	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.07	0.02
Chemical (incl.Petro-Chemical)	2.90	1.72	2.52	1.61	2.15	1.48	1.65	1.87	1.89	2.43	1.89	2.04	2.55	2.44
Non ferrous Metals	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.02	0.03	0.00	0.04	0.04	0.05	0.04
Non metallic Mineral Products	0.00	0.00	0.00	2.06	3.47	4.28	3.93	3.56	2.30	2.13	2.19	2.65	3.77	3.43
Transportation Equipment	0.00	0.00	0.00	0.01	0.02	0.04	0.03	0.03	0.04	0.04	0.07	0.09	0.08	0.11
Machinery	0.00	0.00	0.05	0.31	1.37	0.26	0.25	0.26	0.30	0.24	0.26	0.34	0.43	0.39
Mining and Quarrying	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food, Beverages and Tobacco	0.01	0.01	0.21	0.31	0.47	0.16	0.28	0.26	0.35	0.32	0.30	0.18	0.35	0.34
Pulp, Paper and Printing	3.66	3.90	1.95	7.06	4.55	4.61	4.87	4.89	4.68	6.01	5.32	5.73	7.35	7.10
Wood and Wood Products	2.76	1.16	6.00	13.85	13.21	16.07	14.81	14.61	12.09	11.13	12.08	13.25	14.13	13.04
Construction	0.04	0.03	0.36	0.16	1.35	0.15	0.23	0.27	0.24	0.21	0.29	0.26	0.39	0.35
Textiles and Leather	0.00	0.00	0.00	0.00	0.03	0.01	0.02	0.00	0.01	0.00	0.01	0.02	0.04	0.03
Non Specified (Industry)	0.07	0.07	0.52	0.15	1.96	0.30	0.30	0.34	0.35	0.30	0.31	0.21	0.26	0.35
Total Other Sectors	1.79	2.63	8.22	8.97	15.55	20.89	21.00	22.76	21.77	22.39	22.56	28.86	28.03	25.98
Commerce - Public Services	0.64	0.60	2.27	1.67	2.55	2.20	1.63	2.77	2.89	3.21	3.10	3.53	2.77	1.82
Residential	0.77	1.40	4.50	5.61	10.69	15.39	16.00	16.30	15.55	16.37	16.59	21.93	21.45	20.46
Agriculture	0.38	0.63	1.46	1.69	2.30	3.29	3.37	3.69	3.33	2.81	2.86	3.40	3.80	3.70
Non Specified (Others)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A 97: National Energy Balance 1990–2023. Black Liquor [PJ].

215A Black Liquor	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	17.8	21.4	24.1	26.6	28.5	28.4	32.8	32.7	33.7	33.6	33.2	34.4	34.8	37.1
Total Imports (Balance)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Exports (Balance)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stock Change (National Territory)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gross Inland Deliveries (Obs.)	17.8	21.4	24.1	26.6	28.5	28.4	32.8	32.7	33.7	33.6	33.2	34.4	34.8	37.1
Statistical Difference	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Transformation Sector	5.3	9.3	7.6	8.8	7.3	8.5	8.1	7.9	8.3	8.5	9.4	8.6	8.5	8.3
Public Electricity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Public Combined Heat and Power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Public Heat Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Auto Producers of Electricity	2.6	5.3	2.0	2.4	0.4	1.7	0.4	0.0	0.0	0.1	0.5	0.3	0.4	0.3
Auto Producers for CHP	2.6	4.0	5.6	6.4	6.8	6.7	7.8	7.9	8.2	8.4	8.9	8.3	8.1	8.0
Auto Producer Heat Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Energy Sector	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal Mines	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Patent Fuel Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coke Ovens (Energy)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blast Furnaces (Energy)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas Works (Energy)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BKB (Transformation)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Power Plants	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

215A Black Liquor	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non Specified (Energy)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Distribution Losses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final Consumption	12.5	12.1	16.4	17.9	21.3	19.9	24.6	24.8	25.4	25.1	23.8	25.8	26.3	28.9
Total Transport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inland Waterways	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non Specified (Transport)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Industry	12.5	12.1	16.4	17.9	21.3	19.9	24.6	24.8	25.4	25.1	23.8	25.8	26.3	28.9
Iron and Steel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemical (incl.Petro-Chemical)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non ferrous Metals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non metallic Mineral Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Machinery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mining and Quarrying	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Food, Beverages and Tobacco	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pulp, Paper and Printing	12.5	12.1	16.4	17.9	21.3	19.9	24.6	24.8	25.4	25.1	23.8	25.8	26.3	28.9
Wood and Wood Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Textiles and Leather	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non Specified (Industry)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Other Sectors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commerce - Public Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Residential	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non Specified (Others)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table A 98: National Energy Balance 1990–2023. Biogas [PJ].

309A Biogas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	0.00	0.04	0.36	3.42	5.39	10.61	10.65	11.20	8.38	7.52	7.65	5.21	5.15	12.17
Total Imports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Exports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stock Change (National Territory)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Inland Deliveries (Obs.)	0.00	0.04	0.36	3.42	5.39	10.61	10.65	11.20	8.38	7.52	7.65	5.21	5.15	12.17
Statistical Difference	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Transformation Sector	0.00	0.04	0.22	3.16	4.97	10.28	10.24	10.69	7.81	6.98	7.18	4.75	4.69	5.04
Public Electricity	0.00	0.00	0.00	2.65	4.36	9.77	9.50	10.18	7.17	6.47	6.58	4.26	4.21	4.35
Public Combined Heat and Power	0.00	0.00	0.00	0.20	0.33	0.10	0.27	0.16	0.15	0.14	0.12	0.14	0.16	0.31
Public Heat Plants	0.00	0.00	0.00	0.00	0.08	0.07	0.08	0.06	0.06	0.03	0.03	0.06	0.04	0.06
Auto Producers of Electricity	0.00	0.00	0.12	0.14	0.06	0.15	0.17	0.05	0.06	0.18	0.21	0.11	0.12	0.16
Auto Producers for CHP	0.00	0.04	0.10	0.18	0.13	0.18	0.22	0.24	0.38	0.16	0.24	0.17	0.15	0.17
Auto Producer Heat Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Energy Sector	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Patent Fuel Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coke Ovens (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blast Furnaces (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas Works (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BKB (Transformation)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distribution Losses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Final Consumption	0.00	0.00	0.15	0.25	0.42	0.33	0.41	0.50	0.57	0.54	0.46	0.46	0.46	0.46
Total Transport	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inland Waterways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

309A Biogas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non Specified (Transport)	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Total Industry	0.00	0.00	0.15	0.25	0.40	0.19	0.22	0.22	0.26	0.27	0.21	0.19	0.20	0.18
Iron and Steel	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.05	0.02	0.01	0.01	0.01	0.01
Chemical (incl.Petro-Chemical)	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.04	0.03	0.08	0.05	0.05	0.04	0.04
Non ferrous Metals	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Non metallic Mineral Products	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
Transportation Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machinery	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.01	0.02	0.01	0.01	0.01	0.01
Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.00
Food, Beverages and Tobacco	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.04	0.03
Pulp, Paper and Printing	0.00	0.00	0.12	0.24	0.34	0.04	0.04	0.04	0.06	0.05	0.04	0.03	0.03	0.03
Wood and Wood Products	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textiles and Leather	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Industry)	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Total Other Sectors	0.00	0.00	0.00	0.00	0.02	0.12	0.18	0.27	0.29	0.26	0.24	0.25	0.25	0.25
Commerce - Public Services	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.02
Residential	0.00	0.00	0.00	0.00	0.01	0.10	0.15	0.25	0.27	0.23	0.21	0.23	0.23	0.23
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
Non Specified (Others)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A 99: National Energy Balance 1990–2023. Sewage Sludge Gas [PJ].

309B Sewage sludge gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	0.00	0.62	0.47	1.17	1.08	1.54	1.71	1.72	1.05	1.41	1.09	1.47	2.21	2.32
Total Imports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Exports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stock Change (National Territory)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Inland Deliveries (Obs.)	0.00	0.62	0.47	1.17	1.08	1.54	1.71	1.72	1.05	1.41	1.09	1.47	2.21	2.32
Statistical Difference	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Transformation Sector	0.00	0.62	0.11	0.75	0.59	0.20	0.37	0.29	0.27	0.41	0.37	0.41	0.92	0.94
Public Electricity	0.00	0.01	0.08	0.65	0.28	0.06	0.23	0.15	0.16	0.11	0.04	0.05	0.07	0.08
Public Combined Heat and Power	0.00	0.00	0.00	0.04	0.04	0.05	0.04	0.03	0.02	0.03	0.04	0.04	0.04	0.03
Public Heat Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Auto Producers of Electricity	0.00	0.00	0.03	0.01	0.22	0.07	0.08	0.09	0.05	0.10	0.13	0.14	0.13	0.15
Auto Producers for CHP	0.00	0.61	0.00	0.05	0.05	0.02	0.02	0.01	0.03	0.17	0.16	0.19	0.68	0.68
Auto Producer Heat Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Energy Sector	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Patent Fuel Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coke Ovens (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blast Furnaces (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas Works (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BKB (Transformation)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distribution Losses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Final Consumption	0.00	0.00	0.36	0.41	0.49	1.34	1.34	1.43	0.78	1.00	0.72	1.06	1.29	1.38
Total Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inland Waterways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Transport)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Industry	0.00	0.00	0.36	0.41	0.49	1.34	1.34	1.43	0.78	1.00	0.72	1.06	1.29	1.38
Iron and Steel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chemical (incl.Petro-Chemical)	0.00	0.00	0.36	0.29	0.34	0.49	0.51	0.72	0.26	0.34	0.25	0.51	0.46	0.52
Non ferrous Metals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non metallic Mineral Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

309B Sewage sludge gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Transportation Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food, Beverages and Tobacco	0.00	0.00	0.00	0.10	0.09	0.37	0.24	0.12	0.11	0.08	0.11	0.10	0.13	0.13
Pulp, Paper and Printing	0.00	0.00	0.00	0.02	0.07	0.48	0.59	0.59	0.41	0.58	0.35	0.45	0.70	0.73
Wood and Wood Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textiles and Leather	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Industry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Other Sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commerce - Public Services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Others)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A 100: National Energy Balance 1990–2023. Landfill Gas [PJ].

310A Landfill Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	0.00	0.20	0.44	0.38	0.19	0.19	0.16	0.10	0.08	0.05	0.05	0.07	0.09	0.09
Total Imports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Exports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stock Change (National Territory)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Inland Deliveries (Obs.)	0.00	0.20	0.44	0.38	0.19	0.19	0.16	0.10	0.08	0.05	0.05	0.07	0.09	0.09
Statistical Difference	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Transformation Sector	0.00	0.15	0.44	0.23	0.19	0.19	0.16	0.10	0.08	0.05	0.05	0.07	0.09	0.09
Public Electricity	0.00	0.00	0.01	0.04	0.12	0.09	0.04	0.04	0.03	0.03	0.03	0.05	0.06	0.06
Public Combined Heat and Power	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Public Heat Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Auto Producers of Electricity	0.00	0.12	0.43	0.19	0.07	0.09	0.11	0.07	0.05	0.02	0.01	0.02	0.03	0.03
Auto Producers for CHP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Auto Producer Heat Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Energy Sector	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Patent Fuel Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coke Ovens (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blast Furnaces (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas Works (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BKB (Transformation)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distribution Losses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Final Consumption	0.00	0.05	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inland Waterways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Transport)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Industry	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron and Steel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chemical (incl.Petro-Chemical)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non ferrous Metals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non metallic Mineral Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food, Beverages and Tobacco	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pulp, Paper and Printing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wood and Wood Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

310A Landfill Gas	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Construction	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textiles and Leather	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Industry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Other Sectors	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commerce - Public Services	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Others)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A 101: National Energy Balance 1990–2023. Municipal Solid Waste [PJ].

114B Municipal Solid Waste	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	2.41	3.91	4.64	8.88	14.38	19.35	21.17	18.62	19.44	19.80	21.58	21.54	21.05	22.61
Total Imports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.23	0.00	0.00	0.00	0.00	0.00	0.00
Total Exports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stock Change (National Territory)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Inland Deliveries (Obs.)	2.41	3.91	4.64	8.88	14.38	19.35	21.17	19.85	19.44	19.80	21.58	21.54	21.05	22.61
Statistical Difference	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Transformation Sector	2.41	3.91	4.64	8.88	14.38	19.35	21.17	19.85	19.44	19.80	21.58	21.54	21.05	22.61
Public Electricity	0.00	0.00	0.72	2.19	2.82	5.17	5.34	4.20	4.72	4.37	4.51	4.31	3.98	4.64
Public Combined Heat and Power	1.72	2.32	2.23	3.14	3.01	3.17	4.03	3.90	4.20	4.40	6.29	6.56	6.41	6.15
Public Heat Plants	0.69	1.59	1.69	1.97	1.87	2.06	2.09	2.21	2.12	2.14	1.99	1.95	1.77	1.84
Auto Producers of Electricity	0.00	0.00	0.00	1.46	4.22	5.49	6.08	5.59	4.62	4.31	4.63	4.22	4.53	5.17
Auto Producers for CHP	0.00	0.00	0.00	0.10	2.46	3.46	3.63	3.96	3.78	4.58	4.15	4.49	4.36	4.80
Auto Producer Heat Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Energy Sector	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Patent Fuel Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coke Ovens (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blast Furnaces (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas Works (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BKB (Transformation)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distribution Losses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Final Consumption	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inland Waterways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Transport)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron and Steel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chemical (incl.Petro-Chemical)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non ferrous Metals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non metallic Mineral Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transportation Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food, Beverages and Tobacco	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pulp, Paper and Printing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wood and Wood Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textiles and Leather	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Industry)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Other Sectors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commerce - Public Services	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

114B Municipal Solid Waste	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Others)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A 102: National Energy Balance 1990-2023. Industrial Waste [PJ].

115A Industrial Waste	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Indigenous Production	6.58	7.01	7.63	10.85	17.03	16.09	16.94	16.54	15.33	14.48	14.42	14.65	16.27	14.57
Total Imports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Exports (Balance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stock Change (National Territory)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gross Inland Deliveries (Obs.)	6.58	7.01	7.63	10.85	17.03	16.09	16.94	16.54	15.33	14.48	14.42	14.65	16.27	14.57
Statistical Difference	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Transformation Sector	2.54	1.93	1.46	2.61	5.15	4.31	3.93	3.81	3.27	3.18	2.14	2.45	2.58	2.60
Public Electricity	0.00	0.00	0.00	0.62	0.51	0.68	0.71	0.59	0.30	0.21	0.16	0.37	0.44	0.44
Public Combined Heat and Power	0.00	0.00	0.00	0.72	0.92	2.37	2.28	2.27	2.10	1.91	0.72	0.90	0.88	0.83
Public Heat Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Auto Producers of Electricity	0.00	0.00	0.44	0.25	1.83	0.32	0.14	0.18	0.14	0.00	0.00	0.07	0.00	0.00
Auto Producers for CHP	2.54	1.93	1.02	0.91	1.70	0.76	0.64	0.61	0.58	0.89	1.09	0.88	1.07	1.11
Auto Producer Heat Plants	0.00	0.00	0.00	0.11	0.19	0.17	0.16	0.16	0.16	0.16	0.18	0.24	0.20	0.21
Total Energy Sector	0.00	0.00	0.00	0.44	2.32	1.87	1.82	1.65	0.60	1.12	1.77	1.79	1.73	1.79
Coal Mines	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Patent Fuel Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coke Ovens (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blast Furnaces (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gas Works (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BKB (Transformation)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum refineries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Power Plants	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Energy)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distribution Losses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Final Consumption	4.03	5.08	6.18	7.80	9.55	9.92	11.19	11.08	11.46	10.18	10.51	10.42	11.96	10.18
Total Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inland Waterways	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Transport)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Industry	2.92	4.56	5.61	6.73	9.49	9.92	11.19	11.08	11.46	10.18	10.51	10.42	11.96	10.18
Iron and Steel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chemical (incl.Petro-Chemical)	1.57	1.91	1.64	3.16	3.26	2.45	2.79	2.52	2.64	1.92	2.51	2.44	2.54	2.18
Non ferrous Metals	0.00	0.00	0.00	0.00	0.00	0.17	0.18	0.19	0.00	0.00	0.01	0.00	0.00	0.00
Non metallic Mineral Products	1.31	1.98	3.56	2.66	5.29	6.71	7.49	7.72	7.83	7.35	7.34	7.08	7.67	6.23
Transportation Equipment	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machinery	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food, Beverages and Tobacco	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pulp, Paper and Printing	0.00	0.00	0.00	0.04	0.09	0.19	0.22	0.15	0.20	0.22	0.19	0.11	0.88	1.03
Wood and Wood Products	0.04	0.55	0.37	0.63	0.76	0.31	0.42	0.41	0.69	0.58	0.34	0.69	0.81	0.72
Construction	0.00	0.01	0.02	0.06	0.04	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.03	0.02
Textiles and Leather	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00
Non Specified (Industry)	0.01	0.09	0.02	0.10	0.05	0.06	0.09	0.08	0.09	0.10	0.10	0.06	0.00	0.00
Total Other Sectors	1.11	0.52	0.56	1.07	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commerce - Public Services	1.11	0.52	0.56	1.07	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non Specified (Others)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Annex 3.4.5 – Net Calorific Values

The selected net calorific values of each fuel are presented below.

Table A 103: Net calorific values for 1990-2023 in [MJ/kg], [MJ/m³] taken from (IEA JQ 2024).

