Belgium's greenhouse gas inventory (1990-2022)

National Inventory Document
Submitted under the United Nations Framework Convention on Climate Change

December 15, 2024

Note: All GHG inventory information presented in this report is based on the November 2024 version of the UNFCCC Common Reporting Table (CRT) tool "ETF-GHG". Further updates and corrections in the CRT tool may result in changes to the final GHG inventory data.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

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

Belgium ratified the United Nations Framework Convention on Climate Change (UNFCCC) in January 1996, and the Convention came into force in April 1996. Parties to the Convention are committed to develop, publish and regularly update national emission inventories of greenhouse gases (GHGs).

This is the Belgium's National Inventory Document (NID) submitted in 2024. It contains GHG emissions estimates for the period 1990 to 2022 and describes the methodology on which these estimates are based. This report and the attached Common Reporting Tables (CRT) have been compiled in accordance with decision 24/CP.19[1]

The Belgian Interregional Environment Agency (CELINE - IRCEL) is responsible for the integration of the emission data from the inventories of the three regions of Belgium into the national inventory i.e. for compiling the national inventory.

The inventory covers the seven direct greenhouse gases (or groups of gases) that needs to be reported under the UNFCCC Convention. These are:

Carbon dioxide (CO_2);
Methane (CH_4);
Nitrous oxide (N_2O);
Hydrofluorocarbons (HFCs);
Perfluorocarbons (PFCs);
Sulphur hexafluoride (SF_6) and
Nitrogen trifluoride (NF_3).

These gases contribute directly to climate change owing to their positive radiative forcing effect. Also included in the Belgian inventory are the three indirect greenhouse gases and SO_2:

Nitrogen oxides (reported as NO_2);
Carbon monoxide (CO);
Non-Methane Volatile Organic Compounds (NMVOC); and
Sulphur oxides (reported as SO_2).

The structure of this report is as follows:

Chapter 1 provides background information on climate change and on inventory preparation.
Chapter 2 provides trends in GHG emissions.
Chapters 3 to 7 provide detailed descriptions per inventory sector (energy, industrial processes, agriculture, LULUCF and waste): general description, source, methodology, uncertainties, QA/QC, recalculations and improvements.
Chapter 8 provides information on indirect emissions.
Chapter 9 provides recalculations and improvements.

Annexes are included to provide information about key source analysis, uncertainty analysis and other detailed information.

1 FCCC Decision 24/CP.19. Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf

ES.2 SUMMARY OF NATIONAL EMISSION AND REMOVAL RELATED TRENDS

Table ES2 presents the Belgian Greenhouse Gas Inventory total emissions by gas, both including and excluding net emissions from LULUCF. The largest contribution to total emissions is CO_2, which contributed 85.9% in 2022 (excluding LULUCF). Emissions of CH_4 account for the next largest share with 7.4% and emissions of N_2O make up a further 4.3%.

When excluding LULUCF, emissions of all gases have decreased since 1990, contributing to an overall decrease of 29.0% and 29.8% if you consider the base year for the fluorinated gases (1995).

When including LULUCF, the overall decrease since 1990 is of 27.8% and 28.6% if you consider the base year for the fluorinated gases (1995).

Table ES2	Gg CO_2 Equivalent													% Changes
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990-2022
CO_2 emissions excluding net CO_2 from LULUCF	120 297	125 939	126 723	125 640	114 490	101 275	99 742	99 192	100 159	99 684	91 228	94 886	89 002	-26.0
CO_2 emissions including net CO_2 from LULUCF	117 352	123 629	124 992	123 793	114 044	100 443	98 977	98 543	99 498	99 177	90 747	94 507	88 484	-24.6
CH_4 emissions excluding CH_4 from LULUCF	12 900	12 654	11 444	9 630	9 122	8 486	8 446	8 264	8 181	8 096	7 972	7 871	7 657	-40.6
CH_4 emissions including CH_4 from LULUCF	12 900	12 654	11 444	9 630	9 122	8 486	8 446	8 264	8 181	8 096	7 972	7 871	7 657	-40.6
N_2O emissions excluding N_2O from LULUCF	8 951	9 618	9 071	7 545	6 699	5 331	5 091	5 247	5 015	4 952	4 815	4 763	4 489	-49.8
N_2O emissions including N_2O from LULUCF	8 956	9 639	9 107	7 617	6 785	5 421	5 183	5 340	5 109	5 048	4 912	4 861	4 588	-48.8
HFCs	NO	449	1 089	2 366	3 012	3 782	3 761	4 058	4 196	3 698	3 100	2 387	2 215	–
PFCs	2 035	2 716	403	156	96	138	388	170	121	139	185	182	108	-94.7
SF_6	1 666	2 206	149	94	108	95	100	105	98	109	112	102	104	-93.8
NF_3	NO	NO	NO	NO	1	1	1	1	1	1	8	5	2	–
Total (excluding LULUCF)	**145 849**	**153 583**	**148 879**	**145 430**	**133 529**	**119 108**	**117 528**	**117 035**	**117 770**	**116 680**	**107 421**	**110 196**	**103 576**	**-28.98**
Total (including LULUCF)	**142 909**	**151 294**	**147 183**	**143 655**	**133 169**	**118 367**	**116 856**	**116 479**	**117 203**	**116 268**	**107 036**	**109 915**	**103 157**	**-27.82**

Table ES2: Emissions of GHGs in terms of carbon dioxide equivalent emissions, 1990-2022 (Gg CO_2 Equivalent)

ES.3 Overview of source and sink category emission estimates and trends

ES.3.1 GHG Inventory

The table ES3.1 details total net emissions of GHGs, aggregated by IPCC sector.

The largest contribution to greenhouse gas emissions arises from the energy sector. In 2022 this contributed 74% to the total emissions (excluding LULUCF). Emissions of CO_2, CH_4 and N_2O all arise from this sector. Since 1990, emissions from the energy sector have declined by about 26%. Energy industries and manufacturing industries are both responsible for almost 81% in this decrease while at the same time, transport is responsible for a 12% growth.

Industrial processes and product use make up the second largest source of greenhouse gases in Belgium, contributing 16% to the national total in 2022 (excluding LULUCF). Emissions of all seven direct greenhouse gases occur from this sector and have declined by 34% (when comparing with 1990). All the sectors are concerned but the metal industry has experienced the most severe decrease in absolute figures.

The third largest source of greenhouse gases is agriculture with 8.8% (11.1% if you consider energetic emissions). Emissions from this sector arise mainly for both CH_4 and N_2O. Besides some CO_2 emissions arise from liming and urea consumption. Since 1990, emissions from this sector have decreased by 21%, due to a decline in emissions from enteric fermentation (related to lower livestock numbers but also to the shift from dairy cattle to brood cattle) and agricultural soils (due to changes in agricultural practices, including a decline in the emissions from the use of synthetic fertiliser and to the livestock reduction leading to less nitrogen excreted on pasture).

Land Use, Land-use Change and Forestry contain sinks as well as sources of CO_2 emissions. LULUCF is a net sink in 2022 as it is for the complete time series but in constant decline since 1990. Emissions from this sector occur for CO_2, CH_4 and N_2O.

The remaining source that contributes to direct greenhouse gas emission totals is the sector of waste. In 2022, waste contributed around 1.1% to the national total (excluding LULUCF). Emissions arise for CO_2, CH_4 and N_2O and originate from waste incineration, solid waste disposal on land, biological treatment of solid waste and wastewater handling. Emissions from this sector have steadily declined and are 75% below 1990 levels in 2022.

Total net emissions (including LULUCF) have decreased by 27.8% since 1990. A more detailed analysis of the evolution of sectors (without LULUCF) is provided in Chapter 2.3 of NID.

Table ES3.1	Gg CO_2 Equivalent													% Changes
	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990-2022
1. Energy	103 911	107 794	106 213	105 801	99 507	87 249	85 355	84 878	85 521	85 772	78 197	81 328	76 388	-26.49
2. Industrial Processes and product use	25 505	29 269	27 665	26 525	21 663	20 446	20 981	20 918	21 233	19 924	18 385	18 196	16 863	-33.9
3. Agriculture	11 636	11 754	10 854	9 876	9 714	9 710	9 596	9 647	9 526	9 553	9 509	9 406	9 149	-21.4
4. Land Use, Land-Use Change and Forestry	-2 940	-2 289	-1 695	-1 775	-360	-741	-673	-556	-567	-412	-385	-281	-419	-85.7
5. Waste	4 796	4 766	4 146	3 227	2 645	1 704	1 597	1 591	1 490	1 431	1 331	1 266	1 176	-75.5
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	–
Total (including LULUCF)	**142 909**	**151 294**	**147 183**	**143 655**	**133 169**	**118 367**	**116 856**	**116 479**	**117 203**	**116 268**	**107 036**	**109 915**	**103 157**	**-27.8**

Table ES3.1: Aggregated emission trends per source category, 1990-2022 (Gg CO_2 equivalent)

ES.3.2 Emissions trends

Emissions in 2022 are 29.8 % under base year emissions.

Table ES3.2	Gg CO_2 Equivalent														% Changes	
	Base Year	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	1990-2022	Base Year - 2022
CO_2	120 297	120 297	125 939	126 723	125 640	114 490	101 275	99 742	99 192	100 159	99 684	91 228	94 886	89 002	-26.0	-26.0
CH_4	12 900	12 900	12 654	11 444	9 630	9 122	8 486	8 446	8 264	8 181	8 096	7 972	7 871	7 657	-40.6	-40.6
N_2O	8 951	8 951	9 618	9 071	7 545	6 699	5 331	5 091	5 247	5 015	4 952	4 815	4 763	4 489	-49.8	-49.8
HFCs	449.34	NA,NO	449.34	1 088.81	2 365.70	3 012.49	3 782	3 761	4 058	4 196	3 698	3 100	2 387	2 215	100.0	392.9
PFCs	2 716	2 035	2 716	403	156	96	138	388	170	121	139	185	182	108	-94.7	-96.0
SF_6	2 206	1 666	2 206	149	94	108	95	100	105	98	109	112	102	104	-93.8	-95.3
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	1	0.80	0.67	0.59	0.60	1.05	8.13	5.25	2.21	100.0	NA
Total	**147 519**	**145 849**	**153 583**	**148 879**	**145 430**	**133 529**	**119 108**	**117 528**	**117 035**	**117 770**	**116 680**	**107 421**	**110 196**	**103 576**	**-28.98**	**-29.79**
% Total emissions compared to Base Year Emissions		**98.87%**	**104.11%**	**100.92%**	**98.58%**	**90.52%**	**80.74%**	**79.67%**	**79.34%**	**79.83%**	**79.09%**	**72.82%**	**74.70%**	**70.21%**		

Footnotes:

The data in this table are reported in the 2024 inventory submission (1990 – 2022).

The base year emissions are made up of 1990 emissions for CO_2, CH_4 and N_2O, and 1995 for the F-Gases.

Emissions are presented as Gg CO_2 equivalent, using GWP values taken from the IPCC's Fifth Assessment Report (AR5).

Table ES3.2: Trends of emissions (in Gg CO_2 equivalent)

ES.4 OTHER INFORMATION

ES.4 lists the indirect greenhouse gases and SO_2 for which Belgium has made emissions estimates. NO_x, CO and NMVOC's are included in the inventory because they can increase the tropospheric ozone concentrations and consequently increase radiative forcing. SO_2 is included because it contributes to aerosol formation.

Since 1990, emissions of all indirect gases and SO_2 have decreased. The largest source of emissions for all the indirect gases and SO_2 is the energy sector (more than 47% for SO_2 and up to 74% for NO_x) except for NMVOC where the industrial processes and product use sector is most significant (36%).

These emissions are reported completely consistent with the reported data on air pollutants in the framework of the emep/lrtap-reporting.

Gases	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022	% Changes
NOx	426.67	413.69	360.58	330.58	251.86	202.16	190.37	178.79	171.25	159.39	140.55	142.34	130.49	-69.4
CO	1506.60	1280.08	995.83	800.86	496.24	367.69	349.08	281.21	323.52	353.70	262.09	273.87	262.85	-82.6
NMVOC	431.56	396.83	312.04	261.13	219.32	195.71	192.53	191.31	155.16	152.76	157.55	152.48	146.54	-66.0
SO2	364.57	257.76	170.56	140.25	60.40	41.07	34.01	32.43	31.90	29.70	24.11	23.44	24.73	-93.2

Table ES4: Emissions of Indirect Greenhouse Gases in Belgium, 1990-2022 (in kton)

1 INTRODUCTION

1.1 Background information on greenhouse gas inventories and climate change

The first National Inventory Document (under the Paris Agreement) describes the Belgian greenhouse gas emission inventory in accordance with the revised UNFCCC reporting guidelines on annual inventories. It is aimed at
- complying with decisions 11/CP.4, 3/CP.5, 18/CP.8, 24/CP.19 of the Conference of the Parties and 18/CMA.1 (in particular by the fact that GWP AR5 are used in this submission)
- and the Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, 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 .

The greenhouse gas inventory presented here provides information on anthropogenic emissions by sources and removals by sinks for direct greenhouse gases (CO2, CH4, N2O, PFCs, HFCs, NF3 and SF6), indirect greenhouse gases (CO, NOx, NMVOCs) and SO2. It covers the period 1990-2022. Inventory data for the years 1990 to 2021 have been recalculated/optimized where necessary and in accordance with the IPCC 2006 guidelines (1).
During the 2023 submission Belgium took into account the recommendations published on 20 April 2022 according to the Final Review Report - 2022 Annual Review of National Greenhouse Gas Inventory Data pursuant to Article 19(2) of Regulation (EU) No 525/2013. The checks performed did not identify any significant issues, therefore Belgium was not subject to a second step of the 2022 annual ESD review. As no revised estimates or technical corrections were deemed necessary, the GHG emissions data officially reported by Belgium by 15 March 2022 under the Monitoring Mechanism Regulation could form the basis for determination of ESD emissions.
Besides initial checks were performed on the Belgian inventory submitted on January 2023 and on January 2024 and are taking into account as much as possible for the 2024 definitive submission.
The UNFCCC individual review report about the 2020 submission and published on 19 August 2021 was taken into account in the inventory submission in 2023. This UNFCCC review of the 2020 annual submission of Belgium was conducted at 26-31 October 2020 in accordance with paragraph 84 of the annex to decision 13/CP.20.
A UNFCCC-review took place in 2022 and Belgium took into account the Provisional Main Findings in the 2023 submission, as far as possible. The draft report of this review 'Report on the individual review of the annual submission of Belgium submitted in 2022' was received by February 15, 2023. The final 'Report on the individual review of the annual submission of Belgium submitted in 2022' dates from April 2023. Findings were taken into account in the 2024 submission as much as possible.

This first National Inventory Document under Paris Agreement is presented, as far as possible, according to the outline of the NID as set out in the "*Outline of the national inventory document, pursuant to the modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement* ", as encouraged by para. 2 of decision 5/CMA.3 in November 2021.

When preparing their GHG inventories under the Paris Agreement, Parties are to follow the guidance outlined in the MPGs (decisions 18/CMA.1 and 5/CMA.3), noting also the deadline for submission of the first BTR (at the latest in December 2024 per para. 42 of decision 1/CP.24). The common reporting tables adopted for use in reporting may be found in Annex I to decision 5/CMA.3. The outline for reporting the GHG inventory information may be found in Annex V to decision 5/CMA.3. The outline may be used in cases where the GHG inventory is included as a chapter in the BTR, as well as where it is included as a standalone document. In both cases, its use is encouraged, but not required. Decision 18/CMA.1, section VII will guide the review of information on the GHG inventory once the inventory is submitted in accordance with the MPGs.

The GHG inventory may be submitted as a part of the BTR or submitted as a standalone document. These documents do not need to be submitted at the same time, as long as the respective deadlines are met.
For Annex I Parties under the Convention that are a Party to the Paris Agreement, this means the 15 April for the GHG inventory and no later than 31 December for the BTR in year in which the BTR is due. For developing country Parties, this means the BTR, including the GHG inventory if a standalone document, must be submitted by 31 December in a year when a BTR is due.

Complete CRT tables (performed by using the November version of the ETF-GHG software for the years 1990 to 2022) are provided in annex 3 to this report, under electronic format. Next to the emission data, the CRT-tables are completed with - as requested - the standard indicators (notation keys), providing information on data gaps, methods applied, emission factors used, completeness and quality.

This national inventory document includes a description of the methodologies and data sources used for estimating emissions by sources and removals by sinks, an analysis of the key source categories, a discussion of these emission estimates and their trends, information on recalculations, planned improvements, uncertainties and quality assessment and quality control.

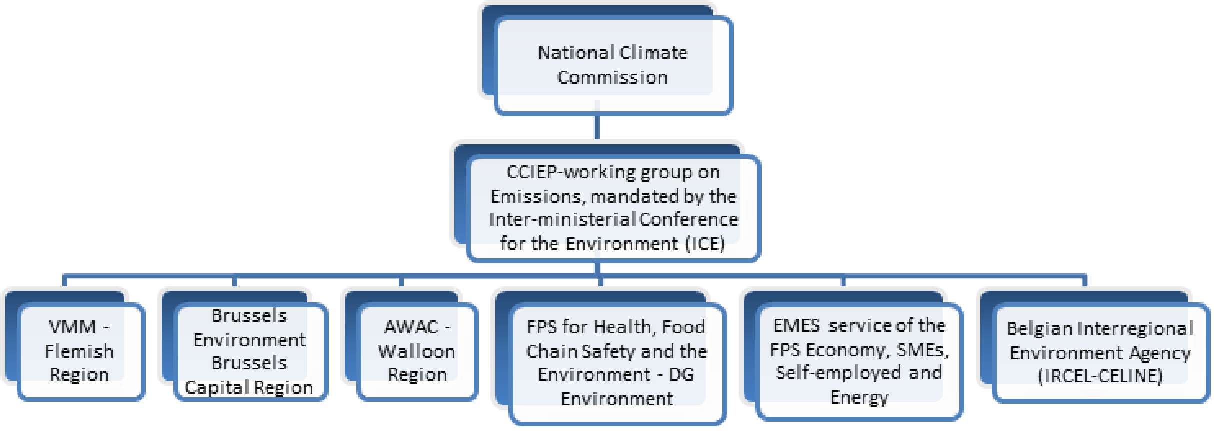
1.2 A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management

In the Belgian federal context, major responsibilities related to environment lie with the regions. Compiling greenhouse gas emissions inventories is one of these responsibilities. Each region implements the necessary means to establish their own emission inventory in accordance with the IPCC guidelines. The emission inventories of the three regions are subsequently combined to compile the national greenhouse gas emission inventory. Since 1980, the three regions have been developing different methodologies (depending on various external factors) for compiling their atmospheric emission inventories. Important efforts were made to tune these different methodologies, especially for the most important (key) sectors. Obviously, this requires some co-ordination to ensure the consistency of the data and the establishment of the national inventory. This co-ordination is one of the permanent tasks of the Working Group on «Emissions» of the *Coordination Committee for International Environmental Policy* (CCIEP), where the different actors decide how the regional data will be aggregated to a national total, taking into account the specific characteristics and interests of each region as well as the available means. This working group consists of representatives of the 3 regions and of the federal public services. The *Belgian Interregional Environment Agency* (CELINE - IRCEL) is responsible for integrating the emission data from the inventories of the three regions and for compiling the national inventory. The National inventory report is then formally submitted to the National Climate Commission, established by the Cooperation agreement of 14 November 2002, for approval, before its submission to the secretariat of the United Nations Framework Convention on Climate Change and to the European Commission, under the Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action.

1.2.1 Overview of institutional, legal and procedural arrangements for compiling GHG inventory

The Inter-ministerial Conference for the Environment took a series of decisions that clarify the role and responsibilities of different entities, as regards the preparation of the national GHG inventory. These decisions are detailed in the NIS.

Entities responsible for the performance of the main functions of the Belgian Inventory System, as well as main institutional bodies in relation with the decision process as regards this system, are presented hereafter.



As decided by the legal arrangements, the 3 regions are responsible for delivering their greenhouse gas inventories, which are afterwards compiled to produce the Belgian GHG inventory. The main regional institutions involved are:

The Department Air of the Flemish Environment Agency (VMM) in the Flemish Region;
The Walloon Agency for Air and Climate (AWAC) in the Walloon Region;
Brussels Environment (BE-LB) in the Brussels Capital Region.

Each region has its own legal and institutional arrangements, which are detailed in the NIS.

The Directorate General Environment of the Federal Public Service Health, Food Chain Safety and Environment (FPS - DG Environment) is involved in its capacity of UNFCCC National Focal Point of Belgium and registry administrator.

The Directorate General Energy (EMES service) of the Federal Public Service Economy, SMEs, Self-employed and Energy (FPS - DG Energy) is responsible for the top-down estimation of energy-related CO_2 emissions using the IPCC 'reference approach'.

The Working group on Emissions of the Coordination Committee for International Environmental Policy (CCIEP) (referred to below as 'CCIEP-WG Emissions') plays a central role in the coordination of the national GHG inventory.

The Belgian Interregional Environment Agency (IRCEL-CELINE) is the single national entity with overall responsibility for the preparation of the Belgian GHG inventory. IRCEL-CELINE operates as national compiler of greenhouse gas emissions in Belgium.

The National Climate Commission is in charge of the approval of the inventory reports.

It is the responsibility of the regions to ensure that staff are sufficiently trained and qualified. To this end, the Party has an established procedure for the training of staff in the Flemish Region.

For the Brussels-Capital Region, there is a step-by-step handover of technical competencies of staff involved in the inventory development. Before a staff member becomes a sectoral expert, it is ensured that they receive support from previous experts for at least one year or one inventory reporting cycle. Moreover, new staff from any Belgian region can count on the expertise of the experts of the two other regions when joining the Belgian supra-regional working group of inventory compilers.

There is no established procedure for the Walloon Region. The current staff consists of regular employees already for more than 10 years. Training is, however, offered during working hours on, for example, Microsoft Excel, Access applications and English.
In addition, depending on their respective sectors, staff from all three regions undergoes some international training or participate in workshops such as those performed in the framework of the EU ESD/ESR review process (e.g. for training on COPERT organized by EMISIA or on LULUCF organized by the Joint Research Centre).

Despite the apparent differences in approaches to ensuring the technical competence of staff between the Belgian regions, the UNFCCC ERT is satisfied that the Party provides sufficient training and support the staff to ensure their technical competency.

1.2.2 Overview of inventory planning

The schedule below is the schedule that Belgian experts follow in the preparation of the Belgian GHG inventory. Because of the continual extension of the tasks and the limitation of personnel, it’s sometimes hard to always follow this tight schedule.

Month	Input	Output
Jan 200x		
Feb 200x		
Mar 200x	15/3 Companies environmental reporting year X-1 reported to the Flemish region and 31/3 to the Walloon region 31/3 ETS-data Belgium reported to EC	
Apr 200x	Data Emission trading year X-1 are reported to the regions	
May 200x		
Jun 200x		
Jul 200x	Regional energy balances (temporary figures incl ETS-data and first estimations for some energy carrires and sectors) year X-1	
Aug 200x		
Sep 200x		
Oct 200x	Complete regional energy balances year X-1	
Nov 200x		
Dec 200x	Regional CRF-tables (1990 to (X-1)*) to NIC by the end of December Compilation of the Belgian inventory by IRCEL-CELINE in December/January	
Jan 200x+1	Compilation of the Belgian inventory by IRCEL-CELINE in December/January	2 days before official submission of 15/1: submission of national inventory data and supplementary information to the National Climate Commission for approval 15/1 submission of provisional national inventory data and supplementary information to the Commission
Feb 200x+1	Jan - Feb - Mar Integration of review results in regional and Belgian definitive inventories and preparation of supplementary information	
Mar 200x+1		2 days before official submission of 15/3: submission of definitive national GHG inventory and NIR to the national Climate Commission for approval 15/3 Submission of definitive national GHG inventory and NIR to the Commission
Apr 200x+1		2 days before official submission of 15/4: submission of national GHG inventory and NIR tot the National Climate Commission for approval 15/4 Submission of national GHG inventory and NIR to the UNFCCC-secretariat

1.2.3 Overview of inventory preparation and management

The regional GHG inventories are transmitted during December as complete as possible to IRCEL-CELINE, the national inventory compiler. IRCEL-CELINE makes the compilation of the three regional inventories into the national one, under the CRT format, during January. This implies coordination with all regions, within the context of the CCIEP-WG Emissions. The top-down calculation of the energy-related CO_2 emissions (reference approach) is made by the Energy Monitoring and Electric System (EMES) service of the Directorate General Energy of the Federal Public Service Economy, SMEs, Self-employed and Energy (FPS - DG Energy) and transmitted to IRCEL-CELINE.
The national CRT-tables are cross-checked by the members of the CCIEP-WG Emissions and afterwards transmitted to the National Climate Commission for the official approval.
After approval by the National Climate Commission, the national GHG inventory is submitted to the EU Commission via the EIONET - Central Data Repository (CDR - https://cdr.eionet.europa.eu/be/eu/govreg/inventory//) of the European Environment Agency (EEA) by the 15th of January (preliminary inventory) and the 15th of March (definitive inventory) and to the UNFCCC secretariat through the UNFCCC National Focal Point by the 15th of April.
The update of the National Inventory Report (NID) is being mainly performed between the submission at the 15^{th} of January and the definitive submission to the EU at the 15^{th} of March each year.

1.3 Inventory preparation

1.3.1 GHG inventory

The main steps are described in chapter 1.2.3 here above. Further details are available in the NIS.

The preparation of the GHG inventory for the LULUCF sector follows the steps and timing described in the present chapter.

The fluorinated gases (categories 2B9, 2E, 2F and 2G) constitute an exception in the inventory process in Belgium in a way that the emission inventory of these gases is set up at the national level as well as for each of the 3 regions, in a single, harmonised approach by external consultancies (Econotec/VITO) and not by the regional inventory agencies. Methodologies and emission results are discussed and approved in a steering group with representatives of the different regions and the federal services.

1.3.2 Data collection, processing and storage

The data flows for the key sources are described in annex 5 of this document.

1.3.3 Quality assurance/quality control (QA/QC) procedures and extensive review of GHG inventory

The QA/QC procedures are described in chapter 1.6 of this NID.

1.4 Brief general description of methodologies and data sources used

General for all regions

Sector	Methodology/data sources
category 1A: energetic emissions	regional energy balances
categories 2B9, 2E, 2F and 2G: emissions F-gases	- full consistency between regions - study by external consultants (Econotec/Vito) - no data of the EC Regulation 842/2006 (art 6(1)) are used in the Belgian greenhouse gas inventory because only figures of placement at the European market are reported here and consequently not appropriate.
category 4: LULUCF	- full consistency between regions - land-use (change) matrix set up originally by Gembloux Agro Biotech University and optimized afterwards
category 1A3b: road transport	- emissions based on ‘fuels sold’ (federal petroleum balance). Regional sales statistics are used for the first time during the 2023 submission to estimate the regional emissions.

As a consequence of the responsibility and the specificity of the regions in developing greenhouse gas inventories, concomitant methodologies have been developed by the three regions for performing their inventory from basic data. This section describes the general approach developed by each region. A similar, but more detailed, presentation of the methodologies and data sources used in the national inventory has been described in the chapters 3 to 7 for each of the IPCC/CRT-categories. Estimating emissions for fluorinated gases are described in chapter 4 of this document.
The QA/QC procedures are not described in detail in the chapters 3 to 7 for each category but in a more general way in section 1.6.

Time consistency is obviously guaranteed for all sectors that have been optimised during all submissions. This occurs as accurate as possible (depending on availability of accurate date)

One of the basic activity data in the **LULUCF-inventory** is the land-use change matrix. This matrix was first established through a study by the Gembloux Agro Biotech University (2) (3) (4). It was developed in order to comply with the principles set out in annex of the decision 16 (CMP1) and with IPCC Good Practice Guidance on LULUCF. This study was conducted at the national scale, to ensure that the same methodology is used by all regions, the results are available both at the national and the regional scales. The results at the regional scale are used by the regional inventory agencies (VMM, AWAC, Brussels Environment) to prepare their estimates of emissions and removals.
The method used to develop the land-use change matrix is described in chapter 6 (LULUCF) of this document. The land use matrix is produced/optimized by the 3 regions based on available GIS data.
Another main source of data are the regional forest inventories, described in chapter 6. of the NID, which are the main reference for data such as species distribution, standing volume or annual increment. Some published references are also used for region-specific data such as soil organic carbon. IPCC default values are used for some parameters and in case no region/country-specific data are available.

The emissions and removals are calculated at the regional level following IPCC Good Practice Guidance on LULUCF and by using a common template between the regions. Regional experts work in close co-operation, taking into account the specificities of the sector such as different cycles of forest inventories.

In the Belgian emission inventory, the greenhouse gas emissions from **road traffic** are calculated for the first time during this 2023 submission as the sum of the emissions of the 3 regional emission inventories, based on the regional sales statistics (see section 3.2.8 for further information). The sum of these regional emissions corresponds to the Belgian emissions, based on the fuels sold, reported in the federal petroleum balance statistics. The Copert-model is used in the 3 regions for the estimation of the fuel-used emissions and are based on fuel consumption of the vehicles that travel within the region's territory.

The regional and national inventory systems are fully described in the National Inventory System which has been reported for the first time by the end of 2006 to the secretariat of UNFCCC. An update of the Belgian National Inventory System was carried out for the first time during the 2017 submission, later during the 2019 submission to the UNFCCC-secretariat and during the submission of March 2021 and is included in annex 3 of this report (see also chapter 12 for more details). Last update of the NIS is officially reported during the submission in 2024.

The greenhouse gas emissions of **off-road activities** are calculated by using the OFFREM-model with emission factors of the IPCC 2006 guidelines (CO_2 and CH_4) and EMEP/EEA guidebook (N2O). Country specific calorific values are used.

The original study of July 2009 was optimized in December 2019 'Actualisatie OFFREM: OFFREM 2019 Marlies Vanhulsel, Frank Sleeuwaert, Tomas Crols, Karolien Vermeiren, Inge Uljee Studie uitgevoerd in opdracht van: Vlaamse Milieu Maatschappij (VMM) 2019/Unit RMA/R/2037 December 2019'. During the 2021 submission a further optimization of this model was performed (see the respective chapters in the NID for more details).

1.4.1 GHG inventory

1.4.1.1 Flemish region

Data source used	Sector
regional energy balance	To estimate all energetic emissions for all sectors except for some special cases (see below).
yearly integrated environmental reports (IMJV)	Emissions from individual companies from mainly energy industries (1A1) and Chemical industry (2B) and industrial process emissions (2). Above in general (until emissions of 2012, in combination with emissions ETS from 2013 onwards)
yearly ETS- emission reports	From the 2015 reporting on (emissions of 2013) all industrial ETS-emissions are included in the Flemish greenhouse gas inventory
chemical federation	process emissions chemical industry (2B) and chemical flaring (5C) (until emissions of 2012, emissions ETS afterwards)
Federations (Fluxys, Synergrid, …)	fugitive emissions from fuels
models (country/region specific)	transport (1A3), other sectors (1A4), agriculture (3), SWDS (5A) and off-road activities

The energy balance for the Flemish region is an important data source for estimating the energetic emissions for all sectors. Until 2020 (data until 2019) this balance was annually established by VITO (5) and funded by the Flemish region. From 2021 on these energy balances are set up by VEKA (Flemish Agency for Energy and Climate). The energy balances describe the quantities of energy imported, produced, transformed and consumed in the Flemish region in a given year. The energy balances are based on legal reported data on energy consumption and electricity and heat production, on statistical data and models and on voluntary surveys among energy suppliers, federations and individual companies. From the year 2013 on, ETS-data reported by the companies become a more important source to draw up the Flemish energy balances and the emission inventories.
The methodology used to set up the energy balances, the data and relevant information is available on the website of the Flemish Energy and Climate Agency (https://www.vlaanderen.be/veka/energie-en-klimaatbeleid-in-cijfers).

Updates of energy balance data in the Flemish region become available in October year x with updated figures until year (x-1).The Flemish energetic greenhouse gas emissions reported during this submission are based on most recent energy balance data.
For the intermediary years 1991 to 1993, another methodology is used to set up energy balances, because of lack of resources at that time. This means that for these years the so-called 'difference methodology' was used (Flemish energy balance data = Belgian energy balance data minus Walloon energy balance data minus Brussels energy balance data) instead of the independent methodology (bottom-up) used for the other years. Also the level of detail in sector classification was different (less detail) for these years 1991-1993.

In Flanders, the greenhouse gas inventory is set up by the team Air Emission Inventory of the 'Core Air' of the *Flemish Environment Agency* (VMM).

Concerning emissions from industry (CRT 1A1, 1A2 and CRT 2):

Since the reporting year of 1993 most important industrial facilities in the Flemish region with a certain level of 'air pollution' are obliged to report annually their (air) emissions when exceeding a defined threshold value (in unit of weight / year) in their yearly integrated environmental report (IMJV).
Besides, from 2005 on, starting with the emission year 2004, the most important industrial sites in Flanders had to report additionally their emissions of greenhouse gases, also when exceeding a defined threshold value.

As a consequence, the emissions of the greenhouse gases (mainly for CH_4 and N_2O) were revised for the industrial sector during the 2006 submission for the complete time series from 1990 on.
From 2006 on this reporting obligation was harmonized in the Flemish region with the EPER-decision (2000/479/EC) and with the EPRTR-regulation (166/2006/EC).
The threshold values are 100 kton for CO_2, 100 ton for CH_4 and 10 ton for N_2O. For the F-gases the threshold values are 0,001 ton for CFC's, for HCFC's and for the halons and 0,1 ton for the HFC's and PFC's and 0,05 ton for SF_6.
In total approximately 400 industrial companies are registered in the database Industry/IMJV in the Flemish region.
Mainly for the sectors refineries and the chemical industry (process emissions) this obliged reporting of emissions is an important source of information for the European and international reporting obligations of greenhouse gases from 1990 on.

Besides the above-mentioned source of emissions of CO_2 for individual industrial companies (IMJV), in the Flemish region all industrial installations falling under the scope of ETS-Directive 2003/87/EC (more than 250 installations) are obliged to report their emissions (mainly CO_2) yearly in an ETS emissions report[2]. The methodology to calculate the CO_2 emissions in this report, should be consistent with a monitoring plan that was approved by the Competent Authority. The ETS emissions report is verified by an accredited verifier[3] who needs to formulate an independent judgment about the reported CO_2-emissions.
The Flemish region has always pursued consistency between the data included in these ETS emission reports and the data used for establishing the GHG inventory.
These efforts have led to the following approach with respect to the use of ETS data in the GHG inventory:

- as from 2014 (2013 emissions), the GHG inventory uses for all sectors the detailed ETS datasets (i.e. including - per source stream - activity data, net calorific values, emissions factors) for establishing the energy and inventory data;
- until 2013 (2012 emissions) and since 2005, the GHG inventory took over the ETS emissions completely of specific sectors e.g. in the iron/steel sector (category 1A2a and 2C) and in the sectors glass (category 2A3) and ceramics (category 2A4). For other (minor) sectors the ETS emissions are used for QA-purposes i.e. to double check reliability of energy and emission data derived from other data sources (e.g. annual integrated environmental reports from installations, data retrieved from sectors, …). When major differences were detected, data were optimized if necessary. As a result, more accurate emissions and/or energy data were obtained through the ETS reporting.

The following approach is the result of a continued effort in the Flemish region:

- in 2010 a study was conducted to examine in detail the differences between energy and CO_2 data reported under the ETS and the data used in energy balances (energy use) and in emission reporting (CO_2): this study was conducted by the VITO (5) and ordered by the Flemish Environment Agency. An advisory group was following up the study and recommendations were taken into consideration to improve energy balances and emission inventories;
- since 2014 (reporting of emissions of the year 2013) the Flemish Region obliges ETS-installations to report their emissions via an Internet-based reporting tool: this tool enables the relevant Competent Authority to store the underlying detailed emissions data (activity data, calorific value, emission factor) in a hands-on ETS database. These detailed data is necessarily shared with inventory people and people responsible for setting up the energy balance.

A comparison between emission data of CO_2 reported in the national CRT-tables and reported under the ETS-Directive can be found in this submission (annex XII 'Reporting on consistency of reported emissions with data from EU Emissions Trading System pursuant to Article 37' of the Governance Regulation 2018/1999 (Governance of the Energy Union and Climate Action).

2 As from 2006 (2005 emissions) until 2013 (2012 emissions) this was done by filling in an Excel-file. As from 2014 (2013 emissions) the reporting is done via an Internet-based reporting tool.
3 As from 2006 (2005 emissions) until 2013 (2012 emissions) this was done by one specific verification office, the Verification Office Benchmarking Flanders (VBBV). As from 2014 (2013 emissions) the verification is done via an accredited verifier.

Summarized, the emissions from industry reported in the inventory, are:

- on an individual company level: for energetic and process emissions: validated emissions reported via ETS (from 2013 on and mainly CO_2 except for N_2O from nitric acid production); before 2013 mainly emission originating from the IMJV's in combination with survey results for process emissions;

- calculated, in a collective way, when no accurate, individual emissions are available, by using the default IPCC CO_2 emission factors in combination with energy data of the energy balance, except for natural gas where country-specific emission factors for CO_2, based on detailed information from the independent responsible of the natural gas infrastructure Fluxys are used (until the submission of 2022 only in the category 1A4 'Other sectors' by using this country-specific factor and from the submission in 2023 onwards in all CRT-categories where no measurements are available).

For the other CRT-categories (1A3, 1A4, 3, 4 and 5) models and country-specific methodologies are used to estimate the greenhouse gas emissions f.i. for calculating the emissions of navigation and transport via railways, for non-road mobile machinery, for agriculture, for solid waste disposal and for distribution, transmission and storage of natural gas.

See the respective chapters (3 to 8) for more detailed information about these sectors.

1.4.1.2 Walloon region

Data source used	Sector
regional energy balance	to estimate all energetic emissions except for some special cases (see below)
Regine and yearly ETS - emission reports	energy industries (1A1), Other industries (1A2f), Mineral industry (2A), Chemical industry (2B) and metal production (2C)
Federations (Fluxys, Synergrid, …)	fugitive emissions from fuels
models (country/region specific)	transport (1A3), agriculture (4), SWDS (6A) and off-road activities

The emission inventories of the Walloon region are compiled by Walloon Agency for Air and Climate (AWAC) using the IPCC methodology (or EMEP/EEA for some sectors where IPCC does not provide emission factors). Emission factors used, are performed for all industrial sectors. In some cases, as Agriculture and forestry, the emission estimates are based on a specific study reflecting the Walloon environment.

One main data source for the inventory preparation is the energy balance delivered yearly by the Energy and Sustainable Building Department and prepared by an external consultant ICEDD (Institut de Conseils et d'Etudes en Développement Durable). The energy balance describes the quantities of energy imported, produced, transformed and consumed in the Walloon Region in a given year. In 2003, an environmental integrated survey has been created which includes all pertinent environment-related reporting requirements for 300 companies. The environmental integrated survey is personalised to the 300 operators of the activities/installations pointed out by one or several regulations (four international Conventions and their protocols, seven European Directives, three European Regulations, two European Decisions, one European Recommendation, two Walloon laws, one Walloon Decree and several non-legally binding agreements). The information related to GHG emissions is used to calculate the emissions of the most important emitters in the energy, industry and waste sectors. In particular, the information coming from the obliged reporting under the ETS-Directive is used in the preparation of the inventory of the greenhouse gases.

A comparison between data (energy consumption in TJ and emissions of CO_2 in kton) reported in the national CRT-tables and reported under the ETS-Directive can be found in this submission (annex V of the MMR Regulation 525/2013).

A new inventory software was developed in Wallonia (WAPI) improving the quality of the regional and the national inventory. Wallonia used the database Collecter before to manage the inventory data's (one collecter database by year).

This new software allows the seeing of all data of a plant or an area source on the complete time series and avoids mistakes during recalculations (jump, zero, errors of unit...). This new software is also used to report some sectors of the LRTAP inventory.

The data sources and inventory preparation are described in detail in the National Inventory System.

1.4.1.3 Brussels Region

Data source used	Sector
regional energy balance	to estimate all energetic emissions except for some special cases (see below)
Federations (Fluxys, Synergrid, …)	fugitive emissions from fuels
models (country/region specific)	transport (1A3), agriculture (3) and off-road activities

The greenhouse gases emission inventory in the Brussels region is compiled by *Brussels Environment* (BE-LB), the environment and energy public administration for residents and companies in the Brussels Capital Region, mainly on the basis of the IPCC-methodology 2006 (1) and the methodology described in the EMEP/EEA guidebook (6).
The sectors taken into account in the Brussels inventory reflect the characteristics of an urban environment, where almost all emissions originate from energy consumption in residential, tertiary and road transport sectors.
The emissions are mostly calculated by multiplying activity data by emission factors.
For fuel combustion emissions (CRT 1A, except road transport) the activity data come from the annual regional energy balance (7) (8). The emissions from road transport are calculated using the COPERT software. The other emissions types are calculated using source-specific activity data and/or in-situ measurements.

1.5 Brief description of key categories

1.5.1 GHG inventory (including LULUCF)

Key source categories are identified according to the tier 1 methodology described in the IPCC 2006 Guidelines (1), Vol 1, Chap 4. Both a level assessment (contribution of each source category to the total national estimate) and a trend assessment (contribution of each source category's trend to the total trend) are conducted during this submission. A level assessment is performed for the years 1990, 2021 and 2022 and trend analysis is carried out for the years 1990-2021 and 1990-2022. See annex 1 for more details.

The key source analysis is realised on the basis of table 4.1 as suggested in IPCC 2006 guidelines (9) (10). Belgium disaggregated the sectors more strongly than recommended in order not to lose in the analysis some categories that could be of particular importance for a region because of its particular institutional situation (each region is responsible for the establishment of its own inventory). Since the 2023 submission, Belgium follows strictly the disaggregation of the table 4.1. Each greenhouse gas emitted by a single source category is considered separately. The key source analysis is performed by using CO_2-equivalent emissions calculated by means of the global warming potentials (GWPs) specified in the UNFCCC reporting guidelines on annual inventories according the fifth assessment report of IPCC - AR5.

The level assessment with LULUCF for 2022 results in the identification of 29 key sources (from a total of 127 sources), covering 95%[4] of the total national aggregated emissions. These 29 key sources are to a large extent the same as those identified for the year 2021 and 1990 (see table below).

IPPC categories - submission 2024	GHG	1990	2021	2022
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	x	x	x
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	x	x	x
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	x	x	x
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fue	CO2	x	x	x
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	x	x	x
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	x	x	x
1.A.3.b. Road Transportation	CO2	x	x	x
1.A.3.e. Other Transportation	CO2	x	x	x
1.A.4 Other Sectors - Gaseous Fuels	CO2	x	x	x
1.A.4 Other Sectors - Liquid Fuels	CO2	x	x	x
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	x	x	x
2.A.1 Cement production	CO2	x	x	x
2.A.2 Lime production	CO2	x	x	x
2.B.8 Petrochemical and carbon black production	CO2	x	x	x
2.C.1. Iron and Steel Production	CO2	x	x	x
3.A Enteric Fermentation	CH4	x	x	x
3.B Manure Management	CH4	x	x	x
3.B Manure Management	N2O	x	x	x
3D1 Direct N2O emissions from managed soils	N2O	x	x	x
3D2 Indirect N2O Emissions from managed soils	N2O	x	x	x
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2	x	x	x
5.A. Solid Waste Disposal	CH4	x	x	x

4 This threshold (95%) is recommended in the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (10) (9), for both the Level Assessment and the Trend Assessment ; it was determined to be the level at which 90% of the uncertainty in a 'typical' inventory would be covered by key source categories, for the tier 1 method.

There is a little bit more differences with the year 1990 (see annex 1). Differences are summarised in the table below:

IPPC categories - submission 2024	GHG	1990	2021	2022
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2		x	x
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2		x	x
1.A.3.d. Navigation - Liquid Fuels	CO2		x	
1.A.4 Other Sectors - Solid Fuels	CO2	x		
2.B.1 Ammonia Production	CO2		x	
2.B.2 Nitric Acid Production	N2O	x		x
2.B.9 Fluorochemical Production	Aggregate F-gases	x		
2.B.10 Other	CO2		x	x
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases		x	x
4.B.2. Land converted to Cropland CSC	CO2		x	x
4.E.2. Land converted to Settlements CSC	CO2		x	x
4.G Harvest w ood products	CO2	x		
5.D. Wastew ater treatment and discharge	CH4	x		

29 categories are identified as key source from the trend assessment with LULUCF 1990-2022 as those that contribute to 95% to the trend of the inventory while 28 categories are key sources for the trend assessment with LULUCF for the years 1990-2021 (see annex 1) and these identified key sources overlap to a large extent.

IPPC categories - submission 2024	GHG	1990-2021	1990-2022
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	x	x
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	x	
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	x	x
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	x	x
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	x	x
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	x	x
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	x	x
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	x	x
1.A.3.b. Road Transportation	CO2	x	x
1.A.3.e. Other Transportation	CO2		x
1.A.4 Other Sectors - Gaseous Fuels	CO2	x	x
1.A.4 Other Sectors - Liquid Fuels	CO2	x	x
1.A.4 Other Sectors - Solid Fuels	CO2	x	x
1.B.1 Fugitive emissions from Solid Fuels	CH4	x	x
2.A.1 Cement production	CO2	x	x
2.A.2 Lime production	CO2	x	x
2.B.1 Ammonia Production	CO2	x	x
2.B.10 Other	CO2	x	x
2.B.2 Nitric Acid Production	N2O	x	x
2.B.8 Petrochemical and carbon black production	CO2	x	x
2.B.9 Fluorochemical Production	Aggregate F-gases	x	x
2.C.1. Iron and Steel Production	CO2	x	x
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases	x	x
3.A Enteric Fermentation	CH4	x	x
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2		x
4.B.2. Land converted to Cropland CSC	CO2	x	x
4.E.2. Land converted to Settlements CSC	CO2	x	x
4.G Harvest w ood products	CO2	x	x
5.A. Solid Waste Disposal	CH4	x	x
5.D. Wastew ater treatment and discharge	CH4	x	x

Key source categories identified from the level and the trend assessments also overlap to a large extent. As a whole (level and trend assessments with LULUCF), 37 key source categories are determined (table 1.1). The absolute change in direct greenhouse gas emissions of these key sources over the period 1990-2022 is listed in table 1.1 and shown in figure 1.1.

IPCC categories Submission 2024	direct greenhouse gas	1990 Estimate	2022 Estimate	criteria for identification		absolute emission trend 1990-2022
		Gg CO_2 eq	Gg CO_2 eq			Gg CO_2 eq
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2755.68	7456.05	T	L	4 700.4
1.A.4 Other Sectors - Gaseous Fuels	CO2	7865.39	11863.48	T	L	3 998.1
1.A.3.b. Road Transportation	CO2	19676.94	22917.26	T	L	3 240.3
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gas	0.00	2023.16	T	L	2 023.2
2.B.8 Petrochemical and carbon black production	CO2	1882.42	3575.99	T	L	1 693.6
4.G Harvest w ood products	CO2	-1516.10	10.77	T		1 526.9
2.B.10 Other	CO2	285.15	1769.66	T	L	1 484.5
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	674.22	2017.83	T	L	1 343.6
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	7846.28	8725.43	T	L	879.2
4.B.2. Land converted to Cropland CSC	CO2	41.51	544.73	T	L	503.2
2.B.1 Ammonia Production	CO2	422.74	866.19	T	L	443.5
4.E.2. Land converted to Settlements CSC	CO2	143.91	515.12	T	L	371.2
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	186.18	543.98	T	L	357.8
1.A.3.e. Other Transportation	CO2	333.95	584.36	T	L	250.4
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2	-1909.52	-1679.47	T	L	230.1
3.B Manure Management	CH4	1376.13	1266.29		L	-109.8
3.B Manure Management	N2O	810.08	560.86		L	-249.2
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	794.59	481.27		L	-313.3
2.A.1 Cement production	CO2	2823.78	2456.03	T	L	-367.7
3D2 Indirect N2O Emissions from managed soils	N2O	965.90	572.05		L	-393.8
1.B.1 Fugitive emissions from Solid Fuels	CH4	484.32	43.90	T		-440.4
5.D. Wastew ater treatment and discharge	CH4	1041.95	245.70	T		-796.3
3D1 Direct N2O emissions from managed soils	N2O	2978.71	2133.59		L	-845.1
3.A Enteric Fermentation	CH4	5326.63	4442.77	T	L	-883.9
2.A.2 Lime production	CO2	2097.12	1115.02	T	L	-982.1
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	4952.30	3675.26		L	-1 277.0
1.A.4 Other Sectors - Solid Fuels	CO2	2017.30	92.72	T		-1 924.6
5.A. Solid Waste Disposal	CH4	3323.27	556.72	T	L	-2 766.5
2.B.2 Nitric Acid Production	N2O	3042.64	165.25	T		-2 877.4
2.B.9 Fluorochemical Production	Aggregate F-gas	3568.03	150.03	T		-3 418.0
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	7396.73	1317.26	T	L	-6 079.5
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	7958.57	1821.75	T	L	-6 136.8
2.C.1. Iron and Steel Production	CO2	10047.90	3416.89	T	L	-6 631.0
1.A.4 Other Sectors - Liquid Fuels	CO2	17896.75	7809.82	T	L	-10 086.9
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	21165.05	5218.38	T	L	-15 946.7

Table 1.1: Level and trend assessment 1990-2022 incl. LULUCF (summary)

CO_2 emissions from “Fuel combustion of Energy Industries” - solid fuels and gaseous fuels, from “road transportation, from “Fuel combustion of Manufacturing Industries and Construction - liquid fuels and solid fuels and from “Other Sectors" - gaseous fuels and liquid fuels are the first key sources (trend assessment with LULUCF) of greenhouse gas emissions in Belgium. They constitute the main drivers of 2022 emissions trends as for 2021 emissions (annex 1). Together, these seven sources cover around 58% of the total change in emissions between 1990 and 2022.

The three most important level key sources (with LULUCF) of non-CO_2 emissions in Belgium are direct N_2O emissions from managed soils (2.06% in 2022), aggregated fluorinated gases emissions from refrigeration and air conditioning (1.95% in 2022) and CH_4 emissions of manure management (1.22% in 2022).

One may finally notice that the five key source categories which displayed the most important absolute increase in their emissions over the period 1990-2022 (figure 1.1, table 1.1) are CO_2 emissions from “energy industries (gaseous fuels)” (category 1A1, +4700 Gg CO_2-eq.), CO_2 emissions from “other sectors (gaseous fuels)” (category 1A4, +3998 Gg CO_2-eq.), CO_2 emissions from “road transportation” (category 1A3b, +3240 Gg CO_2-eq.), aggregated fluorinated gases emissions from “refrigeration and air conditioning” (category 2F1, +2032 Gg CO_2-eq.) and CO_2 emissions from “Petrochemical and carbon black production” (category 2B8, +1694 Gg CO_2-eq.).

On the contrary, CO_2 emissions from “fuel combustion of energy Industries (solid fuels)” (category 1A1, -15947 Gg CO_2-eq.), CO_2 emissions from “other sectors (liquid fuels)” (category 1A4, -10087 Gg CO_2-eq.), CO_2 “process emissions from the iron and steel sector” (category 2C1, -6631 Gg CO_2-eq.) and CO_2 emissions from “fuel combustion of manufacturing industries and construction (liquid fuels and solid fuels) (category 1A2, -6137 Gg CO_2-eq. and -6079 Gg CO_2-eq.) are the source categories that displayed the most important drop in GHG emissions between 1990 and 2022.

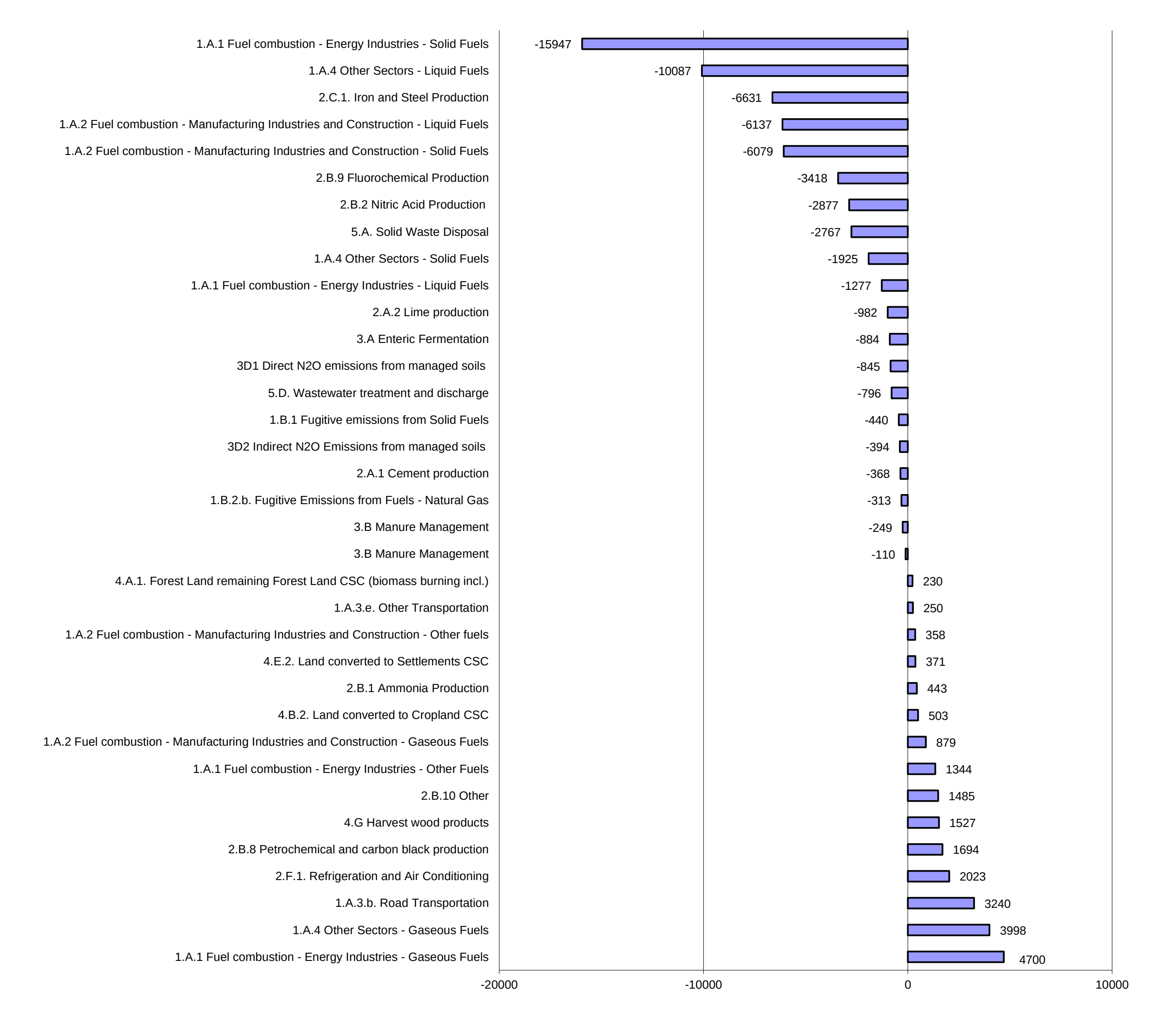


Figure 1.1: Key source category analysis: GHG Emission Trends 1990-2022 (Gg CO_2 equivalent)

Concerning the LULUCF sector and considering the parameter “Carbon stock change”, the following categories 4A1 'Forest Land remaining Forest Land', 4B2 'Land converted to Cropland' and 4E2 'Land converted to Settlements are key sources in the level assessment for 2021 and for 2022. 4G ‘Harvest wood products’ must also be considered as key but only for 1990.

IPCC source categories - Submission 2024	Gas	1990	2021	2022
4.A.1. Forest Land remaining Forest Land CSC	**CO2**	**x**	**x**	**x**
Net Carbon stock change in living biomass	CO2	x	x	x
Net carbon stock change in dead organic matter	CO2			
Net carbon stock change in soils	CO2			
4.B.2. Land converted to Cropland CSC	**CO2**		**x**	**x**
Net Carbon stock change in living biomass	CO2			
Net carbon stock change in dead organic matter	CO2			
Net carbon stock change in soils	CO2		x	x
4.E.2. Land converted to Settlements CSC	**CO2**		**x**	**x**
Net Carbon stock change in living biomass	CO2		x	x
Net carbon stock change in dead organic matter	CO2			
Net carbon stock change in soils	CO2		x	x
4.G Harvest wood products	**CO2**	**x**		

Concerning the trend assessment for the years 1990 – 2022, all the categories listed above for the level assessment are also key sources. Furthermore, 4G ‘Harvest wood products’ is also KS.

1.5.2 Qualitative analysis

Following guidance provided in GPG2000, "it is good practice to identify subcategories as key if they account for 25-30 percent of the overall emissions of removals of the category".

When doing this with the level assessment with LULUCF for 2022, we obtain the following table with 38 key sources at subcategory level.

IPCC source category Submission 2024	Gas	2022 estimate Gg CO2 eq	% at subcategory level
Primary key source for level assessment 2022			
1.A.3.b. Road Transportation	CO2	22 917	
1.A.3.b Road transportation i. Cars - Gasoline	CO2		26.1%
1.A.3.b Road transportation i. Cars - Diesel oil	CO2		26.2%
1.A.3.b Road transportation iii. Heavy duty trucks and buses - Diesel oil	CO2		32.7%
1.A.4 Other Sectors - Gaseous Fuels	CO2	11 863	
1.A.4.a.i Commercial/institutional - Stationary combustion - gaseous fuels	CO2		32.6%
1.A.4.b.i Residential - Stationary combustion - gaseous fuels	CO2		57.8%
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	8 725	
1.A.2.c Chemicals - gaseous fuels	CO2		36.2%
1.A.4 Other Sectors - Liquid Fuels	CO2	7 810	
1.A.4.b.i Residential - Stationary combustion - liquid fuels	CO2		73.5%
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	7 456	
1.A.1.a.i Public electricity and heat production - Electricity generation - gaseous fuels	CO2		58.9%
1.A.1.a.ii Public electricity and heat production - Combined heat and pow er generation - gaseous fuels	CO2		26.5%
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	5 218	
1.A.1.a.i Public electricity and heat production - Electricity generation - solid fuels	CO2		96.9%
3.A Enteric Fermentation	CH4	4 443	
3.A.1 Enteric Fermentation - Dairy Cattle	CH4		80.5%
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	3 675	
1.A.1.b Petroleum refining - liquid fuels	CO2		98.8%
2.B.8 Petrochemical and carbon black production	CO2	3 576	
2.B.8.b. Chemical Industry - Ethylene production	CO2		99.7%
2.C.1. Iron and Steel Production	CO2	3 417	
2.A.1 Cement production	CO2	2 456	
3D1 Direct N2O emissions from managed soils	N2O	2 134	
3.D.1.4 Direct N2O emissions from managed soils - Crop Residues	N2O		37.5%
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases	2 023	
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	2 018	
1.A.1.a.i Public electricity and heat production - Electricity generation - other fossil fuels	CO2		41.1%
1.A.1.a.ii Public electricity and heat production - Combined heat and pow er generation - other fossil fuels	CO2		58.3%
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	1 822	
1.A.2.g Other - liquid fuels	CO2		51.4%
2.B.10 Other	CO2	1 770	
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2	-1 679	
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	1 317	
1.A.2.f Non-metallic minerals - solid fuels	CO2		82.0%
3.B Manure Management	CH4	1 266	
3.B.1.1 Manure Management - Dairy Cattle	CH4		29.6%
3.B.1.3 Manure Management - Sw ine	CH4		56.4%
2.A.2 Lime production	CO2	1 115	
2.B.1 Ammonia Production	CO2	866	
1.A.3.e. Other Transportation	CO2	584	
1.A.3.e.ii Other Transportation - Other - Liquid Fuels	CO2		52.2%
1.A.3.e.i Other Transportation - Pipeline Transport - gaseous fuels	CO2		47.8%
3D2 Indirect N2O Emissions from managed soils	N2O	572	
3.B Manure Management	N2O	561	
3.B.2.1 Manure Management - Non-Dairy Cattle	N2O		45.8%
3.B.2.5 Manure Management - Indirect N2O emissions	N2O		25.1%
5.A. Solid Waste Disposal	CH4	557	
5.A.1.a Managed Waste Disposal Sites - Anaerobic	CH4		100.0%
4.B.2. Land converted to Cropland CSC	CO2	545	
4.B.2. Land converted to Cropland CSC - Net carbon stock change in soils	CO2		96.4%
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	544	
1.A.2.d Pulp, paper and print - other fuels	CO2		28.1%
1.A.2.f Non-metallic minerals - other fuels	CO2		67.2%
4.E2. Land converted to Settlements CSC	CO2	515	
4.E2. Land converted to Settlements CSC - Net Carbon stock change in living biomass	CO2		37.4%
4.E2. Land converted to Settlements CSC - Net carbon stock change in soils	CO2		61.2%
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	481	
1.B.2.b.5 Natural Gas - Distribution (82,9% en 2022)	CH4		82.9%

Table 1.2: Key sources at subcategory level for the 2022 level assessment

1.6 Information on the QA/QC plan including verification and treatment of confidentiality issues where relevant

1.6.1 QA/QC procedures

Belgium did submit for the first time a full QA/QC plan of the Belgian national system for the estimation of anthropogenic greenhouse gas emissions by sources and removals by sinks under Article 5, paragraph 1, of the Kyoto Protocol on the 20th of October 2008 to the UNFCCC-experts as a demand of the UNFCCC-centralized review carried out in September 2008. In the final Annual Review Report of UNFCCC (Report of the individual review of greenhouse gas inventories of Belgium submitted in 2007 and 2008) the ERT concluded that the QA/QC plan has been prepared and implemented in accordance with the IPCC good practice guidance. This plan was updated during the 2010 submission to the UNFCCC-secretariat and later during the 2017 submission.

Belgium is a federal state organized in communities and regions. The three regions (Flemish Region, Walloon Region, Brussels-Capital Region) are responsible for the GHG inventory of their own territory. Consequently, every year, 3 inventories are compiled and aggregated into a national greenhouse gas inventory, which is managed by the National Inventory Compiler (NIC), employed at the Belgian Interregional Environment Agency (IRCEL/CELINE)

The agencies that are responsible for the preparation of inventories in the three regions are:

AWAC: Walloon Agency for Air and Climate;
VMM: Flemish Environment Agency;
BE: Brussels Environment.

The activities of these four agencies (3 regions + interregional agency) with regard to the preparation of the national greenhouse gas inventory and the implementation and development of the QA/QC plan, are coordinated via the 'Working group on Emissions of the Coordination Committee for International Environmental Policy (CCIEP)' (referred to below as 'CCIEP-WG Emissions'). This group plays a central role in the coordination of the national GHG inventory. It is a permanent platform for the exchange of information between the regions, IRCEL-CELINE, the National Climate Commission (see below) and the Belgian UNFCCC National Focal Point. All methodological aspects of the GHG inventory (methodological choices, emission factors, uncertainty analysis, etc.), as well as the implementation and improvement of the national system, including the QA/QC plan, are coordinated via the CCIEP-WG Emissions. This working group meets on a regular basis and is responsible for coordinating all emission inventory tasks in Belgium.

More information on the various actors can be found in the Belgian National Inventory System which was latest updated during this 2024 submission (see annex 3).

1.6.1.1 Responsibilities at the national level

The overall QA/QC responsibilities on the Belgian GHG inventory are carried out at IRCEL/CELINE, the Belgian Interregional Environment Agency which is also responsible for the national inventory and for related European and international obligations in close cooperation with the regions.

As a consequence, the quality and assurance controls already carried out within the responsible regions, are supplemented by the QA/QC performed to the national Belgian inventory. After completion of the Belgian greenhouse gas emission inventory by IRCEL/CELINE, the regions and IRCEL/CELINE carry out further quality control checks of the national inventory before the official submissions take place. IRCEL/CELINE is the final responsible for the reporting of the national inventory, and any change at this stage is conducted only by IRCEL/CELINE, after co-ordination with the relevant regional contacts. The QC checks are described in section 1.6.1.5. below.

Only since 2009 a person is full-time engaged in IRCEL/CELINE, the Belgian Interregional Environment Agency. He is designated as National Inventory Compiler and also ensures the development and implementation of a QA/QC plan at the national level, including the coordination between all actors and the assurance that the various organizations involved in the preparation of the national inventory follow the procedures established in the QA/QC plan.

Independent audits of the greenhouse gas inventories of the regions and the national inventory have started in the course of 2002 and results became available in 2003. The purpose of these audits was to analyse the difficulties encountered while compiling the regional emission inventories into the national inventory in order to improve the quality and completeness of the Belgian national emission inventory and to evaluate the differences between the process at that time and the obligations in the framework of the UNFCCC & IPCC Guidelines.

The results of these audits of greenhouse gases inventories showed clearly that the Belgian national inventory is of qualitative good value. The difference between the situation in Belgium at that time and the fulfilling of the IPCC Guidelines was mainly the absence of the complete implementation of the IPCC Good Practice Guidance for the Belgian emission inventory with respect to setting up a quality system.

Technical working groups are set up since the beginning of 2003 to investigate in detail the implementation of the Good Practice Guidance for the different sectors in Belgium and to harmonise the 3 regional emission inventories in Belgium as much as possible. The overall conclusion in the different technical working groups is that appropriate methods are used for all sectors and in accordance with the IPCC Good Practice Guidance.

Calculations of uncertainties on greenhouse gas emissions estimates on the national level are calculated on tier 1-level (see Chapter 1.7 for more details).

All three regions perform their own QC procedures. Below, the state of the art in the three regions is briefly described. The tier 1 QC checks conducted at the regional and the national level are also included below.

1.6.1.2 QA/QC in the Flemish region

Procedures directly applied to the inventories

In the beginning of 2004, in Flanders, a study started to calculate the uncertainties (both on tier 1 and tier 2 level) and to guide in the implementation of a quality system (QA/QC-plan) of the emission inventory of greenhouse gases. Final results of this study became available in May 2004.

A complete development of the QA/QC system (among others further description in detail of all the procedures involved) as well as a first internal review became operational in the course of 2005. A responsible for the quality management system of the Flemish greenhouse gas inventory was nominated at that time. A full implementation of the quality system for all sectors and on the most detailed level is started in the beginning of 2006.

The quality system set up in Flanders is based on the standardized norm ISO 9001:2000. In the process of development of the quality management system in Flanders, a gap-analysis was carried out, a quality structure and different standardized procedures were set up. A quality handbook was published which includes all aspects of a technical and organizational level to set up the emission inventory of GHG.

Standardized procedures of different levels were defined. In what follows a summary is given of all procedures involved in the QA/QC-system:

General procedures

VMM/EIL/GP/0.004: Procedure for the treatment of a complaint (not yet implemented because not really relevant)
VMM/EIL/GP/0.006: Procedure for the management of quality care-personnel files;
VMM/EIL/GP/0.008: Procedure for the performance of audits;
VMM/EIL/GP/0.010: Procedure for setting up a general quality care–management report;
VMM/EIL/GP/0.011: Procedure for the management of documents.

Specific procedures

VMM/EIL/GP/5.001: Procedure to determine non-conformities, quality problems and proposals for improvement and follow-up by means of corrective and preventive measures;
VMM/EIL/GP/5.002: Procedure for the training of the personnel of the service 'Emissie Inventaris Lucht' (Air Emission Inventory);
VMM/EIL/GP/5.003: Procedure for the main process: setting up the greenhouse gas emission inventory;

Besides these procedures, forms are also used in the Flemish quality management system to follow up the inventory process for the different sectors. These forms describe the required characteristics of input data that needs to be collected to ensure accurate emission estimates. They give an indication of the quality of data, report how the calculation of the emissions occurs and tell something about the trends in that specific sector. These forms were evaluated with all users (responsible for the different sectors) in the course of 2007.

In the course of 2007, a lot of time went to the actualization and further completion of the procedure VMM/EIL/GP/5.003 for the main process (setting up the greenhouse gas emission inventory).
The optimization of these procedures became official in the beginning of 2008.

From 2007 on a management evaluation of the quality system is performed yearly. This document formulates conclusions and recommendations to improve the system with respect to the improvement of the effectiveness of the quality system and the involved processes in relation with the requirements of the clients and the needs of means. This document is approved and signed by an Executive Board Member of the Flemish Environment Agency.

Internal audits performed by the quality manager of the Flemish Environment Agency took place on the 14/12/2005, 7/7/2006, the 15/6/2007, the 12/6/2008, the 29/6/2011, 1/7/2013, 11/12/2014 and 27/11/2015. The conclusions of the audits can be obtained on request.

All the technical procedures involved and an example of one of the forms used in the quality management system of the Flemish greenhouse gas inventory are presented in annex 3 of this report.

In the procedure of the main process (GP/5.003) in the Flemish region a description is given where and how the emission inventory data are archived (procedure GP_5003) i.e. on the server of the Flemish Environment Agency (VMM) after evaluation of the data. Responsible people for the different sectors are responsible for the archiving. Also, all relevant mails are archived. The exact location on the sever is described in the different forms used in the Flemish QMS to follow up the inventory process for the different sectors.

Procedures on secondary data

Greenhouse gas inventories rely for a large part on energy balances established annually. In Flanders, the procedures to prepare the Flemish energy balance (set up by the VITO before and by VEKA, the Flemish Agency for Energy and Climate, since 1 January 2021) are part of a certified ISO 9001 system since July 2003[5]. At that time the certification was only valid for parts of the departments of the VITO and not for the complete organisation. Since 2007, this certificate was part of the Environmental and Quality System of the VITO certified with ISO 9001 and ISO 14001 and ISO 45001 standards. The most recent certificate is available on the VITO website: https://vito.be/en/about-vito/quality-health-safety (English) https://vito.be/nl/over-vito/milieu-veiligheid-en-kwaliteit (Dutch).

From 1 January 2021, the Flemish Agency for Energy and Climate (VEKA) establishes the energy balances, CHP inventories and renewable energy inventories for the Flemish region. This independent agency of the Flemish government is a fusion of the former Flemish Energy Agency and the climate team of the Environment Department of the Flemish government. The new agency is founded to further develop the challenging energy and climate policy plans in order to comply with policies at different political levels.

5 Certificate number 08376-2003-AQ-ROT-BELCERT

1.6.1.3 QA/QC in the Walloon region

In the Walloon Region, the inventory is conducted by the Walloon Agency for Air and Climate (AWAC).

Good practice checks are routinely applied during the development of inventories. Notes covering validity checks and recalculations are filed and stored by inventory compilers. Among others, data obtained from industrial companies concerned by the ETS-process are systematically cross-checked with certified reports in the framework of that mechanism.

Country-specific emission factors used in the inventories are determined from air emission measurements, performed by laboratories which must be agreed by the official institute ISSEP. The agreement covers a review of material and methodologies used and checks the compliance with the requirements of a legal decree[6]. The updated list of agreed laboratories is published on the website of DGARNE, the responsible Institute in Wallonia.

In order to improve the transparency on inventories, archiving procedures are implemented. For the Walloon Region, calculation files, methodological descriptions and AD files are saved on a common server with a daily backup procedure. In addition, a backup is made on two external hard disks that are archived on a yearly basis. Every sectoral expert also archives their own files on their hard disk. Finally, the Walloon Air Pollutant Inventory software was developed in the Walloon Region to improve the quality of the regional and the national inventory. This software allows all data of a plant or an area source to be viewed across the complete time series and avoids mistakes during recalculations. It is also used to report under the Convention on Long-range Transboundary Air Pollution and other emissions of non-GHG pollutants and allows the archiving of the different submissions. The Walloon Air Pollutant Inventory software is located on a server with a daily backup.

Procedures on secondary data

The energy balance in the Walloon region is established by an independent institute, ICEDD (Institut de Conseil et d' Etudes en Développement Durable), whose activities are covered by an ISO 9001 certification.

1.6.1.4 QA/QC in the Brussels region

Procedures directly applied to the inventories

Procedures have been implemented to cross-check the data used in the inventories with other data from the Institute. These data are coming from other departments which use them for other requirements (e.g. PRTR, ETS, environmental reports) and help to check the completeness of the inventory. Some data have been revised following these checks and this work will be continued in the future.

The consistency of the inventory is ensured by recalculating the emissions for the complete time series when a new methodology is applied.

In order to improve the transparency on inventories, archiving procedures are implemented.

Procedures on secondary data

Until 2022, the Brussels energy balance was prepared by consultants, through public contracts with Brussels Environment. Since 2023, the Brussels energy balance is produced by Brussels Environment, who has carried out a complete review and update of the calculation methods and assumptions.

All processing and calculations are automated using a dedicated IT tool, which allows the calculation of time series from 1990 onwards. Wherever possible, the entire time series is updated in line with new methodologies and/or new data sources available.

6 Arrêté royal du 13 décembre 1966 relatif aux conditions et modalités d'agrément des laboratoires et organismes chargés des prélèvements, analyses et recherches dans le cadre de la lutte contre la pollution atmosphérique (M.B. 14.02.1967).

1.6.1.5 QC activities: tier 1 QC checks

The national inventory agency (IRCEL/CELINE) is responsible for the QC checks performed during and after the compilation of the national inventory. The CCIEP- WG Emissions is responsible for all the QC checks done at the most detailed level, and for the co-ordination of the Belgian GHG inventory. If an error identified by the national inventory agency comes from one of the 3 regional sets of data rather than from a compilation problem, the regional agency is consulted by the national inventory compiler before any correction takes place, to maintain data consistency between the different levels.

The deadlines for these checks are presented in table 1.2 below, with 'year X' being the year of the submission.

Due to the specificity of the Belgian National Inventory System and the overall responsibility of the regions in collecting primary activity data and estimating emissions at regional level, QC checks related to these data and to the emission estimates are also performed at the level of the regional inventory agencies presented in the CCIEP-WG Emissions. The implementation of these QC checks on the regional level is also part of the QA/QC-work carried out for the key source categories.
The table 1.2 gives an overview of the QC checks that are performed on the regional and national level in Belgium.

QC activity	Tasks and procedures	Responsible	Deadline
Check that assumptions and criteria for the selection of activity data and emission factors are documented.	Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. Check that any quality control (ISO, verified emissions, accredited laboratory,…) is properly recorded Check that changes in data or methodology are documented Check for consistency with IPCC inventory guidelines and good practices, particularly if changes occur	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP)	Augustus 31(year X-1)
Check for transcription errors in data input and reference	Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. Confirm that bibliographical data references are included (in spread sheet or paper file) for every primary data element Randomly check bibliographical citations for transcription errors	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP)	November 30 (year X-1)
Check that emissions are calculated correctly.	Reproduce a representative sample of emissions calculations. Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. Review spread sheets with computerized checks and/or quality check reports	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP)	November 30 (year X-1)

Check that parameter and emission units are correctly recorded and that appropriate conversion factors are used.	Check that units are properly labelled in calculation sheets. Check that units are correctly carried through from beginning to end of calculations. Check that conversion factors are correct. Check that temporal and spatial adjustment factors are used correctly.	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP) for the calculation sheets. IRCEL/CELINE for the national inventory in ETF-GHG.	November 30 (year X-1) March 15 (year X)
Check the integrity of database files.	Confirm that the appropriate data processing steps are correctly represented in the database. Confirm that data relationships are correctly represented in the database. Ensure that data fields are properly labelled and have the correct design specifications. Ensure that adequate documentation of database and model structure and operation are archived.	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP)	November 30 (year X-1)
Check for consistency in data between source categories.	Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations.	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP) is responsible for the internal consistency of the inventory and the harmonisation of parameters where relevant. IRCEL/CELINE is responsible for the consistency after compilation.	November 30 (year X-1) March 15 (year X)

Check that the movement of inventory data among processing steps is correct.	Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. Check that emissions data are correctly transcribed between different intermediate products. Check a representative sample of calculations, by hand or electronically	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP) up to the data preparation IRCEL/CELINE for the compilation of the inventory. Cross check between results of the database aggregation and representative samples in excel are used.	November 30 (year X-1) March 15 (year X)
Check that uncertainties in emissions and removals are estimated or calculated correctly.	Check that qualifications of individuals providing expert judgement for uncertainty estimates are appropriate. Check that qualifications, assumptions and expert judgements are recorded. Check that calculated uncertainties are complete and calculated correctly. If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses.	IRCEL/CELINE	March 15 (year X)
Undertake review of internal documentation.	Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. Check integrity of any data archiving arrangements of outside organisations involved in inventory preparation.	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP) for all source categories calculated at the regional level. IRCEL/CELINE for the F-gases inventory and the reference approach.	Augustus 31 (year X-1) March 15 (year X)
Check methodological and data changes resulting in recalculations.	Check for temporal consistency in time series input data for each source category. Check for consistency in the algorithm/method used for calculations throughout the time series. When methods or data have changed, check consistency of time series inputs and calculations	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP) for the methodology consistency. IRCEL/CELINE for time series consistency of the compilation results.	November 30 (year X-1) March 15 (year X)

Undertake completeness checks.	Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. Check that known data gaps that result in incomplete source category emissions estimates are documented.	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP) IRCEL/CELINE for data gaps and notation keys consistency.	November 30 (year X-1) March 15 (year X)
Specific checks on aggregation of 3 regional inventories	Check the consistency of type of input data and units between the inventories Check the consistency in allocation of source categories Cross-check the national aggregated data with the sum of input inventories, by hand or electronically, to ensure that emissions are correctly aggregated from lower reporting levels to higher reporting levels. Check that the average values for emission factors or other parameters are properly calculated.	IRCEL/CELINE	March 15 (year X)
Compare estimates to previous estimates.	For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference.	Working group on Emissions of the Coordination Committee for international environmental policy (CCIEP) IRCEL/CELINE	November 30 (year X-1) March 15 (year X)

Table 1.3: Tier 1 QC checks

1.6.1.6 QA checks

In the Flemish region internal audits performed by the quality manager of the Flemish Environment Agency were carried out on 14/12/2005, 7/7/2006, 15/6/2007, 12/6/2008, 29/06/2011, 1/7/2013, 11/12/2014 and 27/11/2015. An external audit performed by 'Det Norske Veritas' was carried out on 1/2/2006. The results of these audits can be obtained through the responsible of the quality system of the greenhouse gas inventory in Flanders.

In the Brussels-Capital Region, since 2016, Brussels Environment has been collaborating with Airparif, the French organisation approved by the Ministry of the Environment for monitoring air quality in the Île-de-France region. An audit of the regional emissions inventory was performed by Airparif in 2016 and 2019. Airparif also worked on the development of tools on the Agriculture and the LULUCF sectors, helping to improve the compilation tools of the region for the preparation of the greenhouse gas and air pollutants inventories. Airparif also provides Brussels Environment with ad hoc expertise on the estimation of emissions in different fields and sectors (e.g. transports, buildings, industry, waste, QC procedures, uncertainties).
Since 2005 a process of approval of the national inventory by the National Climate Commission is in place in Belgium.

Different review processes took place in Belgium:

- A two-level peer-review process: The compilation and aggregation of regional inventories to build the national database constitutes a first opportunity to check the consistency and emissions allocations between regional datasets. The procedure is led by IRCEL/CELINE and the main responsible personnel (sectoral experts) of the regional inventories. It includes the verification that methodologies applied to estimate emission levels are always in line with the UNFCCC requirements (i.e. basically tier 2 methods applied for all identified key sources).
- A second level consists in a peer review with similar foreign countries following the completeness of the inventory. Such an exercise has been performed in collaboration with the Netherlands in the course of 2005.
- An annual management review: All the outcomes of the QA evaluation are used for continuous improvement through an annual management review by the different institutes involved. In the Flemish region this management review has been conducted since 2007 on a yearly basis until 2015 Because of limited personnel within the agency after that date and the conducted reviews on the European and international level on a regular basis, no continuation in these reviews took afterwards place.

As a result of the reviews carried out each year the Belgian GHG emission inventory is continuously optimised and the quality of the inventory is guaranteed.

In 2018-2023 multiple reviews of the Belgian inventory took (will take) place by experts of the European Commission in collaboration with the topic centre ETC/ACM and by experts of UNFCCC:

- UNFCCC In-Country review in September 2018: The annual review report on the individual review of the annual submission of Belgium submitted in 2018 became available on August 7, 2019

- EC initial checks (1st step ESD-review) of submission January 15th, 2019 (January- March 2019): Interim Review Report 2019 annual review of national greenhouse gas inventory data pursuant to Article 19(2) of Regulation (EU) No 525/2013 Belgium 20 April 2019

- ESD (Effort Sharing Decision) -review by the EC of submission March 15, 2019 (March-June 2019): Final Review Report 2019 annual review of national greenhouse gas inventory data pursuant to Article 19(2) of Regulation (EU) No 525/2013 Belgium 28 June 2019

- ESD-review by the EC of submissions January and March 15, 2020 and ESR (Effort Sharing Regulation) – comprehensive review by the EC for fixing the Annual Emission Allocation (AEA) for the period 2021-2030, focusing on the years 2005 and 2016-2018 and compliance check of ESD-targets for the year 2018: Final Review Report 2020 Comprehensive Review of National Greenhouse Gas Inventory Data pursuant to Article 4(3) of Regulation (EU) No 2018/842 and to Article 3 of Decision No 406/2009/EC Belgium 30 August 2020.

- Review of the 2020 annual submission of Belgium – UNFCCC Centralized review conducted remotely at 26 – 31 October 2020 in accordance with paragraph 84 of the annex to decision 13/CP.20: Potential Problems formulated in the course of the review of the 2020 annual submissions (Saturday Paper) of Belgium and the Provisional Main Findings of the ERT became available at October 31, 2020. The final UNFCCC individual review report was published on 19 August 2021.

- ESD-review by the EC of the 2021 submission pursuant to Article 19(2) of Regulation (EU) No 525/2013: Final review report was published on 20 April 2021.

- No UNFCCC-review took place in 2021

- ESD-review by the EC of the 2022 submission pursuant to Article 19(2) of Regulation (EU) No 525/2013: Final review report was published on 20 April 2022.

- From 2023 on (emissions up to 2021) initial checks are carried out on a permanent yearly basis by the EC under the Effort Sharing Regulation without any official review report on a yearly basis. Only in the years 2027 (emissions up to 2025) and 2032 (emissions up to 2030) official review reports will become available under this Regulation.

- Review of the 2022 annual submission of Belgium – UNFCCC Centralized review conducted from 10 to 15 October 2022 in Bonn in accordance with the 'Guidelines for review under Article 8 of the Kyoto Protocol'. The official report of this review became available at April 17th 2023.

Reviews carried out by the EC are/were performed in the framework of the MMR (Monitoring Mechanism Regulation) 525/2013, under the Governance Regulation 2018/1999, under the Effort Sharing Decision 406/2009/EC and the Effort Sharing Regulation 842/2018/EC. All the questions of the Belgian greenhouse gas inventory during these reviews were commented by the Belgian experts in due time.
During the official submissions Belgan experts took the results of these reviews into account as much as possible within the limits of time and resources.

1.6.2 Verification activities

A description of the verification activities of the Belgian GHG inventory can be found in the Belgian QA/QC plan, attached in annex 3.
The verification activities include comparison with emission estimates performed in other countries (regions) and/or with estimates obtained by alternative methods.

In the present plan, Belgium does consider that the verification process is part of the QA process.

Actually, this is already performed by 1) the secretariat of UNFCCC itself, which regularly establishes comparisons among national inventories and issues questions to inventory experts and by 2) the European Commission in collaboration with the European Topic Centre on Air Pollution and Climate change Mitigation (ETC/ACM) perform similar activities on the national greenhouse gas inventories (see section 1.6.1.6 above).

1.6.3 Treatment of confidentiality issues

Some of the reported data in the Belgian GHG inventory are treated in a confidential way. The confidential data are mainly data reported by the industrial companies (mainly chemical industry). In these cases, the obliged (in the context of the IPCC-guidelines) end-result-data are reported (f.i. emission data), other data (f.i. production figures) are not reported because of confidentiality.

1.7 General uncertainty evaluation, including data on the overall uncertainty for the inventory totals

1.7.1 GHG inventory

The IPCC 2006 Guidelines tier 1 methodology has been applied to assess the uncertainty in the emission greenhouse gas inventory (see annex 2). The uncertainty calculation is applied on the Belgian greenhouse gas emission inventory for the year 2022.

A trend uncertainty analysis is performed for the years 1990 and 2022.

As a result of the centralized review of the Belgian greenhouse gas inventory in September 2008, the ERT of UNFCCC recommended in their annual report review (ARR) 'Report of the individual review of the greenhouse gas inventories of Belgium' submitted in 2007 and 2008 of January 2009 that Belgium includes the LULUCF in its uncertainty analysis and encourages Belgium not to include the Kyoto base year for F-gases in the 1990 analysis. This has been performed since 15 April 2012 submission.

As a result of the in-country review of the Belgian greenhouse gas inventory in September 2012, the ERT of UNFCCC recommended in their final presentation to disaggregate agriculture categories as it has been done in the Key Source Analysis. This has been done since the 2013 submission.

In Flanders, a complete study of the uncertainty was conducted in 2004 by an independent consultant, Det Norske Veritas, both on tier 1 and tier 2 level. The uncertainties were determined for the emission level 2001 and for the 1990-2001 trend in emissions for all source categories comprising emissions of CO_2, CH_4 and N_2O. These results are available in the technical report 'Quantification of Uncertainties – Emission Inventory of Greenhouse Gases of the Flemish Region of June 2004'. This methodology was the basis for the uncertainty analyses carried out since that time.

The uncertainty calculation at a tier 1-level of the fluorinated greenhouse gases has been carried out yearly from 2005 on by Econotec and the VITO (see reference (11)).

As most of the data suppliers in Belgium do not provide any information on the associated uncertainty, the IPCC default values have been largely used in the three regions in Belgium, together with expert judgement regarding their applicability in the national /regional circumstances.

In the absence of default IPCC values, estimates have been searched in other sources such as the EMEP/EEA air pollutant emission inventory guidebook 2009 (12) and studies on uncertainty in emission inventories conducted in other member states, when national circumstances could be assumed comparable.

The results of the three regions have been compiled using expert judgement and/or error propagation equation from the Good Practice Guidance, in order to produce one single table 6.1 (as expressed in the guidelines), presented in annex 2.

According to the available references, in most member states the ultimate choice of an uncertainty estimate is often based on expert judgement and is therefore also rather uncertain. However, as stressed by the IPCC Good Practice Guidance (10) (9), uncertainty calculation is a mean to identify and prioritise improvement activities, rather than an objective on itself.

As in other Parties, the outcome of this uncertainty analysis is largely determined by the uncertainty on the estimate of N_2O emissions from agricultural soils. While reviewing the uncertainty calculation of five industrialised countries, Rypdal and Winiwarter (13) pointed out that *'The differences in uncertainty are, in particular, due to different subjective assessment of the uncertainty in emissions of nitrous oxide from agricultural soils'.*

During the submission of April 2022 an actualization and optimization of the uncertainty calculation has been carried out in Belgium. See the respective chapters of the different sectors for more information in this respect.

The tier 1 analysis for 2022 gives an overall uncertainty of 3.50% and a trend uncertainty 1990-2022 of 1.83%.

More than 86% of Belgian total emissions in 2022 (CO_2 emissions compared to total with LULUCF) has a very small uncertainty of 1.83%. Even with the contribution of CH_4 (CO_2 and CH_4 together represent 93% of the total emissions) the uncertainty is still very low, 1.88%. Together, their contribution to variance is about 26%. This confirms the influence of N_2O on the inventory uncertainty even if the disaggregation of agricultural sector (see above) decreased its importance. N_2O emissions contribution to variance in total emissions represent 71 % of the total variance but theses emissions represent only 4.4% of total emissions in 2022. The influence of F-gas emissions (with high uncertainty – 27% taken separately) is low since they account for only a very limited percentage of the total emissions (2.4%).

1.8 General assessment of completeness

1.8.1 GHG inventory

Sources and sinks

All sources and sinks included in the IPCC 2006 Guidelines are covered with the exception of the following less important (in terms of share in emissions) source:

For the categories 2D3 (CO_2 from asphalt roofing and CO_2 from road paving) the greenhouse gas emissions are mainly based on the production activities and are reported in the category 1A2. Consequently, the notation key 'IE' is reported.
IPCC 2006 guidelines indicate that the emissions from 'usage' are negligible.

Gases

All direct and indirect greenhouse gases (CO, NO_x(NO_2) and NMVOC) and SO_2 are covered in the Belgian inventory. These indirect gases and SO_2 are completely consistent with the emep/lrtap-reporting obligations.
No indirect emissions of CO_2 and N_2O are estimated in the Belgian inventory.

Geographic coverage

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

2 TRENDS IN GREENHOUSE GAS EMISSIONS

GHG emission trends are presented in this section. Emission trends are analysed for each greenhouse gas and for the main key sources, as well as in an aggregated format, using global warming potential (GWP) values from the fifth assessment report. The distribution of emissions by gases and by sources is also commented. A more detailed analysis of the drivers of the emission trends is presented in the Belgian 8th National Communication (you can find an English version on https://unfccc.int/documents/624703).

2.1 Description and interpretation of emission trends for aggregated greenhouse gas emissions

Total greenhouse gas emissions (without LULUCF) in Belgium amounted to 103.6 Mt eq. CO_2 in 2022 (table 2.1.) and to 103.2 Mt eq. CO_2 (with LULUCF). This first amount represents a decrease of -30.0% compared to 1990 and -29.8% compared to base year emissions (with 1995 for F-gases).

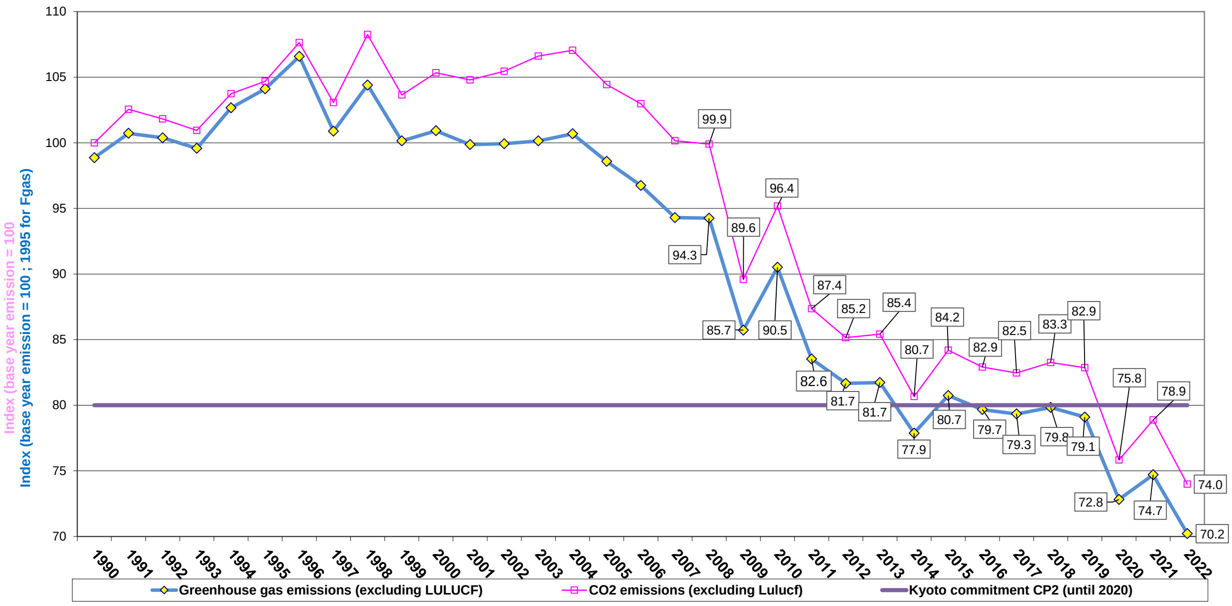


Figure 2.1: Belgium GHG emissions 1990-2022 (excl. LULUCF). Unit: Index point (base year emissions = 100). For the fluorinated gases, the base year is 1995.

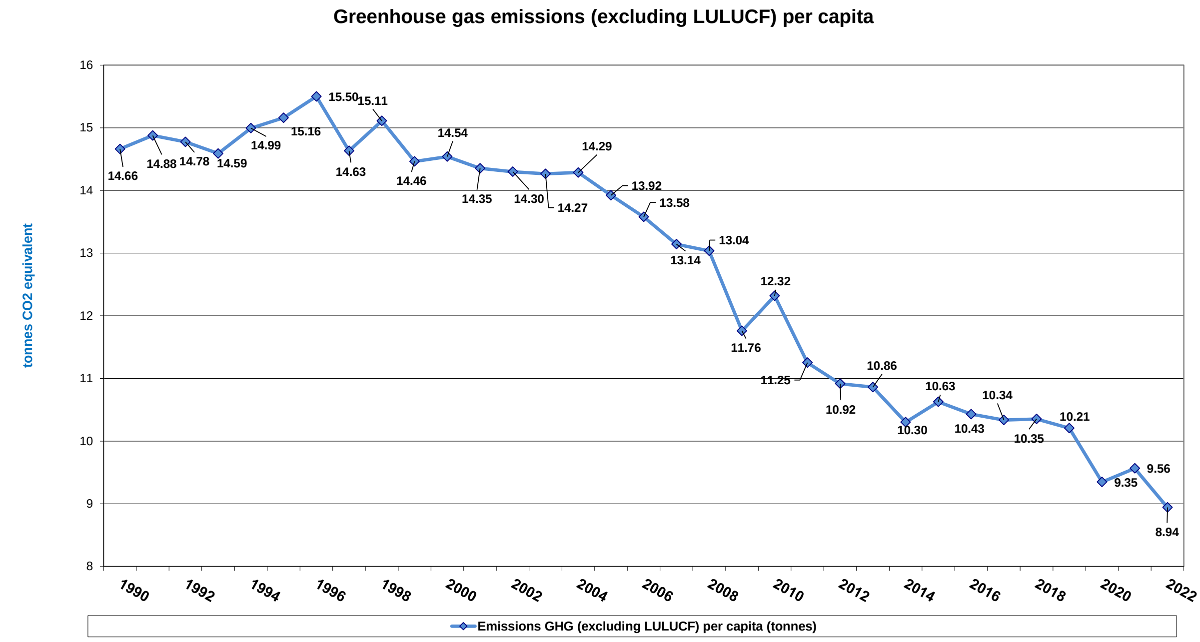


Figure 2.2: Belgium GHG emissions 1990-2022 (excl. LULUCF) per capita

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO2 emissions without net CO2 from LULUCF	120 297	125 939	126 723	125 640	114 490	105 098	102 435	102 762	97 034	101 275	99 742	99 192	100 159	99 684	91 228	94 886	89 002
CO2 emissions with net CO2 from LULUCF	117 352	123 629	124 992	123 793	114 044	104 752	102 105	101 893	96 152	100 443	98 977	98 543	99 498	99 177	90 747	94 507	88 484
CH4 emissions without CH4 from LULUCF	12 900	12 654	11 444	9 630	9 122	8 860	8 818	8 650	8 476	8 486	8 446	8 264	8 181	8 096	7 972	7 871	7 657
CH4 emissions with CH4 from LULUCF	12 900	12 654	11 444	9 630	9 122	8 862	8 818	8 650	8 476	8 486	8 446	8 264	8 181	8 096	7 972	7 871	7 657
N2O emissions without N2O from LULUCF	8 951	9 618	9 071	7 545	6 699	5 630	5 603	5 460	5 463	5 331	5 091	5 247	5 015	4 952	4 815	4 763	4 489
N2O emissions with N2O from LULUCF	8 956	9 639	9 107	7 617	6 785	5 719	5 694	5 551	5 554	5 421	5 183	5 340	5 109	5 048	4 912	4 861	4 588
HFCs	NO	449	1 089	2 366	3 012	3 365	3 382	3 442	3 675	3 782	3 761	4 058	4 196	3 698	3 100	2 387	2 215
PFCs	2 035	2 716	403	156	96	151	115	128	126	138	388	170	121	139	185	182	108
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF6	1 666	2 206	149	94	108	113	115	121	98	95	100	105	98	109	112	102	104
NF3	NO	NO	NO	NO	1	2	1	1	1	1	1	1	1	1	8	5	2
Total (without LULUCF)	145 849	153 583	148 879	145 430	133 529	123 219	120 468	120 564	114 873	119 108	117 528	117 035	117 770	116 680	107 421	110 196	103 576
Total (with LULUCF)	142 909	151 294	147 183	143 655	133 169	122 964	120 229	119 787	114 082	118 367	116 856	116 479	117 203	116 268	107 036	109 915	103 157

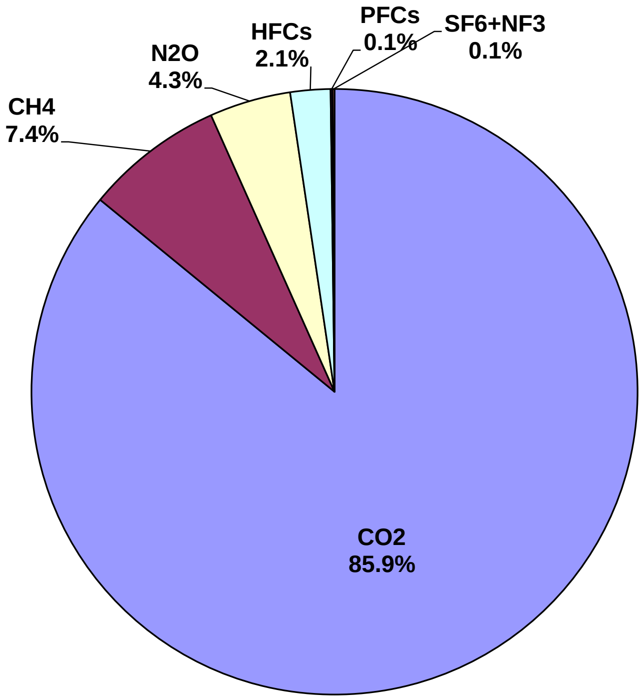
Table 2.1: Overview of Belgium GHG emissions and removals from 1990 to 2022 (Gg CO_2 equivalents)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1. Energy	103 911	107 794	106 213	105 801	99 507	90 029	89 168	88 970	83 021	87 249	85 355	84 878	85 521	85 772	78 197	81 328	76 388
2. Industrial processes and product use	25 505	29 269	27 665	26 525	21 663	21 123	19 386	20 065	20 382	20 446	20 981	20 918	21 233	19 924	18 385	18 196	16 863
3. Agriculture	11 636	11 754	10 854	9 876	9 714	9 639	9 575	9 575	9 703	9 710	9 596	9 647	9 526	9 553	9 509	9 406	9 149
4. Land use, land-use change and forestry(5)	-2 940	-2 289	-1 695	-1 775	-360	-255	-239	-778	-791	-741	-673	-556	-567	-412	-385	-281	-419
5. Waste	4 796	4 766	4 146	3 227	2 645	2 427	2 339	1 954	1 767	1 704	1 597	1 591	1 490	1 431	1 331	1 266	1 176
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)(5)	142 909	151 294	147 183	143 655	133 169	122 964	120 229	119 787	114 082	118 367	116 856	116 479	117 203	116 268	107 036	109 915	103 157

Table 2.2: Overview of GHG emissions and removals in the main sectors from 1990 to 2022 (Gg CO_2 equivalents)

2.2 Description and interpretation of emission trends by gas

The major greenhouse gas in Belgium is carbon dioxide (CO_2), which accounted for 85.9% of total GHG emissions in 2022. Methane (CH_4) accounts for 7.4%, nitrous oxide (N_2O) for 4.3%, and fluorinated gases for 2.1%. Emissions of CO_2 decreased by 26.1% during 1990-2022, while CH_4, N_2O and fluorinated gas emissions have dropped with respectively 40.6%, 49.9% and 54.8%[7] during the same period.



[7] compared to 1995 emissions

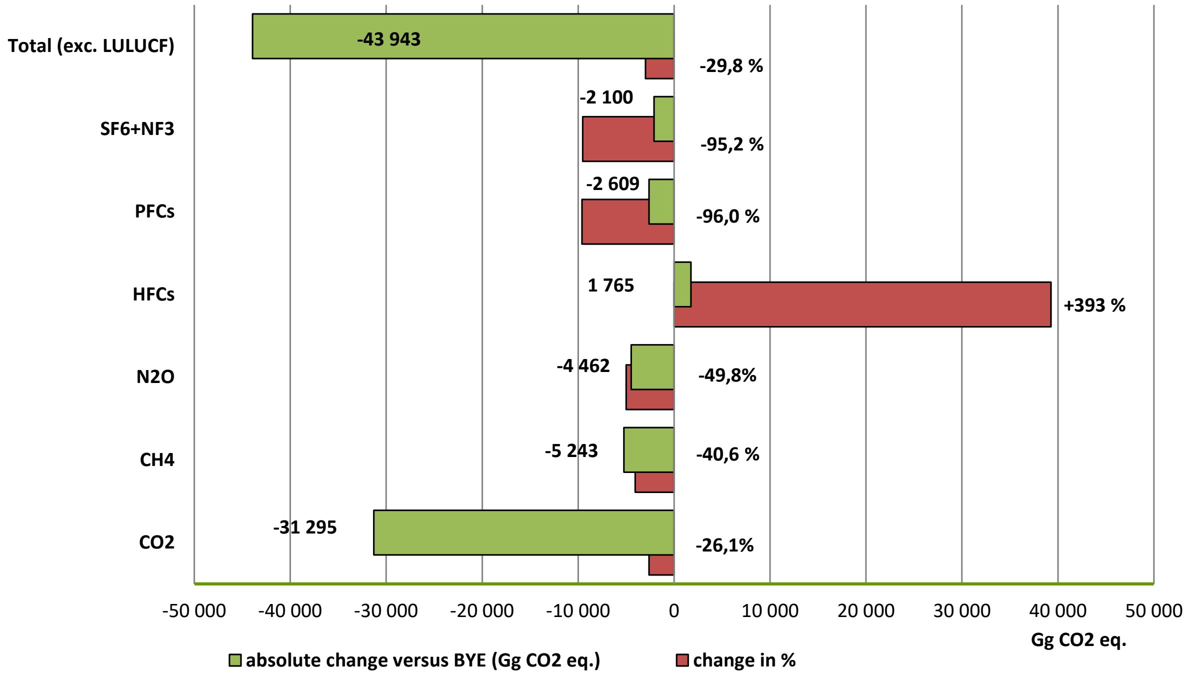


Figure 2.3: Share of greenhouse gases in Belgium (2022) and changes compared to base year (1990 for CO_2, CH_4 and N_2O; 1995 for F-gases)

2.3 Description and interpretation of emission trends by category

An overview of the contribution of the main sectors to Belgium greenhouse gas emissions is given hereunder. Transport, energy industries, manufacturing industry (process) and space heating are the most important sectors in the total GHG emissions in 2022.

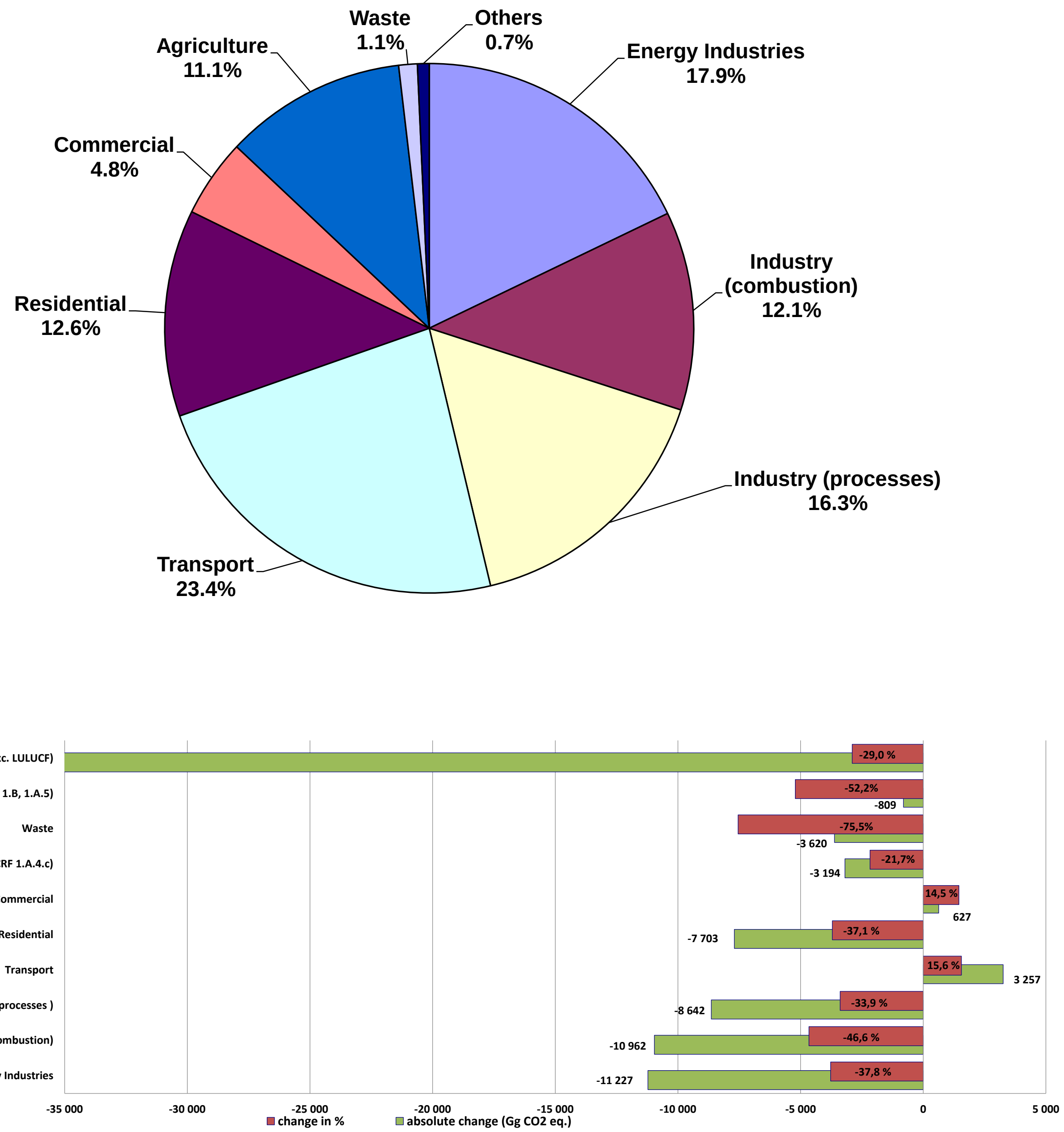


Figure 2.4: GHG emissions: share of main sectors in 2022 and changes from 1990 to 2022

Figure 2.4 summarises the impact of the main sectors on the national trend. It shows the increase in transport on the one hand (while much less spectacular than previous submissions due to the COVID-19 crisis and its always visibles consequences on mobility with telework, etc.) but also the increase of emissions from buildings in the commercial sector on the other hand. Since 1990, those two sectors respectively grew by 16% and 15% and have been together responsible for a 2.7% increase in total emissions (transport grew by +24% when comparing 2019 emissions with 1990).