Fuel Code	Fuel Name		1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
101A	Coking Coal	T	29.07	29.07	29.07	29.10	29.17	29.66	28.66	29.18	29.14	29.00	28.95	29.30	29.91	30.19
102A	Hard Coal	FC	28.00	28.00	27.99	29.08	27.57	27.53	27.37	27.49	28.42	28.83	27.79	28.43	29.88	27.86
		T	28.00	28.00	26.74	29.10	28.14	28.73	28.29	28.67	28.60	28.97	28.82	29.28	29.91	30.18
104A	Hard Coal Briquettes	A	0.00	0.00	31.00	31.00	31.00	31.00	31.01	31.00	31.00	31.00	31.00	31.00	31.00	31.00
105A	Brown Coal	FC	10.90	10.90	14.71	16.04	19.86	20.53	20.63	20.69	21.21	22.06	21.41	21.38	21.52	21.75
		T	10.90	10.90	9.86	9.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
106A	Brown Coal Briquettes	A	19.30	19.30	19.30	19.30	19.30	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80
107A	Coke Oven Coke	T	28.50	28.50	29.00	28.88	28.75	28.84	28.88	28.64	27.90	28.73	28.77	28.48	28.22	28.50
113A	Peat	FC	8.80	8.80	8.80	8.80	8.80	8.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
304A	Coke Oven Gas	P	17.90	17.90	17.61	17.56	17.69	17.69	17.24	17.43	17.61	17.61	17.43	17.01	17.02	17.33
305A	Blast Furnace Gas	P	3.65	3.63	3.70	3.80	3.74	3.67	3.67	3.57	3.51	3.53	3.63	3.65	3.58	3.59
110A	Petrol Coke	A	34.30	28.40	33.92	31.33	29.92	30.86	30.84	31.02	30.26	30.98	30.94	31.56	31.13	30.28
201A	Crude Oil	A	42.50	42.50	42.52	42.50	42.50	42.50	42.50	42.50	42.50	42.50	42.50	42.50	42.50	42.50
203X	Residual Fuel Oil	A	41.00	40.50	41.49	42.15	45.24	41.07	41.16	41.16	41.15	40.99	41.26	41.41	41.66	41.56
204A	Gasoil	A	42.60	42.70	42.80	42.80	42.80	42.94	42.80	42.80	42.80	42.81	42.81	42.70	43.37	43.37
2050	Diesel	A	42.60	42.70	42.80	42.80	42.80	42.40	42.39	42.39	42.39	42.37	42.37	42.37	42.37	42.37
206A	Petroleum	A	43.60	43.30	43.30	43.60	43.36	43.35	43.35	43.35	43.35	43.35	43.35	43.35	43.35	43.35
206B	Kerosene	A	43.60	43.30	43.30	43.30	43.36	43.35	43.30	43.30	43.30	43.38	43.38	43.38	43.30	43.30
207A	Aviation Gasoline	A	42.50	42.50	42.50	44.10	44.10	44.10	44.10	44.10	44.10	44.10	44.10	44.10	44.10	44.10
2080	Motor Gasoline	A	42.50	42.50	42.50	42.68	41.98	41.31	40.53	40.73	41.61	41.64	41.65	41.64	41.81	40.82
217A	Refinery Feedstocks	A	41.87	42.56	42.56	42.59	42.47	42.34	42.65	42.29	42.96	42.51	42.57	42.91	42.31	42.07
219A	Lubricants	A	41.40	41.10	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80
220A	White Spirit	A	41.60	42.50	42.50	44.10	44.10	44.10	44.10	44.10	44.10	44.10	44.10	44.10	44.10	44.10
222A	Bitumen	A	41.80	41.80	43.62	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80
224A	Other Petroleum Products	FC	34.30	28.40	33.92	45.87	45.97	46.02	46.22	45.93	46.01	46.26	46.17	46.13	45.44	46.18
		NE	41.80	41.80	43.62	39.69	37.91	41.59	41.61	41.62	46.01	46.26	46.17	46.13	45.44	46.18
302A	NGL	A	42.50	42.50	42.52	42.50	42.50	42.50	42.50	42.50	42.50	42.50	42.50	42.50	42.50	42.50
303A	LPG	A	46.30	46.30	46.00	46.00	46.00	46.12	46.12	46.12	46.12	46.12	46.12	46.12	46.12	46.12
308A	Refinery Gas	A	49.00	49.00	37.18	30.68	30.68	29.87	29.87	32.44	30.32	29.78	30.32	30.32	30.60	33.76
301A	Natural Gas	A	36.00	36.00	35.85	36.00	36.26	36.48	36.64	36.61	36.61	36.61	36.71	36.64	37.23	37.16

Legend: A…Average; T…Transformation; FC…Final Consumption; P…Production; NE…Non Energy use; NGL…Natural Gas Liquids; LPG…Liquified Petroleum Gas

Table A 104 presents the net calorific values from STATISTIK AUSTRIA, which are used for default unit conversion.

Table A 104: Default net calorific values from STATISTIK AUSTRIA.

Fuel Name	NCV	Unit
Municipal Waste / renewable	8.93	MJ/kg
Municipal Waste / non renewable	9.14	MJ/kg

Fuel Name	NCV	Unit
Industrial Waste	15.76	MJ/kg
Fuel Wood	15.50	MJ/kg
Wood Wastes	11.36	MJ/kg
Bark	7.54	MJ/kg
Sewage Sludge (wet substance)	3.64	MJ/kg
Black Liquor	7.92	MJ/kg
Carcass meal	17.30	MJ/kg
Adipose	36.59	MJ/kg
Liquid Biofuels	42.00	MJ/kg
Biogas	22.06	MJ/m^3
Gas from Waste Disposal Site	17.00	MJ/m^3

Table A 105 presents the IPCC default values of net calorific values of gaseous biofuels which are used for default unit conversion.

Table A 105: Default net calorific values from IPCC Guidelines.

Fuel Name	NCV	Unit
Sewage Sludge Gas	27.00	MJ/m^3

ANNEX 4: QA/QC PLAN

Annex 4.1 – NISA

Austria's Obligations

Regarding Austria's obligations under the United Nations Framework Convention on Climate Change (UNFCCC) the relevant COP (Conference of the Parties) Decisions and Guidelines are:

- Decision 11/CP.4 National communications from Parties included in Annex I to the Convention.
- Decision 3/CP.5 Guidelines for the Preparation of National Communications by Parties included in Annex I to the Convention, Part I: UNFCCC Reporting Guidelines on Annual Inventories (referring to Document FCCC/CP/1999/7) revised with Decision 18/CP.8 (referring to Document FCCC/CP/2002/8).
- Decision 4/CP.5 Guidelines for the Preparation of National Communications by Parties included in Annex I to the Convention, Part II: UNFCCC Reporting Guidelines on National Communications (referring to Document FCCC/CP/1999/7) revised with Decision 19/CP.8 (referring to Document FCCC/CP/2002/8).
- Decision 20/CP.7 (19/CMP.1): Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol;
- Decision 21/CP.7 (20/CMP.1): Good practice guidance and adjustments under Article 5, paragraph 2, of the Kyoto Protocol;
- Decision 24/CP.19: Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention.
- 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 (referring to Document FCCC/PA/CMA/2018/3/Add.2)
- Decision 5/CMA.3: Guidance for operationalizing the modalities, procedures and guidelines for the enhanced transparency framework referred to in Article 13 of the Paris Agreement (referring to Document FCCC/PA/CMA/2021/10/Add.2)

The relevant EU Regulations are:

- 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, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council; ("*Governance Regulation*"[1]). The purpose of this regulation is to monitor anthropogenic greenhouse gas emissions and to evaluate the progress towards meeting the Union greenhouse gas reduction commitments in accordance with the Paris Agreement;

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R1999&from=EN

- Commission Implementing Regulation (EU) 2020/1208 Commission Implementing Regulation (EU) 2020/1208, specifying the reporting obligations and providing templates;
- 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.

In addition to the obligation under the UNFCCC Austria has to comply with the following obligations regarding air emissions:

- Austria's annual obligation under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) and its Protocols (1979) comprising the annual reporting of national emission data on SO_2, NO_X, NMVOCs, NH_3, CO, TSP, PM_{10}, and $PM_{2.5}$ as well as on heavy metals (Pb, Cd, Hg), persistent organic pollutants (POPs), dioxins and furans, hexachlorobenzene (HCB) and polychlorinated biphenyls (PCB).
- Obligation under the Austrian Ambient Air Quality Law[2] concerning the reporting of national emission data on SO_2, NO_x, NMVOC, CO, heavy metals (Pb, Cd, Hg), benzene and particulate matter.
- Austria's obligation according to Article 15 of the European IPPC Directive 1996/61/EC is to implement a European Pollutant Emission Register (EPER). EPER was displaced and upgraded by regulation (EC) No 166/2006 concerning the establishment of a European Pollutant Release and Transfer Register (E-PRTR Regulation). EPER and E-PRTR are associated with Article 6 of the Aarhus Convention (United Nations: Aarhus, 1998) which refers to the right of the public to access environmental information and to participate in the decision-making process of environmental issues.

History of NISA

As there are so many different obligations which are subject to continuous development, Austria's National Inventory System (NISA) has to be adapted to these changes. A brief history of the development and the activities of NISA are shown here:

- Austria established estimates for SO_2 under EMEP in 1978 (Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe).
- As an EFTA country Austria participated in CORINAIR 90, which was an air emission inventory for Europe. It was part of the CORINE (Coordination d'Information Environmentale) work plan set up by the European Council of Ministers in 1985. The aim of CORINAIR 90 was to produce a complete, consistent and transparent emission inventory for the pollutants: SOx as SO_2, NO_X as NO_2, NMVOC, CH_4, CO, CO_2, N_2O and NH_3.
- Austria signed the UNFCCC on June 8, 1992 and subsequently submitted its instrument of ratification on February 28, 1994.
- In 1994, the first so-called Austrian Air Emission Inventory (Österreichische Luftschadstoff-Inventur, OLI) was prepared.
- In 1997, a consistent time series for the emission data from 1980 to 1995 was reported for the first time.

[2] AUSTRIAN AMBIENT AIR QUALITY LAW (1997): Immissionsschutzgesetz-Luft. Federal Law Gazette I 115/1997.

- In 1998, also emissions of HM, POPs and FCs were included in the inventory.
- Inventory data for particulate matter were included in the inventory in 2001.
- In 2005: accreditation according to EN ISO/IEC 17020 as *Inspection Body for Emission Inventories.*
- Periodic external audits by "Accreditation Austria" in 2006, 2008 and 2009
- In 2011: first re-accreditation according to EN ISO/IEC 17020
- Periodic external audits by "Accreditation Austria" in 2012, 2013 and 2014
- In 2016: second re-accreditation according to EN ISO/IEC 17020
- Periodic external audits by "Accreditation Austria " in 2017 and 2018
- In 2020: third re-accreditation according to EN ISO/IEC 17020
- Periodic external audits by "Accreditation Austria" in 2022 and 2023

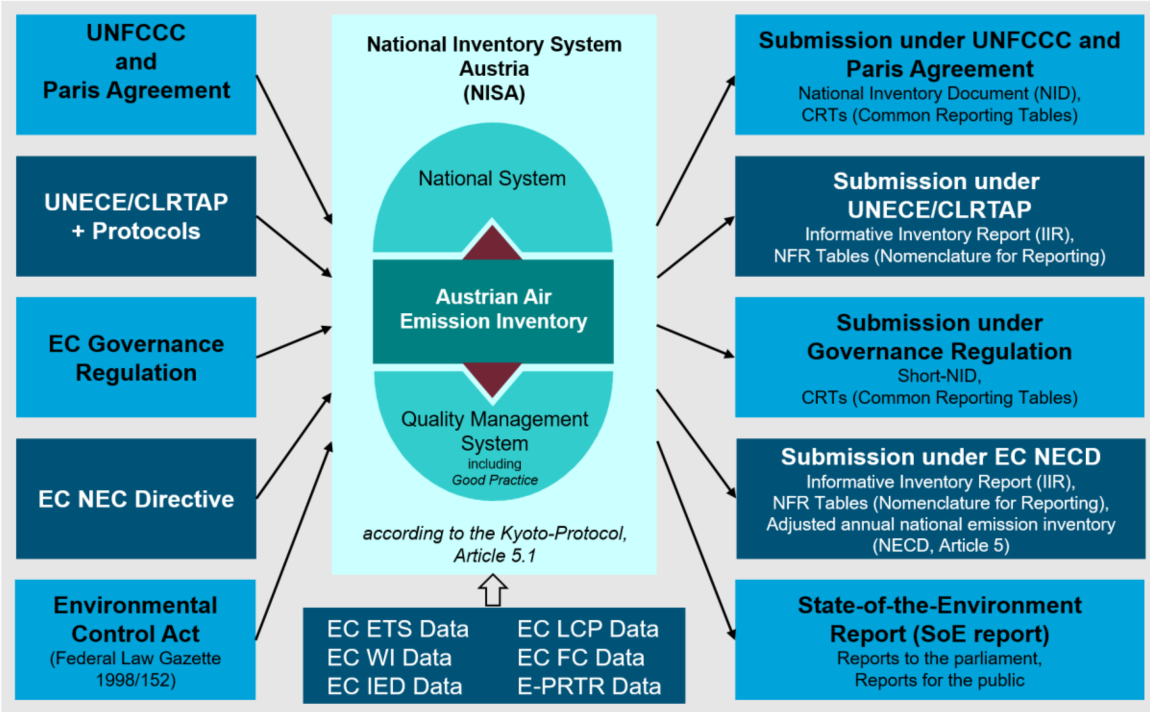
Adaptation of NISA according to the Kyoto Protocol

Regulations under the UNFCCC and the Kyoto Protocol defined new standards for national emission inventories. These standards include more stringent requirements related to transparency, consistency, comparability, completeness and accuracy of inventories. Each Party shall have in place a national system. This national system shall include all institutional, legal and procedural arrangements made within a Party for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and for reporting and archiving inventory information.

Austria's aim was to set up a national system that fulfils all the requirements of the Kyoto Protocol and also works as an efficient system to fulfil all the other obligations regarding air emission inventories Austria has to comply with.

The emission inventory system has a structure as illustrated in Figure 1.

Figure 1: Structure of the National Inventory System in Austria (NISA).



Source: Umweltbundesamt

The Austrian Air Emission Inventory, comprising all air pollutants stipulated in the various national and international obligations, is at the centre of NISA. The national system and the quality management system have been incorporated into NISA as complementary sections.

The Guidelines for National Systems for the Estimation of Anthropogenic Greenhouse Gas Emissions by Sources and Removals by Sinks under Article 5.1 of the Kyoto Protocol (Decision 19/CMP.1) describe the elements to be included in a national system.

The overall goal of National Systems is to ensure the quality of the inventory through planning, preparation and management of inventory activities. National Systems should enable Parties to estimate emissions in accordance with the relevant inventory guidelines to comply with the requirements of the Kyoto Protocol.

The general principles for National Inventories are transparency, consistency, comparability, completeness and accuracy of inventories and the quality of inventory activities (e.g. collecting activity data, selecting methods and emission factors).

The general functions are

- to establish and maintain the institutional, legal, and procedural arrangements defined in the guidelines for national systems between the government agencies and other entities,
- to ensure sufficient capacity for timely performance,
- to designate a single national entity with overall responsibility for the national inventory,
- to prepare national annual inventories and supplementary information in a timely manner and

- to provide information necessary to meet the reporting requirements.

Specific functions stipulated in these guidelines are inventory planning, preparation and management.

Austria has taken significant steps to establish a high-quality emission inventory in which uncertainties are reduced as far as feasible and in which data are developed in a transparent, consistent, complete, comparable and accurate manner.

The following steps have been taken to prepare NISA to meet the requirements of the Kyoto Protocol:

- The Umweltbundesamt has been designated as the single national entity with the overall responsibility for the national inventory by law: the Environmental Control Act ("Umweltkontrollgesetz"; Federal Law Gazette I No. 152/1998) regulates responsibilities of environmental control in Austria and lists the tasks of the Umweltbundesamt. One task is the preparation of technical expertise and basic data for the fulfilment of the obligations under the UNFCCC and the UNECE LRTAP Convention. For further institutional arrangements, please refer to sub-chapter 1.2.4)
- The responsibilities for inventory planning, preparation and management are specified and allocated within the Umweltbundesamt. Following internal Umweltbundesamt quality management regulation, a yearly plan is implemented to ensure capacity for timely performance of the functions defined in the guidelines for national systems. The technical competence of the staff involved in the inventory preparation process is ensured by arrangements according to the QMS of the IBE as well as the internal Umweltbundesamt training plan.
- The inventory preparation, including identification of key categories, uncertainty estimates and QC procedures, is performed according to the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines
- A Quality Management System (QMS) has been developed and implemented.
- The national greenhouse gas inventory is prepared by the inspection body for GHG inventories within the Umweltbundesamt which is accredited as inspection body according to the International Standard ISO/IEC 17020 General Criteria for the operation of various types of bodies performing inspections. The accreditation audit of the Umweltbundesamt as inspection body took place in September 2005. The accreditation was completed officially in December 2005 and renewed in July 2011, May 2016 and February 2020.
- The QMS also includes the necessary procedures to ensure quality improvement of the emission inventory. They comprise documentation of allocated responsibilities, of any discrepancies and of the findings by UNFCCC review experts in particular.
- The inventory management as part of the QMS includes a control system for data and calculations, for records and their archiving as well as documentation of QA/QC activities. This ensures the necessary documentation and archiving for future reconstruction of the inventory and for the timely response to requests during the review process.
- Part of the legal and institutional arrangements in place to provide a basis for the national system concern data availability for the annual compilation of the GHG inventory. The main data source for the Austrian inventory preparation is the Austrian statistical office (Statistik Austria). The compilation of several statistics is regulated by law; the compilation of the national energy balance is regulated by contracts. Other data sources include reporting

obligations under national and European regulations and reports of companies and associations.

- A process for official consideration and approval of the inventory prior to its submission is established. The inventory information is provided by the Umweltbundesamt to the Austrian Federal Ministry of 'Climate Action, Environment, Energy, Mobility, Innovation and Technology' (BMK), where the National Focal Point for the UNFCCC is established. The inventory is then submitted by the Ministry to the UNFCCC secretariat.

The Austrian national system was reviewed during the in-country review of the initial report of Austria (February 2007). Paragraph 10 of the review report (FCCC/IRR/2007/AUT) states that the national system has been developed in line with the relevant guidelines and can fulfil the requirements of the Kyoto Protocol as well as other obligations regarding its air emissions inventory that Austria has to comply with.

Annex 4.2 – QMS and Inspection Body for Emission Inventories (IBE)

History of the Austrian QMS

A quality management system (QMS) has been designed to achieve the objectives of *good practice guidance*, namely to improve transparency, consistency, comparability, completeness and confidence in national inventories of emissions estimates. After having been effectively implemented during the development of the UNFCCC submission 2004, the accreditation audit of the Umweltbundesamt (Environment Agency Austria) as *Inspection Body for Emission inventories (IBE)* took place in autumn 2005. Accreditation was awarded in December 2005 and renewed in January 2011, 2016 and 2020.

Table A 106 presents the timetable for the implementation of the quality management system.

Table A 106: *Timetable for the implementation of the Austrian QMS.*

	Date
Development of a quality management system including Quality Manual	1999–2002
Development of the quality management system Implementation of the quality management system	2003–2005
Accreditation Audit Accreditation as Inspection Body for Greenhouse Gas Inventories	September 2005 December 2005
1st Re-Accreditation Audit Re-Accreditation as Inspection Body for Greenhouse Gas Inventories	January 2011 July 2011
2nd Re-Accreditation Audit Re-Accreditation as Inspection Body for Greenhouse Gas Inventories	December 2015 May 2016
3rd Re-Accreditation Audit Re-Accreditation as Inspection Body for Greenhouse Gas Inventories	February 2020 July 2020

With the start of the EU Emissions Trading system on January 1st 2005 and the entry into force of the Kyoto Protocol on February 16th 2005, greenhouse gas emissions now equal money. Pressure upon national GHG emission inventories is expected to increase, therefore a QMS is considered crucial in order to ensure the quality of emission estimates established according to the requirements of the IPCC 2006 GL as a basis for any kind of international emission trading.

The International Standard EN ISO/IEC 17020

The QMS was drawn up to meet the requirements of the International Standard EN ISO/IEC 17020[3]. It covers the functions of bodies whose work includes assessments of conformity, and the subsequent reporting of results of conformity assessment to clients and, when required, to supervisory authorities. Inspection parameters may include, among others, matters of quantity and/or quality.

The general criteria, with which these bodies are required to comply in order that their services be accepted by clients and by supervisory authorities, are harmonized in the International Standard EN ISO/IEC 17020:2012 *Requirements for the operation of various types of bodies performing inspections.* This standard has been drawn up with the objective of promoting confidence in those bodies performing inspections which conform to it.

The EN ISO/IEC 17020 also takes into account requirements and recommendations of European and international documents such as the EN ISO 9000 series of standards, and goes beyond: additionally to the requirements of the EN ISO 9000 series, the EN ISO/IEC 17020 also provides a clear statement of requirements regarding competence, independence, impartiality and integrity, as well as confidentiality.

Accreditation Act

According to the EN ISO 17000 series, *accreditation* is the procedure by which an authorized body (accreditation body) formally recognizes that an organisation has the competence to perform a stipulated conformity assessment activity.

The Austrian Accreditation Act 2012 ("Akkreditierungsgesetz 2012", Federal Law Gazette I No 28/2012, last amended by Federal Law Gazette I No 40/2014)) regulates the accreditation of testing, inspection and certification bodies. It designates the Federal Ministry for 'Labour and Economy' (BMAW) as accreditation body and defines the conditions for granting, maintaining and extending accreditation and the conditions under which accreditation may be suspended or withdrawn.

Accreditation is granted after a successful accreditation audit, where an expert nominated by the accreditation body assesses the conformity of the organization of the inspection body and its QMS with the standard, and additionally a technical expert assesses the competence of the inspection body and the conformity of the methodologies applied with specific requirements. This audit takes three days of in-house inspection.

The accreditation requires re-assessment in defined intervals (in the case of an inspection body a one day audit takes place every twenty months on average).

Accreditation and Certification

A certification is the procedure by which an official – or officially recognised – body (certification body) gives written assurance that a product, process or service conforms to specified requirements. Thus, in contrast to an accreditation, the certification gives warrantee for conformity,

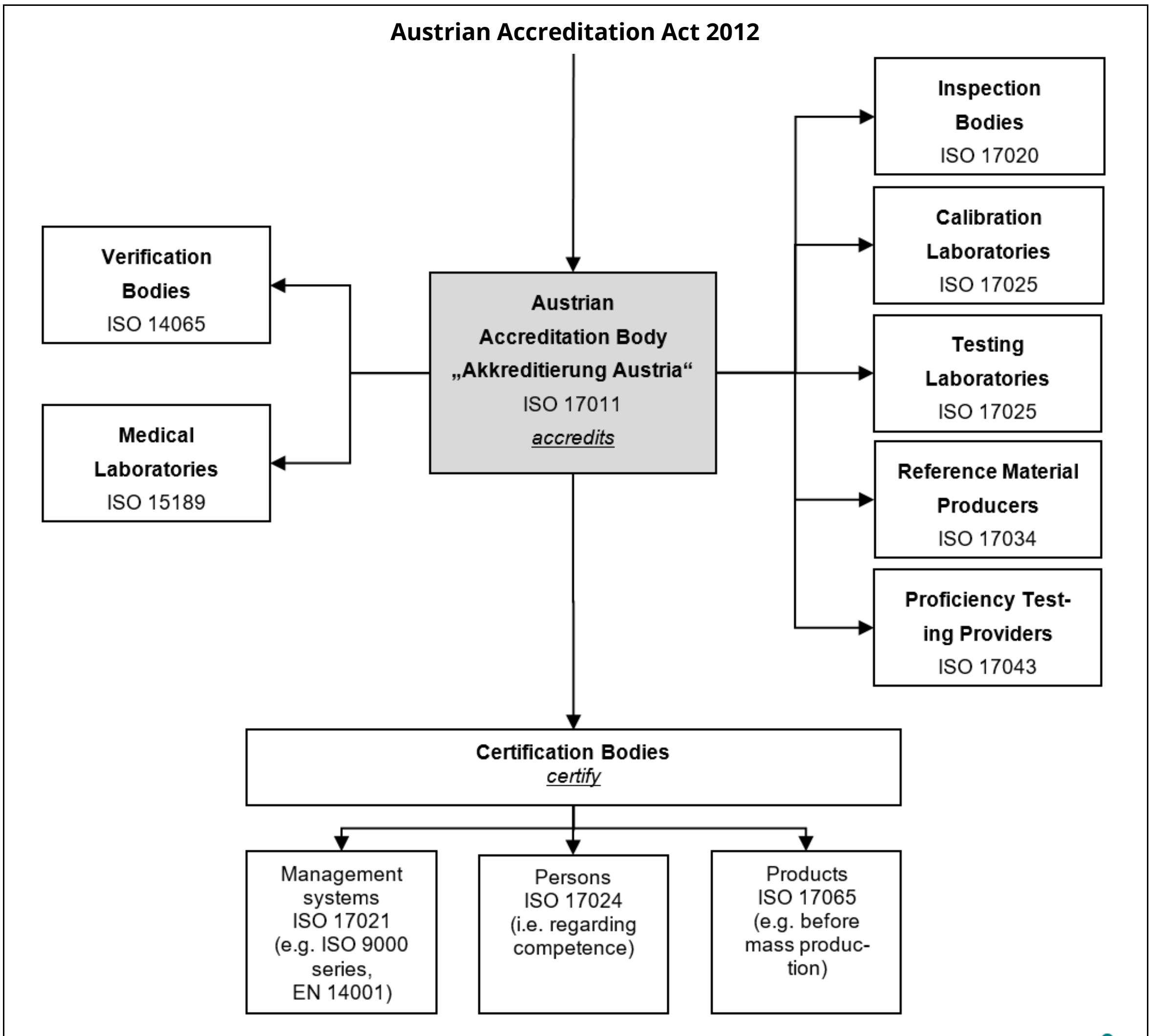
[3] The International Standard ISO/IEC 17020 superseded the European Standard EN 45004.

whereas the accreditation is a warrantee for competence, as well as independence, impartiality and integrity (additionally, both require a QMS that guarantees transparency).

One example for certification is the certification of a QMS according to the EN ISO 9000 series. The certification is issued by a certification body. The certification body on the other side needs an accreditation, which is the warrantee that the certification body is competent to carry out EN ISO 9000 certifications in specific business sectors.

Figure 2 gives an overview of accreditation of conformity assessment bodies by "Akkreditierung Austria" and certification by certification bodies in Austria (based on the Austrian Accreditation Act 2012).

Figure 2: Overview of accreditation of conformity assessment bodies by 'Akkreditierung Austria' and certification by certification bodies in Austria



Source: Umweltbundesamt

Reports issued by an accredited body may carry the federal emblem in addition to the accreditation logo. These reports are official documents.

Independence

The impartiality and independence of the Environment Agency Austria can be deduced from the principles laid down in the UKG (especially sections 5, 6 and 11):

- The Environment Agency Austria GmbH is an independent company which has been assigned public governance functions and specific tasks of public administration.
- In addition to these, the Environment Agency Austria performs only tasks which are in the public interest of protecting the environment.
- Basic annual funds are provided to the Environment Agency Austria as stipulated in the UKG. The responsibility for managing these funds lies with the managing directors of the Environment Agency Austria.

Impartiality and Integrity

The personnel of the inspection body shall be free from any commercial, financial and other pressures which might affect their judgement. It has to be ensured that persons or organisations external to the inspection body cannot influence the results of inspections carried out.

We feel that such a regulation is fundamental in order to guarantee that the emission data reflect real emissions as truly as possible.

Inspection body in the context of the National Greenhouse Gas Inventory

In the case of greenhouse gas emissions inventories, inspection covers (i) data collection (emission data and/or of data which are used to estimate emissions e.g. activity data, emission factors, conversion factors), (ii) the application of appropriate methodologies (IPCC, CORINAIR and country specific methodologies) to estimate emissions, (iii) the compilation of the emissions inventory and (iv) the assessment of conformity with national emission reduction targets. The QMS ensures that all requirements of a Type A inspection body as stipulated in EN ISO/IEC 17020 are met, including independence, impartiality and integrity.

When compiling emission inventories according to the standard, the methodologies applied have to be officially approved by the accreditation body.

The Austrian Quality Management System (QMS) and requirements of IPCC GL

The implementation of QA/QC procedures as required by the IPCC GL support the development of national greenhouse gas inventories that can be readily assessed in terms of quality and completeness. The QMS as implemented in the Austrian inventory includes all elements of the QA/QC system outlined in the IPCC 2006 GL Volume 1 Chapter 6 'Quality Assurance, Quality Control and Verification', and goes beyond. It also comprises supporting and management processes in addition to the QA/QC procedures in inventory compilation and thus ensures agreed standards not only within (i) the inventory compilation process and (ii) supporting processes (e.g. archiving), but also for (iii) management processes (e.g. annual management reviews, internal audits, regular training of personnel, definition of procedures for external communication).

Design of the Austrian QMS

The design of the QMS of the *Inspection Body for Emission Inventories* (IBE) at the Umweltbundesamt follows a *process based approach*, as illustrated in Figure 3.

Figure 3: Process-based QMS of the IBE

Source: Umweltbundesamt

1) Realisation process

The realisation process is the *Inspection Body's for Emission Inventories* (IBE) core competence as they concern the compilation of emission inventories. The inspection process consists of two steps, (i) data collection and (ii) the application of methods to estimate emissions. The Umweltbundesamt uses IPCC methods, CORINAIR methods and country specific methods. Country-specific methods are thoroughly documented and validated. Emission estimates are subject to quality control checks before being published in an inspection report.

The inspection body performs the majority of inspection processes itself. Any subcontractor performing part of the inspection is required to work in compliance with EN ISO/IEC 17020.

2) Management processes

Management Processes comprise all activities necessary for management and control of an organisation: resources and responsibilities, quality system, internal audits, management review, corrective actions and prevention, external communication.

The most important aspect with respect to organisation and management is that it has to be ensured that the personnel is free from any commercial, financial or other pressure which might affect their judgement. Such regulations are considered fundamental in order to guarantee that emission data reflect actual emissions as truly as possible.

The personnel responsible for inspection shall have appropriate qualifications, training, experience and a satisfactory knowledge of the requirements of the inspections to be carried out. They have the ability to make professional judgements as to conformity with general requirements using examination results and to report there-on.

Computers are used for the compilation of emission inventories. Procedures for protecting the integrity of data and for maintenance of data security have been established and implemented. Access authorisation is strictly limited for protecting the integrity of data and to ensure data confidentiality where necessary.

A management review is held every year; the report is presented to the managing directors who are responsible for resources. The management review report includes an evaluation of the QMS based on information obtained mainly from internal audits, as well as results from the UNFCCC review process, the inventory improvement plan (evaluation of fulfilment of previous plan and decision on new plan) and a plan for the QMS (evaluation of fulfilment of previous plan and decision on new plan).

3) Supporting processes

Supporting processes support both the management and the realisation processes. They include a control system for all documents and data as well as for records and their archiving.

ANNEX 5: ANY ADDITIONAL INFORMATION

Annex 5.1 – CRT 3 Agriculture – Austria's N-flow model

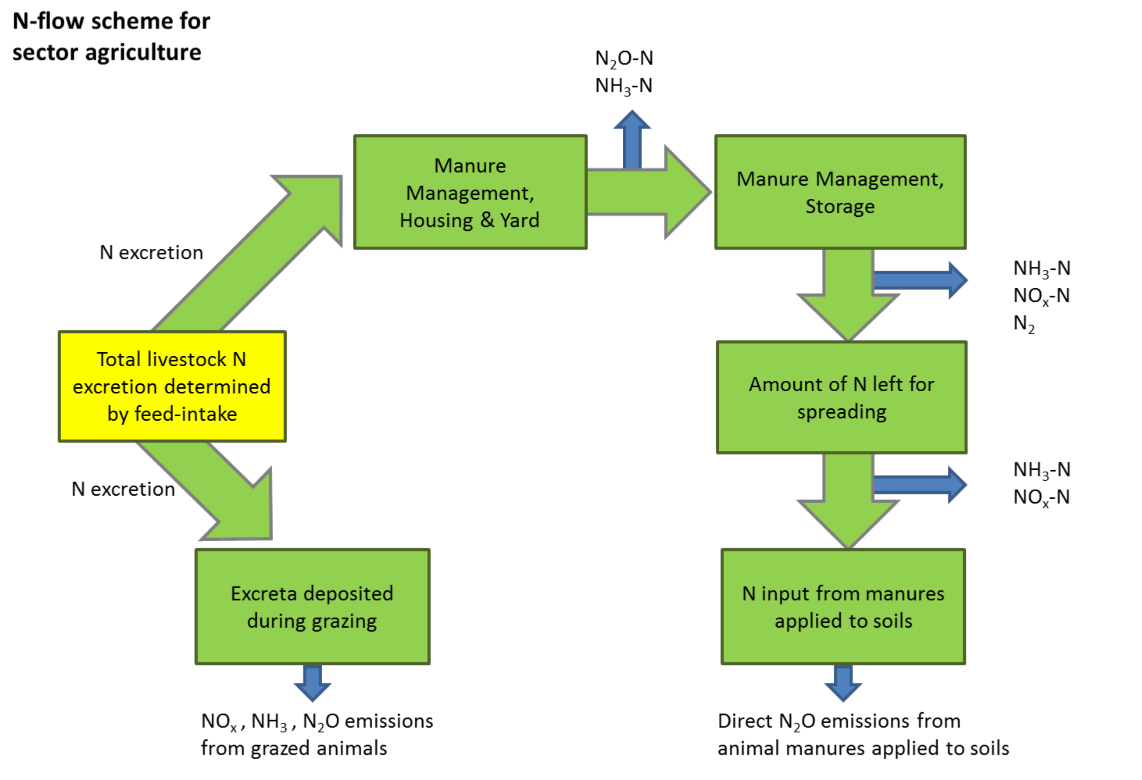
For the calculation of N_2O emissions from agricultural soils Austria uses country specific methods which are consistent with the N-flow approach. The approach used by Austria is more complex than the IPCC method in order to allow for the consideration of the management practices in Austria as those may differ from other countries.

As recommended in the EMEP/EEA Emission Inventory Guidebook 2023 for higher tier methods, NH_3 emissions are calculated on the basis of the amount of total ammoniacal nitrogen (TAN). TAN is present in the urine of animals and considered to be equivalent to the N content of urine. This calculation method is more precise than the calculation on the basis of total N excretion because emissions of NH_3 arise from TAN. The calculation addresses both N pools (N excretion and TAN) for the different stages of manure management (housing -> storage -> spreading) in terms of NH_3, NO_x, N_2O and N_2 emissions and includes information of the total N amount within each relevant stage (N excretion), and the fraction of that amount that is present as TAN. Detailed information on parameters and methods used is provided in Austria's Informative Inventory Report 2024, chapter 5 (UMWELTBUNDESAMT 2024).

The N-flux model used by Austria was developed by the University of Natural Resources and Applied Life Sciences, Vienna, on behalf of the Environment Agency Austria in 2001 and has been regularly further developed (AMON et al. 2002, 2008 & 2010), (AMON & HÖRTENHUBER 2014) and (AMON & HÖRTENHUBER 2019). In submission 2020 the N flow model has been further enhanced according to the EMEP/EEA Guidebook 2019; in the current submission the EMEP/EEA GB 2023 was applied. However, there were no significant changes regarding N-flow in the new EMEP/EEA GB 2023 compared to the 2019 version.

The following figure illustrates the pathways of N in the calculation of N-species emissions from the N excreted by livestock.

Figure 4: Schematic diagram of the Austrian N flow (animal manure)



Source: Umweltbundesamt

For the calculation of N_2O emissions occurring from N-input from manures applied to soils, the chain beginning with the feeding, the housing, the transfer to the storage, the transfer to the application machine and finally the spreading to the fields is relevant. All those emissions are accounted at the appropriate stage of the process.

Feeding

In the first step, N excretion for a given animal category is determined on the basis of national feed-intake data.

Grazing

In the second step the resulting N amount relating to the share excreted on pasture is subtracted based on the proportion of time spent on pasture. Following the 2006 IPCC Guidelines, N_2O emissions resulting from nitrogen input through excretions of grazing animals (directly dropped onto the soil) are calculated under *Manure Management* but reported under *Agricultural Soils*.