This trend is counterbalanced by the decrease in emissions in the other sectors, particularly manufacturing industry (combustions & process recorded together a 40% decrease since 1990 explaining 13.4% of decrease in total emissions) and energy industries (emissions recorded a 38% decrease since 1990 explaining 7.7% of decrease in total emissions).
The drivers of these trends are analysed and commented, sector by sector, in the chapters 3 to 7 of this NID.

2.4 Description and interpretation of emission trends for indirect greenhouse gases and SO2

Emissions trends of ozone precursors (CO, NO_X, NMVOCs) and SO_2 are presented in figure 2.5 below. During the 2024 submission, the emissions of the indirect greenhouse gases and SO_2 are integrated and taken over completely from the emissions reported under the Convention on Long-range Transboundary Air Pollution (CLRTAP) at 15th March 2024 (correction of 15th February 2024 submission).

More details can be found in the official report (IIR) under CLRTAP:
(http://cdr.eionet.europa.eu/be/un/clrtap).

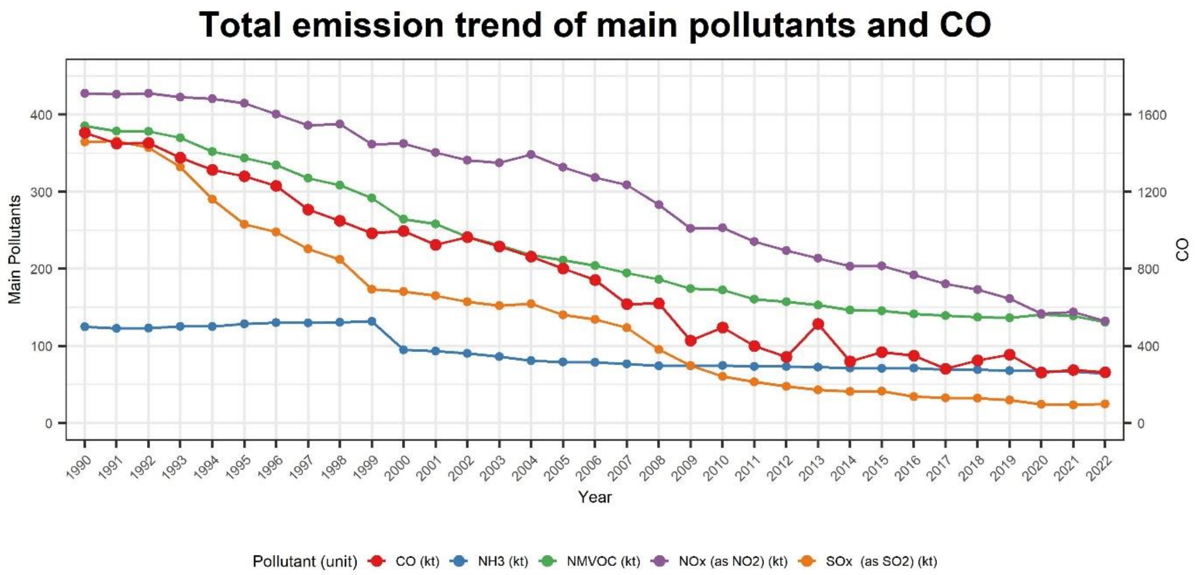


Figure 2.5: Total emission trends of the main pollutants (in Gg)

2.4.1 Nitrogen oxides (NOX)

The greatest contributors to NO_x emissions are the transport (passenger cars and heavy-duty vehicles) and the energy sector. The largest absolute emission reductions are made in these sectors. Consequently, this led to the decrease in total NO_x emissions from 427 Gg in 1990 to 130 Gg in 2022, which is a decline of 69%.

2.4.2 Carbon monoxide (CO)

CO emissions in Belgium originate mainly from industry process (43%), space heating in residential and commercial (31%) and transport (15%).
Between 1990 and 2022, national CO emissions fell by 83%, mostly as a result of the introduction in 1993 of catalytic converters and more recently because of the decline of the iron and steel industry.

2.4.3 NMVOC

The emissions of NMVOC show a steady decrease between 1990 and 2022, from 434 Gg to 182 Gg (-58%). The largest absolute emission reductions are made in the transport sector (passenger cars). An explanation is the shift of fuel until 2015 (gasoline to diesel oil). Other sectors with significant emission reductions are *coating applications* and *other chemical industry* with the exception of “natural emissions” (LULUCF sector).

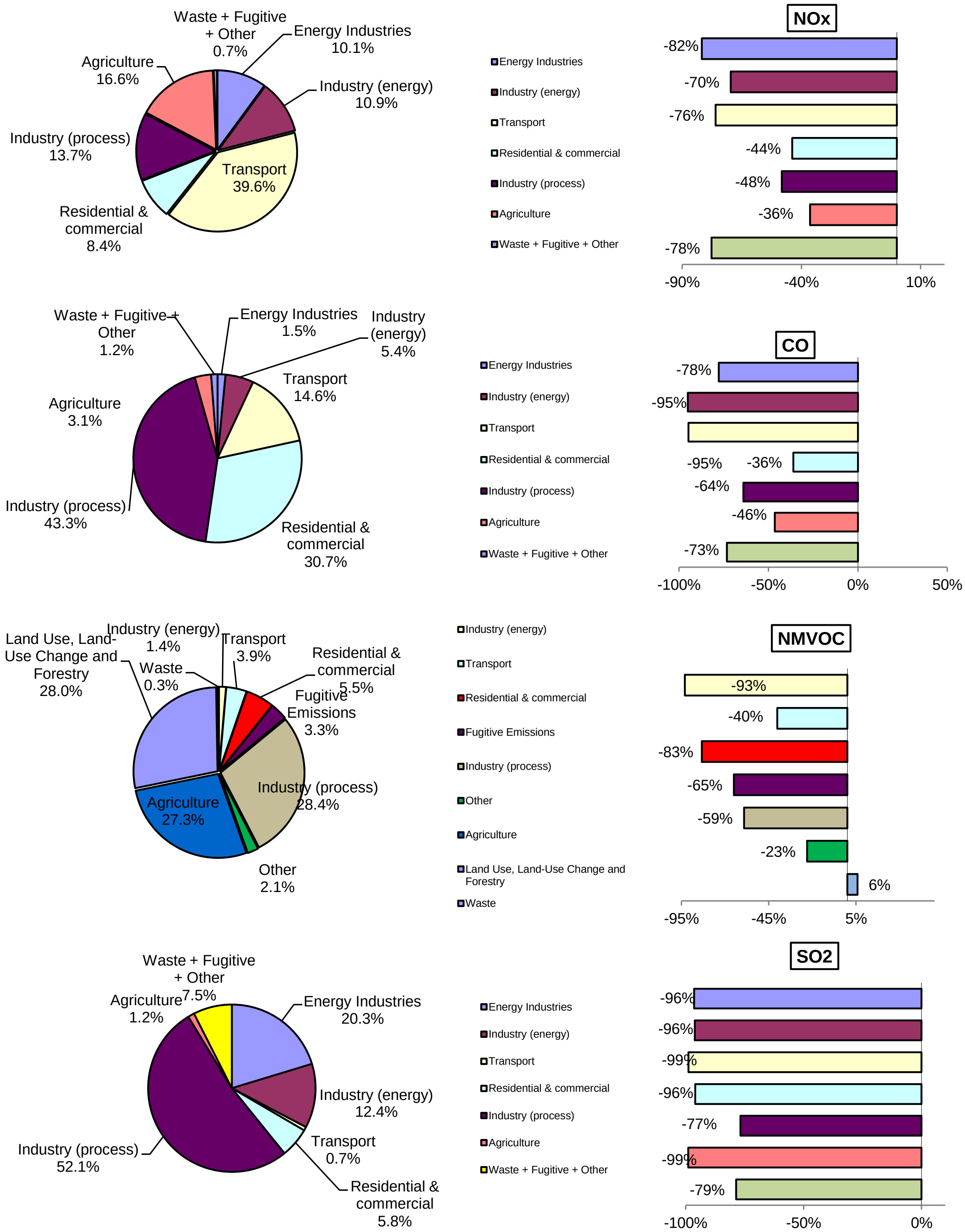


Figure 2.6: Share of main sectors in 2022 and changes from 1990 to 2022

2.4.4 Sulphur dioxide (SO2)

SO_2 emissions produced by the energy sector, industry and space heating sectors decreased sharply in Belgium between 1990 and 2022, leading to a general drop of these emissions by 93%. These reductions are the result of fuel substitution and reduced sulphur content in the oil products used. The energy sector and the combustion in the industry accounts together for 33% of SO_2 emissions, industry process emissions represent 52% of total emissions of SO_2.

In the transport sector, SO_2 emissions have dropped (-99% in 2022 compared with 1990), mainly due to the constant reduction in the sulphur content of fuels since 1996.

2.4.5 Ammonia (NH3)

In Belgium, the agricultural activities are responsible for 95 % of the NH_3 emissions in 2022. Due to the successive Flemish Manure Decrees (1991, 2000, 2003 and 2007), focusing on including manure application and a reduction of the livestock population, the ammonia emissions show a reduction of 49% between 1990 and 2022. In Flanders, more than half of this reduction is attributed to the emission reduction of animal manure applied to soils. In Wallonia, the decrease of emissions is driven by the reduction of livestock on the one hand and on the reduction of use of mineral fertilizer on the other hand.

3 ENERGY (CRT SECTOR 1)

3.1 Overview of sector

General

To prepare the Belgian greenhouse gas inventory for the section energy, the regional energy balances of Flanders, Wallonia and Brussels (bottom-up) are the main source of activity data for estimating the energetic emissions and not the Belgian energy balance (top-down) because of the regional responsibilities to set up the air emission inventories in Belgium, given the federal structure of the country.

One exception on this general rule was, until the submission in 2022, the calculation of the greenhouse gas emissions originating from road transport. These emissions were calculated in Belgium based on the amount of fuel sold reported in the federal petroleum balance statistics. The distribution of the *Fuel Sold* emissions of road transport between the 3 regions in Belgium was based on the results of regional *Fuel Used* COPERT runs using the Fuel Balancing methodology in an Entity-COPERT version (14). From the submission 2023 on, the regional sales statistics are used to estimate the *Fuel Sold* emissions from road traffic in the regions (see 1.2.8.) and afterwards these results are aggregated to obtain the Belgian submission.

The use of regional energy balances instead of the federal energy data is the main reason of differences between the reference approach and the sectoral approach in the different sectors involved.
These differences are described in detail in section 3.2.1. 'Comparison of the sectoral approach with the reference approach'.

A description (including the allocation procedures for specific sources) of the energy sector is given in this chapter together with the methodological issues in the energy sector and the recalculations and planned improvements (sections 3.2 for fuel combustion and 3.3 for the fugitive emissions).

The IPCC 2006 guidelines are used since the submission in 2015 (emissions of the year 2013).

3.1.1 Trend assessment

Energy industries (1A1)

The main source for this sector is public electricity and heat generation (1A1a), which accounted for 73.4% of sectoral emissions in 2022. Petroleum refining (1A1b) and manufacture of solid fuels (1A1c) accounted for 25.8% and 0.9% respectively.
Emissions from the manufacturing of solid fuels have decreased by 92% since 1990 (-1873 Gg CO_2 equivalent) due to the closure of six coke plants in 1993, 1995, 1997, 2000, 2005 and 2010. Emissions in 2022 from petroleum refining are 8% higher in comparison with 1990. Emissions in this sector can fluctuate depending on the general economic context and planned shut-down for inspection, maintenance and renovation works. This was f.i. the case in 2011 for one of the biggest refineries. But 2022 emissions are 16% under 2019 emissions (last non-covid year).
As mentioned above, the main driver in this sector is still public electricity and heat generation although the sector has experienced a sharp decline since 2010. While electricity and heat production have risen by 19% between 1990 and 2022, emissions have decreased (-42%) due to technological improvements, increase of number of combined heat-power installations and the switch from solid fuels (coal) to gaseous fuels (natural gas) and renewable fuels. This is illustrated in figure 3.1.

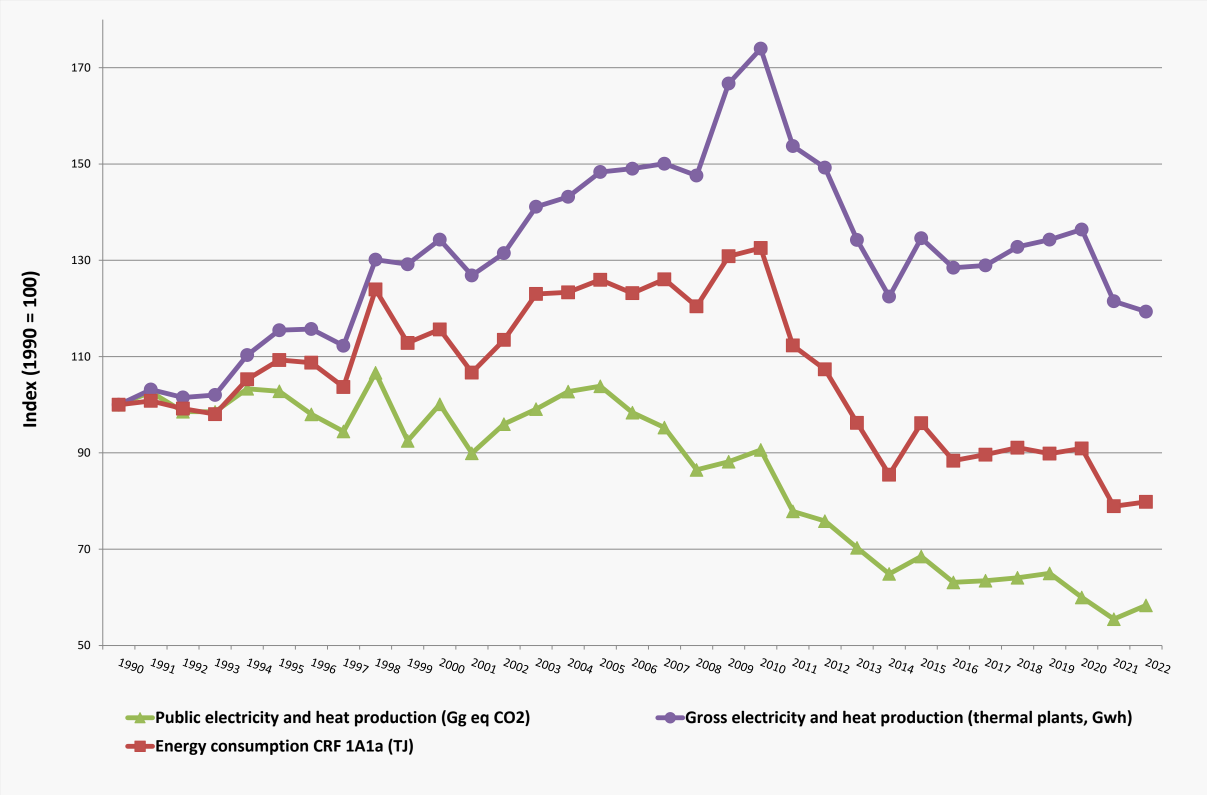


Figure 3.1: GHG emissions in public electricity and heat generation, in relation to gross electricity generation

3.1.1.1 Manufacturing industries (1A2)

In the manufacturing industries, added value[8] has increased by 46% in 2022 compared to 1990, while greenhouse gas emissions (combustion) decreased by 46% in the same period.

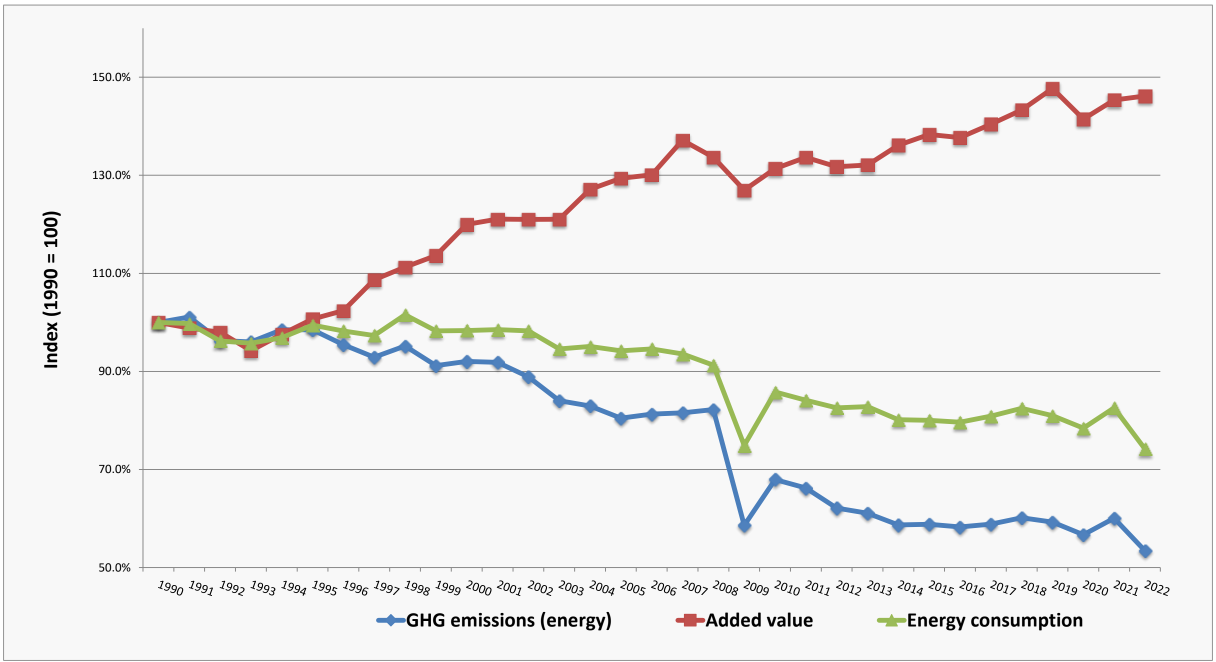


Figure 3.2.a: GHG emissions in the manufacturing industries: index of GHG emissions, energy consumption and added value

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[8] Gross added value of sector 1A2, estimates in chained euros (reference year 2015) - Federal Planning Bureau

As seen in figure 3.2.a , fuel energy consumption decreased by 25% between 1990 and 2022. This strong decrease is obviously due to the impact of the economic crisis in the iron and steel sector. The apparent decoupling of added value and energy consumption can be attributed to various drivers according to sectors:

In the iron and steel industry, many plants have switched to electric furnaces since 1990. For example, the share of iron and steel plants using electricity increased from 9% in 1990 to 35% in 2011. This is the main cause of the apparent decreasing energy consumption, while stable added value is observed in this sector. Because of the re-allocation between the energetic and the process emissions in the iron & steel sector since the 2015 submission, this sector represents now only 9% (instead 18% in 1990) of the energy consumption in 2022 in the manufacturing industries and consequently its impact on the global trend has decreased.

In the chemical sector, fuel consumption (non-energy use of fuels is excluded) has decreased by 5% between 1990 and 2006, compared to 65% growth in added value in the same period. This major decoupling is linked to both rational energy use and high added-value products. In 2022, this sector represents 29% of energy consumption in the manufacturing industries.

Food processing and beverages represented 17% of energy consumption in the manufacturing industries in 2022, but only 11% of added value (2020). The diversity of the plants in this sector does not allow a detailed analysis of the trend; only certain types of plants are commented upon here. In sugar plants, for example, some products with high added value, such as inulin and fructose, have been developed but the main driver is still the sugar beet yield (quantity and sugar content), which is highly climate–dependent.

In cement plants, the decoupling between energy consumption and total production is linked to the production process: the dry process, which is considerably less energy-demanding, is gradually replacing the wet process and is now (2021) used for 82% of clinkers production compared to 57% in 1990.

Figure 3.2.a also shows a decrease in greenhouse gas emissions for an equal level of energy consumption. One reason is the increasing use of gaseous fuels, coupled with a decrease in liquid and solid fuels observed across all sectors. This is illustrated in figure 3.2.b.

The share of gaseous fuels increased from 45% in 1990 to a maximum of 71% in 2021 to decrease to 67% in 2022 because of its price.

The increasing use of 'other fuels' reflects that cement plants have been using more and more substitute fuels since 1990, such as impregnated sawmills, animal waste, tyres, etc. Those fuels represented 56% of their energy consumption in 2021 compared to 8% in 1990. The non-biomass fraction of these fuels is included in the 'other fuels' category. The biomass fraction of these fuels is included in biomass fuels; these CO_2 emissions are not accounted in the national emissions.

About the half (47%) of the biomass fuels used in Belgium in the manufacturing industries are used in the pulp and paper sector, where part of the woody raw material has always been used as fuel in pulp paper plants. The biomass consumption increased by 138% from 1990 to 2022 in this sector while the increase is multiplied by almost 5 for all the manufacturing industries reflecting the development of this fuel since the 2000s.

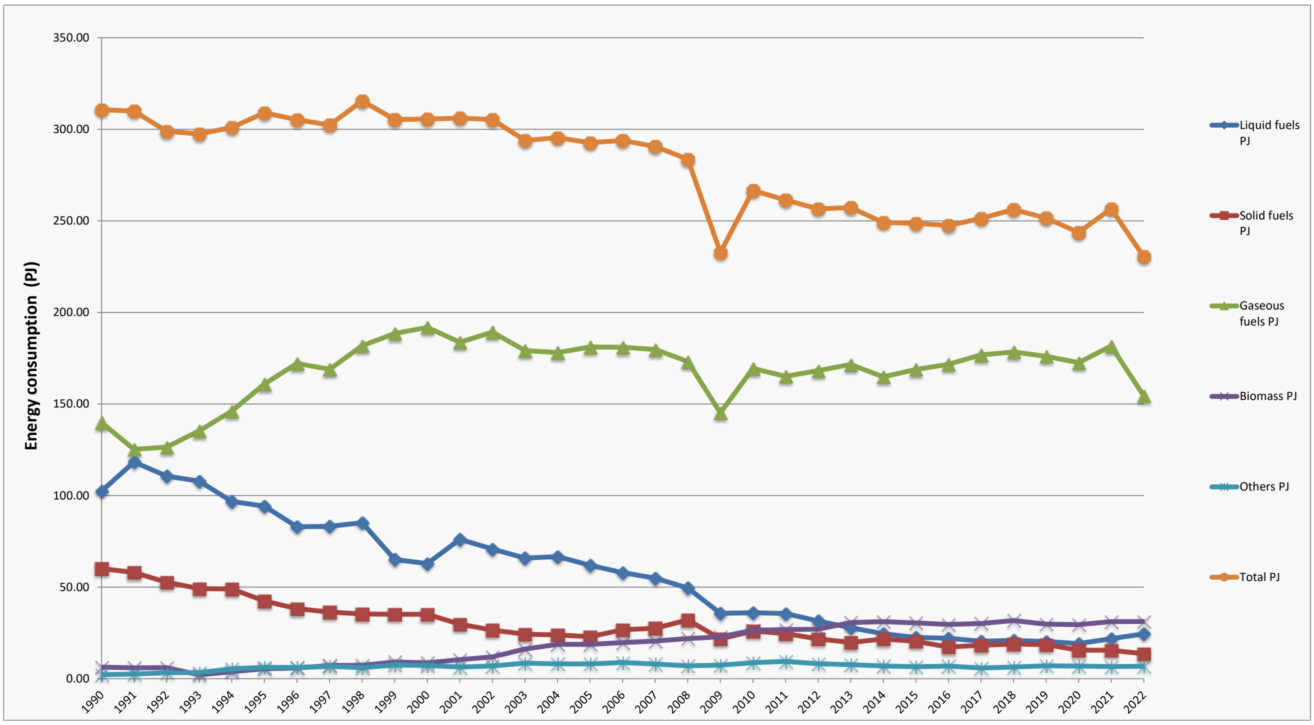

Figure 3.2.b: Type of fuels used in the manufacturing industries

Transport (1A3)

Transport emissions accounted for 14.4% of total GHG emissions in 1990 and 23.4% in 2022. This increasing share is due to road transport, which represents 96.0% of total emissions (included pipelines) by the sector in 2022.
Emissions from domestic navigation are fairly stable and represent 1.7% of transport total emissions in 2022. Emissions from railways (0.3% in 2022) seem to have decreased since 1990, but in fact this reflects the switch from diesel to electrical engines.

In the road transport sector, most indicators are increasing even if 2022 emissions does not seem to have recovered all the loss recorded during the year 2020 related to COVID-19 crisis and its consequences on mobility: the number of vehicles has increased by 72% since 1990 (54% for only passenger cars) (15), together with traffic (vehicle km) which has risen in the meantime by 49% in 2019 (last non-covid year) but only by 39% in 2022[9] (16). During quite the same period, the road freight traffic grew by 114% (ton-kilometers) while the number of passengers carried by cars increased by only 26% (2017).

There was a marked switch from petrol engines to diesel between 1990 and 2014 (the number of petrol engines for cars in the fleet has dropped between 1990 and 2014 (-30%) while the number of diesel engines has almost tripled (+274%) for the same period) but this movement is being reversed since 2015 with the modification of excise duties on fuels as well as the mediatisation of the consequences of diesel vehicles on air pollution. Since 2015 petrol engines (without hybrid vehicles) grew by 51% while diesel engines dropped by 33% (2022).

For other engines taken as a whole, although growth has been almost 600% since 2015, their share in the car fleet represents only 7.5%. Among them, it is above all the "petrol plug-in-hybrid" (38%) and the "petrol conventional hybrid" (29%) cars which represent the strongest part in absolute figures (2022) at the same time as the decline in LPG engines since the 2000s. Battery electric cars represent 21% from other engines with 90.000 vehicles in 2022.

[9] This decrease compared to 2019 reflects both the consequences of a COVID-19 effect on mobility and a change in methodology in estimating kilometers travelled. The increase was only 17% in 2019 since 1990.

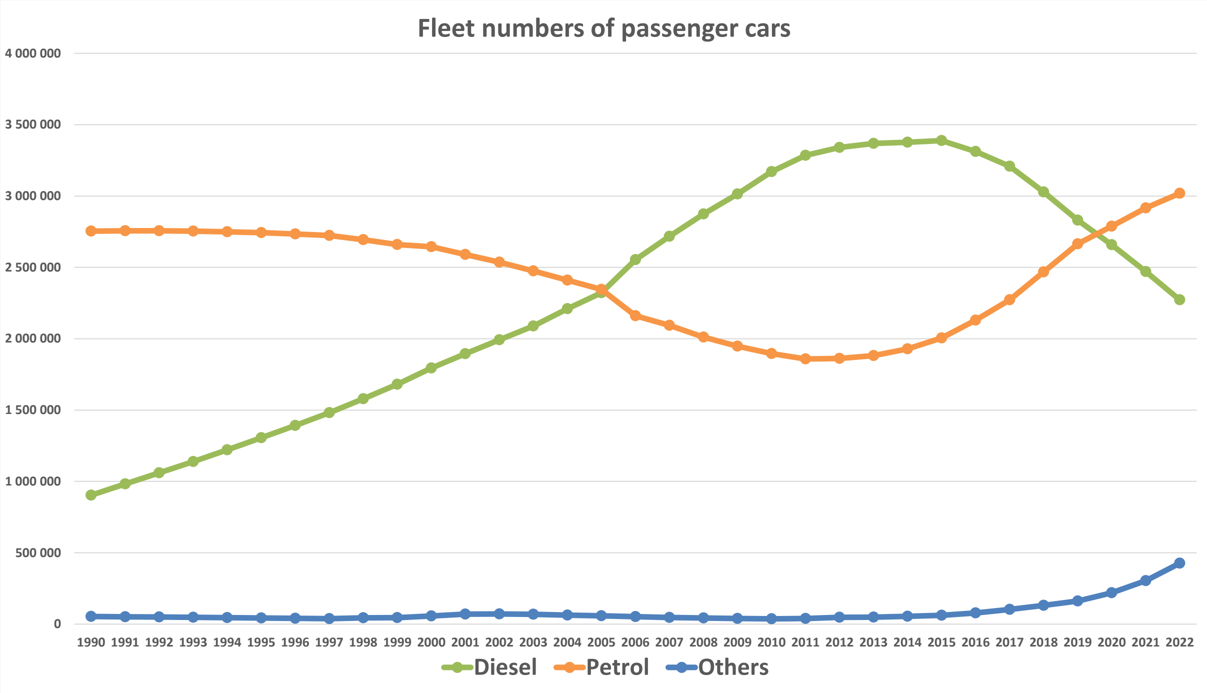

Figure 3.3.a: Fleet numbers of passenger cars in Belgium

The main trend since 1990 is still reflected in their respective traffic figures (- 13% for petrol engines and +114% for diesel engines in 2021 (15)) and in their respective emissions as well (figure 3.3.b).

The average engine capacity has increased since 1995, reflecting the switch to diesel on the one hand and the growing success of Sport Utility Vehicles and Multi-Purpose Vehicles on the other hand. The average age of the cars has also increased (improved rust protection and overall resistance), as well as the average distance travelled, which is nowadays being stabilized.

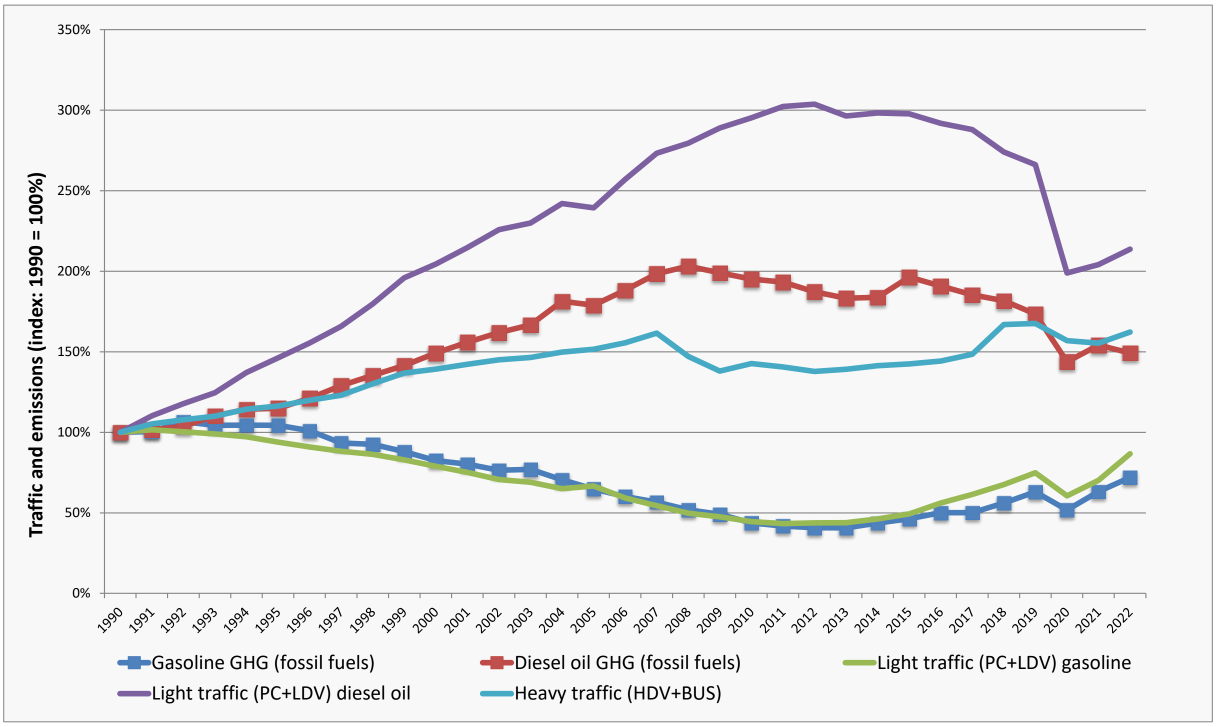

Figure 3.3.b: Emission trends in the transport sector (according "fuel sold approach" for fuels)

Road transport is one of the most important key sources of greenhouse gas emissions in Belgium, in terms of level and trend analysis. With an increase of GHG emissions by 24% between 1990 and 2019 (but only 16% between 1990 and 2022, it constitutes one of the main drivers of emissions trends.

International air and maritime transport

In accordance with the UNFCCC guidelines, emissions from international air and maritime transport are not included in national emissions. In 2022 these emissions represent 28% of national emissions (with a significant increase of nearly 19% between 2022 and 2021) with maritime transport representing the most important source (84% in 2022 of this category). Emissions from international aviation increased by 45% in 2022 since 1990, while emissions from international maritime transport have risen by 81% during the same period.

3.1.1.2 Residential and commercial (1A4)

In the residential sector, fuel consumption has increased by 17.4% between 1990 and 2003. This is mainly linked to the increasing number of dwellings (+26% between 1991 and 2001) since these two years were very similar from a climatic point of view. Annual fluctuations are of course climate-related with degree days[10], one of the key parameters used to analyse the sector energy consumption for heating requirement. This is particularly clear for 1991, 1996, 2010 and 2013 which were cold years with a marked peak of emissions from heating, but also for 2007, 2011, 2014, 2020 and 2022, five years with exceptionally mild winters, which caused a sharp drop in consumption. Recently, rising energy prices (particularly in 2022) and improving building insulation have probably also contributed to reduce consumption. We can observe this when comparing 1998 and 2016, two another similar years from a climatic point of view. While the number of dwellings is increasing by 17% the energy consumption decreases by 22%. Since 1990, gaseous fuels consumption has increased in the residential sector (stationary combustion) from 34 to 51% of total energy consumption (without electricity and heat), together with a decrease in solid fuels and liquid fuels. Liquid fuels still account for 40%. One explanation is that the gas distribution network does not cover sparsely populated areas, hampering the switch from liquid to gaseous fuels, a development which is observed in other sectors.

In the commercial and institutional sector, fuel consumption has increased by 30% since 1990. Annual fluctuations are also climate-related but the overall trend is less affected than in the residential sector. One reason is the rising number of employees, which has risen by 35% (between 1993 and 2017). In the meantime, electricity consumption has also grown by 183% (between 1990 and 2017), mainly due to the development of Information Technologies and the increased use of refrigerated areas and air conditioning. These increases have been partially counterbalanced by a clear switch from liquid fuels to gaseous fuels observed since 1995 and natural gas represent now 78% of the sector's energy consumption (without electricity and heat).

For both sectors, other fuels and biomass were negligible but according a new estimation of consumption of biomass fuels (see 3.2.9) in the residential sector, biomass represents now 8.4%. In the commercial sector, a slow increase has been observed since 1998, but biomass represents only 3.3% of the sector's energy consumption (stationary combustion). The switch from solid and liquid fuels is reflected in the decoupling of energy consumption and GHG emissions (fig 3.5).

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[10] Degree day: the difference expressed in degrees centigrade between the average daytime temperature and a base temperature (15°C for the 15/15 base and 16.5°C for the 16.5/16.5 base). Average temperatures that are higher than the base temperature are not included. The total number of degree days over a given period (month or year, for example) are added together. Degree days enable heating requirements to be assessed.

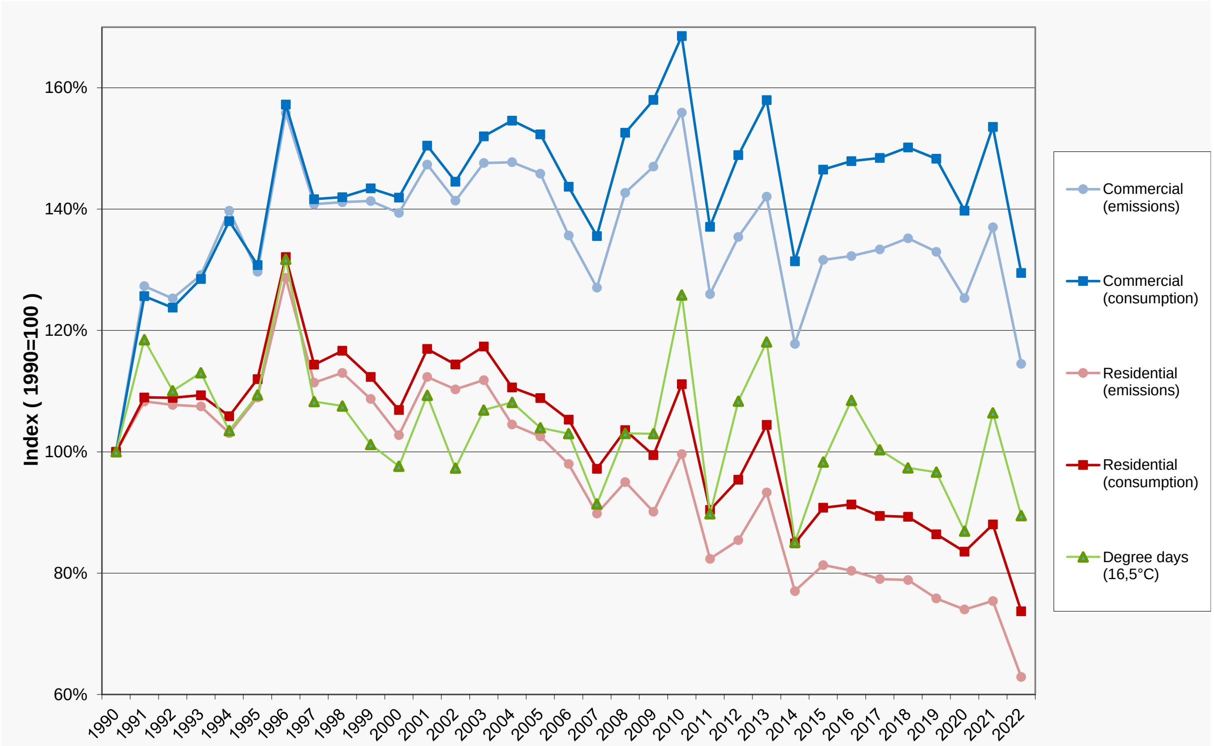


Figure 3.3: GHG emissions and energy consumption in the residential and commercial sectors

3.1.2 Overall recalculations in the energy sector

The tables below give the qualitative and quantitative recalculations in the different subsectors of the energy sector (category 1) compared to previous submission to EC and UNFCCC in Spring 2023. Please note that an important reason for recalculations in the energy sector is the yearly update of the regional energy balances. During this submission, the year 2021 is mainly affected.

Category 1A1 Energy industries:

1A1		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	0,00	0,00	4,54	2,58	1,66	1,60	1,24	1,13	0,89	1,30	2,41
Flemish region	%	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,01
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,01
Belgium	%	0,00	0,00	0,04	0,03	0,03	0,02	0,02	0,02	0,02	0,02	0,05
Brussels region	kt CO2 eq,	0,00	0,00	11,60	6,93	4,48	4,50	3,30	3,12	3,47	3,62	7,35
Flemish region	kt CO2 eq,	0,00	0,00	-0,79	0,17	1,89	0,00	0,00	-0,03	-0,02	0,40	2,07
Walloon region	kt CO2 eq,	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,29
Belgium	kt CO2 eq,	0,00	0,00	10,80	7,10	6,37	4,50	3,30	3,09	3,44	4,02	9,13

Recalculations in category 1A1 mainly due to:

<u>All regions</u>:

Optimization of regional energy balances.

Flemish region:

> Small corrections were made in the Flemish region in this category for some years: mainly in the subcategory CHP-installations and the emissions from gasoil consumption in the nuclear power installations in 2015 was added (+ 2 kton CO2) to become consistency in the time series.

Walloon region:

No recalculation except the revision of the energy balance in 2021.

Brussels-Capital region:

Revision of the CO_2 emissions of the municipal waste incinerator following better knowledge about the facility (the CO_2 emissions from the (small) extra natural gas supply to the installation that were previously subtracted from the measured emissions, are actually not taken into account in the stack measurements).

Category 1A2 Manufacturing Industry and construction:

1A2		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	0,00	0,00	0,00	31,27	-2,35	13,05	14,37	15,53	2,12	1,62	6,81
Flemish region	%	0,00	0,00	0,00	0,00	0,00	0,33	0,26	0,21	0,37	-0,08	-0,32
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,06	0,18	0,27	0,31	0,38	2,57
Belgium	%	0,00	0,00	0,00	0,19	-0,02	0,30	0,33	0,34	0,36	0,13	0,96
Brussels region	kt CO2 eq,	0,00	0,00	0,00	29,94	-2,45	13,54	14,64	15,47	2,08	1,48	6,73
Flemish region	kt CO2 eq,	0,00	0,00	0,00	0,00	0,00	24,65	19,98	16,16	27,85	-6,22	-25,50
Walloon region	kt CO2 eq,	0,09	0,11	0,12	0,09	0,08	3,49	11,26	16,74	19,42	21,98	153,26
Belgium	kt CO2 eq,	0,09	0,11	0,12	30,03	-2,37	41,68	45,88	48,37	49,35	17,23	134,48

Recalculations in category 1A2 mainly due to:

<u>All regions</u>:

Optimization of regional energy balances, mainly the year 2021 is involved.

Flemish region:

- Energy consumption data were optimized in this region from 2016 on. These optimizations mainly effected the category 1A2g viii_other industries and mainly for the liquid fuels (increase of consumption).
- The off-road data were optimized in the OFFREM model during this submission from 2016 on, resulting in a decrease of emissions in this category 1A2gvii (construction sector).

Brussels region:

- Recalculations of historical series in the energy balance, especially for the period 2014–2021 for all energy vectors, and gasoil from 2010 with the revision of the time series and sectorisation based on the federal survey of distributors (sales).
- In 1A2gvii, revision of data from the OFFREM calculation model for the period 2016-2021.

Walloon region:

- Optimization of the OFFREM model for the category 1A2gvii from 2016 on.

Category 1A3 Transport:

1A3		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	0,00	0,00	0,00	0,01	0,01	0,02	0,03	0,02	0,01	-0,04	-0,05
Flemish region	%	0,03	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,01	0,00	0,00
Walloon region	%	-0,01	0,00	0,00	0,00	0,00	0,00	0,00	-0,01	-0,01	-0,01	-0,04
Belgium	%	0,02	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00	-0,01	-0,02
Brussels region	kt CO2 eq,	0,00	0,01	0,01	0,09	0,14	0,25	0,26	0,15	0,13	-0,40	-0,44
Flemish region	kt CO2 eq,	4,58	3,31	2,91	2,81	3,00	3,06	3,24	2,98	1,10	-0,26	-0,61
Walloon region	kt CO2 eq,	-0,46	-0,15	-0,01	-0,05	0,26	0,07	-0,12	-0,41	-0,59	-0,80	-2,63
Belgium	kt CO2 eq,	4	3,18	2,91	3	3	3	3	3	1	-1	-4

Recalculations in category 1A3 mainly due to:

All regions:

Recalculations in the category 1A3b (road transport) in all 3 regions in Belgium for the complete timeseries due to:

- Use of updated COPERT 5.7.3 version during this submission;
- Use of regional sales statistics from the submission in 2023 on instead of federal statistics until the submission of 2022 for the estimation of the regional emissions from road traffic (see 1.2.8) [resulting in interregional changes compared to previous submissions]. Recalculations for the complete timeseries from 1990 on are involved. Belgian data are compiled as the sum of the regional data and are approaching data from previous submission.

Brussels-Capital region:

- In 1.A.3.c - Railways, revision of energy consumption up by on average 4% for the period 2014-2017, and marginal revisions for the years 2018 to 2021 due to the revision of conversion factors used in the energy balance.
- In 1.A.3.d - Domestic Navigation, revision of energy consumption down by on average 6% for the period 2014-2021 due to the revision of conversion factors used in the energy balance.

Flemish Region:

- Small changes in emissions of CO_2 from road transport (< 1 kton CO_2 up to 2019 and a decrease of emissions of CO_2 of 2-3 kton CO_2 for the years 2020 and 2021.Biggest differences in this category (2-5 kton CO_2) due to revision of the model to calculate the emissions from railways (complete timeseries).
- small change in aviation due to new datasets from EUROCONTROL for the years 2015-2021 and an update of aviation fuel data for military aircrafts.

Walloon region:

- Optimization of the OFFREM model for the category 1A3eii.

Category 1A4 Other sectors:

1A4		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	0,00	0,00	0,00	-5,40	6,28	5,53	5,66	6,27	7,67	8,57	9,25
Flemish region	%	0,00	0,00	0,00	0,00	0,00	-0,28	-0,17	0,12	0,18	-0,31	-1,11
Walloon region	%	0,00	0,00	-0,01	-0,01	-0,02	-0,01	0,00	-0,01	-0,01	-0,01	-11,50
Belgium	%	0,00	0,00	0,00	-0,51	0,52	0,31	0,38	0,59	0,73	0,51	-3,60
Brussels region	kt CO2 eq,	0,00	0,00	0,00	-151,46	129,39	116,12	116,28	127,34	150,32	162,45	185,77
Flemish region	kt CO2 eq,	0,00	0,00	0,00	0,00	0,00	-40,24	-24,08	17,42	25,50	-42,17	-169,72
Walloon region	kt CO2 eq,	0,09	-0,32	-0,56	-0,60	-1,60	-0,75	-0,08	-0,81	-0,88	-0,51	-926,62
Belgium	kt CO2 eq,	0,09	-0,32	-0,55	-152,06	127,79	75,13	92,11	143,95	174,93	119,77	-910,57

Recalculations in category 1A4 mainly due to:

All regions:

Optimization regional energy balances.

Flemish region:

For the years 2016-2021, optimization of energy consumption data in the energybalances causes differences in calculated emissions in this category. The largest difference between current and previous submission is for the year 2021. The consumption of gas- and dieseloil in 2021 decreased with 11% in services sector and with 7% in agricultural sector. In the services sector this was due to the correction of an error in the extrapolation method. Together with the decrease of gas- and dieseloil consumption in agricultural sector, there is also a decrease of 39% of coal consumption between current and previous submission. In the agricultural sector this decrease was due to an update of the source data: in the previous submission preliminary data were used for 2021, while in this submission final surveydata from 2021 were available. .

Brussels-Capital region:

- Recalculations of historical series in the energy balance, especially for the period 2014–2021 for all energy vectors, and gasoil from 2010 with the revision of the time series and sectorisation based on the federal survey of distributors (sales).
- In 1A4bii, revision of data from the OFFREM calculation model for the period 2001-2013 and the year 2021.
- 1A4cii, revision of data from the OFFREM calculation model for the year 2021.

Walloon region:

- In 1A4bi, revision on the charcoal consumption on the entire time series and revision of the pellets part in the total wood consumption since 2005.

- Optimization of the OFFREM model for the category 1A4cii.

- In the sector 1A4, in the previous submission, the liquid fuel activity data was based on the Walloon share of the sector's Belgian consumption (taken from the EBM survey - Household Budget Survey), and the total Belgian gasoil consumption of the sector. During this submission, in addition of the optimization of the 2021 energy balance, the sales from the distributors (Belgian survey) were directly used in the energy balance for the year 2021 and 2022. These data determine the regional and sectoral shares of the gasoil consumption.

Category 1A5 Other:

1A5		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flemish region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,90	1,69	0,00
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-14,62
Belgium	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,58	1,07	-5,36
Brussels region	kt CO2 eq,	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flemish region	kt CO2 eq,	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,56	1,13	0,00
Walloon region	kt CO2 eq,	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-5,65
Belgium	kt CO2 eq,	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,56	1,13	-5,65

Flemish region:

Small changes in emissions occurred in the category 1A5b/military aviation in the Flemish region from 2018 on due to updated data in Energy Balance.

Walloon region:

No recalculation in this category except in 2021 with the final energy balance.

Brussels region:

No recalculations took place in this category.

Category 1A Overall recalculations:

1A		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	0,00	0,00	0,27	-2,75	3,77	3,82	3,95	4,34	4,58	5,51	6,18
Flemish region	%	0,01	0,00	0,00	0,00	0,01	-0,02	0,00	0,06	0,10	-0,09	-0,36
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,01	0,04	0,06	0,07	0,09	-3,26
Belgium	%	0,00	0,00	0,01	-0,11	0,16	0,15	0,17	0,23	0,27	0,18	-0,95
Brussels region	kt CO2 eq,	0,00	0,01	11,61	-114,50	131,56	134,41	134,48	146,07	155,99	167,15	199,41
Flemish region	kt CO2 eq,	4,58	3,31	2,11	2,99	4,89	-12,53	-0,86	36,54	54,98	-47,13	-193,76
Walloon region	kt CO2 eq,	-0,28	-0,36	-0,45	-0,56	-1,26	2,81	11,06	15,52	17,96	20,68	-781,93
Belgium	kt CO2 eq,	4,31	2,97	13,28	-112,07	135,19	124,68	144,68	198,13	228,93	140,70	-776,29

3.2 Fuel combustion (CRT 1.A)

In 2022 Belgium's gross inland consumption rose to 52281 ktoe (thousands tonnes oil equivalent), i.e. approximately 4.5 toe per inhabitant. Almost 85% of Belgium's energy needs are met by the net import of energy (44316 ktoe in 2022). This was made up of 2723 ktoe of solid fossil fuels, 28133 ktoe of oil (all petroleum products) and 13069 ktoe of natural gas.

In 2022, the use of nuclear fuels provided 46% of the gross electricity produced.

Although the hydroelectric potential is vigorously exploited in Belgium, its share in the production of energy remains negligible given the topography of the country (0.3% of electricity produced - excluding pumping). The production of wind energy is also limited but steadily increasing (12.9% of total electricity produced in 2022), due to the lack of open spaces exposed to the wind, which greatly constrains the potential for the development of on-shore wind energy. Nevertheless, wind energy from offshore wind farms is already contributing significantly (54% of wind energy in 2022) to the production of electricity from renewable energy sources and will be doing so in the future.

3.2.1 Comparison of the sectoral approach with the reference approach

In compiling its greenhouse gas emission inventory, Belgium applies a sectoral approach (bottom-up approach), as recommended by the IPCC Good practice Guidance 2000 (https://www.ipcc-nggip.iges.or.jp/public/gp/english/2_Energy.pdf) « The bottom-up approach is generally considered the most accurate for those countries whose energy consumption data are reasonably complete. Consequently, inventory agencies should make any effort to use this method if data are available ».

In Belgium, the energy balances used for this sectoral approach are calculated at the regional level because of the regional responsibility in the federal context of Belgium. Hence, the energy data reported in the Belgian greenhouse gas inventory (e.g. all CRT tables except the tables 1AB Fuel Combustion - Reference Approach, 1AC Comparison of CO_2 Emissions from Fuel Combustion between reference approach and sectoral approach, 1AD Feedstocks, reductants and other non-energy use and 1A3b CO_2 Emissions from Fuel Combustion of Road Transport where the supply statistics from the federal energy balance are reported) are the sum of those 3 regional energy balances. However, the IPCC Good Practice Guidance recommends Parties to calculate the emissions of CO_2 according to a reference approach, which is based on fuels delivery statistics. In Belgium, these statistics are only calculated at the national level, by the Directorate-General for Energy. They are calculated on the basis of fuel delivery data, import and export, and fraction of carbon stored/carbon excluded in products. This approach is consequently independent from the regional consumption balances.

The details of this reference approach are provided in the categories 1AB, 1AC and 1AD of the CRT-tables.

Default values recommended in the IPCC 2006 guidelines were adopted for carbon emission factors, fraction of carbon oxidised, and fraction of carbon stored (in feedstocks), except for the fraction of carbon stored of naphtha, LPG and residual fuel, where values are communicated by Flemish Region where refinery activities take place. Previously, the fraction of carbon stored of 100% was taken. Reason for this 100% was that the amount of naphtha reported as feedstock in table 1.AD was revised, after work carried out in the Working Group on Energy Balances in Belgium (see further this section for more information). The reported naphtha equals the amount of naphtha used as feedstock minus the part that was recovered as fuel (approximately 30% each year). This means that the reported naphtha was considered to equal a 'net' amount of C that was stored in products. Until the 2014 submission, the recovered fuels of the naphtha cracking were reported in the sectoral approach as 'other fuels' in the chemical industry (category 1A2c). From the 2015 submission on, and applying the new IPCC 2006 guidelines, these emissions are reported in the IPPU-category 2B8b Ethylene. Consequently, since the 2015 submission, the reported naphtha and LPG in 1.AD are the total quantities[11] (all the carbon is excluded from reference approach – a part is stored in products and the other part is emitted in 2B8b).

Solid fuels are mainly located under 'Industrial Process' (iron and steel sector) in the regional approach contrary to the reference approach (where no data for carbon stored or excluded are provided at the national level). The energy amounts of solid fuels reported in the federal statistics have been reviewed by the Directorate-General Energy and have been optimized during the 2016 submission but there are no data available for carbon stored or excluded. However, to overcome this problem, Belgium has decided to apply the recommendation of the IPCC 2006 guidelines about reductants in chapter 6.6.2: "However, as data for this activity are not always readily available and, in order to preserve the simplicity of the Reference Approach, quantities of coke delivered for the iron and steel and non-ferrous metals industries should be excluded from total carbon. The effect of this will be reflected as a difference between the Reference Approach and Sectoral Approach when the comparison is made". Belgium includes also "pulverized coal" used as reductant. The effects of the correction for the off gases produced and combusted/encoded in the sectoral approach under 1A2a or 1A1a are showed hereunder.

This means that all quantities of coke delivered and other reductants for the iron and steel and non-ferrous metals industries are excluded (and thus encoded in CRT table 1.A(d)) from the total carbon accounted in the comparison between the reference and sectoral approaches in CRT table 1.A(c); however, some solid fuels used for industrial processes (iron and steel and non-ferrous metals industries) are converted to derived gases and used for energy purposes under 1A2a or 1A1a. As a consequence, combustion emissions appear under energy in the sectoral approach while all these quantities have been removed from "Apparent energy consumption" in CRT table 1.A(c). Therefore, to avoid "the effect of this will be reflected as a difference between the reference approach and sectoral approach when the comparison is made" Belgium added these off-gas emissions and energy in its corrected reference approach provided hereunder to permit a fair comparison between the reference and sectoral approaches.

For the submission 2024, last revision was provided by the Directorate-General for Energy on November 23, 2023.

The difference between the reference approach and the national inventory (reference approach corrected for the off gases produced in the blast furnaces and combusted/encoded under 1A2a or 1A1a (corresponding to 5057 CO_2 eq. in 2022 for electricity production in the Flemish region) for all years is visualised in the figure 3.4 below. The corrected comparison in Gg CO_2 with the sectoral approach shows differences between -3.22 % (in 2007) and +4.41% (in 2010).
The difference in 2022 is about -0.30%.

[11] Please note that this may lead to discrepancies with Eurostat data for energetic comparisons as these recovered fuels are encoded there as "final energy consumption in the chemical and petrochemical sector" while in the national inventory there are not included in the sectoral approach since emissions are encoded in IPPU.

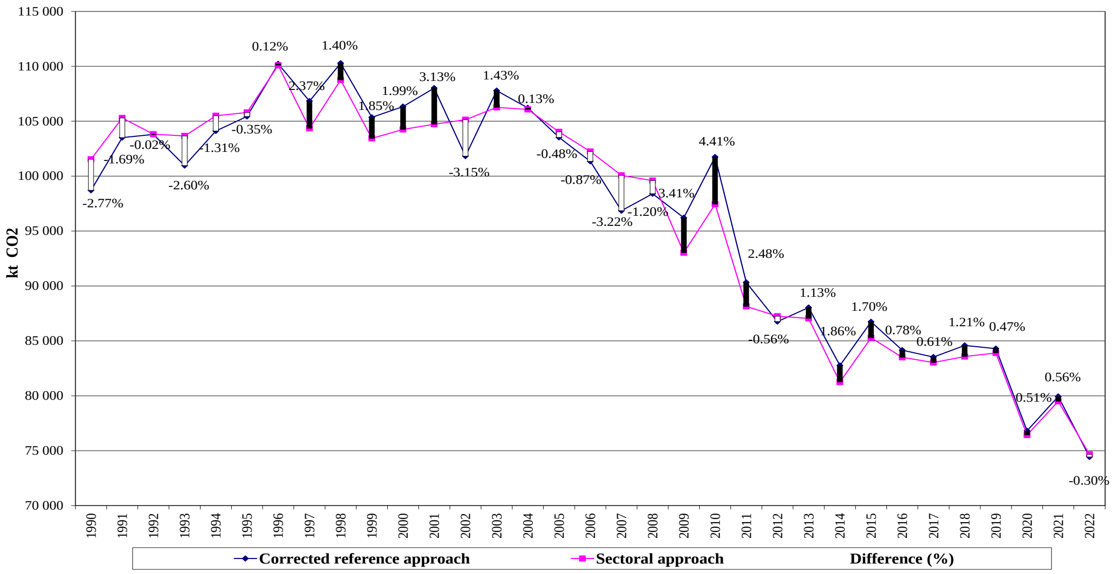


*Figure 3.4: Difference between the **corrected** reference approach and the sectoral approach of the Belgian inventory (Gg CO_2). Correction is made for the off gases produced in the blast furnaces and combusted/encoded in the categories 1A2a or 1A1a.*

The tables below explain the correction made as suggested by chapter 6.2.2 from IPCC 2006 guidelines.

Solid fuels		2005	2010	2015	2016	2017	2018	2019	2020	2021	2022
Energetic combustion for the off gases produced in the blast furnaces and combusted/encoded under 1A2a or 1A1a	kt CO2	6.310	4.443	4.482	4.977	5.128	4.947	5.185	3.779	4.323	5.057
Reference approach as in CRT tables	kt CO2	10.136	6.731	4.882	2.840	2.364	2.522	2.318	1.972	2.040	1.916
Corrected Reference approach	kt CO2	16.446	11.174	9.364	7.817	7.491	7.469	7.502	5.751	6.363	6.973
Sectoral approach	kt CO2	16.034	10.580	8.672	7.283	7.229	7.111	7.285	5.548	6.105	6.628
Corrected difference	%	2,6	5,6	8,0	7,3	3,6	5,0	3,0	3,6	4,2	5,2
Difference as in CRT tables	%	-36,8	-36,4	-43,7	-61,0	-67,3	-64,5	-68,2	-64,5	-66,6	-71,1

All fuels		2005	2010	2015	2016	2017	2018	2019	2020	2021	2022
Energetic combustion for the off gases produced in the blast furnaces and combusted/encoded under 1A2a or 1A1a	kt CO2	6.310	4.443	4.482	4.977	5.128	4.947	5.185	3.779	4.323	5.057
Reference approach as in CRT tables	kt CO2	97.223	97.295	82.253	79.173	78.398	79.638	79.107	73.034	75.614	69.377
Corrected Reference approach	kt CO2	103.533	101.739	86.735	84.149	83.526	84.584	84.292	76.813	79.937	74.434
Sectoral approach	kt CO2	104.032	97.439	85.282	83.502	83.022	83.576	83.894	76.426	79.491	74.659
Corrected difference	%	-0,5	4,4	1,7	0,8	0,6	1,2	0,5	0,5	0,6	-0,3
Difference as in CRT tables	%	-6,5	-0,1	-3,6	-5,2	-5,6	-4,7	-5,7	-4,4	-4,9	-7,1

Unfortunately, ETF-GHG does not allow correcting the “Reference approach” as explained here above. The following table represents the differences (much larger) as encoded in the CRT tables.

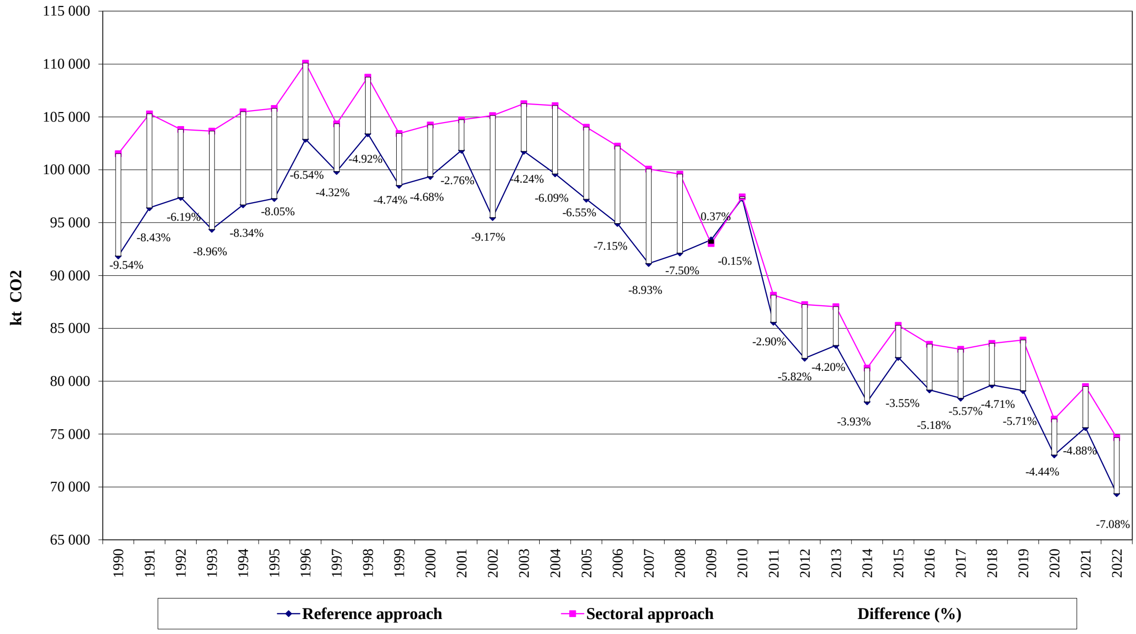


Figure 3.5: Difference between the reference approach and the sectoral approach of the Belgian inventory (Gg CO_2) <u>without correction</u> for the off gases produced in the blast furnaces and combusted/encoded in the categories 1A2a or 1A1a.

There are several reasons why there is a difference between the results of the reference approach and the national inventory at global level in CO_2 emissions. These differences and their potential reasons have been already discussed in previous National Inventory Reports of Belgium. The reasons are:

<u>Reason number 1</u>: the results of the reference approach and the national greenhouse gas inventory are based on different data sets (top-down versus bottom-up). The top-down approach is based on national fuel delivery statistics, the bottom-up approach is based on fuel consumptions.

<u>Reason number 2</u>: the effect of calorific values and emission factors of liquid fuels in the reference approach is important for countries with high import of crude oil. Half of the resulting CO_2 emissions from the use of liquid fuels calculated in the reference approach for Belgium results from the import, export and stock changes of crude oil. A small variation in the average net calorific value used (which is difficult to determine), has a large influence on the total CO_2-emissions following the reference approach. Belgium uses f.i. a value of 42.19 GJ/ton in the reference approach for the year 2017. [every year another calorific value is used for crude oil]. If this value is about 5% lower (40 GJ/ton) the reference approach would be 5478 kt CO_2 lower.

<u>Reason number 3</u>: In the reference approach, the activity data and carbon excluded are based on the federal energy balance and the country-specific calorific values are used (see annex 4) together with the default IPCC 2006 values (table 1.3 in chapter 1 of the guidelines) of the C-content (switch from TJ to ton C) while the emissions from non-energy use in the sectoral approach are mainly based on bottom-up data from the companies themselves (for consistency reasons, Belgium decides to report theses values for CO_2 emissions under 1AD when information is available). For some products, there is no link between the AD and emissions in table 1AB, 1AD and the sectoral approach, which leads to extra differences between sectoral and reference approach. For example:

- Natural gas: For the reference approach, the TJ included in table 1AD are from the federal energy balance and the % of C stored in feedstocks (33%) is the default value from the IPCC guidelines. The emissions from the use of natural gas in the sectoral approach (mostly as feedstock for ammonia production, also for other syngas production) are directly reported by the companies involved through measurements and are reported under 2B.

- Lubricants: the TJ reported in table 1AD are from the federal energy balance. The same TJ (apart from 0.2-0.3% which is used in 2-stroke motor vehicles – emissions are in 1A3b) are used in the sectoral approach to estimate the emissions from lubricant use (category 2D1) but corrected with the activity data (TJ) from lubricants use in 4-strokes motors since these emissions are estimated directly with COPERT-model.

Reason number 4: emissions from solid fuels are mainly located under 'Industrial Process' (iron and steel sector) in the regional approaches contrary to the reference approach (where no data for carbon stored or excluded were provided). However, to overcome this problem, Belgium has decided to apply the recommendation of the IPCC 2006 guidelines about reductants in chapter 6.6.2 (see here above) and provided a corrected comparison for this purpose.

Reason number 5: some data from the Directorate-General Energy are only available for the years 2009-2021 (as the amount of “Naphta” which is transformed in “Other Oil” in the petrochemical industry).

Reason number 6: a little part of solid fuels is considered as solid fuels in the Walloon energy balance but as other fuels in the federal energy balance.

At the beginning of 2003 a working group on Statistics is set up under the ENOVER/CONCERE group (a consultative body that treats all matters concerning energy between the federal and regional authorities) in order to harmonize the regional and federal energy balances, on the basis of a comparison of the methodologies applied by the federal authority (“top-down”) and the regional authorities (“bottom-up”). This comparison shows differences in aggregates, sectors and products definitions used (the federal authority uses European (Eurostat) definitions, while regional authorities use their own definitions) and in reporting rules applied (for auto-producers, losses, …).

A few months later, the working group concludes that what has to be harmonized are not the energy data, but the emissions data.

At the end of 2003, a working group on Energy Balances is set up under the National Climate Commission (decision made on the 30th of October 2003).
The working group consults on different priority areas:
- improvement of the basic data of the federal statistics with respect to extension of the number of companies involved, extension to non-energy operators, link with customs and excise data, electronic delivering of data;
- fine tuning of definitions of economic sectors and products;
- adapting forms of the federal statistics to obtain a regional geographical split;
- improvement of the federal energy balance by including regional information and vice versa;
- arrangements related to yearly data exchange between the federal and regional authorities;
- monitoring and evaluation on a continuous basis.

However, the working group fails to resolve the problem of the regional split of the petroleum balance.

In May 2009, it is decided to reactivate the ENOVER/CONCERE working group on Statistics , which becomes the ENOVER/CONCERE working group on Energy Balances. A first meeting of the working group is held in November 2009.

From 2010 on much progress is done by the working group towards making data fit European definitions as well as satisfying other requirements, favoured by improvements in the practices of the federal and regional authorities (legislative and methodological developments, data collection and treatment digitalization, data validation strengthening among others).

In 2010, at the request of the Walloon Region, the matter of the petroleum balance is passed from the ENOVER/CONCERE working group on Energy Balances (technical level) to the ENOVER/CONCERE group (political level) with the question of a guarantee obligation on fuel suppliers for regional reporting. The official report of the ENOVER/CONCERE group meeting of January 2011 states: “Solutions are proposed by [the Directorate-General] Energy [of the] Federal Public Service [Economy]: statistical data of the 'Excise' for the fuels (pumps) and statement by region in the form 'petroleum balance' for the other fuels. Obligation to notify for the fuel oil distributors is not excluded.”

Because consultations with different sectors are necessary in this process of harmonization and an adaption of the legislation is required in some cases, it is obvious that this process takes time. Regular meetings of the working group are held and the following work is performed:

- good exchange of data for the electricity and heat statistics from 2006 on between federal and regional administrations ;
- set up of procedures in 2008 to help a better exchange of data for other energy sources (natural gas, renewables and waste, oil, solid fuels) and exchange of ideas to possibly help divide federal oil statistics into regional data (still ongoing) ;
- adjustments to the Belgian inventory renewables/waste, based mainly on the regional data (including recovered fuels from the chemical sector) ;
- adjustments to the historical federal petroleum balances concerning the total amount of naphtha used as non-energy feedstock, based on regional data ;
- good exchange of data for transport petroleum fuel between federal and regional administrations (see below) ;
- work on different methodological points.

As they are more accurate than federal data because they are collected “bottom-up” and are “easily” comparable since gas and electricity are part of a network (total “easily” agreed upon), it is decided, around 2014, that regional data for electricity, heat and gas consumption will be used after conversion to make it fit European definitions. Every year, the three regions send their “converted” data to the Directorate-General Energy for the Renewables, Electricity and Heat and Gas annual Eurostat (and International Energy Agency) questionnaires. The data is then checked by the Directorate-General Energy and some questions are asked to the regions. The answers to these questions can lead to some other minor conversions if needed. The three sets of regional data are then summed up, with the addition of federal data (offshore wind energy for instance).

Collection of data concerning sold volumes of transport and heating petroleum products (gasoline, road diesel, LPG and gasoil) on a regional level are organized. The federal authority (the Directorate-General Energy) launches surveys, consolidates the results and transfers the aggregated data to the regions.

More precisely, yearly surveys for public filling stations are launched in 2015 (data of 2014). If answering to the first survey is voluntary, from 2016 on two Royal decrees are successively adopted to ensure reporting obligations about the allocation of delivery for the distributors of gasoil and the suppliers to the petrol stations (the last one, dating from 15th November 2017, imposes the same reporting obligations as the previous one but introduces the notion of sampling). Results improve progressively thanks to the extension of the list of all public stations (the population) and the finetuning of estimates. In 2016 (data of 2015), the Directorate-General Energy undertakes a survey on private filling stations. Administrative data is currently investigated as another source for these filling stations.

The methodology is now mature and the survey for public filling stations is carried out annually. This methodology provides consistent results between national totals and the totals reported in the petroleum balance from 2015 data on (2014 data are less solid because some big filling stations did not respond to the first survey, as it was voluntary).

From 2023 submission on these results are used to estimate “fuel sold regional” for calculating regional emissions of road transport (CRT 1A3b). See chapter 1.2.8.2.1

In 2016 (data of 2015) again, a study concerning heating petroleum products is commissioned from a provider. However, the results are disappointing, in part because of an unrepresentative population of companies. Work is therefore carried out by the Directorate-General Energy on this population. At the beginning of 2019, the ENOVER/CONCERE working group on Energy Balances decides to launch a more limited (without sectoral approach) but exhaustive survey in autumn 2019 (data of 2018) and to organize a more complex survey among largest players in autumn 2020 (data of 2019). In 2022, survey is carried out on the year 2021. First analyses give coherent results for fuel oil and were discussed in the ENOVER/CONCERE working group on Energy Balances. The integration of these results in regional energy balances were discussed but not planned yet. It is planned that the distributor survey will be recurrent; currently it is planned every 2 years.

Concerning solid fossil fuels, annual questionnaire data are pure top-down data (in mass units) which are checked with regional data. Regional data are bottom-up data in energy units. Since it's only possible to report a calorific value for "industry" and not for each sub-part of industry, the same reporting quantities can differ between the mass balance and the energy balance where both are correct (in mass for the AQ and in Energy for MMR).

Several comparisons works were done, in 2014-2015 and 2018, leading to improvements in comparability. In 2014-2015, a harmonization of the end use allows an increase of the number of reporting companies for the federal statistics. It is to note that Belgium can't always use regional data for these fuels for several reasons: they are less disaggregated in regional balances (only "hard coal" and no disaggregation between "anthracite", "coking coal" and "other bituminous coal" for instance) and there is no commonly accepted total since it's not a network.
Concerning the last remaining coking plant and blast furnace installation, a meeting with the industry was held at the end of January 2020 and answers are given to major problems. The COVID-crisis prevented us to integrate the solution of these problems in the 2020 cycle but solutions were integrated as much as possible during the 2022 submission.

3.2.2 International bunker fuels

Category Memo Items

Emissions CO_2 International bunkering	Flemish region	Walloon region	Brussels region
Aviation	The international part [12]of total fuel supply (kerosene and aviation gasoline) from each regional airport and emission factors IPCC 2006	Fuel supply international aviation from regional airports and emission factors IPCC 2006	NO
Marine	Total fuel supply for international marine bunkers from Belgian petroleum balance and emission factors IPCC 2006	NO	NO

No international bunker activities take place in the Brussels region.

Information about the international bunkering originates from the regional energy balances. See also section 3.2.5 for more information about the activity data for international bunkering.

Flemish region:

Fuel supply is reported by the 4 most important regional airports, on a voluntary basis, to the compilers of the Flemish energy balance.
For a number of years now, 2 airports (Ostend-Bruges and Antwerp) have been reporting fuel data with a split in fuel for domestic aviation and international aviation, for the other 2 airports, the split international versus domestic is made, based on the output of the EMMOL-model, using EUROCONTROL data.
These energy data are used in combination with default emission factors from the IPCC 2006 guidelines to estimate the greenhouse gas emissions.

Historical submissions:

For the airports in Flanders, until the 15th April 2012 submission, the reported kerosene fuel amount in the regional energy balance (supplied amounts from the regional airports) was allocated to the bunker fuels and all gasoline (supplied amounts from the regional airports) was allocated to domestic air transport (see also section 3.2.8). Default IPCC 1996 emission factors were used to calculate the CO_2 emissions. Since the 29th October 2012 submission, as a result of the UNFCCC in-country review in September 2012, some missing emissions from the use of kerosene in the civil/domestic aviation were detected (based on flight

[12] The international bunker part of kerosene and aviation gasoline is estimated in the Flemish region by using the output of the EMOLL-model. The international share of the calculated fuel consumption (= output from EMOLL) for each year for each airport is used multiplied with the fuel supply of each airport on a yearly basis.

movements of Belgocontrol data) and added to this category. Consequently, some small emissions, from the kerosene part that were re-allocated to the civil/domestic aviation, were subtracted from the bunkers from the 2013 submission on.

Concerning the marine bunkering activities, the greenhouse gas emissions are estimated by using the default emission factors from the IPCC 2006 guidelines and the energy data from the Flemish energy balance (= Belgian energy balance, as marine activities take only place in the Flemish region). For 1990-2015 light and heavy fuel oil are the bunker fuels that are used and from the year 2016 on LNG is also included as a bunker fuel and taken into account in the natural gas consumption of the energy balance.

Walloon region:

In the Walloon region the bunker fuel consumption for the international air transport is given directly by the two Walloon airports. The emissions of CO_2 are calculated by using the IPCC 2006 emission factors. The emissions of CH_4 and N_2O are newly estimated by using the Eurocontrol data. Data on LTO activities and fuel consumption come from the statistics of the two main airports. Airports divide the statistics following domestic and international activities.
No marine bunkering activities take place in the Walloon region.

3.2.3 Feedstocks and non-energy use of fuels

Categories 2B

The emissions of non-energy use of fuels and related emissions (including emissions from recovered fuels from processes that are used as a fuel and not as a feedstock) are reported under categories 2B1, 2B8 and 2B10. During the 2015 submission a re-allocation of the offgas-emissions/recovered fuels from cracking units (biggest part) plus some other processes (non-energy use) emissions (reported in the category 1A2c / other fuels before), were moved to the category 2B8b Industrial Processes and Product Use / Chemical Industry / Petrochemical and Carbon Black Production / Ethylene as prescribed/obliged in the IPCC 2006 guidelines.

More information about the emission estimates in these categories can be found in chapter 4 in this NID. Besides a description of the follow-up of questions raised during the UNFCCC in-country review in September 2018 is also given in this chapter.

Feedstocks and non-energy use of fuels	Flemish region	Walloon region	Brussels region
Category 2B8 (recovered fuels)	Applicable	NA	NO
Category 2B1 (production of NH_3)	Applicable	Applicable	NO
Category 2B10 (other chemical processes)	Applicable	NA	NO

In Flanders, a recalculation of the non-energy use and related CO_2 emissions was performed during the 2005 submission, based on the results of a study conducted in 2003 (17). The default % of carbon stored in the IPCC Guidelines were considered to be inaccurate in the Flemish situation. The default % of carbon stored in the IPCC guidelines are not accurate defined: it is not clear what is included or excluded in these default % (f.i. is the waste phase included or not?). Belgium participated in a European network on the CO_2-emissions from non-energy use (website http://www.chem.uu.nl/nws/www/nenergy/ is not available anymore) and one of the conclusions of this network is that the new IPCC guidelines need to give more information on this subject. In our opinion, the guidelines are also not very clear on the allocation of the resulting emissions, a problem that should be tackled too: in the CRT table 1.AD, as part of the reference approach, a country should specify in the documentation box where these emissions are allocated.
As a result of the study a recalculation was made for all years. The effect of the recalculation was greater in the more recent years because the petrochemical industry has expanded its activities in the beginning of the nineties (that’s one of the reasons why this sector 2B8b is a key source for the trend assessment).

Since the petrochemical industry is important in Flanders and Belgium and the emissions from the feedstocks are a key source in the Belgian inventory, the study mentioned above was conducted to get more detailed, country-specific information. A distinction is made between:

1. The use of recovered fuels from cracking units or other processes where a fuel is used as raw material and where part of this fuel (or transformed product) is recovered for energy purposes. These emissions are reported under category 2B8. This is the largest source of CO_2 emissions. This includes the recovered fuels in the steam cracking units in the petrochemical industry (approx. 2/3) and other recovered fuels from the chemical industry (approx. 1/3). These recovered fuels are reported directly in the yearly surveys carried out by the chemical federation in cooperation with the VITO (18). From emission estimates from 2013 on, these emissions are taken over completely from the reported emissions via the ETS-Directive.

2. CO_2 emissions occurring during chemical processes, for example, the production of ammonia based on the use of natural gas (important source) or the production of ethylene oxide and production of acrylic acid from propene, production of cyclohexanone from cyclohexane, production of paraxylene/meta-xylene, carbon black, industrial gases, etc. where CO_2 is formed in a side reaction (reported respectively under 2B1 and 2B10). These CO_2 emissions result from the same surveys in the chemical sector in Flanders as those reported under 2B8 and are taken over from the reported emissions via the ETS-Directive (Directive 2003/87/EC) from emission estimates from 2013 on.
Emissions of flaring activities in the chemical industry are allocated to the category 5C1.2.b (Waste Incineration / Non-biogenic / Other / Flaring in the chemical industry).

3. Waste treatment of final products was not included in the study. This is practically impossible due to import/export of plastic products, etc. (it is also not clear if the waste phase is included in the default IPCC carbon stored % or not). For that reason, the emissions of waste incineration are calculated separately and are reported under the sector of waste (category 5C) or under the sector of energy (category 1A1a), depending whether or not energy recuperation takes place during the process.

3.2.4 CO2 capture from flue gases and subsequent CO2 storage, if applicable

Not applicable in Belgium.

3.2.5 Country-specific issues

Regional energy balances and related greenhouse gases

As mentioned above the most important sources to calculate the energetic greenhouse gas emissions in the 3 regions in Belgium are the regional energy balances.

These balances are established
- by the Flemish Institute for Technological Research (VITO) (18) in the Flemish region up to 2021 submission and from 2022 submission on, the Flemish energy balances are established by the Flemish Agency for Energy and Climate (VEKA);
- by the ‘Institut de Conseil et d’Etudes en Développement Durable’ (ICEDD) in the Walloon region;
- Until 2022, the Brussels energy balance was prepared by consultants, through public contracts with Bruxelles Environnement. Since 2023, the Brussels energy balance is produced by Bruxelles Environnement, who has carried out a complete review and update of the calculation methods and assumptions.

Consumption data of the regional energy balances are transferred to the energy sector (CRT category 1 Energy) of the regional CRT-tables to report the energy consumption data. Afterwards the regional energy consumption data are added up to obtain the national data.

The timing of publishing the final regional energy balances is not always compatible with the starting point of establishing the greenhouse gas emissions inventory (October – November of the year before the submission year). For this reason, the activity data from regional energy balances that are used in the CRT-tables might differ from the final regional energy balances. Several questions were already raised during reviews on this issue. For compiling the regional greenhouse gas emission inventories the most recent datasets from regional energy balances are used at the starting point of the compiling process. In some cases, an update of consumption data in the regional energy balances, between the starting point of compiling and submission of the greenhouse gas inventory occurs. If it concerns an important change, this might be still included during the same reporting cycle. However minor changes in energy data between these two moments are not taken into account and are transferred to the next cycle/submission.

Since the ERT recommended Belgium - during a few UNFCCC reviews (also in the last review in September 2018) - to report more transparently on the links between the CRT tables and the regional energy balances, the table below was included.

The corresponding regional energy balances are presented in Annex 8 of this NID.

For some categories, energy consumption data of the regional energy balance are not used to perform the regional greenhouse gas inventory. This is the case for:

- The category 1A3b ‘Road transportation’: This category is excluded from the table as these data originates from the federal energy balance.

- In the Walloon region:
    - Data for aviation are coming directly from the airport with a differentiation between national and international flights and fuel consumptions.
- In the Flemish region:
    - Energy data from civil aviation (1A3a) and military aviation (1A5b) is taken over from the EMMOL-model. Investigation to make the data consistent between the energy balance and the EMMOLL-model is still going on.

Inconsistency between energy data published in the energy balance and in CRT-tables because difference in timing of publication the data. This is the case for activity data and emissions of transport categories that are depending on the output of models (f.i. OFFREM, EMMOL). As a consequence, energy balances contain preliminary activity data and CRT-tables contain more recent data from the models involved.

Code IPCC - CRT	Description	Energy Balance Flemish region	Energy Balance Walloon region	Energy Balance Brussels-Capital region
1	Energy			
1A	Fuel Combustion Activities			
1A1	Energy Industries			
1A1ai	Public Electricity and Heat Production	Transformatie input - elektriciteit en warmte		Incinérateur
1A1ai	Public Electricity and Heat Production		TGV	Cogénération
1A1aii	Public Electricity and Heat Production		Turbojets TAG	Turbojets
1A1aii	Public Electricity and Heat Production		Incinérateurs (recup E)	Stations d'épuration
1A1ai	Public Electricity and Heat Production		Produc élec Autres	
1A1aii	Public Electricity and Heat Production		Produc cogen/chaleur	
1A1aii	Public Electricity and Heat Production		Autop elec	
1A1aii	Public Electricity and Heat Production		Tertiaire (Aut)	
1A1aii	Public Electricity and Heat Production		Agriculture (moteur)	
1A1aii	Public Electricity and Heat Production		Agriculture (Aut)	
1A1b	Petroleum Refining	Eigenverbruik transformatiesector - Raffinaderijen		
1A1ci	Manufacture of solid fuels	Eigenverbruik transformatiesector - Andere transformatie - cokesfabrieken		
1A1cii	Oil and Gas Extraction			
1A1ciii	Other Energy industries			
1A2	Manufacturing Industries and Construction			
1A2a	Iron and Steel	Energetisch finaal verbruik - *Industrie - Ijzer en staal excl. Solid fuels (allocated in 2C1)	Sidérurgie	
1A2b	Non-ferrous metals	Energetisch finaal verbruik - *Industrie - Non-ferro	Non-ferreux	
1A2b	Non-ferrous metals	Energetisch finaal verbruik - *Industrie - Non-ferro		
1A2c	Chemicals	Energetisch finaal verbruik - *Industrie – Chemie excl. Other fuels (allocated in 2B8)	Chimie Aut	
1A2c	Chemicals		Chimie	
1A2d	Pulp, Paper and Print	Energetisch finaal verbruik - *Industrie - Papier en uitgeverijen	Papier Aut	
1A2d	Pulp, Paper and Print		Papier	
1A2e	Food Processing, Beverages and Tobacco	Energetisch finaal verbruik - *Industrie - Voeding, dranken en tabak	Alim Aut	
1A2e	Food Processing, Beverages and Tobacco		Alimentation (-chemical plant)	
1A2f	Non-metallic minerals	Energetisch finaal verbruik - *Industrie - Minerale niet-metaalprodukten		
1A2f	Non-metallic minerals		Minéraux non métalliques	
1A2f	Non-metallic minerals		Verre (Aut)	
1A2f	Non-metallic minerals		MNM (Aut)	
1A2f	Non-metallic minerals		Sucrerie (chaux)	
1A2f	Non-metallic minerals		Papier (chaux)	

1A2gvi	Textile	Energetisch finaal verbruik - *Industrie - Textiel, leder en kleding	Textile	
1A2gvii	Mobile combustion in manufacturing industries and construction	Energetisch finaal verbruik - *Industrie - *Waarvan off-road Industrie	Chimie (offroad)	Off-road Industrie
1A2gvii	Mobile combustion in manufacturing industries and construction		Alimen offroad	
1A2gvii	Mobile combustion in manufacturing industries and construction		MNM (offroad)	
1A2gvii	Mobile combustion in manufacturing industries and construction		Papier (offroad)	
1A2gvii	Mobile combustion in manufacturing industries and construction		Autres industries (offroad)	
1A2gviii	Stationary combustion in manufacturing and construction: other	Energetisch finaal verbruik - *Industrie - Metaalverwerkende nijverheid + Andere industrieën (excl. * Waarvan off-road Industrie)	Autres industries aut	Industrie
1A2gviii	Stationary combustion in manufacturing and construction: other		Bois (Aut)	
1A2gviii	Stationary combustion in manufacturing and construction: other		Fabrications métalliques	
1A2gviii	Stationary combustion in manufacturing and construction: other		Fabrications métalliques (Aut)	
1A2gviii	Stationary combustion in manufacturing and construction: other		Autres industries	
1A3	Transport			
1A3a	Civil Aviation	energy consumption data from the EMMOLL-model and not from energy balance	Aérien	
1A3bi	Road Transportation: cars			
1A3bii	Road Transportation: Light Duty trucks			
1A3biii	Road Transportation: Heavy Duty trucks and buses			
1A3biv	Road Transportation: Motorcycles			
1A3bv	Road Transportation: Other			
1A3c	Railways	* energy consumption data from the EMMOSS-model (and IPCC default caloric values) not from energy balance (Transport – Spoorvervoer)	ferroviaire	Transport ferroviaire
1A3d	Domestic Navigation	*Transport - Scheepvaart	navigation intérieure	Transport fluvial
1A3e	Other			
1A3ei	Other transportation - pipelines	*Transport - Transport door pijpleidingen		Transport par conduites
1A3eii	Other transportation - other	*Transport - *Waarvan off-road tertiaire sector	Tertiaire offroad ports	Off-road Transport et entreposage
1A4	Other Sectors			
1A4a	Commercial / Institutional Combustion	*Residentiële en gelijkgestelde sectoren - Tertiaire sector, handel en administratie excl. *Waarvan off-road tertiaire sector		
1A4ai	Commercial / Institutional Combustion		tertiaire stat	Tertiaire

1A4bi	Residential stationary combustion	*Residentiële en gelijkgestelde sectoren - Huishoudens excl. *Waarvan off-road huishoudens	residentiel aut	
1A4bi	Residential stationary combustion		logement stat	Résidentiel
1A4bii	Household and gardening mobile combustion	*Residentiële en gelijkgestelde sectoren - Huishoudens - *Waarvan off-road huishoudens	logement offroad	Off-road Logement
1A4ci	Agriculture/Forestry/Fishing stationary combustion	*Residentiële en gelijkgestelde sectoren - Land- en tuinbouw, zeevisserij, bosbouw, groenvoorziening excl. zeevisserij en excl. *Waarvan off-road Land-en tuinbouw, zeevisserij, bosbouw, groenvoorziening	agriculture stat	
1A4cii	Off-road vehicles and other machinery from agriculture/forestry/fishing	Energetisch finaal verbruik - Residentiële en gelijkgestelde sectoren - *Waarvan off-road Land-en tuinbouw, zeevisserij, bosbouw, groenvoorziening	agriculture offroad	Off-road Agriculture, sylviculture et pêche
1A4cii	Off-road vehicles and other machinery from agriculture/forestry/fishing		tertiaire offroad esp verts	
1A4ciii	Fishing	*Residentiële en gelijkgestelde sectoren - Land- en tuinbouw, zeevisserij, bosbouw, groenvoorziening - zeevisserij		
1A5	Other (not elsewhere specified)			
1A5a	Other, stationary (including military)			
1A5b	Other, mobile (including military)	energy consumtion data of military aviation from the EMMOLL-model and not from energy balance (consistency is still under investigation) sector	Militaire	Off-road Défense
1A5b	Other, mobile (including military)	part of *Transport - *Waarvan off-road tertiair	Tertiaire offroad mil.	

During the ESD-review, based on the submission of January 2021, a generic question was asked to all member states about the reporting of biogas in the gas network by ETS installations and in the GHG inventory. The question was, if member states have upgraded biogas blended with natural gas in Belgian gas networks and if yes, do the member states report the related CO_2 emissions from biogas under memo items in the current inventory.
The regions in Belgium did investigate this issue and came to the following conclusion:

Walloon region:

> In October 2020 a first injection of biogas took place in the distribution network and was provided to 3 companies via the energy supplier Luminus. There are some other ongoing projects for the near future. This means that for 2020 the amounts are still limited. This will be followed up closely in future years.

Flemish region:

> Since 2018 a small amount of biomethane is injected in the net at one location in the Flemish region. In 2022 there are 3 locations with biomethane-injection into the natural gas grid. The Flemish energy balance includes this small amount in the final consumption of natural gas (cfr. Eurostat prescriptions). In the joint annual questionnaire for gas for reporting towards Eurostat/IEA, Flanders/Belgium reports this amount of biogas injected in the net in the category “Receipts from other sources – renewables”. At this moment this small amount is not redirected from gas towards the memo-item on biomass for reporting in the CRT-tables.

Brussels region:

To our knowledge there is no injection of biogas in the gas network in this region.

Flemish energy balance:

Since the mid-nineties, VITO established in commission of the Flemish Government a yearly energy balance. The first independent energy balance was set up for the year 1994. In 1999 the independent energy balance was set up for the reference year 1990. The years 1991 to 1993 are estimates, mainly based on a calculation derived from the Belgian energy statistics and energy data from the other regions (Flanders = Belgium minus Wallonia minus Brussels). Although the energy balances for the years 1991 to 1993 were set up as qualitative as possible with the available information and interpolation methods. As these years are not updated any longer on a yearly basis, some questions raised by the ERT of UNFCCC or EC during the reviews remain partly unanswered for these years. The Flemish energy balances, once approved by a committee with representatives of the Flemish administration and approved by the Flemish Government, are available for the general public on the website https://www.vlaanderen.be/veka/energie-en-klimaatbeleid-in-cijfers/vlaamse-energiebalans.

From submission 2021 on, VITO is no longer responsible for setting up the Flemish energy balances. The Flemish Agency for Energy and Climate (Vlaams Energie- en Klimaat Agentschap, VEKA), located in Brussels, establishes the yearly energy balances for Flanders from that moment on. Since 1 January 2021, the Flemish Energy Agency (VEA) has been reinforced with a part of the Energy, Climate and Green Economy (EKG) division of the Environment Department to be one single, autonomous agency of the Flemish government, namely the Flemish Energy and Climate Agency or VEKA. VEKA will continue to shape the energy and climate policy in Flanders.

Types of fuels reported meet the European/international standards and fuel definitions reported in de IPCC 2006 guidelines - see 1.4.1.1 Introduction – Data collection issues – Activity data - Fuel definitions – are used.
No combustion of peat takes place in the Flemish region.

By obtaining more accurate and/or more detailed information or by adapting some methodologies the data in the energy balances can change, also for the historical years. This is specific to energy balances as well as to emission inventories.

In general, the energy balance is performed by using the results of reporting obligations for:

- Electricity and natural gas grid managers (DSO – Distribution System Operator (Fluvius) - report offtakes per NACE code since 2003 for electricity, since 2005 for natural gas and TSO – Transport System Operator (Elia, Fluxys) - report offtakes per individual connection point since 2005 for both electricity and gas);
- Industrial, commercial and institutional companies with a primary energy use above the threshold of 0,1 PJ (a.o. yearly integrated environmental reports with energy consumption per fuel type and electricity use per individual company and sourcestream);
- Companies taking part in the ETS system (annual emission reports with activity data and emissions per individual company);
- Operators of CHP-installations, renewable energy plant operators, auto producers (this reporting obligation can also be fulfilled by providing the information necessary for the issuing of green certificates (renewable electricity production) or CHP certificates);
- Operators of big companies that meets the criteria of a non-SME have to carry out an energy audit every four years (aggregated results per sector per fuel type/electricity are used in the energy balances from the year 2017 on).

Also results of voluntary energy agreements, voluntary surveys are integrated in the energy balances. Examples of that are:

- Companies taking part in the voluntary benchmark and audit agreement between the industry and the Flemish Government. This agreement was running from the year 2003 until the year 2014. Results of the yearly monitoring reports per company or per sector were included in the energy balances.

- Companies taking part in the voluntary energy policy agreements (EBO) with the Flemish Government (= follow-up agreement of the benchmark and audit agreement). This agreement is running from the year 2015 on. Results of the yearly monitoring reports per company or per sector are included in the energy balances (if available in time).
- Until the year 2016 voluntary energy consumption surveys were annually sent out by
- VITO to companies not involved in the obliged reporting and companies not involved in the previously mentioned voluntary agreements (between sectors and the Flemish Government). These voluntary surveys were carried out in cooperation with several sector federations (Agoria -technological sectors, Fedustria - textile, wood and furniture and Fevia - food) or were carried out by the federation (f.i. Essenscia, the federation for the chemical industry) in cooperation with VITO.

Also existing statistics and results of models are used to set up the energy balance. This is f.i. the case in the transport sector where models, developed by those responsible for the emission inventory, are used in the balance.

From 2013 on the energy data reported by companies via the ETS-Directive (Directive 2003/87/EC) are integrated completely in the Flemish energy balances. From that moment on, besides the total energy balance, there is also made a split in ETS energy balances and non-ETS energy balances for each year.

Below a short description is given of the main data sources and methodologies used for the different sectors in the Flemish energy balance:

1) Transformation sector:

The <u>energy consumption of public electricity and/or heat production</u> is based on different data sources, depending on the year:

- Until 2003 surveys carried out by the Belgian Electricity Federation in cooperation with the VITO;

- From 2004 on annual obliged integrated environmental reports, reported to the Flemish Environment Agency and the Flemish department of Energy, Climate and Green Economy;

- From May 2005 obliged reporting for the producers of renewable heat, combined heat & power installations and the auto-producers in the Flemish region occurs on a yearly basis. This obliged reporting can also be fulfilled by providing the information necessary for the issuing of green certificates (renewable electricity production) or CHP certificates.

The data reported via the above data sources are used to determine the total fuel input, the output (electricity and/or heat) and the own-use of the sector of electricity and heat production.

Some additional data sources are used for the input and output and own use of waste incinerators with energy production: next to the annual obliged integrated environmental reports an extra semi-voluntary annex on electricity and heat recovery (and waste tariffs) has to be completed by operators of waste incinerators. Because of the biomass-part in the incinerated municipal and equivalent waste, waste incinerators can also receive green certificates for their green electricity production for a specific time-period, when specific conditions are met. Therefore, also the information from the reporting files for green certificates of the Flemish Energy Agency (the former VEA, since January 2021 VEKA) are used to complete the energy statistics for waste incinerators. To determine the green part of incinerated waste, information about the sorting analysis of the waste and the calorific values of the different fractions, available from the responsible waste institute in the Flemish region, are used. The waste-input of waste incinerators with energy recovery is allocated to the transformation sector - public electricity and heat production. As described, a part of the waste is considered as biomass. The not-renewable fraction of waste is therefore allocated to the category ‘other fuels’. The share of biomass is determined on the basis of a sorting analysis.

Be aware that the <u>fuel consumption of auto-producers</u> is <u>not</u> allocated to the transformation sector but to the (final) sector to which they belong. The data sources of the fuel consumption and the electricity (and/or heat) production of auto producers are the same as those of the public electricity and heat producers, mentioned above. So, from 2015 on the data for auto producers also originates from the obliged reporting of the auto-producers to the Flemish authority (the former VEA, since January 2021 VEKA) and from the reporting files of green certificates and CHP certificates, managed by the Flemish Energy and Climate Agency (the former VEA, since January 2021 VEKA).

The input and output figures of the refineries in Belgium (all refineries in Belgium are located in the Flemish region) are published in the Belgian petroleum balances made up by the federal services of Economy. All products/fuels used and produced are taken over in the Flemish energy balance. Only the output of the refinery gas is calculated and not taken over from the Belgian petroleum balance. The output of refinery gas is estimated as the sum of the input of refinery gas for the transformation sector (public electricity and heat), the own-use of refinery gas in the refineries and the end-use of the refinery gas in the final sectors (industry).
The data sources of the figures of own-use of the refineries are the annual emission reports obtained via the ETS-Directive, combined with data in the annual monitoring reports from the voluntary benchmark- and audit agreement and its successor the energy policy agreement, delivered via the sector federation.
Besides, information from the annual integrated environmental reporting obligations is assessed together with extra information/data delivered by some companies and these data are directly included. The combined heat and power installations of 2 big refineries in this region were installations in joint-venture with a public electricity producer and were allocated to the sector of electricity and heat (1A1a). Since the end of 2009, one of these installations was completely renewed and is from that moment on considered as an auto producer plant and consequently reported under 1A1b. Since 2019 the other CHP installation also became an auto producer and is reported under 1A1b from the 2021 submission on. A third refinery has installed a large auto-producer CHP unit in 2010. One of the refineries ended the refinery activities during 2020 and ended its storage activities in 2022.

The figures in the sector of the production of cokes are directly originating from the industry involved. From 1997 only one company in the Flemish region is still involved.

The **other activities in the transformation sector** are limited and only occurred in the early nineties..

The **losses** of electricity, natural gas and heat on the electricity grids, the gas grids and the heat networks are reported under the category “losses” in the Flemish energy balances. The emissions related to these losses of natural gas are **not** allocated to CRT category 1A1.

2) Industry:

The **non-energy use** in the energy balance consists of the of feedstocks of the chemical industry (mainly naphtha, propane/LPG/butane) and of the non-energetic use of some other products like white spirit, bitumen, solvents, …. In the course of 2003, a project was developed to estimate the non-energetic use in the Flemish region. See also chapter 3.2.3 for more information. The study was carried out in cooperation with the chemical sector federation. From that moment on and until the year 2016, yearly surveys were carried out and sent to all companies involved. Information about residual fuels (recuperation of products that are used as fuels) and their emissions of CO_2 as well as process emissions of CO_2 were reported in these surveys. These emissions are not allocated to CRT category 1A2 but to the CRT category 2B8.

The energy consumption of industry is calculated on the basis of a considerable number of individual companies’ annual energy consumption per fuel type. This energy consumption per fuel and per company are available in the data sources mentioned above in the introduction part of Flemish energy balances.
A brief repetition: obliged reporting as well as reporting within voluntary agreements and voluntary surveys are used. A complete dataset is available on the electricity and natural gas consumption in the Flemish industry, reported by the electricity and natural gas grid managers (DSO report offtakes per NACE code since 2003 for electricity and since 2005 for gas and TSO report offtakes per individual connection point since 2005).

The mentioned voluntary surveys in cooperation with the sector federations are no longer executed since the year 2017. The reasons are:

1) a (too) low responding rate and consequently less accuracy and relevancy and
2) since a higher number of companies are included in the (legal) obliged reporting systems, the need for extra surveys became less important.

Since we only have complete energy statistics on the Flemish level for electricity and natural gas and no complete regional statistics for petroleum products, some petroleum products of which we know they are widely used in Flanders like LPG (butane/propane), gas- and diesel oil, heavy fuel oil in certain sectors) are extrapolated on a sectoral level. This extrapolation method is based on the ratio of the known individual companies' electricity consumption versus the known total electricity consumption of the sector they belong to. Via this ratio, the known individual companies' consumption of petroleum products is scaled up to the sector level.
Some more information on the legal reporting by the electricity and natural gas grid managers in Flanders:
Since the liberalisation of the gas and electricity market it became difficult to obtain the consumption data of gas and electricity per sector. For this reason, from 2003 on, the distribution grid operators of electricity are obliged to report on an annual basis the offtake from their grid per sector (using the NACE codes). From 2005 on also the transport grid operator of the electricity net is obliged to report this information.
Since 2005 there is a comparable reporting obligation of the distribution and transport grid operators of natural gas.
These data, together with the results of obliged individual reporting on energy use by companies and the surveys carried out by VITO/VEKA, are used to estimate the electricity and gas consumption per subsector.

Also, since 2005 there is a reporting obligation for the producers of renewable electricity and/or heat, for combined heat-power installations and for auto producers. Besides also a reporting obligation exists for companies that produce green heat. These data are also integrated in the Flemish energy balances.

The consumption of the residual fuels in the chemical sector ('other fuels' in the energy balance) is estimated on the basis of the results of the survey carried out by the chemical federation Essenscia and information available from the ETS-data. In most cases the consumption in Joules of these residual fuels is available or the emission factor is known. In some cases, the consumption is not known and is therefore calculated on the basis of the available emissions of CO_2 with an estimated (expert judgement) emission factor of 70 kton CO_2/PJ. This part of emissions is included in the category 2B8b in the CRT tables instead of 1A2c/other fossil fuels (in which sector the energy consumption data are reported in the documentation box).

From 2017 on, new data became available from the obliged energy audits for the big industrial companies (this is a consequence of the Flemish implementation of the European Directive on energy efficiency 2012/27/EU). These data exist of consumption data per fuel type, aggregated by the Flemish Energy and Climate Agency, VEKA (former VEA Flemish Energy Agency) per industrial sub-sector. The involved companies have to fulfil an energy audit every four years, So, every four years energy consumption of these companies is known. The reported data are nevertheless used on a yearly basis in the energy balances. This estimate for the years in between 2 reporting years is done, using methodologies that take into account heating degree days for the part of the consumption that is sensitive to weather conditions.

3) Households:

The energy consumption of the households in the Flemish region for the base year <u>1990</u> is estimated based on a calculation model, developed by professor Hens of the University of Leuven. The housing stock in the Flemish region, in combination with some assumptions concerning the technical properties of the different types of buildings, are used in this model. The housing stock for the year 1990 is known via the population census of 1991. Electricity and natural gas consumption is available from BFE (former Belgian Federation for the electricity sector) and FIGAS (former Belgian federation for the gas sector).

For the years <u>1994 to 1999</u> the data from the Panel Study of Belgian households (PSBH) of 1995 are used to calculate the energy consumption of the households for the liquid fuels, coal and butane/propane. Because of the climate-dependent resource of the energy consumption in the households, a climate correction is used for the estimation. An assumption of 85% climate dependency of the energy consumption in households is used. For this climate correction, the degree-days are taken into account. The data of the Belgian Electricity Federation BFE and from FIGAS (federation of gas industry) are used for estimating the consumptions of electricity and gas.

For the years 2000 and 2001 the energy consumption of the households in the Flemish region is calculated based on the results of a survey ‘energy and energy efficient behaviour 2001’, (VEA). These results are combined with statistics on the number of households and dwellings, the results of the socio-economic census of 2001 (percentage of respondents per fuel type for heating purposes). The energy consumption in 2001 is based on the same results of the survey in combination with an extrapolation based on the number of buildings in the Flemish region and the relative share of fuel type used in the buildings for heating purposes, originating from the socio-economic census of 2001. Again, the data of the Belgian Electricity Federation and from FIGAS (federation of gas industry) are used for estimating the consumption of electricity and gas.

From 2002 on, a methodology was developed that calculates first the number of households in the Flemish region with their main-heating source: on natural gas, LPG/propane/butane, liquid fuel, coal, biomass and electricity. Afterwards the consumption of the fuels is calculated based on statistics from FIGAS or from the grid operators (gas), results of surveys (liquid fuel, coal, biomass) performed by the Flemish Energy Agency and other statistical data. The consumption of electricity is based on the information of the distribution grid operators.

Since the submission of November 2013, Flanders made recalculations for the use of biomass (for 1990 to 2016) and the use of fuel oil (2002 – 2016) for households using new data. A description of those recalculations is provided below:

- For biomass, a methodology was developed, using the most recent information and insights (including data from a survey Belgium performed with financial aid of Eurostat (19). In a report from 2013 (20), the methodology, that was agreed upon by the steering committee of the Flemish energy balance, is described. The methodology uses the urbanisation degree and unweighted average uses of biomass as main heating source or as secondary heating source (per household) from the Eurostat survey to calculate the total biomass used for the period 1990 -2018. The method to variate the average use per household per year is based on heating degree days.
- For fuel oil, the data from 2002 were based on an estimate of the number of households from the latest census of 2001 using heating oil as main energy source, corrected with newly built homes (+) and demolished houses (-). The switch in existing houses from fuel oil to natural gas was not taken into account, leading to an accumulated overestimation of households using fuel oil as main energy source. The steering committee of the Flemish energy balance requested to recalculate the time series from 2002 on, taking into account this switch that has taken place. The methodology and results of this recalculation are presented in a report and agreed upon by the steering committee in January 2014 (21) and taken into account since the 2014 submission.
- For coal, the same switch to natural gas was taken into account during previous submission for the years from 2002 on.
  From the 2020 submission on, Flanders made new recalculations for the following aspects within the residential sector (building further on the existing methodologies, mentioned above):

Changes that affected more than one fuel type:

- A new survey on the year 2018 was conducted by the Flemish Energy Agency, results from that survey are included in the methodology for estimating the energy use of gas- and diesel oil and coal (a graphic report is published on the following webpage: https://www.energiesparen.be/marktonderzoek direct link to graphic report: https://www.energiesparen.be/sites/default/files/atoms/files/Grafisch rapport REG enqu%C3%AAte 2019.pdf)
- The shares of the number of households per principal fuel type (for heating) and the average use of gas-and diesel oil per household and the average use of coal per household for the year 2017 changed and 2018 was added to the time series.
- A revision of the previous used shares of households per principal fuel type for heating for the years 2002, (2003), 2014, (2015), 2016, (2017). This revision was necessary for consistency reasons (Consistency in the treatment of the different surveys). The years between brackets

are years in which no survey was carried out, but in which the resulting shares also were influenced by changing the survey years.

- Change of the total number of households in Flanders for all years.

Extra changes affecting the energy use of gas- and diesel oil:

- A revision of the previously used average gas- and diesel oil consumption per household for 2002-2018;
- Recalculation of the number of households with gas- and diesel oil as principal fuel type for heating due to new statistics on heat pumps (affecting the total number of households with electricity as principal 'fuel type for heating) and a revision of the number of households with natural gas as principal fuel type for heating for the years 2002 and 2003.

Extra changes affecting the energy use of coal:

- A revision of the previously used average coal consumption per household for 2002-2018.
- A correction in the estimation of the coal use for secondary heating (not as principal heating fuel).

Extra changes affecting the energy use of LPG/propane/butane:

- For 2002-2005: Change of the energy use of LPG/butane/propane by using a new methodology: LPG use for Belgium for 2002-2005 reported to Eurostat (in the framework of Regulation (EC) No 1099/2008 on final energy consumption in households) multiplied with a regional allocation key (for Flemish region) based on data for the year 2016.
- For 2016-2017: Belgian and regional LPG use for households were determined by the Federal Public Service Energy in the framework of Regulation (EC) No 1099/2008 on final energy consumption in households. This data was approved by the interregional-federal consultative body, called 'ENOVER' and were integrated in the Flemish energy balances. For 2018 provisional data was used.

Update of consumption of gasoline for off-road energy use in gardening machines for the years 2016 and 2017 and an update of gasoline for off-road use in squads for the year 2017 because of an optimization of the OFFREM-model in May 2019 for the years 1990-2017.