Housing:

For each animal category, the amount of N accruing from the housing is split based on the relative share of animal-housing systems used in Austria. These systems vary in terms of their emission behaviour (e.g. tied and loose housing systems, liquid versus solid manure systems).

Indirect N_2O emissions from manure management systems

Nitrogen losses begin at the point of excretion and continue through on-site management in storage and treatment systems. Further nitrogen can be lost through runoff and leaching into soils from the solid storage of manure at outdoor areas (not occurring in Austria). The indirect N_2O emissions from volatilization of N in forms of NH_3 and NO_x are estimated following the IPCC Tier 2 methodology. The country specific value of $Frac_{GasMS}$ includes NH_3-N losses from housing, storage, yard and NO_x-N losses from manure management calculated within the Austrian N-flow model.

Storage:

The remaining N is then transferred to the different storage systems used in Austria (e.g. covered or uncovered storage).

For all stages of manure NH_3 emissions are calculated in proportion to the available TAN amount. Emission factors for cattle and swine were derived from the Swiss DYNAMO-model, peer reviewed by the EAGER group and published in (REIDY et al. 2008, 2009). For the non-key livestock categories sheep, goats, horses, poultry and deer the EMEP/EEA default Tier 2 NH_3-N EF and associated parameters have been applied (EEA 2023).

N losses from manure management resulting from emissions of N_2O, NO_x and N_2 are calculated on the basis of N excretion per AWMS, jointly for housing and storage, as recommended by the IPCC guidelines. Throughout the inventory the same MMS distribution is used.

Application on agricultural soils

Remaining amounts of animal manure nitrogen ("N left for spreading") are available for soil application.

Direct N_2O-emissions

Following the 2006 IPCC guidelines for calculation of direct N_2O emissions from soils amounts of applied fertilizers are no longer adjusted for the amounts of NH_3 and NO_x volatilization after application to soils (see below).

NH_3 and NO_X emissions

NH_3 and NO_x emissions are calculated according to different application procedures (broadcast spreading, band spreading) resulting in different N-losses. In particular, volatile NH_3-N losses of cattle and swine manure are subtracted from the TAN content per animal category; volatile losses from NO_x are subtracted from the N amount per animal category available for spreading.

Indirect N_2O emissions from leaching and run-off from managed soils

Calculation basis is the nitrogen amount available for application on soils ("N left for spreading") as a result from the Austrian N-flow model. This amount is multiplied with the country-specific value of $Frac_{LEACH}$.

Results of a country specific study of the Institute for Land & Water Management Research Petzenkirchen (Federal Agency for Water Management) in cooperation with the Institute of Hydraulic Engineering and Water Resources Management (Vienna University of Technology) (EDER et al. 2015) determine a value of 15.154% for the fraction of leaching and run-off from nitrogen additions to Austria's managed soils. The peer reviewed study used 22 lysimeters covering a wide range of soils, climatic conditions and management practices in Austria to evaluate an Austria-specific value of $Frac_{LEACH}$.

Indirect N_2O emissions from atmospheric deposition of N volatised from managed soils

Basis for emission calculation are the country specific volatilization losses (NH_3-N and NO_x-N) occurring during animal grazing and manure application.

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Annex 5.2 – CRT 4 LULUCF – Austrian system for land representation

Overview

The Austrian system for representing total annual areas of land-use categories and annual conversions between land-use categories is based predominantly on national sources of spatially-explicit land-use and land-use change oberservations. The system relies on four separate pre-processing elements that pre-process respective input data on land use and land-use conversion in Austria. The outputs of these pre-processing elements feed into an integregation element, where depending on the hierarchical treatment of the respective land use and conversion categories, specific further adjusments, interpolations and extrapolations are made to derive final annual land transition matrices that are:

- Complete and consistent with respect to the total area of the Austrian territory (use of subcategory "Other land"); and
- Consistent in terms of the land-use and conversion category areas within and across years (Initial land-use category areas of the previous year plus the respective net conversions to those categories equal the final land-use category areas)

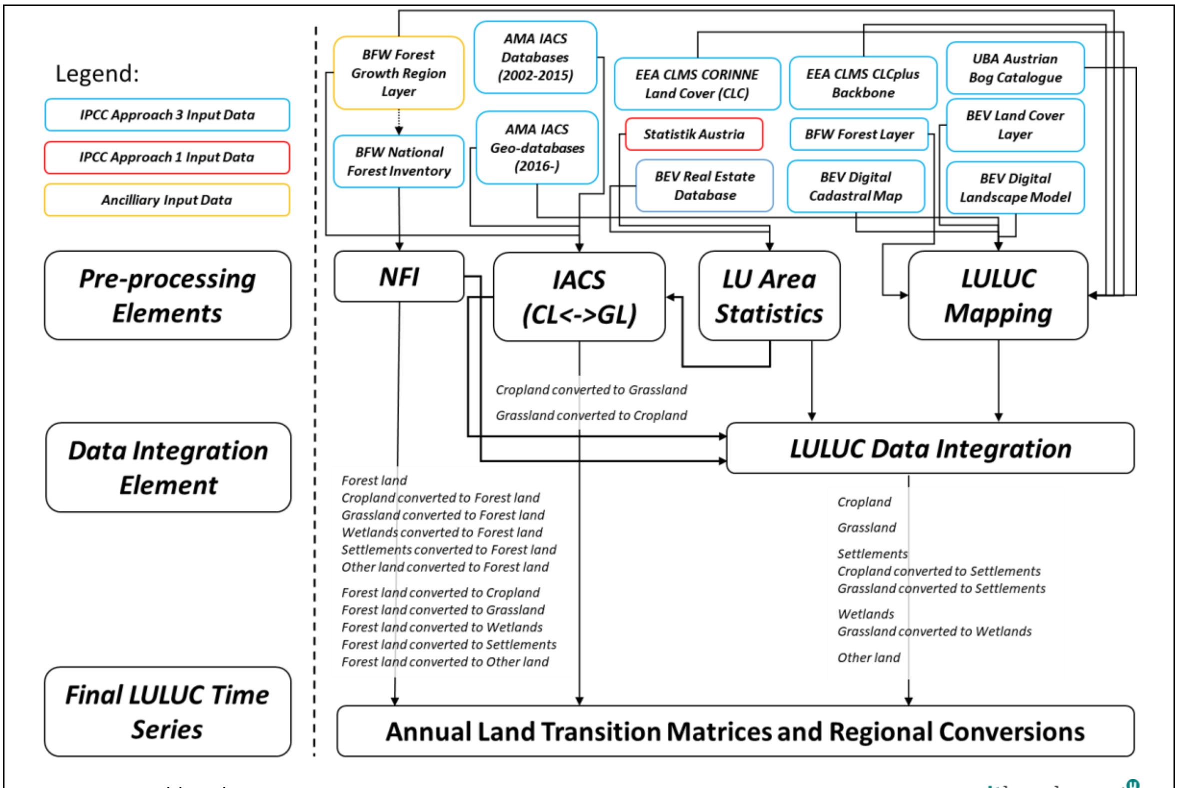
The system furthermore incorporates ancilliary spatial input data to proportionally resolve annual time series of land-use conversion across five ecoregions, according to the national forest growth regions. This regionalisation of the land-use conversion categories allows for the application of region-specific initial and post-conversion stock values for estimating changes in the soil carbon pool due to land-use change.

In terms of the hierachical treatment of different sources of land use and conversion data, the national forest inventory (NFI) is considered the element that provides the most reliable and long-term source of input data to the system. The NFI provides repeated in situ classification of Forest land areas (as well as land-use changes to- and from Forest land) at permanent, georeferenced plots distributed over a 4 x 4 km grid over the country. This *NFI* pre-processing element therefore provides total Forest land areas, as well as conversions to- and from Forest land, that are unchanged and directly incorporated into the annual land transition matrices. Furthermore, given the known locations of the NFI plots, the element also provides conversions to- and from Forest land for each of the five ecoregions. The other element providing direct inputs of conversion data to the annual land transition matrices is the *IACS (CL<->GL)* pre-processing element. Here, the spatially-explicit Integrated Administrative Control System (IACS) is merged with a map of the five ecoregions and sampled to quantify total annual conversions between Cropland and Grassland, as well as respective conversions for each of the five eocregions. As not all Cropland and Grassland areas are contained within the IACS data, the changes are quantified as yearly precentages relative to the total IACS Croplands areas. To derive the final total annual conversion areas between Cropland and Grassland, these relative values are multiplied with the total Cropland area produced in the *LU Area Statistics* pre-processing element. In this element, initial time series of annual total areas of the land use categories Cropland, Grassland, Wetlands, Settlements and Other land are produced by synthesizing aggregated national area statistics derived from maps and geospatial databases, as well as statistical surveys. These initial area estimates however do not flow directly into the annual land transition matrices but instead undergo further adjustment (Cropland), are used for extrapolation (Wetlands, Settlements) or are used simply for QC comparison purposes (Grassland and Other land) via the *LULUC Data Integration* element. The final pre-processing element is the *LULUC Mapping* element. Here, wall-to-wall, 5 x 5 m resolution land use maps for the years 2016, 2018, 2020 and 2022 are produced in a geographic information system that integrates spatially-explicit, data layers on land use and land cover from various sources. The resulting raster data for each year, as well as a rasterised layer of the five ecoregions are combined together at the pixel level to generate a tabular output providing the respective total areas of all possible pixel combinations of ecoregion and land use over the different years. Additionally, the *LULUC Mapping* element processes the EEA CLMS CORINE Land Cover layers for 1990, 2000, 2006, 2012, and 2018 and combines the derived land-use conversions to Settlements with a vector layer of the five ecoregions. This is done to inform the regional resolution of Cropland- and Grassland conversions to Settlements pre-2016.

While the outputs of the NFI and *IACS (CL<->GL)* element feed directly into the annual land transition matrices and subsequent inventory calculations, the outputs of all input elements are nonetheless processed together in the *LULUC Data integration element*. Here, the final annual total and ecoregion area estimates of the remaining land use and conversion categories are processed further to ensure full completeness and consistency in the final land use and land-use change time series.

The following chapters of this Annex describe in detail the pre-processing elements and their respective input data, as well as the *LULUC data integration* element. Furthermore, Figure 5 illustrates graphically how the input data, pre-processing- and data integrations elements are linked.

Figure 5: Data inputs and processing elements of the Austrian System for land representation



Source: Umweltbundesamt

NFI pre-processing element: Processing of the data from national forest inventory for total Forest land area and conversions to- and from Forest land

The area of Forest land, as well as the land-use change areas from- and to Forest land, are based on data from the Austrian National Forest Inventory (NFI) of the Austrian Federal Office and Research Centre for Forests (BFW). Repeated NFI cycles were carried out in the periods 1961–70, 1971–80, 1981–85, 1986–90, 1992–96, 2000–02, 2007–09 and 2016-21. Since the last cycle, the NFI is now carried out continuously, with 1/6 of the grid locations sampled each year meaning a full cycle is complete every six years. For the purpose of land representation, only data from the completed NFI cycles are used.

The Austrian NFI (BFW, 2022; GSCHWANTNER et al., 2010, SCHIELER et al., 1995; WINKLER, 1997) uses a geographically fixed grid system to classify land-use and land-use change at specific, permanent plot locations over time. The NFI uses a permanent ca. 4 x 4 km grid across all of Austria with four permanent sample plots of 300 m^2 size at each grid point. At each permanent sampling plot, land use is prinicipally inspected and classified *in situ* according to BFW NFI field instructions. Generally, a single plot will be classified either as forest according to the national forest definition or as single non-forest land-use class (e.g. an annual cropland or a residential area). For plots where more than one non-forest class occurs, the most dominant non-forest class in the plot area is assigned. For plots where both forest and non-forest land-uses occur, the plot is divided into 10 equal fractions with X/10 of the plot assigned forest, and the remaining fraction assigned to the most dominant non-forest class. By repeated land classification at the plots, the NFI allows quantification of the specific land conversions to and from forests.

For each NFI cycle, the BFW provides the upscaled data on total Forest land area, as well as the total areas for each type of land-use conversion to Forest land (afforestation) and each type of conversion from Forest land (deforestation). In addition to national total areas, Forest land, as well as the conversions to and from Forest land, are stratified by forest type (forests not in yield, and coniferous and deciduous forests in yield) and forest growth region (i.e. the five applied ecoregions in the GHG inventory). These upscaled data are processed for the GHG inventory as follows. For each NFI cycle, data on the total forest areas are assigned to the mid-point year of the respective cycle, with annual area data between two consecutive NFI cycles calculated by linear interpolation. The sum of observed areas of each afforestation and deforestation category (total and per forest growth region) are divided by the years between respective mid-points of the inventory cycles to derive annual estimates of land-use changes to and from Forest land. Prior to this, the conversions are subject to a subtraction to account for osscilating changes observed at the NFI plots over time. This adjustment however impacts total afforestation and deforestation areas equally, thus meaning that the net change in Forest land area is unchanged. Furthermore, to assign the conversions to the correct IPCC LUC category, the NFI non-forest land-use classes are assigned to respective IPCC categories (Cropland, Grassland, Wetlands, Settlements and Other land) according to a translation scheme developed in cooperation with the BFW.

For gap-filling of annual areas since 2019 (mid-point of the last NFI cycle), the rates of afforestation and deforestation derived from the last two NFI cycles (2007/09 and 2016/21) are assumed to have remained constant. Based on these assumed conversion values, the total Forest land area from 2019 is extrapolated to the end of the time series. Finally, the NFI total forest areas are provided in rounded units of kha. To account for small inconsistencies caused by this rounding artefact, the time series of annual total Forest land area are adjusted minimally to ensure consistency with the annual net change in Forest land area derived from the times series of conversions to and from

Forest land. The Forest land category subchapter in the main NID document provides further details on the NFI.

The derived annual time series of total Forest land and all categories of land conversion to and from Forest land are included directly and unchanged in the annual land transition matrices. Likewise the derived conversions to and from Forest land for each ecoregion then flow directly and unchanged into the inventory calculations of soil carbon stock changes caused by afforestation and deforestation. Nonetheless, the data on total Forest land area, and total conversions to and from Forest land, also feed into the LULUC Data Integration element to ensure area consistency in the land transition matrix between categories and years.

IACS (CL<->GL) pre-processing element: IACS sampling for land conversions between Cropland and Grassland

The conversions between annual cropland, perennial cropland and grasslands are calculated in this specific pre-processing element that synthesizes the available, spatially explicit information contained in the databases behind the national agricultural subsidy payment system, the Integrated Administration and Control System (IACS) administered by the Agrarmarkt Austria (AMA). This element queries the historic tabular database pre-2015 and merges this with the geodatabases (Geospatial Aid Application (GSAA datasets)) available since 2016. The five processing steps of this element are described in detail below.

- **Step 1: Sampling of IACS GIS data for the years 2016 onwards**. For the years 2016 onwards AMA publishes IACS-GSAA datasets of the polygons delineating the single plots of subsidized agricultural fields as geopackage files e.g. the *INVEKOS Schläge Österreich 2023-2* dataset (AMA, 2023). As an attribute, the *Schlagnutzungsart* is attached to each plot polygon and describes cultivation practise applied to that plot over that year's vegetation period. In QGIS, these IACS data are sampled by intersection of these polygons with a point vector layer marking the centre points (centroids) of the 100m x 100m cells of the INSPIRE geographical grid system. Importantly, the applied point vector layer has already been pre-intersected with the vector layers of the *2016 Digitale Katastralmappe* (BEV, 2016) and the forest growth regions (BFW, 2024) to extract cadastral pacel-ID number and ecoregion at the centroid locations, respectively. Consequently, the above intersections provide information on agricultural land use (*Schlagnutzungsart*) at each centroid point for year post-2016 together with geoinformation on the associated land parcel-ID and the ecoregion. The attribute table of this intersection is exported as a csv file, with the *Schlagnutzungsart* subsequently translated to annual cropland, perennial cropland or Grassland according to a translation table based on the national land use definitions.
- **Step 2: Merging of data from 2016 onwards with the IACS data from the previous database format (2002-2015)**. A SQL query of the previous IACS database and subsequent processing was done to generate a 2002-2015 time series of agricultural land use (again based on the *Schlagnutzungsart*) for each cadastral land parcel contained within the database. First of all the database is queried to extract the following attributes for each agricultural plot (*Schlag*):
  - Plot ID
  - Plot area (ha)
  - *Schlagnutzungsart* at the plot
  - Cadastral land parcel ID (one or more plots can be associated to single cadastral land parcel; likewise, a single plot can span over two cadastral land parcels)

  After querying these data for all available years (2002-2015), the individual *Schlagnutzungsart* codes are assigned to either annual cropland, perennial cropland or Grassland according to the aforemented *Schlagnutzungsart*-LU Crosswalk. The data are then aggregated at the cadastral land parcel level. For each land parcel-ID, the total IACS area and the total area per land use are calculated for each year between 2002 and 2015. Due to some inconsistency and incompleteness issues in the previous database, as well as the consequence that data from 2016 onwards can only be joined at the aggregated land parcel level, a subset of the queried data was retained for analysis of LUCs. The selection of the subset was based on land parcels that are:

- available for all years; and
- relatively constant in terms of area size over the time series; and
- categorised by relatively homogenous land-use

After selection of the subset, the area data are removed to produce a table of agricultural land-use for each individual land parcel-ID between 2002 and 2015. This subset of 2002-2015 data are then merged with the IACS GSAA data for the years 2016 onwards using cadastral parcel-IDs as the joining variable common to both datasets. The result is a 2002-2023 time series of IACS agricultural land use (categorised as *annual cropland, perennial cropland, grassland* and *other*) for each INSPIRE grid point (i.e. for each ha) of the Austrian territory, albeit incomplete for the years 2002-2015.