In submission 2021, the methodology described above is still used. The only recalculations that were performed, since the previous submission (2020):

- an update of the gasoline consumption for off-road use of garden machinery and quads for the years 2014-2018 was included. This was due to a new version of the OFFREM-model, that recalculated the whole time-series (1990-2019). In the energy balances the years 1990-2013 were not updated.
- An update of the data sources and the methodology to estimate the green heat production/consumption by heat pumps was included. This does not affect the emissions.
- An update for the natural gas consumption for households for the year 2017, from the grid managers was included.
- The preliminary consumption of LPG/propane/butane for 2018 was replaced by the final amount from the Belgian OIL statistics, reported to Eurostat.
-

In the submission of 2022, the methodology described above is still used. The recalculations that were performed, since the previous submission (2021):

- The number of households using wood as principal heating source was update for the years 2016-2020 as well as the number of households using wood as additional heating source. The results of a study on wood appliances (VMM, 2018) were used (affecting memo-item biomass and gasoil consumption).
- The number of households using gasoil as principal heating source was updated to align on the changing numbers with principal heating on wood.

- Consumption of charcoal was estimated for the first time in the Flemish energy balance for the years 2016-2020 (= memo-item biomass) based on Belgian consumption of charcoal and a regional allocation key.
- An update of the gasoline consumption for off-road use of garden machinery and quads for the years 2016-2019 was included, due to a new version of the OFFREM-model. In the energy balances the years 1990-2015 were not updated.
- An update of the data sources and the methodology to estimate the number of households with a heat pump as principal heating source was included for the years 2016-2020. This does also affect the number of households with fuel oil as principal heating source.
- An update for 2016-2019 of the Belgian and regional LPG use for households was determined by the Federal Public Service Energy in the framework of Regulation (EC) No 1099/2008 on final energy consumption in households. For 2020 provisional data was used.

In this submission 2023, the methodology described above is still used. The most important recalculations that were performed, since the previous submission (2022):

- The average gasoil consumption per household for the years 2016-2020 was revised.
- An update of the consumption of charcoal was included for the years 2016-2020 (= memo-item biomass).
- An update for 2016-2020 of the Belgian and regional LPG use for households was determined by the Federal Public Service Energy in the framework of Regulation (EC) No 1099/2008 on final energy consumption in households. For 2021 provisional data was used.
- An update of the gasoline consumption for off-road use of garden machinery and quads for the years 2016-2020 was included, due to a new version of the OFFREM-model. In the energy balances the years 1990-2015 were not updated.

In the submission 2024, the methodology described above is still used. The most important recalculations that were performed, since the previous submission (2023):

- The number of households using heat from heat networks was updated for 2018-2021, affecting also the number of households heating on gasoil, resulting in a change of gasoil consumption.
- Small changes in the natural gas consumption for 2021 due to an update of the data of 1 DSO grid manager and due to a shift from the consumption in identified social housing and service flats that was misallocated to the tertiary sector.
- An update for 2016-2021 of the Belgian and regional LPG use for households was determined by the Federal Public Service Energy in the framework of Regulation (EC) No 1099/2008 on final energy consumption in households. For 2022 provisional data was used.
- An update of the gasoline consumption for off-road use of garden machinery and quads for the years 2016-2021 was included, due to a new version of the OFFREM-model. In the energy balances the years 1990-2015 were not updated.

4) Commercial and institutional sector:

The estimation of the energy consumption of the service sector is based on a number of individual companies' annual energy consumption per fuel type. This energy consumption per fuel and per company are available in the data sources mentioned above (in the introduction part of Flemish energy balances and summarized in the methodology of industry).
So, obliged reporting as well as reporting within voluntary agreements and voluntary surveys are also used for the service sector. Here, also a complete dataset is available on the electricity and natural gas consumption in the Flemish commercial and institutional sectors, based on the reporting by the electricity and natural gas grid managers (DSO report offtakes per NACE code since 2003 for electricity and since 2005 for gas and TSO report offtakes per individual connection point since 2005).

Next to the data sources with energy consumptions on individual company basis also aggregated datasets on energy consumption for specific central organized services (like military services, railway services, post services, universities) are included in the estimations of the energy consumption. In addition, data from an energy cooperation agreement between the Flemish Government and communities and provinces were integrated for the years 2008-2013 for all involved municipal and provincial buildings/services. For 2014-2016, these data were provided by the grid managers on an anonymous basis and from 2017 on, these data are not available any more for integration in the energy balances.

The mentioned voluntary surveys in cooperation with the sector federations are also no longer executed for the commercial and institutional sectors, since the year 2017 (as in industry), because of the low response rate.
Even after the reporting obligations for the distribution grid operators (since 2003) and the transport grid operators of electricity (since 2005) and the gas operators (since 2005) it remains difficult to split up the consumption of the DSO grid into the different subsectors of the service sector.

From the year 2017 on, new data became available from the obliged energy audits for the big companies (this is a consequence of the Flemish implementation of the European Directive on energy efficiency 2012/27/EU). These data exist of consumption data per fuel type, aggregated by the Flemish Energy and Climate Agency, VEKA (former: VEA Flemish Energy Agency) per sub-sector and eliminated from energy consumption that was already included from other data sources mentioned above. The involved companies have to fulfil an energy audit every four years, So, every four years energy consumption of these companies is known. The reported data are nevertheless used on a yearly basis in the energy balances. This estimate for the years in between 2 reporting years is done, using methodologies that take into account heating degree days for the part of the consumption that is sensitive to weather conditions.

Since we only have complete energy statistics on the Flemish level for electricity and natural gas, but no complete statistics on petroleum products a comparable extrapolation method as in industry is used to estimate tot total consumption of some petroleum products (LPG (butane/propane), gas- and diesel oil) in Flanders per tertiary subsector.

In the submission 2022 the consumption of charcoal in the commercial sector was estimated for the first time in the Flemish energy balance for the years 2016-2020 (= memo-item biomass) based on Belgian consumption of charcoal and the use of a regional and sectoral allocation key.

In the submission 2023, this sectoral allocation key was eliminated, since it was unreliable. Consequently, all charcoal is allocated to the residential sector. There was also a re-allocation of natural gas consumption of 1 company implemented. This caused a shift from tertiary sector to agriculture for the years 2017-2020.

In this 2024 submission, the extrapolation percentages for estimating gasoil consumption of the year 2021 are re-used for 2022, since the sample of companies in the services sector with gasoil consumption for the year 2022 was too small.

5) Agriculture:

The calculation of the energy consumption in agriculture was originally based on the use of specific parameters from literature i.e. the energy consumption per unit or per animal. A lot of statistical information was available from the national statistics and the services in the policy areas of agriculture and fishery of the Ministry of the Flemish Community. National statistics were publishing on an annual basis detailed data about the agricultural census/counts (on the 1th of May).
Statistics about the hectares of agricultural crops and the number of animals were used to estimate the energy consumption of the different subsectors. The consumption of gas and electricity is based on the data of the grid operators of gas and electricity. All consumption of gas was in historical years allocated to the greenhouse cultivation. For the electricity consumption the division into the different subsectors is performed by using the specific parameters from literature except for the greenhouse cultivation. The electricity consumption of the greenhouse cultivation is total electricity consumption (from grid operators) reduced with electricity consumption of the other subsectors. The energy consumption of the other energy carriers is based on the specific parameters from literature.

From the year 2007 on, a different approach is used. The Agricultural Monitoring Network (LMN - Landbouw Monitoring Network) collects since 2007 (22) data on energy use (agricultural accounts), within a representative sample of agricultural businesses. These accounts are managed by the Department of Agriculture and Fisheries of the Flemish government. This department together with the VITO developed a methodology to extrapolate the collected data and incorporate the data from auto producer (CHP) units for Flanders in total (for petroleum products, solid fuels, biomass).
The total electricity and natural gas consumption is available from the legal reporting by the grid operators.

The data source for the off-road energy consumption for forestry and landscape operations is the OFFREM model, administered by the VMM. Data reported in the inventory are a more updated version compared to the data reported in the energy balances which are officially reported in an earlier state.

For the energy consumption of the sector sea fishery the EMMOSS-model is used. The VMM, responsible for setting up the greenhouse gas inventory in the Flemish region, updates this model on a yearly basis.

6) Transport:

road transport:
The output of the COPERT 5.4.36 model that was used for the submission 2021, is used for the establishment of the Flemish energy balance for the years 1990-2019, with little adaptations for the bio % of bio-gasoline and bio-diesel.
The adaptation of a Royal Decree in Belgium 11 March 2003, organizing the collection of data for fuel statistics, was a first step in the collection of annual sales data by type of fuel, and by Belgian region (as part of the collection of data on national level). At present, regionalized fuel sales data are produced on a recurring basis, according to a validated and identical methodology for the 3 Belgian regions. Nevertheless, the data are available only from 2015 on for public pumps, and only for one year 2015 for private pumps. The Flemish Region uses the regionalised data (federal data multiplied by the regional distribution key of the year 2017*) by integrating them into its energy balance for the first time for the year 2020 for gas-and diesel oil (fossil part and biomass part) and for gasoline (fossil part and biomass part) and did this also for the years 2021-2022. The compressed natural gas consumption (CNG) as well as the liquified natural gas consumption (LNG) for road transport in the Flemish energy balance is, as of the publication of the energy balance for 1990-2020, derived from regionalised federal statistics for the years starting from 2016. Only the consumption of liquid petroleum gases for road transport in the Flemish Region is still originating from the COPERT model for the years until 2021, with a provisional estimate for 2022, based on COPERT 5.6.1 model output (fuel sold version) for the year 2021 (submission 15 March 2023) and the Belgian trend of LPG consumption from 2021 to 2022.

railways:
The data (tkm) from the National Society of the Belgian Railways (NMBS) are used to calculate the energy consumption for the train services in Belgium. These data were available for the transport of persons and goods and for electricity and gasoil driveng until the year 2013. From the year 2014, the gasoil consumption is calculated with EMMOSS model (see 3.2.8) and included in the Flemish energy balances.
In the Flemish energy balance the electricity consumption from railways from 2009 on is delivered by the railway manager Infrabel (also available via open data). For the years before, data were reported by the railway company NMBS.

trams:
The energy consumption of the trams (only electricity) in the Flemish region is based on the electricity consumption data from the electricity grid operators (DSO, TSO) for the total railway traffic (train + tram + trolley busses) for the years 2002 and 2003. For all other years, the electricity use for railway traffic (train, tram and trolley bus) from the grid managers is lower than the electricity use, received (or estimated on the basis of) from the separate data sources for train, tram and trolley buses. Therefore, the available statistics from the Flemish public Transport Society (De Lijn) and the Society for the Inter-urban Transport in Brussels (MIVB) are also used for estimating the electricity use from trams for the other years. For this estimate an average electricity consumption per kilometre and the total driven kilometres by trams per year are used.

trolley busses: The same methodology as for the trams is used here.

air traffic: All the Flemish airports annually reports their fuel supplies of gasoline and kerosene for the civil air traffic. The fuel supply of kerosene and gasoline used in military aviation are reported annually by the Ministry of Defence. Not all the airports themselves are in the possibility to split the fuel supplies in an international and domestic part. In the past all kerosene was therefore allocated to international bunkers and all aviation gasoline was allocated to national aviation. From the energy balances of year 1990-2016 on, a split up of the kerosene and aviation gasoline in an international and domestic part is carried out for the civil aviation (for military aviation the approach of kerosene for bunkers is still in use). The domestic fuel supply is estimated by multiplying the domestic share per airport of the calculated fuel consumption (as a result from the EMMOL-model) for aviation gasoline and for kerosene with the total fuel supply of aviation gasoline and kerosene for each airport on a yearly basis. The international fuel supply (international bunkering) is estimated by multiplying the international share per airport of the calculated fuel consumption (as a result from the EMMOL-model) for aviation gasoline and for kerosene with the total fuel supply of aviation gasoline and kerosene for each airport on a yearly basis.

navigation: Two subsectors are distinguished in the sector of navigation in the Flemish region: the navigation on the Flemish territory and the navigation which is allocated to the international bunkers. For calculation of energy consumption on the Flemish territory there is a division in inland waterways and sea navigation with departure and arrival in Belgian sea ports. Both are calculated with the EMMOSS model, administered by the VMM (see 3.2.8). The Flemish bunkers are the same as the Belgian bunkers because the Flemish region is the only region which is located to the seaside in Belgium. The Belgian data of international bunkering in the navigation sector are originating from the national petroleum balance (annual OIL questionnaire for Eurostat).

transport through pipelines:
There is some energy required to transport gases and liquids (for liquids: negligible amount of energy) through pipelines. The energy consumption needed for the transport, the transit and the distribution of gas in the Flemish region, is estimated based on data from Fluxys and from Gasco and the grid operators. Fluxys is the independent operator of the high-pressure natural gas network in Belgium. Gassco is an operating company, engaged in the extraction of Natural Gas Liquids from Norwegian origin.

Walloon energy balance

The regional energy balance is prepared by ICEDD in convention with the 'DGO4' (Energy administration of the Walloon region).

The report of the regional energy balance is available in French, but not in English and can be found on the following website: http://energie.wallonie.be/fr/bilan-energetique-wallon.html?IDC=6288. The summary of the two last energy balance (2020-2021) is presented in annex 8.

As in Flanders, the energy balance is performed by using the results of surveys and by using existing statistics.

There are no legal obligations of reporting energy consumption, the Walloon region had a tradition of contacting the most important consumers on a voluntary basis to give their energy consumptions.

The energy data reported by companies via the ETS-Directive (Directive 2003/87/EC) are taken over in the Walloon energy balance.

In what follows a short description is given of the main data sources and methodologies used for the different sectors in the energy balance:

1) Transformation sector:

The production figures of electricity are available from surveys to different operators as grid operators of gas and electricity, auto-producers and operators of renewable energy.
The energy consumption of power installations for the production of electricity and/or heat is based on the REGINE survey (an environmental integrated survey which includes all pertinent environment-related reporting requirements for 300 companies). These data are simultaneously available by the inventory expert and the energy statistics experts.
The figures in the sector of the production of cokes are directly originating from the industry involved, since 2014 no more coke plants are operational.
This sector corresponds to the category 1A1a in the CRT tables except for the auto producers which are included in the respective categories (1A2 and 1A4ai).

2) Industry:

The energy consumption of the industry sector is calculated on the basis of surveys and extrapolations: A part of the data from the companies are reported to Regine (280 companies) and 800 others companies reports also their data.
The consumption data of electricity (high voltage) and gas per sector are given by the CWaPE (Walloon commission for energy).
The consumption and production data of the auto producers and the producers of renewable energy are also given by the CWaPE.
The petroleum products are extrapolated on the basis of electricity consumption.
The non-energy use in the energy balance is the sum of feedstocks in the chemical industry (natural gas) and some other products like solid fuels, grease, mineral oil, … which are used in a non-energetic way. The solid fuels and the natural gas are listed with the annual survey. The others fuels are estimated with federal data extrapolated with the part of the Walloon region in the considered sector and the annual survey.
This sector corresponds to the category 1A2 of the CRT tables.

3) Households:

The energy consumption of the households' sector is calculated on the basis of regional data on the amount of natural gas and electricity sold in this sector (CWaPE), on the basis of national data (liquid fuels and solid fuels), on the basis of the socio-economic survey of 2001 and on the basis of weather data. Since the 2014 submission, AWAC has made recalculations for the use of biomass (for 2002 to 2011) using the data from a survey Belgium performed with financial aid of Eurostat. During the 2019 submission, the liquid fuel activity data were recalculated since 2010 to take into account the Belgium biennial surveys on the household sector consumptions. The new estimate was based on the Walloon share of the sector's Belgian consumption (taken from the EBM survey - Household Budget Survey), and the total Belgian gasoil consumption of the sector (taken from the Energy Balance published by the SPF Economy and Eurostat on their respective websites). During this submission, the sales from the distributors (Belgian survey) were directly used in the energy balance for the year 2021 and 2022. These data determine the regional and sectoral shares of the gasoil consumption. The amount of liquid fuels used for off-road-activities is included in this sector. This sector corresponds to the category 1A4b of the CRT tables.

4) Commercial and institutional sector:

The energy consumption in the service sector is calculated using the energy data of different sources (regional data on the amount of natural gas and electricity sold in this sector (CWaPE), annual survey carried out by ICEDD for all consumers 'high voltage' (4800 establishments with a respond of 58 %). Since this submission, the amount of liquid fuels used for off-road-activities is included in this sector and no longer under the road transportation category. The off-road emissions from the airports and harbours are also included in this sector. This sector corresponds to the category 1A4a and 1A3eii of the CRT tables.

5) Agriculture:

The calculation of the energy consumption in agriculture is based on the use of specific parameters from the 'Faculté des Sciences agronomiques de Gembloux' i.e. the energy consumption per unit or per animal. A lot of statistical information is available from the regional statistics (DGA). The off-road emissions from the forestry are also included in this sector. This sector corresponds to the category 1A4c of the CRT tables.

6) Transport:

The energy consumption data in the transport sector contains only the consumptions of the real transport activities. No other energy consumption data are included (f.i. from buildings, storage areas, … from transport companies). For the different transport modes other methodologies are used to estimate the energy consumptions.

road transport: CO_2 emissions calculated for road transport do not originate from the regional energy balances but from the figures of the national oil balance. On the regional level the COPERT V model is used for policy purposes and for the estimation of CH_4 and N_2O emissions.

railways: The data from the National Society of the Belgian Railways (NMBS) are used to calculate the energy consumption for the train services in Belgium. These data are available for the transport of persons and goods and for electricity and gasoil driving. The total consumption of gasoil in the Walloon region is based on the Belgian data of gasoil consumption and the regional information on driven train- and tonne-kilometres of persons and goods. This sector corresponds to the category 1A3c of the CRT tables.

air traffic: the fuel consumption (put in the tanks) of gasoline and kerosene for the civil air traffic is given by the two major airports. The fuel consumption of kerosene and gasoline used in military aviation are reported annually by the Ministry of Defence. This sector corresponds to the category 1A3a and 1A5b of the CRT tables.

navigation: The energy consumption for the traffic is given by the SPW-DGO2 'Direction générale opérationnelle de la mobilité et des voies hydrauliques' and is based on the tonne-kilometres on the different rivers and channels and an average energy consumption per tonne-kilometre. This sector corresponds to the category 1A3d of the CRT tables.

Pipelines (losses of distribution in the energy balance): There is some energy required to transport gases and liquids (negligible amount of energy) through pipelines. The energy consumption needed for the transport, the transit and the distribution of gas in the Walloon region is estimated based on the figures from Fluxys (the independent operator of the gas network in Belgium). This sector corresponds to the category 1A3ei of the CRT tables.

Brussels energy balance

The annual reports of the regional energy balance for Brussels are available on the Bruxelles Environnement's website (https://environnement.brussels/citoyen/outils-et-donnees/etat-des-lieux-de-lenvironnement/energie-etat-des-lieux?highlight=bilan%20%C3%A9nerg%C3%A9tique).

Until 2022, the Brussels energy balance was prepared by consultants, through public contracts with Bruxelles Environnement. Since 2023, the Brussels energy balance is produced by Bruxelles Environnement, who has carried out a complete review and update of the calculation methods and assumptions.

All processing and calculations are automated using a dedicated IT tool, which allows the calculation of time series from 1990 onwards. Wherever possible, the entire time series is updated in line with new methodologies and/or new data sources available. At a minimum, the update is carried out from 2014 onwards.

As in the other regions, the energy balance is performed by using the results of existing statistics and additional surveys.
Hereunder a short description is given of the main data sources and methodologies used per sector in the energy balance:

1) Transformation sector:

The electricity and/or heat productions are calculated on the basis of regional data received from BRUGEL (the regulator for electricity and natural gas in the Brussels-Capital Region; through the Green Certificates), from Bruxelles Environnement (through the Energy Subsidies granted for the installation of heat pumps or solar thermal panels; and through the EPB Certificates for households), from Bruxelles-Energie (incineration of household and household-like waste) and from other data providers (SIBELGA, Aquiris, Hydria, ENGIE, etc.). Before 2014, data from the federal public service for energy (SPF) were also used.

The primary energy consumption of power installations for the production of electricity and/or heat is based on data from direct contacts (Bruxelles-Energie, SIBELGA, Aquiris, Hydria, ENGIE, etc.), and calculation assumptions discussed and validated by experts. Before 2014, data from the annual reporting obligations associated to environmental permits and from a specific survey were also used.

2) Industry:

The energy consumption of electricity and natural gas of the industry sector is calculated on the basis of regional data received from SIBELGA and ELIA (the distribution and transportation network operators for electricity and natural gas in the Brussels-Capital Region). The total consumption of professional customers, i.e. those in the industrial and tertiary sectors, is known. For large consumers, the available consumption is partially distributed by NACE. The consumption of all small consumers, but also of certain large consumers, is however not broken down by NACE. To break these down by NACE, assumptions are made for a breakdown on the basis of the available distribution data (for large customers), after removing certain large customers who are supposed to have no equivalent in small customers (example: municipal incinerator, waste water treatment plants, etc.).

The consumption of heating oil is estimated on the basis of the federal survey of distributors (sales), after application of the regionalisation and sectorisation breakdown keys derived from this survey. The sector breakdown is further refined by branch of activity based on data collected until 2019 as part of the energy reporting linked to environmental permits.

For other fuels, due to the lack of precise data, the final consumption in 2013 is extrapolated taking degree days into account.

Before 2014, data from a specific survey focusing on the biggest energy consumers were also used (extrapolation to the whole industry sector was performed based on electricity consumptions), as well as data collected through reporting obligations associated to environmental permits.

3) Households:

The electricity and natural gas consumptions of the household sector is received from SIBELGA. Calculations are made to take into account the self-consumption of electricity by household prosumers, as well as the electricity used to charge the batteries of electric vehicles (which is reported in the transport sector).

The total consumption of heating oil is estimated on the basis of the federal survey of distributors (sales), after application of the regionalisation and sectorisation breakdown keys derived from this survey.

The heat consumption is calculated on the basis of regional data from BRUGEL (through the Green Certificates) and from Bruxelles Environnement (through the Energy Subsidies and the EPB Certificates), taking into account the self-consumption of heat by household prosumers.

The charcoal consumption is obtained from sales in Belgium (Prodcom and BNB datat) regionalised on the basis of the number of houses per Region (Statbel).

For other fuels, the energy consumption is evaluated on the basis of the national socio-economic survey of 2001, the energy consumption survey for Belgian households of 2011, the energy performance in building certificates, regional statistics, specific surveys, weather data and other hypotheses validated by experts. Before 2014, data from FeBuPro (for butane and propane) and national data from SPF EPMECME (for liquid and solid fuels) were also used.

4) Commercial and institutional sector:

As for the industry sector, the natural gas and electricity consumption in the commercial sector is evaluated on the basis of regional data received from SIBELGA and ELIA. The total consumption of professional customers is known and, for large consumers, a partial breakdown by NACE is available. The available breakdown is then applied to consumption that is not distributed by NACE (i.e. that of small consumers and a few large consumers), after eliminating the bias caused by certain large consumers that a priori have no equivalent in small consumers (e.g. municipal incinerator, waste water treatment plants, etc.). The electricity consumption for charging the batteries of electric vehicles is deduce from the total electricity consumption. The self-consumption of electricity by commercial prosumers is also taken into account. CNG consumption for transport is assumed to be taken from the natural gas distribution network in the retail sector.

The heat consumption is calculated on the basis of regional data from BRUGEL (through the Green Certificates) and from Bruxelles Environnement (through the Energy Subsidie), taking into account the self-consumption of heat by professional prosumers.

The consumption of heating oil is calculated on the basis of sales from the federal survey of distributors, after application of the regionalisation and sectorisation breakdown keys derived from this survey. The sectorization is refined by branch of activity based on data collected until 2019 as part of the energy reporting linked to environmental permits.

For butane/propane, due to the lack of precise data, the final consumption in 2013 is extrapolated taking degree days into account. Unit 2013, consumption was evaluated on the basis of Belgian sales.

5) Agriculture:

Agricultural activities are very limited in the Brussels region. The energy consumption of electricity and natural gas of agricultural activities is calculated based on the regional data received from SIBELGA. Off-road energy consumption and emissions from the agriculture sector are also evaluated and reported in the Brussels energy balance and the CRT 1A4cii section.

6) Transport:

The evaluation of energy consumptions of transport activities is extended to all persons and goods transporting activities. 'Static' consumptions from transport companies (buildings, storage areas...) are included in the commercial sector.

Different methodologies are used depending on the transport modes:

road transport: the consumption of gasoil, gasoline and LPG by road transport is supplied by the regionalisation of fuels sales from the federal petroleum statistics. For CNG and electricity, regional values based on road mobility are calculated using the COPERT V software.

railways: the energy consumption of rail services (electricity and gasoil) is calculated using data from the National Society of the Belgian Railways (SNCB), from the Belgian railway infrastructure manager (Infrabel) and from the Intercommunal Transport Company in Brussels (STIB).

air traffic: this activity does not occur in the Brussels-Capital region.

navigation: the energy consumption from local river traffic is calculated based on data from the Brussels harbour (Port de Bruxelles).

pipelines: the estimation of the energy consumption required for the transport of gas in the Brussels region is based on figures from Fluxys (the independent operator of the gas network in Belgium).

Energetic greenhouse gas emissions of CO_2

In case no other, more accurate data are available the following IPCC-default emission factors of 2006 are used for calculating the emissions of CO_2 from combustion processes.

From the reporting of emissions of 2013 on, all ETS-data are integrated in the Belgian greenhouse gas inventory.

The consistency of the reported emissions of CO_2 in the complete time series is ensured by various means, such as trend analysis and an average EF calculated by the plant or estimated in consultations with the federations and companies involved and applied to the time series. In addition, industrial companies were contacted to confirm emissions through their annual obligatory environmental reporting. Deviations in reported emissions between EU ETS and annual emission reporting were explained by the fact that not all installations were EU ETS installations. This information is very important in understanding the consistent reporting of emissions. These emission factors are summarized below.

Products	**emission factors (g CO_2/MJ)**		
	Flanders	Wallonia	Brussels
coal tars	94,6	-	
coking coal	94,6 [6]	94,6	94,6
Butane/propane	63.1	63.1	63.1
coke oven coke	107	107	
crude oil	73,3	-	-
Refinery gas	55,1 - 56,5 [1]	-	-
LPG	63,1	63,1	-
Gasoline	70,0	-	-
Kerosene	71,5	71,5	
gas/diesel oil	74,1	74,1	74,1
lamp petroleum	71,9	71,9	71.9
residual fuel oil	77,4	77,4	77.4
Naphta	73,3	-	-
petroleum coke	97,5	97,5	-
other petroleum products	73,3	-	
natural gas [4]	[4]	[4]	[4]
coke oven gas	47,4 (till 2001) and	44,4 (till 2002) and 36-47 (from 2003) on	47,4
	38-40 (from 2002) on[5]		
blast furnace gas	250-265[5]	260 (till 2002) and 258-280 (from 2003) on	
other products	X[2]	38-40 (from 2002) on[5]	
Biogas	54,6	75 [3]	
Waste gas	54,6	66-72,5 [3]	
Black liquor	-	95,3-100 [3]	
Wood/solid biomass	83.83 [8] / 109,633	100-112 [3]	112

Table 3.1: Emission factors used to calculate energy related emissions of CO_2 (IPCC default unless indicated)

(1) Information of the refineries[13]
(2) Depending on the product in question, information through inquiries with the companies involved or default
(3) Source: EMEP/EEA
(4) Country specific emission factors
(5) Inquiry with the electricity sector and iron and steel sector
(6) The default IPCC value is not used for the large power plants
(7) Energy Information Administration (EIA)
(8) Environmental Protection Agency (EPA)

13 The amount of C in the flow is measured by means of Gas Chromatography. The weight % C of the different compounds are determined and afterwards transferred to CO_2.

The Net calorific value of these different products are reported in the annex 4 of this document and are the 'country-specific' values originating from the Directorate-General for Energy in Belgium and are used if no plant-specific values are available.

As a follow-up of the in-country review of September 2018, Belgium did calculate the emissions of CO_2 by using a country-specific CO_2 emission factor for natural gas for all subsectors in the category 1A4 instead of the default IPCC 2006 emission factors before. This correction was performed for the complete timeseries in all 3 regions in Belgium. These emission factors are delivered by the federal service of Economy to regional inventory experts and are based on measurements carried out by Fluxys. Since the 2021 submission the country-specific emission factors for natural gas are further fine-tuned from 2017 on, based on the composition of the natural gas that is effectively used in Belgium rather than all the gas that enters Belgium in previous calculations. Country specific emission factors for the years 1990-2016 remain unchanged in the category 1A4.

From the submission in 2023 on, energetic emissions of consumption of natural gas from 2021 on, are calculated with country-specific emission factors for all sectors and not only for the sectors in the CRT-category 1A4.

Energetic greenhouse gas emissions of CH_4 and N_2O

The emission factors of CH_4 and N_2O used to calculate the energetic emissions in the different subsectors of the sector energy are described in the respective sections 3.2.6. to 3.2.10.

3.2.6 Energy industries (CRT 1.A.1)

3.2.6.1 Source category description

The energy industries contain the following sectors: the public electricity and heat production, petroleum refining and the manufacture of solid fuels and other energy industries.
The category 1A1a (Public Electricity and Heat production) includes fuel combustion emissions associated with the generation of electricity for commercial, industrial or public sale. The emissions of auto-producersof electricity are allocated to the IPCC category 1A1 (refineries), 1A2 (Manufacturing Industries and Construction) and 1A4 (Other sectors), depending on the type of the sector or industry where the energy is used. Some CHP (Combined Heat and Power) units are in joint venture with the energy sector, in which all heat is delivered to the industrial plant and most electricity produced, is sold to the energy sector. In these cases, all fuel in the energy balance is included in the energy sector, category 1A1a.

The emissions of CO_2 and N_2O of the refineries, an activity which takes place only in the Flemish region, are allocated in the category 1A1b. The emissions of CH_4 of the refineries are allocated to category 1B2a (oil) because a large part of these emissions have a diffuse character (the flaring emissions are also included in this sector). See section 3.2.6.2 for more detailed information.

The emissions reported in category 1A1c 'Manufacture of Solid Fuels and Other Energy Industries' are the emissions coming from the combustion in the cokes ovens. Also, the emissions of some energetic activities in the mines (mainly an auto-generator) in the Flemish region during the nineties (until 1999) are included in this category 1A1c.

3.2.6.2 Methodological issues

3.2.6.2.1 Public electricity and heat plants (category 1A1a)

The activity data reported in this sector are the fuel consumption data as reported in the regional energy balances (see section 3.2.1.).
This category contains the power installations for the production of electricity and heat and the combined heat-power installations (in joint venture with the electricity producers). These installations are situated in different sectors in Belgium (refineries, industry, agriculture and service sector).
Also included in this sector are the waste incineration installations with energy recovery (waste incineration installations without energy recuperation are allocated in the sector 5C waste incineration, see chapter 7).

Since 2005 all waste incineration plants in the Flemish region produce electricity and/or useful heat.
In Brussels, there is only one waste incineration installation with energy recovery; the last waste incineration installation without energy recovery was closed in 2009.
In Wallonia, since 2006, the 4 municipal waste incineration plants are fully equipped to produce electricity. The emissions with energy recovery are allocated in the energy sector, category 1A1a, according to IPCC guidelines. A small part of the emissions from municipal waste incineration is still allocated in the waste sector, category 5C. This is the case when waste is incinerated without energy recovery because of occasional problems in the energy recovery systems.
The emissions of CH_4 in the waste sector were estimated for the first time during the 2017 submission. The default IPCC emission factor of 0,2 g CH_4/ton waste is used. This is performed as a result of the ESD-review carried out in August 2016 (Final review report (2016 Comprehensive review of national greenhouse gas inventory data pursuant to Article 19(1) of Regulation (EU) No 525/2013 (ESD-review).

Emissions of blast furnace gas produced in the iron and steel companies and delivered to the electric power installations are also put in this category 1A1a consistent with the reporting in the regional energy balances.
Since 2017 coal is no longer consumed in the power plants in the Flemish region. Consequently, only emissions of the use of blast furnace gas is reported in this category under ‘solid fuels’.

Category 1A1a		Flemish region	Walloon region	Brussels region
Activity data		Regional energy balances (based on individual plant information)	Regional energy balances (based on individual plant information)	Regional energy balances (based on individual plant information)
Emission factors	CO_2	Based on analyses of fuels (a.o. electric power plants) and IPCC 2006 or individual plant reporting of CO_2 via ETS Directive (Directive 2003/87/EC)	Individual plant reporting of CO_2 via ETS Directive (Directive 2003/87/EC)	Based on in situ measurements and IPCC 2006
	CH_4 and N_2O	in some cases based on monitoring, otherwise IPCC 2006 (also for combined heat-power installations)	IPCC 2006	IPCC 2006

CO_2

For the large power plants in the public electricity sector in the Flemish region, the CO_2 emissions are reported directly by the power plants and based on analyses of the fuels (through the individual Integrated Environmental Reporting which is tuned with ETS-data).
For the other, smaller installations mainly the default emission factors from IPCC 2006 guidelines are used except for the waste incineration plants where analyses of the waste are used to determine the emissions of CO_2 (last years an emission factor of 111 kt CO_2/PJ is used).

In Wallonia, since 2004, emission trading companies and IPPC companies (included the power plants and coke oven plants) are obliged to report their energy consumptions and CO_2 emissions via websites (ETSWAP:(https://www.ets-awac.be/) and Regine (http://bilan.environnement.wallonie.be/)). The data from companies reporting under the ETS-Directive (Directive 2003/87/EC) have been checked during the emission trading verifications. Before 2004, the CO_2 emissions were also reported by the plants but there was no external control of the CO_2 emissions of the power plants. The data from IPPC companies (no ETS) have been checked with an internal control.

For the smaller plants for which no emissions of CO_2 are reported directly to the responsible authorities, default IPCC 2006 CO_2 emission factors are used in all regions except for some specific fuel types (see table 3.1). In the latter case more detailed information of the individual companies is used.

In the Brussels region, the only large power plant is a municipal waste incinerator. The annual CO_2 emission factors are based on in situ measurements, in combination with the default IPCC 2006 CO2 emission factor for the (small) extra natural gas supply. For the smaller power plants, default 2006 IPCC CO_2 emission factors are used (see table 3.1).

In the reporting tables, some fluctuations can be observed in the time series for the CO_2 IEF of solid fuels. These fluctuations are due to changes in the share of the different type of solid fuel consumed each year with very different IEF CO_2 (coal, blast furnace gas and coke gas) in the power plants.

CH_4 and N_2O

The emission factors of CH_4 and N_2O (mainly default) used in the sector of public electricity and heat plants are summarized in table 3.2.

In Flanders, the emission factors used, are IPCC 2006 emission factors Tier 1 (1), but not always the default values ‘as such’ in the power plant sector. Based on N_2O and CH_4 measurements, performed by the power plant sector, the IPCC emission factors (lower, higher or default) that approach best the measurements, were recommended by the sector and were used to calculate the emissions of CH_4 and N_2O. For example, for coal the lower IPCC Tier 1 emission factor of 0.5 g N_2O/GJ is used while the upper IPCC Tier 1 emission factor of 3 g CH_4/GJ is chosen (23).

A re-allocation of the emissions of CH_4 and N_2O in the category of electricity & heat production in the Flemish region took place during the 2020 submission: emissions from refinery gas are now allocated to the category of liquid fuels instead of gaseous fuels before and emissions from blast furnace gas and cokes oven gas are now allocated to the category of solid fuels instead of gaseous fuels before. As a result, the reporting of emissions is in line with the IPCC 2006 guidelines.
No change in total emissions occurred in this category ever since.

For the combined heat-power installations, the following emission factors are used:

° in industry:

		CH4	N2O	IPCC 2006
natural gas	engines	258	NA	table 2.6
	turbines	4	1	tables 2.6 en 2.7
liquids	engines	4	NA	tables 2.6 en 2.7
	turbines	3	0,6	table 2.3
biogas	engines	5	0,1	table 2.3
	turbines	1	0,1	table 2.3
other	engines	30	4	table 2.3
	turbines	30	4	table 2.3
coal	turbines	10	1,5	table 2.3

Table 3.1bis: Emission factors used to calculate energy related emissions of CH_4 and N_2O in the combined heat-power installations

° in the refinery sector monitoring results are carried out in the Flemish region;

° the emission factors used in the commercial/institutional and agriculture sector are given in Annex 3.

For the installations with energy recuperation in the waste sector:

All regions:

0.2 kgCH_4/Gg (0.02 kg/TJ if no information on the PCI plant specific) (IPCC 2006 - table 5.3) waste and 1.49 ton N2O/PJ = 15 g N_2O/ton waste (country specific, based on monitoring in the Walloon region). The N_2O emission factor for municipal waste incineration has been calculated using in situ measurements (stack emissions) combined with activity data, for some representative individual companies. Most of the measurements were below the detection threshold (2 mg/Nm³), which corresponds to 15 g N_2O / ton of waste incinerated. This conservative value was accordingly used for the complete time series in the 3 regions.

Some investigation is going on to improve the emissions of N_2O in this category of waste incineration. Monitoring is started in the Flemish region in 2020, first results will become available in the course of 2021. So far, in the beginning of 2023, only limited results became available, too little to make a more accurate estimation of the emissions. At the end of 2023 a more comprehensive study started to optimize the methodology for estimating the emissions in all sub-categories of the waste sector incl. the waste incineration with energy recuperation/electricity production. The results of this study will taken into account in the inventory in the future.

In Wallonia and in the Brussels region, emissions of CH_4 and N_2O are also calculated using emission factors of the 2006 IPCC guidelines for the energy industries (included power installations as well as combined heat-power installations in the service sector in Wallonia and the (small) extra natural gas supply to the waste incinerator in Brussels).

Fuel	**UNIT**	**CH_4**			**N_2O**		
		Fl (1)	**Wall (1)**	**Br (1)**	**Fl (1)**	**Wall (1)**	**Br (1)**
Coal	g/GJ	3	1	/	0,5	1.5	/
Fuel	g/GJ	3	0.8	3	0,2	0,3	0,6
diesel oil	g/GJ	1	0.9	3	0,2	0,4	0.6
diesel oil (in gas turbine)	g/GJ	1	3	3	0,2	0.6	0.6
natural gas (in gas turbine and in heat & gasturbines)	g/GJ	0,3	4	1	0,3	1	0.1
natural gas	g/GJ	0,3	1	1	0,3	1	0.1
Cokes gas	g/GJ	0,3	1	/	0,3	1	/
blast furnace-gas	g/GJ	0,3	1	/	0,3	1	/
H_2-gas	g/GJ	0	-	/	0	-	/
Dry sludge	g/GJ	30	-	/	4	-	/
Bisfenol-resin	g/GJ	3	-	/	0,5	-	/
Agricultural waste	g/GJ	-	11	/	-	7	/
Municipal waste	g/ton	-		0.2	15	15	15
Coffee	g/GJ	30			4		
Olive seeds	g/GJ	30			4		
Biogas (stat. engines)	G/GJ	-	5		-	0,1	
Biofuel	g/GJ	1			0,2		
Wood	g/GJ	10	11		4	7	

Table 3.2: Emission factors of CH_4 and N_2O for the sector 1.A.1.a Public electricity and Heat Production (large power installations)

(1) Source: IPCC 2006 (tables 2.2 and 2.6)

3.2.6.2.2 Petroleum refining (category 1A1b)

Petroleum refining activities take only place in the Flemish region.

A naphtha cracker is located at the site of one of the refineries. The emissions of this naphtha cracker are allocated to the category 2B8b (mainly production of ethylene) according to the IPCC 2006 guidelines instead of the allocation to the category 1A2c until the submission in 2014.

Allocation emissions refineries	Flemish region
Category 1A1a	Emissions combined heat-power installations refineries
Category 1A1b	All emissions CO_2 and N_2O excl. emissions flaring activities and combined heat-power installations
Category 1B2a / oil	Total emissions CH_4
Category 1B2c / venting & flaring	Emissions CO_2 flaring activities

The activity data of the petroleum refining are taken over from the Flemish energy balance (see section 3.2.1 for more information). Since 2013, ETS-activity data are reported, containing all activities within the refineries.

All reported emissions of CO_2 in this category are completely in line with ETS-data since 2013.

The emissions of the petroleum refineries are allocated to the following sectors:

- 1A1a (for the combined heat-power installations of the refineries in joint venture with the electricity producers). From 2019 on, the last CHP installation became an auto producer and was consequently allocated to 1A1b
- 1B2cii for the flaring emissions of CO_2
- 1B2a iv Refining/Storage for the total CH_4-emissions (incl. the flaring emissions which represent an important share) and
- 1A1b for the total emissions of CO_2 and N_2O of the refineries excluding the emissions from flaring (except for N_2O) and from the combined heat-power installations.

Emissions resulting from the production of hydrogen at refineries are included in the category 1A1b instead of category 1B2c1i in the Belgian CRT-tables. Consequently, Belgium did change the notation key 'NO' in the category 1B2c1i Venting/oil to 'IE' during the submission in 2021.

(Emissions of CO2 related to the non-energy-uses of fuels including fuels used for hydrogen production needs to be reported in CRT category 1.B.2.c.1.i (oil venting) according to Vol2/Ch4/p.4.36 of the 2006 IPCC GLs.)

Guidelines are not very clear about the allocation in the categories 1B2a (oil) and 1B2c (venting and flaring).

The emissions of CO_2 are reported to the responsible authorities by the Belgian Petroleum Federation and the petroleum refining companies. Since 2005 (emissions 2004) these emissions are reported by the companies on an obligatory basis via their annual environmental reports (see section 1.4.1.1). These emissions are in line with the emissions reported under the ETS-Directive (Directive 2003/87/EC). A description of this methodology is reported in the monitoring protocols of these companies.
The refinery gas is the most important fuel stream in the refineries. Emissions of CO_2 of the refinery gas are measured, based on continuous analyses of the refinery gas by gas chromatography which determines the C-amounts in the gas.

CH_4 and N_2O emissions from petroleum refining are calculated using a combination of monitoring results (for the 2 largest companies) and emission factors of CITEPA (24) for the smaller companies.
These default emission factors are based on the input of crude oil:
0.24 g CH_4/ ton crude oil (originating from 6% auto-combustion *4 g CH_4/ton crude oil);
22 g N_2O/ton crude oil (originating from 6% auto-consumption and an emission factor of 9 g/GJ (50% fuel oil and 50% gas);
To calculate the fugitive emissions an emission factor of 5 g CH_4 / ton crude oil is used.

The results of the monitoring of the emissions of CH_4 and N_2O became available in 2005 (emissions 2004) for the 2 largest companies exceeding the threshold value (10 ton/year for N_2O and 100 ton/year for CH_4). Based on these results, the emissions of CH_4 and N_2O were revised from 1990 on during the previous submissions (partly monitoring and partly extrapolation) and actualized emissions for the complete time series were included in the inventory.

During the 2020 submission and from 2013 on, the emissions of N_2O are split into 2 parts and allocated partly under the liquid fuels and partly under the gaseous fuels instead of reporting the total emissions only into the gaseous fuels category. No change in total emissions occurred ever since.

3.2.6.2.3 Manufacture of solid fuels and other energy industries (category 1A1c)

Category 1A1c		Flemish region	Walloon region	Brussels region
		2 coke plants until 1996, 1 coke plant from 1997 on and mining activities in the nineties	5 coke plants in 1990 and no more coke plant in 2021 (closure in 1995, 2000, 2005, 2010 and 2013)	1 coke plant until 1993
Activity data		Regional energy balances (based on individual coke plant information and auto-producer (until 1996) and sorting machines (until 1999) in mining industry	Regional energy balances (based on individual plant information)	Regional energy balances (based on individual plant information).
Emission factors	CO_2	Based on monitoring results for the coke plant and default IPCC 2006 for the other activities	IPCC 2006 (until 2004) and based on monitoring results (from 2005 on)	IPCC 2006
	CH_4 and N_2O	CH_4: based on monitoring results and default IPCC 2006 for N_2O for the coke plants and for the other activities	EMEP/EEA (CH_4) and IPCC 2006 (N_2O)	Monitoring results / expert judgement (CH_4) and IPCC 2006 (N_2O)

As indicated in section 3.1.1. the emissions originating from category 1A1c ‘Manufacture of Solid Fuels and Other Energy Industries’ are the emissions from the combustion in the coke ovens.

Since the in-country review of UNFCCC in June 2007 the energetic activities of the mining industry, active in the Flemish region, are also included in this category 1A1c. These activities consisted of an auto-producer of electricity that was active until 1996 (the waste of the coal was used to produce electricity) and of energy needed for the sorting machines which were active until 1999.
Nowadays 1 plant, producing coking coal, is still operational in Belgium instead of 8 plants in the beginning of the nineties. One plant was closed in the Flemish region in 1996, 5 plants closed in the Walloon region in 1995, 2000, 2005 and 2010 and 2014 and the only plant active in the Brussels region was closed in 1994.

In Wallonia, in the category 1A1c, the emission factors for CH_4 and N_2O are those proposed in the 2006 IPCC Guidelines (1). Until 2004, the CO_2 emissions were calculated with the default IPCC 2006 emission factors. Since 2005, the CO_2 emissions have been reported directly by the plant under the ETS-Directive (Directive 2003/87/EC). It’s difficult to use these ETS data (coke oven gas analyses) to make a recalculation for the complete time series as there were 5 coke plants in 1990 and nowadays all plants are closed in Wallonia (these plants closed in 1995, 1998, 2002, 2008 and the last in 2014).

Fuel	UNIT	Wallonia	
		CH_4	N_2O
Diesel oil	g/GJ	3	0,60[(1)]
natural gas	g/GJ	1	0,10[(1)]
Coke oven gas	g/GJ	1	0,10[(1)]
blast furnace-gas	g/GJ	1	0,10[(1)]

Table 3.3: CH_4 and N_2O emissions factors used in the Walloon region per fuel in the coke plants.

(1) Source: IPCC 1996

The emission factors used in the Brussels region for the one plant operational until 1993, are the same as those used in the Walloon region except for the emissions of CH_4 for which monitoring results / expert judgement are used.

In Flanders the emission factors used to calculate the emissions of CO_2 from the mine activities in this category are the IPCC 2006 emission factors as presented in table 3.1. The emissions of CO_2 from the cokes ovens are calculated with specific emission factors from the industry involved based on analysis of the fuels.

The emissions of CH_4 and N_2O included in this category from the Flemish region are:
1° the energetic emissions from the mine activities calculated by using the IPCC 2006 emission factors (see table 3.6) and
2° the emissions of CH_4 (monitoring, results via the yearly reported integrated emission reports) and N_2O (IPCC 2006 default i.e. 0,1 kg N_2O/TJ) from the cokes ovens.

History and clarification:

During the submission in 2006 a revision of the emissions of CH_4 were carried out due to the availability of more detailed information of the industry involved. Based on monitoring results (analyses via GC/FID following the German norm VDI 2459 Blatt 1) carried out in 2001, 2002 and 2004, the emissions of CH_4 were optimized from 1990 on.
These emissions are undoubtedly caused by the dry distillation of the cokes coal. There are about 100 coke ovens operational that are heated via combustion rooms separated from the coke ovens via not completely hermetically closed walls. Emissions of CH_4 occur from the formed cokes gas to the combustion room and consequently to the stack.

Although, contacts with the relevant industry in the past indicated that negligible emissions of N_2O occur in this sector (see previous NID's in this context), the Flemish region did make an estimation of these emissions, as a result of a recommendation during the EC initial checks carried out in February 2018, using the IPCC 2006 default emission factor as given in table 2.2 of the guidelines (0,1 kg N_2O/TJ), Small emissions of 0.4-0.6 ton N_2O were estimated and added to the inventory.

3.2.6.3 Uncertainties and time-series consistency

1A1a Energy industries and 1A1c Manufacture of solid fuels and other energy industries

According to table 2.6 of the IPCC Good Practice Guidance, the uncertainty on activity data is less than 1% in the case of a survey. The uncertainty takes into account that a complete survey of energy industries is conducted yearly for the purpose of establishing the energy balance. An exception on this rule is the activity data of biomass (10%) and other fuels (5%). The uncertainty on emission factors originates from table 2.5 and 2.6 of the IPCC Good Practice Guidance and tables 2.13 and 2.14 of the IPCC 2006 guidelines associated with expert judgement.

1A1b Petroleum Refining

The uncertainties both on activity data and emission factors for CO_2, CH_4 and N_2O are mainly based on IPCC Good Practice Guidance in combination with expert judgement and are mostly in line with the estimates given in other countries. For gaseous fuels the uncertainty on activity data is estimated as 1% because of very accurate statistics in Flanders for this fuel.

3.2.6.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided on request.

Each year, a comparison of activity data is performed between the Walloon ETF-GHG data and the Walloon energy balance for the two last submission years.

3.2.6.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Belgium:

- Inventory with final regional energy balances as a provisional energy balance is made yearly for year (x-1), whereas a final energy balance is made for year (x-2).

  Flemish region*:*

  Small corrections were made in the Flemish region in this category for some years: mainly in the subcategory CHP-installations and the emissions from gasoil consumption in the nuclear power installations in 2015 was added (+ 2 kton CO2) to become consistency in the time series.

  Walloon region:

  No recalculation except the revision of the energy balance in 2021.

  Brussels-Capital region:

  Revision of the CO_2 emissions of the municipal waste incinerator following better knowledge about the facility (the CO_2 emissions from the (small) extra natural gas supply to the installation that were previously subtracted from the measured emissions, are actually not taken into account in the stack measurements).

3.2.6.6 Source-specific planned improvements, if applicable, including those in response to the review process

Some investigation is going on to improve the emissions of N_2O in the category 1A1a concerning waste incineration (also sludge) with electricity production in the Flemish region. Monitoring is started in this region in the course of 2020, results would become available in the course of 2021.
So far, in the course of 2022 and 2023, only limited results became available, too little to make a more accurate estimation of the emissions during this submission.

Besides a study started in the Flemish region at the end of 2023 to optimize the estimations of emissions in the complete waste sector including all subsectors and thus also including the waste incineration with electricity production (CRT 1A1a). The results obtained of this study will be investigated and included in the greenhouse gas inventory in the future.

Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3.2.7 Manufacturing industries and construction (CRT 1.A.2)

3.2.7.1 Source category description

The structure of the industrial sector has undergone profound changes over recent decades. The metallurgy and textile sectors had several waves of closures and restructuring. The metallurgical industry nevertheless remains one of the key sectors of Belgian industry, both in terms of employment and turnover. The two other key sectors of industrial activity are the chemical industry and the food processing industry.
The category 1A2 ‘Manufacturing industries and construction’ contains the energetic emissions of the industrial sector of the 3 regions in Belgium.
The following sectors are involved: iron and steel (1A2a), non-ferrous metals (1A2b), chemicals (1A2c), pulp, paper and print (1A2d), food processing, beverages and tobacco (1A2e), non-metallic minerals (1A2f, a new subsector according to the IPCC 2006 guidelines) and other industries (1A2g). In the category 1A2g the sector textile and leather is integrated in subcategory 1A2gvi. Also, the off-road emissions in industry (incl. the construction activities) are included in this category (1A2gvii).

Other industries integrated in category 1A2gviii (Other/other) are: metal products and other industry (among others wood industry, rubber and synthetic material, manufacturing of furniture, recycling and construction included).

The industrial sector is not very developed in the Brussels region, mainly due to its urban features. The only big industry in this region is a car manufacturer. The other industries are (very) small companies specialised in high added-value products and/or located close to the final consumer. All these industries are classified in the 1A2g category.

The emissions originating from the use of recovered fuels from cracking units or other processes where a fuel is used as a raw material and where a part of this fuel (or transformed product) is recovered for energy purposes is re-allocated from the category 1A2c / other fuels in previous submissions to the category 2B8b in recent submissions, according to the new IPCC 2006 guidelines. Besides the biggest part of the emissions in this category comes from the production of ethylene.

Emissions of industrial combined heat-power installations in joint venture with the energy sector are allocated to the category 1A1a, auto producers in the industrial sector are allocated to this category 1A2.

Emissions of the combustion of blast furnace gas, produced in the steel plants and delivered to the energy sector, are also allocated to the category 1A1a.

3.2.7.2 Methodological issues

The energy consumption data for the category 1A2 originate from the regional energy balances in the 3 regions (see section 3.2.5 for more information).

From the 2015 submission on and from the reporting of the emissions from 2013 on, ETS-data (activity data and emissions of CO_2) are taken over completely in the Belgian greenhouse gas inventory. As a consequence, higher tiers are used. Non-ETS industrial emissions of CO_2 are mainly calculated with default IPCC 2006 emission factors except for natural gas where a country-specific emission factor is used for the first time during this 2023 submission and for the year 2021.

Already since 2004, more analyses of the fuels have been performed by the plants under the ETS-Directive (Directive 2003/87/EC) on f.i. solid fuels, blast furnace gas, coke oven gas and waste fuels. These plant-specific emission factors are taking into account in the inventory. The latter is in particular the case for the iron and steel sector and cement and lime sectors where a tier 3 - methodology is used.

Before the entry into force of the ETS-Directive (Directive 2003/87/EC) default IPCC 2006 emission factors of CO_2 are mainly (where commercial standard fuels are used) used to estimate the emissions (Tier 1), see table 3.1.

The emission factors used to calculate the emissions of CH_4 and N_2O in the category 1A2 are in all regions based on those proposed in the Revised 2006 IPCC Guidelines except for some specific fuels (see table 3.6a).

Iron and steel sector (category 1A2a)

Category 1A2a		Flemish region	Walloon region	Brussels region
Activity data		Regional energy balances (based on individual plant information). Remark: the activity data of solid fuels are reported in the documentation box in 1A2a/solid fuels)	Regional energy balances (based on individual plant information)	NO
Emission factors	CO_2	Based on monitoring results (consistent with ETS) and IPCC 2006 default emission factors for smaller companies	Based on monitoring results (from 2004 on, consistent with ETS) and IPCC 2006 default emission factors	NO
	CH_4 and N_2O	(1) and for N2O (integrated steel plant): measurements from 2004 on and best estimates for the years before	IPCC 2006 (2)	NO

(1) Emissions CH_4 and N_2O of cokes plant area allocated in 1A1c and CH_4 of sinter plant in 2C1d, N_2O in 1A2a / gaseous fuels
(2) Emissions (energetic) of cokes plant in 1A1c, emissions (fugitive) in 1B1b

In the Flemish region there is one integrated steel plant and one plant that produces stainless steel.

In the Walloon region, the last integrated iron and steel plant (blast furnace-oxygen furnace) was closed in **2011**. Five electric arc furnaces was operational in 2012. An electric arc furnace was closed in 2013 and another in 2014. Currently, three electric arc furnaces are operational in 2021.

No iron and steel activities take place in the Brussels region.

The methodologies used to estimate the emissions of the iron and steel sector are described below.

Because different approaches approved by the different companies involved (among others, based on historical background) it is not possible to harmonize completely these methodologies between the 2 regions involved.
Yet the regions have tried to harmonize as much as possible according to the new IPCC 2006 guidelines and in relation to the data that become available via the ETS-Directive (Directive 2003/87/EC).

The CO_2-emissions from the iron and steel sector are put in the following categories:

- in category 1A2a (the energetic part except for the solid fuels that are re-allocated to the industrial process part in CRT category 2). However, the emissions from the coke gas and the blast furnace gas used for energy purpose (boilers) are reported in 1A2a (energy emissions) or in category 1A1a when used for electricity production (see below). Energy consumption data of solid fuels in category 1A2a/solid fuels are reported in the Documentation box of this category in the Flemish region to assure consistency with the RA/SA approach;
- in category 1A1c for the emissions from the use of coke oven gas in the coke ovens;
- and in category 2C1 (process part): 2C1a (steel production) and 2C1b (emissions Wallonia in blast furnaces) for the emissions of solid fuels, 2C1d for the use of limestone and the emissions of CH_4 from sinter production and 2C1f for the use of electrodes.

- In the Flemish region, the emissions of the blast furnace gas, produced in the iron & steel sector and used in other industries, f.i. in the electric power installations, are allocated to the category 1A1a. In 2021 in the Flemish region there is 17,3 PJ of blast furnace gas was used in the category 1A1a which corresponds with an emission of 4323 kton CO_2.

See the respective chapters for more information.

In Wallonia, since 2004, all the IPPC companies are obliged to report their energy consumptions, their productions and the emissions of IPPC pollutants including CO_2, CH_4 and N_2O on a website (Regine). IPPC companies which are also emission trading companies are obliged to report by sector. This information of the plants is compared and combined with the energy balance of the sector. The remainder of the emissions is calculated on the basis of the remaining fuel consumption (energy balance of the sector minus plant energy consumptions).
All the combustion emissions coming from the iron and steel sector are put in the category 1A2a except for the CO_2 emissions from the coke ovens which are allocated in the category 1A1c (the same allocation as in the Flemish region). The CO_2 emissions coming from the solid fuels used in the blast furnaces are allocated in the category 2C1a, these from the sinter plants in the category 2C1d and these in the electric arc furnaces in the category 2C1a. The emissions from solid fuels, coke gas and blast furnace gas are considered as process emissions except for the emissions from coke oven gas and blast furnace gas used as energy purpose (boilers), these emissions are reported in the category 1A2a. All the carbon incorporated in the blast furnace is considered to be emitted as CO_2 emissions. The variety in IEF for solid fuels is due to the mix of coke oven gas and blast furnace gas used. For example, in 2012, there are no more blast furnaces in the Walloon region and 93 % of the solid fuel is coke oven gas. The remaining solid fuel is the coke used in foundries.

In the Flemish region, the emissions of CO_2 of the biggest steel plant are calculated by using specific emission factors obtained through analyses performed by the company (as recorded in the monitoring protocol of the ETS Directive). Consistency with ETS-data is guaranteed for the complete timeseries (see chapter 4.4 for more information). The emissions of CO_2 of the other (smaller) companies are calculated by using mainly IPCC 2006 emission factors. From the 2015 submission on (emissions of 2013), also for these companies the ETS-data were taken over.

Category where the Blast furnace gas (PJ) is used	1A1a Public Electricity
Flemish region 2021	17,3
Flemish region 2022	19,4

As a request of the ERT during the UNFCCC in-country review in September 2018, the file iron_steel.xlsx is added in annex 3 of this document. This file gives an overview of activity data (reported in 1A2a) and the emissions of CO_2 (in 1A2a and 2C1a) for the years 2013 to 2016 on the regional and the federal level. The same approach is used for the years after.

The emissions of CH_4 and N_2O in the iron and steel sector are calculated with different methodologies in the regions:

In the Walloon region the following CH_4 and N_2O emission factors in the iron and steel plants are used:

Fuel		**UNIT**	**CH_4**	**N_2O**
Coke breeze	Sinter and pelletizing plants	g/GJ		1,4 (1)
Coke oven gas	Sinter and pelletizing plants	g/GJ		0.1 (1)
natural gas	Blast furnace	g/GJ	1(2)	0.1 (1)
Coke oven gas	Blast furnace	g/GJ	1	0.1 (1)
blast furnace-gas	Blast furnace	g/GJ	1	0.1 (1)
Natural gas	Electric arc furnace	g/GJ	1	0.1 (1)

Table 3.4: CH_4 emissions factors for the different fuels in the iron and steel plants in Wallonia

Source (1): IPCC 2006
Source (2): EMEP/EEA

During the 2015 submission, the Walloon region had reallocated the emissions of CH_4 from sinter production from 1A2a to 2C1d.

The emissions of N_2O from the sinter plants (solid fuels) and the emissions of CH_4 and N_2O from the blast furnaces (coke oven gas and blast furnace gas) are still in the category 1A2a. No N_2O emissions can be allocated in the categories 2C1a and 2C1d. As emissions of N_2O might occur, they are conservatively included in the Walloon inventory.

In the Walloon region, the fugitive emissions of CH_4 from the coke ovens are allocated to the category 1B1b.

In the Flemish region the emissions of CH_4 of the integrated steel plant the iron and steel sector are allocated in the categories 1A1c (production of cokes) and 2C1d (production of sinter), see these respective sections 3.2.6 and 4.4 for more explanation of the methodology used.

The industry involved in the Flemish region made a first estimate of the emissions of N_2O during the 2014 submission. These emissions were based on measurements carried out from 2004 on in the sinter plants. On the basis of average concentrations and flow data, the company involved performed an estimate of these emissions for the complete time series. These emissions are allocated to the category 1A2a.
The emissions of CH_4 and N_2O of the other (smaller) companies in this category are estimated by using the IPCC 2006 default emission factors (see table 3.6a).

Non-energy use of fuels

Emissions of recovered fuels from cracking units (only available in the Flemish region) and some other (smaller) process emissions in the chemical industry in the Flemish region are re-allocated during the submission of 2017 from the category 1A2c / other fuels to the category 2B8b (production of Ethylene) according to the new IPCC 2006 guidelines. Besides the biggest part of these emissions are linked with the production of ethylene . See section 3.2.3. and chapter 4 for more information.
These emissions were reported via a yearly survey carried out by the chemical federation in cooperation with Vito (18). From 2013 on, these emissions are taken over completely by the reporting under the ETS-Directive (Directive 2003/87/EC). Measurements are carried out to obtain these emissions (Tier 3).

An overview of the activity data of the other fuels in the category 1A2c Chemicals is reported below as well as the emissions of CH_4 and N_2O and the calculated implied emission factor (IE). This is added in the NID as a result of the UNFCCC review of the 2020 submission and one of the UNFCCC-recommendations published in August 2021.

Activity data_PJ_ Other fuels 1A2c Chemicals

	1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022
Flemish region	22,20	53,36	80,25	75,22	79,19	73,15	70,59	68,01	70,29	64,67	71,16	72,37	70,83
Walloon region		0,72	0,06	0,08	0,11	0,22	0,22	0,22	0,22	0,23	0,12	0,10	0,11
Belgium	22,20	54,08	80,31	75,30	79,30	73,37	70,81	68,23	70,51	64,90	71,28	72,47	70,94
Emissions CH4 and N2O_kton_Other fuels 1A2c Chemicals													
CH4													
Flemish region	0,07	0,16	0,24	0,26	0,26	0,22	0,21	0,20	0,21	0,19	0,21	0,22	0,21
Walloon region		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	0,07	0,16	0,24	0,26	0,26	0,22	0,21	0,20	0,21	0,19	0,21	0,22	0,21
N2O													
Flemish region	0,01	0,03	0,05	0,05	0,05	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04
Walloon region		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	0,01	0,03	0,05	0,05	0,05	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,04
IEF CH4	326	336	333	295	309	330	335	335	335	334	334	334	334
IEF N2O	1650	1685	1668	1540	1590	1660	1675	1674	1674	1673	1669	1671	1669

Other industrial sectors

Category 1A2 excl. 1A2a		Flemish region	Walloon region	Brussels region
Activity data		Regional energy balances	Regional energy balances	Regional energy balances
Emission factors	CO_2	Mainly IPCC 2006 and based on analyses (some specific fuels) and ETS-data from 2013 on. For natural gas, country specific emission factors for CO_2 are used from the submission in 2023 on.	Mainly IPCC 2006 and based on analyses, ETS-data from 2013 on. For natural gas, country specific emission factors for CO_2 are used from the submission in 2023 on.	IPCC 2006 and for natural gas, country specific emission factors for CO_2 are used from the submission in 2023 on.
	CH_4 and N_2O	IPCC 2006 and EMEP/EEA (off road)	IPCC 2006 and EMEP/EEA (for some specific fuels, off-road and lime and cement sector)	IPCC 2006 and EMEP/EEA (for some specific fuels and off-road)

The emissions of CO_2 of the other sectors in the category 1A2 are calculated mainly by using default IPCC 2006 emission factors except for natural gas where a country-specific emission factor is used from this 2023 submission on and from the year 2021 on.
For recent years and from 2013 on, ETS-data are taken over in the greenhouse gas inventory.
Some exceptions on this general rule are listed below.

In the lime and cement plants, only located in the Walloon region, the CO_2 emission factors for liquid fuels and gaseous fuels are taken from the IPCC 2006 guidebook. Concerning the solid and waste fuels, an average emission factor has been calculated with plant analyses (2005 to 2008) and applied for the previous years (table 3.6). Since 2005, the CO_2 emissions from solid fuel and waste are reported directly by the companies through the ETS-obligation and based on their fuel consumption and fuel analyses.

EF CO_2 g/GJ	Cement 1	Cement 2	Cement 3	Cement 4	Cement 5	Lime 1	Lime 2	Lime 3	Lime 4	Lime 5	Lime 6
Coal 1	99.3		95.7	94.6		98.3	94.6	94.6			
Coal 2	103.3	95.1	95.7	94.6	102.8						
Lignite		108.2				101	99.5	101	101	101	101
coke						107.0	107.0				
Petroleum coke	99.8	94.5	92.8	92.8	92.8	97.5	97.5	97.5			
wood								100.0			100.0
Industrial waste	81.7	73.2	92.9	97.6	97.6						100.0
Fuel						77.4	77.4	77.4	77.4	77.4	77.4
Diesel oil	77.4					74.1	74.1	74.1	74.1	74.1	74.1
Natural gas						56.1	56.1	56.1	56.1	56.1	56.1

Table 3.5: Emissions factors of CO_2 in lime and cement by plant from 1990 to 2004 in Wallonia (Source: plant specific emission factors)

In the chemical industry (category 1A2c) in the Flemish region the activity data (fuel consumption) of 'other fossil fuels' are reported in the Documentation box (see also above). These data are also put in an indirect way in the tables 1AD Naphtha and 1AD LPG in the reference approach. For the emissions of CO_2 in this category the notation key 'IE' is used, the emissions are allocated to the category 2B8b (mainly ethylene production). These emissions are off gas-emissions/recovered fuels from cracking units (biggest part) and some other processes (non-energy use) emissions.

The methodology to estimate **the emissions of CH_4 and N_2O** are harmonized between the regions as a result of the in-country review in June 2007 in the category 1A2.

The emission factors used to calculate these emissions are for all regions based on those proposed in the Revised 2006 IPCC Guidelines except for some specific fuels (see table 3.6a below).

		Flanders	**Wallonia**	**Brussels**	**Flanders**	**Wallonia**	**Brussels**
Fuel	**Unit**	**CH_4**			**N_2O**		
Coal	g/GJ	10	10	10	1,5	1,5	1,5
Coke oven gas	g/GJ	1	1	-	0,1	0,1	-
Coke	g/GJ	10	10	-	1,5	1,5	-
Natural gas	g/GJ	1	1	1	0,1	0,1	0,1
blast furnace-gas	g/GJ	1	1		0,1	0,1	-
Fuel	g/GJ	3	3	3	0,6	0,6	0,6
Diesel oil	g/GJ	3	3	3	0,6	0,6	0,6
Biogas	g/GJ	-	1	-	-	0,1	-
Waste gas	g/GJ	-	1	-	-	0,1	-
Industrial waste	g/GJ	-	30	-	-	4	-
Wood	g/GJ	30	30	-	4	4	-
Biomass	g/GJ	30	-	-	4	-	-
LPG	g/GJ	1			0.1		

Table 3.6a: Emission factors of CH_4 and N_2O in the sector 1.A.2 Manufacturing Industries and Construction

Source: IPCC 2006 (1)

For the auto-producers in the industrial sector (also allocated to the category 1A2) the following emission factors for CH_4 and N_2O are used:

		CH4	**N2O**	**IPCC 2006**
natural gas	engines	258	NA	table 2.6
	turbines	4	1	tables 2.6 en 2.7
liquids	engines	4	NA	tables 2.6 en 2.7
	turbines	3	0,6	table 2.3
biogas	engines	5	0,1	table 2.3
	turbines	1	0,1	table 2.3
other	engines	30	4	table 2.3
	turbines	30	4	table 2.3
coal	turbines	10	1,5	table 2.3

Table 3.6b: Emission factors of CH_4 and N_2O for the combined heat-power installations in the sector 1.A.2 Manufacturing Industries and Construction

Source: IPCC 2006 (1)

In the lime and cement plants, activities which only take place in the Walloon region, the emissions of CH_4 and N_2O are plant-specific and determined by measurements in the stacks. Implied emission factors for CH_4 and N_2O by fuel are then derived from the energy consumption data and the reported emissions.

Off-road Industry and building activities

In category 1A2gvii off-road emissions of the industrial sectors are allocated (incl. construction industry).

The greenhouse gas emissions are calculated by using the OFFREM-model with emission factors of the IPCC 2006 guidelines (CO_2 and CH_4) and EMEP/EEA guidebook (N_2O). Country specific calorific values are used.

The original study of July 2009 was optimized in December 2019 '*Actualisatie OFFREM: OFFREM 2019 Marlies Vanhulsel, Frank Sleeuwaert, Tomas Crols, Karolien Vermeiren, Inge Uljee Studie uitgevoerd in opdracht van: Vlaamse Milieu Maatschappij (VMM) 2019/Unit RMA/R/2037 December 2019'.*

Activity data used: the fleet of fork-lift trucks and 25 other types of machines in the building sector are obtained from sale statistics 1991-2020 (http://sigmafederation.be/nl/home/) , technical data and activity data of the vehicles and machines are obtained via a technical workshop with experts (2005).
The energy consumption for machinery in the construction sector and industry is calculated with the OFFREM model. This calculated energy consumption is used in the energy balance. Due to a difference in timing between data collection in the energy balance and the calculation of the emissions, there will be a slight deviation each year in the calculated emission factor for these sectors.

A complete detailed description about the methodology used can be found in annex 3 of this report where the Quality Management System of the greenhouse gas inventory in the Flemish region is described. In the technical procedure of the quality management system VMM/EIL/GP/5.003 'Procedure for the main process: setting up the greenhouse gas emission inventory' the methodology used to estimate the off-road emissions is recorded in annex 7.3.17.

In Wallonia, some plants (cement plants, carriers,) report their off-road emissions on an individual basis, these emissions are also included in 1A2gvii. These emissions aren't calculated via the OFFREM-model and are supplementary added.

During the 2020 submission, the OFFREM-model was optimized for all subsectors (version OFFREM 2). Some functional and methodological corrections were made to this tool: e.g. adding of stage V (machinery) and EURO 6, 6c and 6d norms (vehicles), emission factor and energy consumption factors of off road vehicles and quads were updated with most recent COPERT tool and EMEP/EEA Guidebook 2019, calorific values were updated, TAF-factors (Transient Adjustment Factor) were updated according to the EMEP/EEA Guidebook 2019.
More specific for the industrial sector: the share per fuel type in the total amount of fork-lift trucks with a combustion engine has been actualized with data from the SIGMA federation (sector of Material for Civil construction, Construction and Good treatment). These corrections result in lower emissions compared to previous submission.

During the 2021 submission these emissions of off-road are optimized again. Input data of machines used for construction activities, obtained by the federation of Sigma, are the basis for the calculation of emissions in the construction industry. A distribution key was used for dividing the national emissions in the 3 regions. Data about real started construction sites, used for dividing the emissions at the regional level, were no longer available by the National Bank since 2015. Consequently, a new methodology was used during this submission for splitting the emissions into the 3 regions. The distribution key is now calculated based on the amount of building permits reached out in each region and the corresponding space per (re)built building. These data are obtained by the Belgian statistical offices. These changes lead to an increase of the emissions in the Flemish region and a decrease of emissions in the Walloon and Brussels regions.

During the 2024 submission off-road emissions in 1A2gvii are optimized with updated activity data from 2016 on. The main changes for this period occurred in the construction sector. An error was identified and consequently corrected in the calculation of the activity data. Thereby explaining differences between 2023 and 2024 submissions.

3.2.7.3 Uncertainties and time-series consistency

According to table 2.6 of the IPCC Good Practice Guidance, the uncertainty on activity data is between 2 and 3 % in the case of a survey. In Belgium, the annual survey is cross-checked with other sources of information of the biggest industries. However, it is considered that measuring is more accurate for gaseous fuels (25) leading to 2% uncertainty on the activity data, compared in most cases with 5 % for solid fuels. For liquid fuels, the uncertainty lies between 2 and 8 %, depending on the sector considered. Higher values are chosen for biomass and other fuels, respectively 20 and 5%. The uncertainty on emission factors originates from tables 2.5 and 2.6 of the IPCC Good Practice Guidance and tables 2.13 and 2.14 of the IPCC 2006 guidelines associated with expert judgement.

3.2.7.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided on request.

In the Walloon region, some QC-tests were performed in the course of 2012. In particular in the categories 1A2a, 1A2c, 1A2e and 1A2f, a recalculation with the ETS-data is performed.
Each year, a comparison of activity data is performed between the Walloon ETF-GHG data and the Walloon energy balance for the last submission year.
The plant specific activity data from the ETS-Directive are used to build the CO_2 inventory and are also used to build the Walloon energy balance. At the end, the CO_2 inventory is based on the Walloon energy balance.

3.2.7.5 Source-specific recalculations, if applicable, including changes made in response to the review process

All regions:

Recalculation of the (mainly) 2021 inventory with final regional energy balances of this year as a provisional energy balance is made yearly for year (x-1), whereas a final energy balance is made for year (x-2).

Flemish region:

- Energy consumption data were optimized in this region from 2016 on. These optimizations mainly effected the category 1A2g viii_other industries and mainly for the liquid fuels (increase of consumption).
- The off-road data were optimized during this submission from 2016 on, resulting in a decrease of emissions in this category 1A2gvii. As aforementioned above, this decrease is due to a correction of the calculated activity data for offroad emissions in construction.
  An error was identified and consequently corrected in the calculation of the activity data.

Walloon region:

- Optimization of the OFFREM model for the category 1A2gvii (construction) from 2016 on.

Brussels region:

- Recalculations of historical series in the energy balance, especially for the period 2014–2021 for all energy vectors, and gasoil from 2010 with the revision of the time series and sectorisation based on the federal survey of distributors (sales).
- In 1A2gvii, revision of data from the OFFREM calculation model for the period 2016-2021.

3.2.7.6 Source-specific planned improvements, if applicable, including those in response to the review process

No specific planned improvements are foreseen in the near future in this category 1A2.

Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC). Improvements in the inventory will also depend on planned or unplanned (but made) improvements to regional energy balances. These improvements can be made based on recommendations from Eurostat or IEA reviews.

3.2.8 Transport (CRT 1.A.3)

3.2.8.1 Source category description

Belgium is provided with a very dense road (3.94 km/km²) and rail (117 m/km²) network (2009). In Flemish Region the density of the road network increased from 5.03 km/km² in 2000 to 5,29 km/km² in 2010. These densities of road and rail networks should be looked in conjunction with the very high density of population in Belgium: relative to the number of inhabitants the infrastructure is close to the European average. The port of Antwerp-Bruges, located in the Flemish region, is very important for Belgium. It is the second largest European seaport, and it ranks 13th in the top 20 container ports worldwide. The port of Antwerp-Bruges benefits from excellent connections to the hinterland and the large French and German industrial basins by waterway (1500 km of navigable routes). It has also been decided to strengthen the rail infrastructure giving access to the port of Antwerp-Bruges. Road transport is the mean of transport the most generally used in Belgium, both for the transport of goods and passengers, generating severe traffic congestion. Damages to the environment resulting from fuel use in road traffic are considerable. Goods (without pipelines) in 2016 were transported by railways for 12.4% of total achieved tonne-kilometres in Belgium, on navigable waterways for 14.6% and by road transport for 73.0% (16).
The reported emissions in the transport sector are reported in the following categories:

1A3a for civil aviation,
1A3b for road transportation,
1A3c for railways,
1A3d for navigation and
1A3e for other transportation incl. off-road activities in harbours, airports and transhipment companies. These off-road emissions are allocated to category 1A3eii.

No civil aviation (1A3a) takes place in the Brussels region, the Brussels national airport is located on the Flemish territory.

Emissions of the military aviation are allocated to the category 1A5b. This category includes some off-road activities as well.

Estimation of CO_2 emissions from road transport (1A3b) is based on fuels sold statistics, in combination with emission factors from the COPERT 5 model, version 5.7.2 (26). During this submission, this version of the model was an update of the COPERT 5.6.1 model that was used before to the version 5.7.3.

As a result of the UNFCCC in-country review in September 2012, the emissions of CH_4 and N_2O are also calculated according the 'fuel sold' principle since the 29th October 2012 submission.

Sea navigation (1A3d) takes only place in the Flemish region. This category exists of inland navigation and sea navigation (domestic part).

Emissions of international maritime (only Flemish region) and aviation bunkers (Flemish and Walloon region) are allocated to the category ‘memo items’.

In the category 1A3e the emissions are allocated originating from the energy needed to transport the natural gas through pipelines (1A3ei) as well as the off-road emissions from the categories harbours, airports and transhipment companies (1A3eii).

3.2.8.2 Methodological issues

3.2.8.2.1 Road transport (1A3b)

Category 1A3b	Belgium
Activity data	Sum of regional sales statistics for petrol, diesel and LPG (fuels sold) since 2023 submission
Methodology emissions CO_2	Emission factors COPERT 5.7.3 (January 2024)
Methodology emissions CH_4 and N_2O	Regional results from Copert models with correction fuel sold/fuel used (regional basis)

Until the submission in 2022, the energy consumption data and CO_2 emissions for road transport in the Belgian emission inventory are, in contrary with the other sectors where the sum of the regional data is calculated to obtain the national total, based on federal (Belgian) energy statistics. This approach was recommended by the expert review team of UNFCCC during the in-country review in Belgium in 2003. The activity data represent the amount of fuel sold for road transportation in Belgium. These activity data had been used in COPERT 5 to calculate the emissions of CO_2.

From submission 2023 on:
DG Energy is conducting a regional breakdown of Belgian road transport fuel sales - for petrol, diesel and LPG - based on a public pumps survey (conducted annually), and on estimates for private pumps. Regional fuel data are available from 2015 on and are reliable to use. The sum of the regional balances equals the quantities of fuel in the federal fuel balance.
Based on those regional fuel data 2015-2022, the share of each region and fuel in the Belgian fuel balance was calculated. Because no regional fuel data are available from 1990 onwards, the average % share (per fuel per region) was applied to the amounts of fuel in the federal balance for all years from 1990 onward (up to 2014).

The regional fuel statistics petrol, diesel and LPG are used from submission 2023 on to calculate road traffic emissions in the 3 Belgian Regions. This should give a more accurate approach of estimating emissions. For CNG, the amount of fuel calculated in COPERT 'fuel used' is considered as the value for 'fuel sold'. This approach seems conservative given that "fuel used" is currently higher than "fuel sold" probably because of poor consideration of "slow-fill" consumption and a supposedly less exhaustive survey for this fuel (no excise duties for road transport on CNG in Belgium).
As the total fuel quantity in Belgium remains the same, the use of regional statistics mainly affects the interregional distribution of emissions.

Both in the federal energy balance, and in DG Energy's regional energy balances, no distinction can be made between sales of petrol for road and off-road purposes.
For the amount of gasoline, it is necessary to remove off-road consumptions (2 to 3 %) from energy statistics to avoid double counting. Consumptions of off-road activities are estimated with the OFFREM model (see further information in chapter 3.2.8.2.5). This correction is implemented since the 2014 submission.

An overview of the activity data and emissions of CO_2 is given in annex 7 of this report 'Activity data and emissions of CO_2 for road transport in Belgium (category 1A3b)'.

<u>Correction for off-road consumption in fuel data</u>

NRMM (Non road machinery and vehicles) mostly uses diesel fuel, but gasoline and LPG are also used. Different diesel types are reported separately in energy statistics. There are 2 types of diesels in Belgium. The so called 'red gasoil extra' has a lower rate of duty than ordinary diesel. NRMM use this so called 'diesel extra'.
For gasoline, there's no difference in taxes. Consequently, amounts of gasoline for road vehicles and gasoline for off road applications are reported together in the national statistics. Gasoline consumption by mobile machinery in the different economic sectors is not reported separately in the fuel balances. To calculate emissions from gasoline in road transport it is necessary to correct the amount of fuel in the national energy statistics by subtracting the off-road amount.

The emissions from NRMM in different economic sectors are calculated using a tier 3-based model, called OFFREM. The OFFREM calculation tool was developed in 2009 and updated in 2019. Fuel consumption by NRMM is also calculated using the modelling approach of OFFREM. OFFREM uses sales data for different types of mobile machinery and survival rates for different types of machinery to estimate the active fleet. Combined with assumptions on the average use (annual operating hours) and the fuel consumption per hour of operation for the different types of machinery, total fuel consumption of NRMM is estimated.
In these off-road sub-sectors, machines use petrol (and a petrol consumption is calculated in OFFREM):
- Building (construction): 1A2 g vii
- Airports and seaports: 1A3 e ii
- Households: 1A4 b ii
- Landscaping and forestry: 1A4 c ii
- Defence: 1A5 b

The sum of the gasoline consumption in all these sectors is taken into account for the correction of road traffic fuels.

When comparing the amount of gasoline in the Fuel Balance with the amount of fuel reported in the CRT tables, there may be a difference between both. The reasoning behind is:
1) The actual year is x.
2) Each year x, DG Energy determines the amount of total motor gasoline sold in Belgium for the time series up to year x-1
3) The complete year x-1 fuel balance is delivered to the inventory compilers in November of year x
4) The off road energy consumption is calculated with OFFREM for the time series up to year x-1 by the date of the reporting for greenhouse gases and air pollutants (15/01, 15/02 and 15/03 of year x+1). Consequently, updated fuel consumptions calculated with OFFREM up to year x-1 are not yet available at the time of publication of the Fuel Balance.

5) Since a number of years the quantity of motor gasoline for off road machines (from OFFREM calculation) is also shown in the Fuel Balance, but always the off road fuel quantities that are available to them at that moment, i.e. time series up to year x-2.

➔ As a result there is a difference in amount of gasoline reported in Fuel Balance and in the CRT-tables.

A second source of difference between the federal fuel balance and the CRT-tables are the Net Calorific Values used to calculate kg ↔ GJ. Fuel data comes from OFFREM expressed in GJ. Because a correction has to be done for road transport fuels, and road transport is calculated with COPERT, the NCV of COPERT are used for CRT values (43,774 MJ/kg for gasoline fossil). The federal fuel balance uses a NCV of 44.3 MJ/kg.

When comparing fuel balance and the CRT-tables, one must take care to compare the correct (sub)sectors. OFFREM gasoline consumption in the *building* sector (construction), is shown in the total of the *Industry Sector* in the Fuel Balance. OFFREM gasoline consumption in *airports, seaports, defence, forestry, households and landscaping* is shown in the total *Other sectors* in the Fuel Balance.

Regional harmonization

Each Region in Belgium calculates its own regional emission inventory for road transport. These are compiled afterwards to the Belgian emissions and reported in the CRT-tables.
Until the 2013 submission, the 3 regions used COPERT 4 methodologies in specific regional models (previous versions of COPERT 4 were used in the Walloon and the Brussels regions, MIMOSA was used in Flemish region). Moreover, the process to transfer the basic data of the Belgian vehicle fleet to a regional fleet file that serves as input for the regional models was performed separately for the 3 regions)

Since the 2014 submission, regional submissions are almost fully harmonised to assure the consistency between the 3 separate calculations:

- each region uses COPERT to produce regional emissions and “fuel used” consumptions. During this submission in 2024 the COPERT 5.7.3. version is used.
- Each region uses the same module to provide regional mobility data (previously produced by IRCEL-CELINE and now adapted by TML in the MAM (Mobility Allocation Module-tool) as input for COPERT.

Some major determinants of COPERT modelling (e.g. processing of fleet data) are harmonized across the 3 regions. However, some modelling parameters remain regional specific (such as driving mode share and average speed).

The vehicle stock module

To build a basis stock/fleet for COPERT the database of the registration of all Belgian Vehicles is used (DIV = Directorate Registration Vehicles; part of Federal Public Service Mobility). Some calculations/assumptions had to be made to use the fields from this database for classification of vehicles in tune with COPERT stock.
Each year some changes have to be made to adapt to the list of vehicles in the most recent COPERT version. Since COPERT 5.6.1 battery electric passenger cars are added in the fleet.

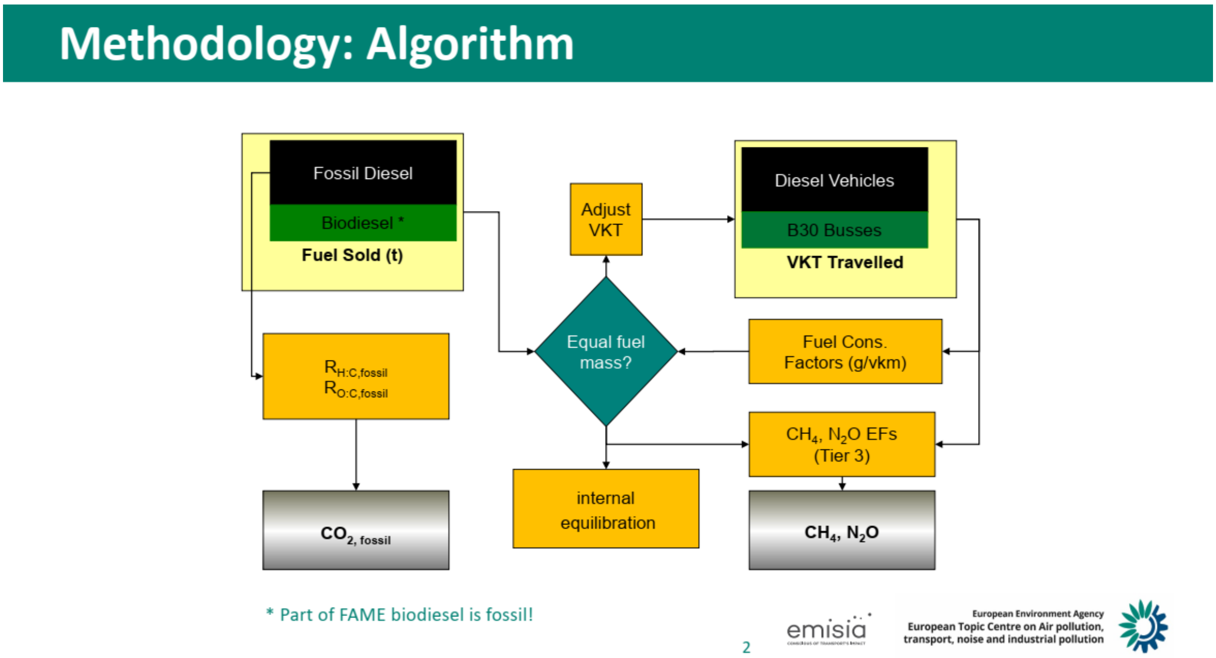
COPERT 5 and balancing for fuel sold amount of fuels

Input parameters in COPERT 5

- For environmental information, the 3 Belgian Regions use the same information for Min and Max Temperatures and humidity from the Royal Meteorological Institute of Belgium.
- Trip characteristics are Region dependent, and are taken e.g. from research on travel behavior.

- Fuel specifications:
    - for H:C and O:C data of the fossil part of the fuel blends (fossil petrol, fossil diesel and fossil LPG) used in Belgium no country specific data are available (despite the many questions sent to the Belgian Fund for the Analysis of Petroleum Products (Fapetro)). H:C, O:C = COPERT 5 data = data in EMEP/EEA air pollutant emission inventory guidebook 2019, p. 43, table 3-29.
    - H:C and O:C for biogasoline and biodiesel has been adapted with country-specific values since 2017 (biogasoline) and 2020 (biodiesel). The calculation H:C and O:C is based on the annual composition of the biofuels : a varying amount of ethanol, ETBE, MTBE, BioMethanol and BioNafta for biogasoline; and FAME and HVO for biodiesel.
    - Density and heavy metals in fuel : default COPERT values (except for biofuels for which country-specific values are calculated).
    - Content S and Pb is country specific.
- LHV: COPERT default values are used but as for fuel specifications, LHV of biogasoline has been adapted since 2017 and biodiesel since 2020 considering accurate data on biofuels composition (from “EMES” service - Directorate General Energy)
- Lubricants Specification: no country specific information is available
- EMTBE content and FAME content: Calculating the fossil fuel fraction in biogasoline and biodiesel is done directly in COPERT if providing some parameters as “g fossil CO2 / g EMTBE or FAME, “g bio CO2 /g EMTBE or FAME” and “Share of EMTBE in biogasoline (%)” or “Share of FAME in biodiesel”. “EMTBE Content” means actually energetic content of ETBE and MTBE in biogasoline. The methodology is taking into account the exact amount of C fossil in biomass (using accurate data on biofuels composition from the “EMES” service - Directorate General Energy Federal Public Service Economy, SMEs, Self-employed and Energy) and following the recommendations of the WG1 of the CCC. The incorporation of HVO in biodiesel occurs since 2020 and of “EMTBE” in biogasoline since 2017.
- Reid Vapor Pressure: country specific values, same in the 3 Regions
- Circulation activity: country specific, no information on the share urban peak and off peak (50%/50% is used). Except for Wallonia which has developed its own methodology from submission 2022 on based on the “HERE 2018 Floating Car database”. Average speed of Driving Mode have also been revised according these data.
- A/C usage: default COPERT values are used
- Blend share: country specific information used (data from Federal Public Service Economy, SMEs, Self-employed and Energy)
- Fuel CO2 correction: Disabled CO2 reduction calculation since the 2022 submission. As expected, this deactivation decreases the difference between “Fuel sold” and “Fuel used”.

Once a COPERT 5 regional fuel used run is done (based on vehicle kilometers traveled and fleet composition) and the regional statistical fuel consumption is encoded, COPERT 5 compares statistical and calculated energy consumption by fuel blend, modifies a number of input data (e.g. mileage, blend share) and then recalculates “fuel sold “ - emissions.



<u>CH_4 and N_2O</u>

Emissions of CH_4 and N_2O were since the 2012 submission based on the amounts of fuel sold of the federal petroleum balance in combination with COPERT emission factors. From the submission in 2023 on, emission of CH_4 and N_2O are based on the amounts of regional fuel sold statistics in combination with COPERT emission factors. The compiled emissions of each region based on COPERT modelling are hereby corrected/increased according the ratio between the fuel used (consumptions compiled by regional models) and the fuel sold (provided by regional statistics) to get consistency with the methodology used to calculate the emissions of CO_2. This approach is carried out per fuel type and was approved by the Expert Review Team during the UNFCCC 2012 in-country review. All these calculations are now made inside the COPERT model (as explained by the figure above).

Emissions of CH_4 and N_2O from biomass (bio-diesel and bio-gasoline) are reported separately for the first time during the 2013 submission consistently for the 3 regions. COPERT makes a distinction between fossil and biomass for CH_4 and N_2O emissions.

It should be noticed that COPERT takes into account the CO_2 emissions due to the use of air-conditioning, the use of lube oil (CO_2 emissions allocated to category 1A3bv for 2-stroke engines and to category 2D1 “Lubricants” for the other vehicles, emissions of CH_4 and N_2O are allocated to category 1A3b) and SCR (Selective Catalytic Reduction) allocated to category 2D3 Other – Urea as a catalyst.

<u>CO_2 emissions factors</u>

COPERT CO_2 emission factors are used to calculate the emissions in category 1A3b for the complete time series. This emission factor-based approach (since COPERT 4) is implemented because no precise validated information about the carbon content and net calorific values of primary fuels in Belgium is currently available from the fuel suppliers. EMISIA explained repeatedly that EFs used in COPERT are in line with the situation in Europe (better than EFs from IPCC). Belgium did observe that the values are in the range with those used by neighboring countries knowing that the fuel market is very open and dynamic in Northern Europe and that refinery industries are integrated across borders. The expert review teams agreed with the explanation provided by Belgium so far. It remains important to further investigate the refinement of COPERT emission factors with country-specific values because it is a key category in Belgium.

However, it should be noticed that for the time being no country specific carbon content or country specific CO_2 emission factors are available in Belgium.
Belgian experts asked the Belgian Petrol Federation already several times (during the centralized review in September 2016 and during the ESD reviews in 2017 and in 2018) to supply country specific values.

So far, unfortunately without any results. The Fund for the Analysis of Petroleum Products by 'Fapetro' - which is funded by the petroleum sector - has been set by the Belgian Government. Fapetro is responsible for the monitoring of the quality of petroleum products consumed in Belgium (http://www.petrolfed.be/nl/petroleumindustrie/productkwaliteit/het-toezicht-op-de-kwaliteit-van-de-petroleumproducten). About twice a year, we asked Fapetro to give us country-specific values for fuels consumed in the transport sector. Belgium also sent them the comments formulated by the experts during European and international reviews and emphasizes the importance of this issue. Unfortunately, their answers are always the same: they cannot provide country-specific values and they will not provide it unless it becomes a European obligation.

This problem is now dealt directly at the European level - inside de Working Group I of the Climate Change Committee - where a special working group try to establish "European values".
Anyway, in the context of Belgium, it appears that given the importance of trade in petroleum products with neighboring countries (in particular the Netherlands) the default values provided by COPERT at European level seem reasonably appropriate and completely in line with the Netherlands, which have the most recent data on this subject (in particular for gasoline which is the most sensitive fuel for this problem).

Here is the answer that Belgium provided on the subject during ESD REVIEW 2022 at European level:
“Belgium would appreciate if a reporting obligation could be inserted in the "Fuel Quality Directive" because the FAPETRO still refuse to deliver specific analysis. Even if the Fapetro would communicate to us the results of the final analyze of the content of C, H and O (to our knowledge, they do not perform ultimate analysis), this would not solve the problem because it is indeed the blends (released for consumption) which undergo analyzes and which since 2009 contain more and more biofuels. However, the required CS EFs are for primary fuels. From a practical point of view, the question seems more important for fossil gasoline because of the addition of oxygenated components. However, in recent years, we can consider that the entire supply of oxygenated components is made via biofuels, the precise composition of which is known thanks to the obligations of other European directives and regulations. Therefore, Belgium precisely calculates the parameters of the biofuels introduced in COPERT.”

You will find below the specific parameters used by Belgium according to the precise composition of the biofuels incorporated in the blends sold on the territory since 2009 (first year of incorporation of biofuels in Belgium).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Biogasoline (volume percentage)	2.00%	5.98%	6.12%	6.10%	6.07%	4.15%	4.08%	4.02%	8.57%	8.84%	9.00%	10.51%	10.72%	10.11%	10.19%
Biogasoline (mass percentage)	2.11%	6.31%	6.46%	6.43%	6.41%	4.39%	4.31%	4.25%	9.01%	9.24%	9.39%	10.87%	11.10%	10.52%	10.60%
Biogasoline (energy percentage)	1.40%	4.24%	4.35%	4.33%	4.31%	2.93%	2.88%	2.84%	6.15%	6.45%	6.57%	7.86%	8.05%	7.45%	7.51%
Biogasoline (OC_RATIO)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.491	0.461	0.458	0.418	0.415	0.446	0.446
Biogasoline (HC_RATIO)	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	2.983	2.922	2.916	2.838	2.833	2.892	2.892
Biogasoline CO_2 EF (kg CO_2/ kg fuel)	**1.911**	**1.911**	**1.911**	**1.911**	**1.911**	**1.911**	**1.911**	**1.911**	**1.923**	**1.971**	**1.976**	**2.042**	**2.046**	**1.995**	**1.995**
Biogasoline (energy content - MJ/kg)	28.800	28.800	28.800	28.800	28.800	28.800	28.800	28.800	28.981	29.644	29.713	30.643	30.695	29.960	29.956
Biogasoline (density - kg/m³)	794.000	794.000	794.000	794.000	794.000	794.000	794.000	794.000	792.367	786.624	786.082	778.322	777.913	783.559	783.557
Biogasoline (C fossil share)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.82%	11.65%	12.24%	21.23%	22.41%	16.14%	16.37%
Biodiesel (volume percentage)	1.70%	4.56%	4.45%	4.59%	4.65%	5.89%	3.29%	5.94%	5.87%	5.74%	5.85%	10.67%	10.66%	11.32%	11.33%
Biodiesel (mass percentage)	1.80%	4.82%	4.70%	4.85%	4.91%	6.22%	3.48%	6.27%	6.19%	6.06%	6.17%	10.79%	10.78%	11.41%	11.41%
Biodiesel (energy percentage)	1.58%	4.23%	4.13%	4.26%	4.32%	5.48%	3.05%	5.52%	5.45%	5.33%	5.44%	10.07%	10.05%	10.69%	10.70%
Biodiesel (OC_RATIO)	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.074	0.074	0.071	0.071
Biodiesel (HC_RATIO)	1.950	1.950	1.950	1.950	1.950	1.950	1.950	1.950	1.950	1.950	1.950	2.010	2.010	2.015	2.016
Biodiesel CO_2 EF (kg CO_2/ kg fuel)	**2.797**	**2.797**	**2.797**	**2.797**	**2.797**	**2.797**	**2.797**	**2.797**	**2.797**	**2.797**	**2.797**	**2.891**	**2.891**	**2.900**	**2.901**
Biodiesel (energy content - MJ/kg)	37.300	37.300	37.300	37.300	37.300	37.300	37.300	37.300	37.300	37.301	37.303	39.494	39.481	39.693	39.697
Biodiesel (density - kg/m³)	890.000	890.000	890.000	890.000	890.000	890.000	890.000	890.000	889.994	889.981	889.948	850.921	851.087	847.535	847.452
Biodiesel (C fossil share)	5.40%	5.40%	5.40%	5.40%	5.40%	5.40%	5.40%	5.40%	5.40%	5.40%	5.40%	3.42%	3.43%	3.25%	3.24%

As explained hereabove, no "country-specific values” are available for “primary fuels”. Consequently, Belgium is using default values provided in COPERT and published in the EMEP/EEA air pollutant emission inventory guidebook 2023 – Update Sep. 2023, page 44.

Fuel (*m*)	Typical Molecule	Ratio of hydrogen to carbon ($r_{H:C}$)	Ratio of oxygen to carbon ($r_{O:C}$)	kg CO_2 per kg of fuel
Petrol	$[CH_{1.86}]_x$	1.86	0.0	3.169
Diesel	$[CH_{1.86}]_x$	1.86	0.0	3.169
Ethanol	C_2H_5OH	3.00	0.5	1.911
Methanol	CH_3OH	4.00	1.00	1.373
Biodiesel	[CH]x-COOH	1.95-2.03	0.11-0.13	2.797-2.727
ETBE	$C_6H_{14}O$	2.33	0.167	2.584
MTBE	$C_5H_{12}O$	2.40	0.20	2.496
Natural Gas / Biogas (REF)	CH4, market fuels also contain C_2H_6	4.00	0.00	2.473
LPG (REF)	C_3H_8 (15%) – C_4H_{10} (85%)	2.525	0.00	3.024
E5		1.92	0.026	3.063
E10 (REF)		1.98	0.053	2.694
E75		2.73	0.38	2.111
E85 (REF)		2.84	0.429	2.026
ETBE11		1.91	0.018	3.094
ETBE22		1.96	0.036	3.021
B7 (REF)		1.86	0.007	3.144
B10		1.86	0.010	3.133
B20		1.87	0.020	3.096
B30		1.88	0.030	3.059

There's a difference in emissions for all greenhouse gases and air pollutants between the submissions 2021, 2022, 2023 and 2024 due to:

Use of other COPERT versions: in the submission 2021 COPERT 5.4.36 was used; for submission 2022 there was a switch to COPERT 5.5.1. during the 2023 submission a switch to COPERT 5.6.1. occurred, and submission 2024 is calculated with COPERT 5.7.3. Listing of different COPERT-versions can be found via https://www.emisia.com/utilities/copert/versions/.

During the 2023 submission the regional fuel sold statistics are used for the first time to calculate the regional emissions instead of the federal statistics before which mainly effects the regional data rather than the federal emission data.

As a result of the European ESD-review in 2019, emissions of road transport were optimized during the 2020 submission by adding the emissions of the fossil part of biofuels into the greenhouse gas inventory. See 'Final Review Report – 2019 annual review of national greenhouse gas inventory data – pursuant to Article 19(2) of Regulation (EU) No 525/2013 – Belgium 28 June 2019'. For this purpose, Belgium uses the methodological note provided by WG1 'annual inventories' of the Climate Change Committee of the European Commission "Annex3_Note on fossil carbon content in biofuels v2.docx" (see Annex 3 in the 2024 submission).

<u>N_2O for CNG heavy duty trucks and buses</u>

Submission 2021: COPERT 5.4.36 is used. In this version, there are N_2O emission factors for CNG BUS, although no documentation is provided by EMISIA. However, Belgium included these (very low) emissions in its submission of 15/03. Considering that the use of "NA" would not seem in line with the ERT 2020 recommendation or with these new hot emission factors N_2O for "CNG BUS" inside COPERT v.5.4.36, Belgium welcomes further guidance on which notation key should be used or whether the currently encoded emissions (15/03 submission) can be left."

Submission 2022: COPERT 5.5.1 is used. No more N2O EF are available for 1A3biii vehicles using gaseous fuels. Since COPERT version 5.4.52 (May 2021), a correction has been implemented by EMISIA: "Correction in the calculation of N_2O and NH_3 emissions for PC LPG & CNG and Urban Buses CNG". See:" https://www.emisia.com/utilities/copert/versions/". This correction notably removed the N_2O emission factors for "urban CNG buses" which had been introduced probably by mistake in earlier versions. Therefore, considering that these emissions do occur but are below the significance threshold described in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines, Belgium reported "NE" as recommended previously by the ERT instead of "NA".

Submission 2023 : COPERT 5.6.1 is used. No N_2O EF for 1A3biii in this COPERT version for CNG. When calculating with default N_2O EF provided in table 3.2.2 of the 2006 IPCC Guidelines (vol. 2, chap. 3, pp.3.21) and considering the default value for natural gas (3 kg/TJ), Belgium calculated the potential N_2O emissions for this source in 2021 which resulted in 0.016 kt CO_2 eq., well below the threshold of significance for Belgium.
When calculating with N_2O EF provided in table 3.2.4 of the 2006 IPCC Guidelines (vol. 2, chap. 3, pp.3.23) and considering the value for natural gas and HDV (185 mg N_2O/km), Belgium calculated the potential N_2O emissions for this source in 2021 which resulted in 0.050 kt CO_2 eq, well below the threshold of significance for Belgium.

Submission 2024: COPERT 5.7.3 is used which introduce N2O EF for 1A3biii vehicles. Estimations for 1A3biii N_2O are now 0.025 kt CO_2 eq. for 2021 (in line with previous estimations provided hereabove) and 0.037 kt CO_2 eq. for 2022.

The introduction of LNG & CNG heavy duty trucks is on the EMISIAs list of planned updates for next year.

During the UNFCCC 2022 Review (Draft Review Report available at the time of this report), the ERT recommended that Belgium include in the NID an explanation of why only a few buses from public transportation operators are using natural gas for experimental purposes in Belgium leading to “NO” being reported for CO2 and CH4 emissions for some years for this category. Belgium confirms that only a few buses from public transportation operators used natural gas for experimental purposes during 1993–2010 in the Brussels Capital-Region. Since 2016, new experiences occur, and Belgium expects a new development in this segment in the future with also LNG/CNG heavy duty trucks.

3.2.8.2.2 Air transport (1A3a and 1A5)

Category 1A3a	Flemish region	Walloon region	Brussels region
Activity data	EUROCONTROL, SKEYES databases, statistics with movements per airport, tanked fuels / for military : tanked fuels	Regional energy balance (tanked fuels from individual airports, distinguish between international and domestic aviation)	NO
Methodology emissions CO_2	EUROCONTROL, EMEP/EEA	IPCC 2006	NO
Methodology emissions CH_4 and N_2O	EUROCONTROL, EMEP/EEA	EUROCONTROL	NO

The energy consumption data for the sector of air transport in Belgium, activities which take place in the Flemish and the Walloon region, are these as reported in the regional energy balances. Data are available by the individual airports. See section 3.2.5 for more information.
The emissions and energy consumption data of the civil/domestic aviation and military aviation are allocated respectively to the sectors 1A3a and 1A5. Besides LTO-activities, also the cruise activities are included. The emissions and energy consumption data of the international activities are allocated to the memo items ‘international bunkers’.

Flemish Region:

In 2015 a study started (EMMOL) (27) in the Flemish region to further optimize the emission estimates in the category 1A3a. Representatives of all regions were involved in this project. First contacts were made in March 2015 with EUROCONTROL to receive more detailed emissions data for Belgium (data per airport, to make distribution of emissions in the regions possible). The improvement of the methodology was finished in December 2015. Data of the entire time series were recalculated during the 2017 Submission.

EUROCONTROL ‘fuel and emissions inventory’ calculates the emissions for all EU Member States. Fuel and emission values were made available for all Belgian airports for flights arriving or leaving to/from Belgium.

As baseline we assume that for international flights (on kerosene) (LTO as well as cruise) the EUROCONTOL emissions (CO_2, CH_4 and N_2O) can be taken over without further corrections.

For the smaller airports a significant part of the air traffic consists of small aircrafts (Visual Flight Rules) and helicopters, which are not taken into account in the EUROCONTROL calculations neither in the SKEYES database.

To calculate the CO_2 emissions for domestic LTO air traffic, statistics with movements in the airports are used, and emission factors from the EMEP/EEA Guidebook 2013 (for turboprops the Guidebook 2006, and for piston engines a combination of EF from Swiss FOCA (Federal Office of Civil Aviation) (28), EPA AP-42 Volume II and EMEP/EEA Guidebook 2006_table 8.5 B851 vs2.3spreadsheet2-1). The same methodology is used to calculate international LTO emissions of airplanes using aviation gasoline.

For N2O LTO (domestic and international, AvGas and Jet A1) an emission factor of 0,2 kg/LTO is used. As there were no EF for N2O aviation gasoline in the EMEP/EEA Guidebook, we used the proposed EF kerosine (table 3-3, International, LTO (kg/LTO) – average fleet in Guidebook 2013 (updated 2014)). In more recent Guidebooks, there were no longer EF factors (EF factor tables) for N2O.
Emissions of CH4 are calculated as 10% of the VOC emissions.

To calculate emissions from domestic cruise, first the fuel consumption used for cruise is calculated by subtracting fuel consumption domestic LTO from the total fuel sold amount 'domestic' per airport. Emission factors CO_2, CH_4 and N_2O used to calculate the emissions for domestic cruise are average EFs of CO_2, CH_4 and N_2O calculated on the EUROCONTROL emission files Oct. 2015, an average over time-series 2010-2014 (years available at the time the EMMOL tool was developed). This results in an emission factor for CO_2 aviation gasoline of 72,845 t/TJ and for kerosene 73,059 t/TJ. For N_2O cruise (domestic and international, AvGas and Jet A1) an emission factor of 0,1 g per kg fuel is used. In the EMEP/EEA Guidebook, there were no EF for N_2O aviation gasoline, therefore the 'calculated EUROCONTROL factor' was compared with the one form table 3-3 of the Guidebook 2013 (updated 2014) = also 0,1 g/kg (kg/tonne).

This methodology is also used to calculate the emissions for international cruise on aviation gasoline.

Early November 2023 EUROCONTROL made available the pivot table database with emissions for years 2015-2022 and a document with the explanation about the changes made. In this dataset a number of flights are 'undetermined' instead of domestic or international. For the Belgian data of EUROCONTROL, all these *undetermined* are domestic flights. The *undetermined* are flights that depart from and arrive at the same airport. Previously they were not included in their calculations, but are now kept in the 'undetermined' category. Certainly in 2020 during the corona pandemic there will be many of those flights. Aircrafts could not fly, but were sometimes sent into the air to be operational and to be able to maintain them technically, and so they departed and arrived at the same airport. In the emission calculation, this category is included as domestic flights.

The complete detailed description of this calculation can be found in Annex 3 of this report where the Quality Management System of the greenhouse gas inventory in the Flemish region is described. In the technical procedure of the quality management system VMM/EIL/GP/5.003 'Procedure for the main process: setting up the greenhouse gas emission inventory' this methodology is recorded in annex 7.3.6. with the data acquisition plan for air traffic in the Flemish region.

Walloon Region:

In Wallonia, there are two main airports in Liège and Charleroi. Data on LTO activities and fuel consumption come from the statistics of the two main airports. Each airport delivers the fuel consumptions for domestic and international activities separately and gives the number of domestic flights and the number of international flights. To calculate CO_2 emissions for domestic air traffic and international air traffic, statistics with fuel consumption from the airports are used with the IPCC emission factors. To calculate N_2O and CH_4 emissions, the results of EUROCONTROL 'fuel and emissions inventory' are used. Fuel and emission values were made available for all Belgian airports for flights arriving or leaving to/from Belgium.

The emissions from domestic LTO and cruise activities are reported under the category 1A3a (civil aviation), while emissions from international LTO and cruise activities are reported under the memo items ‘international bunkers’.
Since 2008, the airports have given the consumption of kerosene and gasoline for the civil aviation.

3.2.8.2.3 Railways (1A3c)

Category 1A3c	Flemish region	Walloon region	Brussels region
Activity data	Regional energy balance (based on EMMOSS-model)	Regional energy balance	Regional energy balance
Emission factors CO_2	IPCC 2006	IPCC 2006	IPCC 2006
Emission factors CH_4 and N_2O	Klein (2006)	IPCC 2006	IPCC 2006

<u>CO2</u>

For the calculation of CO_2 emissions from rail traffic, Belgium uses the values as prescribed in the IPCC 2006 guidelines for combustion of fuel type gas/diesel oil by trains : Volume 2 Energy, Chapter 1 Introduction, p. 1.23, table 1.4, column Effective CO_2 emission factor (kg/TJ), default value, gas/diesel oil 74100 kg/TJ.

However, looking at the trend in the IEFs across the entire time series in CRT table 1.A(a) (sheet 3) for this category, IEF may deviate from that value of 74 t/TJ. This is due to difference in timing between the (earlier) publication of the Flemish energy balance and the calculation of the emissions.
CO2 emissions reported for subcategory 1.A.3.c. railways are correct, but the calculated IEF may not be reflected as used. The reason for this :
Emissions are calculated in year x for time series up to year x-1, but at the same time only a fuel balance with fuel quantities for rail aligned with the emission calculation of year x-2 is available, with a provisional fuel quantity for year x-1. If you calculate an emission factor at that time (in CRT) with the available emissions ((re)calculated for the entire time series up to and including year x-1) and the available energy data (which we have to take from the official fuel balance, data up to year x-2 and provisional for year x-1 at that time), this does not always result in the EF that was used as input for the calculation.
But doing this can result e.g. in an emission factor of 72.6 t/TJ for year x-1.
If no changes have been made in year x in the most recent emission calculation for the time series up to year x-2, then the fuel balance fits with the emission calculation, and the EF as output is 74.1 t/TJ.

Until submission 2023 there was a difference between the calorific value for diesel oil used in the Flemish energy balance (43 GJ/ton) and those used for the inventory (41.4 GJ/ton = IPCC Guidelines , net calorific values, Lower from Volume 2 Energy, Chapter 1 Introduction, p. 1.18, table 1.2). For submission 2024 the values were set equal (43 GJ/ton).

<u>CH4 en N2O</u>

Since the 2009 submission the emissions from railways in the Flemish region are calculated using the EMMOSS-model (29) There are no country specific emission factors. The emissions are calculated as in Klein et al., which means a Tier 1 methodology derived from the EMEP/EEA Guidebook. The fuel consumption is calculated by using gross tonne-kilometres, specific end-energy-use (kWh/tonkm) and an emission factor (g/kWh). For the gross tonne-kilometres a distinction is made between services of trains (goods/persons) and different train types. Emission factor for N_2O is 0,0000256 g per gram FC (Fuel Consumption) and for CH4 is 0,000214 gram per g FC.

The complete detailed description of the EMMOSS model can be found in annex 3 of this report where the Quality Management System of the greenhouse gas inventory in the Flemish region is described. In the technical procedure of the quality management system VMM/EIL/GP/5.003 ‘Procedure for the main process: setting up the greenhouse gas emission inventory’ this methodology is recorded in annex 7.3.10. with the data acquisition plan for railways traffic in the Flemish region.

In the Walloon and Brussels region, the emissions of CH_4 and N_2O are calculated by using the activity data (fuel consumption) of the regional energy balance combined with emission factors of the 2006 IPCC guidelines.

Fuel	**UNIT**	**CH_4**	**N_2O**
Diesel oil	g/GJ	4,15	28.6

Table 3.7: Emissions factors per fuel in railways (2006 IPCC guidelines)

3.2.8.2.4 Navigation (1A3d)

Category 1A3d	Flemish region	Walloon region	Brussels region
Activity data	Regional energy balance (based on EMMOSS-model)	Regional energy balance	Regional energy balance
Emission factors CO_2	IPCC 2006	IPCC 2006	IPCC 2006
Emission factors CH_4 and N_2O	IPCC 2006 (inland waterways) and EF from Klein (2006)	IPCC 2006	IPCC 2006

The energy consumption data in the sector of navigation (category 1A3d) are taken from the regional energy balances. See section 3.2.5. for more details.

<u>Walloon and Brussels region</u>:

To calculate the emissions of CO_2, CH_4 and N_2O in Walloon and Brussels Region, the fuel consumption data are multiplied by the IPCC 2006 default emission factors.

<u>Flemish region</u>:

Since the 2009 submission the emissions from **inland waterways (navigation)** are calculated with the EMMOSS-model in the Flemish region (29). Energy consumption is calculated by using the detailed information on the kilometres covered by inland waterway vessels per waterway. Other parameters are the rate of empty ships, age structure, speed, load.

A new model to calculate emissions on waterways was being worked on in 2023, but it had not yet been fully validated to use to calculate emissions until 2022. Since inputs to the EMMOSS methodology were no longer available for 2022, emissions 2022 were kept the same as 2021 in submission 2024

Using the EMMOSS-model in the Flemish region, causes a lower emission factor for CH_4 compared to the IPCC 2006 default emission factor of 7 kg CH_4/TJ which is used in the other regions. The model is based on modelling used in the neighbouring country, the Netherlands. The Flemish region chooses this model to make the methodology more ‘country-specific’.

Emissions of CH_4 are calculated as a fraction of the emissions of VOC. These emissions are calculated depending on the different classes of construction years and engines of the boats (g/kWh power of the engines).

The methodology is based on the EMS-protocol in the Netherlands (EMS-protocol Emissies door Binnenvaart: verbrandingsmotoren, 15 dec. 2012).

It is not possible to express the used emission factors in kg/TJ. Contrary to the emissions of CH_4, emissions of CO_2 and N_2O are indeed calculated based on the emission factors of the IPCC 2006 guidelines.

To calculate the emissions of maritime inland transport, also emissions of VOC are used from the Netherlands, with a distinction between type of engine and construction year. In this case the emission factors are expressed in g/kg fuel.

The values used in EMMOSS can be given if requested and can be found via the reference ‘Publikatiereeks Emissieregistratie. Emissiefactoren Vluchtige organische stoffen uit verbrandingsmotoren. no. 10, april 1993, Den Haag’.

The emissions reported in the category 1A3d in the Flemish region are the sum of the domestic navigation and the maritime inland transport.

The EMMOSS-model is also used for the calculation of the emissions from the **sea navigation** (departure and arrival in Belgian/Flemish sea ports) in the Flemish region. The traffic of goods between the ports of Antwerp, Gent, Zeebrugge and Oostende is taken into account, and there is an estimation of the emissions from ships for sand extraction, dredging and tug-boats.
Since the 2016 Submission the emissions of sea-fishery are also calculated with the EMMOSS model.
In general, the model can be summarized by three formulas:
1) energy use (kWh) = time (h) x installed engine power (kW) x engine load factor (%) x number of ships;
2) fuel use (kg) = energy use (kWh)/engine efficiency (%)/energy content of the fuel (kWh/kg);
3) emissions (kg) = fuel use (kg) x emission factor (kg/kg) x correction factor (-).

The emission factors for CH_4 and N_2O were taken-over from a study in the Netherlands (30).
The emission factor for CO_2 for the domestic navigation is between 72,56-72,59 t/TJ for the complete time series.

The complete detailed description of the EMMOSS model can be found in Annex 3 of this report where the Quality Management System of the greenhouse gas inventory in the Flemish region is described. In the technical procedure of the quality management system VMM/EIL/GP/5.003 ‘Procedure for the main process: setting up the greenhouse gas emission inventory’ this methodology is recorded in annex 7.3.7. and 7.3.9. with the data acquisition plan for navigation in the Flemish region.

3.2.8.2.5 Other transportation (1A3e)

Category 1A3e	Flemish region	Walloon region	Brussels region
Activity data	Regional energy balance (based on information of the gas operators Fluxys and Gassco and in line with ETS) and off-road AD from the OFFREM-modelling	Regional energy balance (based on information of the gas operators Fluxys) and off-road AD from the OFFREM-modelling	Regional energy balance (based on information of the gas operators Fluxys) and off-road AD from the OFFREM-modelling
Emission factors CO_2	IPCC 2006 and measurements, in line with ETS.	IPCC 2006	IPCC 2006
Emission factors CH_4 and N_2O	IPCC 2006	IPCC 2006	IPCC 2006

In this category 1A3e the energetic emissions originate

1) from the compression activities in the sector ‘storage and transport of natural gas’. See section 3.2.5. (‘transport through pipelines’ in the regional energy balances) for more information. These emissions are allocated to category 1A3ei.

The emissions of CO_2 are delivered directly from the companies involved (Fluxys and Gasco) or are estimated by using the IPCC 2006 default emission. These emissions are in line with the ETS-reporting. The emissions of CH_4 and N_2O are newly recalculated by using the IPCC 2006 emission factors i.e. 1 g CH_4/GJ and 0,1 g N_2O/GJ during the 2020 submission instead of the emission factors from CITEPA90

(24) i.e. 0,3 g CH_4/GJ and 3 g N_2O/GJ before. This recalculation had a minor impact on the emissions in this category.

The gas operator Fluxys is monitoring the emissions of CO_2 since 2013 for the biggest installations in Belgium (compression stations and storage of gas). These monitoring results are integrated in the ETS-reporting and taken over in the greenhouse gas inventory.
Emissions of CO_2 from warming up the natural gas that is imported from Norway (Flemish region) is also included in this category (operator Gassco for sea pipe terminal) and also taken over by the ETS-reporting. Since the 2013 submission the emissions of CH_4 from the venting of this gas is re-allocated from the category 1A3e to the category 1B2c.

2) from off-road activities in harbours, airports and transhipment companies. These emissions are allocated to category 1A3eii.

Emissions are calculated with the country-specific OFFREM-model.

The original study of July 2009 was optimized in December 2019 '*Actualisatie OFFREM: OFFREM 2019 Marlies Vanhulsel, Frank Sleeuwaert, Tomas Crols, Karolien Vermeiren, Inge Uljee Studie uitgevoerd in opdracht van: Vlaamse Milieu Maatschappij (VMM) 2019/Unit RMA/R/2037 December 2019'.*

The emissions of CO_2 are calculated with the use of IPCC 2006 emission factors, for N_2O and CH_4 EMEP/EEA guidebook (2005) is used.
The energy consumption data of these off-road activities originates directly from the OFFREM-model and are updated data compared to data reported in the Flemish energy balance which need to be reported earlier.

As data for fleet and activity in harbours, an inventory of all off-road equipment for 2015 in the port of Antwerp is used. The data from port of Antwerp are used to create a fleet for all years and all ports (sea and inland ports). For airport information on fleet and activity data could be found in a confidential study on Brussels Airport. This information can be used to scale fleet and activity in other airports. Figures for each international airport are available (surface, number of passengers, number of flights) to do this. The fleet and activity data for multimodal transhipment stations or hubs are derived from information found on websites of 3 transhipment companies.

During the 2020 submission, the OFFREM-model was optimized for all subsectors (version OFFREM 2). Some functional and methodological corrections were made to this tool e.g. adding of stage V (machinery) and EURO 6, 6c and 6d norms (vehicles), emission factor and energy consumption factors of off road vehicles and quads were updated with most recent COPERT data and data from the EMEP/EEA Guidebook 2019, calorific values were updated, TAF-factors (Transient Adjustment Factor) were updated according to the EMEP/EEA Guidebook 2019.

More specific for the harbours an update of the basic data used for determining the key values for the calculation of the energy consumption for off road activities took place. Before, an inventory of all off-road equipment for 2006 in the port of Antwerp was used.
The source for the actualization is the survey that was carried out in the framework of the study 'LNG Masterplan for Rhine-Main-Danube'
(http://lngmasterplan.eu/images/D_335_Alternative_fuels_for_port_equipment_Antwerp_v1.0_FINAL_2015-12-23.pdf)
This study focused on machinery as property of the harbour itself as well as on machinery as property of private harbour operators.
An actualization based on the data of the machinery in 2015 resulted in a higher number of registered machines and a higher engine power for most of the machines. Besides also a higher average of working hours was detected. These corrections resulted in higher emissions in this category.
For the airports a.o. different rates of growth per year, per airport and per type has now been defined. Also, a correction in energy consumption of the vehicles used took place.
For the multilateral transfer terminals an update of input data used for the machine park was performed during this optimization.

A further optimization of the OFFREM-model occurred during the 2022 submission. A correction was made in input data for all categories that use gasoline in the vehicles: blend % biofuels were corrected based on data used for emission calculation for road traffic.

A complete detailed description about the methodology used can be found in annex 3 of this report where the Quality Management System of the greenhouse gas inventory in the Flemish region is described. In the technical procedure of the quality management system VMM/EIL/GP/5.003 'Procedure for the main process: setting up the greenhouse gas emission inventory' the methodology used to estimate the off-road emissions is recorded in annex 7.3.17. The methodology used is the same in all 3 regions in Belgium.

3.2.8.3 Uncertainties and time-series consistency

The uncertainty on activity data for CO_2 emissions from road transport is reported on page 2.49 of the IPCC Good Practice Guidance, which mentions that this is the main source of uncertainty for CO_2. The same uncertainty on activity data is used for all gases. For CH_4 and N_2O, the uncertainties on emission factors are those recommended by the IPCC Good Practice Guidance. A higher uncertainty is estimated for N_2O because of the lack of precise monitoring on the combustion conditions (vehicles types, average speed, etc …).

Default IPCC values are used for civil aviation, both for activity data and emission factors.

For railways the uncertainty is allocated under the energy industries. In Belgium 93% of the train kilometers for passengers and 75% for goods are performed in an electrical way (2007). The rest of the locomotives uses diesel as fuel. The uncertainty on the emissions calculated for rail traffic in Flanders is very high. The gross ton kilometres, needed as input, have not been available for several years. Efforts to obtain up-to-date input data to calculate emissions from rail traffic have been ongoing for several years. The emissions factors are derived from EMEP/EEA air pollutant emission inventory guidebook 2009 where their uncertainty rating are respectively 'C' and 'E' for CH_4 and N_2O. This ranking seems quite consistent with the values used in Finland (25), respectively 60-110% for CH_4 and 70- 150 % for N_2O. Similar values were consequently adopted as a first estimate.

Fuel consumption in navigation is estimated on the basis of the traffic, which is quite controlled on the domestic scale. The uncertainty on activity data is estimated at 10%. For emissions factors, the uncertainty is in the same range as for railways, considering the same rating of these emission factors in the EMEP/EEA air pollutant emission inventory guidebook 2009.

The CO_2 emissions under category 'other' (1A3e) include energetic emissions originating from the transport through pipelines (compression stations). An uncertainty is assumed of 5% on activity data (information data from the gas federation) and of 1% on the emission factor (default IPCC emission factor). For liquid fuels in this category (off-road activities in harbours, airports and transhipment companies) a higher uncertainty in AD is assumed (10%). See table 2.5 of the IPCC Good Practice Guidance) for the uncertainty on emission factors.

3.2.8.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided on request.

3.2.8.5 Source-specific recalculations, if applicable, including changes made in response to the review process

<u>All regions</u>:

- Inventory with final regional energy balances as a provisional energy balance is made yearly for year (x-1), whereas a final energy balance is made for year (x-2).

[Inconsistency between energy data published in the energy balance and in CRT-tables can occur because of difference in timing of publication the data. This is the case for activity data and emissions of transport categories that are depending on the output of models (f.i. OFFREM, EMMOL). As a consequence, energy balances contain preliminary activity data and CRT-tables contain more recent data from the models involved. See also chapter 1.2.5.].

- Recalculations in the category 1A3b (road transport) in all 3 regions in Belgium for the complete timeseries due to:
    - Use of updated COPERT 5.7.2 version during this submission;

Flemish Region:

- small change in aviation due to new datasets from EUROCONTROL for the years 2015-2021 and an update of aviation fuel data for military aircrafts.

Brussels Region:

- In 1.A.3.c - Railways, revision of energy consumption up by on average 4% for the period 2014-2017, and marginal revisions for the years 2018 to 2021 due to the revision of conversion factors used in the energy balance.
- In 1.A.3.d - Domestic Navigation, revision of energy consumption down by on average 6% for the period 2014-2021 due to the revision of conversion factors used in the energy balance.

Walloon Region:

- In 1A3eii, optimization of the OFFREM model.

3.2.8.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

In Flanders

- The optimization of the EMMOSS model to calculate emissions from maritime navigation in all ports and in Belgian part of the sea, which started in 2022, is still under revision in 2024. New data will be integrated in the next submission.
- The EMMOSS model that also calculates emissions for 'national' navigation will be replaced by a new model (EISS). The methodology and model are currently being developed (revision started in 2022). New data will be integrated in the next submission.
- For domestic aviation, there is a study assignment for updating the calculation tool (EMMOL) and the emissions factors in it in the second half of 2024. It cannot be decided now whether emissions calculated with the updated tool will be included in submission 2025.
- Road transport : updating mileages with data from CarPass[14] and inspection centres.

Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3.2.9 Other sectors (CRT 1.A.4)

3.2.9.1 Source category description

In the category 1A4 the following sources are taken into account in the Belgian greenhouse gas inventory: commercial/institutional (1A4a), residential (1A4b) and agriculture/forestry/fishery/green area maintenance (1A4c).

Emissions of off-road activities are calculated in line with the IPCC 2006 guidelines and reported separately since the 2015 submission in the categories 1A4b ii (residential) and 1A4c ii (agriculture). Greenhouse gas emissions of fishery activities are, in line with the IPCC 2006 guidelines (table 2.5), reported separately since the 2015 submission in category 1A4c iii. The emissions of fishing activities

[14] https://www.car-pass.be/en//

are estimated by using default IPCC 2006 emission factors in combination with energy data of the energy balance. For the emission calculation of the fishery activities, activity data about average days at sea per fleet segment, number of vessels and fleet fuel data are needed. These data are only available until year -2 (i.e. 2021 data only available in the course of 2023 and consequently reported during 2024 submission).

As a follow-up of the in-country review of September 2018, Belgium did calculate the emissions of CO_2 by using a country-specific CO_2 emission factor for natural gas for all subsectors in the category 1A4 instead of the default IPCC 2006 emission factors before. This correction was performed for the complete timeseries in all 3 regions in Belgium. Data became available from Fluxys and from the federal services of Economy.

Since the 2021 submission the country-specific emission factors for natural gas are further fine-tuned from 2017 on, based on the composition of the natural gas that is effectively used in Belgium rather than all the gas that enters Belgium in previous calculations. Country specific emission factors for the years 1990-2016 remain unchanged.

Belgium is still investigating the possibilities to use country-specific emission factors for liquid fuels and solid fuels as well in the near future. So far (submission 2023) no further information in this aspect is obtained.

3.2.9.2 Methodological issues

The activity data (energy consumption data) of the sector ‘other sectors’ (category 1A4) are taken from the regional energy balances and added up for reporting in the Belgian emission inventory. See section 3.2.5 for more information.

The combined heat-power installations in joint-venture with the energy sector of the commercial/institutional and the agricultural sectors are allocated to the sector 1A1a ‘Public electricity and heat production’. Emission factors used are reported in that chapter 3.2.6 of the NID.

Emissions of auto producer units in the categories 1A4 remain allocated in these categories 1A4.
To calculate the emissions of CO_2, all regions use the default IPCC 2006 emission factors except for natural gas where country specific emission factors are used.

In the **Walloon region and in the Brussels region**, the Tier 1 emission factors for CH_4 and N_2O are still used during this submission (contrary to the Flemish region – see below). In the Walloon region, a study was performed in 2018 to disaggregate the residential fuel combustion between the type of technology (stoves, boilers,) and the year of construction.

In the tables 3.9 and 3.10 the emission factors for CH_4 and N_2O (Tier1) for the ‘other sectors’ (category 1A4) are listed.

Fuel		**Subsector 1A4**	**Unit**	**CH_4**
Coal		commercial	g/GJ	10
		residential	g/GJ	300
Natural gas		commercial/residential	g/GJ	5
		commercial in Wallonia (boilers)	g/GJ	1
		agriculture heating	g/GJ	5
		auto producer (engines)	g/GJ	258
Fuel / diesel oil		commercial/residential	g/GJ	10
		agriculture heating	g/GJ	10
		farming vehicles in Wallonia	g/GJ	4.15

Propane/butane/LPG		commercial/residential	g/GJ	5
Biogas		agriculture heating / commercial	g/GJ	5
		auto producer	g/GJ	258
wood			g/GJ	300

Table 3.9: Emission factors of CH_4 for category 1A4 Other sectors (service, residential and agriculture sector) in the Brussels and Walloon region

Fuel	**Subsector 1A4**	**Unit**	**N_2O**
Coal	commercial/residential	g/Gj	1.5
Natural gas	commercial/residential	g/GJ	0,1
	commercial in Wallonia (boilers)	g/GJ	1
Fuel / diesel oil	commercial/residential	g/GJ	0,6
	agriculture heating	g/GJ	0,6
	farming vehicles in Wallonia	g/GJ	28.6
Biogas	agriculture heating/commercial	g/GJ	0,1
Wood	commercial/residential	g/GJ	4

Table 3.10: Emission factors of N_2O for category 1A4 Other sectors (service, residential and agriculture sector) in the Brussels and Walloon region

In the Flemish region, the results of a new study carried out in 2017 were implemented during the 2019 submission (31). The Tier 2 - methodology (instead of Tier 1 before) was used. A distinction between different types of stoves in the residential sector and an optimization of the emission factors was carried out.
In the residential sector the IPCC 2006 emission factors were used (table 2.5 for CO_2 and table 2.9 for CH_4 and N_2O). In the commercial/institutional sectors the IPCC 2006 emission factors were used (table 2.4 for CO_2 and table 2.10 for CH_4 and N_2O - except for waste and lamp petroleum where table 2.4 was used).
For the agricultural sector, for all fuels with exception of wood, a Tier 1 methodology is used. For wood, as it was possible to make a distinction between the size of the combustion unit used (< 1MW and > 1MW), a tier 2 methodology is applied.

The emission factors used in the Flemish region, can be found in the tables in annex 3 respectively for the residential, for the commercial/institutional sectors, for the agriculture sector and for the auto-producers in these categories.

In the Flemish region emissions of fishery are calculated with the same model as for navigation (EMMOSS model). Activity data are fuel cost, fuel amount, fleet, average days at sea,

All 3 regions: country specific emission factor for natural gas:

For CO_2 country-specific emission factors were used for natural gas in the three regions. This was an optimization carried out during the 2020 submission as a result of the UNFCCC in-country review in September 2018. Data were obtained by Fluxys, the independent company responsible for the transport network for natural gas in Belgium. The average emission factor of CO_2 (yearly basis) was determined on the basis of 1) an average of the composition of gas (consequently also emission factors), on a yearly basis, on the different entry points and 2) the physical flows (year total) on these points. Nominations flows can be found on
https://gasdata.fluxys.com/sdp/Pages/Reports/Nominationsflows.aspx?predefined=none).

Average composition of gas on the entry points can be found via
https://www.fluxys.com/en/products-services/covering/belgium/operational-data-end-consumers
Data are available from 2008 on. A limited difference with the default emission factor is obtained. For the years 1990-2007 the country-specific emission factor of the year 2008 was used.
Since the 2021 submission the country-specific emission factors for natural gas are further fine-tuned from 2017 on based on the composition of the natural gas that is effectively used in Belgium rather than all the gas that enters Belgium in previous calculations. Country specific emission factors for the years 1990-2016 remain unchanged.

So far, no country specific emission factors could be found for the liquid and solid fuels in this CRT category. The use of country-specific emission factors in these fuel categories still needs more investigation.

All 3 regions; no country specific emission factors for liquid and solid fuels:

Owing to the large variability in carbon content and the limited amount used in stationary combustion under the subcategories in the category 1A4 in Belgium, the use of any country-specific value is likely to increase uncertainty, so the IPCC default factor appears to be the best available data.

Off-road:

Since the 2012 submission the emissions from non-road mobile machinery ('off-road') are included in the inventory for the complete territory of Belgium and for the complete time series.
Emissions of off-road activities are calculated in line with the IPCC 2006 guidelines and reported separately since the 2015 submission in the categories 1A4b ii (residential) and 1A4c ii (agriculture). The OFFREM-model is used to calculate the emissions. The energy consumption data of these off-road activities originates directly from the OFFREM-model and are updated data compared to data reported in the Flemish energy balance which need to be reported earlier.
The original study of July 2009 was optimized in December 2019 '*Actualisatie OFFREM: OFFREM 2019 Marlies Vanhulsel, Frank Sleeuwaert, Tomas Crols, Karolien Vermeiren, Inge Uljee Studie uitgevoerd in opdracht van: Vlaamse Milieu Maatschappij (VMM) 2019/Unit RMA/R/2037 December 2019'.*

The emissions from machinery used in harbours, airports and transhipment companies are allocated to the category 1A3e (instead of category 1A4a before), emissions of defence are allocated to the category 1A5b (instead of 1A4a before).

Emission factors N_2O and CH_4 are based on the EMEP/EEA Guidebook (2005), IPCC 2006 emission factors are used to estimate the emissions of CO_2.

- Technology related emissions (N_2O and CH_4)

• machines: emission factor (g/kWh) x energy use (kWh)
• vehicles: fleet emission factor (g/km) x mileage (km)

- Fuel related emissions

• machines: emission factor (g/g) x fuel use (g)
• vehicles: fuel consumption factor (g/km) x mileage (km)

energy use (kWh) = design capacity (kW) x load factor (%) x working hours (h)
fuel use (g) = energy use (kWh) x fuel consumption factor (g/kWh)

Activity data:

- Off-road residential (1A4b):

Two parts are considered: mobile machines gardening and off-road use of quads and motorcycles. For mobile machines for gardening the number, kW and use (hour, frequency) of the machines are combined with the number of gardens per size and the number of households. For the off-road use of quads and motorcycles, sale statistics are available for quads and the number of people taking part in cross-country competitions are the base for the estimation of fleet and activity for off-road motorcycling.

- Off-road agriculture/forestry/fishery/green area maintenance (1A4c):

Forestry and green area maintenance: for one city data on working hours of the machines used in forestry, and for 4 cities data on machines used and hectares of forestry are available. By combining these data, working hours per type of machine and per hectare of forestry are obtained. The hectares of forestry for the 3 Belgian Regions are used.
During this 2021 submission the starting point of coming into force for the Stage II for chainsaws is corrected (as a result of the NEC-review of the inventory of air pollutants) and age distribution is implemented for these chainsaws.

Agriculture: activity data are technical data on cultivations, soil use, size of parcels farm land, technical characteristics machines and vehicles.

A complete detailed description about the methodology used can be found in annex 3 of this report where the Quality Management System of the greenhouse gas inventory in the Flemish region is described. In the technical procedure of the quality management system VMM/EIL/GP/5.003 ‘Procedure for the main process: setting up the greenhouse gas emission inventory’. This methodology is recorded in annex 7.3.17 and is used for all 3 regions in Belgium.

During the 2020 submission, the OFFREM-model was optimized for all subsectors (version OFFREM 2). Some functional and methodological corrections were made to this tool e.g. adding of stage V (machinery) and EURO 6, 6c and 6d norms (vehicles), emission factor and energy consumption factors of off road vehicles and quads were updated with most recent COPERT data and data from the EMEP/EEA Guidebook 2019, calorific values were updated, TAF-factors (Transient Adjustment Factor) were updated according to the EMEP/EEA Guidebook 2019.

More specific for the category 1A4 the following corrections to the OFFREM-model were made:

- residential sector/households: revision of the geographical spreading of total energy consumption of quads and total calculated emissions for quads for Belgium to the 3 regions. For the subcategory ‘recreation’ a correction of the energy consumption data for moto-vehicles and quads based on resp. the COPERT 4 and COPERT 5 models took place.
- Forestry: the hectares of forest is made year-dependent and consistent with the surfaces reported in the LULUCF-sector.
- Landscaping: update of the surfaces in the 3 regions on the basis of the land use-maps.

During the 2024 submission an optimization of the OFFREM model for the category 1A4cii took place in the Walloon region.

3.2.9.3 Uncertainties and time-series consistency

Commercial and residential fuel consumption is the main activity data in this sector. Surveys are combined with extrapolations in order to estimate the consumption. The uncertainty on activity data is based on the table 2.6 of the IPCC Good Practice Guidance (9) (10) and takes into account the types of fuels: natural gas is measured with accuracy, but wood consumption is extrapolated from available data. The uncertainty on emission factors is the same as for energy and industrial sectors and originates from tables 2.5 and 2.6 of the IPCC Good Practice Guidance and tables 2.13 and 2.14 of the IPCC 2006 guidelines associated with expert judgement.

3.2.9.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided on request.

In the Walloon region, some QC-tests are performed in the course of 2013. In particular in the categories 1A4a, 1A4b and 1A4c.

Each year, a comparison of activity data is performed between the Walloon ETF-GHG data and the Walloon energy balance for the last year of the submission.

In the Brussels region QC-tests take place before compiling information. The checks are done on the input data and on the emissions results: comparison is performed with the previous submission data and trend analysis.

3.2.9.5 Source-specific recalculations, if applicable, including changes made in response to the review process

All regions:

- Inventory optimized with final regional energy balances: as a provisional energy balance is made yearly for year (x-1) in the year x, whereas the energy balance for the year (x-2) are made final.

Brussels-Capital region:

- Recalculations of historical series in the energy balance, especially for the period 2014–2021 for all energy vectors, and gasoil from 2010 with the revision of the time series and sectorisation based on the federal survey of distributors (sales).
- In 1A4bii, revision of data from the OFFREM calculation model for the period 2001-2013 and the year 2021.
- 1A4cii, revision of data from the OFFREM calculation model for the year 2021.

Walloon region:

- In 1A4bi, revision on the charcoal consumption on the entire time series and revision of the pellets part in the total wood consumption since 2005.
- Optimization of the OFFREM model for the category 1A4cii.

Flemish region:

For the years 2016-2021, optimization of energy consumption data in the energybalances causes differences in calculated emissions in this category. The largest difference between current and previous submission is for the year 2021. The consumption of gas- and dieseloil in 2021 decreased with 11% in services sector and with 7% in agricultural sector. In the services sector this was due to the correction of an error in the extrapolation method. Together with the decrease of gas- and dieseloil consumption in agricultural sector, there is also a decrease of 39% of coal consumption between current and previous submission. In the agricultural sector this decrease was due to an update of the source data: in the previous submission preliminary data were used for 2021, while in this submission final surveydata from 2021 were available. .

3.2.9.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

No specific planned improvements are foreseen for the next submission.
Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3.2.10 Other (CRT 1.A.5)

3.2.10.1 Source category description

The category 1A5 contains ‘other’ sources.

No activities under category 1A5a take place in Belgium.

In the category 1A5b the energetic activities and emissions originating from the military transport (domestic air transport) are reported. The emissions and activity data in this category originates from the results of the EMMOL-model (see section 3.2.8 for more information)

Besides, off-road emissions of defence activities are also allocated in this category 1A5b.

3.2.10.2 Methodological issues

The energy consumption data are taken from the regional energy balances. See section 3.2.5 for more information.
The emissions of the military transport in Belgium are calculated in the same way as explained in section 3.2.8.2.2.

In Flemish Region there are several airports for military aviation: 6 airports between 1990 and 1996 (Kleine Brogel, Brasschaat, Koksijde, Melsbroek, Sint-Truiden and Goetsenhoven and 4 airports for military aviation from 1997 until 2015 (Kleine Brogel, Brasschaat, Koksijde, Melsbroek). Emission calculation for military flights consist of 2 parts: emission calculation for Melsbroek, representing the biggest part and situated near the Brussels Airport, and a second part for the smaller military airports.

For Melsbroek emissions can be calculated on statistics of movements (split into LTO/cruise domestic/international available).

For the 4 smaller airports emissions are calculated based on fuel sold. No distinction can be made for LTO/cruise domestic/international. Emission factor CO_2 is the average factor calculated over the 2010-2014 time-series from EUROCONTROL. Emission factor N_2O is 0.1 kg/kg fuel (Guidebook2013 Tier 1 (table 3.3). The emission of CH_4 is calculated as 10% from VOC emission. VOC emission for planes on kerosene is based on Guidebook2013 table 3.15, for aviation gasoline it is based on a average emission in EUROCONTROL database (domestic flights).

In the Walloon region, the energy consumption is taken from the energy balance. The fuel is considered to be kerosene with a CO_2 emission factor of 71,5 kg/GJ and N_2O emission factor of 0,1 g/kg (Guidebook emep/corinair 2009).

Off-road:

The off-road emissions for the military activities are also reported in this category. These emissions are calculated by using the OFFREM-model.
The original study of July 2009 was optimized in December 2019 '*Actualisatie OFFREM: OFFREM 2019 Marlies Vanhulsel, Frank Sleeuwaert, Tomas Crols, Karolien Vermeiren, Inge Uljee Studie uitgevoerd in opdracht van: Vlaamse Milieu Maatschappij (VMM) 2019/Unit RMA/R/2037 December 2019'.*

The energy consumption data of these off-road activities originates directly from the OFFREM-model and are updated data compared to data reported yearly in the Flemish energy balance where these data need to be available earlier in the year.

A complete detailed description about the methodology used to estimate the off-road emissions can be found in annex 3 of this report where the Quality Management System of the greenhouse gas inventory in the Flemish region is described. In the technical procedure of the quality management system VMM/EIL/GP/5.003 'Procedure for the main process: setting up the greenhouse gas emission inventory'. This methodology is recorded in annex 7.3.17 and is used in all 3 regions in Belgium.

During the 2020 submission, the OFFREM-model was optimized for all subsectors (version OFFREM 2). Some functional and methodological corrections were made to this tool f.i. adding of stage V (machinery) and EURO 6, 6c and 6d norms (vehicles), emission factor and energy consumption factors of off road vehicles and quads were updated with most recent COPERT data and data from the EMEP/EEA Guidebook 2019, calorific values were updated, TAF-factors (Transient Adjustment Factor) were updated according to the EMEP/EEA Guidebook 2019.
More specific for defence, increasing energy consumption data per type of vehicle based on corrected energy consumption factors took place during this submission.

During the 2022 submission the OFFREM-model was updated again in the Flemish region by correcting the input data for all subcategories using gasoline in the vehicles: blend % of biofuels were corrected based on the emission calculations for road traffic and densities and calorific values of fuels were also taken over by the emission calculations for road traffic.

During the 2024 submission no updates in the OFFREM-model occurred.

3.2.10.3 Uncertainties and time-series consistency

Default IPCC 2006 values are used for civil aviation, both for activity data and emission factors (see also 3.2.8.3).

3.2.10.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are only performed in the 3 regions for the Belgian key source categories and can be provided on request.

3.2.10.5 Source-specific recalculations, if applicable, including changes made in response to the review process

Flemish region:

No major changes in activity data nor in emissions occurred in the category 1A5 in the Flemish region. Minor changes are a result of an update of aviation fuel data for military aircrafts from 2019 on.

3.2.10.6 Source-specific planned improvements, if applicable, including those in response to the review process

No specific planned improvements at this moment are provided in the category 1A5 for the next submission.

Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3.3 Fugitive emissions from solid fuels and oil and natural gas (CRT 1.B)

No recalculations were performed in Belgium in category 1B during this submission.

3.3.1 Fugitive emissions from solid fuels (CRT 1.B.1.)

3.3.1.1 Source category description

In category 1B1a1 (coal mining and handling) the diffuse emissions of CH_4 from mining activities in the years 1990-1992 are allocated.
The CH_4 emissions from abandoned underground mines were newly estimated in the previous submission (only located in the Walloon region).
The diffuse emissions from cokes production are allocated in the category 1B1b (solid fuel transformation).

3.3.1.2 Methodological issues

3.3.1.2.1 Coal mining and handling (category 1B1a1)

During the in-country review in June 2007, the expert review team of UNFCCC detected some missing underground mining activities in the Belgian greenhouse gas emission inventory. In the beginning of the nineties until 1992 there still was some mining activity in the Flemish region. Until 1999 energetic mining activities remain existing. These activities consist of an auto-producer of electricity that was active until

1996 (the waste of the coal was used to produce electricity) and of energy needed for the sorting machines which were active until 1999. The latter energetic activities are allocated to the category 1A1c. See sections 3.2.5 (Flemish energy balance) and 3.2.6 (Manufacturing of solid fuels and other energy industries) for more information about these activities.
The activity data, production of coal, are obtained from the federal statistics in Belgium. The methodology described in the IPCC 2006 guidelines is used to estimate the diffuse emissions of CH_4.

After closure, coal mines that were significant methane emitters during mining operations continue to emit methane unless there is flooding that cuts off the emissions. In Flanders, seven coalmines were active during the 20th century: 1 was closed in 1939 (Houthalen), 1 in 1966 (Zwartberg), 4 were closed in the eighties (Beringen, Eisden, Waterschei and Winterslag) and 1 in 1992 (Zolder). All these coalmines were flooded after closing down. This happened in a natural way because of groundwater was filling the mines. The Belgian geological services are responsible for measuring the movements of the earth's surface and are continuously observing this. Consequently, no abandoned mines since 1990 remained unflooded and no emissions took place.

In Wallonia the last coalmine was closed in 1984 (Farciennes). Most of the old mines were not gassy or were flooded but there were still seven old gassy mines (6 mines closed from the year 1951 to 1975 and one mine closed in 1980). In these mines, the gas was recovered during some years after the closure. In 1990, there were still two mines where the gas was recovered but there was no more recovery in 1993. The CO_2 emissions coming from the combustion of the gas from 1990 to 1992 was already taken account in the inventory. By using the tier 1 methodology of the IPCC 2006 guidelines, the emissions of CH_4 are now newly estimated at 44.8 kton CO2eq/year in 1990 and 43.9 kton CO2eq/year in 2022.

3.3.1.2.2 Solid fuel transformation (category 1B1b)

Emissions during the coke production are caused by the loading of the coal into the ovens, the oven/door leakage during the coking period and by extracting the coke from the ovens. The activity data, production of coke, are directly reported by the companies involved. See also section 3.2.6 and 3.2.7. for more information.

In Wallonia and Brussels, the fugitive CH_4 emissions are estimated with the emission factor of the EMEP/EEA air pollutant emission inventory guidebook 2009 (400 g CH_4/ton cokes). Activity data (tons of coke) are delivered by the corresponding industry. The high CH_4 EF is due to a very poor level of gas tightness in the Walloon coke plants. During the 2017 submission, the CO_2 emissions from the fugitive emissions were estimated. Following the Guidebook emep/corinair 1999, table 3.1, the CO_2 content of coke oven gas is 2,5 % (29 % for the CH_4 content) which lead to an emission factor of 90 gCO_2/t.

From 2015 on, these activities did no longer occur in these regions and consequently the ‘notation key’ NA is reported.

No fugitive emissions take place during cokes production in the Flemish region. Stack emissions are allocated to the category 1A1c.In the Flemish region these emissions are undoubtedly caused by the dry distillation of the cokes coal. There are about 100 cokes ovens operational that are heated via combustion rooms separated from the coke’s ovens via not completely hermetically closed walls. Emissions of CH_4 occur from the produced cokes gas to the combustion room and consequently to the stack. Consequently, no uncontrolled emissions take place in the Flemish cokes plant and emissions are consequently put in category 1A1c.

3.3.1.3 Uncertainties and time-series consistency

Fugitive emissions under category 1B1 are mainly linked to the production of coke. The production is assumed to be well known, while the uncertainty on the emission factor is estimated at 60 %, taking into account the EMEP quality estimate and range of values.

3.3.1.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are only performed in the 3 regions for the Belgian key source categories and can be provided on request.

3.3.1.5 Source-specific recalculations, if applicable, including changes made in response to the review process

No recalculations were performed in Belgium in category 1B1 during this submission.

3.3.1.6 Source-specific planned improvements, if applicable, including those in response to the review process

No specific planned improvements at this moment are provided in the category 1B1 for the next submission.

Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3.3.2 Fugitive emissions from oil and natural gas (CRT 1.B.2.)

3.3.2.1 Source category description

In the category 1B2 the fugitive emissions from refineries, the emissions from all transmission, distribution and transport activities of natural gas and the fugitive emissions from oil transport in Belgium are allocated.

3.3.2.2 Methodological issues

3.3.2.2.1 Petroleum refineries (category 1B2a and 1B2c)

Petroleum refineries are only located in the Flemish region in Belgium.

The activity data reported under category 1B2a4 are obtained directly from the companies involved through their reporting obligations in the Flemish region via the annual integrated environmental report. The activity data is the amount of crude oil used in the refineries and reported as ‘(input – refineries – total petroleum products)’ in the Flemish energy balance .

The estimation of the emissions of CH_4 and N_2O of the sector petroleum refining occurs as described in section 3.2.6.: CH_4- and N_2O-emissions from petroleum refining are calculated using a combination of monitoring results (for the 2 largest companies in the Flemish region) and emission factors of CITEPA (24) for the smaller companies.
All CH_4-emissions of this sector (except the emissions of the combined heat-power installations which are allocated to the sector 1A1a) are allocated in category 1B2a4 (refining) and all N_2O-emissions (except the emissions of the combined heat-power installations which are allocated to the sector 1A1a) are allocated in category 1A1b. The emissions of CH_4 reported in this category 1B2a4 also contain the emissions of flaring activities.
As described in section 3.2.6. emissions of CO_2 of the refineries are allocated to the following categories:

- 1A1a for the involved combined heat-power installations of the refineries;
- 1B2a4 for the emissions of CH_4;
- 1B2c2 iii for the flaring emissions and
- 1A1b for the total emissions excluding the emissions of the combined heat-power installations and excluding the emissions from flaring activities.

Emissions resulting from the production of hydrogen at refineries are included in the category 1A1b instead of category 1B2c1i in the Belgian CRT-tables.
(Emissions of CO2 related to the non-energy-uses of fuels including fuels used for hydrogen production needs to be reported in CRT category 1.B.2.c.1.i (oil venting) according to Vol2/Ch4/p.4.36 of the 2006 IPCC GLs.)

All ETS-emissions of refineries are taken over completely in the CRT-tables and are consistent with each other. Consequently, Belgium did change the notation key 'NO' in the category 1B2c1i Venting/oil to 'IE' during the submission in 2021.

3.3.2.2.2 Transport of oil (category 1B2a3)

As a result of the centralized UNFCCC review of the Belgian greenhouse gas inventory carried out in September 2011, the ERT recommended Belgium to estimate the fugitive emissions of CO_2 and CH_4 from oil transport for the complete time series.

To estimate these fugitive emissions from oil transport, Belgium decided to use the methodology as described in the GPG (p.2.87, table 2.16). The process emissions depend on the amount of crude oil transported through the Belgium territory.
The methodology uses tier 1 default IPCC 2006 emission factors for CO_2 and CH_4 for transport of oil in pipelines. The emissions factor used is 4.9E-07 Gg per 10^3 m^3 oil transported by pipeline for CO_2 and is 5.4E-06 Gg per 103 m^3 oil transported by pipeline for CH_4.

There is no crude oil production in Belgium.

Crude oil used in the Belgian refineries enters Belgium via the pipeline Rotterdam-Antwerp. The activity data (import of crude oil in Belgium) derives from the federal petroleum balance of the Federal Ministry of Economy in Belgium.
The methodology used is the same as the one used in our neighbouring country the Netherlands.

3.3.2.2.3 Gas transmission and distribution (category 1B2b)

The activity data reported in the category 1B2b is the annual total natural gas amount consumed in Belgium. These activity data originate from SYNERGRID, the federation of the grid operators of gas and electricity in Belgium and exist of sales figures (transport and distribution net in GWh) in Belgium.
All transmission, distribution and transport activities of gas in Belgium are allocated in this category 1B2b.

The methodology to calculate the emissions of CH_4 originating from the gas distribution (<u>category 1.B.2.b 5/distribution</u>) is completely harmonised for all the regions in Belgium since the submission in 2004. All information is reported by SYNERGRID. These emissions are determined on the basis of the length of gas distribution pipelines. The lengths of the main pipelines (exclusive additional, service pipelines which are pipelines going to households) per public utility board are available.
The number of additional service pipelines in Flanders is estimated at 1 500 000 for the year 2002 and an increase is assumed of 24 000 every year (until 2002) and 30 000 (from 2003 on). In Wallonia, the number of additional pipelines is estimated at 25094 m for the year 2011. The length per additional pipeline is 5 m in the Flemish and the Walloon region. In Brussels, the number of pipelines is estimated at 191 933 for the year 2022. The average length per pipeline is 3 m because of the urban environment.
Depending on the material of the pipeline different emission factors are used. These emission factors are based on measurements carried out. In particular 869, 7865, 869 and 95 m^3/y/km for respectively steel, pig iron, fibre cement and synthetic material. The density of methane is 0,716 kg/m^3. The methane content of natural gas distributed is 85%.
For each material the length of the pipelines is multiplied with the corresponding emission factor. This results in the total natural gas emission in m^3 per year. Multiplying this figure by the methane content and the density of methane, the diffuse methane emission originating from gas distribution in Belgium is obtained.
The IEF for CH_4 decreases in the period 1990-2012 because of a decrease in emissions (gradually replacement of materials of pipelines in the country: pig iron gives more leakages compared to steel and fibrocement and synthetic materials give least leakages) and because of an increase of activity data (more natural gas consumed).

Based on the composition of the natural gas distributed and the natural gas that escapes through the pipelines (leakages), fugitive emissions of CO_2 from the gas distribution sector are calculated and added to the inventory (natural gas contains +/- 1% of CO_2) in category 1.B.2.b 5/distribution.

In the Brussels Region, the CO_2 emissions associated with gas heating (pressure reduction between the transmission and distribution networks) are also calculated.

As a result of the 2016 Comprehensive review of national greenhouse gas inventory data pursuant to Article 19 (1) of Regulation (EU) No 525/2013 (ESD-review) the following recalculations were performed:

The TERT noted that emissions are based on emission factors depending on the length of the pipeline as well as different pipeline materials. However, according to the 2006 IPCC Guidelines, emissions are to be estimated based on throughput. In response to a question raised by the TERT during the review, Belgium explained that according to the Federation of electricity and gas operators the throughput methodology is considered as unreliable. In response to a technical correction provided by the TERT, Belgium provided more detailed information on the estimation methodology used including different types of emission factors and results from measurement campaigns. The TERT concluded that the methodology did confirm to a higher tier method and accepted the rationale provided by Belgium.

Belgium got the following Information from the SYNERGRYD-experts (Belgian federation of electricity and gas network operators): "the throughput methodology is since long considered as unreliable by European gas industry.
Most methane emissions are very small fugitive emissions. Pipelines are always filled with gas at a certain predefined pressure; the volume of gas flowing through the pipeline system at that pressure has not any influence on the emissions.
There is only a correlation in one case: an incident causing a sudden huge emission of gas during a very short period. Indeed, in that case the methane emissions are increased by the increase of volume created by this incident. However, the grid is operated in such a way that in the case of such an incident the volume of gas emitted is limited."

In fact, there is discussion about what is the best methodology to estimate emissions from pipeline systems. The 2006 IPCC Guidelines also elaborate on different approaches and their pros and cons.

After contacting our experts again, they insist to stay with the current methodology used in Belgium to estimate the emissions from gas distribution and not performing any recalculation of the reported emissions.

We received some basic information from the experts used to calculate these emissions in Belgium: the emission factors and activity factors related to the gas industry used to obtain the global emission factors used for the different materials and pressures of pipelines of the distribution grid used.

These data are based on a study, carried out in 1988 and made by the Battelle Institute in Genova on behalf of the German Ruhrgas. This is the only existing extensive study about emission estimates in gas networks. The study has been used by most big European distribution companies. The study allows to take into account the technical evolution of the materials used. Because of this, the results can nowadays still be used to calculate the emissions. The results are based on 2 measuring campaigns (1976-1978 and 1984-1988), on some published studies in the former West-Germany
in the years 1975-1988 and on data about damages of pipelines during the years 1981-1986 in West-Germany.

Finally, Belgium got also the information that recently some European companies are planning to refine those emission factors on the basis of the typical configuration of the local grid, the evolution of the grid, of its operating, the information, the new operation technologies and of new measurements.

Emissions of CH_4 (category 1.B.2.b.4/transmission) originating from the storage and transport of natural gas in Belgium are calculated and added to the inventory since the 2006 submission.
These emissions are estimated on the basis of measurements and calculations (taken into account pressure, distance, volume) carried out. All necessary interventions in case of problems are known and the amounts of gas blown off are registered as accurate as possible. All information is obtained from Fluxys, the independent operator of the gas network in Belgium.
Diffuse emissions of CO_2 from the transport of natural gas are negligible. Consequently, the notation key ‘NA’ is used.

As a result of the 2016 Comprehensive review of national greenhouse gas inventory data pursuant to Article 19 (1) of Regulation (EU) No 525/2013 (ESD-review) the following recalculations were performed:

A complete revision of the consumption data and the emissions of the control units at the different locations was performed in 2014. As a consequence, an inconsistency occurred with previous years. After consultation of Fluxys, they carried out a recalculation during this submission for the complete time series. The revised estimates are based *on the implied emission factor for the reduction pressure installations of the years 2014 and 2015 and consumption data in each year.*

3.3.2.2.4 Venting and Flaring (1B2c1 Venting ii Gas)

Emissions of CH_4 coming from venting (limited emissions) and activity data of transported gas are reported in this category 1B2c and obtained by GASCO (Terminal in Zeebrugge), responsible for the transport of gas to Flanders/Belgium that comes from Norway (into Europe/Belgium). The Sea pipe receiving terminal is located in the port area of Zeebrugge in Belgium, about five kilometres from the landfall. This facility removes possible residual liquids and solids, and regulates gas pressure and temperature. In addition, it measures volume and checks quality before the gas continues to the transport operator downstream of the terminal. The sea pipe terminal also remotely operates the 'Franpipe' receiving terminal at Dunkerque in France.

The emissions of CH_4 are very small i.e. 10,38 ton CH_4 (originating from venting) in 2018 (or 0,26 kton CO_2 eq). They also report an emission of CO_2 which is allocated (together with the energetic emissions of Fluxys) in the CRT category 1A3ei. The emission of CO_2 in 2018 accounts for 3,249 kt CO_2.
Contact with the company involved, shows that the reporting is performed correctly. This category 1B2c deals with CO_2 emissions related to the separation (in case there are some chemical processes involved to reduce the amount of CO_2 during the production of gas) and diffusion (venting for gas that is not meeting the standards) of CO_2 which is contained in natural gas produced in natural gas production facilities when CO_2 contents do not meet the standard of non-combustion gas content provided by users. This means that emissions of CO_2 need to be reported in the case 'offspec' gas is vented. This is here not the case. The venting gas is always gas that meets the standards needed for the Fluxys network in Belgium. The 'pre' treatment of the gas is already performed in Norway.

3.3.2.3 Uncertainties and time-series consistency

Uncertainty estimates on the fugitive emissions from oil refining and storage (category 1B2a) are assumed to be the same as in the category 1A1b for the activity data and for the emission factors (5% for the activity data and 50 % for the emission factor).
Since the activity data (length of pipelines for the different materials of pipelines) are based on information of the gas distribution company, the uncertainty is estimated at 10%. Emission factors (= leak rates) are based on measurements carried out by this company and their uncertainty is estimated at 30%.

3.3.2.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are only performed in the 3 regions for the Belgian key source categories and can be provided on request.

3.3.2.5 Source-specific recalculations, if applicable, including changes made in response to the review process

No recalculations took place in the category 1B2 during this submission.

3.3.2.6 Source-specific planned improvements, if applicable, including those in response to the review process

No specific planned improvements at this moment are provided in the category 1B2 for the next submission.
Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3.4 CO_2 emissions from biomass

Emissions of CO_2 from biomass are reported in the different categories in the energy sector. The emissions of CO_2 reported are estimated as accurate as possible, depending on the information (activity data) available in the different regions in Belgium.

Total emissions of CO_2 from biomass are calculated automatically via the ETF-GHG software and reported as a memo item in the CRT-table 1D3.
In the category Energy / 1.AA Fuel Combustion - Sectoral approach / Information item / Biomass, the (biomass) emissions of the waste incineration with energy recovery are reported.

3.5 International bunkers and multilateral operations

Emissions of international bunker activities are reported as a memo item in category 1D1.
See chapter 3.2.8 for more information.
These emissions are calculated with activity data from the regional energy balances and with default IPCC 2006 emission factors.

3.6 Comparison between data reported under the ETS-Directive (Directive 2003/87/EC) and CRT-tables

The comparison between data reported under the ETS-Directive and CRT-tables is presented in BE_2024_Art14_AnnexXII_Consistency with ETS_280224.xlsx

All ETS-emissions from 2013 on are integrated in the Belgian greenhouse gas inventory.

The sum of emissions in the GHG inventory from the relevant CRT categories is higher than the verified ETS emissions due to the fact that the inventory includes all plants and does not use any threshold criteria for the inclusion of installations contrary to the regulation under the ETS-Directive. Small remaining differences are due to different allocations.

In Wallonia, there are some cases where the ETS data in a CRT sector are larger than the inventory data:

- In the paper pulp industry (1A2d), a part of the liquid fuels is used to produce lime and are in 1A2f (non-metallic, mineral) in the inventory and in 1A2d in the ETS data;

- In the glass sector (1A2f), the coke consumption is in 1A2f in the ETS data and in 2A3 in the inventory;

- The CO2 emissions from the uses of carbonates in a chemical plant are in 2B10 in the ETS data and in 2A4 in the inventory;

- In the sector flaring in the chemical industry, some fuels are considered to be burn in a flare and are considered to be burn in a boiler in the inventory data following the energy balance.

- The emissions in 2D3 are coming from the use of urea for epuration in a ETS plant.

In Flanders, from 2013 on, because of the extension of the scope of ETS-installations at that time, the ETS-data are completely incorporated in energy statistics and CO_2 emission inventory.

Although there are some difficulties in comparing the data used in the inventory and ETS data:

- The allocation of CHP units: these installations are included in the energy balance and in the CRT-tables in category 1A1a for the main activity producers or in the relevant sector where they belong for the auto-producers (industry, commercial sector, agriculture) . This approach is not the same under the ETS-rules. Data from CHP units cannot be directly extracted from ETS-reporting. Other data sources (e.g. integrated environmental reports) need to be used to get these data. Nevertheless, complete consistency between CRT-data and ETS-data are guaranteed.
- The distinction between process and energy related emissions differs in some cases (for example in iron and steel sector and in refineries), hence the allocation in CRT-tables into different categories is not always completely in line with ETS definitions.
- The allocation of blast furnace gas that is used for electricity production differs between the 2 reporting obligations. These emissions are allocated to the category 1A1a in the CRT-tables and to the iron and steel sector in ETS-legislation.
- Specific units like one of the naphtha crackers situated at the site of the refinery is included in the refinery sector in ETS data, but in the energy balance and in the CRT-tables the unit is included in the chemical sector (resp. energetic part in 1A2c / other products and process part in 2B8b) consistent with the allocation of the other naphtha crackers in this region.
- In the ETS reports, calorific values for the conversion from tonnes to joules is not always clearly listed, and specifically for waste products, recovered fuels etc, the default value can differ from reality.
- The use of biomass is reported as a ‘memo item’ in the CRT-reports and is not included in national totals. Consequently, these data are not always consistently reported by the industrial companies and also not for the complete time-series. Emissions from biomass are (partly) reported in the ETS-reports from 2015 on.
- There can be a different approach in calculating emissions for some sources: mass balance approach in ETS versus emissions calculated based on energy use and emission factors per joule or based on measurements in integrated environmental reports.
- In ETS one source stream is allocated to one source stream category, while the source stream in reality can be applied for different source stream categories. (e.g: x% of fuel A is used as feedstock, while y% of fuel A is used as a fuel, while z% of fuel A is flared (without heat-recovery – in ETS 100% of fuel A is allocated to 1 source stream category fuel, while in reality only y% is used as a fuel).

These different approaches can give different results and some inconsistencies in allocations.

For some categories, more elaborate explanations are given concerning allocation matters.

1. <u>Chemical industry</u>

In the Flemish energy balance, data from the annual “Essenscia” survey (chemical industry) on energy and emissions is used until 2012. The data on the use of other fuels (including waste incineration, flare gas) from this survey are allocated in 2 categories (waste 5C and 1A2c). The typology in ETS, data used from 2013 on in the inventory, is not always completely comparable with this survey. All ETS emissions from other fuels than typical commercial fuels (like natural gas or fuel oil) are allocated to the ‘other fuels’, although they also possibly include some flaring emissions and waste incineration.

Besides emissions of N_2O of nitric acid production are included in ETS-reporting data. These are the only non-CO_2 emissions included in ETS-data (i.e. no emissions of N_2O from caprolactam production are included in ETS-data).

2. <u>Refineries</u>

Emissions from the refineries are taken from the integrated environmental reports in Flanders and are comparable and consistent with the ETS data. There are some differences in allocation: in ETS, emission from the burning of petcoke is considered to be a process emission. In the energy balance, the amounts of petcoke are considered as energy use. These emissions are also allocated to CRT-category 1A1b in the greenhouse gas inventory. Besides, emissions from the use of natural gas to produce H_2, are considered as ‘process’ in ETS. In the energy balance, these amounts used in refineries are included as energy use as well as reported in category 1A1b in the inventory.

3. Iron and steel

Emissions from the companies in the iron and steel are taken from the ETS data.

Emissions of the sector iron and steel are reported completely in accordance with reported ETS-data. All consumed solid fuels (incl. blast furnace gas and cokes oven gas) are reported as process emissions (because the distinction between energy part and process part cannot be taken out of ETS-data transparently) in category 2C1a (except for the cokes oven gas used in the cokes factory which is reported in category 1A1c and the blast furnace gas used in the electricity sector which is reported in category 1A1a); emissions from the use of limestone in the sinter factory are reported in category 2C1d and emissions from the use of electrodes are reported in the category 2C1f. Only emissions from the use of gaseous and liquid fuels are reported in the category 1A2a.

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRT SECTOR 2)

4.1 Overview of sector

4.1.1 General

The structure of the industrial sector has undergone profound changes over recent decades. The mining industries have practically disappeared with the closure of the last coalmines in the beginning of the nineties. The metallurgy and textile sectors have been relatively stable, after several waves of closures and restructuring. The metallurgical industry nevertheless remains one of the key sectors of Belgian industry, both in terms of employment and turnover although recent closures may alter this position in the future. The two other key sectors of industrial activity are the chemical industry and the food processing industry. These three sectors each contribute about 15% of gross value added of the industrial sector.

This sector of industrial processes includes the emissions of industrial activities which cannot be related to the combustion of fossil fuels.

The process emissions originating from the products use containing F-gases are included in this sector.

Following the IPCC 2006 guidelines, the N2O emissions from aerosols products and medical applications, the CO2 emissions from the lubricant use and paraffin wax use and the CO2 emissions from the urea used as a catalyst (from 2006 on) are also included in this sector.

The main process emissions of CO_2, CH_4 and N_2O are calculated in Belgium via obliged monitoring results carried out by the industrial companies or by using production figures - mainly originating directly from the industrial plant - combined with emission factors presented in different reference works such as IPCC 2006 Guidelines, IPCC 1996 Guidelines (1) EMEP/EEA guidebook (6) CITEPA (24) or other specific bibliographies. The activity data recorded in this category also derive mainly directly from the companies involved.

From 2013 on, reported and verified ETS emissions are taken over completely in the Belgian greenhouse gas inventory.

The consistency of the reported emissions of CO2 in the complete time series is ensured by various means, such as trend analysis and an average EF calculated by the plant or estimated in consultations with the federations and companies involved and applied to the time series. In addition, industrial companies were contacted to confirm emissions through their annual obligatory environmental reporting. Deviations in reported emissions between EU ETS and annual emission reporting were explained by the fact that not all installations were EU ETS installations. This information is very important in understanding the consistent reporting of emissions.

4.1.2 Trend assessment

The 'industrial processes and F-gases' sector covers emissions from industrial activity, but not resulting from fossil fuel combustion. In 2022, these emissions of greenhouse gases were mainly caused by the chemical industry (41% of process emissions - of which 51% just for the petrochemical industry and 12% for ammonia production), the mineral products (23% of process emissions of which 63% for cement and 29% for lime production), the metal production (21% of emissions - sharply down from 2009 due to economic crisis). Besides 14% of these process emissions are caused by the ‘product uses as ODS substitutes’.

Mineral products
These emissions occur during the production of clinkers, lime and glass (decarbonation of calcium carbonates) and are closely linked to production levels, which are stable on the whole.

Chemical industry

Despite the closure of two nitric acid plants (one in 1995 and another in 2000), the production of nitric acid in the two remaining plants increased by 32% in 2022 compared with 1990 (after a sharp decline in 2009). In parallel, these plants have taken measures to reduce emissions from their processes (use of catalysts since 2003 with a drop of the emissions in 2011 by the placement of new catalysts on two installations at the end of 2010, emissions were reduced by 95% since 2002).
Because of a re-allocation of emissions of CO_2 from 1A2c/other fuels to category 2B8b, emissions of CO_2 become predominant. These emissions are the recovered fuels in the steam cracking units in the petrochemical industry and other recovered in the chemical industry

Metal production

In the iron and steel sector, greenhouse gas emissions decreased by 65% in 2022 compared to 1990. This is in line with the economic crisis that has hit the iron and steel sector in 2009 with a decrease in activity of almost 50% in all sub-sectors.

Fluorinated gases

Emissions of fluorinated gases accounted for 2.3% of total greenhouse gas emissions without LULUCF in 2022. A distinction is made between 'production emissions', which are fugitive emissions during the production process, and 'consumption emissions', which are those occurring during the use or dismantling of existing equipment and products.

The sharp decrease in emissions from the production of HFC between 1996 and 1999 is due to the installation of a gas incinerator with an HF recovery unit (Fluoride Recuperation Unit) in the most important source identified, which is an electrochemical synthesis unit located in the Flemish region.
The growing consumption of HFC (figure 4.1) is directly linked to the implementation of the Montreal Protocol and EU Regulation 2037/2000, which bans the use of ozone-depleting substances such as CFCs. The CFCs which were formerly used are now replaced by HFCs in most sectors like refrigerating and air conditioning installations, foam production and aerosols. The quantities of HFCs are nonetheless lower than those of CFCs, because in many cases CFCs have been replaced by non-fluorinated gases, like ammonia in refrigeration, pentane and CO_2 for rigid foams, etc.

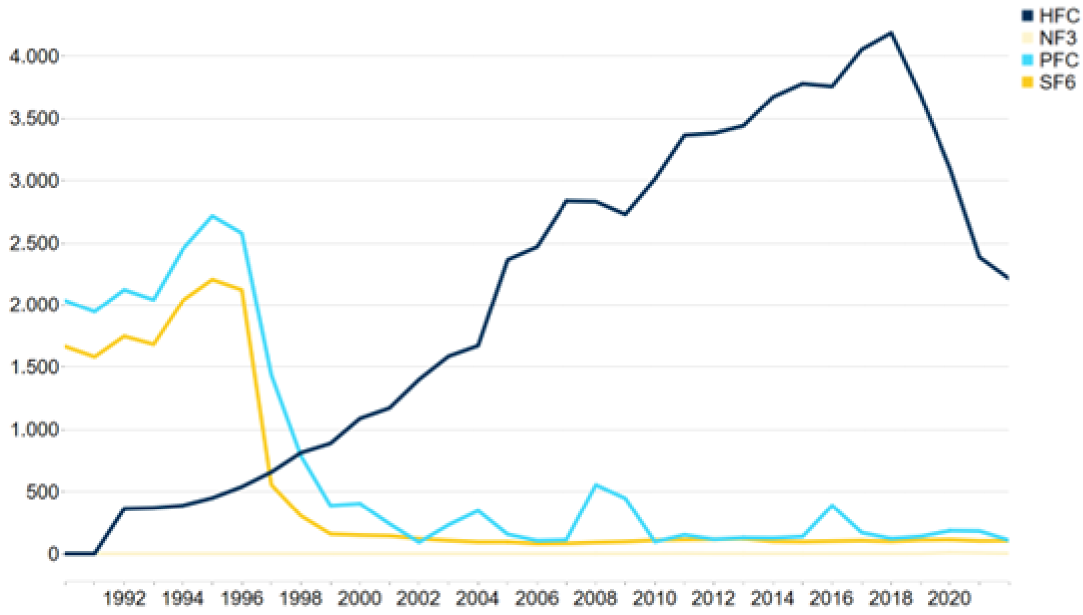


Figure 4.1: Kyoto F-gas emissions per gas category in Belgium (kt CO_2-eq): changes from 1990 to 2022

SF_6 emissions originating from the production of acoustic double-glazing have been cut through the use of alternative products. The remaining SF_6 emissions from that source are those from dismantling of existing equipment.

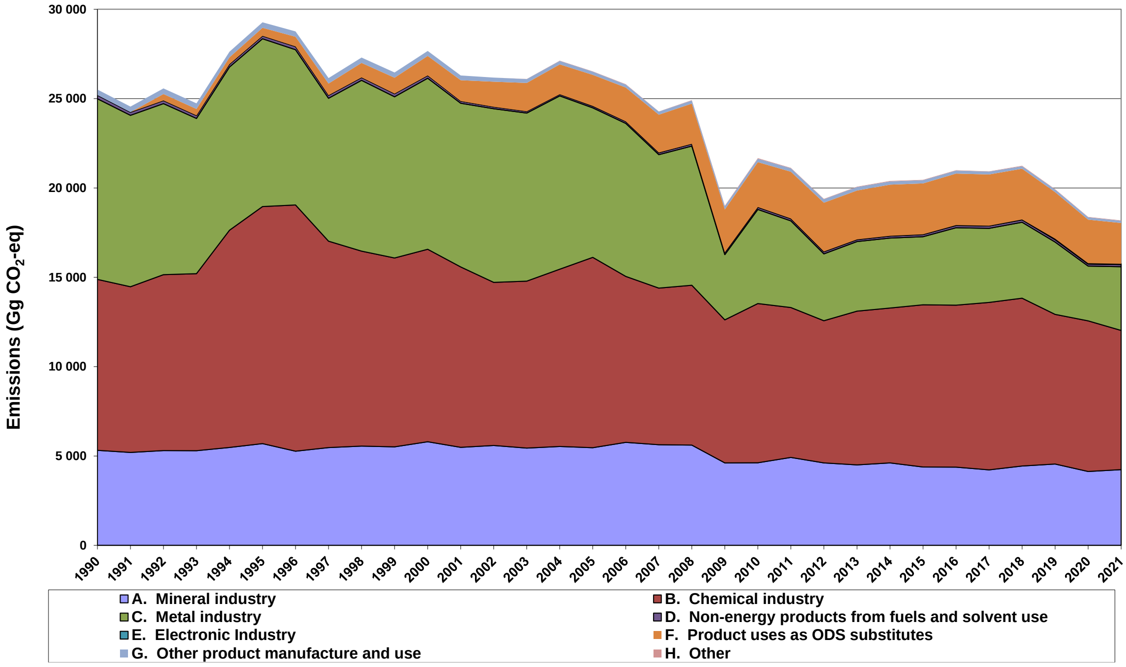


Figure 4.2: GHG emissions in sector 2 'Industrial processes': changes from 1990 to 2022 (Gg CO_2 equivalent)

4.1.3 Overall recalculations in the sector of industrial processes

The tables below give the quantitative and quantitative recalculations in the sector of industrial processes (category 2):

2.A-Mineral Products, Emissions, Aggregate GHGs (CO2, CH4, N2O), (Gg CO2 equivalent)

		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Walloon region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.020.02
Belgium	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
		1990	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Brussels region	Gg CO2 eq.	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Walloon region	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75
Belgium	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81

Very small, insignificant recalculations took place in the category 2A in the Flemish region from 2016 on.
In the Walloon region, a mistake in a lime plant is corrected in 2021.

2.B-Chemical Industry Emissions, Aggregate GHGs (CO2, CH4, N2O, F-gases), (Gg CO2 equivalent)

		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,06	0,06	0,15	0,19
Walloon region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,06	0,05	0,14	0,17
		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	Gg CO2 eq.	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,21	5,75	4,48	11,81	13,50
Walloon region	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,21	5,75	4,48	11,81	13,50

In the Flemish region, the following recalculations were performed during this submission:

- A double counting of emissions of flaring (in CRT 2B10 and in CRT 5C12b) was eliminated during this submission (decrease in emissions in CRT 2B10 from 2019 on of 4-7 kton CO_2);
- Consistency assured for the years 2020 and 2021 compared to 2019 related to allocation of emissions of process_CO_2 from methane-fraction during production of ammonia. These emissions from 2020 and 2021 now allocated to CRT 2B1 and no longer to CRT 2B10. Total emissions in this respect remain unchanged.
- Small corrections were made during this submission assuring complete consistency with ETS-data for the emissions of N2O from production of nitric acid from 2013 on;
- Addition of missing emissions of N_2O from 1 chemical company from 2020 on (+17-18 kton CO_2);
- Corrections in category 2B9 of emissions of F-gases of 1 chemical company from 2017 on (correction/switch from reported non-IPPC gas to IPCC-gas) with consequently an increase of emissions (up to 11,5 kton CO2eq in 2019).

In the Walloon region, no recalculation was performed in the sector 2B.

2.C-Metal Industry Emissions, Aggregate GHGs (CO2, CH4, N2O), (Gg CO2 equivalent)

		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	Gg CO2 eq.	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

No recalculations occurred in category 2C during this submission.

2.D- Non-energy Products from Fuels and Solvent Use, Aggregate GHGs (CO_2, CH_4, N_2O), (Gg CO_2 equivalent)

		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	0,00	0,00	-0,01	-0,01	0,32	1,27	0,35	0,72	-0,29	3,11	5,32
Flemish region	%	0,00	0,00	-0,01	-0,01	0,00	0,50	0,05	0,24	-0,34	0,57	1,71
Walloon region	%	0,02	0,05	0,11	0,04	0,18	0,72	0,20	0,45	-0,11	0,93	2,13
Belgium	%	0,01	0,01	0,03	0,01	0,07	0,61	0,11	0,34	-0,26	0,82	2,03
		1990	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Brussels region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,02	0,10	0,03	0,05	-0,02	0,18	0,33
Flemish region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,41	0,04	0,20	-0,27	0,39	1,28
Walloon region	Gg CO2 eq.	0,02	0,03	0,03	0,02	0,07	0,29	0,08	0,19	-0,04	0,31	0,78
Belgium	Gg CO2 eq.	0,01	0,02	0,03	0,01	0,09	0,79	0,15	0,44	-0,34	0,89	2,39

Recalculations of the emissions in this category 2D for the complete timeseries due are to the use of an updated version of the COPERT 5.7.3 software for the calculation of the emissions of road transport. Emissions from the use of lubricants and from de use of urea as a catalyst have been updated accordingly. No major changes in emissions were observed.

2.E-Electronics Industry, Aggregate GHGs (CO_2, CH_4, N_2O, F-gases), (Gg CO_2 equivalent)

		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Belgium	%	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1990	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Brussels region	Gg CO2 eq.	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	Gg CO2 eq.	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	Gg CO2 eq.	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Belgium	Gg CO2 eq.	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

No recalculations occurred in category 2E during this submission.

2.F- Product uses as substitutes for ODS, (Gg CO_2 equivalent)

		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	NO	0,01	0,02	-0,12	-0,48	-0,53	-0,56	-0,57	-0,60	-0,56	-0,44
Flemish region	%	NO	0,01	0,02	-0,11	-0,46	-0,50	-0,53	-0,55	-0,59	-0,53	-0,42
Walloon region	%	NO	-0,87	-0,76	-0,12	-0,19	-0,52	-0,55	-0,57	-0,60	-0,55	-0,43
Belgium	%	NO	0,01	0,02	-0,12	-0,47	-0,51	-0,54	-0,56	-0,59	-0,54	-0,43
		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	Gg CO2 eq.	NO	0,01	0,03	-0,30	-1,39	-1,56	-1,64	-1,68	-1,64	-1,42	-1,03
Flemish region	Gg CO2 eq.	NO	0,05	0,21	-1,70	-7,62	-8,46	-8,95	-9,17	-8,90	-7,59	-5,67
Walloon region	Gg CO2 eq.	NO	-3,02	-4,00	-0,95	-1,64	-4,70	-4,96	-5,07	-4,90	-4,21	-3,06
Belgium	Gg CO2 eq.	NO	0,08	0,37	-2,95	-13,26	-14,72	-15,55	-15,93	-15,44	-13,21	-9,76

For category 2F, the following recalculations have made during this submission.

CRT code	CRT source category	Period	Nature of the recalculation	Impact for CRT gases in 2021(in kt CO2-eq.)
2.F.1.a.	Commercial refrigeration	2006-2021	Adjustment refilling quantities for other applications	0,67
2.F.1.e.	Mobile air-conditioning	1997-2021	Statistics other vehicles updated on INS.	2,33
2.F.1.f.	Stationary air-conditioning	2006-2021	Update assumptions refrigerants used based on detailed statistics Frixis	-13,68
2.F.2.a	Closed cell foam	2021	Small error correction	0
2.F.4.b.	Technical aerosols	2021	Adjustment based on latest German inventory. Adjustment emissions 1990-1994.	0.92
Total		**1997-2021**		**-9,76**

2.G- Other products manufacture and use, Aggregate GHGs (CO_2, CH_4, N_2O, F-gases), (Gg CO_2 equivalent)

		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,00	0,00
Flemish region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6,42	8,65
Walloon region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,00	0,00
Belgium	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,74	5,04
		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	Gg CO2 eq.	-0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,00	0,00
Flemish region	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,98	6,23
Walloon region	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0,00	0,00
Belgium	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4,98	6,23

For category 2G recalculations only arise from the fact that for 2G2b Particle accelerators emissions were included for the period 2020-2022.

CRT code	CRT source category	Period	Nature of the recalculation	Impact for CRT gases in 2021(in kt CO2-eq.)
2.G.2.b.	Particle accelerators	2020-2022	Inclusion of emissions	6,23

2.H- Other GHGs (CO2, CH4, N2O,), (Gg CO2 equivalent)

		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flemish region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flemish region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Walloon region	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	Gg CO2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

No recalculations were made in the category 2H during this submission.

4.2 Mineral products (CRT 2.A)

4.2.1 Source category description

The mineral products activities in Belgium are covered by categories 2A1 (cement production) and 2A2 (lime production), activities which are taking place only in the Walloon region, category 2A3 (glass production) and category 2A4 (other process uses of carbonate) including ceramics production, limestone and dolomite use in the electric power installations and in the sugar plants.

4.2.2 Methodological issues

The mineral industry is the second most important sector of industrial process emissions in Belgium and contributes now to 23.2 % of sector IPPU emissions in 2022.
In Belgium, **cement production (category 2A1)** only take place in the Walloon region.
The Walloon region has 4 sites which produce cement clinker in 2021. One plant has stopped his activity at the end of June 2014.
Emissions of carbon dioxide result both from calcination of the calcium carbonate, but also from fuels burnt to provide the heat for calcination and clinkering. Emissions of CO_2 from fuel combustion are reported under CRT source category 1A2f while emissions from calcination are reported under category 2A1.
CO_2 emissions occur from:
- the calcination of carbonates ($CaCO_3$, $MgCO_3$, …) in the raw materials used to produce the clinker;
- the partial or full calcination of cement kiln dust or bypass dust removed from the process;
- the non-carbonate carbon content of raw materials.

The IPCC tier 3 methodology is used.
The activity data is the clinker production collected directly from individual plants.
The calculation of the CO_2 process emissions follows the guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC.
The emissions are verified each year by an external agency.
Since 2002, these emissions have been estimated by using plant-specific emission factors. An average emission factor by plant was estimated in 2002 and is applied on the complete time-series 1990-2001.
As there is no change in the installations on this time serie, the consistency between the time-serie 1990-2001 and the years after is ensured. Since 2002, the emission factor varies each year and is calculated directly by the plant. Since 2004, plant data includes information on the CaO and MgO content of the clinker and non-carbonate sources of CaO and MgO. The decarbonisation of the dust re-injected in the furnace is also taken into account.

The calculation is performed by the operators themselves and subject to independent review in the framework of the Emission Trading Scheme. An additional description of the methodology used to determine the emission factors can be provided to the Expert Review Team if needed.
The same approach cannot be applied to the emission factors for the entire time series because of a lack of plant-specific data on the MgO and CaO content of the clinker and non-carbonate sources of CaO and MgO. That is the reason why an average emission factor by plant was estimated in 2002 and applied on the complete time-series 1990-2001.

The evolution of the emission factor is presented in the table 4.1.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Clinker production (kt)	5292	5387	5742	5732	5913	6055	5607	5885	5906	5799	6089
IEF clinker (kg CO_2/t)	534	535	538	538	538	538	537	537	538	537	537
CO_2 emissions (kt)	2824	2880	3089	3082	3179	3255	3009	3162	3175	3113	3270

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Clinker production (kt)	5539	5583	5269	5169	5555	5758	5733	5638	5132	4740	5060
IEF clinker (kg CO_2/t)	534	536	557	549	528	541	539	538	545	545	546
CO_2 emissions (kt)	2957	2993	2933	2837	2934	3112	3087	3033	2795	2582	2761

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Clinker production (kt)	4869	4694	4830	4396	4458	4237	4605	5038	4817	4872	4486.46
IEF clinker (kg CO_2/t)	543	541	547	534	546	541	550	560	547	546	547
CO_2 emissions (kt)	2642	2541	2643	2348	2436	2291	2534	2819	2634	2659	2456

Table 4.1: Cement production in Wallonia

Production of lime (category 2A2) also occurs only in the Walloon region of Belgium.

This source is a key category for CO_2 emissions in terms of level assessment.
From 1990 to 2002, these emissions of lime production were estimated by using default emission factors (790 kg CO_2/T lime and 910 kg CO_2/T dolomite lime) in three different plants and a plant-specific emission factor (754 kg CO_2/T lime) in the three others plants. This plant-specific emission factor resulted from analyses performed in 2002. Since 2003, all the emission factors are plant-specific (except for the dolomite lime in 2003 and 2004). The activity data are the lime and dolomite lime production and are collected directly from individual plants. The data are subject to independent review in the framework of the Emission Trading Scheme. The IPCC tier 3 methodology is used.
The variations of the global emission factors are mainly due to the different proportions of lime and dolomite lime production over the years. This is presented in table 4.2.
A part of the lime production is coming from the craft pulping process: the CO_2 liberated during the conversion of calcium carbonate to calcium oxide in the lime kiln in the craft pulping process contains carbon which originates in wood. This CO_2 is not included in the net emissions (CO_2 biomass in table 4.2). It explains the low IEF lime (750-760 kg CO_2/t) as the lime production coming from the craft pulping process is included in the lime production.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Lime (kt)	2091	2037	1981	1962	2057	2080	1897	1993	2050	2075	2085
IEF lime (kg CO_2/t)	755	760	754	750	740	760	750	750	750	750	750
Dolomite lime (kt)	570	452	408	393	401	374	360	347	385	419	555
IEF dolomite lime (kg CO_2/t)	910	910	910	910	910	910	910	910	910	910	910
% dolomite lime prod	21	18	17	17	16	15	16	15	16	17	21
IEF global (kg CO_2/t)	790	780	780	780	780	780	780	780	780	780	780
CO_2 emissions (kt)	2097	1951	1865	1828	1886	1921	1756	1819	1895	1944	2066
CO_2 biomass emissions (kt)	40,9	42,8	42,8	16,6	38,4	30,8	41,9	41,9	45,6	45,6	57,2

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Lime (kt)	1770	1742	1785	1927	1721	1845	2349	1642	1167	1267	1333
IEF lime (kg CO_2/t)	750	740	740	750	750	710	748	730	739	705	710
Dolomite lime (kt)	823	939	826	851	880	929	328	945	616	850	902
IEF dolomite lime (kg CO_2/t)	910	910	910	910	830	890	861	913	873	889	877
% dolomite lime prod	32	35	32	31	34	33	12	37	35	40	40
IEF global (kg CO_2/t)	800	800	800	800	780	780	762	797	779	774	775
CO_2 emissions (kt)	2070	2144	2072	2228	2018	2139	2040	2061	1399	1648	1741
CO_2 biomass emissions (kt)	48	56,1	61,5	62,3	62,3	72,5	72,5	81,7	72.5	63	76

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Lime (kt)	1254	1609	1323	1311	1273	1270	1280	1198	1032	1081	1061
IEF lime (kg CO_2/t)	713	752.3	694	710	707	711	710	698	727	720	714
Dolomite lime (kt)	837	425.3	787	768	737	727	711	606	498	505	401
IEF dolomite lime (kg CO_2/t)	858	984.2	920	955	935	929	920	925	880	879	892
% dolomite lime prod	40	20.9	37	37	37	36	36	34	33	32	27
IEF global (kg CO_2/t)	772	800.7	778	801	791	791	785	774	779	771	763
CO_2 emissions (kt)	1612	1629	1641	1664	1588	1579	1563	1397	1191	1222	1115
CO_2 biomass emissions (kt)	65.85	61	74	70	75	60	79	70	53	53	48

Table 4.2: Lime and dolomite lime production in Wallonia

Production of glass (category 2A3) in Belgium takes place in the Flemish and in the Walloon regions.

In the Walloon region, since 2005, the CO_2 emission factors are calculated by the glass plants. The activity data are collected directly from individual plants. The calculation of the CO_2 process emissions follows the guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to the ETS Directive (2003/87/EC). Some glass plants had already calculated their CO2 emission factors since 2003. The IPCC tier 3 methodology is used.
An average emission factor by type of production (flat glass, container glass and glass wool) was estimated using the data from 2003 to 2009 and is applied for the time-series 1990-2002.
As there is no change in the installations on this time serie, the consistency between the time-serie 1990-2002 and the years after is ensured. For some plants, it was applied until 2004 as we don't have plant data.
The recycled glass is part of the AD of table 4.3.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Flat glass (kt)	1142	898	1013	961	1103	1193	1157	1162	1163	1085
IEF flat glass (kg CO_2/t)	140	140	140	140	140	140	140	140	140	140
Container glass (kt)	279	237	269	283	250	264	256	278	307	162
IEF container glass (kg CO_2/t)	102	102	102	102	102	102	102	102	102	102
Glass wool (kt)	82	76	94	96	101	117	127	133	111	129
IEF glass wool (kg CO_2/t)	89	89	89	89	89	89	89	89	89	89
IEF global (kg CO_2/t)	**130**	**129**	**129**	**128**	**130**	**130**	**129**	**129**	**129**	**131**
CO_2 emissions (kt)	195	156	177	172	189	204	199	203	204	180

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Flat glass (kt)	1157	1178	1291	1304	1150	1234	1418	1358	1317	1026
IEF flat glass (kg CO_2/t)	140	140	140	137	135	141	137	136	143	133
Container glass (kt)	148	158	166	215	213	216	231	244	227	211
IEF container glass (kg CO_2/t)	102	102	102	105	100	97	100	101	109	99
Glass wool (kt)	140	148	143	164	192	194	207	212	204	156
IEF glass wool (kg CO_2/t)	89	89	89	89	102	88	80	78	90	99
IEF global (kg CO_2/t)	**131**	**131**	**131**	**128**	**127**	**130**	**126.2**	**124.3**	**133**	**124**
CO_2 emissions (kt)	189	194	210	215	219	235	234	226	232	173

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Flat glass (kt)	1169	1211	1008	804	768.4	765.7	773	756	762	690
IEF flat glass (kg CO_2/t)	137	136	133	130.8	124.5	137	132	134	135.5	134
Container glass (kt)	186	198	193	270.6	238.9	214.8	220	251	262	250
IEF container glass (kg CO_2/t)	91	103	87	84.9	79.2	77.4	81.3	78.7	78.2	73.5
Glass wool (kt)	204	211	186	185	195.1	199.7	215.9	232.3	261	255
IEF glass wool (kg CO_2/t)	74	58	54	52.1	53.8	52.3	56.2	53	52.5	49.7
IEF global (kg CO_2/t)	**125**	**122**	**116**	**109**	**104**	**112**	**109.2**	**108**	**107**	**103**
CO_2 emissions (kt)	192	198	160	137.8	125.1	132	132.1	133	137.5	123.5

	2020	2021	2022
Flat glass (kt)	525	771	771
IEF flat glass (kg CO_2/t)	126	134	137
Container glass (kt)	203	235	192
IEF container glass (kg CO_2/t)	65.2	59	44.5
Glass wool (kt)	220	258	258
IEF glass wool (kg CO_2/t)	46.6	46.8	44.2
IEF global (kg CO_2/t)	**94.6**	**102.5**	**102.7**
CO_2 emissions (kt)	89.6	129.5	125.47

Table 4.3: Glass production and related emissions of CO_2 in the Walloon region (1990-2022)

The fluctuations over the years are due to the compilation of the emission factors of three different plants. Since 2016, there is still only one flat glass plant in Wallonia. There is also a decrease of the EF of flat glass plants due to the difference of raw materials between the years 2005 and 2017.
Concerning the Glass wool plants, the emission factor decreases between 2010 and 2018. This reduction concerns one plant in the Walloon region. The reduction of the CO_2 process is directly related to the increase in the use of the external cullet and therefore the decrease of mineral raw materials.

In the Flemish region, since the 2009 submission, the process emissions of CO_2 were newly added for a company as a result of their emission reporting in the framework of the EU-ETS Directive. An estimation of the previous years (1990-2004) was performed by using the same methodology as used in the framework of the EU-ETS (C-content of raw materials used). Because of the comparability of the melting process in the production of glass and enamel, both industries are related in Flanders and consequently put under the same category 2A3, following the IPCC 2006 guidelines. Aggregated data of production of glass and enamel and the corresponding emissions of CO_2 are included in the table 4.4 below for the Flemish region. The recycled glass is part of the AD reported in that table.

History:
The process CO_2-emissions from the glass production, in the Flemish region, was reported since the submission of 2006. The emissions were added for the complete time series after consultation with the industrial companies involved. An emission factor of 125 kg CO_2/ton glass, as proposed by the glass federation, was mainly used in this sector at that time. One company did revise this emission factor in the course of 2006 to 300 kg process CO_2/ton glass.

In the following years up to 2009 more companies did revise their calculation methodology for estimating their emissions of CO_2 based on the methodology used in the framework of the EU-ETS Directive. For the one company involved in the enamel production in Flanders, an emission factor of 650 kg CO_2/ton was used in the 2006 submission. This emission factor was first given by the company and based on the European BREF-documents (reference document Best Available Technology) and is revised in the course of 2006 to 71.12 kg CO_2/ton enamel. The company involved stated that the emission factor of 650 kg CO_2/ton is a combination of process and combustion and consequently a double counting of the emissions of CO_2 occurred.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
AD glass (kt)	453	424	436	440	463	467	468	408	424	360
AD glassfiber (kt)	16	18	20	21	27	26	27	28	33	28
AD enamel (kt)	21	21	20	19	20	15	18	19	19	19
Emission glass (kt CO2)	64	54	55	56	58	59	60	51	53	45
Emission glassfiber (kt CO2)	2	2	3	3	3	3	3	4	4	4
Emission enamel (kt CO2)	1	1	1	1	1	1	1	1	1	1
Total Emission (kt CO2)	**67**	**57**	**59**	**60**	**63**	**64**	**65**	**56**	**59**	**50**
IEF glass (kg CO2/ton)	141	126	126	127	126	127	128	126	125	124
IEF glassfiber (kg CO2/ton)	125	125	125	125	125	125	125	125	125	125
IEF enamel (kg CO2/ton)	71	71	71	71	71	71	71	71	71	71

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
AD glass (kt)	372	395	388	372	387	391	370	363	347	307
AD glassfiber (kt)	38	33	39	41	43	40	47	55	59	35
AD enamel (kt)	21	22	21	18	21	19	21	20	18	17
Emission glass (kt CO2)	46	47	48	27	29	33	31	30	29	27
Emission glassfiber (kt CO2)	5	4	5	5	6	6	7	8	8	6
Emission enamel (kt CO2)	2	1	1	1	2	1	2	2	1	1
Total Emission (kt CO2)	**52**	**53**	**55**	**34**	**37**	**40**	**40**	**40**	**39**	**33**
IEF glass (kg CO2/ton)	124	120	124	74	75	85	83	83	84	87
IEF glassfiber (kg CO2/ton)	125	125	125	125	143	143	150	148	134	159
IEF enamel (kg CO2/ton)	71	64	69	73	76	74	79	77	83	76

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
AD glass (kt)	314	306	276	263	311	299	304	270	210	132
AD glassfiber (kt)	53	57	50	52	57	60	63	66	63	56
AD enamel (kt)	17	15	14	19	18	18	18	18	18	16
Emission glass (kt CO2)	28	26	19	20	24	25	27	21	17	8
Emission glassfiber (kt CO2)	8	9	8	8	9	9	9	8	2	2
Emission enamel (kt CO2)	1	1	1	1	2	1	2	1	1	1
Total Emission (kt CO2)	**37**	**35**	**28**	**30**	**34**	**36**	**38**	**31**	**20**	**12**
IEF glass (kg CO2/ton)	88	83	68	77	76	83	89	79	79	64
IEF glassfiber (kg CO2/ton)	148	151	157	158	157	156	148	122	36	36
IEF enamel (kg CO2/ton)	73	90	86	79	90	79	85	81	82	78

	2020	**2021**	**2022**							
AD glass (kt)	146	188	182							
AD glassfiber (kt)	52	66	65							
AD enamel (kt)	16	18	17							

Emission glass (kt CO2)	16	23	20							
Emission glassfiber (kt CO2)	2	2	2							
Emission enamel (kt CO2)	1	1	1							
Total Emission (kt CO2)	**19**	**26**	**23**							
IEF glass (kg CO2/ton)	107	121	111							
IEF glassfiber (kg CO2/ton)	33	32	28							
IEF enamel (kg CO2/ton)	81	78	75							

Table 4.4: Glass (and enamel) production and related emissions of CO_2 in the Flemish region (1990-2022)

As mentioned above, the recycled glass is part of the production figures presented in the table 4.4. These figures represent the amount of glass produced in the ovens. The calculation of CO_2 emissions doesn't take into account the recycled glass. The calculation is based on the total consumption of raw materials to be decarbonized for the production of « new » glass (not recycled). The activities of one of these companies stopped in 2017.

The other process uses of carbonates (**category 2A4**) includes the production of ceramics and the CO_2 emissions in the flue-gas desulphurisation in electric power installations (2 in the Flemish region), in sugar plants (2 installations in the Walloon region), in chemical plants and in ceramic plants.
The emissions reported in category 2A4 are collected directly from individual plants and are subject to independent review in the framework of the Emission Trading Scheme.
The process emissions of CO_2 originating from the **ceramic sector** are included in the **category 2A4a (Ceramics).** The CO_2 emissions in the flue-gas desulphurization in these plants are also included in this category.

In Flanders, the emissions of CO_2 are estimated in consultation with the federations and companies involved. This estimation is calculated for the Flemish region with the methodology recorded in the monitoring protocol of the companies (emission trading scheme, Directive 2003/87/EC) and is based on production information and the evolution of the gamut of products. There are no complete database of the production figures available for the entire time series. Table 4.5 gives an overview of the ceramic production figures and related emissions of CO_2 (process) in this sector

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Ceramic production (kt)	2772	2641	2702	2746	2897	3224	2870	2872	2780	2687	2678
IEF (kg CO_2/kt)	45	53	38	48	48	71	78	75	71	71	70
CO_2 emissions (kt)	124	141	103	131	138	229	223	214	198	191	189

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Ceramic production (kt)	2621	2624	2561	2613	2732	2797	2837	2598	2161	2225	2322
IEF (kg CO_2/kt)	67	57	60	68	71	72	71	79	80	55	61
CO_2 emissions (kt)	177	151	155	177	193	200	201	206	173	122	141

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Ceramic production (kt)	1984	1783	2127	2144	1929	2097	2152	2100	2034	2148	2184
IEF (kg CO_2/kt)	69	68	59	70	72	71	66	73	77	72	70
CO_2 emissions (kt)	137	121	126	150	139	148	143	153	157	155	152

Table 4.5: Ceramic production and related emissions of CO_2 in the Flemish region (1990-2022)

In the Walloon region, the calculation of the CO_2 process emissions follows also the guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC.
Since 2005, the CO_2 emission factors have been calculated by the ceramic plants. An average emission factor was discussed and established in 2005 with the plants involved in the ceramic industry and was used for the years 1990 to 2004. The productions for the years 1990 to 2004 were given by the brick federation. There are variations of emissions due to the raw material mix used (carbon content of the clay) and the desired ceramic end product. Each plant gives annually the amount of clays with the average carbon content. Table 4.6 gives an overview of the ceramic production figures and related emissions of CO_2 (process) in this sector.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Ceramic production (kt)	483	483	483	483	483	521	402	434	491	483	518
IEF (kg CO_2/kt)	24	24	24	24	24	24	24	24	24	24	24
CO_2 emissions (kt)	11.6	11.6	11.6	11.6	11.6	12.5	9.6	10.4	11.8	11.6	12.4

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Ceramic production (kt)	570	608	626	590	626	622	642	604	452	444	511
IEF (kg CO_2/kt)	24	24	24	25	23	24	25	24	25	25	24
CO_2 emissions (kt)	13.7	14.6	15	15	14.3	14,8	16	14,3	11,3	10.6	12,4

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Ceramic production (kt)	426	356	384	392	376	396	404	404	401	**454**	**402**
IEF (kg CO_2/kt)	22	51	59	63	55	52	48	54	45	**49.6**	**50.6**
CO_2 emissions (kt)	9,5	18.2	22.81	24.844	20.67	20.52	19.38	21.8	18.1	**22.5**	**20.33**

	2012	**2014**	**2016**	**2017**	**2019**	**2020**	**2021**	**2022**
	carbon contents of clay (tCO2/t)							
Plant 1	0.01786	0.1075	0.089	0.158	0.024	0.0267	0.0314	0.0323
Plant 2	0.00455	0.0054	0.0085	0.028	0.156	0.154	0.151	0.151
Plant 3	0.0172	0.095	0.085	0.175	0.160	0.148	0.138	0.148
Plant 4	0.0129	0.0163	0.0145	0.015	0.065	0.05	0.05	0.068
Plant 5	0.01118							
Plant 6	0.05315	0.0416	0.04524	0.0455	0.02	0.021	0.023	0.0199

Table 4.6: Ceramic production, related emissions of CO_2 in the Walloon region (2012-2022) and examples of carbon content of clay in different industries

Differences in implied emission factors between the regions is mainly due to the differences in mixture of raw materials used. This has to do with the C-amount (organic carbon originating from plant debris/waste and organic material and / or carbonates) in the raw materials, on one hand, and with the desired ceramic end-product (technical and functional requirements), on the other hand. This means that some raw materials are more suitable and essential to produce some products and assure that technical and functional requirements are obtained. Traditionally the marine deposits like the clay from Antwerp (Boom) have a high natural organic C-content (until 2%) and are mainly used for fast-construction and inner wall stone with insulating capacity. The loam/mud contains almost no organic material but mainly carbonates and is used for outside light-coloured front stones. These different raw materials cause differences in process emissions of CO_2.
The differences between Flanders and Wallonia are caused by the differences in geological deposits. Even within different sub-regions big differences in emissions can occur.
The clays used in Wallonia contain less carbon.

Compared to other European countries, Belgium measures yearly very accurate the real total C-amount of the raw material for determination of the process emissions. Some other countries calculate their emissions with a fixed conversion factor (only carbonates). Consequently, less fluctuations occur from year to year in these countries.

The CO_2 emission in **the category "Other uses of Soda Ash (category 2A4b)"** are included in the sectors 2A4d (gas epuration in sugar plants and use of lime in the electric power installations), 2A3 (glass production) and 2B10.

Belgium did not use the UN Comtrade Statistics because the amount of Na_2CO_3 that is already taken into account in the greenhouse gas inventory (category 2A3, 2A4d and 2B10) is higher than the figure reported in the Comtrade statistics.

The category 2A4d (other) includes the CO_2 emissions in the flue-gas desulphurisation in electric power installations (2 in the Flemish region), in sugar plants (2 installations in the Walloon region) and in chemical plants (2 installations in the Walloon region). The emissions reported in category 2A4 are collected directly from individual plants and are subject to independent review in the framework of the Emission Trading Scheme. The IPCC tier 3 methodology is used.

From 1990 to 1992, an extrapolation of the emissions was performed and are estimated in 1990 to be between 0.5 to 1 kt. The extrapolation was realized for plants in activity during this period in the Walloon region.

In the Flemish region, the emissions of CO_2 reported in this category originates from the power installations using carbonate (lime) for flue-gas desulphurisation. This purification technique occurred since 1999 in this region and did end in 2017.

4.2.3 Uncertainties and time-series consistency

For lime and cement plants, the uncertainty on activity data comes from the pages 3.15 and 3.21 of the IPCC Good Practice Guidance. The uncertainty on emission factors is assumed to be low, as plant-specific emission factors are used in these sectors.

The uncertainty on activity data for glass production is assumed to be comparable with the other industrial productions. The CO_2 emission factor of the EMEP/EEA guidebook originates from studies in the Netherlands. Consequently, the uncertainty on the emission factor was taken from the NID of the Netherlands for this sector.

4.2.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided by the Belgian experts on request.

The calculation of the CO_2 process emissions in Belgium follows mainly the guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to the ETS Directive 2003/87/EC.
The emissions are verified each year by an external agency.

Validation/control checks are made between emission data reported in the regional ETF-GHG databases and the emission trading data (see annex 11).

4.2.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In the Walloon region, a mistake in a lime plant is corrected in 2021 during this submission.
Very small, insignificant recalculations took place in the category 2A in the Flemish region from 2016 on.

4.2.6 Source-specific planned improvements, if applicable, including those in response to the review process

No source-specific planned improvements are foreseen in the near future in the category 2A in Belgium. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

4.3 Chemical industry (CRT 2.B)

4.3.1 Source category description

The chemical industry is the most important sector in industrial processes in Belgium and contributes to 41 % of the emissions of greenhouse gases in this sector in 2022.
The chemical industry in Belgium is covered by categories 2B1 (ammonia production), 2B2 (nitric acid production), 2B4a (production of caprolactam), 2B6 (production of Titanium dioxide), 2B8 (production of ethylene and vinyl chloride monomer, formaldehyde), 2B9 (fluorochemical production) and 2B10. This last category includes the emissions from the activation of the active carbon in the Walloon region and some other process emissions reported by the chemical industry (f.i. the production of ethylene oxide, acrylic acid, cyclohexanone …) in the Flemish region.

4.3.2 Methodological

4.3.2.1 Ammonia production (category 2B1)

The ammonia production source is a key category of CO_2 emissions in terms of emissions level and trend. The production takes places in 2 companies in Belgium.

In the Flemish region, last years this information (activity data and emissions) comes directly from the plant via their annual integrated environmental reporting obligation. The estimation of the emissions is based on the consumption of natural gas, this is the only raw material used for the production. The consumption is multiplied with the default IPCC emission factor for CO_2 for natural gas (56.1 kton CO_2/PJ) and the caloric value (variable per month).

A part of the CO_2 (recovery part) is transported internally to the nitro-phosphor-installation and effectively measured by flow measurements. This CO_2 is used as raw material in the production of nitro phosphoric acid and afterwards for the production of lime. The produced lime is mainly used in the own branch / site as raw material for the production of fertilizers. The company involved, highlights that the use of CO_2 from the production of ammonia, that arises on the same site as the production of fertilizers, to produce lime, is indeed resulting in a reduction of the emissions of CO_2. Emissions of CO_2 from the application of such lime products is reported in the LULUCF sector. The amount of limestone used in the Belgian inventory to estimate the emissions of liming of agricultural soils is much higher than the amount of limestone produced and sold in Belgium
Not subtracting these emissions in the sector of industrial processes, results in a systematic double counting of these emissions. In the reporting of the ETS-data these emissions of CO_2 are reported as part of the emissions from the production of ammonia and consequently not subtracted. This means an inconsistency between the 2 reporting obligations.
The subtracting amounts of CO_2, the ‘recovered’ amounts, are reported in the CRT-tables for the first time during the 2019 submission and for the complete timeseries. The company involved confirmed, as a result of one of the questions during the European ESD-review in 2020, that no production of urea takes place at their site.
In the past the process emissions of CO_2 originating from the production of ammonia in Flanders were obtained as a result of the yearly surveys carried out by the chemical federation in cooperation with the VITO (see also section 3.2.5 and 3.2.3 for more information).

In the Walloon region, the same methodology is used. The amount of natural gas, also the only raw material used in this process, used in the process is given directly by the plant. There is a flow meter on the duct. The CO_2 process emissions are calculated based on this amount of natural gas. 100% of the carbon content of the natural gas is presumed to be emitted and the default IPCC emission factor for CO_2 for natural gas (56,1 kton CO_2/PJ) is used for the years 1990 to 2012. Since 2013, the plant performs analyses on the C content of the natural gas. A part of the process CO_2 emissions is used by two other plants. The uses of these CO_2 process emissions are Ammonium carbonate production as intermediate, inert agent and food production. All the CO_2 emissions are allocated to the ammonia plant as it is assumed that all gas carbon will be emitted to the atmosphere in Belgium. This ammonia plant declares also very weak CH_4 emissions (≈500 kg) based on a CH_4 analysis in 1999 on the scrubber of ammonia during the production of ammonia. The emissions from the natural gas used in the denox-unit are included in the category 1A2c.

The calculation of the CO_2 process emissions follows the guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC. The IPCC tier 3 methodology is used.

4.3.2.2 Nitric acid production (category 2B2)

This source is a key category of N_2O emissions in terms of emissions level and trend.

Production figures of nitric acid in Belgium are well known and recorded in the category 2B2 'nitric acid production'.

In the Flemish region, since 2003 the information (activity data and emissions) from the production of nitric acid comes directly from the plant via their annual integrated environmental reporting obligation. Because the use of catalyst from 2003 on, lower emission factors are reported. In 2016, 2018 and 2019, the lowest emission factor of 0.44 kg N_2O/ton HNO_3 for the complete time series was registered. The higher emission factor in 2017 is related to a malfunctioning catalyst, which was replaced during 2017.

Before 2003 the emissions are estimated by using an emission factor of 8 kg N_2O/ton HNO_3 from CITEPA (24). The three plants involved in Flanders agreed to use this factor since 1990.

A remark has to be made that during previous submissions the emissions reported in the category 2B2 also included small amounts of emissions of N_2O from the production of nitro phosphoric acid. These emissions of N_2O were reallocated during the 2019 submission to the category 2B10 Other (chemical industry). This has been performed as one of the recommendations during the UNFCCC ICR5 in September 2018.
In the past, there have been some changes at the producers of nitric acid in the Flemish region. Up to 2000 the production of nitric acid could strongly vary each year. After the closure of a plant in 1995 and another one in 2000 the production of nitric acid stabilized more or less until 2008. The year 2009 was an exception due to the economic crisis. Since 2010 a real boost took place in nitric acid production (an increase of 37% compared to 2009). Nowadays there are 4 installations involved, producing nitric acid via the dual pressure process (medium/high pressure) with SCR (emission of N_2O).

In the Flemish region there are (since 2000) 5 installations with production of HNO_3 in one plant.
The first and oldest one was producing HNO_3 via the single pressure process (high pressure) with connected NSCR and causes/caused limited emissions of N2O and the other 4 installations (starting in resp. 1980, 1988, 1991 and 2008) are using the dual pressure process (medium/high pressure) with SCR and causes emissions of N_2O. The most recent one, build in 2008, replaced the oldest one in 2008.

In the Walloon region, there is only one producer of nitric acid (one plant with 3 installations).
In the Walloon region, there is one plant with three installations : high pressure plant with SNCR, medium pressure plant with SCR and bi-pression plant (medium and high pressure) with SCR
Each year, this plant provides the N_2O emissions for each installation based on monitoring. The global emission factor used was 6.34 kg/t in 2009, 6,46 kg/t in 2010, 0,62 kg/t in 2011, 0,68 kg/t in 2016, 0,5 kg/t in 2017 and 0.16 kg/t in 2022. This drop of the emissions in 2011 is explained by the placement of new catalysts on two installations at the end of 2010. The increase of the IEF in 2009 and 2010 is explained by an explosion in the plant in 2009 resulting in higher emissions in 2009 and 2010 as the control unit was out of order.
The calculation of the N_2O process emissions follows the guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC (ETS-Directive). The IPCC tier 3 methodology is used.

No emission factors and N_2O emissions are presented by region as there is only one company by region involved.

4.3.2.3 Caprolactam, Glyoxal and Glyoxylic Acid Production (category 2B4)

In the category 2B4, only the category 2B4a (production of caprolactam) occurs in Belgium.