- **Step 3: Correction of short-term land-use changes/conversions and regional contributions**. In this step, the processing routine checks for- and subsequently corrects short-term land-use changes/conversions between annual cropland, perennial cropland, grassland and other. The check and correction is implemented to detect annual changes in agricultural land use at each INSPIRE grid point, and check if the subsequent land use remains stable for at least the following five years. If within the subsequent 5 years after conversion, another land-use change (e.g. backwards to the initial subcategory) is detected, the initial conversion is removed by correcting the land use to that of the previous year, as demonstrated in the example below.

Orginal:

Inspire Grid	**Ecoregion**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
100mEXXXXXNYYYYY	Foot Hills	C ann	**G**	C ann	C ann	**G**	C ann

Corrected:

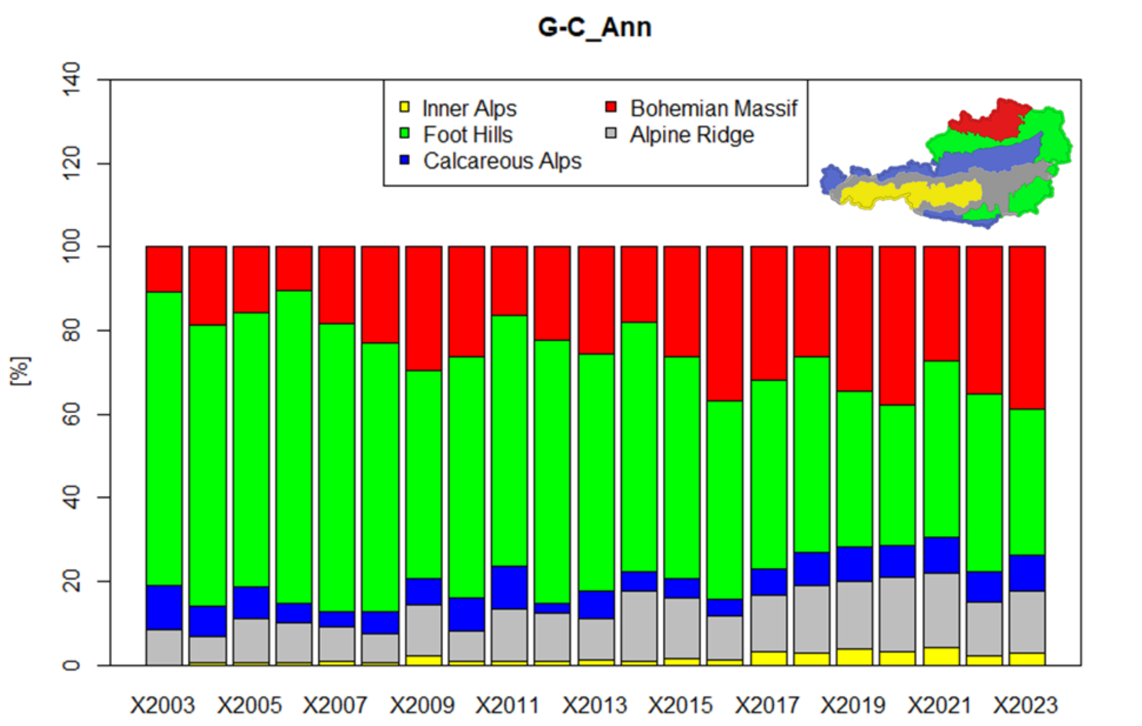
Inspire Grid	**Ecoregion**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
100mEXXXXXNYYYYY	Foot Hills	C ann	**C ann**	C ann	C ann	**C ann**	C ann

Obviously, the routine is limited in being able to detect and correct short-term land-use changes/conversions in the last fives of the time series. Therefore, the above detection and correction process produces partially corrected time series of agricultural land-use at each INSPIRE grid point. Therefore, for subsequent processing in the next step, the total conversion areas per conversion category per year of the partially corrected and the orginal uncorrected datasets are calculated. The respective corrected and uncorrected total conversion areas up to the last five available years are compared to derive average reduction factors for each land-use conversion. As such, the time series of total conversion areas per conversion category per year are derived as follow:

- Total yearly conversion areas from the (partially) corrected dataset except for the last five years (2003-2018)
- Total yearly conversion areas from the orginal uncorrected dataset for the last five years (2019-2023) multiplied by the aforementioned category-specific reduction factors

The partially corrected dataset is nonetheless utilised further in this step to calculate the relative regional contributitions to each conversion category. For example, for each year and each conversion category, the total conversion area per ecoregion is divided by the total conversion area for the whole dataset (see example below, Figure 6). To extrapolate back in time, the mean regional distributions per conversion category between 2003 and 2010 were calculated and were assumed as representative for the years 1971 to 2002.

Figure 6: Relative regional split of the areas of Grassland converted to cropland



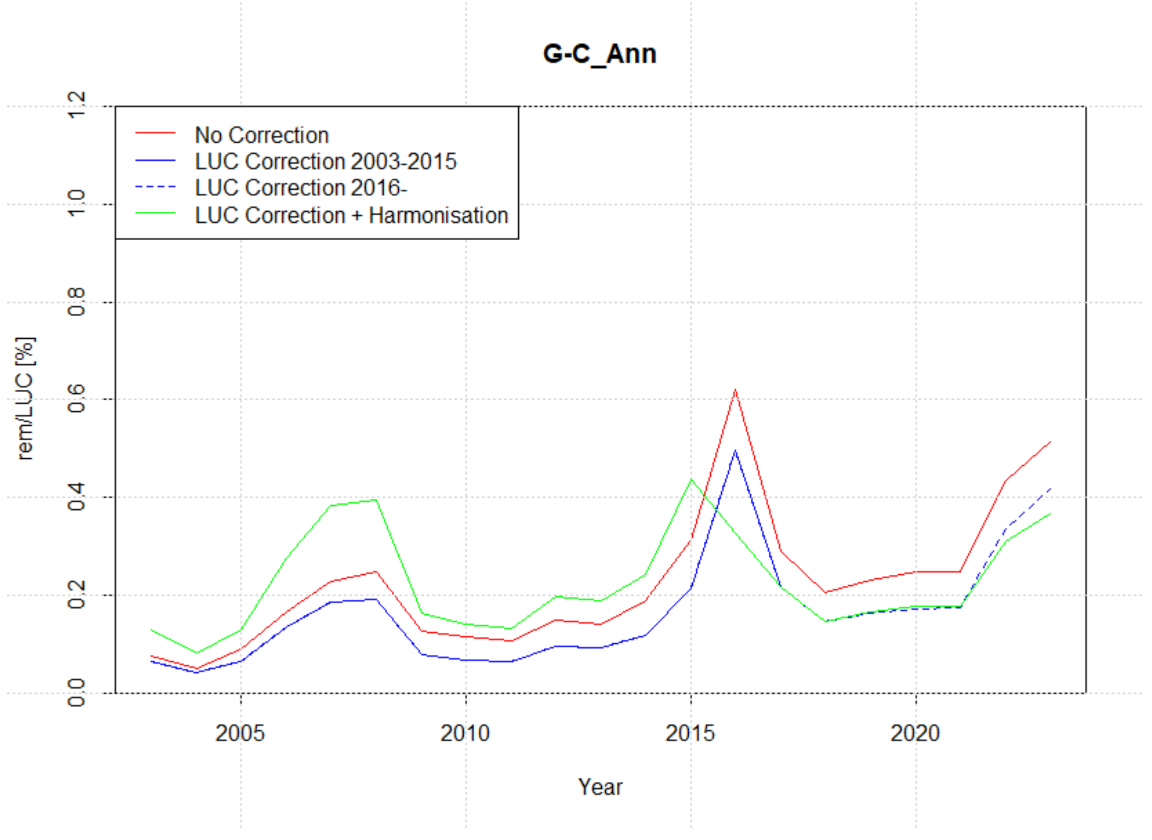
Source: Umweltbundesamt

- **Step 4: Calculation of land-use changes/conversions as percentages of total analysed Cropland area, harmonisation and extrapolation over the time series.** After the above correction for short-term land-use changes/conversions, the annual land-use change/conversion areas in ha are expressed as percentages of the total cropland area per year in the respective analysed datasets. This is done because the completeness of the above synthesised IACS dataset, from which the yearly conversion areas are sampled, varies over time particularly between the 2002-2015 tabular database and the post-2016 geodatabases. Furthermore, even in the increasingly complete post-2016 geodatabase, a small proportion of the total Austrian Cropland area is not included.

  For conversions between the annual and perennial cropland, as well as changes from grassland to annual/perennial cropland, the change/conversion areas are expressed in percentages of the total analysed Cropland area in the same year. For changes from annual/perennial cropland to grassland, the annual changes are expressed as percentages of total analysed Cropland area in the previous year. The rationale behind using Cropland area, rather than respective Cropland and Grassland areas is that the time series for this total estimated Cropland area in the inventory is considered more reliable than the total estimated Grassland area.

  The result of the above is a time series of land-use changes/conversions between annual cropland, perennial cropland and grassland expressed as percentages of the analysed total Cropland area (total area either in the same year or the year before). Before these can be applied to calculate total land-use changes/conversions over the Austrian territory, the data from 2002 to 2015 are first harmonised with those from 2016 onwards. First of all, the values for changes/conversions between 2015-2016 are omitted, because of the sharp peaks caused by the change from an aggregrate land-parcel classification to a classification at the INSPIRE ha resolution. Secondly, we adjust the average level of the respective changes/conversions between 2002 and 2015 to that of the average changes/conversions from 2016 onwards. As 2002-2015 represents only a subset of the land parcels within IACS, a systematic bias is expected in the data pre-2015 and is thus corrected for by the difference in mean land use changes/conversions between 2002-2015 and 2016 onwards. After this level correction, the gaps introduced by omitting the land use changes/conversions between 2015 and 2016 are filled by interpolation. The effect of the correction and harmonisation procedures described this and the previous step after illustrated in the example below (Figure 7).

Figure 7: Grassland converted to annual Cropland as a percentage of total Cropland area. The different lines illustrate the adjusments according to the above correction and harmonisation steps



Source: Umweltbundesamt

Finally, the historic annual land-use changes/conversions outside of the IACS data range (between 2001/2002 back to 1970/1971) are filled by extrapolating the respective mean annual shares of land use changes/conversions calculated between 2002/2003 and 2009/2010.

- **Step 5: Total and regional area estimates of land-use changes/conversions for the Austrian territory.** The result of the above four steps of the processing routine is a 1971-2023 time series of yearly land-use changes/conversions between annual cropland, perennial cropland and grassland expressed as percentages of the total analysed Cropland area in the IACS datasets (total Cropland area in the same year for changes to and conversions between annual and perennial cropland; or total Cropland area in the previous year for land-use changes to Grassland). To obain the final total land-use change/conversion areas between annual cropland, perennial cropland and Grassland, the above precentages are multiplied with the estimate of total Austrian Cropland area produced in the pre-processing element *LU Area Statistics* (described in the next subchapter). The derived, final total land-use change/conversion areas between annual cropland, perennial cropland and Grassland are included directly and unchanged in the annual land transition matrices. Nonetheless, these final estimates of yearly changes between Cropland and Grassland also feed into the LULUC Data Integration element to ensure area consistency in the land transition matrix between categories and years. Finally, land-use change/conversion areas between annual cropland, perennial cropland and Grassland per ecoregion are derived according to the respective yearly regional splits calculated in step 3. These regional estimates flow directly directly into the inventory calculations of soil carbon stock changes caused by land-use changes/conversions between Cropland and Grassland.

LU Area Statistics: Pre-processing of land use area statistics derived from maps, geospatial databases and surveys

In this pre-processing element area, statistics (derived from national maps, spatial databases and statistical surveys) on total Cropland, Grassland, Wetland, Settlement and Other land are pre-processed before feeding into other elements of the system (*IACS (CL<->Gl); LULUC Data Integration*). Note that area estimates from this pre-processing element do not feed directly into the annual land transition matrices and are instead used for the following purposes:

- Cropland area statistics feed into the IACS-LPIS (CL <-> GL) pre-processing element to upscale the sampled land use changes/conversions between Cropland and Grassland and are furthermore subject to minor consistency adjusments in the LULUC Data Integration element.
- Wetlands and Settlements area statistics are used in the LULUC Data Integration element for extrapolation purposes of the pre-2016 areas and to infer total conversions to these categories.
- Grassland and Other land area statistics and are used to QC-check the final Grassland and Other land area time series derived from LULUC Data Integration element.

The pre-processing steps for each land-use category are described in detail below.

Cropland and Grassland area statistics

The initial estimates of total **Cropland** areas are based on data taken from national statistics (Statistik Austria 2022, 2024), in particular the data from the *Agrarstrukturerhebung* (Farm Structure Survey, FSS). Comprehensive Farm Structure Surveys (*Vollerhebungen*) were conducted in 1990, 1995, 1999, 2010 and 2020 (Österreichisches Statistisches Zentralamt (ÖSTAT) 1991, 1996; Statistik Austria 2001, 2013, 2022), with intervening random sample Farm Structure Surveys carried out in 1993, 1997, 2003, 2005, 2007, 2013 and 2016 (Österreichisches Statistisches Zentralamt (ÖSTAT) 1994, 1998; Statistik Austria 2005, 2006, 2008, 2014, 2018). The FSS area estimates are based on the responses to questionnaires sent to all farms and forest enterprises, or a random subset thereof. For the preceding years, specifically 1960, 1970 and 1980, data are taken from the *Land- und forstwirtschaftliche Betriebszählung* (Census of agricultural and forestry enterprises), which was the statistical survey programme that preceded the FSS. For more recent years, the FSS are complemented by the Cropland area data according to the the IACS data base (Statistik Austria, 2024). In contrast to the FSS, IACS is updated yearly, but includes only Cropland area (and Grassland area) of farms that receive support under the common agricultural policy (CAP). Nonetheless, the propotion of total Cropland in the IACS data base has increased over time, with almost all Cropland now included.

The time series of total **annual cropland** area is derived from the comprehensive and random sample FSS, as well as the the census of agricultural and forestry enterprises. The years between these statistical surveys are simply interpolated. Furthermore, the interpolation is extended over certain intermediate random sample FSS years (e.g. 2003 and 2005), for which time series consistency issues were identified. For extrapolating beyond the last comprehensive FSS in 2020, the yearly total area of annual cropland according to IACS is taken and multiplied by the ratio of the 2020 FSS annual cropland area to the 2020 IACS annual cropland land area.

The time series of total **perennial cropland** area (viticulture, orchards, house gardens, Christmas trees and perennial energy crops) are also compiled according to the above statistical surveys, with some specific differences for certain subcategories:

- In the statistical time series for orchards there are two discontinuities which led to substantial area changes:

  - Between 1968 and 1969 there was a sharp increase in the orchard area, probably caused by the inclusion of extensive orchards area for the first time.
  - Between 1982 and 1983 there was a considerable decrease in the orchard area probably due to the changed delimitation: the threshold for the minimum unit was raised from 0.5 to 1 ha. In addition, from 1983 on, municipalities were no longer obliged to report small areas and unproductive agricultural areas, which were previously reported under the orchards category.

  For time series consistency, the pre-1990 area for orchards was complied based on statistical estimates for the years 1960, 1983 and 1990, and interpolation for the years in between.
- In the time series for house gardens two sharp changes occurred:
  - Between 1982 and 1983: this is probably due to the changed delimitation. The threshold for the minimum unit was raised from 0.5 to 1 ha. In addition, from 1983 onwards, municipalities were no longer obliged to report small areas and unproductive agricultural areas, which were reported before under the house gardens category.
  - Between 1994 and 1995: This might be a result of the new EU CAP programme of the time, because house gardens were no longer supported under this policy.

  For time series consistency the area of house gardens between the 1960 and 1995 statistical estimates was therefore interpolated to remove the above potential systematic errors during this period.
- The latter part of viticulture area time series is based on the planted vineyard area of the specific vineyard surveys (Weingartengrunderhebungen) for the years 2009, 2015 and 2020 (Statistik Austria 2011, 2016, 2021), as these explicitly comprise the vineyard area planted with vine stems. The area of vineyards between 2009, 2015 and 2020 were interpolated, while the years 2004 to 2008 were estimated by interpolating between 2003 vineyard estimate of the FSS and the 2009 estimate of vineyard survey.

Finally, the perennial cropland area for the years 2021 onwards are currently extrapolated assuming that the 2020 subcategory areas have remained constant.

The initial estimates of total **Grassland** areas are based on the same sources of national statistics on agricultural areas as used for annual cropland – the comprehensive and random sample FSS, as well as the census of agricultural and forestry enterprises. These statistics were adjusted based on a correction of the subcategory alpine pastures.The Grassland areas in the intervening years between surveys were interpolated in a similar fashion as with the annual cropland, except for the following differences:

- Removal of the 1980 estimate from census of agricultural and forestry enterprises and subsequent linear interpolation between the 1970 and 1990.
- Removal of- and interpolation over the 1995 comprehensive FSS and the 2003, 2007 and 2016 random sample FSS.

Finally, the Grassland areas for 2021 onwards were extraplolated from the 2020 area using the long-term annual trend derived from the 2003 and 2020 statistical estimates.

Wetlands, Settlements and Other land area statistics

The initial estimates of the total area of **Wetlands** are based on data from the Real Estate Database (BEV, 2024a). This database covers the whole area of Austria and gathers the land uses of real estate within the municipalities in digital cadastral maps, based on *in situ* land surveying. It is provided by the Austrian Federal Office of Metrology and Surveying (Bundesamt für Eich- und Vermessungswesen, BEV) and is updated annually since 2005. The total Wetland area is compiled by extracting the the following land-use classes from the database:

- Rivers
- Lakes and reservoirs
- Water's edge areas
- Peatlands and bogs

The total area of Wetlands pre-2005 is based on respective database estimates for the years 1970, 1971, 1981 and 1995, and subsequent interpolation up to the 2005 value.

The initial estimates of the total area **Settlements** are based on data from the Real Estate Database, by extracting the following land-use classes:

- Building land – sealed, partly sealed and unsealed area
- Parks and gardens
- Roads, railway tracks
- Industrial and business areas
- Mining areas, dumps, landfills
- Other, not further differentiated settlement area

The total area of Settlements pre-2005 is based on respective database estimates for the years 1970, 1971, 1981 and 2003, and subsequent interpolation up to the 2005 value.