The only involved company in Belgium lies in the Flemish region. Since 1997 this company offers each year the results of the monitoring carried out (monthly measurements-gas analysing by using the gas chromatography - ECD method to determine the concentration of N_2O in the gas and estimate the emissions of N_2O).
The emissions of the previous years from 1990 on, are estimated by this company as accurate as possible.
Emission figures were asked and delivered by the company involved for the years 1990-1996. The company did examine this issue and confirmed by mail in July 2005 to keep the emission for the years 1990-1996 to 1200 ton N_2O per year, knowing there is an uncertainty on these figures anyway and some fluctuations from year to year, which are not always explainable.
Since 1997 the company did perform measurements which were taking into account to estimate the emissions. From 2010 on there is a decrease in IEF noticeable due to measures taken by the company involved:

- Replacement of the catalyst-network during the incineration of NH_3 resulting in less N_2O formed as a by-product;
- Increase of the efficiency of the absorption towers during production of nitrite resulting in less NH_3 that need to be incinerated per ton caprolactam and consequently a decrease of the absolute amount of N_2O as by-product.

There is a strong increase of emissions of N_2O in the years 2009 and 2010 due to strong growth of production of caprolactam in that period (+20%). Because only one company is involved in Belgium, no emission factors or emissions of N_2O are presented in this report.

As recommended in the final review report (2016 Comprehensive review of national greenhouse gas inventory data pursuant to Article 19(1) of Regulation (EU) No 525/2013 (ESD-review) the following reference here-under is added:

Emissions of N_2O from the production of caprolactam are not included in the Flemish ETS-data. The only non-CO_2-emissions that need to be reported pursuant to Directive 2003/87/EC so far are the emissions of N_2O from the production of nitric acid.

4.3.2.4 Titanium dioxide production (category 2B6)

During the submission of 2022 the emissions of the production of Titanium dioxide have been reallocated from 2B10 to 2B6. Only the emissions that where reported under the ETS-directive could be reallocated to 2B6. Before 2013 these emissions are integrated in 2B10.

4.3.2.5 Soda ash production (category 2B7)

The soda ash production took place in the Walloon region until 1993 in Solvay's plant in Couillet. The production of soda ash was discontinued at the end of 1993 and the plant was closed in 1998. The process used was the Solvay process. The CO_2 emitted from soda ash production originated from coke oxidation, is included in the category 2B10.

4.3.2.6 Petrochemical and Carbon Black Production (category 2B8)

In the Flemish region, the emissions from the production of ethylene are included in the category 2B8b.
From the 2015 submission on, ETS-data are taken over in the greenhouse gas inventory.
Measurements are carried out to obtain these emissions. Until the submission in 2014 these emissions were allocated to the category 1A2c / other fuels.
The emissions reported here are the emissions of the rest-gases/off-gases (other fuels) in chemical industry. These are mainly the emissions from the recovered fuels in the naphtha crackers (mainly naphtha - biggest part and LPG - smallest part) for the production of Ethylene. These energy-

consumption data as well as the emissions of CO_2 were until 2012-data obtained via the confidential survey carried out by the chemical industry in cooperation with the Vito. From 2013-data onwards these data are reported via the ETS-Directive. During the survey the purchased quantity of fuels (with a distinction between the use as raw material and the energetic use) as well as the self-produced energy fuels and the sold fuel amounts are reported by the chemical industry as well as all the corresponding emissions of CO_2 of self-produced rest-fuels and non-energetic CO_2 is reported.

There are 4 naftacrackers in the Flemish region, all located in the harbour of Antwerp. We have no idea how accurate the information on the site https://www.petrochemistry.eu/about-petrochemistry/petrochemicals-facts-and-figures/cracker-capacity/ is but these data shows a cracker capacity in Belgium of 9,5 % of total capacity in Europe. Besides it must be said that the involved companies protect their data (a.o. about the efficiency of the cracker units) very intensively because of the competitive importance. They are not very ‘enthusiastic’ about reporting of these (confidential) data.

As these emissions are not exclusively related to the production of ethylene in the Flemish region, it is not relevant to report about the activity data in this category. Besides most of these data need to be treated in a confidential way. Consequently the notation key ‘NE’ is reported.

The category 2B8c must include the productions of ethylene dichloride and vinyl chloride monomer. Contacting the company involved, the parameter 'methane' seems to be not relevant as a process emission during the production of EDC (ethyleen dichloride)and MVC (vinyl chloride monomeer): as a raw material ethylene is used as well as HCl (hydrogen chloride) or Cl2 (chloorgas). Besides the off-gases of the procesinstallations are burned in the restgasincinerator. The emissionvalues of the organic parameters in the restgasstream were below the determination limit (< 0.8 mg/Nm3) and below the detection limit (< 0.4 mg/Nm3). The UNFCCC ERT noted that the CH4 emissions reported for this category by other Parties are negligible for all of them, with the CH4 EF ranging from 0.006 to 0.023 kt CH4/t product, well below the threshold of significance for Belgium (53.22 kt CO2 eq).
Even an estimation with information of the company involved (flow rate and time of emission) shows that the maximum possible emissions of CH4 are far below the treshold of significance Consequently the notation key 'NE' is reported.

For 2B8d (ethylene oxide) and 2B8g (styrene) it is not possible to make a distinguish between the emissions of the different production installations in this region, these emissions are allocated in the category 2B10. The notation key of IE has been used in this categories. Contacts with the chemical federation are still going on in the Flemish region/Belgium to try to optimize this allocation. Unfortunately our contact changes job shortly and ever since no reaction is obtained.

Since there is only one producer of carbon black (category 2B8f) in Belgium (Flemish region), emitting below the threshold value of 100 kton CO_2 and not (yet) obliged to report under the ETS-directive, no individual emissions of this plant are reported because of confidentiality. These emissions are consequently integrated in the category 2B10 (category 2B5 in previous submissions).
The emissions of this company are reported via the ETS-Directive since 2014 at the moment that a second production line became operational (ratio: obligation under ETS only from a therm. capacity of 20 MWh). Before these emissions were reported by the company via the confidential survey conducted by the chemical federation in cooperation with the Vito. The emissions of CO2 are estimated/calculated by the company via input/output mass balance (C-black feedstocks = oil 'IN' and C-black 'OUT').

In Wallonia, the emissions are included in the 2B8g category and are coming from three sources: production of vinyl chloride, maleic anhydride and phthalic anhydride. The production of phthalic anhydride was stopped in 2007 and the production of maleic anhydride in 2009. From 1990 to 2001, the CO_2 EF was constant for the three sources and was chosen after a discussion with the respective plants. Since 2002, the plants have given annually the production and the CO2 emissions linked with this production. In 2022, the CO_2 process emissions coming from the production of 1,2 dichloromethane and vinyl chloride was 7.1 kton (EF = 0.017 tCO2/t VC produced).
The CO_2 emissions coming from the catalytic conversion of methanol to formaldehyde was 5.3 kt in 2022 (EF = 0.00366 t/t).

4.3.2.7 Fluorochemical production (category 2B9)

The emissions of category 2B9 (Production of halocarbons) are those of an electrochemical synthesis (electro-fluorination) plant, which emits, or has emitted, PFCs and HFCs, as well as fluorinated greenhouse gases not covered by the Kyoto Protocol. This plant produces a broad range of fluorochemical products, which are used as basic chemicals as well as end products, mainly in the electronics industry.

The processes used in this electro-fluorinated plant are unique within Europe (there are however some similar plants in the US). This means that there are no established guidelines for monitoring and reporting.
49 processes are considered, of which a minority are continuous processes and the remaining batch ones. The emissions are partly ducted (those of the continuous processes and of most batch processes) and diverted to a thermal oxidizer, and partly non-ducted (the latter all from batch processes).
The gas incinerator (thermal oxidizer) eliminates almost all the ducted emissions of the plant, but some CF4-emissions nevertheless still occur. These are determined through measurements.
For the non-ducted emissions, estimates are calculated by means of detailed material balances. For each process (all 49 processes for the greenhouse gas emissions) and for each component, an emission factor is established on an empirical basis. The emission factors are combined with detailed specific production data.
In 2015, the company reported that in 2014 it performed laboratory simulations of some specific production processes to better understand air emissions. These tests showed that HFC emissions could have been underestimated. This was already mentioned in previous inventory reports.
To confirm the insights, local measurements on the related production processes were performed. These measurements confirmed the insights.
As part of the evaluation of these laboratory results, and in order to guarantee full transparency and reliability on the monitoring methodology of all processes and emissions, the company was requested to establish a monitoring plan that describes and evaluates in detail the calculation methods used for all F-gas emissions.
The drafting of the monitoring plan was performed in 2019. During that process, the company was assisted by an independent verification office (VBBV), appointed for that specific purpose by the Flemish Government because of its experience in monitoring EU ETS emissions. Its assessments resulted inter alia in the acceptance of updates of some of the emissions factors used until then. The monitoring plan was finalized early 2020.
The Flemish government also requested the company to recalculate the historic emissions, taking into account the new insights and in accordance with the established monitoring plan. The company recalculated its emissions for the period 2005-2018, arguing that before 2005, multiple production processes at the chemical plant were run significantly different and therefore the updated emission factors would not be accurate for this period.
The recalculated emissions for 2005 and the period 2016-2018 were verified by the independent verification office (VBBV), while also a review of the recalculated 2006-2015 emissions was performed. These recalculated emissions are considered to be more valid and accurate than those reported in the past.
The recalculation exercise resulted in a substantial increase of emissions expressed in CO2-eq compared to the previous inventory, especially for the CRT-gases, because the new and more correct method results in higher emissions of CRT greenhouse gases and lower emissions of non-CRT greenhouse gases. It also changed the emission pattern.

The company has taken further measures to monitor emissions more intensively and has implemented measures to substantially reduce emissions in the short term after 2018. The mitigation measures already had an effect in 2019, with emissions below emissions in 2018. This trend continued in subsequent years. In 2022 emissions of CRT fluorinated greenhouse gases had been reduced by 90% (or 1328 kt CO2-eq) compared to 2018.

4.3.2.8 Other (category 2B10)

The process emissions coming from the following chemical processes are allocated in **the category 2B10 other (other non-specified)**:

In the Walloon region:

- the emissions of CO_2 emitted from soda ash production originated from coke oxidation (1990-1993);
- the reactivation of active carbon (25.84 kton in 2021);

In the Flemish region:
During the submission of 2022 the emissions of the production of Titanium dioxide have been reallocated from 2B10 to 2B6. Only the emissions that where reported under the ETS-directive could be reallocated to 2B6. Before 2013 these emissions are integrated in 2B10.

The process emissions coming from the following chemical processes are allocated in **the category 2B10 other (other non-specified)**:

- CO_2 emissions from other process reported by the chemical industry (for example the emissions from the production of ethylene oxide, ethylene dichloride, vinyl chloride monomer, acrylic acid from propene, cyclohexanone from cyclo-hexane, paraxylene/meta-xylene, carbon black etc). These CO_2 emissions result from surveys in the chemical sector (see also sections 3.2.5. an 3.2.3 for more details). These emissions are reported by the companies to the chemical federation (about 15 to 20 companies involved). The data fluctuate, since the processes included can fluctuate. The data are reported in an aggregated way by the chemical federation and need to be treated confidential. From the 2015 reporting on (emissions of 2013) ETS-emissions are completely taken over in this category;
- some small process emissions of N_2O mainly in the chemical industry. These emissions are reported by the industry via their annual environmental emission reporting obligations and are small process emissions from: a naphtha cracker, waste gas combustion (containing NH_3 from the production process), purging of bottles and purifying of bulk product N_2O;
- some small process emissions of CH_4 mainly in the chemical industry. These emissions are reported by the industry via their annual environmental emission reporting obligations and are small process emissions from: an adsorption system of an oxidation unit, naphtha cracker and leak losses from a relax station of natural gas.

The reason for this sharp increase in emissions from 1990 on could be explained by the emissions reported in the Flemish Region, which is responsible for the largest part of these emissions. The Party clarified that emission estimates of about 30 companies were allocated to category 2.B.10; however, the biggest part of the reported emissions came from only a few companies that had gone through significant expansion during this period:
One company increased production from 1990 onward for ethylene oxide/ethylene glycol (1993), extension of the wastewater treatment plant and central steam boilers (no exact starting year currently known), acrylic acid (1995 and 2008) and propylene oxide (2007). A second company started its activities at the end of 2003 when the first steam reformer for the production of hydrogen (and carbon monoxide) came into operation. In 2007, a second steam reformer came into operation. Fluctuations in emissions occur over the years owing to fluctuations in production in line with customer demand. This company is responsible for 44 per cent of the increase in emissions in that period. A third company also expanded its activities over the years, with two extra terephthalic acid production sites opening in 1991 and 1999. And a fourth company installed a regenerative thermal unit in 2000 (as a purification method for hydrocarbons) – but which has a limited impact in the increase in CO2 emissions in that period.

4.3.3 Uncertainties and time-series consistency

The only references found for the ammonia production are the Norwegian uncertainty calculation (32) and the Irish NID. Average values from these references are used in this study following expert judgement.

Since there are only two producers of nitric acid remaining since 2000 with reliable production data, the uncertainty of the activity data is estimated at 2%. The uncertainty on the N_2O emission factors is assumed to be low, as N_2O emissions are to be reported by this sector (ETS directive). The uncertainty is estimated at 7.5 % (ETS monitoring plans).
The uncertainty is estimated at 30% by expert judgment.
The same uncertainty in activity data is used for the production of caprolactam as for the production of nitric acid (2%) for the same reason. The uncertainty of the emission factor is estimated at 30% by expert judgment.

For fluorochemical production, the emission figures are a result of measurements combined with a mass balance. The calculated scientific and model uncertainty is 13 % (based on error propagation analysis). The non-fugitive emissions of CF_4 are measured. Their calculated uncertainty is 45 %. The uncertainty figures have been reviewed and confirmed by an external consultant in 2004. However, they seem to be unrealistically low according to this consultant and the company itself. In order to get a conservative estimate, they have been doubled in the uncertainty calculation table given the small share of this emission source in the overall GHG emissions. The overall impact of this change remains limited (in the order of 0,1% of the total national GHG emissions).

The uncertainties of emissions for the fluorochemical production (category 2B9) are described in detail in the references (33) for the years 2015, 2018 and 2019

And the reference (34) where the methodology (basis) used for the uncertainty analysis was described in detail in the update for the 262262262year 2004.

4.3.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided by the Belgian experts on request.

The emissions reported in the category 2B Chemical industry are taken from official reports from the industry.
Industrial plants have to report their emissions of air pollutants and greenhouse gases from the moment they exceed a defined threshold (in ton/year) via their yearly environmental reporting obligations. The industry also has the obligation to report the methods used to estimate these emissions. All emissions are validated and verified by a team of people experienced in emission inventories. In addition, each year a trend analysis is carried out for all emissions per industrial plant and sector. If any inconsistencies or problems are detected by the team, the industry involved is contacted. In exceptional cases the inspection services are contacted.

Besides during the last years these emissions are also validated in comparison with ETS-data which also are undergoing an official verification by external experts.

4.3.5 Source-specific recalculations, if applicable, including changes made in response to the review process

The following recalculations occurred in the category 2B:

In the Flemish region, the following recalculations were performed during this submission:

- A double counting of emissions of flaring (in CRT 2B10 and in CRT 5C12b) was eliminated during this submission (decrease in emissions in CRT 2B10 from 2019 on of 4-7 kton CO_2);
- Consistency assured for the years 2020 and 2021 compared to 2019 related to allocation of emissions of process_CO_2 from methane-fraction during production of ammonia. These emissions from 2020 and 2021 now allocated to CRT 2B1 and no longer to CRT 2B10. Total emissions in this respect remain unchanged.
- Small corrections were made during this submission assuring complete consistency with ETS-data for the emissions of N2O from production of nitric acid from 2013 on;
- Addition of missing emissions of N_2O from 1 chemical company from 2020 on (+17-18 kton CO_2);
- Corrections in category 2B9 of emissions of F-gases of 1 chemical company from 2017 on (correction/switch from reported non-IPPC gas to IPCC-gas) with consequently an increase of emissions (up to 11,5 kton CO2eq in 2019).

4.3.6 Source-specific planned improvements, if applicable, including those in response to the review process

Flanders is investigating whether it is possible to make a distinction in allocation of the emissions reported in 2B10 based on the different product processes. Consequently, a part of the emissions that are now allocated to 2B10 Other (chemical industry) could possibly be reallocated to 2B8 (Petrochemical and Carbon Black production) or other categories.

4.4 Metal industry (CRT 2.C)

4.4.1 Source category description

The metal production activities in Belgium are covered by category 2C1 (metal production i.e. iron and steel industry), these activities take place in the Flemish and the Walloon region.
Metal production, more specific the iron and steel production (category 2C1) is actually the third most important sector of industrial process emissions in Belgium and contributed to about 33% in 2008 of total greenhouse gas emissions in this sector of industrial processes. But because of the economic crisis in 2009, this share was reduced to 21 % in 2022.

4.4.2 Methodological issues

4.4.2.1 Metal industry / Iron and steel production (category 2C1)

The category 2C1 includes the process emissions of CO_2 from the iron and steel sector (2C1a) and the emissions of CH_4 from sinter production (2C1d). The emissions from the use of limestone in the sinter factory are also allocated to the category 2C1d. Emissions from the use of electrodes are allocated to the category 2C1f. The emissions for casting of iron and processing of metals are also included in 2C1f The emissions from the solid fuels, the coke gas and the blast furnace gas are considered process emissions and are also allocated to the category 2C1a except for the emissions from the coke gas and the blast furnace gas that is used for energy purpose (boilers) or energy production, these emissions are reported in the categories 1A2a and 1A1a (energy emissions). The cokes gas used in the coking plants are allocated to the category 1A1c.

The change in re-allocation in the iron and steel sector - since the 2015 submission - is completely in line with the IPCC 2006 guidelines and ETS-reporting and much more transparent between the 2 regions in Belgium.

All activity data recorded in this sector (fluid steel, pig iron, sinter and cokes) originate directly from the companies involved.

As a request of the ERT during the UNFCCC in-country review in September 2018, the table “overview data from iron_steel.xlsx” is newly reported in annex 3 in this document. This table gives an overview of activity data (reported in 1A2a) and the emissions of CO_2 (in 1A2a and 2C1a) for the years 2013 to 2016 on the regional and the federal level.

The methodologies used to estimate the emissions of the iron and steel sector are described below for the 2 regions involved.

In the Flemish region, the emissions in the iron and steel sector are allocated according to the IPCC 2006 guidelines**.**

The biggest change in allocation, was made during the submission of 2015, is the move of the emissions from the solid fuels (cokes gas, blast furnace gas, cokes grid and anthracite) used for energetic as well as process purposes from the category 1A2a to the category 2C1a for the only big integrated steel plant in Flanders. Because ETS-data are not always transparent and mass balances are used to estimate their emissions, a distinguish between process and energetic emissions is not available. The other process emissions of the integrated steel plant (use of limestone in sinter factory) remain allocated in the same way as in previous submissions. The difference in the two allocations is made clear in table 4.7.

		1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016
kton CO2	*Emissions Liquid and Gaseous Fuels*	*672*	*508*	*688*	*625*	*412*	*377*	*368*	*408*	*404*	*451*	*474*
	Emissions Solid Fuels	*2702*	*2525*	*2975*	*3300*	*3203*	*3213*	*2987*	*811*	*800*	*750*	*904*
	Emissions Proces	*1046*	*1039*	*1035*	*1173*	*814*	*464*	*458*	*2863*	*2875*	*2837*	*3204*
Allocation Before 2015	*Energy (1A2a)*	*3373*	*3033*	*3662*	*3925*	*3615*	*3590*	*3355*	*1220*	*1203*	*1202*	*1379*
	IPPU (2C1)	*1046*	*1039*	*1035*	*1173*	*814*	*464*	*458*	*2863*	*2875*	*2837*	*3204*
Allocation Since 2015	*Energy (1A2a)*	*672*	*508*	*688*	*625*	*412*	*377*	*368*	*408*	*404*	*451*	*474*
	IPPU (2C1)	*3748*	*3565*	*4010*	*4473*	*4017*	*3677*	*3445*	*3674*	*3674*	*3588*	*4109*

Table 4.7: Re-allocation of the Sinter emissions during the 2015 submission in the Flemish region

The 2nd company involved in this category in the Flemish region produces stainless steel. The process emissions in this company are rather small. During the 2013 submission the methodology was optimized and made consistent with the ETS-reporting data. This more accurate methodology takes into account the consumption and the C-amount of all raw materials used and the C-amounts that remain in by- and end-products. Before the submission of 2013 the process emissions in this company were calculated on the basis of the production of fluid steel on the one hand with an overall emission factor of 1.11 – 1.17 %C, being the C-amount blowed off in the convertor. On the other hand, the consumption of electrodes is taken into account. The sum of both emissions of CO_2 was the total process emissions in this company.

Some more different methodology’s have been historically used in Flanders for the iron and steel production. In the start, the calculation of the process CO_2 emissions was based in general on the production figures of fluid steel and pig iron and on the consumption of electrodes of the two biggest industrial plants in this sector and with an emission factor approved by these plants (% carbon blown off in the convertor (1.11 to 1.17%) and an emission factor of 158 kg CO_2/ton pig iron).
During the 2011 submission the emissions of CO_2 of the biggest plant were completely revised and based on the ETS-methodology instead of C-balance-approach. The company involved did recalculate the historical emissions for the complete time-series based on the ETS-methodology.
This revision took place mainly because of inconsistencies in emissions between the GHG emission inventory and the emissions reported from the emission trading directive. Also, during the 2011 submission, the process emissions were completed with the use of lime directly and indirectly (via grinded ores & recovery products) in the sinter factory. These changes resulted in an increase of process emissions of CO_2.

The process emissions originate from:

(1) production of fluid pig iron and
(2) amount of lime used directly in the sinter factory to fix the alkalinity of the slags
(3) the amount of lime used (indirectly) in the grinded mixture (mixture of ores, recovery products, $MgCO_3$, $CaCO_3$, …) in the sinter factory as well.

In 2011, the company started installing a convertor gas installation in the steel plant for recuperation and valorisation of the convertor gas. Consequently, a shift from process to combustion emissions took place. As a result of the UNFCCC in-country review in September 2012, the process emissions originating from the use of limestone during the sinter manufacturing, were re-allocated to the category 2A3 instead of 2C1 before.

In the Walloon region, the last integrated iron and steel plant (blast furnace-oxygen furnace) was closed in 2011. An electric arc furnace was closed in 2013 and another in 2014. Currently, three electric arc furnaces are operational in 2021.

In the blast furnace, the iron was produced through the reduction of iron oxides (ore) with metallurgical coke (as the reducing agent) to produce pig iron. Steel is made from pig iron and/or scrap steel using basic oxygen furnace or electric arc furnace.
During the production of iron and steel, coke and coal were used as reducing agents in the blast furnace, resulting in the production of the by-product blast furnace gas. A small part of these gases was emitted by flaring and the rest were subsequently used as fuels for energy purposes in the integrated plant.
To estimate CO_2 emissions from the blast furnace and the basic oxygen furnace, all the carbon in the coke and the coal brought in the blast furnace is supposed to be converted to CO_2 and are considered as process emissions. These emissions are in the category 2C1a as they included the emissions from basic oxygen furnaces. The tier 2 methodology is used and a carbon balance is made. Carbon consumed in the form of blast furnace gas in boilers and the resulting CO_2 and CH_4 emissions are reported in the energy sectors. During this submission the C content of the steel produced in the basic oxygen furnaces was subtracted from the total CO_2 emissions.

Concerning the electric arc furnaces, CO_2 emissions have been obtained directly by the obliged reporting of the plants under the emission trading scheme. They take into account the carbon storage in the steel and also the emissions from burning electrodes and scrap iron. An average emission factor was estimated using the data from 2005 to 2010 and is applied for the complete time-series 1990-2004. As there is no change in the installations on this time serie, the consistency between the time-serie 1990-2004 and the years after is ensured. This average emission factor was calculated without the CO2 emissions from solid fuels. In 2003 and 2004, the global emission factor differs from the average emission factor because one plant performed a carbon balance of the furnace. The average emission factor was applied on the others plants. The CO2 emissions from coke and coal incoming in electric arc furnace are included in 2C1a. In the Walloon energy balance, this amount of coke and coal is in the energy part (and not in the non-energy use of fuel). Since 2005, the tier 3 methodology has been used. The amount of solid fuels used in the iron and steel sector (excepted solid fuels used in boilers) and the CO_2 emissions coming from the electric arc furnaces are presented in the table 4.8 for the Walloon region. Table 4.9 shows all data reported in the iron and steel category (category 2C1) in the Flemish region.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Pig iron production (kt)	5959	5738	5719	4782	5437	5672	5085	4352	4827	5012	4835
Steel production by basic oxygen furnace (kt)	6652	6518	6184	5388	5976	6133	5402	4490	5099	5076	4984
Solid fuels in the iron and steel sector (process) PJ	73.7	74.4	74.7	65.0	71.6	73.8	66.2	55.4	66.9	63.0	64.9
Steel production by electric arc furnace (kt)	692	660	602	901	1170	1143	940	1757	1651	1555	2171
CO_2 emission factor (kg/t steel) electric arc furnace	71.1	82.3	74.1	49.2	71.5	74.4	97.6	107.7	114.7	107.3	67.7
CO_2 emissions (kt) electric arc furnace	49.2	54.3	44.6	44.3	83.6	85.0	91.7	189.3	189.3	166.8	147.0
total CO_2 emissions (kt) in category 2C1	**4745**	**4748**	**4890**	**4091**	**4526**	**4513**	**4049**	**3204**	**4501**	**4038**	**4176**

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Pig iron production (kt)	4853	4298	4408	3908	3132	3197	2664	3290	337	874	779
Steel production by basic oxygen furnace (kt)	5058	4529	4576	4073	3139	3376	2885	3373	331	900	891

Solid fuels in the iron and steel sector (process) PJ	69.7	59.6	56.7	48.5	41.3	39.9	33.2	41.7	5.2	12.0	11.6
Steel production by electric arc furnace (kt)	2149	2406	2155	2087	1844	2584	2836	2569	1884	2162	2176
CO_2 emission factor (kg/t steel) electric arc furnace	75.3	99.3	104.4	92.6	108.8	82.9	82.1	83.8	75.3	76.9	72.1
CO_2 emissions (kt) electric arc furnace	161.8	238.9	224.9	193.3	200.7	214.3	232.7	215.3	141.9	166.3	156.9
total CO_2 emissions (kt) in category 2C1	**4400**	**3939**	**3673**	**3072**	**2570**	**2480**	**1987**	**2376**	**349**	**747**	**744**
CO2 solid fuels 1A2a → 2C1a (subm 2015)	**3603**	**3140**	**2864**	**2367**	1956	1856	1409	1758	164	468	477

	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Pig iron production (kt)	0	0	0	0	0	0	0	0	0	0	0
Steel production by basic oxygen furnace (kt)	0	0	0	0	0	0	0	0	0	0	0
Solid fuels in the iron and steel sector (process) PJ	1.2	0.5	0.4	0.5	0.47	0,51	0.652	0.542	0.485	0.508	0.383
Steel production by electric arc furnace (kt)	2222	1825	1778	1757	1583	1611	1656	1464	1233	1610	1313
CO_2 emission factor (kg/t steel) electric arc furnace	80	68.6	68.3	67.4	72.7	70	84	80	86.4	72.6	74.6
CO_2 emissions (kt) electric arc furnace	182	125.1	121.6	118.4	115.1	112.9	138.5	117.6	106.5	117	98
total CO_2 emissions (kt) in category 2C1	**182**	**125**	**122**	**118**	**115**	**113**	**139**	**118**	**107**	**117**	**98**

Table 4.8: Data reported in the iron and steel sector in the Walloon region (Source: plant specific /Icedd)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Pig iron production (kt)	3456	3598	2943	3295	3522	3526	3537	3715	3716	3698	3640
Steel production by basic oxygen furnace (kt)	3911	4052	3254	3639	3932	3933	4001	4137	4137	4221	4127
Sinter production (kt)	5267	5250	4461	4803	5260	5230	5160	5468	5541	5366	5601
Solid fuels in the iron and steel sector (process) PJ	66	57	47	49	62	61	62	64	67	64	65
Steel production by electric arc furnace (kt)	315	318	401	387	443	484	513	543	565	572	559
CO_2 emission factor (kg/t steel) electric arc furnace	41	41	41	41	53	53	54	52	50	50	51
CO_2 emissions (kt) electric arc furnace	13	13	16	16	24	26	28	28	28	29	28
total CO_2 emissions (kt) in category 2C1	3748	3566	3403	3505	3472	3565	3533	3588	3745	3677	4010

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Pig iron production (kt)	2816	3656	3406	4316	4054	4317	3914	3690	2751	3814	3892
Steel production by basic oxygen furnace (kt)	3137	4096	3907	4923	4616	5005	4511	4182	3044	4394	4470
Sinter production (kt)	4524	5752	5195	6300	6300	5800	6500	5336	3659	5248	5349

Solid fuels in the iron and steel sector (process) PJ	52	67	67	78	71	71	60	57	50	59	57
Steel production by electric arc furnace (kt)	521	525	770	913	865	935	795	793	491	677	613
CO_2 emission factor (kg/t steel) electric arc furnace	52	54	55	56	55	52	54	71	63	46	44
CO_2 emissions (kt) electric arc furnace	27	28	42	51	47	49	43	57	31	31	27
total CO_2 emissions (kt) in category 2C1	3285	4115	4074	5158	4473	4764	4238	4150	3124	4017	3677

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Pig iron production (kt)	4078	3892	4388	4247	4869	4934	4754	4934	3647	4199	4934
Steel production by basic oxygen furnace (kt)	4759	4470	5019	4899	5418	5602	5438	5602	4133	4568	5602
Sinter production (kt)	5044	5349	5041	4585	5230	5186	5456	5349	4775	5300	6334
Solid fuels in the iron and steel sector (process) PJ	55	64	63	60	69	68	67	67	49	56	60
Steel production by electric arc furnace (kt)	516	536	623	680	764	831	831	632	642	732	732
CO_2 emission factor (kg/t steel) electric arc furnace	42	42	45	40	46	40	34	40	37	35	31
CO_2 emissions (kt) electric arc furnace	22	22	28	27	35	33	28	25	24	25	23
total CO_2 emissions (kt) in category 2C1	3445	3674	3674	3588	4109	3925	3983	3807	2855	3356	3318

Table 4.9: Data reported in the iron and steel sector in the Flemish region (Source: plant specific/VMM)

The emissions from the **category 2C1b** are included in the category 2C1a.

The **category 2C1d** includes the emissions (CO_2 from limestone use and CH_4) which occurred during sinter production.

In Flanders the emissions of CH_4 originating from the production of sinter are completely revised during the 2006 submission and based on the information in the reference document of the Best Available Techniques of the sector iron and steel. Emissions of CH_4 are monitored since 2001.
Emissions of CH_4 occur since the switch of cokes grit into anthracite from 2004 on (because of environmental technical reasons). The volatile part in the fuel that is not completely incinerated causes these emissions of CH_4. Emissions of CH_4 in the years before 2001 are negligible, because no anthracite has been used in these years. Fluctuations in IEF of CH_4 in this category 2C1d originates from the emissions and AD reported by the Flemish region and are depending on the use of coke fines/coke slack or the use of anthracite in the sinter factory, depending on environmental technical reasons. The use of anthracite causes higher emissions of CH_4.
Emissions of CO_2 originating from the use of limestone, in the sinter factory to fix the alkalinity of the slags are allocated to the category 2C1d.

In the Walloon region, there is no longer a sinter plant. Since 1990, sinter production has declined sharply. In 1990, there were 4 sinter plants and the last sinter plant was closed in 2011.

Since the 2016 submission, the combustion emissions have been reported in the process sector. No recalculation was performed during this reallocation. A part of the emissions comes from the combustion of solid fuels in the sinter plant (1A2a), the process emissions from sinter (2A3) are allocated in 2C1d.

The reallocation for the year 1990 is presented in table 4.10.

Wallonia	1990
2014 submission	
Combustion emission (sinter) part of 1a2a (kt)	1161
Process emissions (sinter) in 2A3 (kt)	380.7
Total emissions	**1541**
2016 submission	
Sinter production (kt) 2C1d	8468
CO_2 total emissions (kt) 2C1d	**1541**

Table 4.10: Re-allocation of the Sinter emissions in 1990 during the 2016 submission in the Walloon region

Until 2002, the emissions are calculated by using an IPCC 2006 emission factor of 200 kg CO_2/ton sinter. The emissions calculated involved combustion and process emissions. Knowing the amount of coke and coke oven gas consumed in one plant, the process emissions were the difference between 200 kg CO_2/ton sinter and the emissions from the combustion. There is no double counting on the emissions. These process emissions are originating from additive in the furnace as limestone. From 2005 on, CO_2 emissions have been obtained directly by the obliged reporting of the plants under the emission trading scheme.
In the future, it will be difficult to make a recalculation for the complete time series due to the lack of necessary data. All these data are presented in table 4.11. The total IEF in 1990 and 1991 differs from 200 kg CO_2/t as the production of one "pelletization plant" is taking into account with no process emissions.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Sinter production (kt)	8468	7613	6417	5475	5325	6175	5188	5651	6219	6195	6568
IEF total (kg CO_2/kt)	197	170	200	200	199	200	200	200	200	200	200
CO_2 total emissions (kt)	1541	1209	1210	1022	1062	1235	1038	1131	1244	1239	1312
Solid fuels in the sinter production (process) TJ	11224	10501	9755	8112	6962	7566	6682	7603	8328	6991	9658

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Sinter production (kt)	6981	7481	7396	6494	5381	5370	4801	5227	435	1650	1516
IEF total (kg CO_2/kt)	200	213	214	212	219	213	223	213	208	240	211
CO_2 total emissions (kt)	1397	1594	1582	1376	1179	1142	1070	1111	91	396	320
Solid fuels in the sinter production (process) TJ	10572	8734	11700	11013	9392	8791	8097	8377	686	2912	2349

Table 4.11: Sinter production and related emissions of CO_2 in Wallonia (1990-2011)

The CH_4 emissions in the sinter production are calculated by using an IPCC 2006 emission factor of 0.07 kg CH_4/ton sinter. The emissions calculated involved combustion and process emissions.

Category 2C1f contains the emissions of CO2 originating from the use of electrodes in the stainless-steel plant in the Flemish region. Also, the emissions for casting of iron and processing of metals are included in this category.

4.4.2.2 Metal industry / Lead production (category 2C5)

In the Flemish region in Belgium there is either lead refining and no effective lead production in one of the companies in this sector and consequently the notation key 'IE is used in the CRT-tables during this submission. The reasoning about the change in notation key during this submission is that according to the 2006 IPCC Guidelines, emissions from lead purification should be reported in category 2C5. As it is not possible to distinguish these emissions into the category 2C5, these emissions are allocated to category 2C7. The lead production is only a small part of the total metal production of one company; therefore, it is still allocated at category 2C7.

4.4.2.3 Metal industry / Zinc production (category 2C6)

During the submission of 2021, the Flemish region reported emissions of CO_2 from the production of Zinc in the category 2C6 instead of the category 2C7 before. From 2013 on ETS-data are taken over. Emissions for the complete timeseries are asked to the company involved and are mainly based on monitoring. Emissions in 2021 accounts for 7,68 kton CO2.

4.4.2.4 Metal industry / Other (category 2C7)

Emissions of CO2 of the metal industry are taken over completely from ETS. Before 2013, the data were reported by the individual plants involved.

Emissions of 4 companies in the Flemish region are allocated here.

These companies have the following activities:

- secondary Cu-melting,
- Pb-refining and refining of precious metals resulting in intermediate products further processed in other companies or used in the construction industry,
- production of Cu (small emissions, up to max 1,5 kt CO2eq) and

Only two of these companies are responsible for +/- 95% of the emissions of CO_2 in this category. The emissions are reported from ETS data.

4.4.3 Uncertainties and time-series consistency

The uncertainty on activity data is estimated at 2% because these figures come directly from the companies which dispose of good developed statistical systems. The uncertainty is assumed to be in the low range of IPCC values as the emission factors are mainly plant-specific.

4.4.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided by the Belgian experts on request.

The calculation of the CO_2 process emissions in Belgium follows mainly the guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to the ETS Directive 2003/87/EC.
The emissions are verified each year by an external agency.

Validation/control checks are made between data reported in the regional ETF-GHG databases and the emission trading data.

4.4.5 Source-specific recalculations, if applicable, including changes made in response to the review process

No recalculations occurred in category 2C during this submission.

4.4.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

No improvements are planned in the category 2C in the Belgian greenhouse gas inventory in the near future.

Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

4.5 Non-energy Products from Fuels and Solvent Use (CRT 2.D)

4.5.1 Source category description

In the category 2D, the CO_2 emissions from the use of lubricants (2D1), paraffin wax (2D2), and from urea used as catalyst (2D3) are reported.

The emissions of NMVOC in the source category 2D3 (Solvent use) include paint application (building industry, households and road markings), production of medicines, paints, inks and glues, domestic use of other products (incl. glues and adhesives), coating processes in general (incl. assembly of automobiles), printing industry, wood conservation, treatment of rubber, recuperation of solvents, extraction of oil, cleaning and degreasing and dry cleaning.

No estimation of the indirect CO_2 emissions in this category is carried out in Belgium.

4.5.2 Methodological issues

4.5.2.1 Lubricant use (category 2D1)

The total consumption of lubricant originates from the national statistics and is determined by an annual survey about fuel consumption. Activity data and emissions according to the different uses of lubricant are determined as follows:

- Lubricant used as “fuel” in 2-stroke engines: activity data and CO_2 emissions are calculated using COPERT 5.7.3 (tier 3)
- Lubricant used as “lubricant” in 4-stroke engines : activity data and CO_2 emissions are calculated using COPERT 5.7.3 (tier 3)
- Lubricant used as “lubricant”, except in 4-stroke engines:
    - Activity data = Total consumption of lubricant - Lubricant used as “fuel” in 2-stroke engines - Lubricant used as “lubricant” in 4-stroke engines
    - Emissions of CO_2 are estimated on the basis of the Tier 1 approach of the IPCC Guidelines

The emission factor for lubricant use (except for 4-strokes engines calculated with COPERT 5.7.3 is calculated with a carbon content of 20 kg C/GJ and with an oxidation fraction of 0,2. This is in line with the IPCC 2006 guidelines as illustrated below:

CO_2 emissions (t) = LC * CC * ODU * (44/12) (IPCC 2006, vol.3, eq.5.3)
(vol.3, eq.5.3) http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_5_Ch5_Non_Energy_Products.pdf

LC = AD (TJ) : BEN, lubrifiant industrie + lubrifiant solde

CC (kg C/GJ = t C/TJ) : 20
(vol.1, table 1.3) http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

ODU (oxydation fraction) : 0.2
(vol.3, table 5.2) http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_5_Ch5_Non_Energy_Products.pdf

4.5.2.2 Paraffin wax use (category 2D2)

The IPCC tier 1 methodology is used to estimate the emissions of the use of paraffin wax.

The activity data of non-energy products are collected from the national energy statistics.

The emission factor is calculated with a carbon content of 20 kg C/GJ and with an oxidation fraction of 0,2.

4.5.2.3 Other (category 2D3)

The emissions of CO_2 from the **category 2D3** (urea used as a catalyst in road transport/diesel engines from 2005 on) are estimated by using the updated 5.7.3 software version during this submission.

For the other categories of 2D3 (CO_2 from asphalt roofing and CO_2 from road paving) the greenhouse gas emissions are negligible since the majority of the light hydrocarbon compounds were extracted during the refining process to produce commercial fuels.

Considering the category "solvent use", no estimation of the indirect CO_2 emissions in this category is carried out in Belgium. In accordance with the UNFCCC Annex I inventory reporting guidelines, Parties are not obliged to report these indirect emissions (§29 decision 24/CP.19 : Annex I Parties may report indirect CO_2 from the atmospheric oxidation of CH_4, CO and NMVOCs" and "For Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2"). Discussions with experts during previous reviews showed a large uncertainty in the estimations of these emissions. Regarding the available resources in terms of staff and budgets, this is evaluated as not being a priority in the improvement process of the inventory."

4.5.3 Uncertainties and time-series consistency

The uncertainty on activity data and emission factor is estimated at 5%.

4.5.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided by the Belgian experts on request.

4.5.5 Source-specific recalculations, if applicable, including changes made in response to the review process:

Recalculations of the emissions in this category 2D due to the use of an updated version of the COPERT 5.7.3 software for the calculation of the emissions of road transport. Emissions from the use of lubricants and from de use of urea as a catalyst have been updated accordingly.

4.5.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

No specific planned improvements are foreseen in the category 2D in the near future.
Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

4.6 Electronics industry (CRT 2.E)

4.6.1 Source category description

In this category the F-gas emissions of the electronics industry are reported, which are divided into two sub-categories: Semiconductor industry and Heat transfer fluids. Overall, it is only a minor emission source.

4.6.2 Methodological issues

For the semiconductor industry, there are only manufacturing emissions. The emission figures reported in the inventory are those directly obtained from the relevant companies of the sector. Activity data, represented by the purchase of the corresponding greenhouse gases, have also been obtained from the companies, so that implied emission factors can be calculated. However, as there are only two companies, the activity data, and hence also the implied emission factors, have been kept confidential. One company uses a fixed emission factor, while the other company calculates emission factors based on quantities before and after scrubbing.

4.6.3 Uncertainties and time-series consistency

Given the lack of statistical data and of default values in the IPCC guidelines and considering the very low emission level (about 0.01% of total CO_2-eq emissions) a conservative estimate of 100% has been used for the emission factor uncertainty (all the uncertainty is encoded in the emission factor).

The uncertainties of emissions for the fluorinated gases are described in detail in the references (33) for the years 2015, 2018 and 2019

And the reference (34) where the methodology (basis) used for the uncertainty analysis was described in detail in the update for the year 2004.

4.6.4 Source-specific QA/QC and verification, if applicable

Standard QA/QC and verification activities take place.

4.6.5 Source-specific recalculations, if applicable, including changes made in response to the review process

No specific recalculations were performed for category 2E.

4.6.6 Source-specific planned improvements, if applicable, including those in response to the review process

No source-specific improvements have been planned yet for the future submissions.
Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

4.7 Product uses as substitutes for ODS (CRT 2.F)

4.7.1 Source category description

In this category mainly HFC emissions from refrigeration and air conditioning are reported. Other sources are foam blowing, fire protection and aerosols.

4.7.2 Methodological issues

For estimating the emissions of the F-gases described in annex A to the Kyoto Protocol (hydrofluorocarbons HFCs, perfluorocarbons PFCs, sulphur hexafluoride SF_6), a country-specific methodology was developed by 2 consultancies (ECONOTEC and ECOLAS) in 1999 based on the IPCC Guidelines (35) (10) (9) (1) and updated every year and further optimised by ECONOTEC in collaboration with the VITO (33).

No systematic emission inventories of fluorinated greenhouse gases were made for the years 1990-1994, because it is difficult to obtain reliable information for this period. However, Belgium did try to estimate the F-gas emissions for these years as accurately as possible (see CRT-tables): the emissions of the chemical process industry, which represent 89% of the total fluorinated GHG emissions in 1995, are known for the complete time series. For the years 1990-1994, the emissions of the remaining sources (11% in 1995) were assumed constant and equal to their level of 1995, except for the years in which the corresponding gas is known not to have been available, in which case the emissions have been put to zero. As a result, the Belgian emission inventory of fluorinated gases from 1995 to 2018 can be considered as time consistent for the complete time series.

The emissions are mainly estimated on the basis of: the consumption of the different substances for each application, the consumption of products containing such substances, figures on external trade in substances or products containing substances, as well as on emission modelling by application and assumptions on leakage rates.

The emissions come from the following categories: refrigeration (industrial & commercial and household refrigerators) and air conditioning equipment (in stationary applications and in vehicles), foam blowing (closed cell foams, polyurethane cans and foams in refrigerators/freezers), fire protection and aerosols (Metered Dose Inhalers (MDI) and other aerosols).

4.7.2.1 Refrigeration and air conditioning (category 2F1)

For the refrigeration sector, emissions have been estimated separately for the following source categories: industrial & commercial refrigeration installations, household refrigerators, hermetic commercial refrigerators, stationary air conditioning (chillers, movables, room air conditioners), heat pumps, air conditioning of private cars, air conditioning of buses and coaches, trucks air conditioning and passenger rail transport air conditioning. In accordance with the IPCC guidelines, the assembly emissions, the operation emissions and the disposal emissions are being determined separately. For each substance, the assembly emissions are calculated as a function of the estimated amount charged into new systems and the percentage assembly losses, the operation emissions as a function of the amount stocked in existing systems and assumptions on annual leakage rates, and the disposal emissions in function of the amount in systems at time of disposal and the estimated recovered fraction.

An annual inquiry is made on the consumption of the major F-gas containing product manufacturers, among which the 2 car manufacturers.

The HFC emissions from household refrigerators (which are imported) are rather negligible. They have been calculated separately for the 3 regions together with the emissions of CFCs and HCFCs from these applications. Emissions from imported hermetic commercial refrigerators (which are also imported) have been calculated in the same way and are reported under source category 2F1a Commercial refrigeration.

Industrial and commercial 'installations' represent all on-site assembled systems for industrial & commercial refrigeration as well as stationary air-conditioning applications. They represent the largest single source of F-gas emissions and are also reported under 2F1a ‘Commercial refrigeration’. The stock and the emissions of refrigerants are modelled using a mass-balance approach, on the basis of the annual supply of refrigerants. The latter is obtained from an annual survey among refrigerant suppliers on their national supply of each refrigerant mixture. The estimated supply for refilling stationary air conditioning equipment, refrigerated transport and mobile air conditioning is subtracted. Assumptions are made on the average loss rates. No distinction is made between industrial and commercial refrigeration installations, as it is not possible to disaggregate the consumption data between these sub-sectors, because of the presence of intermediary wholesalers, and the fact that no inventory of installations is available.

From the annual surveys, a regular decline can be observed in the total supply (in tonnes) of F-gas refrigerants since 2006, with a total decrease of 64% over the period 2006-2022. This trend, resulting from higher refrigerant prices, policy measures, and technology alternatives and improvements, has started well before the implementation of the EU F-gas Regulation 2015. For the years 2014-2017 the supply lies even slightly above, rather than below, the average trend. For commercial and industrial refrigeration, as no data are available for estimating annual changes in product life factors, a simple hypothesis has been made, which is that of a constant annual decrease in the product life factor for HFCs of 3.3% per year since 1996 (originally an exponential decrease from 20% in 1996 to 15% in 2003 when air conditioning chillers were included).

Box Why Belgium does not disaggregate between industrial and commercial refrigeration.

Source category 2F1 ‘Refrigeration and air conditioning’ is a key category. For such a category, the IPCC Guidelines require, in section 7.5.2.1, that the emissions be estimated by sub-application for six sub-applications (domestic refrigeration, commercial refrigeration, industrial refrigeration, transport refrigeration, stationary air conditioning, mobile air-conditioning). The emissions for only five sub-applications are quantified, industrial and commercial on-site assembled refrigeration installations are not split because of a lack of data. In its Annual Review Report of the 2018 submission, the Expert Review Team of the UNFCCC has recommended that Belgium “make efforts to collect data separately for commercial and industrial refrigeration applications following a Tier 2a approach in accordance with the 2006 IPCC Guidelines”. On the Decision tree of Fig. 7.6, the IPCC Guidelines do indeed recommend Tier 2a (even when country-specific emission factors are not available). However, this is in contradiction with their statement on page 7.48 (“The mass-balance approach is particularly applicable to the Refrigeration and Air Conditioning application because of the significant servicing component required to maintain equipment”), as well as with chapter 1.5 ‘Choosing between the Mass-Balance and Emission-Factor approaches’, of which Table 1.7 (see below), clearly shows that the Mass-Balance approach (Tier 2b) is to be preferred to the Emission-Factor approach (Tier 2a) in this case, given that emission rates vary across facilities and are much higher than 3%.

TABLE 1.7
CHOOSING BETWEEN THE MASS-BALANCE AND EMISSION-FACTOR APPROACHES

Mass-Balance Approach	Emission-Factor Approach
How it works: Tracks the amount of new chemical introduced into the country or facility each year, accounting for gas that is used to fill new equipment capacity or to replace destroyed gas. The consumption that cannot be accounted for is assumed to be emitted or to replace emitted gas.	**How it works:** Equates emissions to the product of an emission factor and either (1) the nameplate capacity of the equipment that uses or holds a chemical, or (2) the bank of a chemical. (These quantities are similar but not necessarily identical.)
Level of aggregation: Both the mass-balance and the emission-factor-based approaches can be applied at several levels of aggregation. For electrical equipment, these include the country, the facility, and the lifecycle stage of the equipment at the facility. For refrigeration, air-conditioning and fire-protection equipment, they include the application, sub-application or further-disaggregated equipment types..	
More accurate where: • Emission rates vary across facilities and/or equipment, and to some extent, over time • Process emission rates are above 3%/year • Equipment is refilled frequently • Equipment stock is growing slowly • Equipment containing HFCs, PFCs, or SF_6 has been in use in the country for at least as long as the typical time between refills for that equipment. ○ 10-20 years for electrical equipment ○ 5-20 years for air-conditioning and refrigeration equipment	**More accurate where:** • Emission rates are fairly constant within defined types of equipment and/or facilities • Process emission rates are below 3%/year • Equipment is rarely or never refilled • Equipment stock is growing quickly • Equipment containing HFCs, PFCs, or SF_6 has been in use in the country for less than the typical time between refills for that equipment. ○ 10-20 years for electrical equipment ○ 5-20 years for air-conditioning and refrigeration equipment
Other considerations: In the long run, this approach will reflect actual emissions, but there may be a significant time lag (in some cases, 20 years or more) between emissions and their detection.	**Other considerations:** Emission factors should be periodically checked to ensure that they remain consistent with reality.

The Mass-Balance approach applied is based on the total yearly sales of refrigerants in the country by type of refrigerant, from which the estimated consumptions of the four other sub-applications are subtracted. Unfortunately, it is not possible to disaggregate the sales data between commercial and industrial refrigeration, because of the presence of intermediary wholesalers on the market.

Applying approach Tier 2a would imply a huge number of assumptions on very uncertain parameters by equipment type, number of equipment items, average charge (for wide capacity ranges), emission factors, refrigerant shares, lifetime, retrofits, gas recovery, etc., over a long past period in a rapidly changing world. It would mean losing the consistency with the refrigerant sales and hence the accuracy of overall emissions.

The disposal emissions have been calculated using equation 7.14, page 7.51 of the 2006 IPCC Guidelines for National GHG Inventories:

EQUATION 7.14
EMISSIONS AT SYSTEM END-OF-LIFE

$$E_{end-of-life,t} = M_{t-d} \bullet \frac{p}{100} \bullet (1 - \frac{\eta_{rec,d}}{100})$$

where:

$E_{end-of-life,t}$ = amount of HFC emitted at system disposal in year t, kg
M_{t-d} = amount of HFC initially charged into new systems installed in year (t-d), kg
D = lifetime
p = residual charge of HFC in equipment being disposed of expressed in percentage of full charge, percent
$\eta_{rec,d}$ = recovery efficiency at disposal, which is the ratio of recovered HFC referred to the HFC contained in the system, percent

The calculation is made for all industrial and commercial refrigeration installations. The lifetime is assumed to be 15 years, which is an average.

The recovery efficiency of disposal for these installations is assumed to be 25%, except for the disposal from retrofitting, for which it has been assumed to be 50% (as the recovery is more likely to be carried out by certified technicians). This figure is justified as follows. Figures on recovery of fluorinated gases are available from surveys among the companies authorized to collect such gases, carried out annually by ECONOTEC-VITO in the framework of the updating of the F-gas emission inventory. The main reason why these figures have not been used directly for calculating disposal loss factors (ratios “disposal emissions”/”amount in systems at time of disposal”) is that the “amount in systems at time of disposal” is only estimated by modelling, based on simplified assumptions (such as a common lifetime of installations, equal to the average lifetime). If the annual data of recovered fluorinated gases were used, the calculation would sometimes lead to unrealistic values of disposal loss factor for individual years (e.g. larger than 100%). However, an order of magnitude of disposal loss factor can be obtained by comparing the sum over time of the recovery figures with the sum over time of the “amount in system at time of disposal”. For HFCs, this average recovery rate, calculated over the period 1998-2022 for commercial and industrial refrigeration as well as stationary air conditioning, amounts to 24.6%.

Belgium manufactures cars, buses & coaches, and trucks. The emissions from filling the manufactured vehicles are calculated based on data obtained from each manufacturer. For source category 2F1e (Mobile Air-Conditioning), the product manufacturing factor for HFC-134a increased from 1.2% (2017) to an all-time maximum at 5.4 % in 2019. Given the price increases for HFCs in recent years it may seem surprising that emission factors during production did not remain stable or decrease. We receive data from all manufacturers on the quantities purchased and filled into manufactured cars, which results in a difference between our approach and the losses that occur from filling only (which tend to be very low). We used the conservative approach for the emission inventory. It is not clear what all underlying reasons for these differences are, but in 2018 for example there was an incident in one factory, resulting in the leakage of relatively high quantities of R134a.

The refrigerant consumption and emissions of the vehicle stock in the transportation sector are estimated by modelling the evolution of the vehicle stock, on the basis of the number of new vehicle registrations and of the percentage of new vehicles equipped with air conditioning, by category of vehicles. The emissions are modelled separately for cars, buses and coaches, trucks air conditioning, refrigerated transport and passenger rail transport, but the structure of the models is principally the same. Both fugitive and disposal emissions are considered. For cars, which is the most important source, the model uses:

- the annual new registrations: this is the total number of new registrations, as there is no distinction between cars with and without air conditioning
- the percentage of new registrations with air conditioning: this is not constant throughout the entire time series but is since 2010 96% which we assume as a plateau. This percentage is

multiplied with the number of registrations to calculate the number of new cars with air conditioning.

- the average quantity of R134a in car air conditioning of new cars, this is also not constant throughout the time series and decreases to reflect technological development.
- an average life expectancy of cars (11 years).

These input variables are used to assess the stock of cars and the bank of R-134a contained in cars, for each year. The fugitive emissions are calculated based on an annual emission factor (including both regular and irregular loses) applicable to all cars and loses resulting from recharging the air conditioning system, which is assumed to take place every four years (i.e. when cars are 4 and 8 years old).

There is no systematic survey concerning the fraction of new car registrations with air conditioning in Belgium. However, the Federal Public Service of Mobility in collaboration with GOCA (association of the companies carrying out the technical control of automobiles) has performed an inquiry in October 2005 which has resulted in an estimate for several years of the percentage of new cars having air conditioning. The results of this inquiry have been used as a basis in the calculations of the emissions together with data from Germany for the more recent years.

The emissions from refrigerated transport are calculated on the basis of the annual number of new registrations of refrigerated trucks and trailers by gross / net weight categories, the average quantity of refrigerant (by type of refrigerant) contained in each vehicle (by vehicle category) and emission factors taken from the literature. Based on information from industry, the product life factors have been assumed to decrease from 25% in 2014 to 10% since 2017. The lifetime assumed is 12 years, the same as for refrigerated trucks (statistics on the number of new trucks each year are used to estimate the size of the stock; there are also statistics on the total size of the stock, but they are not complete, as it is not always registered whether a truck is refrigerated or not; the results from the modelled approach and the statistics are in line with one another and differences are not large).

The lifetimes assumed by sub-application are given in the table below.

2F1a	Commercial refrigeration installations	15
2F1b	Commercial cooling sealed	10
2F1b	Domestic cooling	15
2F1d	Refrigerated transport	12
2F1e	Bus	17
2F1e	Coach	17
2F1e	Cars	11
2F1e	Train	40
2F1e	Trucks	12
2F1f	RAC < 7 kW	15
2F1f	RAC > 7kW	15
2F1f	Chillers	15
2F1f	HP boilers	15
2F1f	Movable AC	15

Table 4.12: Assumed lifetimes by sub-application for source category 2F1

Expressed in tonnes CO2-eq, the total source category 2F1 emissions[15] per inhabitant exceed those of EU-28[16] by 29% in 2010 and by 35% in 2019, which shows that they are not underestimated. Given the large spread between countries, it cannot be concluded that they are significantly overestimated.

[15] From the 2021 Submission to UNFCCC
[16] EU-27 + UK by 29%.

4.7.2.2 Foam blowing agents (category 2F2)

For the foam sector, the modelling of emissions is based on an annual inquiry among the foam manufacturers on their consumption of blowing agents, and on assumptions on emission rates for manufacturing and product use, as well as on external trade, by type of insulation foam.

Two types of closed cell foam are taken into consideration: extruded polystyrene foam and polyurethane foam (panels or blocks). The emissions from closed cell foams are calculated from:

- the annual consumptions of F-gases by the manufacturers;
- assumptions on assembly emission factors;
- assumptions about the relative share of external trade;
- assumptions about the emission factors from the foam bank.

The end-of-year bank of F-gases is calculated annually, by substance, from the end-of-year bank of the year before, the quantity added to the bank and the emission from the bank.

The figures for the consumption of foaming agents used to be obtained from Federplast.be (Belgian Association of Plastics and Rubber Converters), separately for the manufacture of polyurethane foam (PUR), One-Component-Foam (OCF) and extruded polystyrene (XPS). For 2013 and the subsequent years they were obtained directly from the companies or from the official emission reporting by the companies.

Belgium is a large producer of polyurethane cans (‘one component foam’) and its production is almost completely exported. However, emissions of HFCs from this sector, which arise both during manufacturing and as a result of their use, have been drastically reduced since 2008, as EU Regulation 842/2006 and EU Regulation 517/2014, which replaced it, have prohibited the sale in the EU of ‘one component foams’ containing mixtures with a GWP of 150 or more, except when required to meet national safety standards. The emissions during manufacturing are based on data obtained from the manufacturer. The residual emissions of HFCs contained in polyurethane cans sold in Belgium are based on per capita data for Germany.

The foam of domestic refrigerators and freezers contains HFC245fa. The emissions have been evaluated but are rather negligible.

4.7.2.3 Fire protection (category 2F3)

For fixed fire extinguishing installations, an annual questionnaire is being sent out since 2005 to the companies that install such systems in Belgium, asking for their consumption of HFCs (HFC 227ea and HFC 125). For the emissions from the stock an emission factor of 3% has been considered up to 2010. Since then, a value of 2.5% has been taken, because of a decreasing trend. Manufacturing emissions have been estimated based on an emission factor of 0.1%, taken from a study[17] and based on data from the leading German installer and filler, as well as from company experts. Assuming a 20 years lifetime, disposal emissions appear for the first time in 2013.

4.7.2.4 Aerosols (category 2F4)

The emissions resulting from the consumption of metered dose inhalers (MDI) are based on the data on annual sales of MDIs in Belgium that were obtained from the specialised market research firm IMS Health, both in terms of number of units and number of doses. The emissions are estimated on the basis of the type of gas used in each pharmaceutical product (taken from the Compendium of AGIM) and on assumptions on the quantity of fluorinated gas per dose. CFCs have now completely disappeared from the market.

As far as other aerosols are concerned, the former CFC aerosol market has practically completely moved to alternative propellants than fluorinated gases, essentially hydrocarbons. However, in the technical aerosol sector there are some applications for which it is inappropriate, usually for safety reasons, to use hydrocarbons, and manufacturers have switched to HFCs (generally HFC 134a) as a

[17] Schwarz W. 2005. *Emissions, Activity Data and Emission Factors of Fluorinated Greenhouse Gases(F-gases) in Germany 1995-2002*. Research Report 201 41 261/01. Federal Environmental Agency (Umweltbundesamt).

safe alternative. The emissions during production have been estimated on the basis of HFC consumption data obtained through Essenscia, the professional association of the chemical industry. The scarcity and diffused character of this emission source makes it difficult to quantify the emissions during use. Estimates of the latter have been based on data for Germany.

4.7.3 Uncertainties and time-series consistency

The main emission source is the application of distributed refrigeration systems (refrigeration plants in industry and the commercial sector, as well as air conditioning plants that are built and filled with refrigerant on site). The emissions are calculated as the product of the bank (activity variable) and the emission rate (emission factor). The size of the bank itself is calculated on the basis of past refrigerant deliveries and assumptions on the emission rate. Therefore, the activity variable and the emission factor are correlated.

Because of this correlation, the uncertainty has been assessed globally, and this in particular by carrying out sensitivity analyses on the impact of the emission rate on the emissions, using the emission calculation model.

For the remaining emission sources, the uncertainty has in general been estimated separately for the activity variable and for the emission factor. Given the lack of statistical data and default values in the IPCC guidelines, the figures are generally based on expert judgement.

The uncertainties of emissions for fluorinated gases are described in detail in the references (33) for the years 2015, 2018 and 2019

And the reference (34) where the methodology (basis) used for the uncertainty analysis was described in detail in the update for the year 2004.

4.7.4 Source-specific QA/QC and verification, if applicable

Standard QA/QC and verification activities take place.

4.7.5 Source-specific recalculations, if applicable, including changes made in response to the review process

For category 2F, the following recalculations have occurred for the period 1990-2021:

CRT code	CRT source category	Period	Nature of the recalculation	Impact for CRT gases in 2021 (in kt CO2-eq.)
2.F.1.a.	Commercial refrigeration	2006-2021	Adjustment refilling quantities for other applications	0,67
2.F.1.e.	Mobile air-conditioning	1997-2021	Statistics other vehicles updated on INS.	2,33
2.F.1.f.	Stationary air-conditioning	2006-2021	Update assumptions refrigerants used based on detailed statistics Frixis	-13,68
2.F.2.a	Closed cell foam	2021	Small error correction	0
2.F.4.b.	Technical aerosols	2021	Adjustment based on latest German inventory. Adjustment emissions 1990-1994.	0.92
Total		**1997-2021**		**-9,76**

4.7.6 Source-specific planned improvements, if applicable, including those in response to the review process

No source-specific improvements have been planned yet for the future submissions.
Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

4.8 Other Product Manufacture and Use (CRT 2.G)

4.8.1 Source category description

In this category 2G, the N_2O emissions from product uses are reported, as well as the SF_6 emissions from electrical equipment, soundproof windows and sport shoes.
The SF_6 emissions originating from SF_6-insulated particle accelerators are those reported by one company for the years 2020-2022 and included for the first time during the 2024 submission. The emissions occur during maintenance of the electron particle accelerator which results in losses of small quantities of SF6. The emissions are assumed to be the same as the annual quantities of SF6 needed for refilling.

4.8.2 Methodological issues

4.8.2.1 Electrical equipment (category 2G1)

SF_6 emissions from the electricity sector are small (8.6 kton CO_2-eq in 2019). In Belgium there is no manufacturing of electrical equipment containing SF6. Therefore, only emissions resulting from the installation of new equipment on site have been considered as “Manufacturing emissions”, for which a conservative emission factor of 1% has been used. In a study specifically on the subject[18], which is referred to in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines), installation emissions are included in the manufacturing EF, which is estimated at 3% in 2003. As most of the manufacturing emissions occur at the production plant, it seems conservative to allocate one third of the emissions to the installation site (i.e. to consider an EF of 1% for emissions during installation). As no activity data were available for the years 1990-2008, an order of magnitude was estimated as follows. The “amount of fluid filled into new manufactured products” for the years 1990–2008 was estimated as the difference between the “amount of fluid in operating systems” for the current year and the “amount of fluid in operating systems” for the previous year. The actual emissions were then estimated by applying an EF of 1 per cent, as for the years 2009–2012.

Emissions from stock are based on figures respectively provided by the production sector (source: FEBEG), the transport sector (ELIA) and the distribution sector (source: SYNERGRID). For 2020, the corresponding emission factors are 0.11%, 0.22% and 0.03% respectively. As the equipment lifetime is assumed to be 40 years (36) disposal emissions have started in 2016 for the transport sector and will only start in 2034 for the distribution sector, except for those of one significant plant in the transport sector that has been dismantled in 2011.

4.8.2.2 SF_6 and PFC from other product use (category 2G2)

<u>2G2b Particle accelerators</u>

The SF_6 emissions originating from SF6-insulated particle accelerators are those reported by one company for the years 2020-2022 and reported for the first time during the 2024 submission. The emissions occur during maintenance of the electron particle accelerator which results in losses of small

[18] Wartmann S and Harnisch J. 2005. *Reductions of SF6 Emissions from High and Medium Voltage Electrical Equipment in Europe.* Final Report to CAPIEL, Ecofys 28 June 2005.

quantities of SF6. The emissions are assumed to be the same as the annual quantities of SF_6 needed for refilling.

2G2c soundproof windows

The SF_6 emissions originating from the production and the stock of soundproof double-glazing are calculated from the SF_6 consumption data, which have been obtained from the main manufacturers. The stock of SF_6 contained in existing glazing in Belgium is evaluated on the basis of a balance between production, import, export, annual losses and disposal of this glazing over the years. From information obtained from the double-glazing producers we assessed a specific export rate for each of them. The import of acoustic double glazing was estimated to be around 10% of the Belgian consumption. The emission rate from the bank is assumed to be 1%/year. The emissions from production have now disappeared, notably as a result of EU Regulation 842/2006. The disposal emissions are based on an assumed unique lifetime of 25 years.

2G2d adiabatic properties: shoes and tyres

For the emissions of SF_6 from sport shoes, it was assumed that there were no fugitive emissions from leakage. The lifetime of the shoes was estimated at 3 years, after which the entire quantity of gas contained in the soles is assumed to have been emitted to the atmosphere during disposal (disposal emission factor of 100%). Emissions of both SF_6 and C_3F_8 (PFC-218) have been estimated.

2G2e SF_6 from other product use: other

This category corresponds to small laboratory uses of C6F14, for which the consumption data has been obtained from the gas supplier and for which it has been assumed that emissions equal consumption (manufacturing emission factor of 100%).

4.8.2.3 N2O from product uses (category 2G3)

2G3a medical applications

Since 2005, the emission calculation for the emission of N_2O from anaesthesia is based on the sales of medical N_2O obtained from Essenscia - Industrial gases. It has been assumed that all of the nitrous oxide sold for medical use is eventually released to the atmosphere (emission factor of 1 kg/kg).

The emission calculation from 1990 to 1995, is based on the number of hospital beds and the average consumption of anaesthetics per bed (10,3 kg N_2O/bed/year). This factor was determined by inquiries carried out in 1995 by the independent consultant agency ECONOTEC. It has been assumed that all of the nitrous oxide used for anaesthetics will eventually be released to the atmosphere. The number of beds used for the emissions calculations was obtained from the Health Public Federal Service. For the years 1996 to 2004, an interpolation has been performed between the data of 1995 and 2005.

2G3b Other (propellant for pressure and aerosol product)

The N_2O emission from aerosol cans are newly estimated on the basis of the average consumption in the European Union (number of food aerosol can/inhab - average for 28 Member States = 0,585 can/inhab) obtained from DETIC (Belgian-Luxemburg Association of producers and distributors of soaps, cosmetics, detergents, cleaning products, hygiene and toiletries, glues and related products) for the year 2017. The previous average consumption data received for the year 2012 (number of food aerosol can/inhab - average for 18 Member States = 0,32 can/inhab) was underestimated. Because of a lack of activity data, DETIC recommends to use the average European consumption in 2017 as activity data for the all-time series. The emission factor for N_2O of 7,6 g/can has been actualized by DETIC in 2017 after exchanges with a big European producer. The content of N_2O per can has decreased to 6,3 g/can. This decreasing in the N_2O content of the cans is due to the fact that the companies use mixtures of N_2O/N_2 instead of pure N_2O in the cans. This figure also takes into account the different volumes of the cans (250, 500 and 700 ml). A linear evolution from 7,6 g/can in 2012 to 6,3 g/can in 2017 is used, as recommended by DETIC.

4.8.3 Uncertainties and time-series consistency

The uncertainties of emissions for the fluorinated gases are described in detail in the references (33) for the years 2015, 2018 and 2019

And the reference (34) where the methodology (basis) used for the uncertainty analysis was described in detail in the update for the year 2004.

2G3a N_2O emissions from anesthesia

Before 2005, the activity data is the number of hospital beds, which is well known. The uncertainty of the emission factor estimated through surveys in hospitals is considered high.

Since 2005, the sales of medical N_2O have been used to calculate the emissions. Consequently, the uncertainty for this sector has been reduced.

Due to the "CEFIC Statistical rules" (that help comply with Competition Law), the regional data could however no longer be released from 2015 data on.
As a consequence, only consolidated Belgium data could be received from Essenscia. The repartition between the regions since 2015 is based on the regional repartition given by Essenscia in 2014. The regional repartition of the N_2O emissions from anaesthesia (2G3a) for the years 2011 and 2012 is based on the regional repartition given by Essenscia in 2010 in order to ensure consistency in the regional time series.

2G3b N_2O emissions from aerosol cans.

As the activity data (number of cans) is estimated on the basis of the average European consumption, the uncertainty is considered high.

4.8.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories only and can be provided by the Belgian experts on request.

4.8.5 Source-specific recalculations, if applicable, including changes made in response to the review process

For category 2G recalculations only arise from the fact that for 2G2b Particle accelerators emissions were included for the period 2020-2022.

CRT code	CRT source category	Period	Nature of the recalculation	Impact for CRT gases in 2021(in kt CO2-eq.)
2.G.2.b.	Particle accelerators	2020-2022	Inclusion of emissions	6,23

4.8.6 Source-specific planned improvements, if, including those in response to the review process

No specific planned improvements at this moment are provided in the category 2G for the next submission.

Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

4.9 Other (CRT 2.H)

4.9.1 Source category description

In this category 2H, the CO_2 emissions from the pulp & paper industry are reported.

4.9.2 Methodological issues

The reported CO_2 emissions in this category comes from the pulp & paper industry in the Flemish region (activity since 2003 when a new installation for the combustion of sludge was build). The reported data are completely taken over from the ETS-reporting.

The company reports process emissions (19,71 kt CO2 in 2021) in category 2H coming from the C-content in the raw materials used in this paper industry i.e.

1) the use of Na-bicarbonate as an additive for the cleaning of the flue gas that decomposes after adding HCl into CO_2, H_2O and NaCl and
2) sludge is a waste product of the paper company, also named 'paper sludge'. The sludge contains $CaCO_3$ (ash component) and is decomposing at high temperature into CO_2 and CaO. This CaO can be used a.o. for ground stabilization.
These emissions are clearly not caused by a combustion process to generate energy.

Besides the company reports energetic emissions (combustion of gasoil, gas, coal and fossil fractions from the sludge) which are allocated in category 1A2d.
The fossil fraction of the waste sludge is one of the 'fuels' used in the fluidized bed furnace to generate energy (electricity and steam).
However, these emissions are allocated to the category 1A2d and not 1A1a because these installations are auto-producers of energy (and not operating as joint-ventures with the electricity producers).

4.9.3 Uncertainties and time-series consistency

See chapter 1.7 for more information.

4.9.4 Source-specific QA/QC and verification, if applicable

Standard QA/QC and verification activities take place.

4.9.5 Source-specific recalculations, if applicable, including changes made in response to the review process

No specific recalculations were performed in the category 2H during this submission.

4.9.6 Source-specific planned improvements, if, including those in response to the review process

No specific planned improvements at this moment are provided in the category 2H for the next submission.

Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

5 AGRICULTURE (CRT SECTOR 3)

5.1 Overview of the sector

5.1.1 Description of the sector

The evolution (1990-2022) in Belgium of the main categories of livestock and cultivation businesses and their numbers are represented in the tables 5.1 and 5.2. Those data are available on a yearly basis and are used as one of the activity data for the agricultural sector. Table 5.1 gives an overview of the main types of cultivation in Belgium. These data originate from 'Statistics Belgium'. Table 5.2 gives the evolution of the livestock.

The land used for agriculture in 2022 extends to 1 361 911 hectares (table 5.1) or 44% of Belgium. In 2022, the number of agricultural and horticultural businesses amounted to 35 192. This number has dropped by 43% since 2000. The disappearance of small businesses becomes a general trend in the sector. Additionally, in Flanders, this partly can be explained due to the subsidized cut down of the number of cattle. This was in 2001 and 2002 only the case for swine. In 2003 however an extension to bovine and poultry occurred. In 2021, a voluntary discontinuation of the activities of mink farming occurred due to the covid pandemic, which explains the very sharp decline in the number of fur animals in 2021. In 2022, a sharp drop in the number of swines occurred in Flanders due to the uncertainty in agricultural (nitrogen) policy and the low market value for swines. Nevertheless, the land area used for agricultural purposes remained more or less the same during this period. In 2022, Wallonia has 54% of the land used for agriculture, but 64% of agricultural businesses are situated in Flanders. The land area used for farming is on average 28 ha per farm in the Flemish region and 58 ha per farm in the Walloon region. The agricultural activities on the Brussels territory are extremely limited compared to the 2 other regions in Belgium. The agricultural area or animal number (see annex 9.1c) does not exceed 0.2% of the national figure. Detailed information for the three regions can be found in annex 9, table 9.1(a-c). Camels, lamas and buffalo do not occur in Belgium. Therefore, they are not included in the inventory.

Organic farming and the businesses in transition towards this type of farming only represent 8% of the total area in 2022 (12% in Wallonia, 1.6% in Flanders, see https://statbel.fgov.be/nl/themas/landbouw-visserij/biologische-landbouw#figures). The evolution of the Belgian agricultural sector is of course directly related to the Common Agricultural Policy of the European Union.

Climate:
With an average temperature of 12.2°C in 2022 (https://www.meteo.be/nl/klimaat/klimaat-van-belgie/klimatologisch-overzicht/2022/jaar), Belgium as a whole has a 'cool' climate following the 2006 IPCC Guidelines.

	1990	2000	2005	2010	2015	2020	2021	2022
Number of businesses	86 962	61 705	51 540	42 854	36 913	35 996	36 012	35 192
Usable agricultural area (ha)	1 357 366	1 394 083	1 385 582	1 358 019	1 344 329	1 367 082	1 368 315	1 361 911
Cropland (ha)	760 559	864 076	842 999	834 388	908 847	864 877	865 641	863 551
Grains (ha) *(without maize)*	327 226	277 702	267 975	276 571	283 076	252 461	261 987	260 204
Wheat (ha)	205 050	204 022	204 209	209 532	201 629	179 474	190 506	189 576
Sugarbeet (ha)	107 837	90 858	85 527	59 303	52 341	56 751	55 191	53 255
Potatoes (ha)	49 255	65 845	64 952	81 760	78 640	97 337	89 918	91 941
Maize (ha)	140 066	202 120	218 081	238 844	231 773	233 416	231 298	241 246
Permanent Grassland (ha)	578 626	506 946	519 096	499 687	410 884	476 119	476 277	471 629

Table 5.1: Main types of cultivation in Belgium in 1990-2022

	1990	2000	2005	2010	2015	2020	2021	2022
Cattle	3248795	2993812	2664162	2612238	2510520	2347656	2320914	2292307
Dairy cattle	838700	581461	494743	463406	483456	502075	502928	506248
Non-dairy cattle	2410095	2412351	2169419	2148832	2027064	1845581	1817986	1786059
Sheep	192133	123943	118644	104705	118984	123347	135285	136283
Goats	8700	13226	24021	30880	47678	79243	86520	90024
Horses	19359	41437	43667	52571	64285	71875	74814	76706
Mules and asses	1971	4878	6542	8778	9553	10899	11261	12071
Swine	6700422	6895301	6159738	6616949	6643508	6310453	6237626	5750892
Poultry (total)	27166675	37034994	32173633	32624287	39009237	47766985	48788010	48555533
other	23745	76187	54884	64500	74584	37116	10426	10429

Table 5.2: Number of heads in the main livestock categories in Belgium in 1990-2022

5.1.2 Allocation of emissions

Five source categories occur in the agricultural sector:

- Category 3.A Enteric fermentation: CH_4 emissions;
- Category 3.B Manure management: CH_4 and N_2O emissions;
- Category 3.D Agricultural soils: N_2O emissions;
- Category 3.G Liming: CO_2 emissions;
- Category 3.H Urea application: CO_2 emissions.

Some agricultural sectors such as rice cultivation, prescribed burning of savannahs (categories 3.C and 3.E) and field burning of agricultural residues (category 3.F) are not occurring (NO) in Belgium. As described in chapter 1.5 and table 5.29, no other carbon-containing fertilizers are used in Belgium. Therefore, a notation key NO for category 3.I is used.

5.1.3 Trend assessment

GHG emissions from agriculture (without fuel used) account in 2022 for 8.9% of the total emissions in Belgium. Overall (including emissions from energy sector 1A4c), they have decreased by 22% between 1990 and 2022.

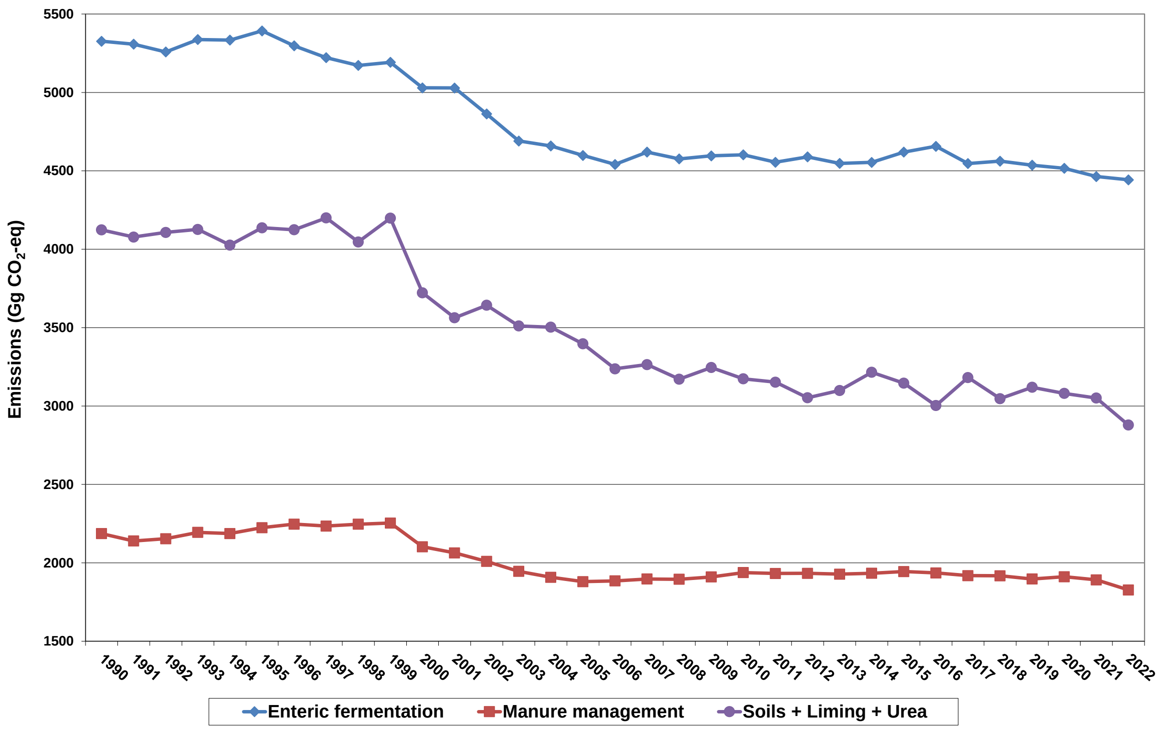


Figure 5.1: Emission trends in agriculture

49% of these emissions (without fuel used) are CH_4 emissions from enteric fermentation (category 3A) in 2022, cattle are for 93% responsible for these emissions. As can be seen in figure 5.1 those emissions decreased by 17% since 1990. This is mainly due to a general livestock reduction (1), but also to the shift from dairy cattle to brood cattle (which is a general EU trend linked to the Common Agriculture Policy), the latter having smaller emissions.

20% of the emissions are emissions from manure management in 2022 of which swine accounts for the biggest part (57%). These emissions are driven by the livestock: the swine livestock is rising from 1990 until 1999 and decreasing since then, its impact on the emissions being smoothed by the cattle livestock evolution explained above.

30% of the emissions in the agriculture are originating from N_2O emissions from soils. Those have decreased by 31%, due to the smaller quantities of nitrogen from mineral fertilizer applied on the one hand and to the livestock reduction (nitrogen excreted on pasture and from organic fertilizer applied) on the other hand. Both reductions have also an impact on indirect emissions.

5.1.4 Data sources

The main activity data used are the livestock figures, agricultural land area and edible crop production. 'Statistics Belgium' (37) (Statbel) publishes these numbers yearly in its agricultural census. As the main statistical authority in Belgium, 'Statistics Belgium' is in charge of collecting, processing and disseminating relevant, reliable and commented statistical and economic information. Until 2008, the agricultural census reached 100% of the farms. Since 2008 (with exception of 2010) this inquiry has changed slightly. 75% of all agricultural businesses (including the biggest farms) have to fill in a form each year about the situation at the farm on the 1st of May of that year. The other 25% is estimated. To come to this 75%/25% ratio, the farms are divided in two groups: 50% contain the biggest farms, the other 50% the smaller farms. The 50% biggest farms have to fill in the form each year. From the other 50% smaller farms, the half has to fill in the form in year x and the other half is estimated. The next year (x+1) the part of small farms that is not contacted in the year x, is obliged to fill in the form. At this way every two years 100% of the farms are questioned. To be compliant with the European legislation, in the survey 2010 ones again 100% of the farms were questioned.

However, since 2015, the agricultural census is no longer as detailed as needed. Therefore, Wallonia uses also complementary regional statistics from 2013 data on.
Flanders uses from 2000 on data from the Manure Bank of the Flemish Land Agency (VLM) (https://www.vlm.be/en). All Flemish farmers are by legislation obliged to yearly fill in the form by April 30th of year x describing the situation of year x-1. Therefore, the Manure Bank of the Flemish Land agency includes data from all farm animals in Flanders.
The conditions for this obligation are described in the following link
https://www.vlm.be/nl/SiteCollectionDocuments/Publicaties/mestbank/startersbrochure%20mestbank_website.pdf. Briefly these are:
(1) have at least 2 ha of agricultural land in use or
(2) have at least 50 are of growing medium in use or
(3) have at least 50 are of permanently covered agricultural land in use or
(4) produces at least 300 kg of P_2O_5 from animal manure on an annual basis or
(5) have stored more than 300 kg of P_2O_5 from animal manure.
In this respect, it does not matter whether the farmer operates the farm as a main or secondary occupation or if he only carries out agricultural activities as a hobby. If one or more of the above situations apply to the farmer, he is a declarable farmer, even if he has no income from his activities, as a farmer. The different animal categories inventoried by the manure bank are given in https://www.vlm.be/nl/SiteCollectionDocuments/Publicaties/mestbank/Bemestingsnormen_2022.pdf.
Pets, such as cats and dogs, are not inventoried.

In Brussels, the evolution of agricultural surfaces (cropland and grassland) and livestock numbers shows a significant statistical break in 2011 in Statbel data due to a methodological change in data aggregation leading to a significant increase in agricultural surfaces and livestock attributed to the region. According to the discussions during the 2018 in-country review, the livestock numbers and the agricultural surfaces from 2011 on should be calculated using the trend in each animal category at the national level. Therefore, in order to overcome the dropout of the Statbel data for the region, the following calculation method is applied: the Statbel data are used for the period 1990-2010, the 2011 data are taken equal to the previous five-year average, and then the Belgian evolution as published by Statbel is applied.
Further detail on the agricultural census methodology and QA/QC issues can be found on the Statbel website: https://statbel.fgov.be/nl/enquete/landbouwenquete.

Edible crop production:
Data on edible crop production (area and production) are available on:
https://statbel.fgov.be/nl/themas/landbouw-visserij/land-en-tuinbouwbedrijven#figures.
The cultivated area for each crop originates from different surveys in the three regions. The crop production originates from an additional survey performed in January following the inventory year.

Table 5.3 gives an overview of the production data of the main types of crops in Belgium from 1990-2022. Detailed information of the trend of the crop production in the three regions is given in annex 9, table 9.2a-c.

Crop	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**	**2021**	**2022**
Wheat	6175	8008	8509	8827	10053	14780	13460	14900
Barley	5752	6864	7548	8333	9685	12550	12840	13610
Maize	39950	38723	38425	37362	38952	49390	55710	48660
Storage potatoes	34492	44376	42813	42267	40064	41060	43730	39410
Sugar beet	59520	67710	69957	75288	79300	84300	82440	89080
Fodder beet	90560	9840	99118	95797	104150	84800	89470	87310

Table 5.3: Production data (in kg/ha) of the main types of cultivation in Belgium in 1990-2022

<u>Livestock numbers:</u>
The livestock numbers are the primary activity data used in the calculation of CH_4 and N_2O emissions. Until 1999 in Flanders and until 2012 in Wallonia, the numbers originate from the agricultural census, available on:
https://statbel.fgov.be/nl/themas/landbouw-visserij/land-en-tuinbouwbedrijven#figures.
These data can be found in annex 9, table 9.1(a-c). Table 5.4 gives an overview of the origin of livestock numbers in the three regions for the different time periods.

Livestock numbers	**Flanders**	**Wallonia**	**Brussels**
1990-1999	STATBEL	STATBEL	STATBEL
2000-2012	Manure Bank (VLM)	STATBEL	STATBEL until 2010. 2011 equals to the previous five-year average. From 2011 the Belgian evolution as published by Statbel is applied.
2013-2022	Manure Bank (VLM)	STATBEL & Walloon Statistics (DGO3-Agriculture Administration)	Evolution based on the Belgian total as published by Statbel.

Table 5.4: Origin of the livestock numbers in the three regions

In Flanders, from 2000 on, input data such as animal number and N-production are obtained by the Manure Bank of the Flemish Land Agency (https://www.vlm.be/nl/themas/waterkwaliteit/Mestbank/aangifte/mestbankaangifte). Unfortunately the reports and declaration forms are not available in English. The detailed information is available on the level of the stable as necessary for the NH_3-model. In 2009, in Flanders, a new model for the calculation of the NH_3 emissions was developed (in 2017 a thorough actualisation and extension of this model occurred). This model calculates the NH_3 emission in different emission stadia taking into account the manure flow. This is done on the level of the stable. Therefore data (animal number, manure transport, N-excretion) are necessary on this detailed level. These data are inventoried by the Manure Bank from the Flemish Land Agency (VLM). The VLM, a Flemish government agency, is among other things, responsible for the execution of the Flemish Manure Policy. Statbel can provide data on animal number, only on the level of municipality. This is not detailed enough for the NH_3-model. On the other hand, data from the Manure Bank are only available from 2000 on. To be consistent between different models used (NH_3, NOx, NMVOC, N_2O, CH_4) Flanders decided to use the VLM data source for animal number and N-excretion for all models and from 2000 on. From 1990-1999 Flanders uses the Statbel numbers, which also means that NH_3 emissions in this period can only be calculated on the level of the municipality.
It is of course true that the animal number between Statbel and the manure bank is not exactly the same. Statbel collects data on the 1st of May, which means that farmers give the animal number present at the farm at the 1st of May. For the manure bank farmers give the average animal population over the past year. This difference explains differences in animal number between the two data sources.

A consistency check of the activity data has been done for CH_4. In table 5.5 below CH_4 emissions are relatively compared using either Statbel animal numbers or VLM animal numbers for 2000-2007. Numbers from STATBEL are systematic higher than Manure Bank numbers (VLM). The CH_4 emission estimates calculated from both data sets differ, ranging from 1.4% to 5.3% for enteric fermentation and from 0.5% to 6.0% for manure management, depending on the year. The differences between the data sets do not exceed 10%, which is the uncertainty level for the animal population data from STATBEL. Therefore, Flanders considers it not desirable and time-consuming to continue using two data sources for the calculation of the N_2O and CH_4 emissions in the Flemish region. Flanders is considering the dataset of the Flemish Land Agency as much more accurate than the STATBEL data and consequently prefers using this dataset in the future. This data source is not available for the other regions in Belgium that are obliged to continue using the agricultural census of the National Statistical Office.

	Difference in CH_4 emission for enteric fermentation (%) (STATBEL/VLM)	**Difference in CH_4 emission for manure management (%) (STATBEL/VLM)**
2000	3.8	6.0
2001	5.3	3.3
2002	4.4	3.6
2003	4.6	3.2
2004	4.1	1.3
2005	4.1	2.7
2006	3.9	1.8
2007	1.4	0.5

Table 5.5: Consistency check of CH_4 emission with STATBEL and VLM animal numbers in Flanders

In Wallonia, as STATBEL gives no longer detailed numbers for ovine and goats from 2014 on, livestock figures come from the Walloon agriculture department (DGO3). Comparisons were made on 2013 figures (yet available in STATBEL and also in Walloon statistics).

For Brussels, STATBEL values are used until 2010. For 2011 activity data equals to the previous five-year average, then for the years that follow the evolution at the Belgian level as published by Statbel is applied. The reason for the choice of this method to estimate the livestock is due to the revision of the Statbel methodology from 2011 consisting in the allocation of agricultural surfaces and livestock by operator headquarters, instead of where the activity effectively takes place. This revision leads to a very important increase of the livestock attributed to the region. According to the Statbel data for the Brussels-Capital region, the number of cattle would have increased from 238 in 2010 to 872 in 2015. Taking into account the cattle population recorded an important decrease from 1990 to 2010 according to the previous Statbel methodology, and the continuous increase of the population leaving less space to such agricultural activities, these new numbers have been considered not appropriate to estimate livestock of the region in an accurate manner. The method of applying the Belgian evolution to historical regional data has been judged the only possible way to continue estimate emissions from agricultural activities for the region.

5.1.5 Overall recalculations in the agricultural sector

The tables below give the quantitative and qualitative recalculations in the agricultural sector and subsectors compared to the previous submission.
<u>Category 3.A Enteric fermentation:</u>
Recalculations in emissions of CH_4 in category 3.A due to:
Flemish and Walloon regions:
No recalculations.

Brussels region:
Correction of the coefficient corresponding to animal's feeding situation for non-dairy cattle (Ca) from grazing large areas to pasture.

Difference between current and previous submission (%)

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	-3,82	-4,56	-4,26	-3,11	-3,43	-3,47	-3,39	-3,35	-3,27	-3,20	-3,17
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Difference between current and previous submission (kt CO2-eq)

kt CO_2 eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	-0,04	-0,04	-0,03	-0,01	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	-0,04	-0,04	-0,03	-0,01	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02	-0,02

Category 3.B Manure management:
Recalculations in emissions of CH_4 and N_2O in category 3.B due to:

Flemish and Walloon regions:
No recalculations.

Brussels region:
Correction of the calculation method of indirect N_2O emissions from manure management, in line with the methodology applied in Wallonia.
Correction of the coefficient corresponding to animal's feeding situation for non-dairy cattle (Ca) from grazing large areas to pasture.

Difference between current and previous submission (%)

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	-11,12	-11,51	-11,18	-10,37	-10,67	-10,70	-10,65	-10,65	-10,64	-10,57	-10,59
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Difference between current and previous submission (kt CO2-eq)

kt CO_2 eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	-0,02	-0,02	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	-0,02	-0,02	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01

Category 3.D Agricultural soils:

Recalculations in emissions of N_2O in category 3.D due to:

Flemish region:
No recalculations.

Walloon and Brussels regions:
Actualisation of 3D15 activity data (areas) on the whole time series.

Difference between current and previous submission (%)

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	0,01	0,01	-1,49	-1,89	-0,92	-1,00	-0,91	-0,99	-0,96	-0,96	-0,55
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,00	0,00	0,03	0,03	0,03	0,03	0,02	0,03	0,03	0,03	0,03
Belgium	0,00	0,00	0,01	0,02	0,02	0,02	0,01	0,02	0,01	0,01	0,02

Difference between current and previous submission (kt CO2-eq)

kt CO_2-eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	0,00	0,00	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	-0,01	0,00
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,05	0,05	0,48	0,47	0,46	0,45	0,45	0,45	0,44	0,44	0,44
Belgium	0,05	0,05	0,47	0,46	0,45	0,45	0,44	0,44	0,44	0,43	0,43

<u>Category 3.G Liming:</u>

Recalculations in emissions of CO_2 in category 3.G due to:

Flemish and Brussels regions:
No recalculations.

Walloon region:
Actualisation of activity data (areas) on the whole time series.

Difference between current and previous submission (%)

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,34	-2,16	-3,44	-4,52	-7,23	-7,78	-8,33	-8,89	-9,45	-10,01	-10,57
Belgium	0,18	-1,18	-1,92	-2,57	-4,08	-4,38	-4,69	-4,99	-5,30	-5,61	-5,92

Difference between current and previous submission (kt CO2-eq)

kt CO_2 eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,29	-1,79	-2,83	-3,67	-5,80	-6,22	-6,65	-7,07	-7,50	-7,92	-8,35
Belgium	0,29	-1,79	-2,83	-3,67	-5,80	-6,22	-6,65	-7,07	-7,50	-7,92	-8,35

<u>Category 3.H Urea Application:</u>

Recalculations in emissions of CO_2 in category 3.H due to:

Flemish, Walloon and Brussels regions:
No recalculations.

Difference between current and previous submission (%)

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	0	0	0	0	0	0	0	0	0	0	0
Flanders	0	0	0	0	0	0	0	0	0	0	0
Wallonia	0	0	0	0	0	0	0	0	0	0	0
Belgium	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Difference between current and previous submission (kt CO2-eq)

kt CO_2 eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	0	0	0	0	0	0	0	0	0	0	0
Flanders	0	0	0	0	0	0	0	0	0	0	0
Wallonia	0	0	0	0	0	0	0	0	0	0	0
Belgium	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Category 3 Total Agriculture:

Difference between current and previous submission (%)

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	-2,19	-2,52	-3,45	-3,12	-2,76	-2,89	-2,71	-2,80	-2,73	-2,70	-2,49
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,01	-0,03	-0,05	-0,07	-0,12	-0,13	-0,14	-0,16	-0,17	-0,18	-0,19
Belgium	0,00	-0,02	-0,02	-0,03	-0,06	-0,06	-0,06	-0,07	-0,07	-0,08	-0,08

Difference between current and previous submission (kt CO_2-eq)

kt CO_2 eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels	-0,06	-0,06	-0,06	-0,03	-0,04	-0,04	-0,03	-0,03	-0,03	-0,03	-0,03
Flanders	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wallonia	0,34	-1,74	-2,35	-3,20	-5,34	-5,77	-6,20	-6,63	-7,05	-7,48	-7,91
Belgium	0,28	-1,80	-2,41	-3,23	-5,38	-5,80	-6,23	-6,66	-7,09	-7,52	-7,94

5.2 Enteric fermentation (Category 3.A)

5.2.1 Source category description

Because in Belgium, CH_4 emissions from enteric fermentation are a key source category for cattle, a tier 2 approach is required in the 3 regions. This methodology is based on the IPCC 2006 Guidelines (IPCC 2006 GL) and harmonized between the 3 regions. For Brussels, parameters and emission factors from Wallonia are used. CH_4 emissions from enteric fermentation from the other, non-key sources, animal categories (sheep, goats, swine, horses and mules and asses) are, in all regions, estimated using the tier 1 methodology as described in the IPCC 2006 Guidelines (1). Enteric fermentation emissions from poultry, rabbits and fur-bearing animals (although existing in Belgium) are not estimated because the IPCC 2006 Guidelines do not provide an emission factor for poultry. This is due to the insufficient data for calculation of methane emission from enteric fermentation for this category. Therefore, a notation key 'NE' for these categories is used. Camels, llamas and buffalo do not occur in Belgium. Therefore, they are not included in the inventory.

Table 5.6 gives an overview of the methodologies used in the three regions.

A list of parameters used by the three regions to calculate the CH_4 emissions is given in annex 3.

Used methodology	Flanders	Wallonia	Brussels
Key sub-source category (3.A.1)	IPCC 2006 GL (Tier 2)		
Non key sub-source categories (3.A.2, 3.A.3, 3.A.4)	IPCC 2006 GL (Tier 1)		

Table 5.6: Overview of the methodologies used in the three regions

5.2.2 Methodological issues and data sources

Key sub-source categories

Dairy and non-dairy cattle are key sub-source categories in Flanders and Wallonia. Therefore, the tier 2 methodology as described in the IPCC 2006 Guidelines is used in the three regions. Emissions from enteric fermentation in the tier 2 approach are calculated by multiplying the animal number by the appropriate emission factor:

CH_4 emission (kg CH_4) = $\sum$EF(kg CH_4/animal$_{category\ x}$) * animal number$_{category\ x}$

The emission factors for each category of cattle are estimated based on the gross energy (GE) intake and the methane conversion rate (Y_m) for each category.

EF (kg CH_4/animal/yr) =[GE_{intake} (MJ/day) * Y_m/100 * 365 days] / 55.65 MJ/kg CH_4

In successive steps the gross energy intake is calculated. These steps include the amount of feed energy required for maintenance, activity (to obtain their food), growth, lactation and pregnancy. The different steps and the formulas used are hereunder discussed in detail.

Animal population
The cattle population is divided into slightly different groups in Flanders, Wallonia and Brussels as can be seen in table 5.7.

Net energy for Maintenance
The formula used for the calculation of the net energy for maintenance originates from the IPCC 2006 Guidelines, equation 10.3. The average animal weight used for the estimation of the net energy for maintenance (NE_m) originates in Flanders from the *Agency for Agriculture and Fisheries.*

In response to the centralized review of October 2020, Belgium corrected the weight gain factor for dairy cows, brood cows and bovine more than 2 years. In Flanders, at the age of 2 years the cattle reaches the mature weight, therefore the weight gain factor is adjusted to zero. Currently, the average weight of the different cattle categories has been held constant throughout the time series. However, the development of a time series has been investigated as part of the study in Flanders. This study was not yet finished for the 2024 submission. Table 5.7 shows the weight gain factors for the cattle categories in the 3 regions.
In Wallonia and Brussels, the average weights and the weight gain parameters have been revised in 2021 submission, based on three sources: 1) by following the 2006 IPCC Guidelines as recommended by the ERT , 2) by adjusting the cattle subcategories with the data available in the national statistics (no distinction in cattle between 1 and 2 years) and 3) by using new information provided by the Walloon Agricultural Research Center and the Walloon livestock breeding association who have the weight gain of typical races of cattle in Wallonia (mainly Holstein and Blanc bleu belge). These information help to build new factors as shown in table 5.7 below.
The coefficient Cf_i used originates from the IPCC 2006 Guidelines, table 10.4. The animal weight and Cf_i used in the three regions are given in table 5.7 here under.

Subcategories	Average weight (kg)	Weight gain (kg/day)	Coefficient Cf_i	Coefficient C
Flanders				
Slaughter calves	162	1.100	0.322	1.2
Bovine under 1 year	184	0.750	0.322	1
Bovine between 1 and 2 years	427	0.700	0.322	1
Bovine more than 2 years	660	0	0.322	1
Dairy cows	600	0	0.386	0.8
Brood cows	600	0	0.386	0.8
Wallonia				
Bovines under 6 months	131	1	0.322	1.2
Bovines between 6 months and 1 year: male	357.5	1.35	0.370	1.2
Bovines between 6 months and 1 year: female	240	0.775	0.322	0.8
Bovines more than 1 year for fattening: male	639	1.20	0.370	1
Bovines more than 2 years for reproduction: male	1050	0	0.370	1.2
Bovines female between 1 and 2 years	435	0.715	0.322	0.8
Bovines female older than 2 years	725	0	0.322	0.8
Dairy cows	650	0	0.386	0.8
Brood cows	800	0	0.386	0.8
Brussels				
Dairy cattle	650	0	0.386	0.8
Brood cattle	800	0	0.386	0.8
Other female bovine > 2 years	725	0	0.322	0.8
Heifers for slaughter > 2 years	725	0	0.322	0.8
Male bovine > 2 years	1050	0	0.370	1.2
Female bovine between 1 and 2 years	435	0.715	0.322	0.8
Heifers for slaughter between 1 and 2 years	435	0.715	0.322	0.8
Male bovine between 1 and 2 years	639	1	0.370	1.2
Slaughter calves	131	1	0.322	1
Other female bovine < 1 year	240	0.775	0.322	0.8
Other male bovine < 1 year	358	1.35	0.370	1.2

Table 5.7: Average weight, weight gain and coefficients Cfi & C (for Net Energy for maintenance & growth calculation) for the different cattle categories in Belgium

Net energy for Activity

The formula used for the calculation of the net energy for activity originates from the IPCC 2006 Guidelines, equation 10.4. The calculation of the net energy for activity (NE_a) in Wallonia, Brussels and Flanders is based on the value of table 10.5 of 2006 IPCC Guidelines: Ca = 0.17 for pasture.

In Wallonia and Brussels, as cattle is grazing half a year and in stable the other half of the year, the value is divided by 2. Therefore, in Wallonia and Brussels a coefficient (C_a) of 8.5% of the net energy for maintenance (NE_m) is used for most bovine, considering that those animal categories spend half of the time on pasture. However, 0% is used for slaughter calves (bovines under 6 months) and 7.5% for dairy cows which spend a bit more time in stable (205 days in stable). There is currently no new information available to build a temporal evolution of these parameters.

In Flanders for slaughter calves a coefficient (C_a) of 0% is used, considering the animals are kept inside their entire lifetime. In 2022, dairy cows spend 14% of the year on pasture, brood cows 55% and the other bovine 3%. Resulting in a coefficient (C_a) respectively of 2.38% and 9.35% and 0.51%. From 1990 till 2022, in Flanders for dairy cows the days on pasture and therefore also the $C_{a,}$ evolved through time as can be seen in table 5.8.

Flanders Subcategories	C_a 1990-1995	C_a 1996-1999	C_a 2000-2005	C_a 2006-2010	C_a 2011-2014	C_a 2015-2022
Slaughter calves	0	0	0	0	0	0
Bovine under 1 year	1.02	1.02	0.68	0.51	0.51	0.51
Bovine between 1 and 2 years	1.02	1.02	0.68	0.34	0.34	0.51
Bovine more than 2 years	0	0	0	0	0	0
Dairy cows	4.76	4.08	3.40	2.72	2.38	2.38
Brood cows	9.35	9.35	9.35	9.35	9.35	9.35

Table 5.8: The evolution of the coefficient C_a (for Net Energy for activity calculation) for the different cattle categories in Flanders

Net energy for growth

The formula used for the calculation of the net energy for growth originates from the IPCC 2006 Guidelines, equation 10.6. The coefficient C in the equation 10.6 is detailed by category and by region in the table 5.7. In Flanders a coefficient of 1 has been used for the categories bovine under one year, between one and two years and more than two years. This coefficient is an average of 0.8 for females, 1 for castrates and 1.2 for bulls. Unfortunately, in this category no distinction can be made between male and female. For dairy cows and brood cows, a coefficient of 0.8 is used.

Net energy for Lactation

For the calculation of the net energy for lactation (NE_l) the milk production by dairy cows and brood cows is taken into account (see table 5.12). The milk production by brood cows is taken 4.66kg milk/day/head in all regions. Equation 10.8 from the IPCC 2006 Guidelines is used.
The data of milk production by dairy cows used in Flanders is the real production of milk in the region: milk supplies from Flemish producers to consumers and the direct sales on the farm. For 1990-2003 the real milk production is calculated per milk quota year (e.g. 1st April 2000 till 31st March 2001).
The milk production data from 2004 on (with exception of the direct sales on the farm) are calculated for a calendar year (1st January till 31st December). Before 2004 this information per calendar year is not available.
In the Walloon region data of milk production originate from the agriculture administration based on data provided by the milk producers. In 2022, there was an improvement in statistical calculations which lead to actualised values of milk yield since 2010 on.
Brussels uses the average milk production per cow of Wallonia.

Net energy for Pregnancy

The formula used for the calculation of the net energy for pregnancy (NE_p) originates from the IPCC 2006 guidelines (equation 10.13). In the three regions, for dairy and brood cows, a coefficient of 0.10 is applied. For the calculation of NE_p it is assumed that 80% of this subcategory is actually pregnant each year.

Digestible Energy

Data for feed digestibility (DE%) originate from a report from the Netherlands http://www.rivm.nl/bibliotheek/rapporten/680125001.html (reference (38), page 19, table 3.14). This is a neighbouring country with comparable feeding situations. Table 5.9 gives an overview of the feed digestibility of the different feed types. When new information will be available in Belgium, these values will be updated.

Feed	DE%
Calf milk replacer	90%
Concentrates	80%
Maize	72%
Grass silage	72%
Fresh grass (grazing animals)	79%

Table 5.9: Digestibility of the feed of cattle in %

Feeding situation

In Flanders slaughter calves are fed with 100% milk replacer until 2006. From 2007 on slaughter calves in Flanders are fed with 86% milk replacer and 14% roughage. The diet of dairy cows contains more or less 30% concentrates and the rest roughage. The absolute amount of concentrates in the diet from dairy cows remained more or less constant over the time series, but by increasing the absolute amount of roughage in the diet (and by sustained breeding of the dairy cattle breeds) the milk production has strongly increased from 11kg milk/day/cow in 1990 to 26kg milk/day/cow in 2022 (see also table 5.11). For non-dairy cattle the feeding situation is not yet specified, a DE% of 75% is used. This information is based on a Dutch study (39), because no specific data for Belgium are available. However, we do not have any reasons to expect that the Belgian situation differs from the Dutch one. Unfortunately, the study is in Dutch, although an abstract in English is available from https://www.rivm.nl/publicaties/methaanproductie-als-gevolg-van-pensfermentatie-bij-rundvee-berekend-middels-ipcc-gpg. We used the following digestibility percentages from this study: milk replacer (90%), concentrates (80%), grass silage and maize (72%) and meadow grass (79%).

In Flanders, to better estimate the digestibility of the ration, a typical Flemish ration is determined for each animal subcategory and the digestible energy for each feed material is calculated. Therefore, the results of a study performed by the Institute for Agricultural and Fisheries Research (ILVO) (40) were analyzed and incorporated in the Flemish study that revised the CH_4- and N_2O-model. This study was not yet finished for the 2024 submission. Because of the postponed delivery of the study, the results of the study have not yet been implemented in a new time series for the emission-inventory in Flanders. Flanders will examine whether implementation in the 2025 submission is possible.

In Wallonia and Brussels an average digestibility of 75% is used, considering that the cattle are fed with fresh grass during pasture and with silage and concentrates in stable. No detailed data are available at this moment to better estimate this parameter. Due to late delivery of the study, the results of the Flemish study could not be integrated yet in the 2024 submission (see previous paragraph).

When new quantitative information will be available thanks to Belgian research or survey, these values will be improved.

Methane Conversion Factor

In all regions a methane conversion factor (Y_m) of 6.1% is used to calculate the emission factor for each cattle type, with exception of slaughter calves in Flanders.

In Flanders, for slaughter calves until 2006 a Y_m of 0% is used, from 2007 on Y_m is taken 0.854% (86% milk replacer and 14% roughage). The default value in table 10.12 of the 2006 IPCC Guidelines (pp 10.30) is 6.5% with a range of ± 1%. As described in the guidelines, the lower bounds should be used when good feed is available. ILVO estimated the Y_m 6.1%. The estimation has been based on measurements on about 60 lactating dairy cows in open-circuit chambers and on 8 non-lactating dairy heifers. The lactating dairy cows had a Y_m of 5.9% (58 animals), the non-lactating dairy heifers (used to simulate the 42 days of dry period) had a Y_m of 7.9% (8 animals). This brings Y_m for dairy cows during an entire cycle on 6.1%. The possibility to implement a Y_m factor for dairy cattle that reflects changes in the time series has been considered in the literature study performed by ILVO as part of the Flemish study. This study was not yet finished for the 2024 submission. The default values mentioned in the IPCC GL are more specific for a North American ration and not really representative for the Flemish situation. Therefore, the working group decided to maintain the region specific Y_m of 6.1%.

Implied Emission Factor

The emission factors for all categories with exception for dairy and brood cows stay constant over the entire time series (table 5.10). For dairy cows the emission factor increases with increasing milk production, from 85.26kg CH_4/head in 1990 to 134.99 kg CH_4/head in 2022 in Flanders, from 91 kg CH4/head in 1990 to 115 kg CH4/head in 2022 in Wallonia and Brussels. The implied emission factor for non-dairy cattle decreases from 38.14 kg CH_4/head in 1990 to 37.38 kg CH_4/head in 2022 in Flanders, from 49 kg CH4/head in 1990 to 56 kg CH4/head in 2022 in Wallonia and decreases from 57 kg CH4/head in 1990 to 50 kg CH4/head in 2022 in Brussels.

Table 5.10 shows the emission factors used in the three regions for the different cattle types in 2022. Table 5.11 gives the evolution of the milk production and IEF for dairy cattle in Flanders, Wallonia and Brussels.

Subcategories	Emission factor (kg CH_4 / head)
Flanders	
Slaughter calves	4.05
Bovine under 1 year	31.91
Bovine between 1 and 2 years	47.90
Bovine more than 2 years	41.36
Brood cows	68.70
Dairy cattle	134.99
Wallonia	
Bovine under 6 months	18.47
Bovine between 6 months and 1 year: male	50.59
Bovine between 6 months and 1 year: female	34.04
Bovine more than 1 year for fattening: male	78.38
Bovine more than 2 years for reproduction: male	73.05
Bovines female between 1 and 2 years	51.45
Bovines female older than 2 years	48.15
Brood cows	81.02
Dairy cattle	115.06
Brussels	
Dairy cattle	115.06
Brood cattle	81.02
Other female bovine > 2 years	48.15
Heifers for slaughter > 2 years	48.15
Male bovine > 2 years	73.05
Female bovine between 1 and 2 years	51.45
Heifers for slaughter between 1 and 2 years	51.45
Male bovine between 1 and 2 years	74.79
Slaughter calves	19.45
Other female bovine < 1 year	34.04
Other male bovine < 1 year	50.59

Table 5.10: Emission factor for each animal category (2022) in Belgium

Dairy cattle	1990	2000	2005	2010	2015	2020	2021	2022
Flanders								
Milk production	10.99	15.99	19.00	22.74	23.26	26.65	26.25	27.26
Fat %	3.98	4.08	4.10	4.08	4.16	4.27	4.30	4.23
IEF for methane	85.26	99.63	108.94	119.89	122.04	133.56	132.60	134.99
Wallonia and Brussels								
Milk production	11.35	13.54	15.86	17.08	17.68	19.33	18.80	19.06
Fat %	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
IEF for methane	91.40	98.14	105.25	109.00	110.85	115.88	114.28	115.06

Table 5.11: Milk production (kg milk/head/day), % fat and IEF (kg CH_4/head/yr) for dairy cattle in Belgium (1990-2022)

Non-key sub-source categories

Sheep, goats, swine, horses, mules and asses are no key sub-source categories. Therefore, a Tier 1 methodology is used in all three regions:

CH_4 emission (ton) = number of animals * emission factor.

The IPCC 2006 Guidelines emission factors in table 10.10 are used for all non-key sub-source animal categories and for all three regions. The classification of the animal categories occurs according to the IPCC 2006 methodology. Table 5.12 gives an overview of the emission factors used in the three regions.

Categories	**Emission factor**
	(kg CH_4 / head)
Sheep	8
Goats	5
Swine	1.5
Horses	18
Mules and asses (only Flanders)	10

Table 5.12: The emission factors (kg CH_4/head) for the different non-key sub-source categories

5.2.3 Uncertainties and time-series consistency

The only activity data here is the national livestock census. The uncertainty is judged small taken into account the features of the monitoring (census twice a year, individual earmarks and registration for all bovines). The emission factors are mainly the IPCC default values, using tier 2 methodology. Consequently, the IPCC uncertainty estimate of 20% is used for the emission factor.

A consistent methodology is used for the entire time-series in the three regions. Emissions are calculated from animal population data and emission factors. The animal population originates from the annual census as published by Statistics Belgium over a long period of time. In Flanders from 2000 on another source is used, but a consistency check has been performed. From 2013 on, in the Walloon region data originate from the Walloon Statistics (DGO3 Agriculture Administration).
Emission factors are either constant (IPCC default values) or calculated from data collected by an annual survey in which a continuity in the data collection is provided.

5.2.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key sub-source categories and can be provided by the Belgian experts on request.

5.2.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In the Brussels-Capital Region, the correction of the coefficient corresponding to animal’s feeding situation for non-dairy cattle (Ca) from grazing large areas to pasture resulted in a decrease of the emissions, of 40 tCO2eq in 1990 and 17 tCO2eq in 2021.

5.2.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

In Flanders, at the end of 2018, a Working Group on Emissions was set up to examine (among other things) the possibility to give an evolution in time for some of the parameters needed to obtain a year-dependent IEF for non-dairy cattle. In 2019 a Steering Body ‘Convenant Enteric Emissions’ was set up by the Flemish Government as well as a Working Group ‘Monitoring and assurance (of management and emissions)’ which contains experts from different agricultural and environmental domains in Flanders. The goal of the Convenant is to reduce the CH_4-emissions from enteric fermentation (cattle) till 2030. The measures from the Convenant can be implemented on the farm since April 2022. Because the implementation rate was not yet available for the 2024 submission, the corresponding methane reductions could not yet be taken into account. The farmer can choose between several measures as can be found at the following link: https://www.rundveeloket.be/CEER/maatregelen.

At this moment 12 measures are available. They can be divided into 3 groups:
1. Adjustments at the feed ration
2. Farm management focused on longevity and the share of young stock
3. Genetics and selection

(1) use of feed additives by mixing it into the rations: for each measure, a methane reduction percentage was established by scientists. For lactating dairy cattle, nitrate (-10%), 3-NOP (-26%), canola meal (-5%), extruded linseed (-9%), beer draff/rapeseed meal (-8%) and the combination of nitrate-rapeseed meal (-14.5%) and nitrate-extruded linseed (-18.1%) can be used. For beef cattle, nitrate (-8%) can be used. The total methane emission of cattle that received these feed additives will be reduced by the mentioned percentage for the time period that the feed additive was applied.
(2-3) other measures, e.g. to increase longevity, will be reflected in the inventory through effects on animal numbers.

Flanders Environment Agency (VMM) engaged for the monitoring of the CH_4-emissions from the different animal categories (cattle) in Flanders.
In 2021-2023, the CH_4-emission model was revised taking into account the implementation of measures with CH_4-reducing potential and taking into account the before mentioned parameters. In this study not only the methodology for the estimation of CH_4-emissions from enteric fermentation processes was revised. Also, the methodology to calculate CH_4 and N_2O-emissions from manure management and N_2O-emissions from agricultural soils was taken into account. All parameters used (feed intake, digestibility of the feed…) and activity data were reexamined where necessary. Where possible/available an evolution of the parameters in time is given. Further analysis of region specific calculation factors is needed.

Also, the methodology to calculate the NO_x emissions from manure management and agricultural soils is revised. This new integrated model is an extension of the EMAV2.1-model and calculates NH_3- and NO-emissions and therefore follows the N-flow throughout the farm in a more integrated way. The model already foresees in the implementation of the calculation of the greenhouse gases in the future.
The study was performed by ILVO and was commissioned by the VMM. The Steering Body and Working Group replaces the Working Group on Emissions set up in 2018. The kick-off of the Steering Body was given January 18, 2021. This study was not yet finished for the 2024 submission. Because of the postponed delivery of the study, the results of the study have not yet been implemented in a new time series for the emission-inventory in Flanders. Flanders will examine whether implementation in the 2025 submission is possible. In Wallonia and Brussels, it is planned to update the methodology with the IPCC 2019 GL and potentially with the results of the Flemish study.
Small improvements are inherent to the inventory process and occur yearly. Also in 2024 a continuous control/update of the used activity data and parameters will occur where necessary. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

5.3 Manure management (Category 3.B)

5.3.1 Source category description (e.g., characteristics of sources)

The storage and handling of manure from cattle, swine, poultry and other animals, leads to the emission of both CH_4 and N_2O. The methodologies are harmonized between the three regions: the Tier 2 methodology of the IPCC 2006 GL is applied for all the emissions of 3.B.1 & 3.B.2, except for non-key sub-source categories (3.B.1.2 and 3.B.1.4) where the Tier 1 methodology is applied. A list of parameters used by the three regions to calculate the CH_4 and N_2O emissions is given in annex 3.

Used methodology	Flanders	Wallonia	Brussels
CH_4 manure management - 3.B.1			
- key sub-source categories 3.B.1.1 and 3.B.1.3	IPCC 2006 GL (Tier 2)		
- non key sub-source categories 3.B.1.2 and 3.B.1.4	IPCC 2006 GL (Tier 1)		
N_2O manure management - 3.B.2			
- Direct N_2O emissions 3.B.2.1 – 3.B.2.4	IPCC 2006 GL (Tier 2)		
- Indirect N_2O emissions 3.B.2.5	IPCC 2006 GL (Tier 2)		

Table 5.13: An overview of the methodologies used in the three regions

CH_4 emissions from manure management are a key source category for swine and in previous submissions for cattle. Therefore, a tier 2 approach is required. The methodology used for the estimation of the CH_4 emissions from manure management is based on the IPCC 2006 Guidelines and is harmonized between the three regions. Sheep, goats, poultry, horses, mules and asses are no key sub-source categories; therefore, a tier 1 approach is used.
Camels, llamas and buffalo do not occur in Belgium. They are not taken up in the inventory, the notation key NO is used.
The methodology used in Flanders, Wallonia and Brussels to estimate N_2O emissions from manure management is based on the IPCC 2006 Guidelines. To estimate direct and indirect N_2O emissions, the methodology includes a Tier 2 approach based on region-specific Nex data, the proportion of animals per type of AWMS and region-specific $Frac_{GASM}$. The emission factors used are default and derived from the IPCC 2006 GL. According to chapter 10.5.1 of the IPCC 2006 Guidelines, a Tier 2 methodology follows the same calculation of Tier 1, but includes the use of country-specific data for some or all of the variables. These are Nex data, %AWMS and $Frac_{GASM}$ for each animal category.
N_2O-emissions from manure produced by grazing animals are not taken into account in the source category 3.B, but are included in the source category Agricultural Soils (3.D). This is as described in the IPCC 2006 Guidelines.

5.3.2 Methodological issues

5.3.2.1 Methane

<u>Key sub-source categories</u>
Methane emissions from manure management in the tier 2 approach are calculated by multiplying the animal number by the appropriate emission factor.
The process of developing tier 2 emission factors involves determining the mass of volatile solids excreted by the animals (VS) along with the maximum CH_4 producing capacity for the manure (B_o). Therefore equation 10.23 of the IPCC 2006 Guidelines is used. A CH_4 conversion factor (MCF) is obtained for each manure management system (MS).

$$EF_i = (VS_i * 365 \text{ days/yr}) * [B_{oi} * 0.67 \text{ kg/m}^3 * \Sigma MCF_j * MS\%_{ij}]$$

where:
EF_i = Emission factor (kg) for animal type i;
VS_i = Volatile solids excreted per day on a dry weight basis for animal type i;
B_{oi} = Maximum methane producing capacity (m³/kg of VS) for manure produced by animal type i;
MCF_{jk} = Methane conversion factors for each manure management system j;
$MS\%_{ij}$ = fraction of animal type i's manure handled using manure system j.

The volatile solids excreted by cattle are calculated with equation 10.24 of the IPCC 2006 Guidelines.

$$VS\ (kg\ dm/day) = [GE_{intake}\ (MJ/day) * (1\text{-}DE\%/100) + (UE * GE)] * [(1\text{-}ASH\%/18.45)]$$

where:
GE_{intake} = Daily average feed intake (MJ/day);
DE% = Digestibility of the feed (%);
(UE*GE) = Urinary energy expressed as fraction of GE;
ASH% = Ash content of the manure (%).

Table 5.14 gives an overview of the factors and IEF used in Flanders, Wallonia and Brussels, in 2022. The gross energy intake (GE) and DE% for cattle are derived from the methodology used to calculate the CH_4 emissions from enteric fermentation from cattle. The factors ash content of the manure and maximum methane producing capacity originate from the IPCC 2006 Guidelines (B_o table 10.A.4 – 10.A.8). The factor urine energy (UE) is taken (0.04) as given in the IPCC 2006 Guidelines.

Volatile solids excreted by swine are not derived as described in the IPCC 2006 Guidelines (equation 10.24), but are region-specific, using the average manure production in m³, its density and its dry matter content. This methodology allows for a more accurate calculation of VS for the various swine categories but does not refer to the GE. For the Walloon and Brussels region, these data are downloadable at: https://protecteau.be/resources/shared/publications/legislatif/PGDAIII.pdf.
For Flanders these data originate from the www.varkensloket.be. This portal is the main source of information for Flanders pig farmers.

As can be seen in table 5.14, the IEF for dairy cattle in Flanders (33,57 kg CH_4/head in 2022) is considerably higher than in Wallonia and Brussels (14.03 kg CH_4/head). This can either be explained by the fact that the AWMS from dairy cattle are region specific and differ as follows. In the Walloon and Brussels Region 24% is liquid storage and 32% solid. In the Flemish Region this is 60% liquid and 26% solid. The methane conversion factor for liquid storage (19%) is much higher than for solid storage (2%). Another reason can be found in the amount of milk production. In Flanders in 2022 this is 27.26 kg milk/cow/day. In Wallonia and Brussels this is 19.06 kg milk/cow/day. This has an important effect on the gross energy (GE) intake, which is 337 MJ/day in Flanders, 288 MJ/day in Wallonia and Brussels. This GE is one of the region-specific factors used to calculate the CH_4 IEF from manure management.

Subcategories	GE (MJ/day)	ASH (%)	VS (kg dm/day)	Bo (m³/kg of VS)	IEF (kg CH_4/head)
Flanders					
Slaughter calves	72	8	0.50	0.18	4.22
Bovines under 1 year	80	8	1.15	0.18	1.20
Bovines between 1 and 2 years	120	8	1.73	0.18	5.07
Bovines more than 2 years	103	8	1.49	0.18	3.32
Dairy cattle	337	8	4.81	0.24	33.57
Brood cattle	172	8	2.48	0.18	1.93
Piglets from 7 to 20kg	NE	NE	0.08	0.45	1.61
Fattening pigs from 20 to 110kg	NE	NE	0.23	0.45	4.82
Fattening pigs from more than 110kg	NE	NE	0.31	0.45	6.37
Boars	NE	NE	0.31	0.45	4.64
Sows including piglets less than 7kg	NE	NE	0.60	0.45	12.34
Wallonia					
Bovines under 6 months	46.2	8	0.7	0.18	1.28
Bovines between 6 months and 1 year: male	126.5	8	1.8	0.18	1.59
Bovines between 6 months and 1 year: female	85.1	8	1.2	0.18	1.36
Bovines more than 1 year for fattening: male	195.9	8	2.8	0.18	3.12
Bovines more than 2 years for reproduction: male	182.6	8	2.6	0.18	3.89
Bovines female between 1 and 2 years	128.6	8	1.9	0.18	2.74

Bovines female older than 2 years	120.4	8	1.7	0.18	2.56
Dairy cattle	287.6	8	4.2	0.24	14.03
Brood cattle	202.5	8	2.9	0.18	2.72
Piglet under 20 kg	NE	NE	0.26	0.45	4.29
Piglet between 20 and 50 kg	NE	NE	0.26	0.45	4.29
Fattening pigs more than 50 kg	NE	NE	0.26	0.45	4.29
Swine	NE	NE	1.05	0.45	13.67
Fully grown male and female pigs	NE	NE	1.10	0.45	14.16
Brussels					
Dairy cattle	286	8	4.3	0.24	14.03
Brood cattle	216	8	3.1	0.18	2.96
Other female bovine > 2 years	131	8	1.9	0.18	2.62
Heifers for slaughter > 2 years	131	8	1.9	0.18	2.62
Male bovine > 2 years	199	8	2.9	0.18	2.99
Female bovine between 1 and 2 years	136	8	2.0	0.18	2.80
Heifers for slaughter between 1 and 2 years	136	8	2.0	0.18	2.80
Male bovine between 1 and 2 years	198	8	2.9	0.18	3.06
Slaughter calves	49	8	0.7	0.18	1.29
Other female bovine < 1 year	90	8	1.3	0.18	1.39
Other male bovine < 1 year	134	8	1.9	0.18	1.89
Piglets < 20 kg	NE	NE	0.263	0.45	4.29
Sows	NE	NE	1.052	0.45	13.67
Breeding males	NE	NE	1.096	0.45	14.16
Swine >=50 kg	NE	NE	0.263	0.45	4.29

Table 5.14: Overview of the factors used in 2022 to calculate the CH_4 emission from manure management for cattle and swine in Belgium

The methane conversion factors for each manure management system (table 5.15) are harmonized between the three regions and originate from the IPCC 2006 Guidelines. The MCF's corresponding to 11°C is used because the average temperature (over different years) in Belgium is 11.5°C.

Manure Management System	MCF
MCF pit storage below animal confinements*	19%
MCF daily spread MCF dry lot	0.10% 1%
MCF solid storage*	2%
MCF poultry manure	1.5
MCF pasture, range and paddock	1%

Table 5.15: The methane conversion factors (%) for each manure management system

The fraction manure handled in each management system (MS%) is region-specific. The allocation of animals to AWMS originates in Flanders from the Agency for Agriculture and Fisheries. In Wallonia and Brussels, the allocation of animals to each animal waste management system (AWMS) comes from the STATBEL agricultural census of 1992 and 1996, where those data were published by animal type. Those data are not collected yearly by the STATBEL given their slow pace of change. The factors are presented in tables 5.17 and 5.18 under nitrous oxide emissions.

Non-key sub-source categories

Sheep, goats, poultry, horses, mules and asses are no key source categories. The tier 1 methodology from the IPCC 2006 GL is used in each region.

Trend in implied emission factor

The table below gives a summary of the evolution of the IEFs of the key source categories in the 3 regions. The IEF for manure management of dairy cattle increased significantly between 1990 and 2022. This can be explained by the increased milk production (and increased feed intake) in that period which results in a higher manure production per cow and a higher organic matter content of the cattle manure.

IEF (kg CH_4/head.yr)	**1990**	**2000**	**2005**	**2010**	**2015**	**2020**	**2021**	**2022**
Flanders								
Dairy cattle	12.20	16.88	21.33	26.63	30.35	33.21	32.97	33.57
Non-dairy cattle	3.84	3.67	3.58	3.31	3.12	3.17	3.18	3.18
Swine	4.69	4.71	4.64	4.54	4.46	4.44	4.43	4.43
Wallonia								
Dairy cattle	9.83	11.96	12.83	13.29	13.51	14.13	13.93	14.03
Non-dairy cattle	2.23	2.36	2.40	2.41	2.47	2.45	2.45	2.45
Swine	5.56	5.22	4.94	4.73	4.64	4.60	4.59	4.59
Brussels								
Dairy cattle	9.83	11.96	12.83	13.29	13.51	14.13	13.93	14.03
Non-dairy cattle	2.26	2.49	2.44	2.27	2.29	2.27	2.26	2.26
Swine	6.00	4.29	4.29	4.65	4.87	4.82	4.83	4.83

Table 5.16: Methane IEF (kg CH_4/head/yr) for manure management for the key source categories (1990-2022) in the three regions

5.3.2.2 Nitrous oxide

Direct nitrous oxide emissions from animal manure are calculated by following the Tier 2 methodology of the IPCC 2006 Guidelines (equation 10.25) and so by multiplying the nitrogen content of the manure produced by a certain animal category, in a defined animal waste management system (AWMS), with the corresponding N_2O emission factor. N_2O emission factors used for solid, dry lot, pit storage below animal confinements and poultry manure with and without litter are IPCC defaults from table 10.21 from the IPCC 2006 Guidelines (respectively 0.005, 0.02, 0.002, 0.001 and 0.001 kg N_2O-N/kg N excreted).
Indirect nitrous emissions from animal manure result from volatile nitrogen losses that occur primarily in the forms of ammonia and NO_x. The indirect N_2O emission is calculated as a fraction of the nitrogen excreted that volatilised as NH_3 and NO_x and the default emission factor from the IPCC 2006 (Tier 1, equation 10.27).
The method used in the three regions is fully in compliance with the IPCC 2006 Guidelines. N_2O emissions from manure produced by grazing animals are not taken into account into category 3.B but are included in the category 3.D, managed soils, as described in the IPCC 2006 Guidelines. When relevant, the Belgian parameters are established from a weighting of the regional parameters on the basis of the relevant activity data.

Direct N_2O emissions from manure management: 3.B.2.1 – 3.B.2.4

N-excretion factors (Nex):

The N_2O emission estimation from manure management is based on the nitrogen excreted by each animal category, estimated through local production factors. Therefore, these are region specific factors. The calculation takes into account the number of days in pasture and in the different animal waste management systems: pit storage below animal confinements, solid storage, dry lot and poultry manure with and without litter, which also are region specific data. Therefore, a Tier 2 method is used.
The three regions use different N-excretion factors. Tables 5.17 and 5.18 give an overview of the nitrogen excretion factors used in the three regions. The Belgian parameters are established from a weighting of the regional parameters on the basis of the relevant activity data.

Flanders
For the N-excretion factors of swine and poultry in Flanders, a farmer can choose to use the standard excretion factors (no special effort to reduce N and/or P production). Or they can choose (or in some cases are obliged) to use the other systems (regressive balance, animal feed covenant, a complete fodder (input-output) balance). These data are obtained by the Manure Bank of the Flemish Land Agency and this for each agricultural exploitation (farmer) and for each year. Therefore N-excretion factors for swine and poultry can change from year to year, following the on field situation. The N-excretion factors of cattle, sheep, goats, horses, mules and rabbits used in 2022 were established by the manure decree (or MAP6), and can be found in:
https://www.vlm.be/nl/SiteCollectionDocuments/Publicaties/mestbank/bemestingsnormen_2022.pdf.
Unfortunately, no translation in English is available.

For dairy cows, in MAP6, these N-excretion factors depend on the average milk production per cow.

Wallonia and Brussels
In Wallonia and Brussels, Nex factors are derived from the information in the PGDA, the Walloon program for sustainable use of nitrogen built for the implementation of the EU Nitrates Directive 91/676 (see annexes of the decree downloadable on https://www.protecteau.be/fr/le-pgda). The figures in the PGDA represent the Nex after deduction of the atmospheric losses. To estimate the Nex including the atmospheric losses, it is assumed a mean atmospheric loss of 25%. During the ESD review of June 2020, new values for "Other cattle" were available in the last PGDA (2014), so new emission factors have been updated based on these parameters. From the 2021 submission, the Nex evolution follows the values of the different PGDA (<2007, 2008-2014, >2015).
Concerning the %AWMS, the number of days in stable was identified from the surveys and this allowed for the estimate of the fraction of livestock grazed and the fraction of those stayed in the stable. The percent fraction of solid and liquid was deduced from; (1) the amount of manure produced by animal in the different "Manure management systems" (MMS) coming also from the PGDA, and (2) from the number of places in the different manure management systems, coming from the national statistics STATBEL.

Animal waste management system (AWMS):
The animal waste management systems used in Belgium differ between the three regions. In all three regions swine and poultry stay 100% of their lifetime in house (with exception of ostriches in Flanders). The differences between the regions and the origin of the data are given in the tables 5.18 and 5.19 hereunder. In CRT table 3B of Belgium, a theoretical weighting of the regional parameters on the basis of the relevant activity data for each region is made.

Flanders
In Flanders the allocation of animals to AWMS originate from the Agency for Agriculture and Fisheries and is based on expert judgement for each category combined with questionnaires. The experts work for the Agency for Agriculture and Fisheries and the Flemish Land Agency and have a good eye on the field situation. Every 5 years the allocation between AWMS in Flanders is reconsidered. The last update was in 2016 (previous updates were in 1990, 1996, 2001, 2006 and 2011). No interpolation was made between years with updated AWMS distribution information. Table 5.17 gives an overview of the different systems used for each detailed animal category.

Category	**Nex (kg N/animal/yr)**	**AWMS (%)**
Bovine		
Slaughter calves	10.5	100% pit storage
Other bovine under 1 year		
for replacement	33	8% pit storage 26% solid storage 6% pasture 60% dry lot
other bovine	22.3	6% pit storage 3% solid storage 1% pasture 90% dry lot

Bovine from 1 to 2 year		
for replacement	58	62% pit storage 8% solid storage 6% pasture 24% dry lot
other	58	8% pit storage 7% solid storage 85% dry lot
Bovine more than 2 years	77	22% pit storage 9% solid storage 69% dry lot
Dairy cows	123.53	60% pit storage 9% solid storage 14% pasture 17% dry lot
Brood cows	65	4% pit storage 5% solid storage 55% pasture 36% dry lot
Sheep		
Sheep under 1 year	4.36	10% solid storage 90% pasture
Sheep more than 1 year	10.5	ditto
Goats		
Goats under 1 year	4.36	95% solid storage 5% pasture
Goats more than 1 year	10.5	ditto
Swine		
Piglet from 7 to 20 kg	2.28	99% pit storage 1% dry lot
Fattening pigs from 20 to 110 kg	10.39	ditto
Fattening pigs more than 110 kg	20.86	98% pit storage 2% dry lot
Boars	20.76	69% pit storage 15% solid storage 16% dry lot
Sows including piglets less than 7 kg	21.17	98% pit storage 2% dry lot
Horses		
Horses and pony less than 200 kg	35	60% solid storage 40% pasture
Horses and pony from 200 to 600 kg	50	ditto
Horses more than 600 kg	65	ditto
Rabbit		
Rabbits closed housing	7.22	100% solid storage
Rabbits for breeding	3.06	ditto
Rabbits for fattening	0.62	ditto
Furred animals		
Furred animals closed housing	2.3	100% solid storage
Furred animals for breeding	0.9	ditto
Furred animals for fattening	0.7	ditto

Poultry		
Broilers (for breeding)	0.39	100% poultry manure with litter
Broilers (parental animals)	1.08	87% poultry manure with litter 13% poultry manure without litter
Broilers (for fattening)	0.52	100% poultry manure with litter
Laying hens (for breeding)	0.33	36% poultry manure with litter 64% poultry manure without litter
laying hens	0.77	33% poultry manure with litter 67% poultry manure without litter
Turkeys (for fattening)	1.70	100% poultry manure with litter
Turkeys (parental animals)	2.00	ditto
Ostriches (between 0-3 months)	3.5	ditto
Ostriches (for fattening)	8.6	40% pasture 60% poultry manure with litter
Ostriches (for breeding)	18	20% pasture 80% poultry manure with litter
Other poultry	0.24	100% poultry manure with litter

Table 5.17: Nitrogen excretion factors and allocation of animals to AWMS for each category in Flanders (2022)

Wallonia and Brussels

In Wallonia and Brussels, the allocation of animals to AWMS comes from the STATBEL agricultural census of 1992 and 1996. These data were published by animal type. The agricultural census allows a detailed disaggregation in subcategories according to the age or the weight of the animals. The AWMS data are not collected yearly by the STATBEL given their slow pace of change. The factors are presented in table 5.18. This table gives an overview of the ratio of liquid and solid manure for the main animal categories. The pace of change is slow between 1992 and 1996 for AWMS. However, although changes are limited for many subcategories, they have significant impact on emissions for some important categories, such as dairy cows. An update of the 1996 data would likely be useful in the future. So far, we have no information about a possible STATBEL update.

The last column of the table gives the ratio per animal category of in housing system versus pasture.

Animal category	**Nex**	**1992**		**1996**		**1992-1996**
	(>2015)	**Solid manure**	**Liquid manure**	**Solid manure**	**Liquid manure**	**Stable vs pasture**
	(kg N/animal/yr)	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
Bovines under 6 months	13.39	86	14	87	13	100
Bovines between 6 months and 1 year: male	33.48	94	6	90	10	50
Bovines between 6 months and 1 year: female	37.50	88	12	87	13	50
Bovines more than 1 year for fattening: male	88.39	88	12	87	13	50
Bovines more than 2 years for reproduction: male	88.39	78	22	77	23	50
Bovines female between 1 and 2 years	64.29	78	22	77	23	50
Bovines female older than 2 years	64.29	78	22	77	23	50
Brood cows	88.39	93	7	91	9	50
Dairy cows	120.54	63	37	56	44	56
Piglet under 20 kg	2.54	20	80	25	75	100
Piglet between 20 and 50 kg	10.45	20	80	25	75	100
Fattening pigs more than 50 kg	6.3	20	80	25	75	100
Sows	20.09	54	46	42	58	100

Breeding males	20.09	45	55	43	57	100
Lambs	4.42	100	0	100	0	100
Sheep <1 year	4.42	100	0	100	0	50
Sheep >1year	8.84	100	0	100	0	50
Goats <1year	4.42	100	0	100	0	50
Goat > 1 year	8.84	100	0	100	0	50
Horses	77.01	100	0	100	0	50
Broilers	0.36	78	22	89	11	100
Laying hens	0.80	3	97	6	94	100
Other poultry	0.60	48	52	26	74	100

Table 5.18: Nitrogen excretion factors in Wallonia and Brussels, and allocation of animals to AWMS for each category in Wallonia and Brussels. Evolution between 1992 and 1996 data from STATBEL

Indirect N_2O emissions from manure management: 3.B.2.5

$Frac_{GasM}$:
For the calculation of the indirect N_2O emissions form manure management, the tier 2 methodology with equation 10.26 from the IPCC 2006 Guidelines is used. The fraction $Frac_{GASM}$ is different for the three regions and is therefore discussed separately. The Belgian submission results from the aggregation of $Frac_{GASM}$ of the three regional inventories. Therefore, the Belgian parameters for agriculture are established from a weighting of the regional parameters on the basis of the relevant activity data. It is not possible to harmonize the methodology from all regions as each region uses its own methodology (in compliance with IPCC 2006 GL). Belgian emissions are summations of each regional inventory.

Flanders
The N volatilised as NH_3 from manure management systems ($Frac_{GasM}$) is derived from the model used to calculate the respective NH_3 emissions (41). The Emission Model Ammonia Flanders (EMAV) is a conceptual model and has been developed to follow the N-flow throughout the individual farm and takes into account activities at the farm and during manure processing, emissions at different stages (indoor stable, outdoor storage of manure, manure application to land and emissions from grazing animals), recent legislation and manure transport to and from the farm. This model also calculates the NH_3 emission from fertilizer use. The output of the model is the NH_3-emission for each stage and is used as inputdata for the N_2O-model: NH_3-emission from manure management, NH_3-emission form inorganic fertilizer use, NH_3-emission from animal manure applied to soils, NH_3-emission from other organic fertilizers applied to soils (including compost). $Frac_{GASM}$ is estimated by taking into account the NH_3-N emitted in the stable (calculated with the EMAV model) in relation to the N excreted by the animals in the stable (calculated in the N_2O-model). For $Frac_{GasM}$, in the N_2O-model, no distinction is made between animal category or AWMS. In EMAV on the other hand, the NH_3-emission is of course calculated taking into account different AWMS/stable types/animal categories. The input data used by the EMAV model is very detailed and originates from the Manure Bank of the Flemish Land Agency. It is based on data reported by the farmers, i.e. animal numbers, animal category, stable type, % liquid manure, feeding techniques and N reduction measures. The Flemish Land Agency performs quality checks to validate the reported data. During the different calculation steps in EMAV, quality control checks are performed. At different steps pop ups appear to verify whether the right input data is used (e.g. version of calculation factors, figure 5.1) or to inform the user something unusual has been detected (e.g. empty rows or columns, figure 5.2) or an overview of the result of the programmed controls performed (figure 5.3). In 2020 an external validation of the previous EMAV model was carried out by the Flemish Institute of Technical Research (VITO) on behalf of VMM. A summary in English is given in annex 3b of this NID. The outcome of the validation will be prioritized and integrated in the model during the following years/revisions. Also each year, when relevant, the results of the Review of National Air Pollutant Emission Inventory Data are taken into account.

The rate for NO volatilisation is 1.5% and stays constant over the entire time series. This factor is based on extensive field campaigns measuring NO emissions, representing the intensive Flemish agriculture (42) (43).

The fraction volatilised from manure management systems (indoor stable) as NH_3 and NO in Flanders ($Frac_{GASM}$) varies from 0,14 kg(NH_3-N+NO-N)/kg Nex in 1990 to 0,15 kg(NH_3-N+NO-N)/kg Nex in 2022. The $Frac_{GASM}$ in Flanders is lower than the default values in table 10.22. In Flanders stables for poultry and swine have to be built in an NH_3-emission poor way. The success of the implementation of these and other manure management techniques is reflected in the lower NH_3-emissions. This can explain the lower $Frac_{GASM}$.

In 2021-2023 a study was performed to revise the N_2O-model. This new integrated model is an extension of the EMAV2.1-model and calculates NH_3- and NO-emissions and therefore follows the N-flow throughout the farm in a more integrated way. The model already foresees in the implementation of the calculation of the greenhouse gases in the future. With this new model it is possible to have a $Frac_{GasMS}$ for each animal category and each manure management system. This study was not yet finished for the 2024 submission. Because of the postponed delivery of the study, the results of the study have not yet been implemented in a new time series for the emission-inventory in Flanders. Flanders will examine whether implementation in the 2025 submission is possible.

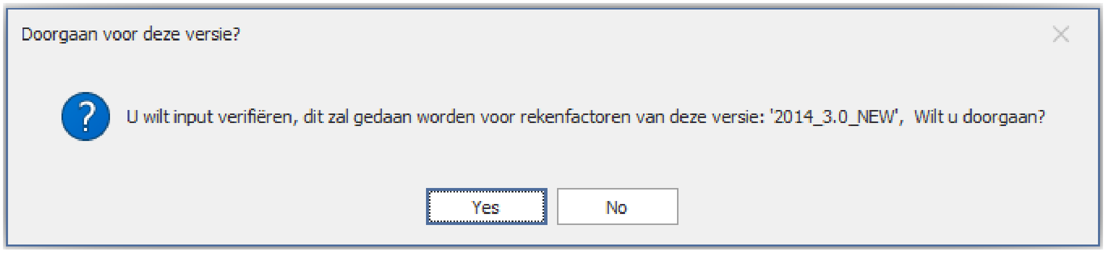


Figure 5.2: Pop up in the EMAV model to verify whether the correct version of the calculation factors is selected.

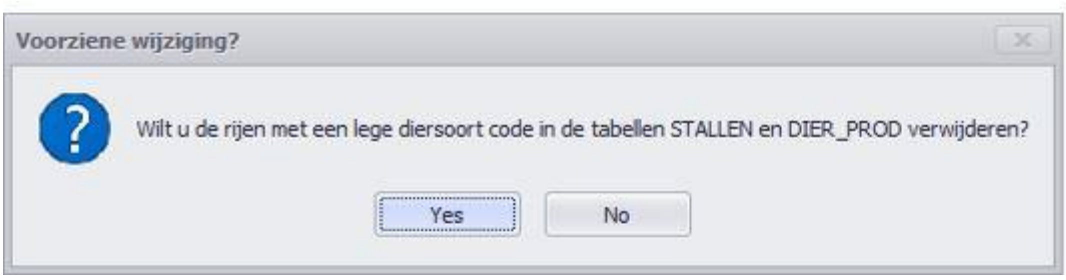


Figure 5.3: Pop up in the EMAV model to verify whether empty rows can be deleted.

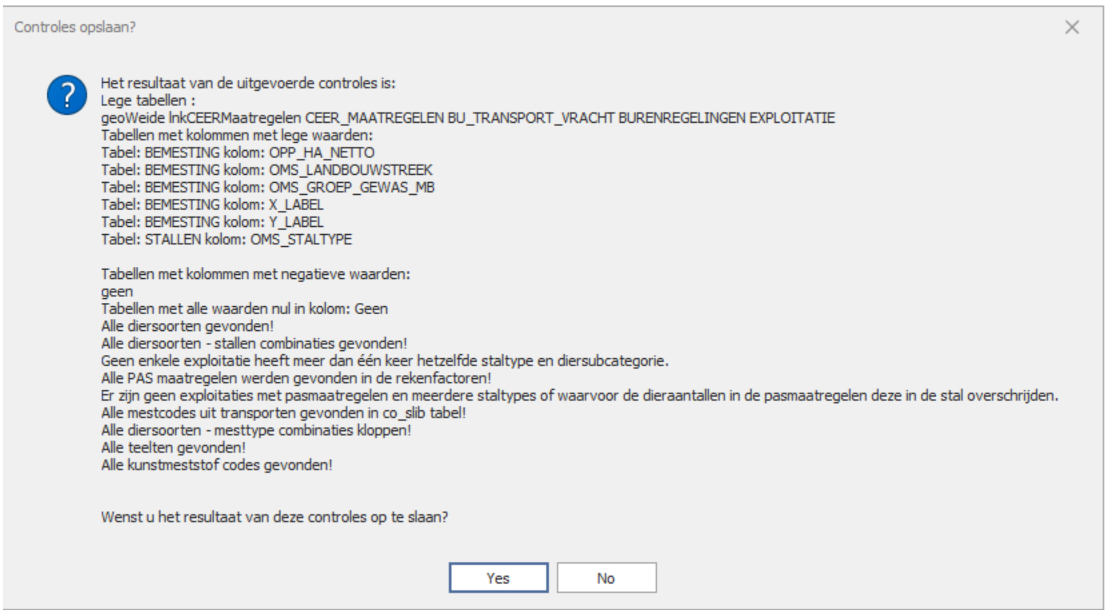


Figure 5.4: Pop up in the EMAV model giving an overview of the results of the automatic checks.

Wallonia and Brussels
In Wallonia and Brussels, the N volatilised as NH_3 ($Frac_{GasM}$) is also derived from the methodology to calculate the NH_3 emissions. The methodology was updated to follow the 2019 EMEP Guidebook. The coherency of the N cycle is then improved between the inventories.
The global fraction volatilised from manure management systems (indoor stable) as NH_3 and NO in Wallonia and Brussels ($Frac_{GASM}$) varies from 0.21 kg(NH_3-N+NO-N)/kg Nex in 1990 to 0.22 kg(NH_3-N+NO-N)/kg Nex in 2022.
The table 5-19 provides the $Frac_{GasMS}$ values used for the key animal categories in Wallonia and Brussels.

$Frac_{GasMS}$	Wallonia	Brussels
Dairy – slurry	27%	27%
Dairy – solid	17%	18%
Other cattle – slurry	27%	27%
Other cattle - solid	19%	19%
Swine – slurry	26%	27%
Swine - solid	26%	28%

Table 5.19: $Frac_{GasMS}$ values used in Wallonia and Brussels for 2022

$Frac_{leachMS}$:
For Wallonia and Brussels, the fraction of nitrogen that is lost through leaching/runoff ($Frac_{LEACH}$) is also derived from the NH_3 methodology. In the 2016 EMEP Guidebook the default value is 12 % as a proportion of TAN for solid manure entering in storage. This leads to values varying from 2.34 kt N in 1990 to 1.7 kt N in 2022 for Wallonia, and 928 kg N in 1990 to 459 kg N in 2022 for Brussels. The EF used is the IPCC default one (0.0075 kg N_2O-N / kg N, see Table 11.3 in 2006 IPCC GL).

For Flanders, no region-specific information is available on the fraction of nitrogen loss due to leaching and runoff from manure management systems. So, equation 10.28 could not be applied. In Flanders it is compulsory to store manure on a hard, impermeable surface, independent of whether manure storage occurs inside or outside the stable.

5.3.3 Uncertainties and time-series consistency

The activity data are the livestock census, but also the type of animal housing. The type of housing is more difficult to assess than the number of animals. Consequently, the uncertainty on the activity data is estimated at 10%.

The CH_4 emission factors are based on a regional-specific study. However, given that many assumptions were necessary to calculate these emission factors, the uncertainty on these emission factors is estimated to be twice the uncertainty used on enteric fermentation emission factor.

The IPCC emission factors are used to calculate the emissions of N_2O. Consequently, the IPCC uncertainty (page 4.43) in combination with information of the Finnish emission inventory, are used in the uncertainty calculation.

For the category 3B5 'indirect N_2O emissions' higher uncertainties are used: 30% for the activity data and 250% for the emission factor (see chapter 5.4.3).

5.3.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key sub-source categories and can be provided by the Belgian experts on request.

5.3.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In the Brussels-Capital Region, the correction of the calculation method of indirect N_2O emissions from manure management, in line with the methodology applied in Wallonia, resulted in a decrease of the emissions, of 19 tCO_2eq in 1990 and 10 tCO_2eq in 2021.

In the Brussels-Capital Region, the correction of the coefficient corresponding to animal’s feeding situation for non-dairy cattle (Ca) from grazing large areas to pasture resulted in a decrease of the emissions, of 2 tCO_2eq in 1990 and 1 tCO_2eq in 2021.

5.3.6 Source-specific planned improvements, if applicable including those in response to the review process

In Flanders, at the end of 2018, a Working Group on Emissions was set up to examine (among other things) the possibility to give an evolution in time for some of the parameters needed to obtain a year-dependent IEF for non-dairy cattle. In 2019 a Steering Body ‘Convenant Enteric Emissions’ was set up by the Flemish Government as well as a Working Group ‘Monitoring and assurance (of management and emissions)’ which contains experts from different agricultural and environmental domains in Flanders. The goal of the Convenant is to reduce the CH_4-emissions from enteric fermentation (cattle) till 2030. Flanders Environment Agency (VMM) engaged for the monitoring of the CH_4-emissions from the different animal categories (cattle) in Flanders. Therefore in 2021-2023 the CH_4-emission model was revised taking into account the implementation of measures with CH_4-reducing potential and taking into account the before mentioned parameters. In this study not only the methodology and parameters for the estimation of CH_4-emissions from enteric fermentation processes were revised. Also the methodology and parameters to calculate CH_4- and N_2O-emissions from manure management and N_2O-emissions from agricultural soils were taken into account. All parameters used and activity data were reexamined where necessary. Where possible/available an evolution of the parameters in time is given. Further analysis of region specific calculation factors is needed.
Also, the methodology to calculate the NO_x emissions from manure management and agricultural soils is revised. This new integrated model is an extension of the EMAV2.1-model and calculates NH_3- and NO-emissions and therefore follows the N-flow throughout the farm in a more integrated way. The model already foresees in the implementation of the calculation of the greenhouse gases in the future.
The study was performed by ILVO and was commissioned by the VMM. The Steering Body and Working Group replaces the Working Group on Emissions set up in 2018. The kick-off of the Steering Body was given January 18, 2021. This study was not yet finished for the 2024 submission. Because of the postponed delivery of the study, the results of the study have not yet been implemented in a new time series for the emission-inventory in Flanders. Flanders will examine whether implementation in the 2025 submission is possible.
In Wallonia, the percentage of MMS and the fraction of livestock grazing are still data to update. Work has to be done for next submission. Also, it is foreseen to apply the IPCC 2019 GL methodology for next submission.
In all the three regions, small improvements are inherent to the inventory process and occur yearly. Also, in 2024 a continuous control/update of the used activity data and parameters will occur where necessary. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

5.4 Managed soils (CRT 3.D)

5.4.1 Source category description

As described in the IPCC 2006 Guidelines, the N_2O emission estimation from agricultural soils in Belgium can be divided into:

- Direct soil emissions from the application of inorganic fertilizers, animal manure and sewage sludge, crop residues, mineral soils and the cultivation of histosols (3D1.1, 3D1.2, 3D1.4 - 3D1.6);
- Emissions from animal production by grazing animals (3D1.3);

- Indirect emissions from N-leaching and runoff and from atmospheric N deposition (3D2).

Table 5.20 gives an overview of the methodologies used in the three regions to calculate the N_2O emissions from managed soils.

A list of parameters used to calculate the N_2O emissions in the three regions is given in annex 3.

Used methodology	Flanders	Wallonia	Brussels
Direct N_2O emissions 3.D.1			
3.D.1.1 and 3.D.1.2 Emissions from application of inorganic fertilizers, animal manure and sewage sludge	IPCC 2006 GL (Tier 1)		
3.D.1.3 Emissions from grazing			
3.D.1.4 Emissions from crop residues			
3.D.1.5 Emissions from mineral soils			
3.D.1.6 Emissions from cultivation of organic soils			
Indirect N_2O emissions 3.D.2			
3.D.2.1 Emissions from atmospheric deposition	IPCC 2006 GL (Tier 2)	IPCC 2006 GL (Tier 1)	IPCC 2006 GL (Tier 1)
3.D.2.2 Emissions from nitrogen leaching and runoff	IPCC 2006 GL (Tier1)		

Table 5.20: Overview of the methodologies used in the three regions

5.4.2 Methodological issues

Direct soil emissions: 3.D.1

The direct N_2O emissions are calculated according to the tier 1 methodology as described in the IPCC 2006 Guidelines using country or region-specific data when available. The same methodology is used in all 3 regions, using the equation 11.1. In Wallonia and Brussels however no cultivated organic soils are present, therefore that part of the equation is not taken into account in the Walloon and Brussels regions.

$$N_2O_{direct}\text{-}N = [(F_{SN} + F_{ON} + F_{CR} + F_{SOM}) * EF_1]+ [F_{OS,CG,Temp} * EF_{2CG,Temp}] + [(F_{PRP,CPP} * EF_{3PRP,CPP})+(F_{PRP,SO} * EF_{3PRP,SO})]$$

where:
F_{SN} = amount of synthetic fertilizer nitrogen applied to soils
F_{ON} = amount of animal manure nitrogen, compost, sewage sludge applied to soils
F_{CR} = amount of nitrogen in crop residues returned to soils;
F_{SOM} = amount of nitrogen in mineral soils that is mineralised;
$F_{OS,CG,Temp}$ = the area of managed/drained organic soils, cropland and grassland, Temperate;
$F_{PRP,CPP}$ = amount of urine and dung nitrogen deposited by grazing animals (cattle, poultry, pigs) on pasture
$F_{PRP,SO}$ = amount of urine and dung nitrogen deposited by grazing animals (sheep, other) on pasture
EF_1 = N_2O emission factor for emissions from direct nitrogen inputs (kg N_2O-N/kg N);
$EF_{2CG, Temp}$ = N_2O emission factor for emissions from drained/managed organic soils cropland and grassland, Temperate (kg N_2O-N/kg ha);
$EF_{3PRP,CPP}$= N_2O emission factor for emissions from urine and dung N deposited on pasture (cattle, poultry, pigs);
$EF_{3PRP,SO}$ = N_2O emission factor for emissions from urine and dung N deposited on pasture (sheep, other).

<u>Application of Synthetic fertilizer: F_{SN} (3.D.1.1)</u>
Table 5.21 gives an overview of the origin of the activity data (AD) and the implied emission factor (IEF) used in the three regions. The amount of synthetic fertilizer use (F_{SN}) can be found in table 5.22. The amount used, as well as the data sources, is different in the three regions. Therefore the 3 regions are discussed separately.

AD & IEF & fraction used	Flanders	Wallonia	Brussels
F_{SN}	Region specific: Agency for Agriculture and Fisheries and Flemish Land Agency	Region specific: Ministry of environment and agriculture	Value from Wallonia
IEF	Default IPCC 2006 GL		

Table 5.21: Overview of the origin of AD and IEF used in the 3 regions

Flanders
In Flanders the Agency for Agriculture and Fisheries conducts surveys on a representative sample of different types of agricultural businesses and produces yearly weighted averages on the fertilizer use, taking into account manure pressure and soil type (44)(table 5.22). This information is combined with data collected by the Flemish Land Agency.

Wallonia
In Wallonia, the fertilizer use (N) is obtained by the department of Natural and agricultural land of the Ministry of environment and agriculture (Direction of the agricultural economy analysis).

Brussels
In Brussels the amount of synthetic fertilizer applied is estimated by taking the average amount of fertilizer in kg N per ha in Wallonia.

Synthetic fertilizer use (kton N)	1990	2000	2005	2010	2015	2020	2021	2022
Flanders	110.06	75.71	71.98	74.21	80.18	87.57	82.52	68.11
Wallonia	100.11	87.08	75.76	75.00	71.72	69.63	67.23	54.35
Brussels	0.10	0.06	0.04	0.03	0.03	0.03	0.03	0.03

Table 5.22: The amount of synthetic fertilizer use (kton N) in each region between 1990 and 2022

<u>Application of animal manure: F_{ON} (3.D.1.2)</u>
The N_2O emissions from animal manure application are calculated in the same way as N_2O emission from mineral fertilizer application using the following formulas: equations 11.3 and 11.4 of the IPCC 2006 GL.

$$F_{ON} = (N_{MMS\ Avb} * [1-(Frac_{FEED} + Frac_{FUEL} + Frac_{CNST})]) + F_{SEW} + F_{COMP} + F_{OOA}$$

where
$N_{MMS\ Avb}$ = amount of managed manure N available for soil application, feed, fuel or construction (kg N);
$Frac_{FEED}$ = fraction of managed manure used for feed = 0;
$Frac_{FUEL}$ = fraction of managed manure used for fuel = 0;
$Frac_{CNST}$ = fraction of managed manure used for construction = 0;
F_{SEW} = amount of total sewage N applied to soils (kg N);
F_{COMP} = amount of compost N applied to soils (kg N);
F_{OOA} = amount of other organic amendments used as fertilizer (kg N) = 0.

The total nitrogen excreted per animal category is described above in 5.3.2.2 (nitrous oxide emission from manure management).
In Belgium, no animal manure is burned, used for construction or for feed. This is indicated with the notation key ‘NO’ and $Frac_{FUEL}$, FracCNST and $Frac_{FEED}$ = 0. F_{SEW} is only calculated in Wallonia. In Flanders no sewage sludge spreading is allowed and in Brussels it does not take place.

Table 5.23 gives an overview of the origin of the activity data (AD), implied emission factor (IEF) and the fractions used.

AD, EF and Fraction used	Flanders	Wallonia and Brussels
$N_{MMS\ Avb}$	Region specific: Manure Bank	Region specific: PGDA
$Frac_{FEED}$	NO	NO
$Frac_{FUEL}$	NO	NO
$Frac_{CNST}$	NO	NO
F_{SEW}	NO	Walloon Soils and Waste Department (For Brussels : Fsew = 0)
F_{COMP}	Manure Bank (VLM)	Walloon Soils and Waste Department
F_{OOA}	NO	Walloon Soils and Waste Department
IEF	Default IPCC 2006 GL	

Table 5.23: Overview of the origin of AD, fractions and IEF used in the 3 regions

Flanders

In Flanders, $N_{MMS\ Avb}$ in the equation above is calculated taking into account the manure produced (including the imported manure), but minus exported manure. Rationale: because of the severe manure surplus in Flanders, a Manure Action Plan (MAP) has been set up. The first in 1991 with the manure decree which reduced the period in which manure can be spread and foresees for the first time in the emission poor application of manure on land. The MAP2bis in 2000 focuses on the reduction of the manure surplus and manure processing in order to reduce the NH_3 emissions from manure application on land. Other MAP's followed. These successive MAP's have a positive effect on the NH_3 and N_2O emission. Among other things, the MAP describes the amount of manure that a farmer can apply to his agricultural soils. Briefly, this depends on the proportion of the amount manure produced to the available agricultural soils of that farmer. The manure surplus (the part that may not be applied to the soil) must be either exported or processed. On the level of the farmer, exporting can be export to another farmer, to another country, to a manure processor or others. On the level of the entire region, this means that there is a net export of manure out of Flanders. Therefore, in Flanders the animal manure nitrogen applied to land (total N excreted) is first corrected for the amount of manure transported outside Flanders or to a fertilizer processing company before calculating the N_2O direct and indirect soil emissions. This amount (net export) is inventoried by the Manure Bank of the VLM and yearly published as the 'manure balance' in the following progress reports: https://www.vlaanderen.be/publicaties/mestrapport. Unfortunately, there is no translation in English available. So, in other words, manure that is not applied to the soils in Flanders, cannot lead to direct or indirect N_2O emissions in Flanders. On the other hand, manure that is imported in Flanders and applied to Flemish soils does lead to direct or indirect N_2O soil emissions. This as well has been taken into account for the N_2O direct and indirect calculation. Although most imported manure goes directly to a processing company. The main countries to which manure from Flanders is exported are France, the Netherlands and Germany. Export from Flanders to Wallonia is prohibited.
In annex 3a a table can be found in which the setup of the manure balance numbers in Flanders is described for 2022. The yearly amount of compost spread on agricultural soils originates from the Manure Bank of the Flemish Land Agency.

Wallonia

In Wallonia, the amount of managed manure N available for soil application has been harmonized with the NH_3 methodology to improve the coherency of the N cycle between the inventories. The amount of sludge and compost spread on agricultural soils is reported every year to the Soils & Waste Department. Analyses of the sludge and other organic amendments are conducted to certify that they have the good composition for agricultural use (agronomic parameters) and they satisfy environmental norms. These analyses allow to improve the estimation of the N content of the different organic fertilisers applied (compost, sludge and digestates), since 2013.

Brussels

No sludge is spread on agricultural soils in Brussels.

Urine and dung from grazing animals: F_{prp} (3.D.1.3)
Nitrogen excreted by grazing animals is estimated, taking into account the number of days in pasture and the nitrogen excreted by each animal category (see table 5.17 and 5.18). The equation 11.5 from the IPCC 2006 Guidelines is used.

$$F_{PRP} = \sum[(N_{(T)} * N_{ex(T)}) * MS_{(T,PRP)}$$

Where
$N_{(T)}$ = number of head of livestock category T
$N_{ex(T)}$ = annual average N excretion per head of category T (kg N/animal.yr)
$MS_{(T,PRP)}$ = fraction of total annual N excretion for each livestock category T that is deposited on pasture, range and paddock.

The IPCC default emission factors of table 11.1 from the IPCC 2006 Guidelines are used. For cattle, poultry and pigs, the emission factor of 0.02 kg N_2O-N / kg N excreted is used and 0.01 kg N_2O-N / kg N for sheep and other animals.
Table 5.24 gives an overview of the origin of the activity data (AD) and implied emission factor (IEF) used.

AD & EF used	Flanders	Wallonia and Brussels
Nex grazing	Region specific: Manure Bank	Region specific: PGDA
$MS_{(PRP)}$	Region specific: Agency for Agriculture and Fisheries	Region specific
IEF	IPCC 2006 GL (table 11.1)	

Table 5.24: Overview of the origin of AD and IEF used in the three regions

Crop residue N, including N-fixing crops and forage/pasture renewal, returned to soils: F_{CR} (3.D.1.4)
The methodology used for estimating the amount of nitrogen in crop residues returned to soils (F_{CR}) is based on equation 11.6 from the IPCC 2006 Guidelines (8th corrigenda for the 2006 IPCC Guidelines).

$$F_{CR} = \sum\{Crop_{(T)} * Frac_{Renew(T)} * [(Area_{(T)} - Areaburnt_{(T)} * C_f) * R_{AG(T)} * N_{AG(T)} * (1-Frac_{Remove(T)}) + Area_{(T)} * R_{BG(T)} * N_{BG(T)}]\}$$

Where
$Crop_{(T)}$ = harvested annual dry matter yield for crop T (kg dm/ha);
$Frac_{Renew(T)}$ = fraction of total area under crop T that is renewed annualy = 1;
$Area_{(T)}$ = annual area harversted of crop T (ha);
$Areaburnt_{(T)}$ = area of crop T burnt (ha);
C_f = combustion factor;
$R_{AG(T)}$ = ratio of above-ground residues dry matter to harvested yield for crop T;
$N_{AG(T)}$ = N content of above-ground residues for crop T (kg dm);
$Frac_{Remove(T)}$ = fraction of above-ground residues of crop T removed annually for feed, bedding and construction;
$R_{BG(T)}$ = ratio of below-ground residues to harvested yield for crop T;
$N_{BG(T)}$ = N content of below-ground residues for crop T (kg N).

Table 5.25 gives an overview of the origin of the activity data (AD), fractions and implied emission factor (IEF) used.

AD & EF & fraction used	Flanders/Wallonia/Brussels
Crop production	Statistics Belgium
Cultivated crop area	Statistics Belgium
Dry matter content	Region specific or IPCC 2006 GL (table 11.2)
$Frac_{Renew}$	IPCC 2006 GL
$Frac_{Remove}$	NO
Area crop burnt	NO

R_{AG}	IPCC 2006 GL (table 11.2)
N_{AG}	IPCC 2006 GL (table 11.2)
R_{BG}	IPCC 2006 GL (table 11.2)
N_{BG}	IPCC 2006 GL (table 11.2)
IEF	Default IPCC 2006 GL (table 11.1)

Table 5.25: Overview of the origin of AD, IEF and fractions used

Data of crop production (area and yield) originate from 'Statistics Belgium'. In tables 9.2a-c of annex 9 the evolution (1990-2022) of the crop production for each crop is given for the three regions. The dry matter content is region specific or a default from the IPCC 2006 GL, table 11.2.
In Belgium, no crops or residues are burned. Therefore, the area crop burnt is taken zero.
No data to estimate the fraction of above-ground residues of crop removed for purposes such as feed, bedding and construction is available. Therefore, the fraction is assumed zero, as also proposed in the IPCC 2006 GL. The fraction renew is equal to 1 as it is assumed that all crops are renewed annually. In exception of clover (FracRenew = 0.6) and alfalfa (FracRenew = 0.5) in Flanders.

Table 5.26 gives an overview of the dry matter fraction of the crops (%) used in the entire time series for Flanders. For Wallonia and Brussels, see table 11.2 of the 2006 IPCC Guidelines (pp 11.17-18).

	Dry matter content (%) used in Flanders
Clover	90
Alfalfa	90
Dry beans	90
Horse beans	91
Green beans	91
Dry peas	90
Green peas	91
turnip	22
Winter wheat	89
Spring wheat	89
Rye	88
Spelt	88
Brewing barley	89
Winter barley	89
Spring barley	89
Oats	89
Triticale	88
Chicory	91
Flax	90
Winter rape	90
Summer rape	90
Vetch	90
Grain maize	87
Green maize (entire plant)	87
Green maize (only cob)	87
Sugar beet	26
Fodder beet	15
Seed potatoes	22
Early potatoes	22

	Dry matter content (%) used in Flanders
Bintje (specific type potato)	22
Other potatoes	22

Table 5.26: Dry matter fraction used in Flanders

Implied emission factor: EF_1
The default IPCC emission factor (IPCC 2006 GL) of 0.01 kg N_2O-N/kg N is used to calculate the direct N_2O emission from the above-described sources. This factor is used in the three regions.

<u>Mineralisation associated with loss of soil organic matter: F_{SOM} (3.D.1.5)</u>
The methodology used to estimate the nitrogen in mineral soils (F_{SOM}) that is associated with the loss of soil carbon is based on equation 11.8 from the IPCC 2006 Guidelines.

$F_{SOM} = \Delta C_{Mineral,LU} * 1/R * 1000$

Where
$\Delta C_{Mineral,LU}$ = average loss of soil carbon for each land-use type (tonnes C);
R = C:N ratio of the soil organic matter.

The factors used are the same in the three regions. The origin is given in table 5.27 below.

AD en EF used	**Flanders/Wallonia/Brussels**
ΔC	Region specific
R	Default IPCC 2006 GL
IEF	Default IPCC 2006 GL (table 11.1)

Table 5.27: Overview of the origin of AD, R and IEF used

Sector 3D1.5 includes N_2O emissions from managed soils for the N source "N mineralisation associated with loss of soil organic matter resulting from change of land use or management of mineral soils (F_{SOM})". Only emissions from mineral soils in cropland remaining cropland are reported in sector 3D1.5. Emissions from other land uses or changes of land use are reported under LULUCF, sector 4(III).
To calculate the annual loss of soil carbon (kt C) for mineral soils in cropland remaining cropland, the following formula is used:
*annual loss of soil carbon (kt C) = area of mineral soil (kha) * variation in soil carbon (ton C / ha / yr)*
The values for variation in soil carbon are region specific:

- Flanders: -0.016 ton C / ha / yr (Meersmans, 2015).
- Walloon and Brussels regions: The area of mineral soil (kha) for cropland remaining cropland is in accordance with the LULUCF sector (see table 4.B).

The C to N ratio of soil organic matter is 10 as given in the IPCC 2006 Guidelines. The default value for the implied emission factor of 0.01 kg N_2O-N/kg N is used.

<u>Cultivation of organic soils: F_{OS} (3.D.1.6)</u>
The cultivation of organic soils only occurs in Flanders. The area of histosols in Flanders has been estimated using region specific data based on an intersection between the CORINE Land Cover Geo dataset from 1990 and the Belgian 'Soil association map'. The area of cultivated organic soils is obtained by the *University of Leuven* (KUL). Given the slow pace of change the area is taken constant over the entire time series. The implied emission factor (EF_2) for temperate organic crop and grassland soils is 8 kg N_2O-N / ha as described in the IPCC 2006 Guidelines (table 11.1)
No histosol cultivation occurs in Wallonia and Brussels. In Wallonia the only recorded organic soils are part of a nature reserve and as such are not subject to agricultural management or drainage

Table 5.28 gives an overview of the origin of the activity data (AD) and implied emission factor (IEF) used.

AD & EF used	Flanders	Wallonia	Brussels
Area cultivated organic soils	University of Leuven	NO	NO
IEF	IPCC 2006 GL (table 11.1)	NO	NO

Table 5.28: Overview of the origin of AD and IEF used

Indirect soil emissions: 3.D.2

Leaching and runoff of applied N in aquatic systems and the volatilisation of applied N as ammonia and oxides of nitrogen followed by deposition as NH_4 and NO_x on soils and water lead indirectly to N_2O emissions, called $N_2O_{indirect}$. The indirect N_2O emissions are calculated according to the tier 1 methodology as described in the IPCC 2006 GL using country or region-specific data when available. The same methodology is used in all regions, using the equations 11.9 and 11.10 of the IPCC 2006 Guidelines.

<u>Atmospheric deposition of NO_x and NH_4: $N_2O_{(ATD)}$ (3.D.2.1)</u>
To calculate the N_2O emissions from volatilisation of applied synthetic fertilizer and animal manure nitrogen and its atmospheric deposition as NO_x and NH_4 the equation 11.9 from the IPCC 2006 Guidelines is used.

$$N_2O_{(ATD)}\text{-}N = [(F_{SN} * Frac_{GASF}) + ((F_{ON} + F_{PRP}) * Frac_{GASM})] * EF_4$$

where
F_{SN} = amount of synthetic fertilizer nitrogen applied to soils (kg N);
$Frac_{GASF}$ = fraction of synthetic fertilizer nitrogen that volatilizes as NH_3 and NO_x;
F_{ON} = amount of managed animal manure nitrogen applied to soils (kg N);
F_{PRP} = total amount of urine and dung nitrogen deposited by grazing animals on pasture, range and paddock (kg N);
$Frac_{GASM}$ = fraction of applied organic fertilizer, urine and dung deposited by grazing animals' nitrogen that volatilizes as NH_3 and NO_x;
EF4 = kg N2O-N / kg NH_3-N + NOx-N volatilised.

F_{SN}, F_{ON}, F_{PRP} are described above (3.D.1.1 – 3.D.1.3). The emission factor, EF_4, used is the IPCC default of 0.01 kg N_2O-N/kg NH_3-N +NO_x-N volatilised (table 11.3 of the IPCC 2006 GL). Table 5.29 gives an overview of the origin of the implied emission factor (IEF) and the fractions used.

IEF & fractions used	Flanders	Wallonia and Brussels
$Frac_{GASF}$	Region specific	IPCC 2006 GL (table 11.3)
$Frac_{GASM}$	Region specific	IPCC 2006 GL (table 11.3)
EF_4	IPCC 2006 GL (table 11.3)	IPCC 2006 GL (table 11.3)

Table 5.29: Overview of the origin of the IEF and fractions used

The fractions, $Frac_{GASF}$ and $Frac_{GASM}$, are different for the three regions and are therefore discussed separately.

Flanders
The N volatilised as NH_3 from fertilizer use ($Frac_{GASF}$ and $Frac_{GASM}$) is derived from the model used to calculate the respective NH_3 emissions (41). The Emission Model Ammonia Flanders (EMAV) has been developed to calculate NH_3 emissions from animal manure, taking into account four emission stages: indoor stable, outdoor storage of manure, manure application to land and emissions from grazing animals. This model also calculates the NH_3 emission from fertilizer use.
$Frac_{GASF}$: the average rate for NH_3 volatilisation from synthetic fertilizer use in 2022 is 4.7% (3.1% in 1990). The increase between 1990 and 2022 can partly be explained by the change in fertilizer type from ammonium nitrate to liquid fertilizers which has a higher emission coefficient, and by the increase

of the average fertilizer use per ha. The rate of NO volatilisation of synthetic fertilizer use is 1.5% and stays constant over the entire time series.
Table 5.30 gives an overview of the evolution of the different types of synthetic fertilizer used in Flanders. The group of Nitrogen solutions is composed mainly of urea ammonium nitrate (UAN). The group other synthetic fertilizers includes the following products: Calcium Nitrate, Sodium Nitrate, Ammonium Chloride and Magnesium AN.

Fertilizer use in Flanders	Ammonium sulphate (%)	Ammonium nitrate (%)	Urea (%)	Nitrogen solutions (%)	Other synthetic fertilizers (%)
1990	1	73	1	0	26
2000	4	68	1	9	19
2005	5	66	1	16	13
2010	2	63	5	21	9
2015	2	50	6	35	8
2016	2	50	6	34	8
2017	2	50	6	34	8
2018	2	49	6	36	7
2019	2	52	6	33	7
2020	2	52	6	33	7
2021	2	52	6	33	7
2022	2	52	6	33	7

Table 5.30: Fertilizer use in Flanders (1990-2022)

$Frac_{GASM}$: the fraction volatilised from animal manure and urine and dung deposited by grazing animals as NH_3 and NO in Flanders ($Frac_{GASM}$) varies from 0.35 kg(NH_3-N+NO-N)/kg Nex in 1990 to 0.14 kg(NH_3-N+NO-N)/kg Nex in 2022. The reason for this strong reduction of $Frac_{GASM}$ is due to a strong reduction of the NH_3 emission which is calculated in the NH_3 inventory in Flanders and can be explained by the implementation of the different successive Manure Action Plans (MAP) in Flanders (see above). Due to these MAP's, the NH_3 emission reduced significantly. The rate for NO volatilisation is 1.5% and stays constant over the entire time series.

Wallonia and Brussels
$Frac_{GASF}$ and $Frac_{GASM}$: the IPCC default values are used (IPCC 2006 GL table 11.3) for the entire time series.

<u>Leaching/runoff of applied or deposited nitrogen: $N_2O_{(L)}$ (3.D.2.2)</u>

Indirect N_2O emissions resulting from leaching and runoff N-emissions are estimated using equation 11.10 from the IPCC 2006 Guidelines.

$$N_2O_{(L)}\text{-}N = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) * Frac_{LEACH} * EF_5$$

where
F_{SN} = amount of synthetic fertilizer nitrogen applied to soils (kg N);
F_{ON} = amount of managed animal manure nitrogen applied to soils (kg N);
F_{PRP} = amount of urine and dung nitrogen deposited by grazing animals on pasture, range and paddock (kg N);
F_{CR} = amount of nitrogen in crop residues returned to soils (kg N);
F_{SOM} = amount of nitrogen mineralised in mineral soils associated with loss of soil carbon (kg N);
$Frac_{LEACH}$ = fraction nitrogen lost through leaching and runoff;
EF_5 = kg N_2O-N / kg N leached & runoff.

The calculation of F_{SN}, F_{ON}, F_{PRP}, F_{CR} and F_{SOM} is described above. The emission factor, EF_5, used is the IPCC default of 0.0075 kg N_2O-N/kg N leached & runoff (table 11.3 of the IPCC 2006 Guidelines).

All three regions use the IPCC default $Frac_{LEACH}$ factor of 0.3 kg N/kg fertilizer or manure N (table 11.3 of the IPCC 2006 Guidelines)[19].

19 According to the note under table 11.3: FRACleach is taken as zero except for the region where soil water-holding capacity is exceeded.

IEF & Fraction used	Flanders/Wallonia/Brussels
$Frac_{LEACH}$	0.3
EF_5	0.0075

Table 5.31: Overview of the origin of AD and IEF used

5.4.3 Uncertainties and time-series consistency

In comparison with the other agricultural sectors, N_2O emissions from soils involve the use of more activity data, such as the use of mineral fertilizers, the atmospheric deposition and runoff, the amount of manure applied on the fields, etc. Consequently, the uncertainty on activity data is estimated at 30%, which seems in line with the values applied by other parties.

It is well known that the uncertainty of N_2O from agricultural soils is crucial for the determination of the overall uncertainty. Although most countries use the IPCC default values, the uncertainty on emission factors varies widely: 2 orders of magnitude (Norway, (32)), 509% (UK, in IPCC Good Practice Guidance), 200% (France and the Netherlands, NID 2003), 100% (Ireland, NID 2003), 75% (Finland, overall uncertainty for AD*EF, (25)), 24% (Austria, NID 2003). For the time being, a more or less average value of 250% is used for this uncertainty calculation.

5.4.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided by the Belgian experts on request.

5.4.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In Wallonia and Brussels, there was an actualisation of 3D15 data (surfaces coming from the LULUCF matrix) on the whole time series.

5.4.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

In Flanders, at the end of 2018, a Working Group on Emissions was set up to examine (among other things) the possibility to give an evolution in time for some of the parameters needed to obtain a year-dependent IEF for non-dairy cattle. In 2019 a Steering Body ‘Convenant Enteric Emissions’ was set up by the Flemish Government as well as a Working Group ‘Monitoring and assurance (of management and emissions)’ which contains experts from different agricultural and environmental domains in Flanders. The goal of the Convenant is to reduce the CH_4-emissions from enteric fermentation (cattle) till 2030. Flanders Environment Agency (VMM) engaged for the monitoring of the CH_4-emissions from the different animal categories (cattle) in Flanders. Therefore in 2021-2023 the CH_4-emission model was revised taking into account the implementation of measures with CH_4-reducing potential and taking into account the before mentioned parameters. In this study not only the methodology for the estimation of CH_4-emissions from enteric fermentation processes was revised. Also, the methodology to calculate CH_4 and N_2O-emissions from manure management and N_2O-emissions from agricultural soils was taken into account. All parameters used and activity data were reexamined where necessary. Further analysis of region specific calculation factors is needed.
Also, the methodology to calculate the NOx emissions from manure management and agricultural soils is revised. This new integrated model is an extension of the EMAV2.1-model and calculates NH_3- and NO-emissions and therefore follow the N-flow throughout the farm in an integrated way. The model already foresees in the implementation of the calculation of the greenhouse gases in the future.
The study was performed by ILVO and was commissioned by the VMM. The Steering Body and Working Group replaces the Working Group on Emissions set up in 2018. The kick-off of the Steering Body was given January 18, 2021. This study was not yet finished for the 2024 submission. Because of the postponed delivery of the study, the results of the study have not yet been implemented in a new time

series for the emission-inventory in Flanders. Flanders will examine whether implementation in the 2025 submission is possible.
In the 2025 submission, Flanders plans to update the 3D15 data (area coming from the LULUCF matrix) for the whole time series.
Small improvements are inherent to the inventory process and occur yearly. Also, in 2024 a continuous control/update of the used activity data and parameters will occur where necessary. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

5.5 Liming (CRT 3.G)

5.5.1 Source category description

Liming is a common practice on cropland and grassland to maintain soil pH. For Belgium the amount of limestone and dolomite applied has been estimated by the Agricultural Economic Analysis Directorate of the Walloon Region (based on 2 surveys on agricultural practices conducted in 2010 and 2012, in 450 agricultural businesses): 205.6 kg $CaCO_3$/ha yr (50% each for dolomite and limestone).

The amount of carbon recovered from ammonia production in the Flemish region is reported in the CRT-tables in category 2.B.1. See chapter 4 for more information. These recovered CO_2 is used in the company involved as a raw material to produce fertilizers and finally lime. We only did receive confidential data for the year 2012 from this company. Besides this company confirmed that there is no production of urea at their site. During past reviews the European experts confirmed that the amounts of lime reported under agricultural soils are much higher than these figures.

5.5.2 Methodological issues

Decarbonation of these components leads to CO_2 emissions, estimated with the default factor defined by IPCC (0.12 t C/ t product for limestone and 0.13 t C/ t product for dolomite) and equation 3.3.6 of the IPCC GPG on LULUCF.

5.5.3 Uncertainties and time-series consistency

An uncertainty of 100% for activity data and of 50% for the emission factor is used.

5.5.4 Source-specific recalculations, if applicable, including changes made in response to the review process

Walloon region:
Actualisation of area coming from the LULUCF matrix. This results in an increase from 0.29 kt CO_2 in 1990 to a decrease of 8.35 kt CO_2 in 2021.

5.5.5 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

In the 2025 submission, Flanders plans to update the area coming from the LULUCF matrix for the whole time series.
Small improvements are inherent to the inventory process and occur yearly. Also, in 2024 a continuous control/update of the used activity data and parameters (CH_4 and N_2O) will occur where necessary. No significant improvements are planned at this moment in the category 3G for the next submission. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

5.6 Urea Application (CRT 3.H)

5.6.1 Source category description

Adding urea to soils during fertilisation leads to a loss of CO_2 that was fixed in the industrial production process. Urea is converted into ammonium, hydroxyl ion and bicarbonate in the presence of water and urease enzymes. The bicarbonate evolves into CO_2 and water. The bicarbonate evolves into CO_2 and water. The CO_2 emissions are reported in the category 3.H, Urea Application.
See also chapter 5.5.1. concerning the production of urea which does not occur in the Flemish region.

5.6.2 Methodological issues

Used methodology	**Flanders, Wallonia, Brussels**
CO_2 emission from Urea Application 3.H	IPCC 2006 GL (Tier 1)
AD & EF used	
Amount urea applied	Region specific: Department/Agency of Agriculture and Fisheries & IFA
Emission factor	IPCC 2006 GL (Tier 1)

Table 5.32: Overview of the methodology and origin of AD and IEF used in Flanders, Wallonia and Brussels

For the estimation of CO_2 emissions from urea fertilisation the tier 1 methodology from the IPCC2006 GL (equation 11.13) has been used:
CO_2-C emission = M * EF

where
CO_2-C emission = annual C emissions from urea application, tonnes C/yr
M = annual amount of urea fertilisation, tonnes urea / yr
EF = emission factor, tonne of C/ tonne of urea

The default emission factor of 0.20 ton C / ton urea of the IPCC 2006 Guidelines is used.

Data of urea application in Flanders originate from the Agency for Agriculture and Fisheries and the International Fertilizer Association (IFA). Table 5.29 gives an overview of the evolution (%) of the synthetic fertilizers like urea and nitrogen solutions. According to IFA, the group of ‘nitrogen solutions’ is composed mainly of urea ammonium nitrate, which is therefore also taken into account in category 3.H.

In Wallonia and Brussels, the Agricultural Department estimates the proportion of urea in the Nitrogen fertilizers (mainly through Nitrogen solutions). In 2021, the proportion reaches around 20% of the total N amount of fertilisers applied.

5.6.3 Uncertainties and time-series consistency

5.6.4 Source-specific recalculations, if applicable, including changes made in response to the review process

No recalculations.

5.6.5 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

Small improvements are inherent to the inventory process and occur yearly. Also, in 2024 a continuous control/update of the used activity data and parameters (CH_4 and N_2O) will occur where necessary. No significant improvements are planned at this moment in the category 3H for the next submission. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

6 LULUCF (CRT SECTOR 4)

6.1 Overview of sector

6.1.1 General

Belgium follows the methodology described in IPCC 2006 Guidelines to establish the LULUCF inventory.

The emissions and removals are calculated at the regional level following IPCC 2006 GL and using a common template, and eventually compiled to form the national inventory, as for the other sectors. Regional experts work in close co-operation, taking into account the specificities of the sector such as different cycles of forest inventories. The inventory of the LULUCF sector was deeply revised in 2010.

The LULUCF-sector is not a source in Belgium. The sink from land use and land use change accounted for 0.4% of total GHG-emissions in Belgium for the year 2022.

Here are the main sources of emissions or sinks:

Emissions/sinks falling under the *land use* category:

- changes in soil carbon stock of permanent grasslands and croplands (mineral soils),
- change in above-ground biomass of trees in forests.

Emissions/sink falling under the *land use change* category:

- emissions from cutting down trees, sink from afforesting.
- emissions and sinks due the soil organic carbon change related to a land-use-change.

The IPCC Good Practice Guidance for LULUCF defines six categories for land use: forest land, cropland, grassland, wetlands, settlements and other land. For the category other land, there are no points in the land-use matrix of this category in Belgium, so no emissions are calculated for this land-use in Belgium.

6.1.2 Trend assessment

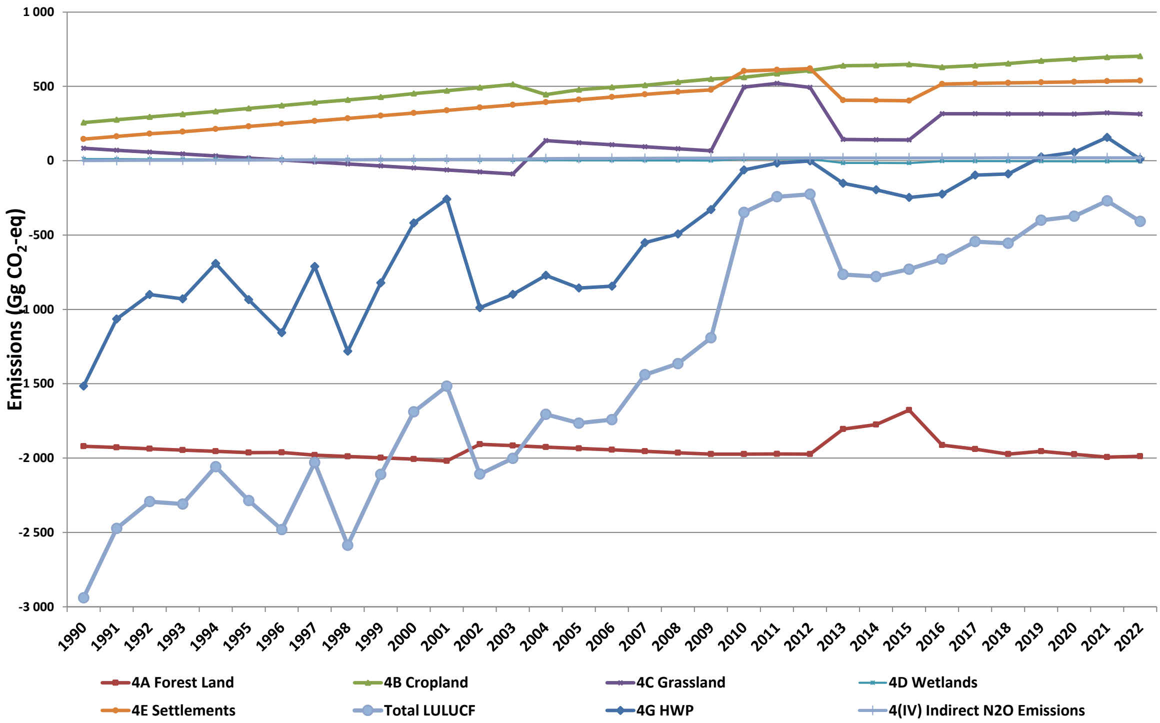


Figure 6.1a: Emission and removal trends in LULUCF sector

As seen in figure 6.1a, forests in Belgium are the largest sink of carbon with a major impact on the trend on LULUCF sector. The level of this sink is related with some methodological aspects in carbon stock change (see 6.2.1.1). Grasslands is no longer a sink. This is in line with the new data available (2020) for carbon stock in soils.

The area of settlements increased steadily since 1990. Increased urbanized areas explain this growth and the conversion from lands to settlements provoke emissions from carbon stock in soils.

The HWP pool shows a decrease of net removals, with significant impact on the overall trend and even becoming a source since 2019. It seems essentially to be related to subcategory “wood panels” with a decline in production compared to the 1990s and currently leading to negative variations in carbon stocks.

Cropland is an increasing net source of emissions since 1990.

Emissions of N_2O and CH_4 increase steadily from 2-3% in 1990 to about 7% of total sector sources mainly because of Direct N_2O Emissions from N Mineralization/Immobilization (except in 1996 with 26.2% due to fires).

The overall trend is a huge decrease of net removals from the LULUCF sector. This is obviously directly linked, in addition to HWP, to the evolution of the surface areas of the different land uses. The table below presents the evolution of areas according to CRT table 4.1. Wetlands is not represented because it is at a very low level.

It can be seen on this figure the contradictory evolution between Settlements and Grassland areas while Forestland and Cropland remain fairly stable.

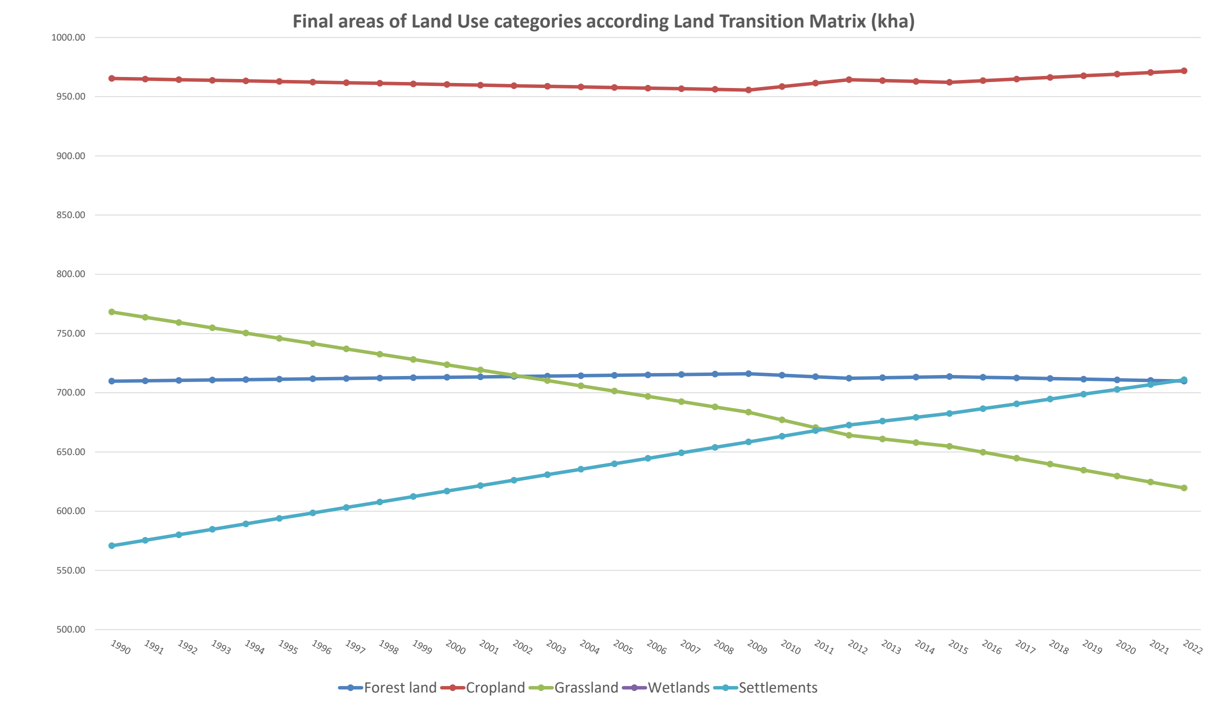


Figure 6.1b: Final areas of land-use categories according to land-transition matrix (kha)

6.1.3 Overall recalculations in the LULUCF-sector

LULUCF Belgium	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
kt CO_2 eq.	-3.87	-9.07	-9.60	2.61	115.12	95.82	89.70	41.67	68.87	-49.82	43.75

Table 6.1: Overview of recalculations in the LULUCF-sector

In the three regions, following the revision of the surface of the country and all three regions by STATBEL (the Belgian statistical office)[20] the extension factor determining the surface associated to each point of the LULUCF matrix was revised to match with the updated surface for the whole time series. All subcategories in this sector are affected.

Brussels Region:

- Revision of land use changes in the LULUCF matrix for the period 2016-2018.
- Revision of the C/N ratio for forest lands from 19.254 to 17 on the basis of analysis from the regional Good Soil measurement campaigns.

6.1.4 Overall planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

An exercise started in the beginning of 2024 in the Flemish region by the Flemish Environmental Planning Agency (VPO) to optimize the LULUCF-matrix (land-use), in first instance and on short-term through 'machine learning' for the years 2018 and 2021, i.e. an assessment based on the year 2015 (manual exercise) and in second place (in the medium/long term) through a study with Vito and the consultancy office Kenter to think about a more modern method and to go to a detailed, area-wide, algorithmic, LULUCF-tailored land use solution.

20 https://statbel.fgov.be/en/themes/environment/land-cover-and-use/land-use

The Flemish region is currently setting up a LULUCF-action plan to investigate the challenges in terms of exchanging data and information within the region, to further optimize the emission inventory in this sector as well as tackling the challenges in terms of the implementation of the proposed measures on the terrain.

6.2 Soil related information

6.2.1 Soil Organic Carbon

The estimates of the soil C stock changes of land use change areas is calculated according to equation 2.25 of the IPCC 2006 guidelines, assuming a 20 years duration of the transition from $SOC_{fromLand}$ to SOC_{toLand}.

Table 6.2 gives an overview of the estimates for soil organic carbon (0-30 cm) in the Walloon, Brussels Capital and Flemish region. The estimates are described in further detail per land use category in the following chapters (6.4: forest land, 6.5: cropland and grassland, 6.6: wetlands and settlements). The data in table 6.2 present the values as estimated in 2000, but it should be noted that for cropland and grassland, a soil carbon stock evolution is also considered in the absence of land-use change (e.g. land remaining in the same category). These changes are described in sections 6.4.3.3. and 6.5.2.1.B.

Carbon stocks in soil (t C/ha)	Wallonia & Brussels	Flanders
A. Forest Land	110	89,5
B. Cropland	51	54
C. Grassland	90	74
D. Wetlands	100	100
E. Settlements	51	54

Table 6.2: Average carbon stocks in soils (t C/ha, 0-30 cm) in 2000

6.2.2 N_2O emissions from N mineralization associated with the loss of soil organic matter

N_2O Emissions are caused by two sources: nitrogen fertilization and mineralization of soil organic matter. Only the emissions linked with the mineralization of organic matter are considered in the LULUCF sector, as emissions from nitrogen fertilization are estimated under agriculture sector. Emissions from mineralization of organic matter in cropland remaining cropland are reported under Agriculture (sector 3.D.1.e). Emissions from all other land uses or changes of land use are reported under LULUCF. Emissions are caused by the nitrogen cycle, intimately linked to carbon cycle.

N_2O emissions are calculated for all land uses and all changes of land use, including afforestation and deforestation. However, if the land use or change of land use does not entail a carbon stock change or leads to a net gain of carbon, the nitrous oxide emission is set to zero. This is the case for forest land remaining forest land and cropland/grassland/settlements converted to forest land. Because of the lower SOC in Forest land than in Wetlands in Flanders (see table 6.2), there are N_2O emissions calculated for Wetlands converted to Forest land.

The methodology used to estimate the nitrogen in mineral soils (FSOM) that is associated with the loss of soil carbon is based on equation 11.8 from the IPCC 2006 Guidelines.

$$F_{SOM} = \Delta C_{Mineral,LU} * 1/R * 1000$$

$\Delta C_{Mineral,LU}$ = average loss of soil carbon for each land-use type (tonnes C);

R = C:N ratio of the soil organic matter.

The average loss of soil carbon (kt C) is calculated using the formula:

annual loss of soil carbon (kt C) = area of mineral soil (kha) * variation in soil carbon (ton C /ha/yr).

The values for variation in soil carbon are region specific.

The C/N ratio of (converted) land uses are 19.254 for forest (based on measurements conducted within the Walloon Forest inventory) in Wallonia and Flanders, and 17 in the Brussels-Capital Region (based on analysis from regional Good Soil[21] measurement campaigns). In the three regions, default IPCC values of 15 for grassland and 10 for cropland. For wetlands the C/N ratio of 15 was used and for settlements a ratio of 10.

During the UNFCCC 2022 Review, the ERT recommended that Belgium provide evidence in the NID that the region-specific C/N ratio (19.254) for estimating the net annual amount of N mineralized in mineral soils (FSOM in equation 11.8 of the 2006 IPCC Guidelines (vol. 4, chap. 11, vol. 4)) is representative of the Brussels-Capital and Flemish Regions mineral soil conditions; otherwise apply the region-specific C/N ratio (19.254) for both direct and indirect N2O emissions resulting from forest land conversions to other land uses for the Walloon Region only and apply the 2006 IPCC Guidelines default C/N ratio of 15 (vol. 4, chap. 11, p.11.16) for the Flemish and Brussels-Capital Regions.

For the 2024 submission, without specific data available for Flanders, the data available from the studies performed in the Walloon region are considered as the best proxy available representing the region' soil conditions.

In the Brussels-Capital Region, analysis from the regional Good Soil measurement campaigns allowed to determine a region-specific C/N ratio of 17 for forest lands in the region.

Two parameters are taken into account in equation 11.8 of the IPCC 2006 GL, for the calculation of direct N_2O emissions: FE = 0,01 kg N_2O -N/kg N and C/N ratio of the converted land. Emissions are caused by the nitrogen cycle, intimately linked to carbon cycle.

Indirect N_2O emissions are calculated using F_{SOM} in the IPCC equation 11.10, with a default $Frac_{leach}$ of 0.3.

Table 6.3 and 6.4 below presents activity data and direct and indirect N_2O emissions respectively for each forest land conversion subcategory and for each non-forestland conversion subcategory both for each of the three regions.

21 https://environnement.brussels/goodsoil

Brussels									
	Unit	1990	2000	2005	2010	2015	2020	2021	2022
Forest Land converted to Settlements	*ha*	*17*	*126*	*173*	*185*	*123*	*76*	*66*	*57*
Annual loss of soil carbon in mineral soils	*kg*	*-48 941*	*-371 325*	*-512 998*	*-547 804*	*-364 581*	*-224 594*	*-196 561*	*-168 517*
Direct N2O emissions	ton	*0.05*	*0.34*	*0.47*	*0.51*	*0.34*	*0.21*	*0.18*	*0.16*
Indirect N2O emissions	ton	*0.01*	*0.08*	*0.11*	*0.11*	*0.08*	*0.05*	*0.04*	*0.04*

Wallonia									
	Unit	1990	2000	2005	2010	2015	2020	2021	2022
Forest Land converted to Cropland	*ha*	*50.07*	*550.76*	*801.10*	*1011.39*	*1071.47*	*1111.53*	*1121.54*	*1131.55*
Annual loss of soil carbon in mineral soils	*kg*	*-147 600*	*-1 641 790*	*-2 399 139*	*-3 033 883*	*-3 196 347*	*-3 359 124*	*-3 391 717*	*-3 424 322*
Direct N2O emissions	ton	*0.12*	*1.34*	*1.96*	*2.48*	*2.61*	*2.74*	*2.77*	*2.79*
Indirect N2O emissions	ton	*0.03*	*0.05*	*0.08*	*0.11*	*0.14*	*0.16*	*0.19*	*0.22*
Forest Land converted to Grassland	*ha*	*140.19*	*1542.12*	*2243.08*	*3224.43*	*5747.90*	*7430.21*	*7850.79*	*8271.36*
Annual loss of soil carbon in mineral soils	*kg*	*-149 980*	*-1 649 780*	*-2 416 728*	*-3 609 379*	*-6 823 081*	*-9 074 815*	*-9 648 845*	*-10 229 267*
Direct N2O emissions	ton	*0.12*	*1.35*	*1.97*	*2.95*	*5.57*	*7.41*	*7.87*	*8.35*
Indirect N2O emissions	ton	*0.03*	*0.30*	*0.44*	*0.66*	*1.25*	*1.67*	*1.77*	*1.88*
Forest Land converted to Wetlands	*ha*	*30.04*	*330.45*	*480.66*	*570.78*	*390.54*	*270.37*	*240.33*	*210.29*
Annual loss of soil carbon in mineral soils	*kg*	*-15 537*	*-170 903*	*-248 586*	*-295 196*	*-201 976*	*-139 830*	*-124 293*	*-108 756*
Direct N2O emissions	ton	*0.01*	*0.14*	*0.20*	*0.24*	*0.16*	*0.11*	*0.10*	*0.09*
Indirect N2O emissions	ton	*0.00*	*0.03*	*0.05*	*0.05*	*0.04*	*0.03*	*0.02*	*0.02*
Forest Land converted to Settlements	*ha*	*130.18*	*1431.97*	*2082.86*	*2653.65*	*2954.06*	*3154.33*	*3204.40*	*3254.47*
Annual loss of soil carbon in mineral soils	*kg*	*-379 058*	*-4 216 920*	*-6 162 514*	*-7 859 572*	*-8 760 412*	*-9 362 225*	*-9 512 834*	*-9 663 506*
Direct N2O emissions	ton	*0.31*	*3.44*	*5.03*	*6.41*	*7.15*	*7.64*	*7.76*	*7.89*
Indirect N2O emissions	ton	*0.07*	*0.77*	*1.13*	*1.44*	*1.61*	*1.72*	*1.75*	*1.77*

Flanders									
	Unit	1990	2000	2005	2010	2015	2020	2021	2022
Forest Land converted to Cropland	*ha*	*30.06*	*330.67*	*480.97*	*504.35*	*390.79*	*270.55*	*240.49*	*210.43*
Annual loss of soil carbon in mineral soils	*kg*	*-53 950*	*-596 021*	*-868 809*	*-913 001*	*-709 247*	*-491 858*	*-437 394*	*-382 883*
Direct N2O emissions	ton	*0.04*	*0.49*	*0.71*	*0.75*	*0.58*	*0.40*	*0.36*	*0.31*
Indirect N2O emissions	ton	*0.01*	*0.11*	*0.16*	*0.17*	*0.13*	*0.09*	*0.08*	*0.07*
Forest Land converted to Grassland	*ha*	*90.18*	*992.01*	*1 442.92*	*2 581.89*	*4 211.85*	*5 587.96*	*5 931.99*	*6 276.02*
Annual loss of soil carbon in mineral soils	*kg*	*-72 201*	*-803 532*	*-1 175 552*	*-2 115 605*	*-3 474 942*	*-4 631 292*	*-4 921 996*	*-5 213 346*
Direct N2O emissions	ton	*0.06*	*0.66*	*0.96*	*1.73*	*2.84*	*3.78*	*4.02*	*4.25*
Indirect N2O emissions	ton	*0.01*	*0.15*	*0.22*	*0.39*	*0.64*	*0.85*	*0.90*	*0.96*
Wetlands converted to Forest Land *	*ha*	*20.04*	*220.45*	*320.65*	*380.77*	*260.53*	*180.36*	*160.32*	*140.28*
Annual loss of soil carbon in mineral soils	*kg*	*-10 521*	*-115 734*	*-168 340*	*-199 904*	*-136 776*	*-94 691*	*-84 170*	*-73 649*
Direct N2O emissions	ton	*0.01*	*0.12*	*0.18*	*0.21*	*0.14*	*0.10*	*0.09*	*0.08*
Indirect N2O emissions	ton	*0.00*	*0.03*	*0.04*	*0.05*	*0.03*	*0.02*	*0.02*	*0.02*
Forest Land converted to Settlements	*ha*	*300.61*	*3 306.68*	*4 809.72*	*6 312.76*	*6 245.96*	*6 379.56*	*6 412.96*	*6 446.36*
Annual loss of soil carbon in mineral soils	*kg*	*-531 777.95*	*-5 875 247.39*	*-8 564 497.95*	*-11 265 425.73*	*-11 175 330.08*	*-11 175 330.08*	*-11 239 969.69*	*-11 304 661.20*
Direct N2O emissions	ton	*0.43*	*4.80*	*6.99*	*9.19*	*9.12*	*9.12*	*9.17*	*9.23*
Indirect N2O emissions	ton	*0.10*	*1.08*	*1.57*	*2.07*	*2.05*	*2.05*	*2.06*	*2.08*

Table 6.3: Activity data and direct and indirect N_2O emissions for each forest land conversion subcategory for each of the three regions

** In Flanders due to the soil organic carbon for forest land that is lower than in wetlands there are emissions reported in this region for Wetlands converted to Forest land. Because this land-use-change leads to a CO_2 emission, also the N_2O emissions where calculated and reported for this region.*

Brussels									
	Unit	1990	2000	2005	2010	2015	2020	2021	2022
Grassland converted to Settlements	*ha*	*25*	*189*	*260*	*318*	*285*	*330*	*349*	*335*
Annual loss of soil carbon in mineral soils	*kg*	*-46 771*	*-357 128*	*-492 698*	*-589 853*	*-514 805*	*-582 091*	*-612 995*	*-585 750*
Direct N2O emissions	ton	*0.05*	*0.37*	*0.52*	*0.62*	*0.54*	*0.61*	*0.64*	*0.61*
Indirect N2O emissions	ton	*0.01*	*0.08*	*0.12*	*0.14*	*0.12*	*0.14*	*0.14*	*0.14*

Wallonia									
	Unit	1990	2000	2005	2010	2015	2020	2021	2022
Grassland converted to Cropland	ha	*700.96*	*7 710.59*	*11 215.41*	*16 222.29*	*29 440.45*	*38 252.55*	*40 455.58*	*42 658.61*
Annual loss of soil carbon in mineral soils	kg	*-1 300 391*	*-14 558 891*	*-21 246 470*	*-30 110 593*	*-49 143 116*	*-67 422 995*	*-71 023 817*	*-74 593 907*
Direct N2O emissions	ton	*1.36*	*15.25*	*22.26*	*31.54*	*55.33*	*70.63*	*74.41*	*78.15*
Indirect N2O emissions	ton	*0.31*	*3.43*	*5.01*	*7.10*	*12.45*	*15.89*	*16.74*	*17.58*
Wetlands converted to Grassland	ha	*NO*	*NO*	*NO*	*20.03*	*140.19*	*220.30*	*240.33*	*260.36*
Annual loss of soil carbon in mineral soils	kg	*NO*	*NO*	*NO*	*-11 786.19*	*-91 756.06*	*-151 634.33*	*-167 245.77*	*-183 161.64*
Direct N2O emissions	ton	*NO*	*NO*	*NO*	*0.01*	*0.10*	*0.16*	*0.18*	*0.19*
Indirect N2O emissions	ton	*NO*	*NO*	*NO*	*0.00*	*0.02*	*0.04*	*0.04*	*0.04*
Grassland converted to Settlements	ha	*761.05*	*8 371.50*	*12 176.73*	*15 781.68*	*19 146.30*	*21 389.39*	*21 950.16*	*22 510.93*
Annual loss of soil carbon in mineral soils	kg	*-1 411 852.62*	*-15 806 796.31*	*-23 067 595.77*	*-29 292 774.33*	*-34 346 076.88*	*-37 700 397.27*	*-38 535 694.85*	*-39 363 169.69*
Direct N2O emissions	ton	*1.48*	*16.56*	*24.17*	*30.69*	*35.98*	*39.50*	*40.37*	*41.24*
Indirect N2O emissions	ton	*0.33*	*3.73*	*5.44*	*6.90*	*8.10*	*8.89*	*9.08*	*9.28*
Wetlands converted to Settlements	ha	*10.01*	*110.15*	*160.22*	*190.26*	*130.18*	*90.12*	*80.11*	*70.10*
Annual loss of soil carbon in mineral soils	kg	*-23 979.43*	*-267 410.81*	*-391 177.43*	*-465 117.76*	*-318 726.64*	*-220 882.21*	*-196 389.81*	*-171 884.90*
Direct N2O emissions	ton	*0.03*	*0.28*	*0.41*	*0.49*	*0.33*	*0.23*	*0.21*	*0.18*
Indirect N2O emissions	ton	*0.01*	*0.06*	*0.09*	*0.11*	*0.08*	*0.05*	*0.05*	*0.04*

Flanders									
	Unit	1990	2000	2005	2010	2015	2020	2021	2022
Grassland converted to Cropland	*ha*	*3 597*	*39 570*	*57 556*	*73 826*	*68 508*	*66 545*	*66 054*	*65 563*
Annual loss of soil carbon in mineral soils	*kg*	*-3 576 021*	*-39 271 892*	*-57 075 958*	*-73 149 699*	*-67 814 150*	*-65 826 803*	*-65 330 366*	*-64 834 088*
Direct N2O emissions	ton	*3.75*	*41.14*	*59.79*	*76.63*	*71.56*	*68.96*	*68.44*	*67.92*
Indirect N2O emissions	ton	*0.84*	*9.26*	*13.45*	*17.24*	*16.10*	*15.52*	*15.34*	*15.28*
Wetlands converted to Grassland	*ha*	*20*	*220*	*321*	*381*	*261*	*180*	*160*	*140*
Annual loss of soil carbon in mineral soils	*kg*	*-26 051*	*-288 632*	*-421 335*	*-502 124*	*-345 027*	*-239 543*	*-213 077*	*-186 575*
Direct N2O emissions	ton	*0.03*	*0.30*	*0.44*	*0.53*	*0.36*	*0.25*	*0.22*	*0.20*
Indirect N2O emissions	ton	*0.01*	*0.07*	*0.10*	*0.12*	*0.08*	*0.06*	*0.05*	*0.04*
Grassland converted to Settlements	*ha*	*1 513*	*16 644*	*24 209*	*30 017*	*26 216*	*23 905*	*23 327*	*22 749*
Annual loss of soil carbon in mineral soils	*kg*	*-1 504 120*	*-16 518 261*	*-24 006 879*	*-29 742 403*	*-25 950 625*	*-23 647 163*	*-23 071 768*	*-22 496 560*
Direct N2O emissions	ton	*1.58*	*17.30*	*25.15*	*31.16*	*27.19*	*24.77*	*24.17*	*23.57*
Indirect N2O emissions	ton	*0.35*	*3.89*	*5.66*	*7.01*	*6.12*	*5.57*	*5.44*	*5.30*
Wetlands converted to Settlements	*ha*	*60*	*661*	*962*	*1 209*	*1 015*	*909*	*882*	*855*
Annual loss of soil carbon in mineral soils	*kg*	*-137 919*	*-1 522 251*	*-2 217 920*	*-2 792 499*	*-2 349 816*	*-2 105 290*	*-2 044 055*	*-1 982 778*
Direct N2O emissions	ton	*0.14*	*1.59*	*2.32*	*2.93*	*2.46*	*2.21*	*2.14*	*2.08*
Indirect N2O emissions	ton	*0.03*	*0.36*	*0.52*	*0.66*	*0.55*	*0.50*	*0.48*	*0.47*

Table 6.4: Activity data and direct and indirect N_2O emissions for each non-forest land conversion subcategory for each of the three regions

6.3 Land use related information

6.3.1 Establishment of Land Use Change matrix

The LUC matrix was determined by the Gembloux University (Gembloux Agro Bio Tech), a study conducted specifically for the LULUCF reporting in Belgium (1) (6) (2).The methodology is summarised hereunder, a more detailed description is given in the study report.

The method adopted for monitoring of the land-use for Belgium is a grid of points (grid of reference) on which a diagnosis of occupation/land use is carried out for the various dates of reference. This method is in agreement with the coherent representation of the land use in the 2006 IPCC Guidelines. This method makes it possible to identify the activities of the size of the minimal surface of the forest chosen by Belgium (0,5 ha). It also makes it possible to avoid double counting and to facilitate obtaining the uncertainty of the estimates of surface. With each point of the grid of reference is allocated one of the 6 categories of land use proposed by the IPCC. A method of estimate of surface, by counting of points is then possible.

The diagnoses of occupation/land use are carried out following two types of information: vectorial cartographic layers or raster bearing on sets of themes related to the land use (example: Forest reference layer in Flanders, agricultural area data collected in the framework of the Common Agricultural Policy of the EU); layers images (orthophoto-plans or satellite images with very high resolution).

The chronology of the use of these various data is the following:

1. The sets of themes layers are used initially. Geoprocessing of sets of themes layers on the points of sampling covered by these layers allows automatically to assign a category of land use with these points. To realize this geoprocessing, it is necessary first of all to establish a correspondence between the categories at the set of themes layer and the 6 categories defined by Guidelines of the IPCC.

2. The attribution of a category of land use on the points not classified following geoprocessing is ensured by photograph interpretation of orthophoto-plans.

For this step to give acceptable results, it is important to collect cartographic layers and images which are as much as possible contemporary of the studied dates of reference. Information on the occupation of the grounds is then recorded in a shape file which takes again all the points of the grid of reference, the identifier of the data source which was used to classify the point, the possible remarks and other information. This diagnosis is supplemented by documentation on data used, in particular with regard to the dates of catch of the image's layers used or dates of the data sources of the sets of themes layers exploited by geoprocessing. Lastly, the method of estimate of land use by systematic sampling will make it possible to calculate the confidence intervals which quantify the reliability of the estimates of surface in each category.

This study delivered a first estimate of the land-use change matrix during the 2010 submission at both the regional and national levels. This first estimate was further refined during the 2011 submission. Last estimates by Gembloux Agrobiotech were delivered in December 2011.

Emissions were calculated for the first time during the 2011 submission for the Brussels-Capital Region with a view to ensure complete geographical coverage in this sector.

Since 2011, the matrix is produced by the 3 regions, based on the same methodology and same permanent grid.

Further details on the methodology are presented in chapter 10.2.