Finally, the initial estimates of the total **Other land** area are based on data from the Real Estate Database, by extracting the following land-use classes:

- Rocks and screes
- Glaciers
- Unmanaged alpine dwarf shrub heaths

LULUC Mapping: Pre-processing element for spatially-explicity mapping of land use and land-use change

In this element, 5 x 5 m resolution land-use maps for the years 2016, 2018, 2020 and 2022 are compiled and combined with a respective map of the BFW forest growth regions (BFW, 2024) to derive total and regional estimates of land use and land-use change for 2016 onwards. Furthermore, the vector layers of 1990, 2000, 2006, 2012 and 2018 CORINNE Land Cover (CLC; EEA, 2020) status maps are intersected with one another and with the BFW forest growth regions to derive regional contributions of pre-2016 conversions to Settlements from agricultural lands. These two subelements are described in detail below.

LULUC Mapping 2016-2022

For mapping land use and land-use change from 2016 onwards, a number of spatial datasets are pre-processed and integrated according to a hierarchy that considers both the temporal and thematic accuracy for the respective datasets. The individual datasets are described below.

- **The 2022 Water Body Layer (*Digitales Landschaftsmodell – Gewässer*)**, a high-precision vector dataset mapping water bodies that is produced and made available by BEV (BEV, 2023a). This dataset maps both flowing and standing water bodies (Code 41) for the 2022 reference year. However, for the LULUC Mapping it is used only for mapping the standing water bodies
- **The Digital Cadastral Map (*Digitale Katastralmappe;* DKM)** is a wall-to-wall vector dataset delineating all cadastral land parcels in Austria and attributing parcel land use according to the 26 DKM classes (Table A 107). The datasets for the reference years 2016, 2018, 2020 and 2022 (BEV, 2024b) are produced and made available by the Austrian Federal Office of Metrology and Surveying (Bundesamt für Eich- und Vermessungswesen, BEV).

Table A 107: Land-use categories of the DKM and translation to the LULUCF categories

DKM Code	DKM Category	LULUCF Category: Subcategory	LULUCF Code
55	Krummholzflächen	Forest land	10
56	Wälder		10
58	Forststraßen		10
40	Dauerkulturanlagen oder Erwerbsgärten	Cropland: Perennial cropland	22
53	Weingärten		22
48	Äcker, Wiesen oder Weiden	Grassland	30
54	Alpen		30
57	verbuschte Flächen		30
41	Gebäude	Settlements: Built-up	51
52	Gärten		51
83	Gebäudenebenflächen		51
72	Friedhöfe	Settlements: Gardens and Parks	52
96	Freizeitflächen		52
42	Parkplätze	Settlements: Transport infrastructure	53
65	Verkehrsrandflächen		53
92	Schienenverkehrsanlagen		53
95	Straßenverkehrsanlagen		53

DKM Code	DKM Category	LULUCF Category: Subcategory	LULUCF Code
63	Betriebsflächen	Settlements: Industry and Commercial	54
84	Abbauflächen, Halden oder Deponien	Settlements: Landfill, mining	55
59	Fließende Gewässer	Wetlands: Flowing water body	40
60	Stehende Gewässer	Wetlands: Standing water body	41
61	Feuchtgebiete	Wetlands: Peatlands and bogs	42
64	Gewässerrandflächen	Wetlands: Flowing water body	40
62	Vegetationsarme Flächen	Other land	60
87	Fels- und Geröllflächen		60
88	Gletscher		60

- **BEV Land Cover** is a dataset of land cover based on automatised intrepretation of orthophotos taken between 2016 and 2020. This dataset is produced and made available by BEV (BEV, 2024c). This layer provides for better mapping of Other land. Based on the land cover class *non-vegetated surface*, the layer is used to reclassify parts of alpine grasslands (*Almen*) according to IACS as Other land (Code 60).
- **IACS: Fields (*INVEKOS Feldstücke*)** is the geospatial aid application (GSAA) vector dataset of the Integrated Administration and Control System (IACS) that delinates and classifies the subsidized agricultural fields (Table A 108). The datasets for the reference years 2016, 2018, 2020 and 2022 are administered and made available by the *AgrarMarkt Austria* (AMA, 2022a). As mentioned above, the mapping of the category alpine grassland (*Almen*) is corrected where parts of these fields overlap with the land cover class *non-vegetated surface* according to BEV Land Cover. Furthermore, the mapping of agricultural fields is supplemented by additional IACS GSAA datasets, **IACS: Plots (*INVEKOS Schläge*).** According to this vector dataset (AMA, 2022b) so-called additional landscape elements (*Landschaftselemente*) for the same reference years are mapped, and based on their proximity to the closest IACS field, they are assigned a respective LU classification.

Table A 108: Land-use categories of the the IACS: Fields datasets and translation to the LULUCF categories

IACS: Fields Category	LULUCF Category: Subcategory	LULUCF Code
FORST	Forest land	10
ACKERLAND	Cropland: Annual cropland	21
GESCHÜTZTER ANBAU		21
PFLEGEFLÄCHE		21
SONSTIGE NUTZFLÄCHE		21
SPEZIALKULTUREN	Cropland: Perennial cropland	22
WEINGARTENFLÄCHEN		22
WEINGARTENFLÄCHEN - TERRASSENANLAGEN		22
ALMEN	Grassland	30
GRÜNLAND		30
GEMEINSCHAFTSWEIDE		30

- **The BFW Forest Layer (*BFW Waldkarte*)** is a vector dataset produced and made available by the same federal agency responsible for the NFI (Bundes-forschungszentrum für Wald, BFW) based on the national forest definition and interpretation of orthophotos from the years

2013 to 2018 (BFW, 2023). The layer is used as a stand-alone map of Forest land (Code 10) and is furthermore used to reclassify the IACS category alpine grassland (*Almen*) as Forest land where parts of these fields overlap with the BFW Forest layer.

- **The non-IACS agriculture layer** is an in-house dataset that uses the aforementioned DKM and BEV Land Cover layers, as well as the land-use layer of the DLM (*Digitales Landschaftsmodell – Gebietsnutzung*; BEV, 2023b) and the CLMS CLC+ Backbone (EEA, 2023). The integration of the datasets is used to map potential agricultural land, particularly Grassland, which lies outside of the IACS reference area.
- A pre-final version of the updated **Austrian Bog Catalogue** (*Österreichischer Moorschutzkatalogue*) that maps Austrian bogs, fens and peatlands (i.e. Code 42) and is compilied by the Environment Agency Austria (Umweltbundesamt, 2023).

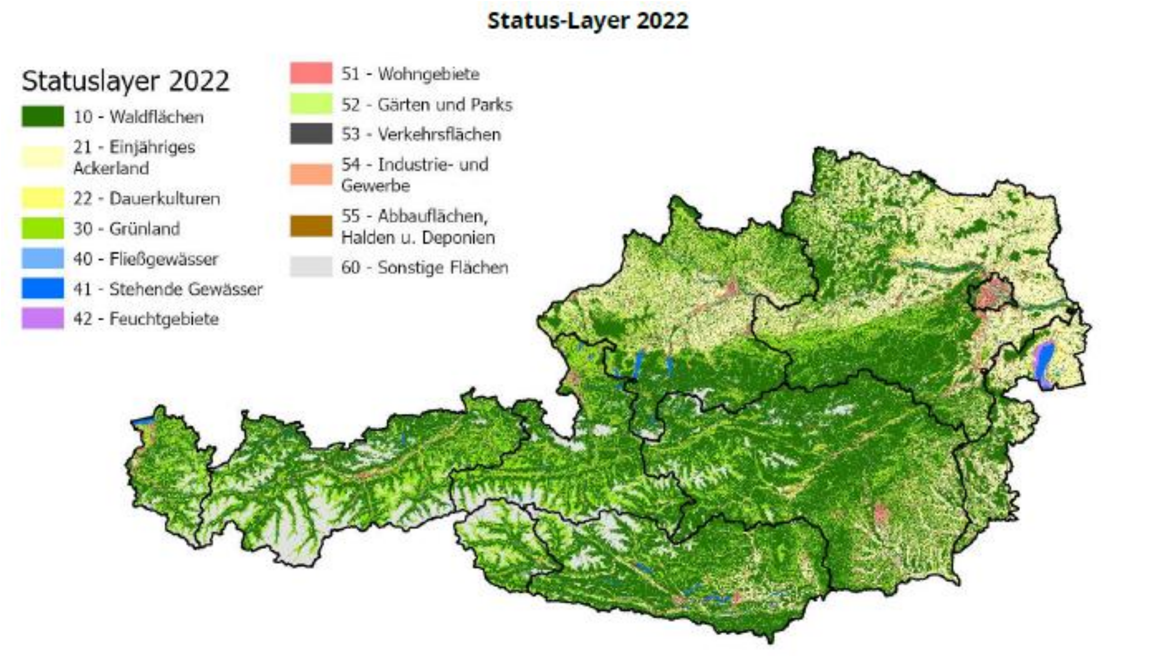
The above datasets are incorporated according the following hierarchy that determines which datsaset (or subset thereof) provides the ultimate land classification in cases of overlap (Table A 109). For the years 2016, 2018, 2020 and 2022 respective land-use layers (e.g. *LU 2016* to *LU 2022*) are compiled using a harmonized collection of datasets, principally for the purpose of mapping land-use changes. A best guest baseline land use status map (*LU 2022 Baseline*) is compiled for year 2022 with additional datasets only available for the 2022 reference year.

Table A 109: Hierachy of land-use datasets and dataset subsets used to compile the wall-to-wall maps of national land use in Austria

Hierachy Position	**LU 2016**	**LU 2018**	**LU 2020**	**LU 2022**	**LU 2022 Baseline**
Highest					Water Body Layer (2022)
	DKM Subset for LU codes 40 and 53 (2016)	DKM Subset for LU codes 40 and 53 (2018)	DKM Subset for LU codes 40 and 53 (2020)	DKM Subset for LU codes 40 and 53 (2022)	DKM Subset for LU codes 40 and 53 (2022)
	BEV Land Cover subset for LU code 60 (2016-2020)	BEV Land Cover subset for LU code 60 (2016-2020)	BEV Land Cover subset for LU code 60 (2016-2020)	BEV Land Cover subset for LU code 60 (2016-2020)	BEV Land Cover subset for LU code 60 (2016-2020)
	BFW Forest Layer correction of IACS (2013-2018)	BFW Forest Layer correction of IACS (2013-2018)	BFW Forest Layer correction of IACS (2013-2018)	BFW Forest Layer correction of IACS (2013-2018)	BFW Forest Layer correction of IACS (2013-2018)
	IACS-LPIS: Plots subset for landscape elements (2016)	IACS-LPIS: Plots subset for landscape elements (2018)	IACS-LPIS: Plots subset for landscape elements (2020)	IACS-LPIS: Plots subset for landscape elements (2022)	IACS-LPIS: Plots subset for landscape elements (2022)
	IACS-LPIS: Fields (2016)	IACS-LPIS: Fields (2018)	IACS-LPIS: Fields (2020)	IACS-LPIS: Fields (2022)	IACS-LPIS: Fields (2022)
	BFW Forest Layer (2013-2018)	BFW Forest Layer (2013-2018)	BFW Forest Layer (2013-2018)	BFW Forest Layer (2013-2018)	BFW Forest Layer (2013-2018)
					Austrian Bog Catalogue (2022)

	Non-IACS agriculture layer (2022)	Non-IACS agriculture layer (2022)	Non-IACS agriculture layer (2022)	Non-IACS agriculture layer (2022)	Non-IACS agriculture layer (2022)
Lowest	DKM (2016)	DKM (2018)	DKM (2020)	DKM (2022)	DKM (2022)

Figure 8: Map of land-use according to the 2022 baseline layer



Source: Umweltbundesamt

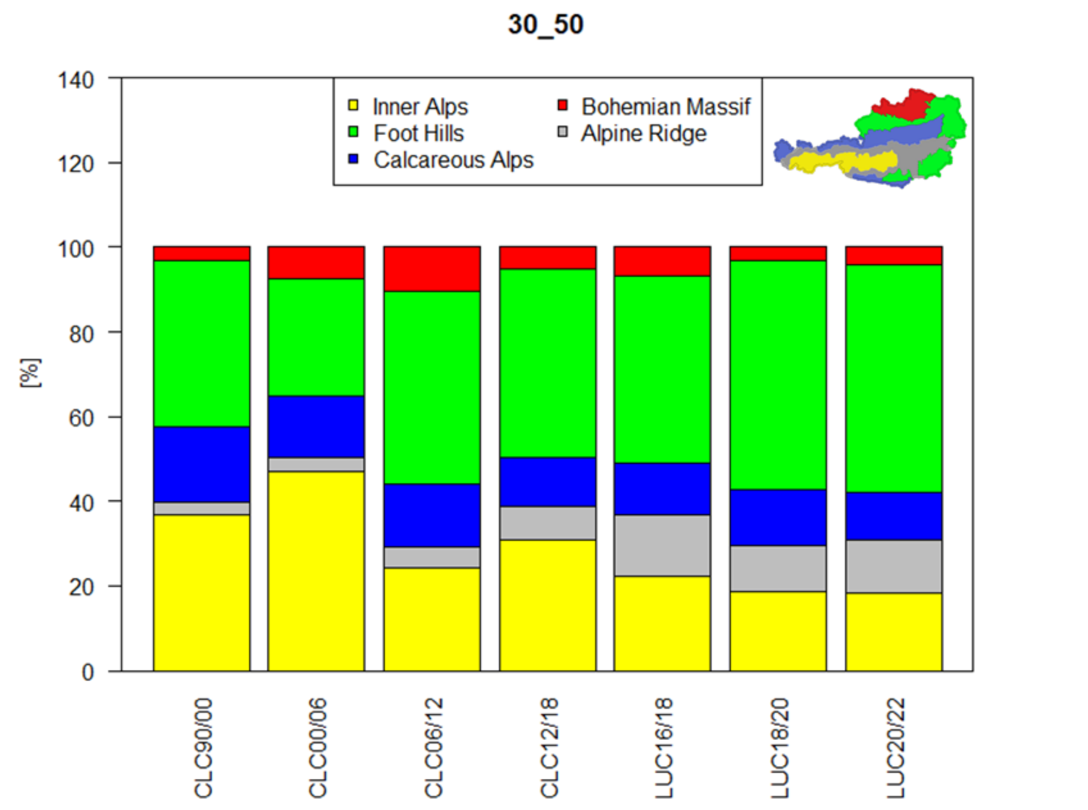
The LU 2016-2022 layers and LU 2022 Baseline layer are compiled in a GIS software and exported as seperate 5 x 5 m raster files. A complementary 5 x 5 m raster layer of the BFW forest growth regions is also exported. A R script combines the above raster files and calculates the sum area of the occurring land-use and ecoregion combinations over the above layers.

Regional conversions to Settlements

In a separate QGIS project the vector layers of the 1990, 2000, 2006, 2012 and 2018 CLC status maps (EEA, 2020) are intersected with one another and with the BFW forest growth regions. The attribute table of the intersection is exported and processed further in R.

First of all, the CLC classes are translated to IPCC LU categories according to a specific national crosswalk. Polygons containing conversions back and forth between categories are corrected, assuming only the most recent conversion is valid. Subsquently, the dataset is filtered for polygons containing conversions to Settlements from Cropland and Grassland and based on the associated area attribute, the percentage of conversions per ecoregion per category are calculated (Figure 9).

Figure 9: Proportional regional contributions to total Grassland converted to Settlements according to the national land-use layers (LUC16/18, LUC18/20 and LUC20/22) and according to CORINNE Land Cover (CLC90/00, CLC00/06, CLC06/12 and CLC12/18)



Source: Umweltbundesamt

LULUC Data Integration: Integration element to complete and ensure consistency in the final annual land transition matrices

In this final integration element, all outputs of the pre-processing elements are integrated to derive the final remaining estimates of annual land use and land-use change areas.

First of all, the combine output of 2016-2022 LU layers and forest growth regions (*LULUC Mapping* pre-processing element) is processed to derive relative regional splits of the following land-use change categories:

- Grassland converted to Wetlands
- Cropland converted to Settlements
- Grassland converted to Settlements

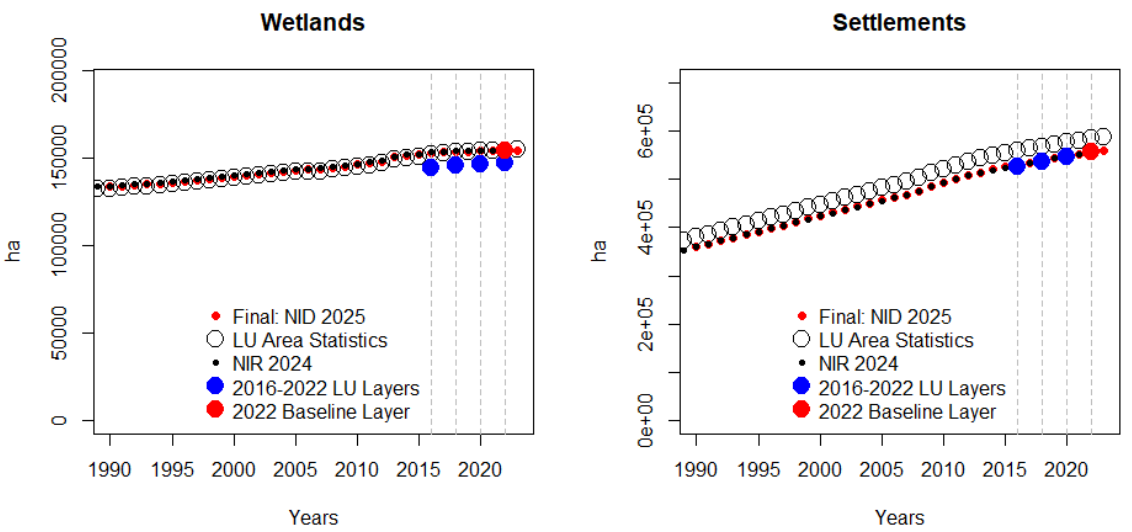
The derived 2016-2022 time series of percentage conversions per category and ecoregion are then extrapolated as follows:

- Regional splits in conversions between 2020 and 2022 are extrapolated for the years 2023 onwards
- Regional splits in Grassland converted to Wetlands between 2016 and 2018 are assumed constant and extrapolated back to 1971
- Regional splits in Cropland- and Grassland conversions to Settlements are extrapolated back to 1990 according to the processed output of the CLC and forest growth region intersection. The repective regional splits for the conversions assessed from the 1990 and 2000 CLC layers are used to extrapolate back further to 1971.