		1990						Total 2022	
		F	C	G	W	S	O		
2022	F	**672.9**	4.6	30.0	0.6	2.0	0	**709.8**	**23.1%**
	C	2.6	**802.8**	164.1	0	1.7	0	**971.7**	**31.7%**
	G	17.5	96.3	**497.2**	0.7	3.5	0	**619.6**	**20.2%**
	W	1.2	1.3	1.5	**51.7**	1.1	0	**56.8**	**1.9%**
	S	15.5	60.3	75.4	1.8	**562.5**	0	**710.9**	**23.2%**
	O	0	0	0	0	0	**0**	**0.0**	**0.0%**
Total 1990	**Area (kha)**	**709.8**	**965.3**	**768.2**	**54.8**	**570.8**	**0**	**3068.92**	
		23.1%	**31.5%**	**25.0%**	**1.8%**	**18.6%**	**0.0%**		

Table 6.5: Land use Change in Belgium 1990-2022

6.3.2 Spatial assessment unit used for determining the area of the units of land

The method adopted for monitoring of the land-use for Belgium is a grid of points (grid of reference) on which a diagnosis of occupation/land use is carried out for the various dates of reference. This method is in agreement with the coherent representation of the land use in the 2006 IPCC Guidelines and Revised supplementary methods and Good Practice Guidance 2013. This method makes it possible to identify the activities of the size of the minimal surface of the forest chosen by Belgium (0,5 ha). It also makes it possible to avoid double counting and to facilitate obtaining the uncertainty of the estimates of surface. With each point of the grid of reference is allocated one of the 6 categories of land use proposed by the IPCC. A method of estimate of surface, by counting of points is then possible. The diagnoses of occupation/land use are carried out following two types of information: vectoral cartographic layers or raster bearing on sets of themes related to the land use (see 10.2.3.); layers images (orthophoto-plans or satellite images with very high-resolution).

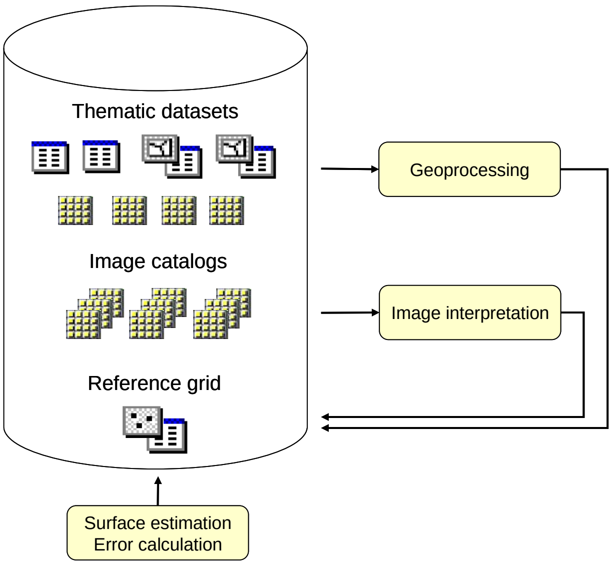


Figure 6.2: Main steps of the spatial assessment (2)

6.3.3 Methodology used to develop the land transition matrix

6.3.3.1 Methodology

The implementation of the method rests on the creation of a geodatabase (ESRI personal geodatabase) making it possible to structure the data in a coherent way and to resort to automatic tools of geo-treatment, via a computer programming language (VBA). With each point of the grid of reference a Land-Use code will be assigned.

Geoprocessing tool

The module of geoprocessing is an application functioning in the Excel environment and in particular calling upon functions of ESRI. For collecting the contained information in the sets of themes layers, it was necessary to establish a correspondence between the categories of each sets of themes layer used and 6 LU categories. Then, a crossing (intersect) between the vectoral layers and the points of sampling are carried out.

Photo-interpretation tool

The module 'photo-interpretation' consists of an application developed by the forest Unit of management of the Resources and the Natural environments which is called OrthoViewer. It is about an application functioning in the Excel environment and which uses the component open source mapwingis.ocx [http://www.mapwindow.org]. This module comprises a series of functionalities facilitating the work of image-interpretation at the beginning of different catalogues from images (figure 6.3).

The steps of the photo-interpretation within OrthoViewer are the following ones:

1. Posting of the orthophoto-plan of the studied year which takes again the point to be diagnosed.
2. The first interpretation of the homogeneous unit which contains the point of sampling.
3. Visualization of topographic layer IGN/NGI in case of doubt about interpretation (mainly between the meadow category and arable land).
4. Visualization of another orthophoto-plan of the place if interpretation remains difficult.
5. Final diagnosis on the occupation/assignment of the homogeneous unit in which the point is. Relevant marks are also encoded in addition to the category diagnosed on some of the points (difficulty to ascertain diagnosis of the land use for example).

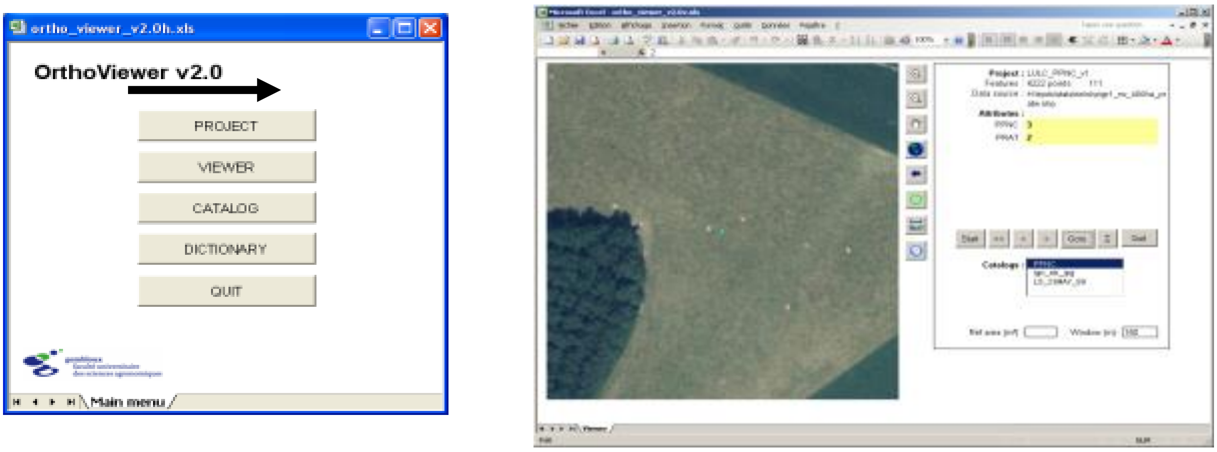


Figure 6.3: Ortho-viewer functionalities facilitating the work of image-interpretation

6.3.3.2 Results

The sets of themes layers selected make it possible to classify by geoprocessing, in the 6 IPCC categories of land use, 14% of the points of sampling for 1990 and 48% per 2008.

The points of the mesh grid of 1*1 km (1 point for 100 ha) which were not geo-processed were photo- interpreted.

Year 1990
The photo-interpretation of 1990 was carried out starting from black and white orthophotos IGN and of the PPNC for the Walloon region. In the OrthoViewer application, code LULUCF of 1990 generated by geoprocessing of layer PRAT is posted in lower part of the cell of encoding of the assignment of the ground. This posting enables us to detect the points whose occupation of the ground diagnosed by photo-interpretation differs from that of layer PRAT. A checking of the interpretation of 1990 is thus possible. A closer attention was paid to the points whose first diagnosis differed from the classification of the PRAT.

In Flemish region, in fact the orthophotos of Eurosense of 1988 to 1991 were used except for the province of Limbourg. In this province the diagnosis was carried out starting from topographic charts IGN analogical (scale 1/10.000) for the wet forests, meadows, grounds and the establishments. The last revisions of these charts go back to 1986 to 1989.

For the Brussels-Capital region, the topographic charts IGN numerical 10.000ème (board 31) are used with the assistance of the QuickBird images of 2008.

Year 2008
The photo-interpretation of 2008 for the Walloon region was carried out starting from the infra-red images of the General Directorate of the Agriculture (DGA) of 2006-2007.

In the Flemish region, the provincial orthophotos of 2006 to 2009 were used. Lastly, for the Brussels-Capital region, QuickBird images of 2008 were used for the photo-interpretation.

In the OrthoViewer application, the diagnosis of 1990 of the point to be interpreted in 2008 is posted in lower part of the cell of encoding for the assignment of the ground of 2008. This posting enables us to detect the points whose assignment of the ground diagnosed in 2008 differs from that of 1990 and to check the reason of it (land use change, light shift between the photographs of 1990 and 2008 bringing a positioning of the point on another homogeneous unit, different interpretation from an unchanged ground assignment between 1990 and 2008). A correction can then be carried out if necessary.

Years 2014-2022
The land use matrix is now produced by the three regions, based on available GIS data.

In the three regions, following the revision of the surface of the country and all three regions by STATBEL (the Belgian statistical office)[22] the extension factor determining the surface associated to each point of the LULUCF matrix was revised to match with the updated surface for the whole time series. All subcategories in this sector are affected.

Brussels Region

The land use matrix for Brussels was updated for the years 2018 and 2021 for the submission 2023, by photo-interpretation of all sampling locations. A correction of the changes in land use occurred for the years 2016-2018 for the 2024 submission.

Walloon Region

In the Walloon Region the matrix has been updated for the year 2014 and 2019. A first classification is based on the Regional Forest inventory data (detailed grid). Cropland and grassland are then classified according to SIGEC data (detailed agricultural data filled by each farmer for the purpose of compliance with EU Common Agricultural Policy). Sectoral plans are then used to cross-check and refinement of the analysis. Cross-check of sectoral plans and PICC data allows the identification of settlements.
The remaining points, for which automatic geo-processing is impossible or leads to inconsistent classification,

22 https://statbel.fgov.be/en/themes/environment/land-cover-and-use/land-use

are then treated “manually”, using careful photo-interpretation based on aerial photographs. A similar “manual” check is also conducted for all the points for which 2 successive land-use change are observed on the basis of geo-processing.

Flemish region

In the submission of 2020, an extra quality control was conducted for all the points for which 2 successive land-use changes were observed on the basis of geo-processing, the matrix has been updated for the reference year 1990 – 2009 – 2012. Also, in that submission new data were collected to do implementation of a new reference year 2015.

Years before 1990

Belgium did not estimate land-use change areas before 1990 and thus did not construct land-use conversion categories on the basis of 20 years' accumulation of land-use change areas for the entire time series because no set of data using the same systematic and geolocated grid is available and considering that Belgium applies a 20-year transition time for soils, any change before 1990 would not have any effect on the inventory after 2010 and no impact on the LULUCF (and KP-LULUCF)accounting. For living biomass, the effect could only be an increase in removals, as deforestation is accounted in the year of the deforestation while potential afforestation before 1990 could have an effect until 2009 and, in this context, the lack of a land-use matrix before 1990 does not result in an overestimation of removals or underestimation of emissions.

6.3.3.3 Interpolation and extrapolation

For making an entire timeline out of these matrix years a linear inter- and extrapolation has been used, to determine the land use change for each year.

In Flanders the years 1991 until 2008 are interpolated based on the matrix years 1990 and 2009. The years 2010 and 2011 are interpolated based on the matrix years 2009 and 2012. For the years 2013 and 2014 the interpolation is based on the matrix years 2012 and 2015. And for the extrapolation or the years 2016 and onwards the trend between matrix years 2009 and 2015 has been used.

In Wallonia the years 1991 until 2008 are interpolated based on the matrix years 1990 and 2009. The years 2010 until 2018 are interpolated based on the matrix years 2009 and 2019. For 2020 to 2022, the extrapolation is based on the trends between 2009 and 2019.

In Brussels, matrix data are available and have been updated based on interpretation of orthophoto plans for the years 1989, 1992, 2008, 2013, 2015, 2018,2021 and 2022. For all the other years, matrix data have been interpolated between two years of update.

6.3.4 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Belgium uses a single national boundary, because Belgium is a small country, with limited ecological and climate variability.

A first inventory of the numerical data available on the land use of the 3 regions was drawn up (1) (6) (2) Only the data entering the process of inventory are presented here. Tables 6.6 to 6.10 present the batches of data used for the inventory of 1990, 2008, 2009 ,2010, 2014-2015 and 2019.

In Wallonia, data from 2008 and 2014 are used to verify the pivot years 2009 and 2019.

Data	Format	Date production or edition	Reference year	Data source year	Description
Couches thématiques					
Flanders					
Bosreferentielaag	V		1990	1978-1992	Based on infrared orthophotoplans (1/30 000) from 1978 to1992
Landbouwgebruikspercelen	V	1996	1994		Realised form B/W orthophotos
Wallonia					
Plan Régional d'Aménagement du Territoire (PRAT)	R		1989	1988-1989	Numerical treatment of LANDSAT and SPOT verified by airborne IR picture. Sectors plans used for urban areas.
Brussels-Capital Region					
/					
Belgium					
Corine Land Cover (CLC)	V		1990	1987-1994	Photo-interpreted LANDSAT images from 1987 to 1994. Minimal polygon size: 25 ha.

Table 6.6: Thematic data layers used for 1990 (V = vectoral et R = raster)

Data	Format	Date production or edition	Reference year	Data source year	Description
Couches images					
Flanders					
Orthophotos	R		1988-1991	1988-1991	Resolution 1 x 1 m, airborne, scale 1/30 000
Carte topographique IGN/NGI 1/10 000 (Top10s)	R	1977-1993	1977-1993	~1974-1989	
Wallonia					
Orthophotos N/B IGN	R	?-1995	?-1995	?-1995	20% of Belgium covered yearly. Uneven orthophotos quality
Plan Photographiques Numériques Communaux (PPNC)	R	1994-2000	1994-2000	1994-2000	Color aerial photos, scale from 1:15 500 and 1:25 000. Overall accuracy between 1,60 m and 3,20 m.
Carte topographique IGN/NGI 1/10 000 (Top10s)	R	1977-1993	1977-1993	~1974-1989	
Carte topographique IGN/NGI 1/20 000 (Top20r)	R	1990-2005	1990-2005	~1987-2002	
Brussels Capital Region					
Carte topographique IGN/NGI 1/10 000 (Top10r)	R	1994 et 2003	1994 et 2003	~1991-1993	

Table 6.7: Thematic data used for 1990 (R = raster)

Data	Format	Date production or edition	Reference year	Data source year	Description
Layers					
Flanders					
Landbouwgebruikspercelen	V		2006		
Wallonia					
Plan de Localisation Informatique (PLI)	V		2006		Based on cadastre data Scale 1/10 000
Système intégré de gestion et de contrôle (SIGEC)	V		2007		Annual area declaration for financial support for the Common Agricultural Policy PAC. Statistics added to a layer from orthophotoplans. Scale 1/10 000
Brussels-Capital Region					
/					
Images					
Flanders					
Orthophotos couleur provinciales	R	2006-2009	2006-2009	2006-2009	Scale 1/10 000 and 1/15 000, resolution 25 cm
Wallonia					
Orthophotos IR de la DGA	R	2006-2007	2006-2007	2006-2007	Resolution 50 cm
Brussels-Capital Region					
Images QuickBird panchromatiques	R	2008	2008	2008	High resolution satellite images corrected by orhtophotos (61 cm).

Table 6.8: Thematic data layers used for 2008 (V = vectoral et R = raster)

Donnée source	Reference year	Description
Couches thématiques		
Région flamande		
Landbouwgebruikspercelen (LPC)	2009	Annual area declaration for financial support for the Common Agricultural Policy PAC.
Région wallonne		
Système intégré de gestion et de contrôle (SIGEC)	2009	Annual area declaration for financial support for the Common Agricultural Policy PAC. Statistics added to a layer from orthophotoplans. Scale 1/10 000
Plan de Localisation Informatique	2009	The Plan de Localisation Informatique (acronym PLI) aims to enrich the IGN 1:10,000 base plan with a continuous cadastral reference on the territory of the Walloon Region. The PLI is made up of municipalities, divisions, sections, plots and buildings from cadastral maps, vectorized and calibrated on IGN 1:10,000 topographic maps.
Plan De Secteur	2009	Sectors plans are mainly used to define land-use at 1/10000 scale in order to develop human activity in a consistent and harmonized manner.
Brussels Capital Region		
/		
Couches images		
Région flamande		
Orthophotos couleur	2009	Scale 1/10 000 to 1/15 000, resolution 25 cm
Région wallonne		
Orthophotos IR du DGA	2009-2010	Resolution 25 cm
Brussels Capital Region		
Orthophotos couleur de la Région de Bruxelles-Capitale	2013 + interpolation of the 2008-2012 tendency	Resolution 40 cm

Table 6.9: Geographical data used for the 2009 and 2010 land use inventory

Donnée source	Reference year	Description
Couches thématiques		
Région flamande		
AGIV: Bodembeddekingskaart (BBK)	2015	Resolution 1m
Région wallonne		
Système intégré de gestion et de contrôle (SIGEC)	2015 - 2019	Annual area declaration for financial support for the Comon Agricultural Policy PAC. Statistics added to a layer from othophotoplans. Scale 1/10 000
IPRFW	2019	Regional Walloon forest inventory
PICC	2019	Projet Informatique de Cartographie Continue: All identifiable elements from the landscape are recorded with X,Y,Z coordinates
PDS	2019	Sectors plans are mainly used to define land-use at 1/10000 scale in order to develop human activity in a consistent and harmonized manner.
Brussels Capital Region		
/		
Couches images		
Région flamande		
Orthophotos couleur	2015	Scale 1/10 000 to 1/15 000, resolution 25 cm
Région wallonne		
Orthophotos IR du DGA	2015	Resolution 25 cm
Données SIGEC (LPIS)	2015-2019	Used to discriminate between permanent grassland and cropland
Orthophotos	2014, 2015, 2016,2018-2020	Scale 1/10 000 to 1/15 000, resolution 25 cm
Masque forestier	2020	Pixel analysis to determine woody areas. Information is cross-cut with other layers to check if the minimum area of 0,5 ha is reached
Plan de secteur	2019	Some areas can be recently classified as settlements, which is an indication that the harvested forest will not be replanted.
PICC (Projet Informatique de Cartographie Continue)	2018-2020	http://geoportail.wallonie.be/catalogue/b795de68-726c-4bdf-a62a-a42686aa5b6f.html Used to identify settlements areas.
Brussels Capital Region		
Orthophotos couleur de la Région de Bruxelles-Capitale	2015-2022	Resolution 40 cm

Table 6.10: Geographical data used for the 2015-2022 land use inventory

6.4 Forest land (CRT 4.A)

6.4.1 Source category description

Belgium has a temperate maritime climate, with moderate temperature variability, prevailing westerly winds, heavy cloud cover and regular rain.

No natural forest occurs in Belgium.

In Wallonia, half of the total forest is owned by public institutions and managed by the Public Service Agriculture, Natural Resources and Environment - Nature and Forest Department ("SPW ARNE") From the regeneration of the settlements until the sale of the tree, the entirety of the management of public forests is carried out on the basis of plan of multi-functional management plans, with a view to sustainable management of the forests. These plans organize the forest in space and time by envisaging at the same time objectives on the long run (50 to 100 years) and a work on the short term (20 to 25 years), ensuring the balance between production and social and environmental services of the forest (biodiversity, carbon stocks, water regulation, soil protections, …). Private forests are also managed and financial incentives, information and assistance are also provided by the SPW ARNE to the private owners in this view.

In Flanders, less than half of the total forest (41%) is owned by public institutions such as ANB (Agency for Nature and Forests) or municipalities. Other characteristics as mentioned in the previous paragraph are similar as in Wallonia.

In Brussels, forest lands are almost entirely managed by public institutions. The forest of Soignes occupies about 10% of the region's territory. The Sonian forest is certified by the Forest Stewardship Council and sustainably managed accordingly[23].

6.4.2 Definition of forest and any other criteria

The vast majority of woody species developing in Belgium on areas over 0.5 ha reach at maturity heights greater than or equal to 5 m. The criteria taken into account in allocating the forestry status are the minimum area of 0.5 ha and a coverage rate of at least 20%, these two criteria being measured by photo-interpretation. Christmas trees are a special case, since it is harvested before reaching this height of 5 m. The identification of Christmas tree plantations is difficult: it is based on location criteria (generally parcels in agricultural areas) or the comparison of successive images (1-3 years apart), the latest image being used to detect the tree harvesting in early age. In case of doubt, young plantations are classified as forest, subject to confirmation in the following years (sometimes plantations intended to be Christmas trees are not harvested and left to grow as forest).

Belgium adopted the following forest definition for use in accounting for its activities under the Convention, and Article 3.3 and 3.4 of the Kyoto Protocol:

Minimum tree crown cover: 20 %
Minimum land area: 0.5 ha
Minimum height at maturity: 5 m

In the case of **deforestation**, all carbon from deadwood and litter is considered emitted in the year of deforestation.

These choices allow to use the result of the present and projected regional forest inventories (Wallonia and Flanders) to calculate the C stock of different pools (biomass, dead organic matters and mineral soil). This definition is fully consistent with the official FAO definition and is already reported in the 2015 Forest Resource Assessment. (66)

23 https://environnement.brussels/media/1229/download?inline

The distribution of forests in Belgium is shown in table 6.11.

Regions	Forest cover	% of the total
	%	Belgian forest area
Wallonia	28.4%	75.4%
Flanders	13.1%	24.3%
Brussels Capital	11.3%	0.3%
Belgium	20.6%	100%

Table 6.11: Forest cover in Belgium (7) *(source: National Institute of Statistics and regional forest inventories)*

This category includes all land with woody vegetation consistent with thresholds used to define forest land. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category.

<u>Forest inventories</u>

Forest inventories were conducted both in the Flemish and the Walloon regions using similar sampling techniques. The inventories are drawn up by sampling to determine the surfaces by categories of property (Private or Public: State, Province, Community), type of forest, species, age, size and quality. The sampling points of the regional forest inventories were selected according to a 1.0 km x 0.5 km grid oriented from the east to the west on the National Geographic Institute (NGI) maps at a scale of 1/25000. The rectangular grid had the advantage of going against the orientation of the relief elements oriented along a southwest – northwest axis and against ecological and geological gradients predominant in the N-S orientation. Each grid intersection, located in a forest, represented the center of a sampling plot. (7). For the Walloon region the sampling plots are circular and of 10 are each. For the Flemish region the sampling plots are a rectangle of 16m on 16m and the measurement of circumference at 1.3m.

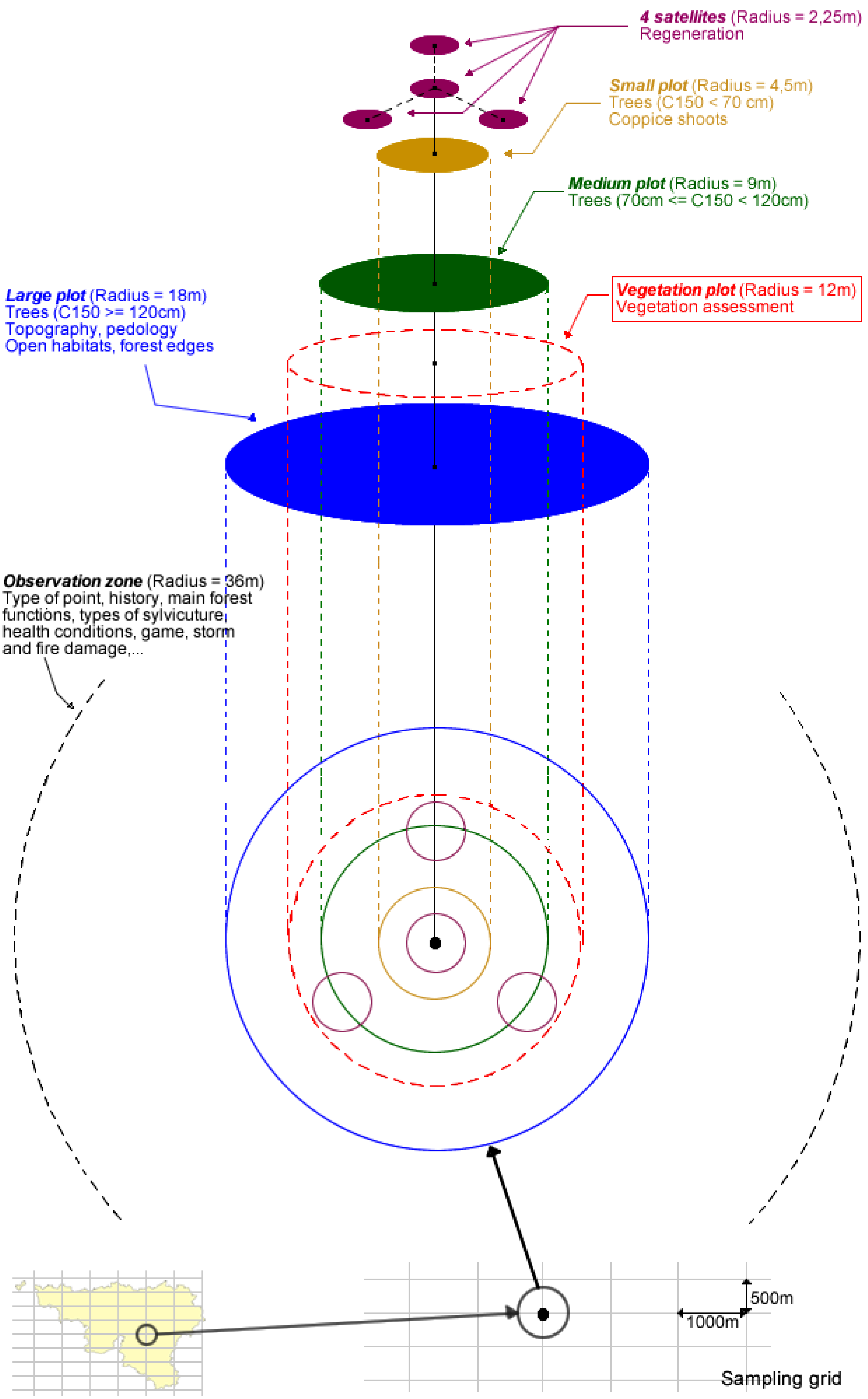


Figure 6.4: Scheme of a sampling unit and data collected (Rondeux et al*, 2005)*

The following information was collected: category of property (private or public: state, region or province), municipality, forest type, stand structure and development stage, evidence of damage caused by game and the health and condition for harvest (these two last categories are only available for the Walloon forests) (see figure 6.4). Topography (exposition and slope), soil texture and drainage class, age (class), canopy closure, tree species, circumference at 1.5 m and total and dominant heights were also collected. Basic information in the Flemish and the Walloon inventories was therefore very similar. Moreover, the same cubage tables were applied to calculate the total solid wood (TSW) volume from tree circumference and tree height. The terminology ‘total solid wood’ refers to the combination of stem and branches with a circumference exceeding 22 cm at smaller end. (8)

The first Walloon Forest inventory was conducted between 1979 and 1984 (central year is 1981). The first cycle of permanent systematic sampling of the permanent forest inventory was conducted between 1994 and 2008 (central year is 2001), covering each year around 10 % of the approximately 11000 sampling points (9) The third cycle of the forest inventory started in 2008 and the last results include the year 2016 (central year is 2012). From 2013 on, the evolution of the forest is estimated using a regional forest model based on the data from the Permanent Forest Inventory.

In Flanders, 2665 plots were sampled in the framework of the first forest inventory, which was constituted in the period 1997-1999 (10). This regional inventory is intended to be repeated every 10 years, to allow e.g. the calculation of growth rates in the Flemish forests. In 2009 measurements started for the second permanent forest inventory in the Flemish region. During this second forest inventory each year 10% of the approximate 3000 sampling points are measured. A database system has been set up, including detailed information of all the sampled plots of the second forest inventory. The data of the second inventory cycle covers the period 2009-2019 (central year is 2014).

In the Brussels region, a continuous forest inventory has been implemented from 2008 on. The complete inventory cycle lasts 8 years. This measuring network, based on 200m x 200m plots, provides up-to-date information about the state and the evolution of forest resources managed by Brussels Environment (~1800 ha). Results from 2 successive complete inventory cycles are required to calculate accurate specific growth rates for Brussels.

With more than 13000 plots over a territory of 30528 km^2, forest inventories in Belgium have one of the highest sampling rates in Europe. Compared to other countries or regions, the Belgian sampling grid, with each sampling point representing 50 ha of forest, is very dense (11). In comparison, one plot represents 2400 ha of forest land in the U.S. (Brown, 2002).

6.4.3 Methodological issues – Forest land remaining forest land

6.4.3.1 Change in carbon stocks in living biomass

Both the Walloon and Flemish region now apply the carbon stock change method (IPCC 2006 Guidelines) for the estimation of changes in carbon stock in living biomass in forest land, based on the regional forest inventories in Wallonia and Flanders. Stock difference approach is recommended when very accurate forest inventories are carried out (IPCC 2006 chap 4.2.2.1), and this is the case in Wallonia and Flanders as mentioned in section 6.4.1.

However, considering that the length of the inventory cycle does not allow to deliver annual estimates of emissions and removals for the recent years, Wallonia decided to use a regional model, based on the data from the Permanent Forest Inventory. Hence from 2013 on, each of the measured stands from the regional forest inventory are completed by modelling, to estimate the carbon stock changes between the time of measurement and the last year of the submission. This model is further described hereunder (changes in carbon stocks).

The Brussels Capital region uses tier 1 based on data observed in beech forest of Wallonia (about 65% of the Brussels forest is beech).

In each region, the area of forest land remaining forest land from the land-use matrix is used as the area data for the stock difference method applied.

	Forest management (average living biomass growth in t C/ha.year)
Brussels	0.98
Flanders	1.46
Wallonia	0.42

Table 6.12: Average regional values for living biomass growth (t C/ha.year), used for forest management

Total solid wood volumes and carbon stocks

Based on the information of the regional forest inventories (see 6.4.1), the total solid wood volumes (TSW) of each species were calculated for Wallonia and Flanders, as given in table 6.13 and table 6.14.

Species	**Stem wood volume (Mm^3) 2001**	**Stem wood volume (Mm^3) 2012**
Picea abies (Norway Spruce)	48,9	43,1
Quercus petraea et Q. robur (Oaks)	22,1	24,5
Fagus silvatica (Beech)	13,7	15,4
Pinus silvestris (Scots Pine)	2,8	2,7
Populus sp (Poplars)	1,7	1,9
Betula sp (Birch)	3,4	3,9
Pinus laricio (Corsican Pine)	0,4	0,4
Fraxinus excelsior (Ash)	3,0	3,8
Larix sp (Larch)	2,5	2,5
Pseudotsuga menziesii (Douglas fir)	4,4	6,1
Other species	15,8	19,5
Total	**118,6**	123,5

Table 6.13: Volume per species in the forest inventories in Wallonia, years 2001 and 2012 (Stem wood volume in Mm^3)

Species	**TSW (Mm^3) 1998**	**TSW (Mm^3) 2014**
Picea abies (Norway Spruce)	0,5	0,8
Queruspetraea et Q. robur (Oaks)	4,6	7,5
Fagus silvatica (Beech)	2,2	2,8
Pinus silvestris (Scots Pine)	8,3	8,4
Populus sp (Poplars)	5,1	4,4
Betula sp (Birch)	1,3	2,2
Pinus laricio (Corsican Pine)	4,0	4,2
Fraxinus excelsior (Ash)	0,4	0,9
Larix sp (Larch)	0,7	0,9
Pseudotsuga menziesii (Douglas fir)	0,4	0,5
Other species	3,3	6,4
Total	**30,8**	**38,9**

Table 6.14: Volume per species in the forest inventories in Flanders, years 1998 and 2014 (TSW in Mm^3)

Biomass expansion factors

The calculation of the amount of carbon stored in the biomass of trees is based on biomass expansion factors. We converted solid wood volumes into carbon. For each dominant species, we transformed: volumes of solid wood in total dry mass multiplying by the infra-densities (WD); solid wood total dry mass in total above-ground dry biomass (biomass expansion factor 2); above-ground dry biomass in below-ground dry biomass (roots R-root to shoot ratio) and total dry biomass in carbon quantities (carbon fraction of dry matter).

The biomass expansion factors used in Flanders are those used for the 2010 Forest Resource Assessment of the FAO.

In Wallonia, the biomass expansion factors (BEF) were revised with updated values, derived from the use of species-specific equations which take into account diameter at breast height (DBH) and total height. The analysis of these results compared to the previous ones also highlighted that the BEF should be applied on the stem wood volume only, and not the total solid wood (stemwood + large branches up to 22 cm diameter), as it was the case in previous inventories, following the approach described by Van de Walle (2005), where a specific reference to the application of BEF to the total solid wood (including branches) was included. This revision conducted in 2019 had a significant impact on the total biomass estimate. Wood density values have also been slightly updated in 2019 (table 6.15, Wallonia).

Species (Wallonia)	BEF 2 Biomass expansion factor 2001	BEF 2 Biomass expansion factor 2012	R Root to shoot ratio	Basic Wood density	Carbon fraction of dry matter
Picea abies (Norway Spruce)	1,15	1,14	0,20	0,38	0,5
Quercus petraea et Q. robur (Oaks)	1,35	1,35	0,21	0,56	0,5
Fagus silvatica (Beech)	1,38	1,38	0,24	0,59	0,5
Pinus silvestris (Scots Pine)	1,13	1,12	0,16	0,42	0,5
Populus sp (Poplars)	1,29	1,29	0,21	0,34	0,5
Betula sp (Birch)	1,33	1,33	0,21	0,53	0,5
Pinus laricio (Corsican Pine)	1,14	1,12	0,16	0,42	0,5
Fraxinus excelsior (Ash)	1,25	1,25	0,21	0,56	0,5
Larix sp (Larch)	1,11	1,11	0,20	0,46	0,5
Pseudotsuga menziesii (Douglas fir)	1,17	1,16	0,17	0,43	0,5
Other deciduous	1,55	1.52	0,21	0,52	0,5
Other coniferous	1,08	1,07	0,165	0,42	0,5

Table 6.15: Conversion factors used to derive forest inventory data for deciduous and coniferous forests in Wallonia (Lecomte, Bauwens, pers. com., 2019) in Flanders the same factors have been used, also a modeled BEF have been used, so this will be different as the average BEF reported in this table by Wallonia.

The carbon fraction of dry matter of 0.5 is maintained, as the impact of default values of 0.48 and 0.51 presented in table 4.3 of the IPCC 2006 Guidelines for broadleaved and conifers is very limited, taking into account the fact that their respective ratio on the Belgian forest is close to 50% (See table 6.13 and 6.14 of this chapter).

Changes in carbon stock

Wallonia: stock-change (1990-2012)

In Wallonia, the evolution of the carbon stock is based on the stock change method for the full time series since the 2010 submission. The complete results of the second permanent inventory cycle are available and the results of the first 8 years of the 3rd cycle are also used. Central years for the 3 cycles are 1981, 2001 and 2012 (see 6.4.1). See tables 6.13 and 6.15 above for the relevant data (total solid wood volumes and conversion factors) used to apply the carbon stock change method in Wallonia. As one can see in table 6.13 (volumes), large changes were observed in Wallonia for the main species between 2001 and 2012, with a decrease of Norway spruce volume and an increase for Oak and Beech. Given the higher wood density of both oak and beech, this leads to significantly higher carbon stocks in 2012. Annual changes in carbon stocks are calculated using equation 2.8 of the 2006 IPCC GL, with t1 and t2 being respectively 1981-2001 and 2001-2012.

Wallonia regional model (2013-2020)

In Wallonia, from 2013 on, the evolution of the total living biomass is simulated using the forest simulation software SIMREG. SIMREG is a tree-level distance-independent forest simulation software. The software uses tree and stand level models and requires trees and plot data coming from Forest Inventory data. SIMREG starts by computing each virtual stand on the basis of forest inventory data measured on the corresponding sample plot and then run calibrated forest sub-models of removal (thinning and clearcut), growth and regeneration (recruitment and reforestation) to predict the forest evolution (Figure 6.5).

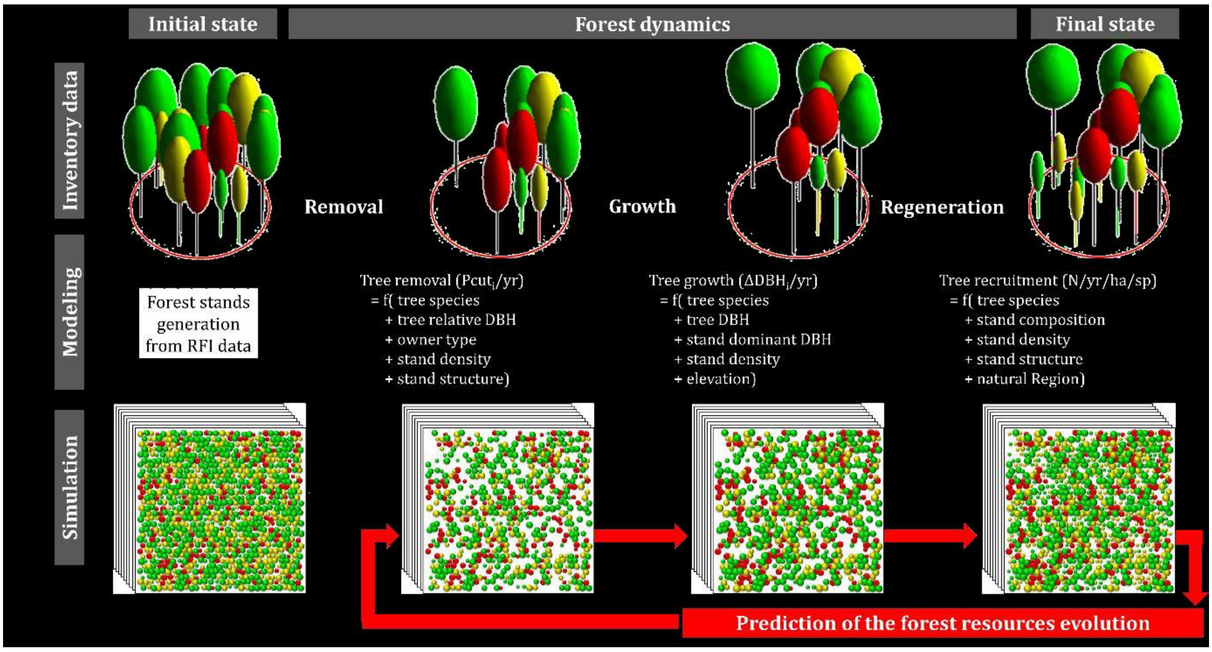


Figure 6.5: Overview of the operating of the forest simulation software SIMREG

Each simulated forest stands is represented by a set of trees each with their own species and girth (circumference) at breast height (Cbh) and by a list of stand variables: simulated area, elevation, natural region, type of owner, etc. Various computation methods are integrated to estimate the individual tree solid wood volume using the corresponding species-dependent taper models and calculate usual stand characteristics such as density, total basal area, volume and biomass per ha. The development of each virtual forest stands is simulated annually by applying stand-level clearcut and reforestation models and tree-level removal, growth and recruitment models. The calibrated models are then applied sequentially each simulated years from the generation of a stand. First removal if in a rotation year (clearcut or thinning), then recruitment and finally growth which marks the transition to the following simulated year.

Virtual stands were generated from the currently available data of the last cycle of the IPRFW, the most recent stands being measured in 2018. Every virtual forest stand is generated by simple extrapolation from the tree data measured in a single permanent sample plot so that each measured tree is represented by a number of simulated trees strictly equal to the number it represents at the regional level. Virtual forest stands are thus perfectly representative of the available forest inventory data. The model is then applied up to year 2020, individually for each stand, to deliver annual data on emissions and removals.

To summarize, from 2013 on, each of the measured stands from the regional forest inventory are completed by modelling, to estimate the carbon stock changes between the time of measurement and the last year of the submission.

The model is described in more details in Perin et al, 2019. [47]

Flanders: stock change

In Flanders, the carbon stock change method has for the first time been applied for the March 2018 submission, based on preliminary results of the 2nd Flemish Forest inventory cycle (approximately 75% of sampling points). Since the submission in 2021 a full 2nd Forest Inventory was implemented. The methodology is consistent with the Walloon Region (described above). The central year used is 1998 for the first Flemish forest inventory (1997-1999) and 2014 for the 2nd forest inventory (data for the period 2009-2019). ANB reported that there was an error in the delivered data to calculate the previous carbon uptake factor. INBO's advice was sought to calculate the new carbon stock change factor. This was documented in INBO.A.4103 (13). Several changes in methodology were made: now a modelled BEF is used and other factors are brought in line with the Walloon region.

Brussels Capital region

In Brussels-Capital region, until 2000, the emissions and removals were estimated by applying the average annual net biomass increment data derived from the stock-change approach in beech forest of Wallonia (65% of the Brussels forest is beech) to the total forest area of the Brussels-Capital region. No detailed information from regional forest inventory was indeed available for this period. Moreover, given the very limited share of forest in Brussels-Capital region (0.3% of the total Belgian forest), this estimate is deemed reasonable in first approach. From 2001 on, biomass expansion factors were derived from new data from the regional forest inventory.

Annual increments

The annual increments are presented in table 6.16. For Wallonia, these data are presented for information only, as they are not used in the current methodology which uses stock-change approach.

Species	Annual increment m3/ha/an
Picea abies (Norway Spruce)	14,8
Quercus petraea et Q. robur (Oaks)	3,6
Fagus silvatica (Beech)	6,9
Pinus silvestris (Scots Pine)	3,6
Populus sp (Poplars)	4,9
Betula sp (Birch)	4,0
Pinus laricio (Corsican Pine)	7,8
Fraxinus excelsior (Ash)	5,1
Larix sp (Larch)	6,8
Pseudotsuga menziesii (Douglas fir)	13,3
Carpinus betulus (hornbeam)	6,2
Average coniferous	14,2
Average deciduous	4,1

Table 6.16: Annual increment for different tree species (based on Walloon Forest Inventories)

The table 6.17 represents the confidence interval (CI 95%) associated with the volume estimation. We combine the error due to the measurement techniques (diameter, height, number of trees per plot) and the error linked to the surface and volume estimation for the whole region (error dependent on the sampling plot number per species).

		Wallonia	Flanders
Spruce	Picea excelsa	1,6 %	15,10%
Douglas fir	Pseudotsuga menziesii	8,5 %	14,40%
Larches	Larix sp,	7,0 %	15%
Pines	Pinus sp	5,5 %	6,50%
Other resinous		4,5 %	20,20%
Beech	Fagus sylvatica	3,4 %	12%
Oaks	Quecus robur and Q. petraea	2,1 %	12,40%
'Noble' broadleaves		2,8 %	11,10%
Other broadleaves		3,8 %	2,20%
Poplars		12,4 %	11,70%

Table 6.17: Confidence interval associated with the volume estimation per species (2000 forest inventory in Flanders, 2001 inventory in Wallonia)

6.4.3.2 Carbon in dead organic matter (deadwood and litter)

For carbon in dead organic matter (litter and deadwood), Belgium applies Tier 1 according to section 4.2.2.1 of the IPCC 2006 GL.

The data on deadwood were updated in the 2012 submission, using the value of 1,9 t C/ha calculated in a recent article written in the framework of the study by Gembloux University (Gembloux Agro Bio Tech) (3).

For the carbon in litter pool the values were also updated using the same study as for deadwood.
The litter and deadwood C stock is assumed stable over the period, with respectively 7,56 t C/ha and 1,9 t C/ha. Consequently, no variation of the C stock for the DOM category is calculated for forest land remaining forest land.

In Wallonia, a legal decision regarding the research in application of the Forest Code (67) underlines the importance of "ensuring the maintenance of soil fertility by promoting the internal cycle of mineral elements by the mixture of species and thinnings on the one hand, and by limiting exports by the management of the remnants on the other hand". Hence the remnants, constituted by the residues of harvest, should be left on site, ensuring the increase or at least the conservation of litter and dead wood carbon stock. In private forest, recommendations to owners for the management of the remnants also takes into account the importance of maintaining the soil fertility. These recommendations to forest are consistent with the assumptions of stable DOM carbon stocks in forest land remaining forest land.

6.4.3.3 Soil organic carbon in soils

The soil organic carbon (0-30 cm) in forest land in Wallonia & Brussels has been estimated at 110 t C/ha in 2005, in the framework of the study by Gembloux Agro Bio Tech (3) . Updated results from the permanent sampling plots of the forest inventory, give an average value of 111 t C/ha for samples collected between 2004 and 2014 (12) (773 sampling plots). Taking into account the uncertainty, this is very close to the average value of 110 t C/ha published by Latte (3) and based on the 566 sampling plots available at that time, but suggest a stable C stock.

The SOC evolution between 1990 and 2000 was estimated at 0.55t C /ha/yr in Wallonia and Brussels in the former submissions. This stock change was estimated from a study by Lettens (4) based on 1960 and 2000 sampling plots. The drivers identified by Lettens were that forest was on average younger in 1960, containing less living biomass than in 2000, and that the biomass has increased between 1960 and 2000, leading to an increased amount of residues and progressive increase of SOC. Another driver could be the increase of below-ground biomass, leading to increased SOC from root mortality and C exudates (4).

These average stock change have been applied in the former inventory submissions, on the entire time series.

A new survey of SOC in forest has begun in Wallonia during the current forest inventory cycle, covering the same sampling plots as those cited above for 2004-2014. The aim of this survey is to verify whether SOC changes can be detected after 12 or 13 years on the inventory permanent sampling plots. This survey should provide results on the carbon stock change in SOC for the recent years. The results of this survey are not available yet, as more sampling plots have to be analyzed. For the time being, preliminary results suggest no noticeable trend (Prof. Colinet G., pers com).

In Flanders, where the organic content in forest soils is generally lower than in Wallonia, the carbon stock in soil is estimated at 89.5 t c/ha in 2000 and the SOC variation was kept constant for the complete timeseries during this submission. This was one of the recommendations during the UNFCCC ICR5 in September 2018.

In Flanders, the current forest inventory cycle does not include soil carbon measurements. In the Brussels-Capital Region, a personal communication by the University of Ghent underlines indications of an increase in soil carbon stocks, but no quantified data are available. In Flanders, a study from 2009 (5) also suggests an increase in soil carbon stocks. However, the number of samples is currently too limited and the uncertainty margin (95% confidence interval) too large to deliver significant results.

In this context, the UNFCCC review in 2018 also drew the attention to the fact that the carbon stock change applied for SOC appeared to be an outlier compared to other Parties. The consultation of the EU NID (table 6.17) confirms this assessment, as the SOC stock change reported by Belgium in the former submissions was the highest of all member states: 18 member States report no change in carbon stocks and the other present a very limited sink (or source for 2 MS). Only one Member State currently reports an annual change of the same order of magnitude.

In the absence of complete updated values from the regional forest inventories, it is deemed that the currently available data and studies do not allow the application of the average carbon stock change factor from 1960-2000 to the recent years, as it appears likely to overestimate the actual carbon stock change. Hence, Belgium decides to apply Tier 1, assuming no change in carbon stock for this carbon pool, which is now reported as NA.

As a consequence, and considering that no recent information confirms that the drivers of the SOC change between 1960 and 2000 are applicable to the present forest, Belgium revised its estimates for soil carbon since the 2020 submission.

Belgium underlines that the available data showed an increase in carbon stocks in mineral soils between 1960 and 2000, so this pool is not a source in this period and the assumption of no stock change in SOC is conservative and in line with the Tier 1 approach described in section 4.2.3.1; of the IPCC 2006 Guidelines, which assumes that forest soil carbon stocks do not change with management. Some measures in public forest, described in 6.4.3.2. above (dead organic matter), tend to ensure the maintaining of soil fertility by leaving the remnants on site, a management practice that would also tend to maintain or increase the carbon stock. The fact that forest soils are not a source was also confirmed by a former study by Lettens (4), showed an increase in carbon stocks between 1960 and 2000. The drivers identified by Lettens were that forest was on average younger in 1960, containing less living biomass than in 2000, and that the biomass has increased between 1960 and 2000, leading to an increased amount of residues and progressive increase of SOC. Another driver could be the increase of below-ground biomass, leading to increased SOC from root mortality and C exudates (4).

6.4.3.4 N_2O emissions from fertilization and drainage (Category 4.A.2)

No nitrogen fertilization (nor liming) occurs in the Belgian forests. Only some pilot experiments were conducted, on very limited plots.

No drainage on forest land occurred in the reporting period. In Wallonia the new forest code (13) and in Flanders the forest code of 1990 (see http://www.natuurenbos.be/nl-BE/Natuurbeleid/Bos/Wetgeving_en_vergunning/Bosdecreet.aspx) bans any new drainage. The old drains are not really functional anymore and it is rather rewetting which is encouraged on wet soils, combined with the replacement of coniferous species with more site-specific indigenous species.

Consequently, notation key NO is used for these two subcategories.

N_2O emissions from N mineralization associated with the loss of soil organic matter (Category 4.A.2.):

See chapter 6.2.2, general consideration on methodological issues, for a description of the calculation of N_2O emissions from N mineralisation associated with the loss of soil organic matter.

Direct N_2O emissions are calculated using the IPCC default value for the implied emission factor of 0.01 kg N_2O-N/kg N and equation 11.8 of the IPCC 2006 Guidelines.

Indirect N_2O emissions are calculated using F_{SOM} in the IPCC equation 11.10 of the IPCC 2006 Guidelines, with a default $Frac_{leach}$ of 0.3.

N_2O emissions are calculated for all land uses and all changes of land use. However, if the land use or change of land use does not entail a carbon stock change or leads to a net gain of carbon, the nitrous oxide emission was set to zero. This is the case (among others) for forest land remaining forest land and cropland/grassland/settlements converted to forest land. Because the soil organic carbon for forestland is lower in Flanders there are emissions reported in this region for Wetlands converted to Forestland.

6.4.3.5 Emissions from wildfires (Category 4.A.1)

Emissions from fires are calculated using the current available data, which cover the period 1990-2022.

Forest fires can be of two kinds: controlled fires and wildfires. In the case of Belgium, controlled fire is not a forest management practice, so all fires are classified as wild fires. Both in Wallonia and Flanders, post-logging burning of harvest residues is banned by the (new) forest code in Wallonia (13) and the Forest Decree in Flanders (14).

Data on areas affected by wildfires in Belgium are available for 1996 and 2011. The occurrence of fires is low, given the usually wet and cool Belgian climate. Since fires do not occur every year, notation key “NO” is used for years where no fire has been observed.

Wildfires are only reported in the years after the latest forest inventory. Because therefore these emissions are considered implicitly included in the carbon stock change method.

Between August 1995 and July 1996, only 476.1 mm of rainfall were recorded in Uccle (reference national station of IRM), compared to a usual average of 800 mm/year. This explains the forest fires that have occurred in April 1996 on 863 ha. In 2011, dry conditions also led to fires in the Fagnes, covering 35 ha of forest and 1265 ha of grassland in this area of natural reserve (Walloon region) and 678 ha (mainly grassland) in Kalmthout and Meeuwen-Gruitrode (Flemish region).

Equation 2.27 of the IPCC 2006 Guidelines is applied for GHG emissions, using country specific average biomass stock as calculated in section A above. Combined with a combustion factors of 0.45 for forest (for ‘all other temperate forest’) from the 2006 IPCC Guidelines (vol. 4, chap. 2, table 2.6, p.2.46). Emission factors used for CH4 and N2O are respectively 4.7 and 0.26 $g/kg_{dy\ matter\ burned}$ also from the 2006 IPCC Guidelines (vol. 4, chap. 2, table 2.5, p.2.47).

However, as Belgium applies the stock difference method for living biomass pool in forest land remaining forest land, the reported CO_2 emissions in CRT Table 4(V) from forest fire which occurred in the years before the latest year of the forest inventory data (ex. in 2011 for Wallonia and 2012 for Flanders) are considered implicitly included in the carbon stock changes estimated based on the stock difference method reported in the CRT Table 4.A. Hence, CO2 emissions from forest fires will only be reported in table 4(V) according to equation 2.27 in case of fires are occurring after the latest central year of forest inventory data.

6.4.4 Methodological issues - Land converted to forest land

6.4.4.1 Area

The areas of land converted to forest land are estimated following the methodology described in chapter 6.1.3. And none of these conversions occur on organic soils.

6.4.4.2 Living biomass

For afforestation, changes in carbon stocks in living biomass are estimated with the average regional values for biomass growth, following tier 2 approach presented in section 4.3.1.1 of the IPCC 2006 GL.

These values (annual growth in above-ground and below-ground living biomass and average carbon stocks in forest) are presented in table 6.18. These values are weighted averages of the species composition and growth measured at the regional level, as no information on the specific species located on the ARD areas is available.

	Afforestation/reforestation (average living biomass growth in t C/ha.year)
Flanders	1.46
Wallonia	2.72

Table 6.18: Average regional values for living biomass growth (t C/ha.year)

Changes in carbon stocks in living biomass on land converted to forest are estimated using equations from chapter 4.2 of the IPCC 2006 guidelines.

The annual increase in carbon stocks in living biomass due to growth in land converted to forest land is calculated as a weighted average of the various coniferous and deciduous species annual increment, as no detailed data is available regarding the species planted on the land areas converted to forest land.

6.4.4.3 Litter and deadwood

Consistent with tier 1 presented in IPCC 2006 Guidelines, section 2.3.2.2, it is assumed that afforestation results in buildup of litter and dead wood carbon pools, starting from zero carbon in those pools. DOM carbon gains on land converted to forest occur linearly, starting from zero, over a default transition period of 20 years. Equation 2.23 of the 2006 IPCC Guidelines is applied.

Consistent with tier 1 presented in IPCC 2006 Guidelines, section 2.3.2.2, it is assumed that conversion of non-forest land to forest land results in buildup of litter and dead wood carbon pools, starting from zero carbon in those pools. DOM carbon gains on land converted to forest occur linearly, starting from zero, over a default transition period of 20 years. Equation 2.23 of the 2006 IPCC Guidelines is applied.

In Flanders there has never been made a calculation of the DOM and Litter in afforested land. This explains why DOM CSCs is reported “NO” for Belgium for 1990-2009 (“NO” for any CSC from 1990 to 2009 for Wallonia and no cropland converted to forestland for Brussels).

6.4.4.4 Soil organic carbon

The estimates of the soil C stock changes of land use change areas to forest land is calculated according to equation 2.25 of the IPCC 2006 guidelines, assuming a 20 years duration of the transition from $SOC_{Non\ Forest\ Land}$ to SOC_{Forest}.

6.4.4.5 Losses of carbon stocks from orchards

In cropland converted to forest (afforestation) emissions due to the conversion of orchard to forest land are estimated following the methodology described in section 6.5.2.1. This is applied to the whole time series, but in practice, no such conversion occurred since 2010, they are reported under UNFCCC for the years 1990-2009.

The losses of carbon stocks from orchards converted to forest land are calculated, following the 2013 review recommendation. The annual change in carbon stocks in living biomass due to actual conversion to forest land is included under cropland converted to forest land.

As no detailed data on orchard converted to forest land is available, the percentage of orchards on cropland was calculated for each year (between 1,3% and 2% of total cropland area in the period 1990-2012); an average carbon stock of 7.265 t C/ha was considered for carbon stock in living biomass in orchards (see section 6.5.2.1.). These percentages and average carbon stocks were then multiplied by the annual area of cropland converted to forest land.

This approach is deemed conservative, considering that in Wallonia, a cross-check between the land use maps (including orchards) and the land-use change matrix gave only 3 points with conversion from cropland including orchards to other land-use and that these points were converted to grassland or settlements, but not forest. Hence the losses from conversion from orchards to forest land are probably overestimated. Very likely, this is the same for Flanders.

6.4.5 Uncertainties and time-series consistency

A tier 1 uncertainty analysis for the LULUCF sector is performed since the 2012 submission and was updated in the 2021 submission. The uncertainties on areas were determined by the study on land-use change (6) (2). The uncertainty on total areas is 2% for forest land, grassland and settlements, 1% for cropland and 8% for wetlands. For land use changes, the uncertainty on areas is estimated at 44%.

The uncertainty on total solid wood volume is estimated by the regional forest inventory (personal communication), and remains low, at 1.24% Uncertainties of conversion factors were taken from the IPCC Guidelines (25% for wood density, 20% for BEF, 30% for below ground biomass BEF and 10% for carbon content). The overall uncertainty on living biomass for afforestation and deforestation is estimated at respectively 42% and 29%. The uncertainty on SOC is estimated at 63% for forest soils (4) and 29% and 33% for cropland and grassland (15). SOC uncertainty on settlements was estimated at 100%.

Uncertainties were combined using equations 3.1 and 3.2 of the IPCC 2006 Guidelines.

Uncertainties on N_2O and CH_4 emissions from biomass burning are estimated following default values proposed for N_2O in the IPCC Guidelines, namely 30% for AD (area burned, which are all measured by the forestry service, given the small occurrence of fires) and 70% for EF.

6.4.6 Source-specific QA/QC and verification, if applicable

QA procedures applied to the Walloon and Flemish Forest Inventory: Data are directly encoded on a ruggedized tablet PC and there are a lot of automatic procedures which verify the coherence of encoded data. After the data's transfer into the main database, data for each sample plot are still verified by the inventory staff's engineer. After that, a last automatic verification procedure also takes into the calculated variables to verify the likelihood of the obtained results.

For the QA/QC of The Flemish Forest Inventory also additional measurements are carried out in the field: In each sample plot two trees are re-measured. This to assess the repeatability. And each year 18 sample plots are re-measured in order to estimate the reproducibility.

6.4.7 Source-specific recalculations, if applicable, including changes made in response to the review process

In the three regions, following the revision of the surface of the country and all three regions by STATBEL (the Belgian statistical office)[24] the extension factor determining the surface associated to each point of the LULUCF matrix was revised to match with the updated surface for the whole time series. All subcategories in this sector are affected.

24 https://statbel.fgov.be/en/themes/environment/land-cover-and-use/land-use

Brussels Region:

- Revision of land use changes in the LULUCF matrix for the period 2016-2018
- Revision of the C/N ratio for forest lands from 19.254 to 17 on the basis of analysis from regional measurement campaigns

6.4.8 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

Belgium will continue to collect data on SOC in category 4A (forest land), to further demonstrate that this pool is not a source.

For the 2024 submission, Belgium did not have the data to estimate carbon pools related to deadwood for forest land. Belgium will try to provide estimates for the next submission.

In Wallonia, the permanent inventory of forest resources (IPRFW) is carried out in cycles of more or less 10 years. The second phase of this inventory has not yet been completed and only one average value for dead wood is available. As soon as the new values are obtained, it will be possible to define the trend between the two inventory cycles and to provide estimates for dead wood pool.

Same situation more or less in the Flemish region where current values are used in the inventory based on the results of 2 forest inventories with an average time of 1998 and 2014. Results of the 3th forest inventory will be included in future inventories.

6.5 Cropland and grassland (CRT 4.B and 4.C)

6.5.1 Source category description

Croplands include arable and tillage land, and agro-forestry systems where vegetation falls below the thresholds used for the forest land category, consistent with the selection of national definitions. The carbon stocks of perennial woody crops such as orchards are also estimated.

The final area of Cropland is increasing only for the last years in Belgium (2016-2020) but for all the timeseries in Flanders. This trend is essentially linked to the conversion from Grasslands to Cropland (these conversions represent more than 95% of areas converted to cropland at Belgian level). In Flanders this conversion from grassland to cropland in recent years can be explained - partly because older farmers (with livestock or mixed farming) are stopping their activities and tenant farmers are cultivating the land for other crops. The Department of Agriculture & Fisheries (parcel registration) noticed that between 2014 and 2019, moreover, permanent grassland declined to the detriment of temporary grassland (these temporary grassland being classified in cropland) , perhaps because it fits better in modern business management and because the status of permanent grassland is subject to more conditions, among others, in the context of the Common Agricultural Policy, but also nature policy and erosion (20). It is assumed that the same mechanisms also cause these land-use changes in Wallonia

Grasslands includes rangelands and pasture land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold of forest definition and are not expected to exceed, without human intervention, the threshold used in the forest land category.

6.5.2 Methodological issues

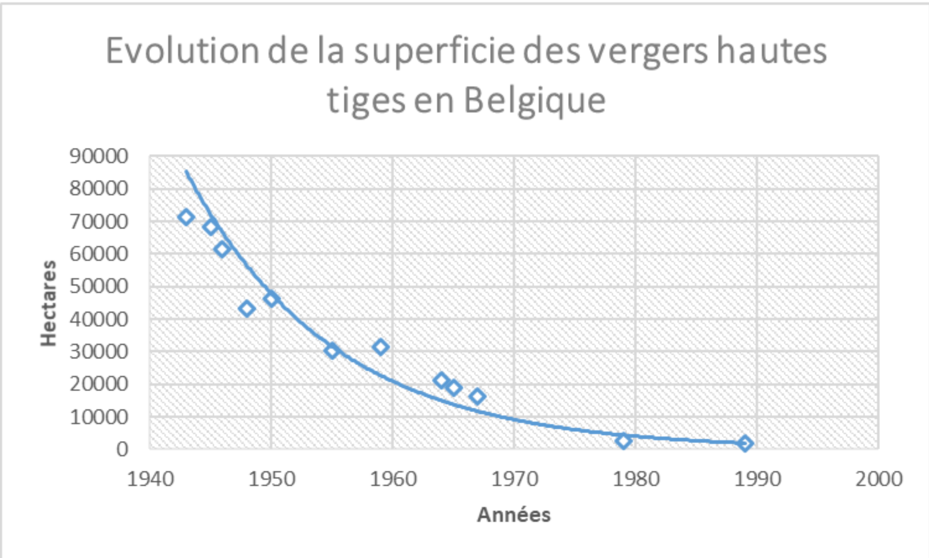
6.5.2.1 Cropland remaining cropland and grassland remaining grassland

<u>*A. Change in carbon stocks in living biomass*</u>

For annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year - thus there is no net accumulation of biomass carbon stocks.

The carbon stocks of perennial woody crops such as orchards is based on data published in the German National Inventory Report 2018 (16), section 6.1.2.3.4.1, table 345. The orchards considered in Germany have a density between 1600 and 2300 trees/ha, which is typical of low-stem rather intensive orchards, similar to the current orchards cultivated in Belgium, where the density can reach 3000 trees/ha according to the agricultural census. No country-specific value nor IPCC default value on carbon stocks in orchards was found.

High-stem orchards have practically disappeared in Belgium between 1945 and 1990, as presented in figure 6.6.



Diversifruits ©

Figure 6.6: High stem orchards area evolution in Belgium (17)

According to the agricultural census, the share of apple and pear trees in the total orchards area is between 91 and 93%. This share is stable since 1990. Hence, the average carbon stock was calculated from the German data for apple and pear tree, as published in 2012, namely 7,58 and 6,95 t C/ha, which gives an average value of 7,265 t C/ha (above ground+below ground living biomass). A constant value is used: further refinement was not deemed necessary, considering the small difference between apple and pear biomass and the remaining uncertainties on the actual comparability with Germany regarding the age of trees and density.

The carbon stock within a constant area of orchard is assumed stable overtime, as tree growth is balanced by trimming of the fruit trees. However, given that the overall orchard area increased significantly since 1990 (fig 6.7), this subcategory is a net sink over time. The increase of area is likely due to the public subsidies (18) including agri-environmental measures under the Common Agricultural Policy of the EU, which are conducted since 2002 (measure 1b, which includes orchards and hedges) (19).

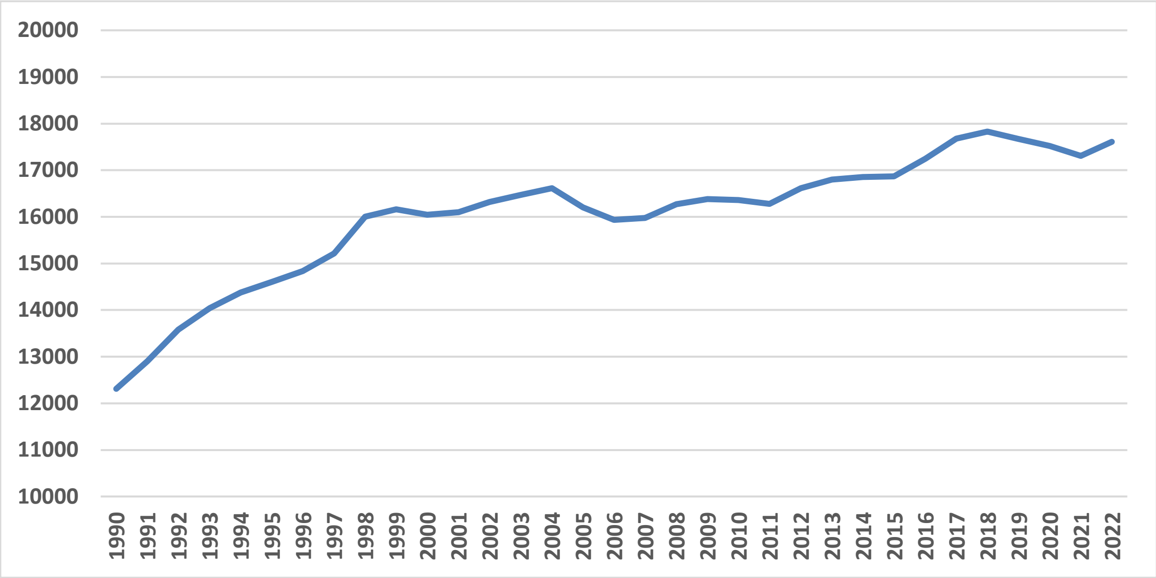


Figure 6.7: Orchard area (ha) in Belgium, according to the agricultural census (1990-2022)

Following the recommendations of the 2018 UNFCCC review, the changes in carbon stocks due to the new orchards are calculated applying a period of ten years period to reach the steady state of carbon stock. Hence, in case of an increase of area, an annual increment of 0.7265 tC/ha.y is applied, and after 10 years, the stock is assumed stable. In case of loss of area, the total stock is considered emitted in the year of the decrease.

The ten-year period is based on documentation published in Wallonia (22) and Lorraine, which is a french-neighbouring region, where it is specified that orchards in Belgium will give fruits after 2 to 7 years, depending on the type of orchards (standard or dwarf, depending on the stem height) and that the shape pruning takes up to 8 years (20). Hence, a period of ten years to reach a steady state seems a reasonable estimate.

B. Change in carbon stocks in soils

The estimates of the changes in soil C stock for land converted to/from grassland and cropland are calculated according to equation 2.25 of the IPCC 2006 guidelines, assuming a 20 years duration of the transition.

The methodology for SOC evolution in mineral soils and organic soils, in cropland remaining cropland and grassland remaining grassland, is detailed hereunder. Emissions from lime application are presented under section D below.

Mineral soils

Each region applies equation 2.25 of the IPCC guidelines to estimates changes in carbon stocks, applied to regional specific data (see table 6.19 and 6.20 below). The source of data regarding soil carbon content is explained below. The average carbon stocks in 2000 are given in table 6.2 (section 6.2.1).

Flanders

The soil C values in mineral soils (0-30cm) for cropland and grassland have been updated in 2015, following the recommendations by the UNFCCC expert review team and after consultation with Flemish soil experts, through a new study by Dr. Meersmans (21),. The values used in the calculations are summarized in table 6.19 below.

	SOC mass per surface unit (ton/ha)		*SOC changes (ton/ha/yr)*
Land use	1960	2006	***1960-2006***
cropland	54,59	53,87	***-0,016***
grassland	74,57	73,70	***-0,019***

Table 6.19: Soil organic carbon (ton/ha) and evolution in soil organic carbon (ton/ha/yr) in mineral soils in cropland and grassland in the Flemish Region (21)

Wallonia

In Wallonia, the data on SOC evolution were updated in a study conducted by the UCL (Université Catholique de Louvain) 2022, using data from the “requasud” network, which collects soil analysis performed on agricultural soils, all over Wallonia.

The study covers two periods, 2004-2014 and 2015-2019, based on 86,000 samples.

The Soil C value obtained in Wallonia for cropland and grassland are weighted average values between the different soil types and landscapes units (agricultural regions, which are linked to soil type). In this regard they implicitly account for the different soil type and landscape units. An annual trend is derived from these data, for the agricultural regions where the change is statistically significant.

	Mean SOC (ton C/ha, weighted by actual agricultural areas)	
	Cropland	Grassland
T1 (2004-2014)	51.12	88.45
T2 (2015-2019)	51.02	86.69

Table 6.20: Wallonia, Soil carbon variation – UCL study. CARBIOSOL (22)

For the years 1990-2004, the data on cropland are based on a former study (Carbiosol (62)), which indicated a slight decrease in SOC between 1956 and 2004. Regarding grassland, the same study suggested an increase in carbon stocks between 1956 and 2004. However, as the recent data indicate at the contrary a decrease of SOC in grassland since 2004, an expert judgement was conducted together with UCL and it was concluded that this increase likely took place before 1990. Accordingly, the SOC in grassland is assumed stable between 1990 and 2004.

Brussels-Capital region

In Brussels-Capital region, the emissions and removals were estimated by applying the soil carbon data observed in Wallonia to the land use changes in the Brussels-Capital region calculated according to the methodology determined by the study by Gembloux. Given the very limited share of crop- and grasslands in Brussels-Capital region compared to Wallonia and Flanders, the land use affectation is largely based on the interpretation of aerial photographs.

Organic soils

Emissions from organic soils are calculated using equation 2.26 of the IPCC 2006 Guidelines. Default IPCC emission factors from tables 5.6 and 6.3 are used, for warm temperate moist climate (the new official average temperature in Belgium is 10.5°C for the reference period 1981-2010, formerly it was 9.7°C for the reference period 1961-1990), namely 10 t C /ha.y for cropland and 2,5 t C/ha.y for grassland.

In Flanders, the area of organic soils is 2520 ha, of which 1899 ha in cropland and 621 ha in grassland. These areas are included under ‘cropland remaining cropland’ and ‘grassland remaining grassland’ (no changes in land use are known for these areas). These values are based on research by Van Orshoven et al., KU Leuven.

In Wallonia there is 7957 ha of organic soils, amongst which 2655 ha are included in natural reserves. These organic soils are mainly peat, located in Forest and Wetlands according to a cross analysis between Land Use map and Soil map. There are no organic soils in croplands in Wallonia. Concerning grasslands, only 2 points (400 ha) are classified between 1990 and 2008, and only one sampling plot (200 ha) between 2008 and present.

However, as the grassland organic soil area in Wallonia is under natural reserves and not subject to drainage or tillage, no CO_2 emissions from cultivation of organic soil in Wallonia occurs.

In Table 6.21 is an overview of the areas, net carbon stock change and IEF of the organic soils from grassland remaining grassland for the different regions.

4.C.1 Grassland Remaining Grassland	**Unit**	**1990 --> 2007**	**2008 --> 2022**
Area of organic soil Belgium	kha	1,02	0,82
Area of organic soil Flanders	kha	0,62	0,62
Area of organic soil Wallonia	kha	0,40	0,20
Area of organic soil Brussels	kha	NO	NO
Net carbon stock change in organic soils Belgium	kt C	-1,55	-1,55
Net carbon stock change in organic soils Flanders	kt C	-1,55	-1,55
Net carbon stock change in organic soils Wallonia	kt C	NA	NA
Net carbon stock change in organic soils Brussels	kt C	NO	NO
IEF organic soils Belgium	t C/ha	-1,52	-1,89
IEF organic soils Flanders	t C/ha	-2,50	-2,50
IEF organic soils Wallonia	t C/ha	NA	NA
IEF organic soils Brussels	t C/ha	NO	NO

Table 6.21: Areas, net carbon stock change and IEF of the organic soils from grassland remaining grassland per region

C. Emissions from wildfires (Category 4.C.1)

Emissions from fires are calculated using the current available data, which cover the period 1990-2022. Emissions from wildfires are only relevant for the years 2011 and 2021 so far.

Data on areas affected by wildfires in Belgium are available for 1996 (forest fires) and 2011 (forest and grassland affected). The occurrence of fires is low, given the usually wet and cool Belgian climate. Since fires do not occur every year, notation key “NO” is used for years where no fire has been observed.

In 2011, dry conditions also led to fires in the Fagnes, covering 35 ha of forest and 1265 ha of grassland in this area of natural reserve (Walloon region) and 678 ha (mainly grassland) in Kalmthout and Meeuwen-Gruitrode (Flemish region).

Equation 2.27 of the IPCC 2006 Guidelines is applied for GHG emissions, using a default value of 11,5, as indicated in table 2.4 of the IPCC 2006GL page 2.46, for “All other temperate forest/Shrublands/Calluna heath”, considering that this type of vegetation appeared the closest to the one observed in the Belgian Fagnes, where Calluna and other Ericacae are common and where most of the fires occurred in 2011.

D. N2O emissions from N mineralization associated with the loss of soil organic matter (4.B.2, 4.C.2)

Please refer to chapter 6.2.2., general consideration on methodological issues, for a description of the calculation of N_2O emissions from N mineralization associated with the loss of soil organic matter.

The methodology is based on equation 11.8 from the IPCC 2006 Guidelines.

N_2O emissions are calculated for all conversions to cropland and grassland and for grassland remaining grassland. (Emissions from cropland remaining cropland are reported under 3.D.1.5 in Agriculture). However, if the conversion to cropland or grassland does not entail a carbon stock change or leads to a net gain of carbon, the nitrous oxide emission was set to zero. This is the case e.g. for the conversion of settlements to cropland, where the Soil C was estimated similar to the cropland soil C.

6.5.2.2 Land converted to cropland or grassland

Living biomass

Concerning land converted to cropland or grassland, changes in carbon stocks in living biomass actually only occur on for forest land converted to grassland or cropland. No changes in living biomass are considered for all the other changes involving non-forest land converted to cropland or grassland.

The decrease in carbon stocks in living biomass due to the felling of the trees is calculated considering the weighted average living biomass carbon stock for deciduous and coniferous trees.

	Deforestation (average carbon stocks in living biomass in Forest land, t C/ha)
Brussels	127.2
Flanders	85.8
Wallonia	79.9

Table 6.22: Average regional values for carbon stocks in living biomass (t C/ha)

In Flanders the land-use-matrix years are 1989; 2009;2012 and 2015. There were no land-use-changes determined between 2012 and 2015 for forestland converted to grassland, therefore the notation key NO has been used for living biomass in the years 2013-2015.

For forestland converted to cropland there were some land-use-changes between 2009 and 2012 that where redeterminations to its original land-use (forestland). Also the trend after 2015 gives no land use changes in this category. No gains or losses are estimated for this specific case, and the notation key NO has been used for change in living biomass for the years 2010-2012. The change in 2009 of land-use was not considered as replantation because of the 20-year time gap between the two land-use-matrixes of 1989 and 2009. Because these rechanges to the original land-use made that there is no the trend between 2009-2015. Also, no land use change in this subsector was used for the extrapolation after 2015, and the notation key of NO was used for living biomass for the years 2016-2022.

Soil organic carbon

The estimates of the soil C stock changes of land use change areas are calculated according to equation 2.25 of the IPCC 2006 guidelines, assuming a 20 years duration of the transition.

Dead organic matter

In the case of forest land converted to cropland or grassland, all carbon from deadwood and litter is considered emitted in the year of deforestation, applying the values presented in section 6.2.2.1.B.

6.5.3 Uncertainties and time-series consistency

See paragraph 6.4.5.

Uncertainties on N_2O and CH_4 emissions from biomass burning in grassland (in practice grassland areas included in forested areas) are estimated following default values of the IPCC 2006 Guidelines, namely 30% for AD (area burned, which are all measured by the forestry service, given the small occurrence of fires), 37% for biomass fuel (table 2.4) , 42% for fraction burned (table 2.6) and 50% for EF (table 2.5).

For N_2O emissions due to the conversion to cropland, an uncertainty of 18% on the Area converted is used, and an uncertainty of 150% on the N_2O emission factor. Results are reported in annex 2.

6.5.4 Source-specific QA/QC and verification, if applicable

Source-specific QA/QC and verification is planned for the next submission.

6.5.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In the three regions, following the revision of the surface of the country and all three regions by STATBEL (the Belgian statistical office)[25] the extension factor determining the surface associated to each point of the LULUCF matrix was revised to match with the updated surface for the whole time series. All subcategories in this sector are affected.

6.5.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

Further data on SOC in grassland and cropland will be collected in Wallonia in the coming years.

6.6 Wetlands, settlements and other lands (CRT 4.D, 4.E and 4.F)

6.6.1 Source category description

Wetlands include land that is covered or saturated by water for all or part of the year (e.g. peat land) and that does not fall into the forest land, cropland, grassland or settlements categories. It includes reservoirs as a managed subdivision and natural rivers and lakes as unmanaged subdivisions, in line with IPCC 2006 Guidelines.

Settlements include all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. Some specific issues regarding the application of the definition have been raised during the Belgian LULUCF study, regarding the photo-interpretation as presented in NID chapter 6.3..1.1. For example, points of sampling points located on the side of a road are classified as settlements if the management of this land is linked to the road management.

The land use category 'Other lands' include bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available. Following a recommendation by the expert review team, no more areas are reported under the category 'Other lands', as all points have been reclassified (included in one of the other five categories) (see 10.2.3).

6.6.2 Methodological issues

6.6.2.1 Wetlands

<u>Area</u>

The areas of wetland and land converted to wetland are estimated by the study described in chapter 6.3.1.

All the areas are encoded in "4D13 Other Wetlands remaining Other Wetlands" and "4D23 Land converted to Other Wetlands" because it is impossible to distinguish with "4D12 Flooded land remaining Flooded land" and "4D22 Land Converted to Flooded land". As there are no emissions only the areas are encoded "IE" and there is a comment provided in the CRT.

25 https://statbel.fgov.be/en/themes/environment/land-cover-and-use/land-use

Living biomass

Changes in carbon stocks in living biomass were estimated for all land use change from forest land to other land use, including wetlands. The decrease in carbon stocks in living biomass due to the felling of the trees is calculated considering the weighted average living biomass carbon stock for deciduous and coniferous trees.

Soil organic carbon

The estimates of the soil C stock changes of land use change areas is calculated according to equation 2.25 of the IPCC 2006 guidelines, assuming a 20 years duration of the transition.

The SOC of peat land was estimated at 100 t C/ha by Van Wesemael (pers com, 2007). This value is used for calculation of C stock change in soils. It is considered as provisional as a clear distinction of peat land and reservoirs is still lacking. However, it should be noted that the areas subjects to land use from and to wetlands are very limited compared to other subcategories. In this sense, the impact of this subcategory on the emissions/sinks should also be limited.

For wetlands remaining wetlands, emissions are reported as 'not occurring' (NO). No data are available on an evolution of the C stock, which is assumed stable. The wetlands are mostly located in the 'Fagnes' in the Belgian Ardennes. This area is a natural reserve, managed under a LIFE project, aiming at restoring the original wetlands by rewetting previously drained areas. Therefore, these lands are assumed not to be a net source of CO_2.

No peat extraction occurs in Belgium.

6.6.2.2 Settlements

Area

The areas of settlements and land converted to settlements are estimated by the study described in chapter 6.3.1.

Living biomass

Changes in carbon stocks in living biomass were estimated for all land use change from forest land to other land use, including settlements and other lands. The decrease in carbon stocks in living biomass due to the felling of the trees is calculated considering the weighted average living biomass carbon stock for deciduous and coniferous trees.

Soil organic carbon

The estimates of the soil C stock changes of land use change areas is calculated according to equation 2.25 of the IPCC 2006 guidelines, assuming a 20 years duration of the transition.

In the absence of default values in the IPCC guidelines, average soil carbon content under settlements was estimated based on the SOC under cropland. The rationale for this value is the following:

According to the study by Gembloux (2011 report), most (78%) of the lands converted to settlements since 1990 are grasslands and croplands. Grasslands represent 47 % of the conversion to settlements and croplands 31%. In the absence of relevant data, one can assume that the LUC were comparable in the past.

The average carbon content of the soils in Belgium in 2000 were 48 t C/ha (cropland) and 87 t C/ha (grassland). SOC under cropland is thus the lowest value of the 3 main land use categories (forest land, grassland, cropland).

Although many settlements were likely built on former grasslands, the SOC from cropland is used as an average value, as this approach is deemed more conservative and should reflect possible carbon losses during construction.

For settlements remaining settlements, after consulting soil experts, it was deemed that no changes in soil C occur as these soils are largely covered by concrete. This is consistent with tier 1 as described in chapter 8.2.3.1 of the 2006 IPCC Guidelines ("soil C stocks do not change in *Settlements Remaining Settlements"*).

N_2O emissions from N mineralization associated with the loss of soil organic matter (4.D.2, 4.E.2):

See chapter 6.1.1, general consideration on methodological issues, for a description of the calculation of N_2O emissions from N mineralization associated with the loss of soil organic matter.

The methodology is based on equation 11.8 from the IPCC 2006 Guidelines.

N_2O emissions are calculated for all land use categories and conversions to land uses. However, if the conversion to a new land use does not entail a carbon stock change or leads to a net gain of carbon, the nitrous oxide emission was set to zero.

6.6.2.3 Reclassification of "Other lands" (submission 2015)

Belgium is a small country and all land is managed.

In submissions before 2015, a limited percentage of points in the Belgian land use matrix was assigned to the land use category "other land". These were the points of which the land use could not be determined.

As recommended by the ERT during the 2014 review, these points have been reclassified, by new photo-interpretation of the historical images and using the most recent aerial images. As a consequence, all land use in Belgium is now classified under forest land, cropland, grassland, wetlands and settlements. Most of the formerly "other land" points (> 80%) have been reclassified as settlements.

6.6.3 Uncertainties and time-series consistency

See paragraph 6.4.5.

6.6.4 Source-specific QA/QC and verification, if applicable

Source-specific QA/QC and verification is planned for the next submission.

6.6.5 Source-specific recalculations, if applicable, including changes made in response to the review process

In the three regions, following the revision of the surface of the country and all three regions by STATBEL (the Belgian statistical office)[26] the extension factor determining the surface associated to each point of the LULUCF matrix was revised to match with the updated surface for the whole time series. All subcategories in this sector are affected.

Brussels Region:

Revision of land use changes in the LULUCF matrix for the period 2016-2018

6.6.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

Belgium will strive, for the next submission, to review each occurrence of changes of land use to 'Settlements' and assign them to one of the subcategories according section 8.3.3.2. (vol.4, Ch.8 of IPCC 2006 guidelines). By following the guidelines, we should be able to provide new estimates of carbon losses in mineral soils and living biomass related to "subcategories" transitions.

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26 https://statbel.fgov.be/en/themes/environment/land-cover-and-use/land-use

6.7 Harvested wood products (CRT 4.G)

Belgium reports domestically produced Harvested Wood Products for forest management activity using the first order decay approach (Tier 1 method). Deforestation activity is estimated using tier 1 « instantaneous oxidation ».

The annual fraction of HWP originating from deforestation is calculated using equation 2.8.3 from the 2006 IPCC Guidelines. The volume of wood originating from deforestation is based on the average wood volume in each of the regions, as determined by the regional forest inventories and the area under deforestation. This volume is then compared to the annual harvested wood volume using equation 2.8.3.

6.7.1 Source category description

Harvested wood products (HWP) category represents the carbon remaining in wood materials for differing lengths of time after leaving harvest sites. The carbon reported under HWP is the carbon from the carbon pool inflow in different semi-finished products categories, such as sawn wood, wood-based panels and paper and paperboard.

6.7.2 Methodological issues

The HWP contribution in the land-use sector in Belgium, in terms of greenhouse emissions by sources and removals by sinks, was reported for the first time in the 2015 submission, based on approach B outlined in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, chapter 12.

Until 2016 the reported values were based on a generic model (German Wood Carbon Monitor) developed by S. Rüter (23). Belgium has now developed his own model (24).

Since 2017, HWP contribution is estimated according to the production approach as described in 2013 IPCC Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, chapter 2.8.

The estimates cover all wood products that are produced in Belgium with domestic material. That consists of wood that originates from trees harvested in Belgium and used for their material (not energy) value. The carbon stored in wood in solid waste disposal sites is not taken into account as specified in the 2013 IPCC Guidance.

Deforestation activity is estimated using tier 1 « instantaneous oxidation ».

Forest Management contribution is estimated following tier 2 method “first order decay”.

6.7.2.1 Data source

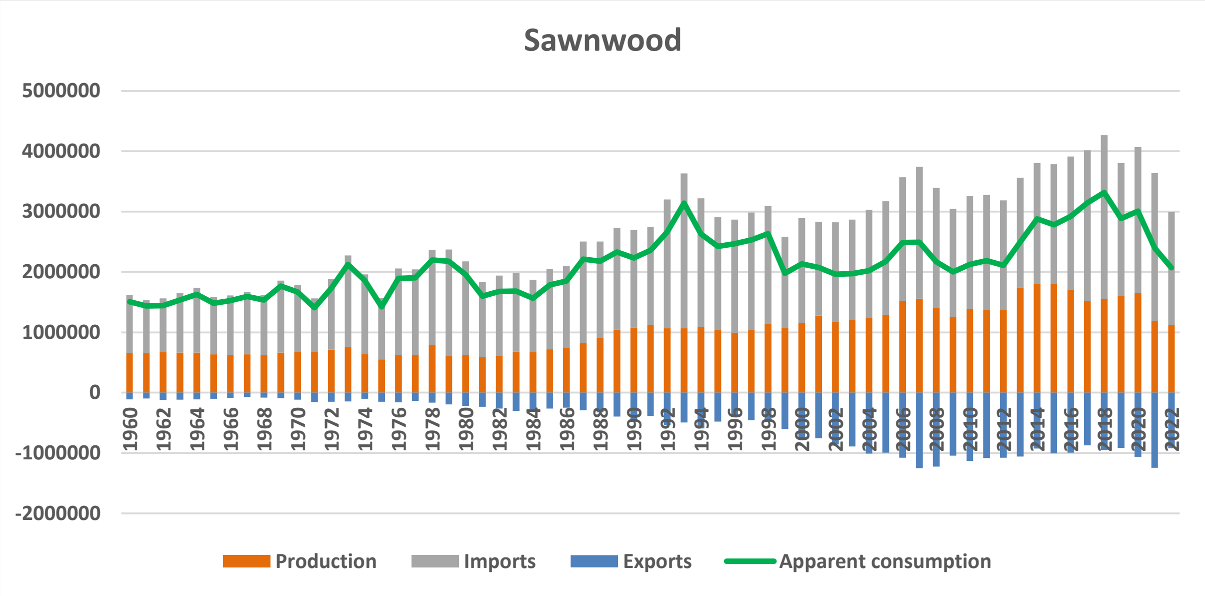
Data for production and exports are estimated using data from the FAO database from 1961 to 2018. A consistency check on the exports and production FAO data reveals a potential inconsistency with the Joint Forest Sector Questionnaire (JFSQ) definitions. It seems that some« in-transit » HWP may be included in the Belgian’s FAO data, especially for the paper and paperboard subcategory.

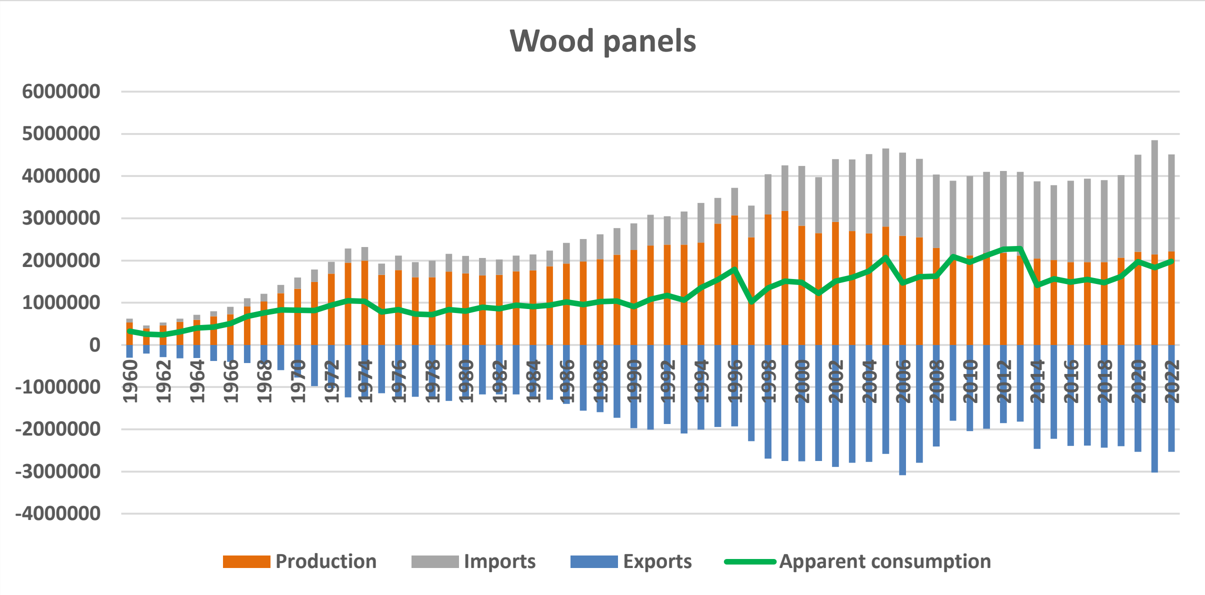
Recent FAO data present inconsistencies and outliers. The Filière Bois Wallonie conducts on a regular basis thorough analysis and corrections of the import-export data published by the BNB - National Bank of Belgium (https://www.filiereboiswallonie.be/la-filiere/panorabois checking units and consistency between prices and volumes. These validated data were used for the years 1999-2022.

For the period 1961-1999, no data is found for Belgium in the FAO database. After a deepest search in the database, it appeared that the data are published, but for Belgium+Luxembourg as a whole. The share of Belgium in these data was estimated on the basis of the share of Belgium in the total (Belgium+Luxembourg) in the 5 closest years closest to the 1961-1999 period, namely 2000-2004, for which country-specific data are available. This period was determined after the analysis of the trends, as some categories increase in

Luxembourg afterwards, such as the start of paper production in 2006 and increase of Wood-Based panels in 2004 (for this category, 2000-2003 was finally selected to assess the share of Belgium, as the increase of production in Luxembourg is identified in 2004).

The consistency of the reconstructed time series is presented in figure 6.8.





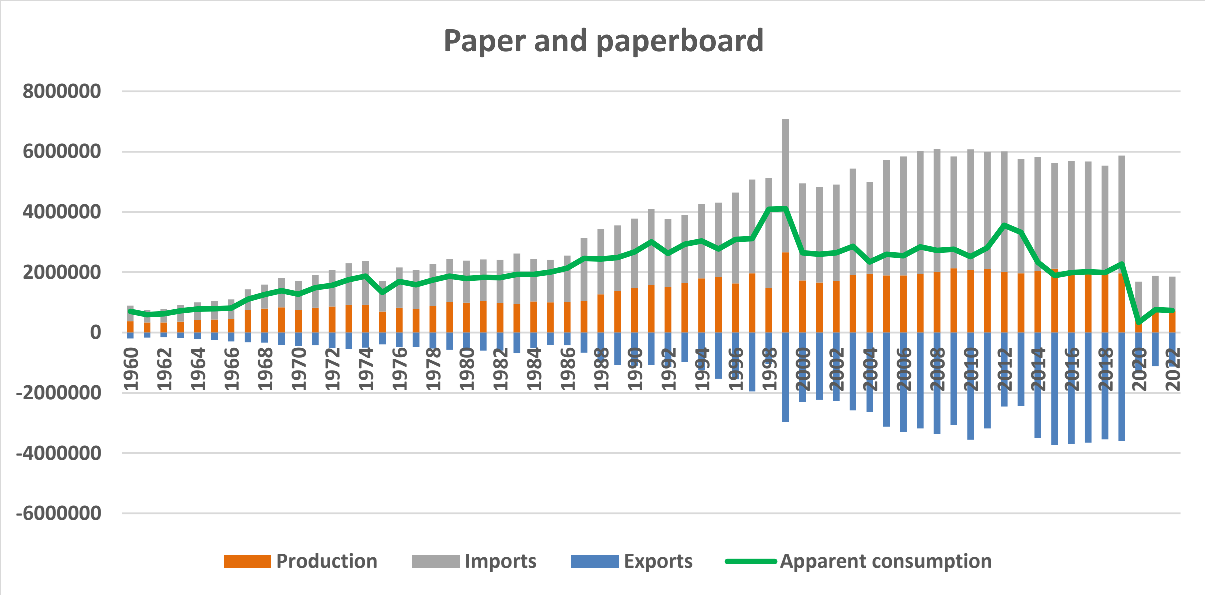


Figure 6.8: Activity data for HWP (Production, import, export and apparent consumption) in m³ (Sawnwood and Wood based panels) and tons (paper and paperboard)

Since the 2020 submission, the carbon stocks of the HWP pools at initial time (period 1900-1961) are estimated applying equation 2.8.6 of the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, instead of equation 12.6 of the 2006 IPCC Guidelines applied in the 2019 submission.

6.7.2.2 HWP estimates

Equation 2.8.1 of the KP supplement is applied for estimating the annual fraction of the feedstock coming from domestic harvest for the HWP category sawnwood and wood-based panels and equation 2.8.2 to estimate the annual fraction of domestically produced wood pulp as feedstock originating from domestic harvest.

Equation 2.8.3 and 2.8.4 are applied to estimate the annual inflow of the three subcategories sawnwood, wood-based panels and paper and paperboard. Equation 2.8.3 is used to estimate the volume of wood harvested from deforestation (based on the annual deforested area times the mean volume according to the forest inventory), which is then excluded from the HWP inflow.

Carbon stocks (C) and annual carbon stock changes (∆C) deriving from forest management under art 3.4 are estimated for each HWP subcategories using Eq. 2.8.5 of the KP Supplement.

Where, i = year; C (i) = the carbon stock in the particular HWP category at the beginning of year i; Gg C, k = decay constant for the first-order decay for HWP category (HWP j) given in units yr-1; k = ln(2)/HL, where HL is the half-life of the HWP pool in each year. Inflow (i) = the inflow to the particular HWP category (HWP j) during year i;∆C (i) = carbon stock change of the HWP category during year i, Gg C yr-1.

The Deforestation activity estimation of annual carbon stock changes (∆C) is estimated following the "instantaneous oxidation" of the carbon stocks (C) for each HWP subcategories (see section 10.3.1.1).

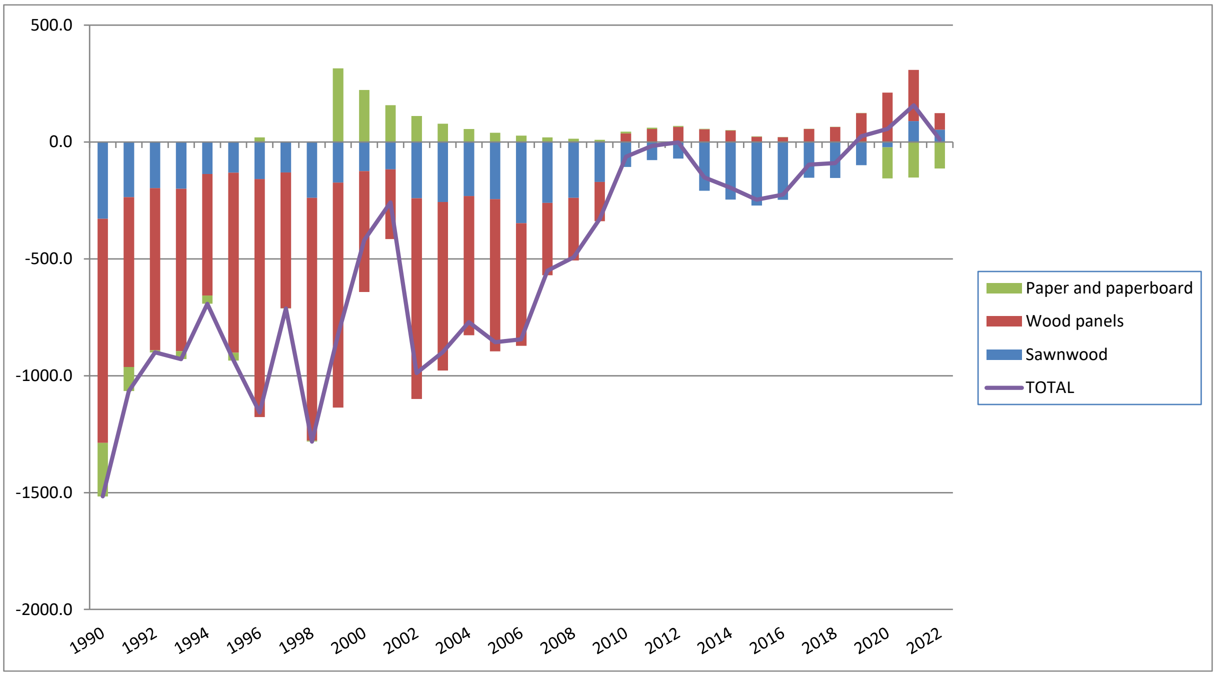


Figure 6.9: Emissions and removals from HWP pools

6.7.3 Uncertainties and time-series consistency

Based on expert judgment, the uncertainty on emission factor and activity data was set to 50%.

Uncertainties were combined using equations 3.1 and 3.2 of the IPCC 2006 Guidelines.

6.7.4 Source-specific QA/QC and verification, if applicable

For the time being, quality control mainly concerned the activity data, as some discrepancies appeared in the FAO data. The “Filière Bois Wallonie” data on import-export are subject to quality control procedures.

The consistency of the calculation model developed by Belgium was subject to a basic check, using FAO data from another Party and comparing the obtained results with the CRT data reported by that same Party. The results of the comparison were satisfying, as it highlighted only small differences that could be explained by the use of slightly different emission / conversion factors.

6.7.5 Recalculations

Recalculations occurred from 2010 for the 2024 submission because of updated data available from the Food and Agriculture Organization of the United Nations regarding annual production and trade statistics for forest products.

6.7.6 Source-specific planned improvements, if applicable (e.g., methodologies, activity data, emission factors, etc.), including those in response to the review process

Further checks on possible other sources of activity data for Harvest wood products will be performed.

6.7.7 Information relating to Forest Management

6.7.7.1 Conformity with the definition in item 10.1 above

The areas under Forest management are determined following the strict application of the criteria presented in section 6.4.2., regarding Minimum tree crown cover, land area and height at maturity.

6.7.7.2 Forest management is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner

The first Belgian Forest Code was published in 1854 (68). It was progressively amended and replaced by regional laws.

In Wallonia, the Forest Code (13)) has introduced a certain number of constraints in favor of forest conservation and the maintenance of ligneous materials and carbon, including:

- the abolition of inheritance duties on the stumpage value, which encourages more ecological forestry choices (maintaining the material, greater possibility to choose species with a long life cycle and to apply continuous cover, etc.);
- the restriction of clear-cutting;
- the obligation to plant species suited to the site, which contributes to limiting the risks of blowdown and dieback and improves resistance to climate change;
- the creation of integral reserves;
- the limitation on drainage (which encourages maintenance of organic matter);
- incentives for production of high-quality wood and therefore use of wood in long-term applications with gains in CO_2 linked to substitution by other materials;
- thinning standard in even-sized spruce stands of 2009 (69). This new standard is part of more dynamic forestry than that practiced in many places. The aim behind the desire for renewed dynamism in forestry regarding the main coniferous species existing in Wallonia is mainly to produce timber in stable, healthy stands, with higher biodiversity and a shorter life-cycle. In the context of global warming, these advantages linked to the dynamism of the clearings can only be beneficial to production, by limiting the disadvantages suffered from pronounced droughts or more numerous beetle populations, for example. In addition, increasing the dynamism of forestry of both coniferous and deciduous trees contributes to increasing the proportion of wood in long-term uses and therefore storage in wood products.

The designation of 1.500 km^2 of forests in Natura 2000 under special fixed rules of management also contributes to these various objectives.

In the Brussels Capital Region, the Forêt de Soignes/Zoniënwoud is protected (no deforestation allowed) and FSC certified. Its management aims to ensure ecological stability and a long-term balance in the distribution of forest age. In addition to ensuring the ability to regenerate, biodiversity and ecological and social aspects are taken into account.

The Flemish Region has an active forest expansion policy. The Flemish authorities have drawn up a strict regulation for optimum conservation and protection of the Flemish forest (69) (Decree of 18 May 1999 concerning the organization of spatial planning and Decision of the Flemish Government on 16 February 2001 to clarify the rules concerning compensation and deforestation and exemption from the ban on deforestation). As a general rule, deforestation is prohibited. There are a number of exceptions, but a permit is required in each case and this permit will be granted only in exchange for compensation. The obligation for compensation consists of the planting of a forest of equal size or larger at another location.

The compensation can also be financial in the form of a forest maintenance contribution to the Forests Compensation Fund. In addition, the Flemish authorities have created instruments to ensure the biodiversity and sustainable use of natural resources. In various cases, planting of forests is subject to acquiring a nature permit in the case of protected (open) vegetation (Decree of 21 October 1997 concerning nature conservation and the natural environment; Decision of the Flemish Government of 23 July 1998 establishing the rules for the implementation of the Nature Conservation Decree) or the planting of forests in agricultural areas (Rural Code of 7 October 1886).

6.7.7.3 Forest Management Reference Level (FMRL)

According to the Decision 2 / CMP.7 anthropogenic greenhouse gas emissions by sources and removal by sinks, resulting from forest management under Article 3.4, shall be counted against the Forest Management Reference Level (FMRL) for the second commitment period of the Kyoto Protocol. The FMRL contains a value that projected the average annual net emissions of Forest Management in the second commitment period of historical data and policy decisions.

For Belgium a FMRL of –2.499 million tonnes of carbon dioxide equivalent (Mt CO_2 eq) per year applying a first order decay function for harvested wood products (HWP) and –2.407 Mt CO_2 equivalent per year assuming instantaneous oxidation of HWP (submitted in 2011 FMRL documents and related review report which can be found on http://unfccc.int/bodies/awg-kp/items/5896.php on the UNFCCC website).

Belgium is one of the member States of the EU for which the JRC of the European Commission developed projections in collaboration with two EU modeling groups. The FMRL73 is the averages of the projected forest management (FM) data series for the period 2013-2020, taking account of policies implemented before mid-2009, with emissions/removals from harvested wood product (HWP) using the first order decay functions, and assuming instant oxidation. Aboveground and belowground biomass, dead organic matter and HWP are included in the FMRL.

6.7.7.4 Technical Corrections of FMRL

Decision 2/CMP.7 and the IPCC KP Supplement require a technical correction of FMRL when methodological changes in the calculation of the time series appear, new historical data are available or pools were not taken into account in FMRL, in order to ensure methodological consistency between the FMRL and reporting for *forest management* during the second commitment period.

Updated historical data became available since the submission of the FMRL in 2011 and recent improvements were performed in the inventory. The main changes are summarized hereunder, with reference to their description in the relevant section of this NID:

- Second inventory cycle in Flanders and application of the stock-change approach and revised estimates (6.4.1)
- Update of Forest inventory data in Wallonia (6.2.2.1.A)
- Updates of the BEF in Wallonia (6.2.2.1.A)
- Revision of Dead Organic Matter carbon pool following review recommendations (10.3.1.1)
- Revision of the Soil carbon pool at Belgian level (6.2.2.1.C and 10.3.11)
- Update of the HWP calculation (6.5.2)

The most important recalculation is Soil organic carbon, with a difference around 1570 kt CO_2-eq in the average 200-2008. The second one is the updates of the forest inventories in Flanders and Wallonia, which increases the sink by 141 kt CO_2 in 200-2008 and the third is the recalculation of the HWP time series (increase of the sink by 419 kt in the 2000-2008 average). In 2022, the land-use matrix was updated in the 3 Regions.

Considering the magnitude of the changes, a technical correction of the reference level is proposed, in order to ensure methodological consistency between the FMRL and the current reporting for forest management.

The technical correction of the FRL presented below is based on the ex-post processing of the model results, as presented in the report “Submission of information on forest management reference levels by Belgium”, submitted in February 2011 and taking into account the corrections (new model run) applied according to the recommendations of the ERT during the technical assessment of the reference level in 2011.

The difference of historical emissions and removals reported in submissions 2011 and 2022 is summarized in Table 6.23 HWP values in 2011 come from the model used for the FMRL.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	av. 2000-2008
Submission 2011										
Biomass (1)	-1748	-1827	-1637	-1697	-1589	-1612	-1583	-1541	-1468	-1633
Non-biomass pools	-1093	-1640	-1637	-1634	-1632	-1629	-1626	-1623	-1620	-1570
HWP	376	659	-788	-900	-639	-756	-468	269	-73	-258
TOTAL	-2465	-2808	-4062	-4231	-3860	-3997	-3677	-2895	-3161	-3461
Submission 2022										
Biomass (1)	-1877	-1876	-1752	-1750	-1748	-1745	-1743	-1741	-1739	-1775
Non-biomass pools	0	0	0	0	0	0	0	0	0	0
HWP	-420	-259	-990	-901	-773	-859	-846	-553	-495	-677
TOTAL	-2297	-2135	-2742	-2651	-2521	-2604	-2589	-2294	-2234	-2452

Table 6.23: Belgium's historical emissions and removals from FL remaining FL (Gg CO2eq) and HWP, based on GHG inventory submitted to UNFCCC (update of Table 6 from the "Submission of information on forest management reference levels by Belgium", 2011)

			av. 2000-2008	2000	2005	2010	2015	2020	av. 2013-2020
Step 1: models' results (only biomass)	EFISCEN (1)		-1463	-1945	-1110	-1670	-1767	-1745	-1752
	G4M		-2912	-4221	-2358	-1858	-1312	-450	-1029
	Average of models		-2188	-3083	-1734	-1764	-1539	-1097	-1390
Step 2: ex-post processing	Offset (2)	biomass	554						
		non-biomass pools and GHG sources	-1570						
		total offset	**-1016**						
	Calibrated average of models (3)		-3204	-4099	-2750	-2780	-2556	-2113	**-2407**

(1) Efiscen does not estimate data for all countries for 2000 and 2005. When data were missing, backward extrapolation was applied as follow: sink in 2005 = sink in 2010 x ratio of harvest 2010/2005; this approach assumes that in the short term harvest is the main factor determining the sink. Estimates were extrapolated for the following countries: Bulgaria, Czech Republic, Estonia, Hungary, Italy, Latvia, Lithuania, Netherlands.

(2) The "offset" is distinguished between:

- Biomass: calculated as difference between [average of country's emissions and removals from biomass for the period 2000-2008] and [average of models' estimated emissions and removals from biomass for the period 2000-2008]

- Non-biomass pools and GHG sources: calculated as the sum of non-biomass pools and GHG sources as reported by the country for the period 2000-2008.

(3) The calibrated average of models, which is used for the setting of reference level, is obtained by adding the offset to the models' average.

Table 6.24: Emissions and removals from FM as estimated by models (above and below-ground biomass, Gg CO2eq), and calibration of models' results. Update of Table 8 from the "Submission of information on forest management reference levels by Belgium", as revised according to new model runs performed in 2011, following ERT recommendations during the technical assessment. This table is the source of the current value of -2407 kt, with an additional sink of -92 kt for the HWP pool, leading to the final value of -2499 kt.

The calibration applied in 2011 on the model's results (Table 6.23 as revised taking into account the new model run after the technical assessment, leading to the official value of -2407 kt CO2-eq. without HWP and a final value of -2499 kt including HWP) has been applied on the same model's results, to avoid any change in the model or in the underlying assumptions, using the updated data from the GHG inventory, as submitted in 2022. This calculation is presented in Table 6.24. The changes in the GHG inventory between 2011 and 2022 have a significant impact on the offset calculation for biomass and non-biomass, which changes from -1016 to +413 Gg CO2-eq.