The derived time series of relative regional splits in the above conversion categories are then multiplied by the respective annual total conversion areas. These final total conversion areas are compiled in this element together with the times series of final total areas of Cropland, Grassland, Wetlands, Settlement and Other land. The final compilation of these total category and conversion areas is done in the following step-wise approach.

- Step 1: Compilation of the 2022 total Grassland, Wetlands and Settlement areas according to the area totals of the best-estimate LU 2022 Baseline layer.
- Step 2: Compilation of the 2016 onward time series of total Wetlands and Settlement areas starting with the respective 2022 baseline estimates. To do this, total annual conversions areas to and from these categories are derived from the combination of LU 2016, LU 2018, LU 2020 and LU 2022 layers. The annual conversion areas derived from LU 2020 and LU 2022 layers are extrapolated for 2023 onwards. From these total to and from conversion areas, annual net conversion areas for Wetlands and Settlements are derived for 2016 to 2023. Starting with the 2022 baseline areas and extrapolating backwards and forwards according to the derived net changes, respective 2016-2023 time series of total Wetlands and Settlement areas are derived.
- Step 3: Extrapolation of annual total Wetland and Settlement areas back to 1970 is done using respective time series compliled in the *LU Area Statistics* pre-processing element from the Real Estate Database. This is done by seperately normalising the entire Wetland and Settlement area time series from the LU Area Statistics element by the respective 2016 values to create time series of proportional area changes relative to 2016 values. Multiplying these 1970–2015 time series of relative changes by the 2016 total areas derived from the spatial datasets in step 2 above, allows for the final time series of annual total Wetland and Settlements area for 1970 onwards to be compiled (Figure 10).

Figure 10: Wetland and Settlement areas according to the LU Area Statistics and LULUC Mapping elements and the final derived area time series compared to those reported in the previous submission. Vertical grey lines mark the years of the LU layers.



Source: Umweltbundesamt

- **Step 4: Inference of the land-use changes to Wetlands and Settlements.** First of all, the respective changes to and from Forest land (output of the *NFI* element) are accounted for, resulting in a residual net change in both categories that needs to be balanced between conversions to and from the other categories. This is done for Wetlands and Settlements as follows:
    - **Step 4.a: LUC to Wetlands**. For Wetlands, the remaining net change (a net increase over time) is assumed to be explained completely by Grassland conversions to Wetlands, allowing for the annual areas of this conversion category to be quantified as such. The above assumption was verified by the net conversion of Grassland to Wetland derived from analysis of the 2016, 2018, 2020 and 2022 LU layers.
    - **Step 4.b: LUC to Settlements.** For Settlements, the remaining net change (a net increase over time) is assumed to be explained completely by conversions of agricultural land (Cropland and Grassland) to Settlements. The above assumption was verified by the net conversion of Cropland and Grassland to Settlements derived from analysis of the 2016, 2018, 2020 and 2022 GIS layers. The relative split between conversions from Cropland and conversions from Grassland are calculated by first estimating the conversions from Cropland and then inferring the remaining net increase in Settlements as conversions from Grassland.
        - **Step 4.b.i: Croplands converted to Settlements (+ Consistency adjustment of total Cropland area)** For the years 2017 onwards, the yearly areas of Cropland converted to Settlements are estimated from the net conversion of Cropland to Settlement derived from the 2016, 2018, 2020 and 2022 GIS layers. These conversions, together with conversions between Cropland and Forest land (*NFI*) and conversions between Cropland and Grassland (*IACS (Cl <->Gl)*) yield a net change in Cropland

area that is compared to the net change in Cropland area according to the Cropland area time series from the *LU Area Statistics* element. Leaving the 2020 Cropland area estimate unchanged (estimated based on the latest comprehensive FSS), the cumulative difference in the two annual net changes in Cropland area are sequentially added to each year's Cropland area as one goes back from 2019 to 1970. In the other direction, the cumulative difference in the two net changes in Cropland area are sequentially subtracted from each year's Cropland area as one moves forward from 2021 onwards. The above adjustments thus produce an initially corrected Cropland area time series that is consistent with conversions to and from Cropland for 2016 onwards. This initially corrected Cropland area time series is then used to infer the conversions of Cropland to Settlement occurring between 1971 and 2016. For this part of the time series, after taking into account conversions to and from Forest land (*NFI* element) and conversions to and from Grassland (*IACS (CL<->GL)* element), a residual net change in Cropland remains (a net decrease) that is quantified as Cropland conversion to Settlements. Where the residual net change in Cropland area provides a larger annual area than that required to explain the residual net increase in Settlement area, these cumulative differences are sequentially subtracted from each year's Cropland area as one goes back from 2015 to 1970. Before deriving the final Cropland conversion areas to Settlements for 1971 to 2016, a last adjustment is made to achieve consistency with the 2010 Cropland area according to that years comprehensive FSS. The above intermediate corrections of the Cropland area time series cause a deviation from the 2010 FSS estimate of total Cropland area. This total residual is thus allocated as an additional yearly correction to the years 2015 to 2011. These yearly corrections are sequentially cumulated and added to each year's Cropland area as one goes back from 2015 to 1970. This final corrected Croland area time series thus yields a net change in Cropland area, which after accounting for conversion to and from Forest land and Grassland, yields a final time series of inferred Cropland conversions to Settlements that ensure:

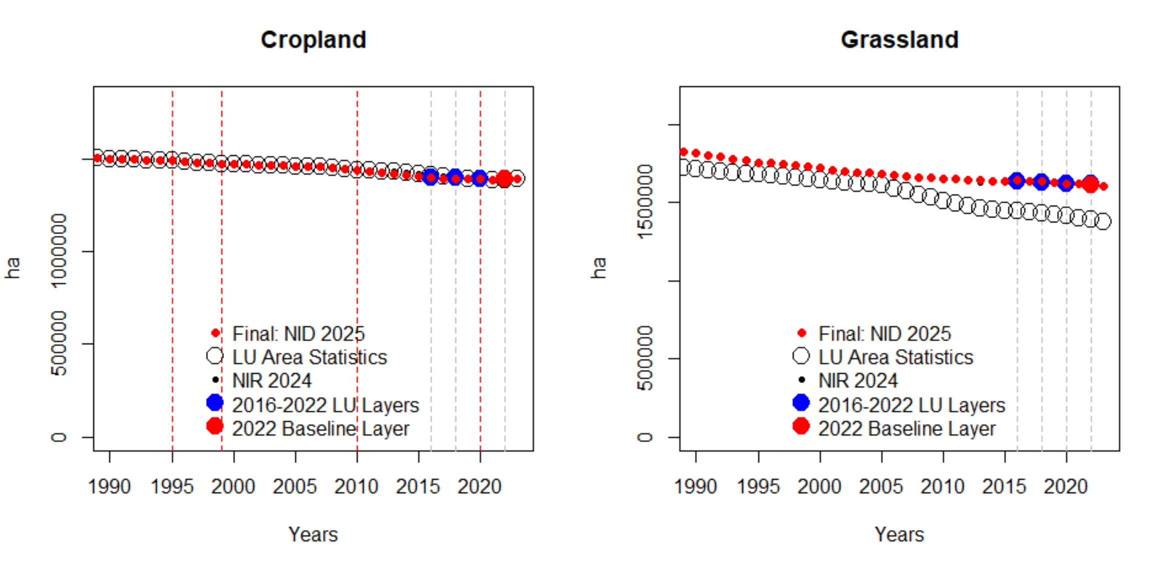
1. Consistency in the land transition matrices;
2. Consistency with the 2016-2022 GIS analysis of Cropland converted to Settlements; and
3. Consistency with the Cropland area estimates according to the FSS in the years of the comprehensive surveys e.g. 2020 and 2010.

The above adjustments of the total Cropland area lead to small corrections (<|1%|) of the initial Cropland area estimates from *LU Area Statistics* element for some of the years in between the comprehensive FSS surveys (Figure 11). At the subcategory level, the above area changes are reflected in the annual cropland areas.

- **Step 4.b.ii: Grassland converted to Settlements and compilation of the total Grassland area time series.** After quanfiying and accounting for Cropland conversions to Settlement, the remaining residual net change in Settlement area is quantified 1:1 as Grassland conversion to Settlements.

This step marks not only the completion of all occurring conversions to Settlements but also all occurring conversions to and from Grassland. With all yearly Grassland conversions estimated from 1970 onwards (to and from Forest land, *NFI*; to and from Cropland, *IACS (CL<->GL)*; conversions to Wetlands and to Settlements, *LULUC Data Integration*), the Grassland area is estimated for all years back to 1970 starting with the 2022 baseline estimate from step 1. Likewise, the conversions for 2023 onwards are used to extrapolate the Grassland areas forward from the 2022 baseline estimate (Figure 11).

Figure 11: Cropland and Grassland areas according to the LU Area Statistics and LULUC Mapping elements and the final derived area time series compared to those reported in the previous submission. Vertical grey lines mark the years of the LU layers, while vertical red lines mark on the left panel mark the years of the comprehensive Farm Structure Surveys (FSS).



Source: Umweltbundesamt

- **Step 4.c: Regional LUCs to Wetlands and Settlements** are then calculated by multiplying the total areas of the individual conversion categories by respective time series containing the associated regional splits (described at the beginning of this subchapter).

- **Step 5: Estimate of the Other land areas.** Finally, with the annual areas of Forest land, Cropland, Grassland, Wetlands and Settlements calculated, Other land is quantified as the difference between the total area of the Austrian territory and the total estimated area of the five land use categories above. Note that if the above five land use category areas were summed together with the Other land areas according to the Real Estate Database, the resulting sum of annual areas of all land use categories would be 0.8% lower- to 0.1% higher than the total territorial area of Austria. From these small differences, it is assumed that the Austrian system for land representation gives an accurate picture of how the total Austrian area is distributed between the land use categories over time.

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Annex 5.3 – CRT 5 Waste – Additional information on S_{mass}

In accordance with the method provided in the IPCC 2019 Refinement, the organic component removed from wastewater in the form of sludge (S_j) needs to be considered when calculating CH_4 emissions from the treatment of domestic wastewater. Equation 6.3B of IPCC 2019 determines this factor S_j as the product of S_{mass} (i.e. the amount of raw sludge removed from wastewater treatment as dry mass in tonnes/year) and a sludge factor (K_{rem}) in kg BOD/kg sludge. To calculate $\mathbf{S_{mass}}$, country specific factors are used from a COD balance based on DWA-A 131 and published in (Parravicini, et al 2022[4]): 0.59 t sludge per t COD removed for short sludge age, and 0.51 t sludge per t COD removed for long sludge age. The following illustrations show how these are derived:

Figure 12: S_{mass} derived for C-plants, sludge age 5 days (short sludge age)

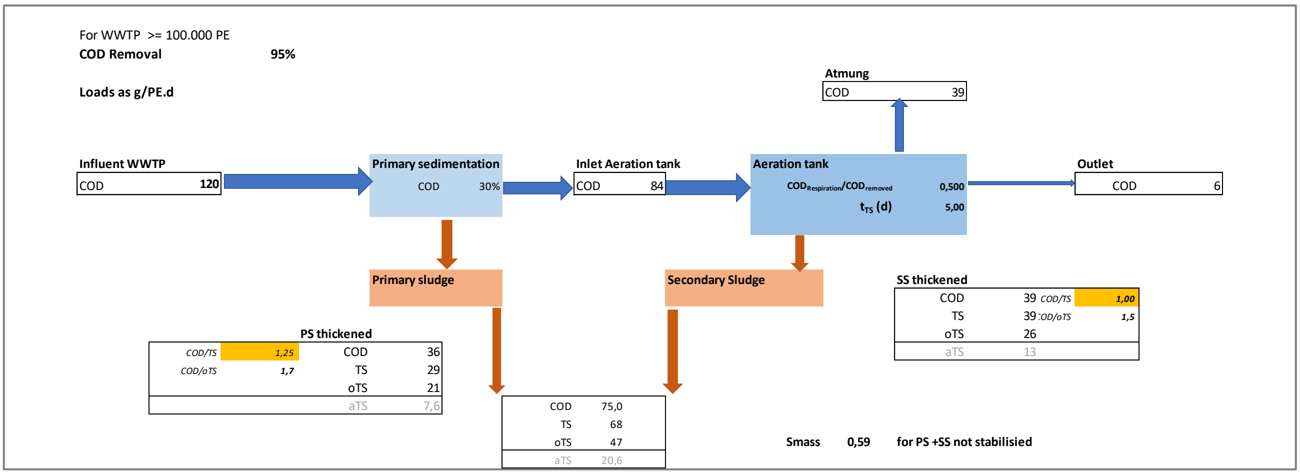
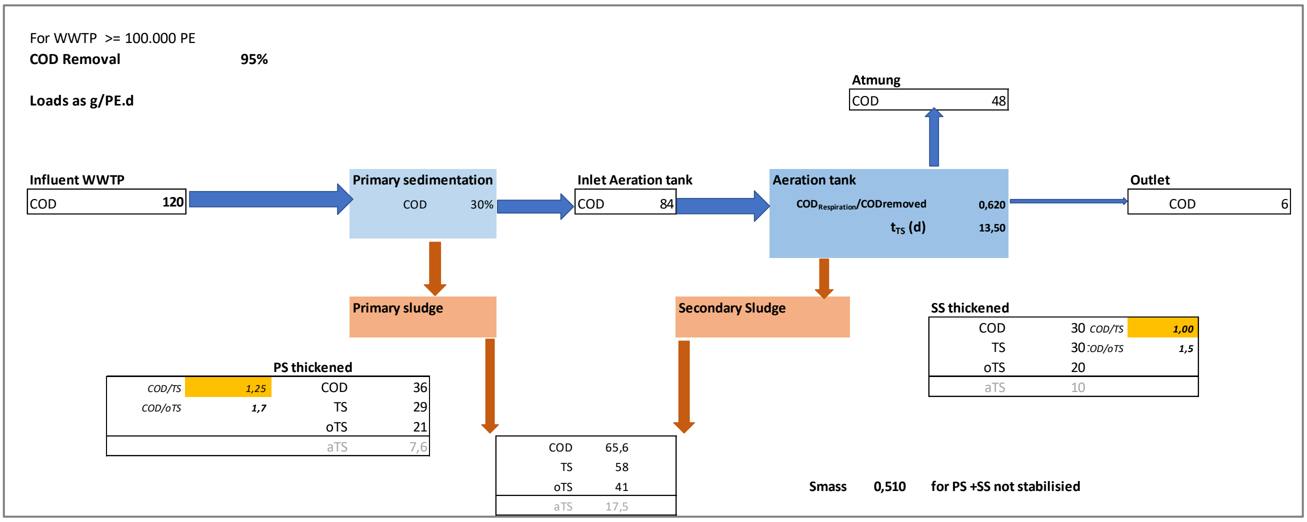


Figure 13: S_{mass} derived for CNP-plants, sludge age 13.5 days (long sludge age)



[4] Parravicini, V., T. Valkova, J. Haslinger, E. Saracevic, A. Winkelbauer, J. Tauber, K. Svardal, P. Hohenblum, M. Clara, G. Windhofer, and Pazdernik, K. & Lampert, C., 2015. ReLaKO - Reduktionspotential bei den Lachgasemissionen aus Kläranlagen durch Optimierung des Betriebes. BMLFUW. Wien.

Annex 5.4 – Information on the National Registry

Reporting under CMP-decisions of the Kyoto Protocol is not mandatory any more, as the second period of the Kyoto-Protocol has expired (including the additional period for fulfilling commitments for the second commitment period of the Kyoto Protocol (true-up-period)). There is no third commitment period under the Kyoto Protocol. Nevertheless the Registry under the Kyoto Protocol is still running and therefore information, dealing with the proper functioning of the registry and the units on its accounts, is given on a voluntary basis.

According to Commission Implementing Regulation (EU) 2020/1208 Member States shall clearly state in the national inventory report if there were no changes in the description of their national inventory systems or, if applicable, of their national registries referred to in points (k) and (l) of Part 1 of Annex V to Regulation (EU) 2018/1999[1] since the previous submission of the national inventory report.

The following changes to the national registry of Austria have occurred in 2024.

Table A 110: Changes to the national registry of Austria in 2024.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	The name and contact of the registry administrator as an institution has not changed.
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	Regular updates were performed to the Union Registry in order to keep it technically up to date. But no specific changes have been implemented in the National Kyoto Protocol part of the registry. Therefore no changes were applied to the database. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Regular updates were performed to the Union Registry in order to keep it technically up to date. But no specific changes have been implemented in the National Kyoto-Protocol part of the registry. Therefore no change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No changes regarding security occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change to the registry internet address occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	No change during the reported period.

Information on accounting of Kyoto Protocol units

Austria received the Final compilation and accounting report for Austria for the second commitment period of the Kyoto Protocol[5], which stated that: "The aggregate GHG emissions of all EU member States, Iceland and the United Kingdom of Great Britain and Northern Ireland from sources included in Annex A to the Kyoto Protocol in the second commitment period did not exceed the total quantity of Kyoto Protocol units in the retirement accounts of the EU and its member States, Iceland and the United Kingdom for the second commitment period."

Information from the national registry on acquisition, holding, transfer, cancellation, retirement and carry-over of AAUs, RMUs, ERUs, CERs, tCERs and lCERs in 2024 is included in the Standard Electronic Format ('SEF'). There is no obligation to submit a SEF after the end of the true-up-periods of CP1 and CP2. However, the SEF tables including data from the Union Registry with the status of 7 January 2025 are available in xls and xml format at Umweltbundesamt.

Discrepancies and notifications

- No discrepancies occurred in 2024. Therefore, no report R-2 is submitted.
- No CDM notifications occurred in 2024. Therefore, no report R-3 is submitted.
- No non-replacements occurred in 2024. Therefore, no report R-4 is submitted.
- No invalid units exist at the 31 December 2024. Therefore, no report R-5 is submitted.

There were no actions necessary to correct any problem causing a discrepancy because there were no discrepancies in 2024.

Publicly accessible information

Section E of the annex to Decision 15/CMP.1 outlines provisions for making available non-confidential information to the public via a user interface. Austria makes available some of the publicly accessible information on the website of the Austrian emissions trading registry https://www.emissionshandelsregister.at/en/publicreports/unfcccreports. Additionally, Austria uses the possibility to provide this information in the public section "Kyoto Protocol Public Reports" of the Austrian part of the Union Registry which is maintained by the European Commission: https://unionregistry.ec.europa.eu/euregistry/AT/public/reports/publicReports.xhtml) to enable additional access for the public.

Although efforts are taken to keep the information consistent, it might be, that – on this additional place for public information – the information provided there is not exactly the same as on the National Website exceptionally at certain times, as it is not maintained by Austria.

Additional up-to date public information concerning the Consolidated System of EU Registries (CSEUR) is available at the European Union Transaction Log website: http://ec.europa.eu/environment/ets/.

[5] UNFCCC (2024): Final compilation and accounting report for Austria for the second commitment period of the Kyoto Protocol. FCCC/KP/CMP/2024/CAR/AUT. 29 October 2024

ANNEX 6: COMMON REPORTING TABLES

The Common Reporting Tables (CRT) are submitted to the UNFCCC via the National Reports Submission Portal (NRSP).

ANNEX 7: RECALCULATIONS

Table A 111: Recalculations in kt CO_2e

IPCC Category Code	IPCC Category	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
0	Total (without LULUCF)	538.56	584.37	748.35	735.65	648.75	643.83	598.10	557.85	493.86	424.33	456.17	440.01	538.05	582.42	648.73	713.48	671.13
1	Total Energy	168.90	167.61	169.15	174.11	173.85	171.04	167.84	165.26	160.43	156.39	155.08	155.45	155.70	157.47	147.96	125.92	-29.54
1 A	Fuel Combustion Activities (Sectoral Approach)	0.65	0.81	0.31	-5.13	-11.41	-11.63	-11.71	-11.48	-11.31	-10.87	-7.58	-1.26	3.22	6.80	2.82	-9.99	-153.72
1 A 1	Energy Industries	-	-	-	-1.37	-0.42	-54.76	-0.68	-33.58	-33.73	-44.81	-47.66	-51.02	-51.53	-134.75	-132.67	-222.83	-303.26
1 A 1 a	Public Electricity and Heat Production	-	-	-	-	-	-	-	-	-	-	-	-	-0.00	-5.28	-3.43	-26.07	-168.88
1 A 1 b	Petroleum Refining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 A 1 c	Manufacture of Solid Fuels and Other Energy Industries	-	-	-	-1.37	-0.42	-54.76	-0.68	-33.58	-33.73	-44.81	-47.66	-51.02	-51.53	-129.48	-129.24	-196.76	-134.38
1 A 2	Manufacturing Industries and Construction	-	-	-	1.37	0.42	54.76	28.63	33.58	33.73	44.81	68.38	93.33	92.53	175.97	169.30	279.78	121.41
1 A 2 a	Iron and Steel	-	-	-	0.00	-	-	-	-	0.00	-	-	-	-	-	-	9.21	-162.36
1 A 2 b	Non-Ferrous Metals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-1.93	6.51
1 A 2 c	Chemicals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.53	32.59
1 A 2 d	Pulp, Paper and Print	-	-	-	-	-	-	-	-	-	1.01	-	-	-	-	-	13.06	13.10
1 A 2 e	Food Processing, Beverages and Tobacco	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.62	44.99
1 A 2 f	Non-Metallic Minerals	-	-	-	-	-	-	-	-	-	-	-	0.07	0.09	0.08	0.10	0.08	0.08
1 A 2 g	Other (please specify)	-	-	-	1.37	0.42	54.76	28.63	33.58	33.73	43.80	68.38	93.26	92.44	175.89	169.20	241.22	186.51
1 A 3	Transport	0.69	0.85	0.68	1.21	2.02	2.01	2.12	2.32	2.44	2.74	-17.21	-38.37	-35.24	-33.33	-34.28	-6.41	53.16
1 A 3 a	Domestic Aviation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 A 3 b	Road Transportation	0.69	0.85	0.68	1.21	2.02	2.01	2.12	2.32	2.44	2.74	-17.21	-38.37	-35.24	-38.61	-37.72	-10.34	53.21
1 A 3 c	Railways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 A 3 d	Domestic Navigation	-	-	-	-	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00	-0.00
1 A 3 e	Other Transportation	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.28	3.43	3.93	-0.05
1 A 4	Other Sectors	-0.00	0.00	0.01	-0.00	-0.00	0.00	-28.00	0.01	0.01	0.01	0.01	0.01	0.01	0.06	0.13	-61.33	-25.82
1 A 4 a	Commercial/ Institutional	-0.00	0.00	0.01	-0.00	-0.00	-0.00	-28.01	-0.00	-0.00	-7.18	-0.00	-0.00	-0.00	-0.00	-0.00	27.57	1.49

IPCC Category Code	IPCC Category	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1 A 4 b	Residential	-	-	-	0.00	-0.00	0.00	0.00	0.01	0.01	7.19	0.01	0.01	0.01	0.00	0.07	-88.64	-36.98
1 A 4 c	Agriculture/ Forestry/Fishing	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	0.06	-0.26	9.66
1 A 5	Other	-0.04	-0.04	-0.39	-6.34	-13.43	-13.65	-13.77	-13.81	-13.76	-13.63	-11.10	-5.21	-2.55	-1.14	0.35	0.81	0.80
1 B	Fugitive Emissions from Fuels	168.25	166.79	168.85	179.24	185.25	182.67	179.54	176.74	171.74	167.26	162.66	156.71	152.48	150.67	145.14	135.91	124.18
1 B 1	Solid Fuels	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 B 2	Oil and Natural Gas	168.25	166.79	168.85	179.24	185.25	182.67	179.54	176.74	171.74	167.26	162.66	156.71	152.48	150.67	145.14	135.91	124.18
1 B 2 a	Oil	83.65	75.35	70.69	62.24	63.77	62.17	60.93	61.59	64.28	61.73	54.82	51.32	48.34	45.65	43.32	40.77	37.93
1 B 2 b	Natural Gas	84.60	91.44	98.16	117.00	121.48	120.50	118.61	115.15	107.45	105.53	107.84	105.39	104.14	105.02	101.82	95.14	86.25
1 B 2 b 1	Exploration	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 B 2 b 2	Production and gathering	-83.65	-75.35	-70.69	-62.24	-63.77	-62.17	-60.93	-61.59	-64.28	-61.73	-54.82	-51.32	-48.34	-45.65	-43.32	-40.77	-30.23
1 B 2 b 3	Processing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 B 2 b 4	Transmission and storage	-6.18	-7.78	-6.08	-0.89	4.21	2.75	0.36	-2.08	-6.09	-9.78	-13.56	-18.67	-22.07	-23.10	-27.48	-35.35	-52.00
1 B 2 b 5	Distribution	0.77	0.92	1.27	1.81	0.94	0.09	-0.72	-1.56	-2.31	-3.11	-3.82	-4.52	-5.15	-5.78	-6.34	-6.86	-7.36
1 B 2 b 6	Other	173.65	173.65	173.65	178.32	180.11	179.84	179.91	180.37	180.14	180.15	180.04	179.91	179.71	179.54	178.97	178.12	175.85
2	Total Industrial Processes	7.88	6.43	37.39	-2.02	26.76	30.72	-1.12	-25.14	-76.71	-138.63	-115.76	-112.65	-33.39	4.06	62.49	138.04	240.43
2 A	Mineral Industry	7.43	2.17	8.80	2.42	2.20	3.22	-2.73	-1.58	-1.11	0.82	0.73	0.05	-0.94	0.17	-0.41	-0.98	-1.07
2 A 1	Cement Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 A 2	Lime Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 A 3	Glass Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 A 4	Other Process Uses of Carbonates	7.43	2.17	8.80	2.42	2.20	3.22	-2.73	-1.58	-1.11	0.82	0.73	0.05	-0.94	0.17	-0.41	-0.98	-1.07
2 B	Chemical Industry	-	-	-	0.00	0.39	0.43	0.45	0.50	0.59	0.65	0.58	0.34	0.57	0.85	0.06	0.61	1.25
2 B 1	Ammonia Production	-	-	-	0.00	0.39	0.43	0.45	0.50	0.59	0.65	0.58	0.34	0.57	0.85	0.06	0.61	1.25
2 B 2	Nitric Acid Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 B 3	Adipic Acid Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 B 4	Caprolactam, Glyoxal and Glyoxylic Acid Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 B 5	Carbide Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 B 6	Titanium Dioxide Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 B 7	Soda Ash Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 B 8	Petrochemical and Carbon Black Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

IPCC Category Code	IPCC Category	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2 B 9	Fluorochemical Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 B-10	Other (please specify)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 C	Metal Industry	0.01	0.01	0.03	0.02	0.07	0.70	3.03	1.85	1.71	2.71	0.47	-0.29	1.02	0.49	-0.23	-0.42	134.04
2 C 1	Iron and Steel Production	-	-	-	-	-	-	-	-	-0.00	-	-	-	-	-	-	-	134.45
2 C 2	Ferroalloys Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 C 3	Aluminium Production	0.01	0.01	0.03	0.02	0.07	0.70	3.03	1.85	1.71	2.71	0.47	-0.29	1.02	0.49	-0.23	-0.42	-0.40
2 C 4	Magnesia Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 C 5	Lead Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 C 6	Zinc Production	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 C 7	Other (please specify)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 D	Non-Energy Products from Fuels and Solvent Use	-	-	18.31	7.28	1.96	-1.28	-1.82	4.24	4.50	8.79	9.88	7.48	5.91	3.80	4.12	7.71	5.14
2 D 1	Lubricant Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 D 2	Paraffin Wax Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 D 3	Other (please specify)	-	-	18.31	7.28	1.96	-1.28	-1.82	4.24	4.50	8.79	9.88	7.48	5.91	3.80	4.12	7.71	5.14
2 E	Electronics Industry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.40	0.05	-0.68
2 E 1	Integrated Circuit or Semiconductor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.40	0.05	-0.68
2 E 2	TFT Flat Panel Display	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 E 3	Photovoltaics	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 E 4	Heat Transfer Fluid	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 E 5	Other (please specify)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 F	Product Uses as Substitutes for ODS	-	3.81	9.79	-12.20	21.69	27.18	-2.95	-30.63	-82.99	-152.26	-128.15	-121.41	-43.14	-5.58	48.57	124.37	95.55
2 F 1	Refrigeration and Air Conditioning	-	3.81	9.79	-12.21	21.45	26.83	-3.32	-31.04	-83.58	-154.30	-130.74	-124.65	-45.85	-8.31	45.91	121.79	94.34
2 F 2	Foam Blowing Agents	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 F 3	Fire Protection	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-1.23
2 F 4	Aerosols	-	-	-	-	-0.10	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	0.13	0.13	0.13	0.13	0.13
2 F 5	Solvents	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 F 6	Other applications	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

IPCC Category Code	IPCC Category	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2 G	Other Product Manufacture and Use	0.44	0.43	0.46	0.45	0.45	0.46	2.91	0.48	0.59	0.67	0.73	1.18	3.20	4.33	7.99	6.72	6.19
2 G 1	Electrical Equipment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-2.76
2 G 2	SF_6 and PFCs from Other Product Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 G 3	N_2O from Product Uses	0.37	0.37	0.37	0.37	0.37	0.37	2.82	0.41	0.51	0.63	0.67	1.13	3.15	4.26	7.97	6.70	8.90
2 G 4	Other	0.07	0.06	0.09	0.09	0.08	0.09	0.08	0.08	0.08	0.04	0.06	0.05	0.05	0.07	0.02	0.02	0.05
2 H	Other (please specify)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	Total Agriculture	164.42	208.33	355.63	381.81	286.99	281.88	272.13	258.89	251.70	248.24	247.83	231.23	248.50	254.92	271.60	285.24	296.56
3 A	Enteric Fermentation	27.38	32.74	33.70	33.51	32.26	32.29	31.82	32.09	31.93	33.19	36.22	34.90	37.39	39.59	41.69	44.67	47.71
3 A 1	Cattle	17.14	20.34	21.47	21.52	19.16	18.58	17.40	17.63	18.15	18.38	17.80	17.50	18.58	19.40	20.61	22.10	23.89
3 A 2	Sheep	12.58	14.99	14.08	13.67	15.20	15.35	15.53	15.26	14.94	15.17	16.26	17.29	17.53	17.41	17.06	17.47	17.43
3 A 3	Swine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 A 4	Other	-2.34	-2.59	-1.85	-1.67	-2.10	-1.64	-1.11	-0.80	-1.16	-0.35	2.17	0.11	1.28	2.78	4.02	5.10	6.39
3 B	Manure Management	197.17	198.84	194.20	191.45	161.57	153.23	145.80	138.75	132.59	126.19	120.18	113.07	124.61	133.35	148.17	162.00	167.10
3 B 1	Cattle	124.42	127.83	129.03	128.67	106.24	98.20	92.31	87.21	82.44	77.19	70.80	65.15	76.01	84.45	97.43	109.81	115.60
3 B 2	Sheep	2.03	2.41	2.26	2.19	2.44	2.46	2.49	2.44	2.39	2.43	2.60	2.76	2.59	2.36	2.10	1.94	1.73
3 B 3	Swine	48.55	46.98	42.41	40.76	34.97	35.22	34.12	32.50	31.39	30.63	30.36	30.29	31.94	33.20	35.87	38.06	38.17
3 B 4	Other	1.30	1.70	2.10	2.31	2.40	2.48	2.59	2.70	2.76	2.80	3.70	2.99	3.20	3.47	3.65	3.78	4.04
3 B 5	Indirect N_2O emissions	20.87	19.91	18.40	17.52	15.52	14.87	14.29	13.90	13.61	13.14	12.72	11.87	10.87	9.87	9.12	8.41	7.58
3 C	Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3 D	Agricultural Soils	-60.13	-23.25	127.73	156.84	93.15	96.35	94.51	88.04	87.18	88.86	91.43	83.26	86.50	81.97	81.74	78.58	81.74
3 D 1	Direct N_2O emissions from managed soils	-170.40	-127.16	8.74	42.07	-8.66	-9.62	-9.35	-13.70	-18.39	-16.31	-17.03	-20.09	-15.63	-18.13	-18.87	-21.89	-16.77
3 D 2	Indirect N_2O Emissions from managed soils	110.27	103.92	118.98	114.78	101.81	105.98	103.86	101.75	105.57	105.17	108.46	103.35	102.13	100.10	100.61	100.47	98.50
3 E	Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3 F	Field Burning of Agricultural Residues	-	-	-	-	-0.00	-	-	-	0.00	-	0.00	-	-	0.00	-	-	-
3 G	Liming	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 H	Urea application	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 I	Other (please specify)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

IPCC Category Code	IPCC Category	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
4	Land Use, Land Use Change and Forestry	-2 074.24	937.23	-4 102.33	2 870.91	7 705.58	4 007.94	-3 712.97	891.37	-2 542.04	2 149.13	-1 457.21	-1 500.42	-3 390.34	3 565.04	4 893.58	7 714.22	4 267.36
4 A	Forest Land	-2 485.72	420.35	-4 745.05	2 231.33	7 040.97	3 334.02	-4 368.40	252.73	-3 174.60	1 509.49	-2 096.75	-2 132.45	-4 005.62	2 942.16	4 254.15	7 071.25	3 520.57
4 B	Cropland	188.36	188.72	189.79	191.02	180.06	182.35	178.25	177.61	168.99	143.84	156.52	169.20	172.48	168.48	166.20	163.56	152.67
4 C	Grassland	87.27	87.09	86.83	87.02	110.45	110.65	106.89	110.76	113.93	148.99	148.30	147.97	123.87	126.88	134.54	131.24	133.65
4 D	Wetlands	17.19	17.74	16.73	15.60	18.33	17.48	18.15	11.24	17.89	20.19	16.79	22.01	22.01	19.13	19.18	21.03	21.05
4 E	Settlements	103.02	207.72	333.74	330.30	341.28	348.94	337.64	323.40	317.24	312.04	303.36	278.27	282.34	293.81	304.92	312.55	306.73
4 F	Other Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08
4 G	Harvested Wood Products	0.01	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	118.10
4 H	Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5	Total Waste	197.37	202.00	186.17	181.75	161.15	160.19	159.25	158.83	158.44	158.33	169.01	165.98	167.23	165.98	166.68	164.27	163.69
5 A	Solid Waste Disposal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 B	Biological Treatment of Solid Waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 C	Incineration and Open Burning of Waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 D	Waste Water Treatment and Discharge	197.37	202.00	186.17	181.75	161.15	160.19	159.25	158.83	158.44	158.33	169.01	165.98	167.23	165.98	166.68	164.27	163.69
6	Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

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The National Inventory Document 2025 (NID 2025) gives a detailed and comprehensive description of the trend and the methodologies applied in the Austrian air emissions inventory for the greenhouse gases carbon dioxide, methane, nitrous oxide, HFC, PFC, SF_6 and NF_3.

With this report, Austria complies with its reporting obligations under the EU Governance Regulation No 2018/1999 as well as the UNFCCC by providing transparent and verifiable documentation. It contains emission data by sector for the years 1990−2023 as well as information on emission factors, activity data and other basic data for emission calculations.

Moreover, the report provides documentation of the national inventory system and quality control and assurance activities as performed by the accredited Inspection Body for Emission Inventories (ISO/IEC 17020).

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