The third step is the calculation of the HWP offset. The average values for 2000-2008 in the 2022 submission present a difference of -419 kt CO2 with the 2011 values used for the submission of the FMRL in 2011. This offset is added to the 2011 value of -92 kt CO_2 projected for the HWP pool in 2013-2020, to ensure consistency with the historical data of the 2022 submission, without any change in the model or underlying assumptions.

				av. 2000-2008	2000	2005	2010	2015	2020	av. 2013-2020
FMRL calibration	Step 1: models' results (only biomass)	EFISCEN (1)		-1463	-1945	-1110	-1670	-1767	-1745	-1752
		G4M		-2912	-4221	-2358	-1858	-1312	-450	-1029
		Average of models		-2188	-3083	-1734	-1764	-1539	-1097	-1390
	Step 2: ex-post processing	Offset (2)	biomass	413	0	0	0	0	0	0
			non-biomass pools and GHG sources	0	0	0	0	0	0	0
			total offset	**413**	0	0	0	0	0	0
		Calibrated average of models (3) : FMRL asssumin IO in HWP in 2022		-1775	-2670	-1321	-1351	-1126	-684	**-978**
		FMRL assuming FOD of HWP in 2011								**-2499**
HWP offset and calibration	Step 3: adding HWP using first-order decay function	HWP 2011		-276						-92
		Offset (2)	HWP 2022	**-419**						-419
		Calibrated average of models assuming FOD of HWP : FMRL corrected		-2470						**-1489**
	Technical correction									**1010**

(1) Efiscen does not estimate data for all countries for 2000 and 2005. When data were missing, backward extrapolation was applied as follow: sink in 2005 = sink in 2010 x ratio of harvest 2010/2005; this approach assumes that in the short term harvest is the main factor determining the sink. Estimates were extrapolated for the following countries: Bulgaria, Czech Republic, Estonia, Hungary, Italy, Latvia, Lithuania, Netherlands.

(2) The "offset" is distinguished between:

- Biomass: calculated as difference between [average of country's emissions and removals from biomass for the period 2000-2008] and [average of models' estimated emissions and removals from biomass for the period 2000-2008]

- Non-biomass pools and GHG sources: calculated as the sum of non-biomass pools and GHG sources as reported by the country for the period 2000-2008.

(3) The calibrated average of models, which is used for the setting of reference level, is obtained by adding the offset to the models' average.

	2011	2022	Technical correction
Biomass - average 2000-2008	-1633	-1775	-141
Non-biomass - average 2000-2008	-1570	0	1570
HWP average 2000-2008	-258	-677	-419
Total	-3461	-2452	1010
FMRL assuming IO in HWP	-2407	-978	1429
FMRL assuming FOD HWP	-2499	-1489	1010

Table 6.25: Comparison of the 2011 and 2022 submission. FMRL is presented assuming instantaneous oxidation (IO) or first order decay (FOD). The impact of HWP is -92 kt CO_2 in 2011 and (-92-419 kt) in 2022.

According to the calibration presented in Table 6.24 and 6.25, the total technical correction proposed by Belgium is +1010 Gg CO2-eq., and the FMRL corrected proposed for the period 2013-2020 is -1489 Gg CO_2-eq.

This technical correction is applied to ensure the methodological consistency between the FRL and the current reporting, for all pools (biomass, dead organic matter, soil carbon and HWP).

6.7.7.5 Information related to the natural disturbances provision under article 3.4

Belgium intends to use the provision to exclude emissions caused by natural disturbances during the second commitment period of the Kyoto-Protocol for forest management under Art. 3.4. Only wildfires will be elected in Belgium.

The Belgian background level has been calculated in accordance with the first approach described in footnote 7 of Decision 2/CMP.7, applying the following steps:

(1) Calculation of the arithmetic mean of the annual emissions for forest management, summed over disturbance types using all years in the calibration period (1990-2009).
(2) Calculation of the corresponding standard deviation (SD) of the annual emissions;
(3) Checking whether any emission estimate is greater than the arithmetic mean plus twice the SD. In this case, such estimates have been removed from the dataset and go back to step (1) above using the reduced dataset.
(4) When no further outliers can be identified, the arithmetic mean and twice the SD, as calculated in the last step of the iterative process, define the background level and the margin, respectively.

Emissions from Disturbances	average	stdev	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
GHG Emission Wildfires (BE)	28.21	110.43	10.49	10.57	8.96	6.38	7.38	0.57	497.09	4.64	7.59	1.61	0.02	0.51	4.81	2.82	0.00	0.02	0.06	0.72	0.00	0.00
1st iteraction	3.54	3.90	10.49	10.57	8.96	6.38	7.38	0.57		4.64	7.59	1.61	0.02	0.51	4.81	2.82	0.00	0.02	0.06	0.72	0.00	0.00
2nd iteration	3.54	3.90	10.49	10.57	8.96	6.38	7.38	0.57		4.64	7.59	1.61	0.02	0.51	4.81	2.82	0.00	0.02	0.06	0.72	0.00	0.00
3rd iteration	3.54	3.90	10.49	10.57	8.96	6.38	7.38	0.57		4.64	7.59	1.61	0.02	0.51	4.81	2.82	0.00	0.02	0.06	0.72	0.00	0.00
	Background	Margin																				
2.CMP/7, footnote 7	3.54	7.80																				

Table 6.26: Calculation of the background level and margin for Natural Disturbances (wildfires) in Belgium, following §33 and footnote 7 of Decision 2/CMP.7

The background level regarding wildfires for forest management in Belgium is 3.54 Gg CO2-eq, with a margin of 7.80 Gg CO2-eq.

As one can see in table 6.26, for the period 1990-2009, significant emissions from wildfires were only observed in 1996. For the period 2010-2014, significant wildfires only occurred in 2011(59 Gg CO2-eq). The year 1996 can be considered as an outlier and has been excluded to calculate the background level. In this regard, the expectation of net credits has been avoided.

As one can see in table 6.26, all the requirement of Box 2.3.6. of the_2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol are met, so the approach applied to calculate the background level and its margin avoids the expectation of net credits

6.7.7.6 Harvested Wood Products

The method that had been applied in the FMRL (i.e. flux data method) is presented in detail in Rüter (23) It is based on Equation 12.1 from IPCC 2006 GL using activity data from UNECE TIMBER database, calculating the carbon inflow back to the year 1900 as suggested. Missing activity data from before the first year for which activity data had been available (i.e. 1964) was assumed to equal the average of the first five years for which activity data are given (i.e. 1964-1968).

New estimates of HWP were submitted in 2017. Data from 1961-1999 were found and are used since the 2019 submission (see section 6.5.2).

6.7.7.7 Carbon equivalent forest

Belgium never applied the provisions of article 37-39 of Decision 2/CMP.7 in its accounting. All afforested and deforested lands are reported under Art. 3.3 (see section 10.2.4) and no deforested area nor plantation are reported under forest management under the concept of "carbon equivalent forest " of paragraph 37.

7 WASTE (CRT TABLE 5)

7.1 Overview of the sector

7.1.1 Description of the sector

The largest sources of waste in Belgium are manufacturing industry (37.8 million tons or 55% of all waste produced in 2020) and the construction sector (20.7 million tons or 30% in 2020)[27]. Regarding municipal waste, the total volume collected amounted to 8 million tons in 2022, which corresponds to 683 kg per inhabitant. In 2022, the recycling rate was 33%. 46% of municipal waste was incinerated, 19% was used for composting and fermentation and 0.2% was landfilled [28].

The waste policy in Belgium evolved from a locally organized and uncoordinated waste disposal system to the present waste management system and a professional waste sector. There is a well-structured regulatory framework for prevention, re-use, recycling and end-processing of waste products. It is built out of a good mix of instruments which strengthen each other and which are introduced in a general or stream specific way.

The three regions have implemented waste management plans for many years now and therefore there is no "unmanaged waste disposal site" in Belgium.

The objectives and actions of the Flemish region for the waste sector are defined in the report Flemish Air Policy Plan 2030 and the Flemish Energy- and Climate plan 2021-2030. Besides a Flemish Climate Strategy 2050 is set up. See https://omgeving.vlaanderen.be/energie-en-klimaat for more information (in Dutch). The Waste Decree is the legal basis and the Flemish Regulation of Waste Prevention and Management (VLAREA) is the most important implementing act. Supplementary for some waste streams there is a more detailed planning via the sectoral implementation plans. For further information the website of OVAM, the institute responsible for waste management in Flanders can be consulted (www.ovam.be).

The Walloon Government adopted the 22nd of March 2018, the waste plan 'Plan Wallon Déchets-Ressources'. This plan contains 157 measures to reduce, reuse, sort, recycle and valorise waste. Citizens, enterprises, associations, municipalities and public services, all are concerned by this plan.

In the Brussels-Capital Region, the "Resources and Waste Management Plan 2018-2023", corresponding to the 5th version of the "Waste Plan", has been adopted in November 2018. The general objectives of the plan are to ensure more sustainable and circular-economy consumer practices, to maximize the preservation and valorisation of materials, if possible locally, and to enhance the adoption of circular-economy practices by the economic sector[29].

In addition, at the federal level, a body (FOST Plus) has been created by the private sector to finance, co-ordinate and promote the selective collection, the sorting and recycling of household packaging waste. FOST Plus was created to enable industry to respond in a global and concrete way to the legislation on packaging and, more specifically, to the introduction of European Directive 94/62/EC of 20/12/1994, and the Co-operation Agreement between the Regions of March 1997 relating to the prevention and management of waste from household packaging. The recovery of used materials is becoming a major industry in Belgium and creates plenty of employment. The most intensive industries in manpower are textile, paper and construction materials recycling.

[27] https://statbel.fgov.be/fr/themes/environnement/dechets-et-pollution/production-de-dechets#panel-11 - These data are collected every 2 years. The most recent data available relate to 2020.
28 https://statbel.fgov.be/fr/themes/environnement/dechets-et-pollution/dechets-municipaux#news
29 https://environnement.brussels/citoyen/nos-actions/plans-et-politiques-regionales/plan-de-gestion-des-ressources-et-dechets-pgrd

Regarding wastewater handling, in 2022 the connection rate of the population to the public wastewater treatment network was 87% in Flanders, around 90% in Wallonia and 100% in the Brussels-Capital Region.

7.1.2 Allocation of emissions

The emissions from the waste sector are allocated in 4 source categories:

- 5A: solid waste disposal
- 5B: biological treatment of solid waste
- 5C: incineration and open burning of waste
- 5D: wastewater treatment and discharge

No solid waste disposal site (SWDS) is located in the Brussels-Capital Region.

Regarding waste incineration, the emissions from municipal waste incineration plants equipped with energy recovery systems are allocated under category 1A1a.

7.1.3 Trend assessment

GHG emissions from waste (excluding waste incineration with energy recovery) accounted for 1.1% of total national emissions without LULUCF in 2022, compared to 3.3% in 1990. This decrease is mainly due to CH_4 emissions from solid waste disposal on land, a sub-sector which represents 47.4% of total emissions from the waste sector in 2022. Emissions in solid waste disposal on land have dropped by 83% in 2022 since 1990. Biogas recovery in landfills by flaring or for energy purposes - depending on the richness of the landfill gas - has been developed on a wide scale since 1990 and is the main driver of the trend in this sector, together with a significant decrease in the amounts of waste disposed due to the shift from waste disposal to re-use, recycling, composting or incineration of waste.

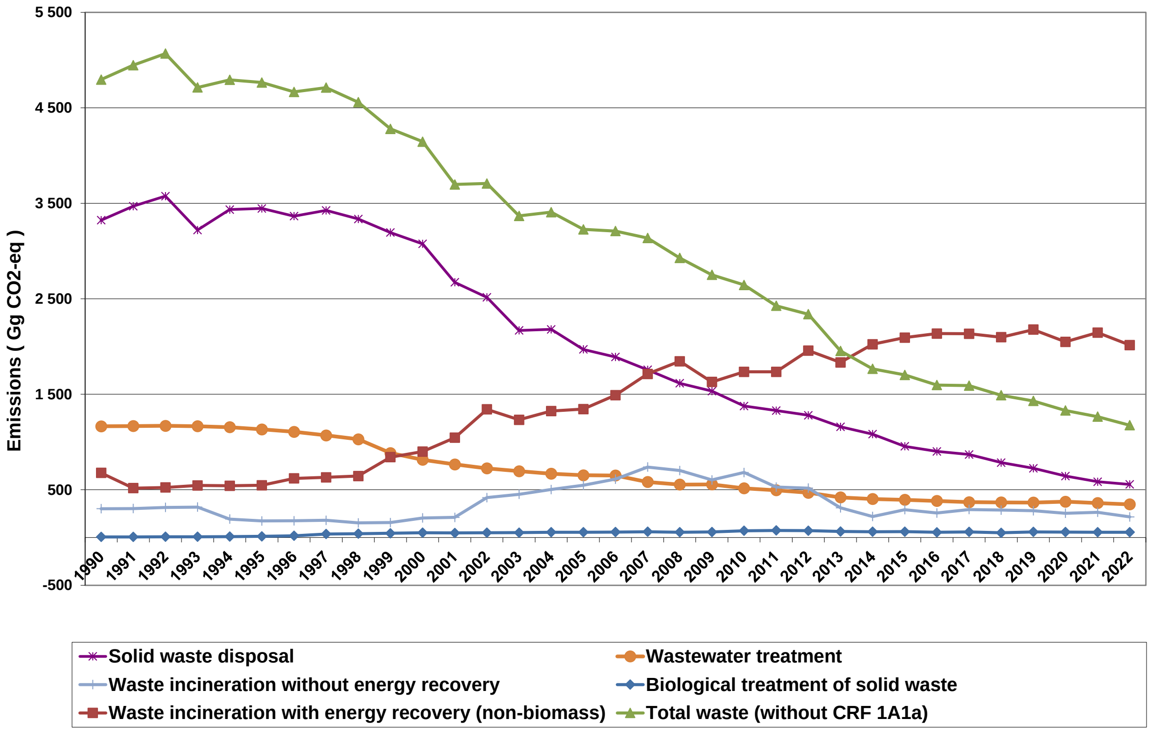


Figure 7.1: Emission trends (1990-2022) in the waste sector (CRT 5), and non-biogenic GHG emissions from MSW incineration (CRT 1A1ai)

The remaining 52.6% of GHG emissions in 2022 stems from three sources: waste incineration (18.4%), wastewater treatment (29.6%) and composting (4.7%). Emissions from waste incineration (sector 5C) include mainly CO_2 emissions from flaring activities (and after-combustion activities) in the chemical industry while emissions from municipal waste incineration without energy recuperation decrease significantly. Emissions of municipal waste incineration are mainly allocated to the energy sector (1A1a) as almost all the municipal waste incineration plants are also producers of electricity (except for some plants in the beginning of the nineties). Incineration of hospital waste is also included according to the IPCC Guidelines. The non-biogenic CO_2 emissions from the municipal solid waste incineration with energy recovery (sector 1A1a) are shown separately in Figure 7.1 to give a complete overview of the greenhouse gas emissions associated with waste (kt CO_2 eq).

7.1.4 Overall recalculations in the waste sector

The table below shows the recalculations between the submissions 2023 and 2024 in the waste sector in Belgium.

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	2.72	1.14	2.22	0.98	1.89	5.02	8.76	10.66
Flemish region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
Walloon region	0.00	0.00	0.00	0.31	0.17	0.67	0.48	0.58	1.14	2.24	3.43
Belgium	0.00	0.00	0.00	0.09	0.06	0.23	0.16	0.20	0.40	0.77	1.22

kt CO2-eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	0.16	0.07	0.13	0.05	0.11	0.26	0.47	0.68
Flemish region	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.02	0.08	0.12
Walloon region	0.00	0.00	0.00	2.32	0.99	3.54	2.53	2.91	5.39	9.67	14.40
Belgium	0.00	0.00	0.00	2.48	1.04	3.67	2.58	3.02	5.67	10.22	15.21

Category 5A:
In Wallonia, biogas recovery data of 2021 have been updated with new data from site owners. In 2023 submission, the data were partly provisional.

No recalculations took place in the Flemish and Brussels regions.

Category 5B:
In the Brussels-Capital region, activity data (amount of waste used for composting) is revised during this 2024 submission from 2018 on. Consequently differences in emissions occurred in 2018-2021.

Category 5C:
No recalculations took place in this category in the 3 regions.

Category 5D:
In the Flemish region the amounts of N influent at WWTP as well as the amount of N effluent (from inhabitants not connected to WWTP) are updated during this submission from 2011 on, resulting in small, not significant, differences in emissions compared to previous submission for these years.

In Wallonia and the Brussels-Capital region recalculations took place for the period 2010-2021 due to new data available from the Food and Agriculture Organization of the United Nations regarding the consumption of protein per inhabitant in Belgium.

In Wallonia, the N content in sludge has been updated from 2016 on to improve the coherency with data coming from agricultural sector.

7.2 Solid Waste Disposal (CRT table 5.A)

7.2.1 Source category description

Category 5.A contains the emissions of CH_4 originating from solid waste disposal on land in Belgium. All solid waste disposal sites are situated in the Flemish Region and Walloon Region. No such waste disposal site is located in the Brussels-Capital Region.

No CO_2 emissions are reported in the CRT table 5.A, because landfill gas is considered as biogenic, and combustion of waste at disposal sites as a management practice does not occur in Belgium.

7.2.2 Methodological issues

7.2.2.1 Choice of method

Emissions from solid waste disposal sites on land (SWDS) in Belgium were calculated using the IPCC Waste Model (MS Excel spreadsheet), which is provided by IPCC as a supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The IPCC methodology is based on the First Order Decay (FOD) method. Belgium applies the tier 2 method:

- using country-specific data regarding amounts of waste deposited, Methane Correction Factor (based on the classification into managed or unmanaged SWDS), DOC (based on composition of waste), and recovery (R);
- using IPCC default values for climate zone, starting year, delay time, fraction of DOC dissimilated (DOC_f), methane generation rate constants (k), fraction of CH_4 in landfill gas (F) and oxidation factor (OX).

Calculations were performed separately for the Flemish and the Walloon regions, in order to take the region-specific waste policies and waste statistics into account (region-specific information is included in paragraph 7.2.2.2). Both regions use the IPCC Waste Model spreadsheet and consequently methodologies used are consistent with each other. The choice of emission factors and parameters are harmonized.

Country-specific activity data regarding the amount of waste disposed and waste composition are available for recent years from the Flemish Waste Agency OVAM (Flemish Region) and the Walloon Waste Office OWD (Walloon Region). Historical data back to 1950 are optimized by extrapolating the first available data, corrected with the number of inhabitants instead of using IPCC default emissions before.

The emission source includes CH_4 emissions from disposal of municipal solid waste (including garden wastes, wood products...) and similar commercial and institutional wastes, industrial, construction and demolition wastes, and sewage sludge.

7.2.2.2 Choice of activity data, emission factors and parameters

<u>Region and Climate zone</u>

Belgium is situated in Western Europe. The climate zone is wet temperate (in accordance with the IPCC climate zone definitions):

- mean annual precipitation (MAP) / potential evapotranspiration > 1
- mean annual temperature < 20°C

Starting year

The recommended IPCC default value for the starting year was used i.e. the year 1950.

DOC_f (fraction of DOC dissimilated)

The recommended IPCC default value for DOC_f was used i.e. 0.5.

Half-life value $t_{1/2}$, methane generation rate constant *k*

The half-life value $t_{1/2}$ is the time taken for the DOC_m in waste to decay to half its initial mass. In the IPCC 2006 Waste Model and the equations in the 2006 IPCC Guidelines, the reaction constant *k* is used. The relationship between *k* and $t_{1/2}$ is: $k = \ln(2)/t_{1/2}$.
The IPCC default values for *k* were used, in function of the 'bulk waste' option and the climate zone 'wet temperate':

- Bulk Municipal Solid Waste: k = 0.09
- Industrial Waste: k = 0.09
- Sewage Sludge: k = 0.185

Delay time (months)

The recommended IPCC default value of six months for the delay time was used.
The delay time is the period between deposition of the waste and full production of CH_4 (production of CH_4 does not begin immediately after deposition of the waste: at first, decomposition is aerobic).

Fraction of CH_4 in generated landfill gas (F)

The recommended IPCC default value of 0.5 for the fraction of CH_4 in landfill gas was used.

Oxidation Factor (OX)

The oxidation factor reflects the amount of CH_4 from SWDS that is oxidised in the soil or other material covering the waste.

After discussion with the ERT during the ESD review of June 2020, it was decided to use the IPCC default values of '0.1' for managed SWDS and '0' for unmanaged sites.

In Belgium, landfills are now covered with a sealing layer and end cover when closed in order to minimize emissions from SWDS.

In the Flemish region, environmental legislation (VLAREM II articles 5.2.4.5.2 en 5.2.4.5.3) includes strict terms and conditions with respect to the finish of landfills. These are specifically designed to prevent water from penetrating into the landfill. The finish consists of a sealing layer (0.5 m bottom material + 2.5 mm HDPE liner or equivalent) and end cover (min. 0.5 m drainage layer + 1 m layer for root development). Similar legislation is valid in the Walloon region (Arrêté du Gouvernement wallon du 27 février 2003 fixant les conditions sectorielles d'exploitation des centres d'enfouissement technique - M.B. 13.03.2003).

The measures concerning covering of SWDS when the sites are closing are valid for all SWDS in Belgium. Those who are responsible for the sites need to give the definitive date of closure of (parts of) the SWDS to the supervisory officials immediately after ending disposal activities (within the month). The covering of (parts of) the SWDS starts immediately with applying a sealing layer. The complete covering needs to be finalized no later than one year after. There are some transitional provisions foreseen in this legislation. These measures/arrangements are valid from January 1st 1996 in Flanders. As the non-active SWDS in the Flemish region all ended their activities after this date, all SWDS are bound by this legislation.

During the operation period of the solid waste disposal sites, some oxidation takes place, however modern SWDS are designed to optimise the generation and capturing of landfill gas for energetic recovery, with minimum losses.

In Wallonia, it is considered that SWDS where biogas recovery occurs and emissions are controlled, are 'managed sites. The first measures of recovery started in 1993. Consequently before 1993, the OX factor value is '0' and since 1993, the value is '0.1'.

Amounts of waste deposited

The IPCC 2006 Waste model requires historical data back to1950. Historical data for the amounts of waste disposed in the period 1950-1969 were estimated via the sheet 'Activity' in the IPCC spreadsheet model, applying country-specific population data (obtained from the Belgian National Statistics Office), the deposed waste in 1970 (during this submission instead of the IPCC default values before) and % of waste which goes to SWDS.

From 1970 onwards, country-specific data of the amounts of MSW are available i.e. industrial waste, inert wastes and sludge deposited (study conducted by the VITO) and waste statistics from the Flemish and Walloon Waste Offices). These amounts were entered directly into the sheet 'Amnt_Deposited' in the IPCC spreadsheet model.

Table 7.1 presents the amounts of waste disposed at SWDS (in kton) in the Flemish and Walloon regions since 1990, including inert waste (only in Flanders) and sludge. The evolution for Belgium is shown in figure 7.2.

	Municipal Solid Waste			Industrial Waste			Total Waste		
	FL	WAL	BE	FL	WAL	BE	FL	WAL	BE
1990	1 137	1 217	2 354	1 208	1 370	2 578	2 345	2 586	4 932
1995	963	1 303	2 267	1 280	1 345	2 625	2 243	2 648	4 892
2000	284	873	1 157	1 071	1 068	2 139	1 354	1 941	3 295
2005	116	659	775	719	823	1 542	835	1 482	2 317
2010	27	0	27	244	510	755	271	510	782
2015	17	0	17	251	775	1 026	268	775	1 043
2016	23	0	23	190	864	1054	213	864	1077
2017	15	0	15	189	779	968	204	779	983
2018	16	0	16	186	827	1013	202	827	1029
2019	17	0	17	160	706	866	177	706	883
2020	19	0	19	195	657	852	214	657	871
2021	14	0	14	178	888	1066	192	888	1080
2022	14	0	14	137	619	756	151	619	770

Table 7.1: Amounts of waste disposed (kton) in Belgium since 1990. FL = Flemish region, WAL = Walloon Region, BE = Belgium

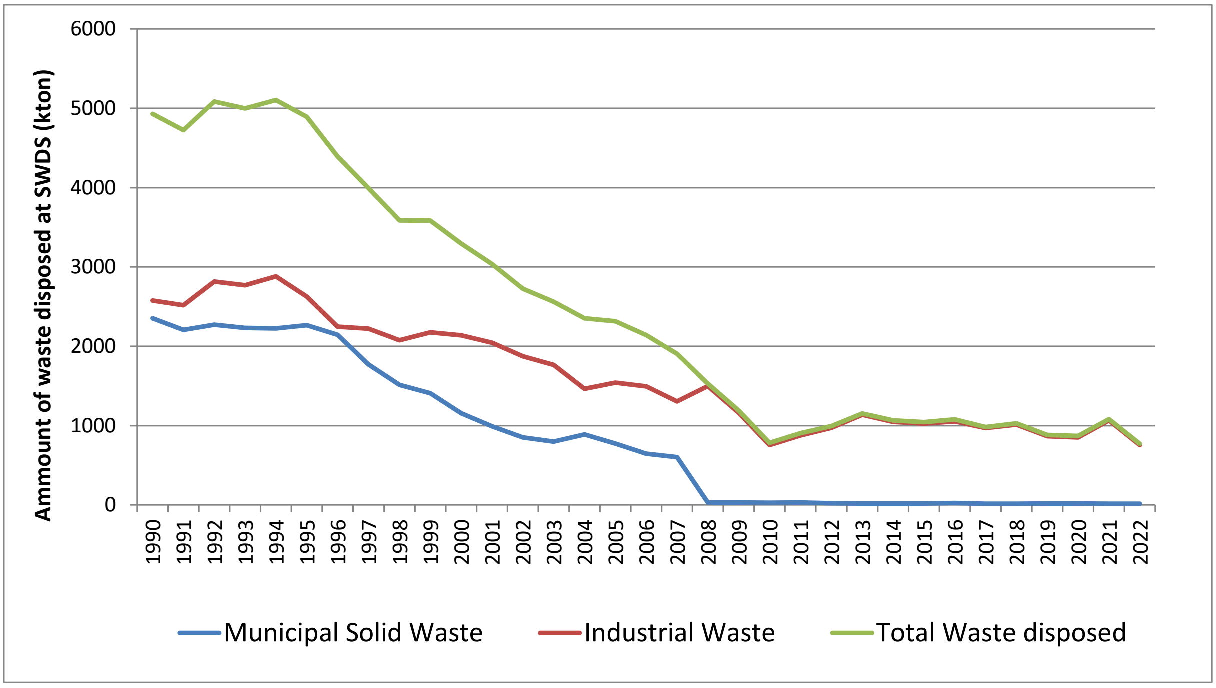


Figure 7.2: Evolution of the amount of municipal solid waste (MSW), industrial waste and total waste disposed at SWDS in Belgium (in kton) from 1990 to 2022

Thanks to the different waste plans in Belgium, the amounts of waste disposed have decreased significantly from 1995 onwards in both regions. In 2022, the total amount of waste disposed in Belgium was 84% less compared to 1990. This is due to prevention, citizens' sensitization to compost production and also the ban on disposal of municipal solid waste (in both regions) from 2006.

Classification of SWDS, calculation of Methane Correction Factor (MCF)

The classification of Belgium's waste sites into managed or unmanaged evolves during the period 1950-2022 as regional waste management policies are implemented.
For the 1950's and 1960's, no information is available to allow the classification of SWDS into different categories of managed or unmanaged SWDS. Therefore, the Methane Correction Factor for 'uncategorised' SWDS (MCF = 0.6) was applied for the period 1950-1969.
Between 1970 and 1989, an increasing share of the waste was disposed at managed solid waste disposal sites. Based on the available data on waste disposal (study conducted by the VITO (77) and waste statistics from the Flemish and Walloon Waste Offices), the Methane Correction Factor was calculated as a weighted average. The default MCF of 1.0 was used for waste disposed at managed SWDS and the default MCF of 0.6 for all other waste (for which no information is available to allow the classification into different categories of SWDS). As a result, the weighted average MCF increases from 0.6 in 1970 (all waste unmanaged / uncategorised) to 0.64 in 1980 (10% of waste at managed SWDS), 0.89 in 1985 (73% managed waste) and 0.996 in 1989 (99% managed waste).
From 1990 onwards, all waste is disposed at managed SWDS, MCF = 1.0.

Composition of waste, calculation of DOC (degradable organic carbon)

As the composition of MSW and industrial waste in Belgium changes over time, the evolution of DOC was taken into account in the calculations following the instructions provided in the IPCC Waste Model spreadsheet:

- in the "Parameters" sheet, the Bulk Waste Option was chosen;
- amounts of waste deposited were entered into the sheet "amnt_deposited";

- country-specific DOC data for MSW (Flemish and Walloon Region) were entered directly into the DOC column in the “MSW” sheet;
- country-specific DOC data for industrial waste (Walloon Region) were entered directly into the “Industry” sheet by adding a column for DOC, entering country-specific DOC values in this column, and referring to these values (instead of the fixed IPCC-value) to calculate the formula in the column “Decomposable DOC (DDOCm) deposited”.

DOC: Flemish Region

Data on amounts of waste disposed and composition of waste are annually provided by the Flemish Waste Agency, OVAM. Based on the codes and descriptions in the data files, waste amounts can be classified into the following categories:

- municipal solid waste (“household waste, waste from municipalities[30] and bulky waste[31]”);
- sludge;
- inert materials (“asbestos cement waste”, “ceramics, stone and china”, etc.);
- industrial waste (different categories).

For MSW, detailed information on the composition of the waste is available based on waste sorting analyses by the Flemish Waste Agency from 1985 onwards. Since 2006, there has been an absolute ban on the disposal of combustible household waste (i.e. waste that can be incinerated instead).
The DOC values were entered into the IPCC spreadsheet model (“MSW” sheet) as follows:

- period 1950-1984: default value of the first available year 1985: DOC = 0.18(during this submission and consistent with the Walloon region instead of 0.19 before)
- period 1985-2005: DOC calculated based on waste sorting analyses by the OVAM (% food waste, paper, etc.) in combination with IPCC default values of DOC fractions (food waste 0.15, garden waste 0.2, paper 0.4, wood and straw 0.43, textiles 0.24, disposable nappies 0.24, plastics and other inert wastes 0).
- from 2006 onwards: only inert waste is disposed: DOC = 0

For sludge, the IPCC default value of 0.05 for DOC was used for the entire time series.
For industrial waste, the amount of waste deposited is the sum of different OVAM categories in the waste data files (including also “mixed building and demolition waste”). Some of these categories (e.g. “recycling residues”, “non-solidified waste”) only give an aggregated figure which is not detailed enough to allow the calculation of DOC values. For this reason, the IPCC default value of 0.15 for DOC of industrial waste was used for the entire time series. However, this is likely to be an overestimate (since “recycling residues” and “non-solidified waste” contain a large fraction of inert waste). Hence, the estimation of DOC for industrial waste in the Flemish region can be considered a conservative approach.

Table 7.2 gives the amount of waste (in ton) by DOC category to illustrate the evolution of the last 10 years in Flanders.

Year	Sludge	Deposited MSW	Inert	Other industrial waste	TOTAL (ton)
2012	385	21.162	130.918	123.062	275.527

30 Waste from municipalities refers to waste from markets, street cleansing and sweepings, beaches, receptacles to combat litter, contaminated roadside clippings and the cleaning up of illegal dumping.
31 Bulky waste refers to all waste generated by the normal operation of a private household and similar wastes which because of their size, nature and/or weight cannot be placed in the container for household waste collection (with the exception of selectively collected fractions) and which are collected door-to-door. Bulky waste also includes the residual fraction that remains for removal after being presented at the civic amenity site.

2013	84	16.985	322.469	92.872	432.410
2014	58	17.621	186.183	71.080	274.941
2015	8	17.238	190.515	60.573	268.334
2016	307	22.359	140.089	50.260	213.015
2017	1.028	13.849	138.401	50.994	204.272
2018	236	15.362	104.858	81.179	201.636
2019	190	16.742	107.363	52.738	177.033
2020	136	18.598	150.707	44.529	213.970
2021	253	13.725	112.589	64.061	191.627
2022	203	13.784	87.262	49.519	150.768

Table 7.2: Waste fractions used to calculate DOC values for the period 2012-2022 in the Flemish region

DOC: Walloon Region

In Wallonia, the quantity of waste disposed comes from the statistics of OWD (Walloon Waste Office). Until the 2008 data, it published each year the industrial and municipal waste disposed, based on the tax's declaration forms covering the Walloon solid waste disposal sites of various sizes. For 2008 data, industrial and municipal wastes were gathered. Furthermore, since 1st January 2008, no more household and municipal waste may be disposed in landfills, so all waste amounts are supposed to come from industry. The data are classified according to main categories (and subcategories), thus allowing an accurate calculation of the amounts of waste and its degradable organic carbon content (DOC), which are used as an input in the IPCC Waste model. Those statistics are available on a yearly basis since 1994. For the years before, the amounts have been estimated using available data and OWD expert judgement assumptions.

The DOC values for municipal and industrial waste were calculated using the detailed waste types from OWD and from the 2006 IPCC Guidelines (tables 2.4 & 2.5, pages 2.14 & 2.16).
Sludge has been included in industrial waste, and the IPCC default value of 0.09 (industrial sludge) was used in the calculation of DOC for the entire time series (conservative approach).
For historical years, as recommended by the ERT during the ESD review of June 2020, the DOC value for MSW is the same as the first year when a regional DOC was available instead of IPCC default.

For MSW, the DOC values were entered into the IPCC spreadsheet model ("MSW" sheet) as follows:

- period 1950-1984: DOC value = 0.18
- period 1985-2007: DOC calculated based on waste sorting data in combination with IPCC default values of DOC fractions (food waste 0.15, garden waste 0.2, paper 0.4, wood and straw 0.43, textiles 0.24, disposable nappies 0.24, plastics and other inert wastes 0).
- from 2008 onwards: DOC = 0

For industrial waste, the DOC values were entered into the IPCC spreadsheet model ("Industry" sheet) as follows:

- for the period 1950-1969: DOC value = 0.17
- from 1970 onwards: DOC is calculated based on waste sorting data in combination with IPCC default values of DOC fractions (food waste 0.15, garden waste 0.2, paper 0.4, wood and straw 0.43, textiles 0.24, disposable nappies 0.24, plastics and other inert wastes 0). The values of these last years are included in Table 7.4.

Table 7.3 gives the amount of waste (in ton) by DOC category to illustrate the evolution of the last 10 years in Wallonia.

Year	Wood and wood products	Pulp and paper/	Garden and Park waste	Food, beverages and tobacco	Sludge industrial	Construction and demolition	Other industrial waste	TOTAL (ton)
2012	180	0	9 318	0	9 858	32 403	667 756	719 515
2013	1 317	0	6 713	763	35 065	49 938	627 990	721 786
2014	1 637	0	5 238	0	44 772	50 025	687 695	789 366
2015	938	0	4 701	0	53 641	29 388	686 446	775 115
2016	837	0	4 721	3 408	123 168	29 308	702 870	864 313
2017	308	0	1 673	463	10 015	36 579	729 996	779 034
2018	1 003	0	1 528	1 372	54 574	27 972	740 546	826 995
2019	1 076	0	1 032	0	24 717	45 498	634 072	706 461
2020	644	0	608	6 768	69 413	42 851	536 626	656 944
2021	822	0	897	333	319 464	83 777	483 039	888 363
2022	762	0	909	1 128	80 549	51 864	484 160	619 401 *

** In 2022, the total of waste also includes 29 ton of textile (not mentioned in the columns of the table).*

Table 7.3: Composition of the waste landfilled (in ton) in Wallonia

Table 7.4 shows the evolution in DOC for MSW and industrial waste in the Flemish and Walloon regions in the period 1990-2022.

	DOC MSW		DOC industrial waste*	
	FL	**WAL**	**FL**	**WAL**
1990	0.17	0.18	0.15	0.03
1995	0.17	0.18	0.15	0.03
2000	0.15	0.14	0.15	0.02
2005	0.14	0.07	0.15	0.02
2010	0	0	0.15	0.03
2015	0	0	0.15	0.02
2016	0	0	0.15	0.02
2017	0	0	0.15	0.01
2018	0	0	0.15	0.02
2019	0	0	0.15	0.02
2020	0	0	0.15	0.02
2021	0	0	0.15	0.04
2022	0	0	0.15	0.02

** For industrial waste, the Flemish Region has used the IPCC default value for the entire time series.*

Table 7.4: Evolution of DOC for MSW and industrial waste in the Flemish Region (FL) and the Walloon Region (WAL), 1990-2022

Following the implementation of the Wallonia Waste Plan, the 'green waste' is increasingly sorted by the citizens and collected for compost production, thus decreasing the ratio of biogenic waste deposited in solid waste disposal sites (for Municipal Solid Waste). The drop in 2008 can be explained by the impact of the Walloon legislation: since 1st January 2008, no more unmanaged household and municipal waste can be disposed in landfills[32].

Similarly, in the Flemish Region, the decrease in DOC of municipal solid waste reflects the implementation of policies around sorting and selective collection of household wastes. There is a total ban on the disposal of combustible household waste from 2006 onward.

Recovery (R)

CH_4 generated at SWDS can be recovered and combusted in a flare or energy device. The amount of CH_4 which is recovered (R) is subtracted from total emissions, following equation 3.1 of the IPCC 2006 Guidelines. Recovered amounts are always reported in kton CH_4, not in m^3 of landfill gas, as landfill gas contains only a fraction of CH_4 (IPCC default value: 50% methane content).
In accordance with the IPCC 2006 Guidelines, CH_4 recovery for SWDS in Belgium is only reported when data are available based on either metering of landfill gas recovered for energy and flaring, or on the monitoring of produced amount of electricity from the gas. In the case where no such data are available, the IPCC default value of zero was used for CH_4 recovery.

32 Arrêté du Gouvernement wallon du 18 mars 2004 interdisant la mise en centre d'enfouissement technique de certains déchets et fixant les critères d'admission des déchets en centre d'enfouissement technique, Article 2, §5 alinéa b), available on : http://environnement.wallonie.be/legis/dechets/decen008.htm

Recovery: Flemish Region

In the Flemish Region, since 1995, the landfill gas produced at SWDS must be legally recovered for flaring or energetic utilisation. This obligation applies to sixteen managed SWDS (it does not apply to 'historic' dumps or landfills). By the end of 2004, fifteen of the sixteen managed SWDS had a flare, and electricity was produced at twelve SWDS. At one SWDS, the landfill gas generation was insufficient for active recovery.
For historic landfill sites, the IPCC default value for CH_4 recovery of zero was used, since there are no facilities for recovery of the landfill gas at these sites.
For managed SWDS which have facilities for recovery of landfill gas, R has been considered separately for flaring and energetic valorisation. For flaring, the IPCC default value of zero was applied, due to the lack of comprehensive data based on measurements at the SWDS.
For energetic valorisation, data on the amount of landfill gas captured and used for energetic valorisation (expressed in GJ) are annually compiled by VITO in the Flemish energy balance.
[Since the collection of 2020-data, setting up the Flemish energy balance becomes a responsibility of the Flemish Agency for Energy and Climate.]
These data are available from 2001 onwards. They are obtained through the mandatory reports to the (former) Flemish Energy Agency (VEA) by the operators of renewable energy facilities and CHP plants, as well as data provided to VITO by the Flemish Regulator of the Electricity and Gas markets (VREG) regarding green electricity certificates and cogeneration certificates.
To convert the amount of landfill gas in GJ to the amount of landfill gas in m^3, the following formula is used: landfill gas (m^3) = landfill gas (GJ) * 1000 / Low Calorific Value LCV (MJ/m^3). (Assumption: LCV = 20 MJ per m^3 landfill gas). The landfill gas used for energetic valorisation is assumed to have an average methane content of 50%. These values are confirmed by Flemish waste experts to be realistic.
Thus, the amount of CH_4 (m^3) is calculated using the formula: CH_4 for energetic valorisation (m^3) = landfill gas for energetic valorisation (m^3) * 0.50.

Recovery: Walloon Region

CH_4 recovery started in 1993 and largely increased since that year, by gradually equipping more and more disposal sites. It is the main historic driver of the reduction of the net emissions in this sector, together with the recent 2008 legislation.
The amount of CH_4 recovery is measured in all the SWDS which are equipped with recovery system (volume of biogas with CH_4 concentration). For Wallonia, the information is provided by the landfill's owners under their environmental reporting: they declare each year the volume of biogas (Nm^3) for motors or flaring and the fraction of CH_4. The CH_4 content is measured by landfill owners as it determines the possible use of the biogas (only 'rich' biogas' is used in engines, the rest is flared). This information is precise (regular measures and counters data). Following a 1997 legal decree, a contract with the ISSEP (Scientific Institute for Public Service in Wallonia) also organises a close follow up of the environmental impacts of the Solid Waste Disposal Sites on Air, Water and Health. Twelve main sites are followed for the time being and the report includes biogas analysis. Details can be found on the website of the Walloon Environment Public Service[33].

7.2.2.3 Evolution of CH_4 generation, recovery and emissions (1990-2022)

Table 7.5 and figure 7.3 show the evolution of CH_4 generation, recovery and emissions for SWDS in Belgium in the period 1990-2022.
The evolution of CH_4 generated is very similar in the Flemish and Walloon regions. In both regions, CH_4 generation reaches a maximum level in 1997. From 1998 onwards, there is a continuous decrease.
In the calculation of CH_4 emissions, data on CH_4 recovery are taken into account from 2001 onwards for the Flemish region (energetic valorisation only) and from 1993 onwards for the Walloon region (flaring and energetic valorisation). The emissions of CH_4 from solid waste disposal sites in Belgium reach a maximum level in the

33 http://environnement.wallonie.be/data/dechets/cet/

period 1992-1997, after which there is a strong decrease of emissions. This trend reflects the waste policy in the Flemish and Walloon regions in the period 1990-2022, including policy measures to reduce the amount of waste disposed and to encourage the sorting and selective collection of waste, as well as strict legal obligations for the management of landfill sites, including the recovery of landfill gas for flaring and energetic utilization.

	CH_4 generated			CH_4 recovery (R)			CH_4 emissions		
	FL	WAL	BE	FL	WAL	BE	FL	WAL	BE
1990	63.3	58.5	121.8	0.0	0.0	0.0	60.2	58.5	118.7
1995	75.6	69.5	145.1	0.0	10.6	10.6	70.1	53.0	123.1
2000	73.3	69.5	142.8	0.0	22.2	22.2	67.2	42.6	109.8
2005	62.2	57.7	120.0	16.0	26.7	42.7	42.5	27.9	70.4
2010	47.6	42.5	90.1	11.9	24.1	36.0	32.6	16.6	49.2
2015	32.3	28.7	61.1	7.7	15.8	23.5	22.5	11.6	34.1
2016	29.8	26.6	56.5	5.7	15.4	21.0	22.0	10.2	32.2
2017	27.5	25.0	52.4	4.4	13.8	18.2	21.0	10.0	31.0
2018	25.3	23.1	48.4	4.2	13.4	17.6	19.3	8.8	28.0
2019	23.5	21.5	45.0	3.7	12.8	16.5	18.1	7.8	25.9
2020	21.7	20.0	41.7	3.3	13.1	16.4	16.8	6.2	23.0
2021	20.0	18.7	38.7	2.9	12.8	15.7	15.6	5.3	20.9
2022	18.6	18.2	36.8	2.9	11.9	14.8	14.2	5.6	19.9

Table 7.5: Evolution of CH_4 generation, recovery and emissions (kton) from solid waste disposal sites in Belgium, 1990-2022. FL = Flemish region, WAL = Walloon Region, BE = Belgium

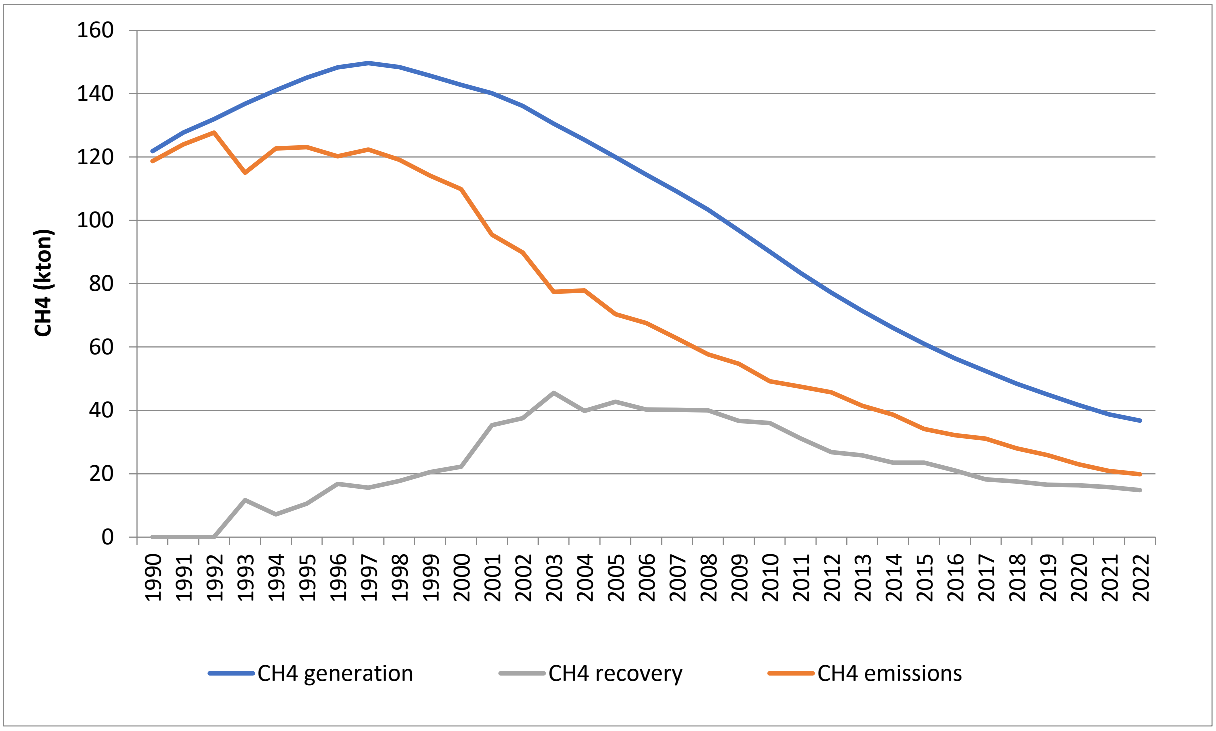


Figure 7.3: Evolution of CH_4 generation, recovery and emissions (kton) from solid waste disposal sites in Belgium, 1990-2022

7.2.3 Uncertainty and time series' consistency

An uncertainty of 30% for the activity data and 40% for the emission factors is used. These uncertainty percentages are comparable with other member states. There is a correlation between activity data across the years and therefore sensitivity A is used.

7.2.4 Source-specific QA/QC and verification

Standard QA/QC and verification activities take place. Tier 1 quality control checks are performed in the 3 regions for the Belgian key source categories and can be provided by the Belgian experts on request.
Both regions implemented the IPCC 2006 Guidelines, using the IPCC Waste Model (MS Excel spreadsheet) from the 2015 submission on. Furthermore, the choice of emission factors and parameters are fully harmonized between the two regions.
The choices of the parameters are in full agreement with the information and data ranges given in the 2006 IPCC Guidelines.

7.2.5 Source-specific recalculations

The table below shows the recalculations between the submissions 2023 and 2024 in the category 5A in Belgium.

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flemish region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.38
Belgium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60

kt CO2-eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flemish region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.47
Belgium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.47

In Wallonia, biogas recovery data of 2021 have been updated with new data from site owners. In 2023 submission, the data were partly provisional.

No recalculations took place in the Flemish region during this submission.

7.2.6 Source-specific planned improvements

Investigations are going on to eventually optimize the estimations of the emissions in all subsectors of the waste sector including the emissions of this category (SWDS). A study in this respect started in the Flemish region at the end of 2023. The possible application of the 2019 Refinement to the 2006 IPCC Guidelines will also be investigated during this study. Results will be included in next submissions if relevant.

Planned improvements will also depend on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

7.3 Biological treatment of solid waste (CRT 5.B)

7.3.1 Source category description

Emissions of CH_4 and N_2O from the composting of organic waste (5B1) are allocated to the category 5B.

7.3.2 Methodological issues

In Belgium, CH_4 and N_2O emissions from composting of organic waste are estimated using regional activity data combined with ‘country specific’ emission factors of 0.75 kg CH_4 and 0.096 kg N_2O / ton waste entering in the composting centres.
The source of these emission factors is ‘DHV B.V. (2010) Update of emission factors N_2O and CH_4 for composting, anaerobic digestion and waste incineration – Final report July 2010’. These emission factors are used after consultation with colleagues from the Netherlands who use these factors as a result of measurements carried out since 2009. This monitoring program involved the Ministry as well as the waste sector. The monitoring was not a random indication of emissions but was carried out over a longer period, which increases the reliability of these emission factors values.

Belgium rather prefers to stay with the emission factors for CH_4 and N_2O used so far which are in line with the emission factors used by our neighbouring country The Netherlands. Various reasons can be reported for this choice:
1) Compost handling is most likely comparable between 2 neighbouring countries Belgium and the Netherlands and can be seen either as a country-specific approach which is a more accurate approach compared to the default approach as described in the IPCC guidelines.
2) The use of the emission factors of the Netherlands was also agreed by the institution VLACO, a Flemish organization which take care of all policies and interests of the biological cycles for already more than 25 years in this region.
3) Following the IPCC 2006 guidelines: Composting is an aerobic process and a large fraction of the degradable organic carbon (DOC) in the waste material is converted into carbon dioxide (CO_2). CH_4 is formed in anaerobic sections of the compost, but it is oxidised to a large extent in the aerobic sections of the compost. The estimated CH_4 released into the atmosphere ranges from less than 1 percent to a few per cent of the initial carbon content in the material (Beck-Friis, 2001; Detzel et al., 2003; Arnold, 2005).
Composting can also produce emissions of N_2O. The range of the estimated emissions varies from less than 0,5 percent to 5 percent of the initial nitrogen content of the material (Petersen et al., 1998; Hellebrand 1998; Vesterinen, 1996; Beck-Friis, 2001; Detzel et al., 2003). Poorly working composts are likely to produce more both of CH_4 and N_2O (e.g., Vesterinen, 1996). It is rather unlikely that compost sites are poorly working in Belgium. Everything is taken into account as much as possible to minimize emissions on these sites.

In Wallonia, the activity data figures are based on the quantities of waste coming out of the compost centres. According to experts’ judgement, the rate between the output of the compost centres (i.e. the amount of compost production) and the input (i.e. the amount of fresh organic waste that is composted) is around 35%. Then, by dividing the output by 0.35, we obtain the amount of waste that will be composted. Data are well collected and it allows avoiding confusions between the different valorisations of organic waste (compost, biomethanisation,…). Even if these figures do not exist before 2006, the activity data from 1997 to 2005 have been improved by crossing diverse sources. The CH_4 and N_2O emissions factors are the same as those used in Flanders (0.75 kg CH_4 and 0.096 kg N_2O / ton waste entering in the composting centres).

In the Brussels-Capital Region, the activity data corresponds to the amount of (biological) waste treated in the only large scale compost centre located in the Region. The drop in ton of waste composted in 2017 compared with 2016 is due to a fire in December 2016 which resulted in a stop of activity for several months and the export of waste to other compost centres. The CH_4 and N_2O emissions factors are the same as those used in Flanders (0.75 kg CH_4 and 0.096 kg N_2O / ton waste entering in the composting centres).

	Flanders	Wallonia	Brussels
1990	138 001	NO	NO
1995	271 636	NO	NO
2000	828 873	265 560	NO
2005	768 967	416 404	13 462
2010	736 369	777 148	19 262
2015	649 015	652 161	16 840
2016	675 989	492 326	15 373
2017	656 205	603 978	8 437
2018	663.966	381 793	14 778
2019	706.573	539 551	16 700
2020	663.254	559 183	15 851
2021	663.254	524 060	17 398
2022	663.254	518 847	12 948

Table 7.6: Amounts of waste (ton) composted in the three regions in Belgium (1990-2022)[34]

7.3.3 Uncertainties and time-series consistency

For composting, the uncertainties both on activity data and emission factors for CH_4 and N_2O are based on expert judgment and results in an uncertainty of 30% on the activity data and 200% on the emission factor.

7.3.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions only for the Belgian key source categories and can be provided by the Belgian experts on request.

7.3.5 Source-specific recalculations, if applicable, including changes made in response to the review process

The table below shows the recalculations between the submissions 2023 and 2024 in the category 5B in Belgium.

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.76	1.25	5.01
Flemish region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.02	0.07

kt CO2-eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.04
Flemish region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.04

34 Composting activities did not occur in the Walloon Region between 1990–1996 or in the Brussels-Capital Region between 1990 and 2001.

In the Flemish region, no recent activity data (amount of waste used for composting) became available during this 2024 submission. Consequently no differences in emissions are reported.

In the Brussels-Capital region, activity data (amount of waste used for composting) is revised during this 2024 submission from 2018 on. Consequently differences in emissions occurred in 2018-2021.

No recalculation took place in Wallonia.

7.3.6 Source-specific planned improvements, if applicable

Any improvement will depend on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC) during the coming year.

Investigations are going on to eventually optimize the estimations of the emissions in all subsectors of the waste sector including the emissions of this CRT-category. A study in this respect started in the Flemish region at the end of 2023. The possible application of the 2019 Refinement to the 2006 IPCC Guidelines will also be investigated during this study. Results will be included in next submissions if relevant.

7.4 Incineration and open burning waste (CRT 5.C)

7.4.1 Source category description

The waste incineration category (category 5C1) includes incineration of municipal waste, industrial waste and hospital waste (clinical waste). Emissions originating from flaring activities are allocated partly to the sector 5C1 (Flemish and Walloon regions, for flaring activities in the chemical industry) and partly to the sector 1B2 (Flemish region, refineries, see section 3.3.2 for more information). The emissions of the waste incineration plants with energy recovery are allocated to the category 1A1a.
Only one incineration plant with energy recovery was still operational in 2021 in the Brussels-Capital Region. The corresponding emissions are allocated to the category 1A1a. The other incineration plants in this region (without energy recovery) were closed in 1997, 1998 and 2009.

Open burning of waste (category 5C2) does not occur in Belgium or more accurate said, no (statistical) data are available to try to estimate greenhouse gas emissions in this category.

7.4.2 Methodological issues

7.4.2.1 Waste incineration

<u>N_2O emissions from waste incineration</u>

Belgium estimates the emissions of N_2O from waste incineration using the conservative value of 15 g N_2O / ton of waste incinerated.
The emission factor for N_2O for municipal waste incineration has been calculated using in situ measurements (stack emissions) combined with activity data, for some representative individual companies. Most of the measurements were below the detection threshold (2 mg/Nm³), which corresponds to 15 g N_2O / ton of waste incinerated. This conservative value was accordingly used for the complete time series in the 3 regions.

During the UNFCCC review in 2020, the ERT noted that the incineration of sewage sludge has quite higher N_2O emission factor (2006 IPCC GLs' default EF: 900 g N_2O/t wet waste) than that of MSW incineration (country-specific EF in Belgium: 15 g N_2O/t wet waste) and asked Belgium to justify why they did not distinguish activity data of sewage sludge incinerated from those of MSW in this category.

In Wallonia, only one municipal waste incineration plant incinerated more than 99% of the sewage sludge incinerated in 2021: 15 872 ton of sewage sludge has been incinerated in this plant in 2021 (15 713 ton with energy recovery reported in 1A1a and 159 ton without energy recovery reported in 5C1). The country-specific emission factor of 15 g N_2O/ton is not used to calculate the N_2O emissions of this plant. The N_2O emissions of this plant are calculated more accurate on basis of stack measurement. That is the reason why the emissions of N_2O coming from each category of waste incinerated cannot be distinguished. The global N_2O IEF for this plant was 13.9 g/ton of waste incinerated in 2021. This IEF is quite stable from year to year (it was 11.5 g/t in 2019 and 11 g/t in 2020). The N_2O emissions of the 159 ton of sewage sludge incinerated without energy recovery are included in the 238 kg of N_2O emissions of the 16.59 kton of biomass waste reported in “5.C.1.1.a”.

In Wallonia, the reason why the activity data of sewage sludge incinerated is not distinguished from those of MSW is because the part of the emissions coming from each category of waste cannot be distinguished because of the methodology used to calculate the emissions (stack measurement).

The notation key IE reported in "5.C.1.1.b.iii Sewage Sludge" should have referred only to "5.C.1.1.a" and not to 1A1a because in this case, there is no energy recovery. The notation keys have been corrected in the 2021 submission. The table below shows the notation keys for Sewage Sludge and Industrial Solid Wastes in Wallonia for sector 5.C.1 Waste incineration. These notation keys are used for the entire time series.

	Sewage Sludge		Industrial Solid Wastes	
	Biogenic	Non-biogenic	Biogenic	Non-biogenic
CRT sector	5.C.1.1.b.iii	5.C.1.2.b.iv	5.C.1.1.b.i	5.C.1.2.b.i
NK	IE	NO	IE	IE
Comment	Reported in 5.C.1.1.a (Municipal Solid Waste – Biogenic) – The emissions are impossible to distinguish because they are calculated on the basis of stack measurements.	The sewage sludge incinerated are biogenic and reported in 5.C.1.1.a together with biogenic municipal solid wastes.	Reported in 5.C.1.1.a (Municipal Solid Waste – Biogenic) – The emissions are impossible to distinguish because they are calculated on the basis of stack measurements	Reported in 5.C.1.2.a (Municipal Solid Waste – Non-Biogenic) – The emissions are impossible to distinguish because they are calculated on the basis of stack measurements

Flemish region:

During the UNFCCC centralized review in 2020, the proposal was given by the TERT to use the higher emission factor of 900 g N_2O/ton for sewage sludge. Using this emission factor, the Flemish region calculated a maximum emission (conservative approach) of 5.45 kton CO_2eq. This calculation was based on the reported amount of sludge (more than only sewage sludge) in the Flemish energy balance. This is a (maximum) surplus of 5.35 kton CO_2eq compared to previous estimation for 2018 in this region to be allocated in the category 1A1a. Contact with the industry involved, demonstrated that this emission factor is much too high and should not be used to improve the calculation of these emissions. The installation involved started a monitoring campaign in the course of 2020. First results became available in the course of 2021. As only limited results of measurements became available by the end of 2022, the Flemish region decided to stick for the time being with the emission factor for N_2O of 15 g N_2O/ton.

Additional reasoning for this is:

1) the UNFCCC review in the autumn of 2020 focused mainly on sewage sludge as an argument for using the higher emission factor. Given the limited amount of sewage sludge used in this installation under 1A1a (sludge incinerated in the plant since 2011 and accounts for 1 à 4% of total treated waste), this argument is not really relevant and

2) further investigation is needed to ensure the consistency for the complete timeseries. See also 1.4.6. Source-specific planned omprovements in this respect.

CH_4 emissions from waste incineration

Following a recommendation by the expert review team during the 2016 ESD review (2016 Comprehensive review of national greenhouse gas inventory data pursuant to Article 19(1) of Regulation (EU) No 525/2013), Belgium decided to estimate the emissions of CH_4 from waste incineration using the tier 1 default emission factor of 0.2 kg CH_4/Gg waste incinerated presented in the IPCC 2006 Guidelines, table 5.3 This emission factor corresponds to 0.02 kg/TJ and is in line with the measurement of hydrocarbons at the stack.
For CH_4 emissions, as IPCC Good Practice Guidance states on page 5.25: Emissions of CH_4 are not likely to be significant because of the combustion conditions in incinerators (e.g. high temperatures and long residence times)[35]*, Belgium did not estimate CH_4 emissions from waste incineration in the previous submissions. During the review process in May 2016, the expert review team noted that CH_4 emissions from waste incineration are not estimated although it is expected in the 2006 IPCC Guidelines (the 2006 IPCC Guidelines recommend to calculate CH_4 emissions from incineration and give a default emission factor of 30 kg CH_4/TJ). In response to a question raised during the review, Belgium explained that the 4 Walloon waste incineration plants measure the concentration of total hydrocarbons (including CH_4) at the stack. This concentration is at the mg/Nm³ level, so the specific measure of CH_4 (which only represents a small part of total hydrocarbons) is difficult. The total emissions of total hydrocarbons for the 4 Walloon waste incineration plants equal 14 tons in 2014 (=> EF = 14 kg/kt or 1.4 kg/TJ). CH_4 only represents a small part of total hydrocarbons and it is normally the part that best oxidizes. So, it seems reasonable to consider that the CH_4 emissions are negligible, as Belgium did for the previous submissions. In response, the expert review team noted that the issue is below the threshold of significance for technical correction but recommended that Belgium reports CH_4 emissions from waste incineration in its next submission. As explained above, Belgium decided to estimate the emissions of CH_4 using the tier 1 default emission factor of 0.2 kg CH_4/Gg waste incinerated.*

CO_2 emissions from waste incineration

To estimate the CO_2 emissions, each region applies its own methodology according to the available activity data.

Flanders

Emissions of waste incineration plants with energy recuperation are allocated to the sector 1A1a and emissions of plants without energy recuperation are allocated to the category 5C1.
Waste incineration without energy recuperation only takes place in the period 1990-2004. CO_2 emissions are estimated for municipal and industrial waste. We distinguish between emissions from biogenic waste (category 5.C.1.1) and non-biogenic waste (category 5.C.1.2).
For municipal waste, the Flanders Public Waste Agency (OVAM) performs the analysis of the different fractions in the waste. Based on this information, the amounts of non-biogenic waste (excluding the inert fraction) and biogenic waste are determined. The carbon content of the waste is based on data from literature for the different fractions involved.
For industrial waste, the fraction of biogenic waste is considered to be the same as in municipal waste. The remaining amount is considered to be the non-biogenic part in which no inert fraction is present. For industrial

35 http://www.ipcc-nggip.iges.or.jp/public/gp/english/5_Waste.pdf

waste, it is more difficult to determine the content of C and therefore the results of a study carried out by the VITO ‘*Debruyn en Van Rensbergen ‘Greenhouse gas emissions from municipal and industrial wastes of October 1994*’ are used. This study gives a content of C of the industrial waste of 65.5 %.
The amount of energy used in waste incineration plants (PJ) (Flanders Energy Balance - VITO) is used in the calculations.
The activity data of the Flemish region for the complete time series are shown in tables 7.7 below.
As these data are completely taken over by the data reported in the Flemish energy balance, these are expressed in PJ in table 7.7a. As the UNFCCC expert review team recommended the Party in 2021 to report in the NID mass units for the AD for the entire time series for the Flemish Region instead of energy units, the activity data in ton are presented in the table 7.7b, During this 2023 submission the waste is further split into household and industrial waste and calculated by using an average calorific value of 10,04 GJ/ton for household waste and an average calorific value of 11 GJ/ton for industrial waste, values agreed by the experts of one of the biggest incineration plants in this region.

	waste incineration (PJ)	waste incineration (PJ)	organic content (%)	organic content (%)
	with energy recovery (1A1a)	without energy recovery (5C1)	household waste	industrial waste
1990	4.02	2.19	37	65.5
1995	2.54	0.72	56.4	65.5
2000	5.01	0.86	55.78	65.5
2005	7.12	0	58.32	65.5
2010	9.20	0	58.32	65.5
2015	9.53	0	58.32	65.5
2016	9.38	0	58.32	65.5
2017	9.43	0	58.32	65.5
2018	9.33	0	58.32	65.5
2019	9,18	0	58.32	65.5
2020	9.53	0	58.32	65.5
2021	12.15	0	58.32	65.5
2022	10.38	0	58.32	65.5

Table 7.7a: Waste incineration (PJ) with and without energy recovery and carbon content of waste incinerated in the Flemish region (1990-2022)

ton	total waste incinerated	municipal waste	industrial waste	total waste incinerated with Energyrecup	municipal waste	industrial waste
2000	572686	451483	121203	488373	379516	108857
2005	709634	709634	0	709634	709634	0
2010	888872	604247	284625	888872	604247	284625
2015	922958	649045	273913	922958	649045	273913
2016	908500	637618	270882	908500	637618	270882
2017	913980	645949	268031	913980	645949	268031
2018	904044	639370	264674	904044	639370	264674
2019	888436	612448	275988	888436	612448	275988
2020	924772	1176542	251769	924772	1176542	251769
2021	1169682	1590660	420977	1169682	1590660	420977
2022	1000313	1346233	345920	1000313	1346233	345920

Table 7.7b: Amounts of waste incinerated (ton) in the Flemish region (2000-2022) with a distinguish between household and industrial waste

Different technologies used in the waste incineration plants in the Flemish region can be found on the website of the Flemish Public Waste Agency (OVAM), www.ovam.be.
A complete inventory of the Flemish waste incineration sector is published on https://www.ovam.be/sites/default/files/ovor20060901inventaris_afvalverbrand_sector.pdf.

Wallonia

In Wallonia, following a legal decree in 1998, the air emissions from municipal waste incineration were measured in 1998 by ISSEP and the results were validated by a Steering Committee. Since 2004, the amount of incinerated waste (in ton) and the annual emissions (calculated on the basis of stack measurement) are reported annually by the operators in a software dedicated to environmental reporting, called REGINE.
From 1990 to 2000 CO_2 emissions of municipal waste incineration are reported assuming that 68 % of the waste is composed of organic material. This is based on the average garbage composition in Wallonia and the use of IPCC equation on organic content of the various materials. Since 2001, the waste incineration plants provide each year the organic content of the incinerated waste in the context of their environmental reporting so that we can adapt the data from year to year. The time-series was not recalculated from 1990 to 2000 because of the lack of data on the composition of the incinerated waste for these years. Due to a quick evolution of the policies regarding waste sorting, collection and composting, the composition of the incinerated waste has been modified. So, the organic content of the years 2001 to 2009 cannot be used to recalculate the time-series before 2001. In 2005 and 2010, the average organic content is respectively 31% and 50%. The increase of the organic content between 2005 and 2010 is mainly explained by the stop of old plants where part of the waste was composted instead of being incinerated.
In the early 1990s, about 45% of the waste was still incinerated without energy recovery. Since 2006, the 4 municipal waste incineration plants are fully equipped to produce electricity. The emissions with energy recovery are allocated in the energy sector, category 1A1a, according to IPCC guidelines. The emissions are reported under two fuel categories: biomass (biogenic part, this fuel category also includes other biomass use, such as wood used in one of the public power plants, so the part coming from MSW incineration cannot be isolated as such from the CRT table) and other fuels (non-biogenic part of the MSW, in Wallonia this fuel category only includes MSW). A small part of the emissions from municipal waste incineration is still allocated in the waste sector, category 5C, when waste is incinerated without energy recovery because of occasional problems in the energy recovery systems. In 2010, this represents 2% of the incinerated waste. In 2013, this represents 20% of the incinerated waste. In 2013, the fraction of waste that has been incinerated without energy recovery is higher than the previous years because the turbine of 2 of the 4 waste incineration plants in Wallonia had to be stopped

during more than 6 months for repair. From 2014 to 2021, the incinerated waste without energy recovery represents 2 to 4% of the incinerated waste.
To allocate the emissions in the energy sector, category 1A1a, the activity data must be converted to TJ/year. Before 2012, the conversion of incinerated waste with energy recovery from ton/year to TJ/year was performed on the basis of an average net calorific value (NCV) of 10 GJ/ton of incinerated waste. This corresponds to the default NCV for municipal waste given in the 2006 IPCC Guidelines. Since 2012, the conversion is performed on the basis of the net calorific values reported annually by the operators.
The composition of the incinerated waste is: municipal solid waste, standard industrial waste, sewage sludge and some hospital waste.
There is a distinction between the emission from municipal waste incineration and hospital waste incineration. CO_2 emissions from hospital waste incineration are measured and are integrated in the waste incineration sector. Since 2005, the only hospital waste incineration plant was closed. Some hospital waste is incinerated in the municipal waste incineration plants. These emissions are thus included in the incineration plants, as they cannot be distinguished anymore. The non-hazardous hospital waste (A & B1) can be incinerated in the 4 municipal waste incineration plants. However, only one municipal waste incineration plant is authorized to incinerate hazardous hospital waste (B2).
This plant incinerates about 5000 tons of hazardous waste per year. That corresponds to 1.5% of the total amount of incinerated waste in this plant. About 680 tons of hazardous hospital waste (B2) are also yearly exported to France and Germany. The activity data only takes into account the waste that is incinerated in Wallonia, not the waste that is transferred to other countries for incineration.

	With energy recovery (1A1a)		Without energy recovery (5C)		TOTAL	
	Amount (ton)	**Organic content (%)**	**Amount (ton)**	**Organic content (%)**	**Amount (ton)**	**Organic content (%)**
1990	199 249	68	157 614	68	356 863	68
1995	210 217	68	181 914	68	392 131	68
2000	242 817	68	82 042	68	324 859	68
2005	476 685	30	21 716	41	498 401	31
2010	859 075	50	17 231	41	876 306	50
2015	1005 808	56	20 823	58	1026 631	56
2016	979 461	56	39 667	59	1019 128	56
2017	991 595	55	20 612	58	1012 207	55
2018	962 695	56	44 769	57	1 007 463	55
2019	990 362	55	33 394	56	1 023 756	55
2020	962 021	55	19 207	57	981 229	55
2021	979 810	55	29 482	55	1 020 916	55
2022	962 508	55	21 160	56	983 668	55

Table 7.8: Amounts of waste incinerated (ton) and organic content (%) in the Walloon region (1990-2022)

The Brussels-Capital Region

The emissions from the waste incineration plant with energy recovery are allocated to the sector 1A1a.
The CO_2 emissions derive from annual in-situ measurements (stack release samplings). The biogenic fraction of CO_2 emissions is calculated on the basis of the organic mass fraction (biomass) of incinerated waste.

The evolution of the corresponding amount of waste incinerated and of its organic content are presented in table 7.9.

	Municipal waste incineration with energy recovery (1A1a)	
	Amount (tons)	Organic fraction (%)
1990	511 528	62
1995	528 850	58
2000	535 000	53
2005	509 363	53
2010	443 229	56
2015	460 547	56
2016	488 639	57
2017	506 354	56
2018	489 040	58
2019	493 667	52
2020	488 620	56
2021	510 224	56
2022	476 618	56

Table 7.9: Amounts of municipal waste (tons) incinerated in the Brussels-Capital Region with energy recovery (category 1A1a) (1990-2022)

Another municipal waste incineration plant was also in activity until 1998, as well as two hospital waste incineration plants until 1997. The amounts of waste incinerated are presented in table 7.10. No energy recovery occurs in these 3 plants. IPCC 2006 default emissions factors for municipal and hospital waste are used to calculate the CO_2, CH_4 and N_2O emissions.

	Municipal waste (t) (parc Léopold)	Hospital waste (t) (St-Luc)	Hospital waste (t) (Pasteur)
1990	145	464	250
1991	145	464	250
1992	145	464	250
1993	145	464	250
1994	145	210	250
1995	145	464	250
1996	145	341	250
1997	145	245	33
1998	82	0	0
>1998	0	0	0

Table 7.10: Amounts of municipal and hospital waste (tons) incinerated in the Brussels-Capital Region without energy recovery (category 5C)

Incineration of sewage sludge (5C1.1b) occurred between 2004 and 2009 in one of the two wastewater treatment plants operating in the region. CO_2 emissions are calculated using the 2006 IPCC guidelines emission factor of 1650 kg/t of sludge considering a carbon content of 45%. These emissions are considered to be entirely of biogenic origin. CH_4 emissions are calculated using the default emission factor of 9.7 g/ton of sludge as proposed by in the 2006 IPCC guidelines. N_2O emissions are calculated using the default emission factor of 900 g/ton of sludge from the 2006 IPCC Guidelines and as recommended during the UNFCCC centralized review in 2020.

7.4.2.2 Flaring in the chemical industry

Flaring activities in the chemical industry take only place in the Flemish and Walloon region.

<u>CO_2 emissions from flaring</u>

The emissions of CO_2 from the flaring in the chemical industry are reported in category 5.C.1.2.b.1 - Non-biogenic - Flaring in the chemical industry. Since 2013 these data are taking over from ETS-data, before mainly data reported in the integrated environmental reports by the industrial companies were used.

Some fluctuations in IEF are observed at the higher categories since no activity data from the Flemish region are included in the CRT-tables in this subcategory. The inconsistency between the AD and the emissions reported are consequently the main reason for these fluctuations.

These flaring activities represent a large share of total emissions in this category 5C12b (65% in 2002 and 74% in 2013).
The allocation of this activity in the waste sector is coming from the chapter 7 of the IPCC guidelines 2006 and the emep/corinair guidebooks. In this chapter 7, the table (table 7.1) links the IPCC categories with the corresponding methodology chapters in Emep/corinair guidebook.
The information in this chapter can be found via: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_7_Ch7_Precursors_Indirect.pdf.
The former CRT code 6C (updated to 5C) is linked with B924 and B924 is linked with the flaring in the chemical industry.

<u>CH_4 and N_2O emissions from flaring</u>

In absence of emission factors to estimate CH_4 and N_2O emissions from flaring activities (no emission factors are found in various documents as EPA-AP-42, EMEP/EEA guidebook, NID from others MS and the IPCC guidelines) and in absence of measurements carried out by the involved industry these emissions are not estimated in Belgium.

7.4.3 Uncertainties and time-series consistency

For N_2O, an uncertainty of 200% on the emission factor is applied, following IPCC Good Practice Guidance. The uncertainty on activity data (amount of waste) is estimated at 5%.
In Wallonia, CO_2 emissions are measured in each waste incinerator. The confidence interval was calculated for each of the incinerators, based on the standard deviation of the mean. Those uncertainties were then combined according to equation 6.3 of the IPCC Good Practice Guidance, using the 1990-2001 average quantities of waste for each plant. This estimate gives an overall uncertainty of 24% on the CO_2 emission factor. However, the estimate of the biogenic content of the waste is another source of uncertainty. Six results on the average composition of the municipal waste are available since 1997, allowing a calculation of the confidence interval. It appears that the average biogenic part of those wastes is rather stable, although the effect of some waste

policies such as separate collection of paper can be observed. The uncertainty based on the confidence interval is 3%. Using equation 6.4, the total uncertainty on the CO_2 emission factor is 24.2%.
In Flanders the major uncertainty for the estimation of CO_2 is the estimation of the fossil carbon fraction. As in Flanders the methods to determine this fossil carbon fraction are identical for this sector (combustion of waste without energy recuperation) and for the energy sector (combustion of waste or other fuels with energy recuperation), the uncertainty on the CO_2 emission fraction for waste combustion is estimated at 10% (the same as for category 1A1-other fuels). The average of both estimations gives an average uncertainty of 17%.
Flaring in the chemical industry is monitored, uncertainty on activity data is estimated at 20% according to expert judgement. The uncertainty on the emission factor is estimated at 20%.
At Belgian level, uncertainties of both sources are combined using equation 3.2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

7.4.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the 3 regions only for the Belgian key source categories and can be provided by the Belgian experts on request.
For the CO_2 emissions of the 5.C category, QA/QC procedure is a continue improving process. Since the 2013 submission, an Excel file is dedicated to the QA/QC of this category and the check list tier 1 QC is completed. The QA/QC procedure consists in:

- Check of the primary data (activity data and CO_2 emissions) for each plant;
- Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels;
- Check that emissions data are correctly transcribed between different intermediate products;
- Check of the time series consistency.

7.4.5 Source-specific recalculations, if applicable, including changes made in response to the review process

The table below shows the recalculations between the submissions 2023 and 2024 in the category 5C in Belgium.

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flemish region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
kt CO2-eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flemish region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Walloon region	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Belgium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

No recalculation took place during this submission.

7.4.6 Source-specific planned improvements, if applicable

As a result of the UNFCCC centralized review in 2020:

- The UNFCCC expert review team noted in 2021 that the total amounts of waste incinerated sourced from incineration plants and reported in the CRT table 5.C (both biogenic and non-biogenic municipal solid waste, industrial solid waste and clinical waste, but excluding flaring in the chemical industry) (e.g.

44.8 kt for 2018) are much smaller than those of the Eurostat data (e.g. 1753.6 kt for 2018). During the review, Belgium explained that it is very likely that most of the quantities in the Eurostat data cannot be compared with activity data that the Party uses in this category since it is unclear how these Eurostat statistics are produced, including separation of energy recovery in waste incineration. Belgium added that making a robust comparison between these statistics and the CRT figures would require a lot of research.
However, the ERT recommends that Belgium conducts a research on the discrepancy between the amount of waste incinerated Belgium uses for its calculations and the Eurostat data, with the aim to verify the activity data used in category 5.C.1, and report on the results of the research in the NID.
Other reasoning for these differences could be differences in definitions of 'waste' between the IPCC guidelines and the Eurostat reporting and different allocations of incineration of waste in the sector categories between the CRT-tables and Eurostat.

The issue could not been resolved yet for the 2024 submission, nevertheless the recommendation has been addressed and regional waste statistics experts have been contacted by the inventory team. Concerning the Walloon region, it is known that the data reported to Eurostat are overestimated. The only waste incinerated without energy recovery are the animals in the animal incinerators and the waste in the municipal waste incineration plants without energy recovery. Discussions take place among experts to investigate the data in more detail.

Investigations are going on to eventually optimize the estimations of the emissions in all subsectors of the waste sector including the emissions of this CRT-category. A study in this respect started in the Flemish region at the end of 2023. The possible application of the 2019 Refinement to the 2006 IPCC Guidelines will also be investigated during this study. Results will be included in next submissions if relevant.

Other planned improvements will also depend on the future recommendations of the European and international reviews of the Belgian greenhouse gas inventory.

7.5 Wastewater treatment and discharge (CRT 5.D)

7.5.1 Source category description

The emissions from the treatment of domestic and commercial wastewater are allocated to the category 5D1.

The category 5D2 (industrial wastewater handling) is also briefly discussed in this chapter.

7.5.2 Methodological issues

5D1. Domestic wastewater

Regarding the emissions from municipal wastewater handling and treatment: CO_2 emissions from septic tanks and municipal wastewater treatment plants are not included in the inventory because the carbon derives from biomass raw materials. Septic tanks and municipal wastewater treatment plants are potential sources of CH_4 emissions, depending on the process implemented (aerobic or anaerobic treatment). The N_2O emissions are calculated using the human sewage approach, IPCC equation 6.8 (Walloon and Brussels-Capital Region) and IPCC equations 6.9 and 6.7 for wastewater treatment and discharge (Flemish region).

CH_4 emissions

IPCC 2006 guidelines (equation 6.3) are used to estimate the emissions of CH_4 originating from the use of septic tanks.
In Belgium, the CH_4 emissions from septic tanks decrease continuously, linked with the increased connection rate of the population to the public wastewater treatment network.

In Wallonia, following the discussion with the ERT during the ESD review of June 2020, emissions have been revised.
From 1990 until 2001, the percentage of population in individual wastewater treatment are based on the Walloon report on state of the environment, which clearly indicates the number of inhabitants not connected to the sewage system (from 18.5% in 1990 to 11.7% in 2001). From 2001 until 2019, the percentage are based on the Aquawal report (11.9% and 12.2% in 2019). The emissions are relatively stable.
Besides this percentage of people not connected to the sewage system, there is the part of load which is collected through the sewage system but not treated and rejected directly in surface waters without wastewater treatment (Wallonia was late in the implementation of the Directive 91/271/CEE for the treatment of wastewater and installations of wastewater treatment plants). It is assumed that this load rejected to surface water cannot be considered as "septic tank" as surface waters are aerobic. Translated in percentage of population, this load discharge in rivers represented 59.8% in 1990 and decreased until less than 1% from 2018.

The MCF used are those of Table 6.3 in 2006 IPCC Guidelines: 0.5 for septic systems and 0.1 for river discharge. The Bo value is the default value in 2006 IPCC Guidelines, 0.6 kg CH_4/kg BOD). Emissions are calculated following the equations 6.1, 6.2 and 6.3 of the 2006 IPCC Guidelines.

In the Brussels-Capital region, historical CH_4 emissions from wastewater river discharge are estimated using the same parameters as Wallonia. The percentage of the population not connected to the wastewater treatment plants is deduced from the capacity of the wastewater treatment plants in operation. From 2007 the rate of connection of the population to the public wastewater treatment system reaches 100% when the second treatment plant entered into operation.

In the Flemish region, the methodology used to calculate the emissions of CH_4 from septic tanks is illustrated hereunder and is completely based on the IPCC guidelines.

		1990	1995	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Equation 6.3													
TOW = P * BOD * 0,001 * I * 365													
P		5.739.736	5.866.106	5.940.251	6.043.161	6.251.983	6.444.127	6.477.804	6.516.011	6.552.967	6.589.069	6.629.143	6.653.062
BOD		60	60	60	60	60	60	60	60	60	60	60	60
I		1	1	1	1	1	1	1	1	1	1	1	1
TOW (kg BOD) *(Equation 6.3)*		**125.700.218**	**128.467.721**	**130.091.497**	**132.345.226**	**136.918.428**	**141.126.381**	**141.863.908**	**142.700.641**	**143.509.977**	**144.300.611**	**145.178.232**	**145.702.058**
BOD	60	g DBO5/hab/jr											
U	1%	(en zone transitoire --> hypth = tous avec fosse septique)											
T	1	(dans cette catégorie, tous avec 100% utilisation fosse)											
Bo *(kg CH4/kg BOD ou COD)*													
Domestic Wastewater	0.6												
Industrial Wastewater	0.25												
TABLE 6.3 DEFAULT MCF VALUES FOR DOMESTIC WASTEWATER		EF domestic ww											
Type of treatment and discharge path	MCF	(kgCH4/kgBOD)											
Centralized, aerobic treatment plant	0	0											
Septic system	0.5	0.3											
Emissions CH4 (ton)		377.101	385.403	390.274	397.036	410.755	423.379	425.592	428.102	430.530	432.902	435.535	437.106
IEF (kg CH4/hab)		6.57	6.57	6.57	6.57	6.57	6.57	6.57	6.57	6.57	6.57	6.57	6.57
aantal IE ongezuiverde inwoners (inwoners niet aangesloten op RWZI's)		4.483.389	4.429.765	2.964.420	2.201.992	1.747.205	1.195.050	1.127.489	1.070.520	1.049.074	1.013.921	1.035.950	941.876
% gezuiverde inwoners		*22%*	*24%*	*50%*	*64%*	*72.054%*	*81.455%*	*82.595%*	*83.571%*	*83.991%*	*84.612%*	*84.373%*	*85.843%*
% ongezuiverde inwoners		*78%*	*76%*	*50%*	*36%*	*28%*	*19%*	*17%*	*16%*	*16%*	*15%*	*16%*	*14%*
emissions CH4 (ton)		**29.456**	**29.104**	**19.476**	**14.467**	**11.479.136**	**7.851.478**	**7.407.606**	**7.033.316**	**6.892.416**	**6.661.461**	**6.806.191**	**6.188.129**

No CH_4 emissions are accounted for municipal wastewater treatment plants in Belgium. Most of the plants are indeed conducted aerobically, and those who use anaerobic digestion of the sludge recover the CH_4 for energy purposes. These emissions are allocated in the category 1A1a.

In the **Brussels-Capital Region**, the anaerobic wastewater treatment plant (www.aquiris.be) generates yearly around 6 650 000 m³ of biogas, valorised in a cogeneration installation for the production of electricity and heat.

In **Wallonia**, according to the energy balance, 9 municipal wastewater treatment plants anaerobically conducted produce biogas through sludge digesters. In 2010, 804 000 m³ of biogas was produced, mostly used for electricity and warming of the buildings and digester itself. This should be compared with 63 million of m³ recovered in SWDS, so biogas from wastewater treatment plants represent about 1.3% of the SWDS biogas. The emissions linked to the energy recovered by these anaerobic treatment plants are included in the energy sector, as biomass fuels.
In Wallonia, when a zoning of industrial activity or artisanal is subject to collective wastewater treatment, domestic wastewater of the zoning is generally poured in the sewage system. As for industrial wastewater, they are treated in situ, except authorization of rejection in the sewage system. If it is the case, they are regarded as waste urban water and undergoes the same treatment that domestic wastewater. According to the data resulting from the service of taxation of industrial wastewater, industrial water represented 205 000 equivalent-inhabitant in 2003, that is to say approximately 10% of the load treated by public wastewater treatment plants.

In the **Flemish Region,** the energy balance reports 29 installations of wastewater treatment that use the biogas to produce electricity (15 installations with biogas of sewage sludge of municipal wastewater treatment installations and 14 installations with anaerobic water treatment). The amount of biogas used for electricity production in 2016 is 0,532117 PJ (or 7 450 000 m³). The emissions linked to the energy recovered by these treatment plants are included in the energy sector (category 1A1a, biomass fuels).
In 2018 0.473167437 PJ of biogas (from sludge from WWT-plants and other anaerobic treatment of wastewater) at these sites was used for production of electricity in this region. Calculating with an average energetic value of 23.4 MJ/Nm3, as the biogas captured at waste water treatment plants (industrial waste water) in 2018 is 0.296875317 PJ, we calculate: 23.4 MJ/m3 gives 12 686 979 m3 biogas *0.5 * 0.05 = 317174 m3 CH4 = 226.55 ton CH4 of 5.7 kton CO2eq. For the biogas captured at waste water treatment plants (municipal waste water or corresponding waste water): 0.176292120 * 23.4 gives 7 533 851 m3 biogas * 0.5 * 0.05 = 188346 m3 CH4 = 134.533 ton CH4 of 3.4 kton CO2eq.

N_2O emissions

Walloon Region and the Brussels-Capital Region

In the Walloon Region and the Brussels-Capital Region, the N_2O emissions are calculated using the human sewage approach (IPCC equation 6.8).
The N_2O emissions from human sewage are estimated by using the methodology described in the IPCC 2006 Guidelines by multiplying the protein consumption per capita with the population, the N fraction in the protein and the default EF. Default correction factors are also used for the fraction of proteins non-consumed, and the input from industrial wastewater treated in municipal plants. The default values for N fraction in protein (kg N / kg protein) and N_2O emission factor are 16% and 0.005 kg N_2O-N / kg sewage-N produced. The figure of protein consumption originates from the Food and Agriculture Organization of the United Nations statistics (the food balance sheets). The population figures come from the National Institute of Statistics and are the figures at 1st January of the respective year. Table 7.11 gives an overview of the AD and factors used in 2021.

Protein consumption (kg/capita/yr)	40.811
N fraction in protein (kg N/kg protein)	0.16
EF (kg N_2O-N/kg sewage-N)	0.005
Correction factor (non-consumed fraction)	1.4
Correction factor (industrial fraction)	1.25

Table 7.11: Factors used in the Brussels and Walloon regions to calculate the N_2O-human sewage in 2022

In the Brussels-Capital Region, a nitrogen abatement rate is applied in order to take the tertiary treatment of wastewater (denitrification) into account. The abatement rate is specific to each of the two wastewater treatment plants, and based on in-situ measurements.

In Wallonia, nitrogen removed with sludge is known since 1994 and the amount of N is well deduced as foreseen in the Equation 6.8 from the IPCC Guidelines. These amounts integrate all the types of valorisations (agriculture, landfill, incineration and storage). Analyses of sludge provide the N content of sludge (% of dry matter). By multiplying these values with the amount of sludge in dry matter, we obtain the nitrogen removed with sludge, used in equation 6.8. The Table 7.12 gives the amount of sludge valorised in ton of dry matter, the N content in percentage of dry matter and the N removed in ton of N. The N content is coming from annual analyses made on sludge.

	1994	2000	2005	2010	2015	2020	2021	2022
Sludge valorised (ton DM)	13 267	18 228	30 285	38 460	50 502	52 101	54 439	50 750
N content (%/DM)	3.60	3.60	3.16	2.96	4.77	3.01	3.04	3.44
N removed (ton N)	478.05	656.80	956.12	1137.26	2408.93	1568.22	1654.91	1743.77

Table 7.12: Amount of sludge valorised and N removed in Wallonia

The value reported in CRT table 5.D as 'sludge removed' is indeed related to the Nitrogen removed in the table above. But in the CRT-table it is not in kt N removed but in kt of dry matter. If we multiply the dry matter of CRT table 5.D.1 (50.7 kt in 2022) by the N content (3.44%) we obtain the 1.7 kt N reported in the table above.

Flemish Region

In the Flemish region, a new methodology was developed to estimate the emissions of N_2O from wastewater treatment and discharge, following a recommendation of the expert review team during the 2016 ESD review (2016 Comprehensive review of national greenhouse gas inventory data pursuant to Article 19(1) of Regulation (EU) No 525/2013). Wastewater experts confirmed that the emissions in Flanders are largely overestimated when using the human sewage approach, since a large part of wastewater in Flanders is treated effectively at WWTP.

In cooperation with the wastewater experts a new methodology was developed in line with the IPCC 2006 Guidelines (equations 6.9 and 6.7). IPCC equation 6.9 is used to estimate N_2O emissions from waste water that is treated at WWTP. Additionally, N_2O emissions from waste water that is not treated at WWTP (= wastewater effluent) are estimated using IPCC equation 6.7. The calculations take into account effective measurements at WWTP and data regarding nitrogen influent, nitrogen effluent and the amount of nitrogen treated, in combination with the IPCC default emission factors for WWTP (EF_{PLANT} = 3.2g N_2O / person / year) and nitrogen effluent ($EF_{EFFLUENT}$ = 0.005 kg N_2O-N / kg N).

The resulting N_2O emissions are 85% - 93% lower than the estimates in the previous submission. The new values are realistic according to Flemish wastewater experts.

5D2. Industrial wastewater

Regarding the emissions from industrial wastewater handling and treatment: emissions from industrial wastewater treatment are not included in the Belgian greenhouse gas inventory because most of the industrial wastewater is treated in an aerobic way. Recovery of CH_4 occurs (using fermentation tanks for recovering the emissions via flaring or energy production) for this very limited part of installations that treat the wastewater anaerobically. Consequently, no or negligible amounts of emissions take place.

The notation key 'IE,NE' is encoded in the CRT tables for CH_4 emissions from 5.D.2. 'IE' because no distinction can be made in Wallonia and Brussels between industrial and municipal wastewater treated by wastewater treatment plants. And 'NE' because, as explained above, even when the activity data could eventually be estimated, emissions are considered negligible in reference to the estimation above in the Flemish region. In the case of Brussels and Wallonia, in-situ treatment of industrial wastewater exists for a limited number of sites and it is considered that in case of in-situ treatment of industrial wastewater the aerobic treatment is used and CH_4 emissions are considered negligible as indicated in Table 6.8 of the IPCC 2006 guidelines. This is the reason why Belgium does not put the necessary time and energy to report the additional information and the activity data given the complexity in collecting this information, and 'IE,NE' is also encoded for activity data.

<u>Overview of the methodology used for calculating N_2O emissions from wastewater in the three regions</u>

Brussels Region	Walloon Region	Flanders Region	Flanders Region
N_2O emissions from wastewater effluent are calculated using IPCC eq. 6.7. N.B. The formula is adapted to include a nitrogen abatement rate	N_2O emissions from wastewater effluent are calculated using IPCC eq. 6.7.	N_2O emissions from wastewater effluent are calculated using IPCC eq. 6.7. N.B.: This includes only emissions from wastewater from inhabitants *<u>not</u>* connected to centralised waste water treatment plants	N_2O emissions from the centralized wastewater treatment process are calculated separately. The formula used is based on IPCC eq. 6.9. Formula used: N_2O_{PLANTS} = (total $N_{INFLUENT}$ / amount of N treated at plants per inhabitant equiv.) * EF_{PLANT}
AD: $N_{EFFLUENT}$ (kt N/year) = calculated using IPCC eq. 6.8 N in wastewater from human population; industrial and commercial co-discharged protein an abatement rate is included on the basis of in-situ measurements in the WWTP's	AD: $N_{EFFLUENT}$ (kt N/year) = calculated using IPCC eq. 6.8 N in wastewater from human population; industrial and commercial co-discharged protein N removed with sludge is counted since 1994	AD: $N_{EFFLUENT}$ (kt N/year) = data Flemish Environment Agency (model calculations) N in wastewater from human population wastewater from inhabitants *<u>not</u>* connected to centralised WWTP's	AD: $N_{INFLUENT}$ (kt N/year) = data Flemish Environment Agency (measurements at WWTP's) N in wastewater from human population; industrial and commercial co-discharged protein wastewater treated at WWTP's
$EF_{EFFLUENT}$ = 0.005 kg N_2O-N/kg N (IPCC 2006 default)	$EF_{EFFLUENT}$ = 0.005 kg N_2O-N/kg N (IPCC 2006 default)	$EF_{EFFLUENT}$ = 0.005 kg N_2O-N/kg N (IPCC 2006 default)	EF_{PLANT} = 3.2 g N_2O/person/year (IPCC 2006 default)

Table 7.13: Overview of the methodology used for calculating N_2O emissions from wastewater in the three regions

The activity data are reported in the table 7.14 below:

	Brussels Region	Walloon Region	Flanders Region	Flanders Region
	$N_{EFFLUENT}$ (kt N/year)	$N_{EFFLUENT}$ (kt N/year)	$N_{EFFLUENT}$ (kt N/year)	$N_{INFLUENT}$ (kt N/year)
	IPCC eq. 6.8 incl. abatement factor for WWTP's	IPCC eq. 6.8	model calculations (for inhabitants not connected to WWTP's)	measurements at WWTP's
1990	10.24	34.4	13.8	6.0
1995	10.04	34.4	12.8	14.1
2000	7.54	32.4	9.9	16.8
2005	8.20	33.5	7.7	19.5
2010	2.44	34.6	5.2	24.1
2015	2.47	34.4	4.8	25.3
2016	2.55	36.1	5.0	27.4
2017	2.45	35.2	4.6	27.2
2018	2.44	35.2	4.7	27.4
2019	2.27	37.4	4.6	28.4
2020	2.43	39.6	4.6	28.1
2021	3.02	40.0	5.3	28.3
2022	2.49	40.1	4.1	26.8

Table 7.14: Overview of the activity data used for calculating N_2O emissions from wastewater in the three regions

7.5.3 Uncertainties and time-series consistency

IPCC recommends an activity data uncertainty of 5% for population and 30 % for BOD/person. An overall uncertainty of 20 % is considered for activity data. The same uncertainty is used for N_2O calculation, assuming that the uncertainty on the annual per capita protein intake and the fraction of nitrogen in these proteins lies in the same range.
The uncertainty on CH_4 emission factor reported by other parties goes from 48 % (UK, 2000) to 104 % (Finland), mainly depending on the uncertainty on the Methane Conversion Factor (fraction treated anaerobically). A default value is used for the time being and further expert judgement is needed on this estimate. Thus, an average uncertainty of 70 % is used for the time being.
For N_2O the default IPCC emission factor of 0.005 kg N_2O/kg N is used. This emission factor originates from IPCC 2006 Guidelines, with a given range of 0.0005 to 0.25. This range represents an uncertainty of –75% to +125%. An uncertainty of 110 % is used in this calculation.

7.5.4 Source-specific QA/QC and verification, if applicable

Tier 1 quality control checks are performed in the three regions only for the Belgian key source categories and can be provided by the Belgian experts on request.

7.5.5 Source-specific recalculations, if applicable, including changes made in response to the review process

The table below shows the recalculations between the submissions 2023 and 2024 in the category 5D in Belgium.

%	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	3.21	1.31	2.52	1.06	2.15	6.03	9.95	11.43
Flemish region	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.01	0.04	0.07
Walloon region	0.00	0.00	0.00	1.35	0.64	2.33	1.67	1.91	3.48	6.22	7.07
Belgium	0.00	0.00	0.00	0.48	0.26	0.97	0.70	0.83	1.58	2.80	3.35

kt CO2-eq	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021
Brussels region	0.00	0.00	0.00	0.16	0.07	0.13	0.05	0.11	0.27	0.46	0.65
Flemish region	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.02	0.08	0.12
Walloon region	0.00	0.00	0.00	2.32	0.99	3.54	2.53	2.91	5.39	9.67	10.93
Belgium	0.00	0.00	0.00	2.48	1.04	3.67	2.58	3.02	5.68	10.21	11.70

In the Flemish region the amounts of N influent at WWTP as well as the amount of N effluent (from inhabitants not connected to WWTP) are updated during this submission from 2011 on, resulting in small, not significant differences in emissions compared to previous submission for these years.

In Wallonia and the Brussels-Capital region recalculations took place for the period 2010-2021 due to new data available from the Food and Agriculture Organization of the United Nations regarding the consumption of protein per inhabitant in Belgium.

In Wallonia, the N content in sludge has been updated from 2016 on to improve the coherency with data coming from agricultural sector.

7.5.6 Source-specific planned improvements, if applicable

Investigations are going on to eventually optimize the estimations of the emissions in all subsectors of the waste sector including the emissions of this CRT-category. A study in this respect started in the Flemish region at the end of 2023. The possible application of the 2019 Refinement to the 2006 IPCC Guidelines will also be investigated during this study. Results will be included in next submissions if relevant.

Planned improvements will also depend on the future recommendations of the European and international reviews of the Belgian greenhouse gas inventory.

8 INDIRECT EMISSIONS

See chapter 1.8.1 for more information

Gases

All direct and indirect greenhouse gases (CO, $NO_x(NO_2)$ and NMVOC) and SO_2 are covered in the Belgian greenhouse gas inventory. The indirect greenhouse gases (CO, $NO_x(NO_2)$ and NMVOC) and SO_2 are reported completely consistent with the reported data on air pollutants in the framework of the emep/lrtap-reporting (Convention on Long-range Transboundary Air Pollution) at March 15th 2024.

As in the previous submissions, no indirect emissions of CO_2 and N_2O are estimated in the Belgian inventory.

9 RECALCULATIONS AND IMPROVEMENTS

9.1 Recalculations, including in response to the review process and for KP-LULUCF inventory

9.1.1 GHG inventory

Recalculations carried out between the 2024 and 2023 submissions are described in the respective chapters (chapter 3 to 7) of the different sectors in this document. Quantitative as well as qualitative explanations of recalculations are reported.

An overview of the recalculations performed is listed below per CRT-category:

CRT 1 Energy

CRT 1A1 Energy industries

Recalculations in category 1A1 mainly due to:

All regions:

Optimization of regional energy balances.

Flemish region:

> Small corrections were made in the Flemish region in this category for some years: mainly in the subcategory CHP-installations and the emissions from gasoil consumption in the nuclear power installations in 2015 was added (+ 2 kton CO2) to become consistency in the time series.

Walloon region:

> No recalculation except the revision of the energy balance in 2021.

Brussels-Capital region:

> Revision of the CO_2 emissions of the municipal waste incinerator following better knowledge about the facility (the CO_2 emissions from the (small) extra natural gas supply to the installation that were previously subtracted from the measured emissions, are actually not taken into account in the stack measurements).

CRT 1A2 Manufacturing industries and construction

Recalculations in category 1A2 mainly due to:

All regions:

Optimization of regional energy balances, mainly the year 2021 is involved.

Flemish region:

- Energy consumption data were optimized in this region from 2016 on. These optimizations mainly effected the category 1A2g viii_other industries and mainly for the liquid fuels (increase of consumption).

- The off-road data were optimized in the OFFREM model during this submission from 2016 on, resulting in a decrease of emissions in this category 1A2gvii (construction sector).

Brussels region:

- Recalculations of historical series in the energy balance, especially for the period 2014–2021 for all energy vectors, and gasoil from 2010 with the revision of the time series and sectorisation based on the federal survey of distributors (sales).
- In 1A2gvii, revision of data from the OFFREM calculation model for the period 2016-2021.

Walloon region:

Optimization of the OFFREM model for the category 1A2gvii from 2016 on.

CRT 1A3 Transport

Recalculations in category 1A3 mainly due to:

All regions:

Recalculations in the category 1A3b (road transport) in all 3 regions in Belgium for the complete timeseries due to:

- Use of updated COPERT 5.7.3 version during this submission;
- Use of regional sales statistics from the submission in 2023 on instead of federal statistics until the submission of 2022 for the estimation of the regional emissions from road traffic (see 3.2.8) [resulting in interregional changes compared to previous submissions]. Recalculations for the complete timeseries from 1990 on are involved. Belgian data are compiled as the sum of the regional data and are approaching data from previous submission.

Brussels-Capital region:

- In 1.A.3.c - Railways, revision of energy consumption up by on average 4% for the period 2014-2017, and marginal revisions for the years 2018 to 2021 due to the revision of conversion factors used in the energy balance.
- In 1.A.3.d - Domestic Navigation, revision of energy consumption down by on average 6% for the period 2014-2021 due to the revision of conversion factors used in the energy balance.

Flemish Region:

- Small changes in emissions of CO_2 from road transport (< 1 kton CO_2 up to 2019 and a decrease of emissions of CO_2 of 2-3 kton CO_2 for the years 2020 and 2021.Biggest differences in this category (2-5 kton CO_2) due to revision of the model to calculate the emissions from railways (complete timeseries).
- small change in aviation due to new datasets from EUROCONTROL for the years 2015-2021 and an update of aviation fuel data for military aircrafts.

Walloon region:

Optimization of the OFFREM model for the category 1A3eii.

CRT 1A4 Other sector

Recalculations in category 1A4 mainly due to:

<u>All regions</u>:

Optimization regional energy balances.

Flemish region:

For the years 2016-2021, optimization of energy consumption data in the energy balances causes differences in calculated emissions in this category. The largest difference between current and previous submission is for the year 2021. The consumption of gas- and dieseloil in 2021 decreased with 11% in services sector and with 7% in agricultural sector. In the services sector this was due to the correction of an error in the extrapolation method. Together with the decrease of gas- and dieseloil consumption in agricultural sector, there is also a decrease of 39% of coal consumption between current and previous submission. In the agricultural sector this decrease was due to an update of the source data: in the previous submission preliminary data were used for 2021, while in this submission final surveydata from 2021 were available.

Brussels-Capital region:

- Recalculations of historical series in the energy balance, especially for the period 2014–2021 for all energy vectors, and gasoil from 2010 with the revision of the time series and sectorisation based on the federal survey of distributors (sales).
- In 1A4bii, revision of data from the OFFREM calculation model for the period 2001-2013 and the year 2021.
- 1A4cii, revision of data from the OFFREM calculation model for the year 2021.

Walloon region:

- In 1A4bi, revision on the charcoal consumption on the entire time series and revision of the pellets part in the total wood consumption since 2005.

- Optimization of the OFFREM model for the category 1A4cii.

- In the sector 1A4, in the previous submission, the liquid fuel activity data was based on the Walloon share of the sector's Belgian consumption (taken from the EBM survey - Household Budget Survey), and the total Belgian gasoil consumption of the sector. During this submission, in addition of the optimization of the 2021 energy balance, the sales from the distributors (Belgian survey) were directly used in the energy balance for the year 2021 and 2022. These data determine the regional and sectoral shares of the gasoil consumption.

CRT 1A5 Other

Flemish region:

Small changes in emissions occurred in the category 1A5b/military aviation in the Flemish region from 2018 on due to updated data in Energy Balance.

Walloon region:

No recalculation in this category except in 2021 with the final energy balance.

Brussels region:

No recalculations took place in this category.

CRT 1B

No recalculations in the category 1B are performed compared to previous submission to the EC and to UNFCCC in March-April 2022.

CRT 2 Industrial processes and product use

CRT 2A Mineral Products

Very small, insignificant recalculations took place in the category 2A in the Flemish region from 2016 on.
In the Walloon region, a mistake in a lime plant is corrected in 2021.

CRT 2B Chemical industry

In the Flemish region, the following recalculations were performed during this submission:

- A double counting of emissions of flaring (in CRT 2B10 and in CRT 5C12b) was eliminated during this submission (decrease in emissions in CRT 2B10 from 2019 on of 4-7 kton CO_2);
- Consistency assured for the years 2020 and 2021 compared to 2019 related to allocation of emissions of process_CO_2 from methane-fraction during production of ammonia. These emissions from 2020 and 2021 now allocated to CRT 2B1 and no longer to CRT 2B10. Total emissions in this respect remain unchanged.
- Small corrections were made during this submission assuring complete consistency with ETS-data for the emissions of N2O from production of nitric acid from 2013 on;
- Addition of missing emissions of N_2O from 1 chemical company from 2020 on (+17-18 kton CO_2);
- Corrections in category 2B9 of emissions of F-gases of 1 chemical company from 2017 on (correction/switch from reported non-IPPC gas to IPCC-gas) with consequently an increase of emissions (up to 11,5 kton CO2eq in 2019).

In the Walloon region, no recalculation was performed in the sector 2B.

CRT 2C Metal industry

No recalculations occurred in category 2C during this submission.

CRT 2D Non-energy products from fuels and solvent use

Recalculations of the emissions in this category 2D for the complete timeseries due are to the use of an updated version of the COPERT 5.7.3 software for the calculation of the emissions of road transport. Emissions from the use of lubricants and from de use of urea as a catalyst have been updated accordingly. No major changes in emissions were observed.

CRT 2E Electronic industry

No recalculations occurred in category 2E during this submission.

CRT 2F Product uses as substitutes for ODS

For category 2F, the following recalculations have made during this submission:

CRT code	CRT source category	Period	Nature of the recalculation	Impact for CRT gases in 2021 (in kt CO2-eq.)
2.F.1.a.	Commercial refrigeration	2006-2021	Adjustment refilling quantities for other applications	0,67
2.F.1.e.	Mobile air-conditioning	1997-2021	Statistics other vehicles updated on INS.	2,33
2.F.1.f.	Stationary air-conditioning	2006-2021	Update assumptions refrigerants used based on detailed statistics Frixis	-13,68
2.F.2.a	Closed cell foam	2021	Small error correction	0
2.F.4.b.	Technical aerosols	2021	Adjustment based on latest German inventory. Adjustment emissions 1990-1994.	0.92
Total		**1997-2021**		**-9,76**

CRT 2G Other product manufacture and use

For category 2G recalculations only arise from the fact that for 2G2b Particle accelerators emissions were included for the period 2020-2022.

CRT code	CRT source category	Period	Nature of the recalculation	Impact for CRT gases in 2021(in kt CO2-eq.)
2.G.2.b.	Particle accelerators	2020-2022	Inclusion of emissions	6,23

CRT 2H Other

No recalculations were made in the category 2H during this submission.

CRT 3 Agriculture

CRT 3A Enteric fermentation

No recalculations took place in this category.

CRT 3B Manure Management

Recalculations in emissions of CH_4 and N_2O in category 3.B due to:

Flemish and Walloon regions:
No recalculations.

Brussels region:
Correction of the calculation method of indirect N_2O emissions from manure management, in line with the methodology applied in Wallonia.

Correction of the coefficient corresponding to animal's feeding situation for non-dairy cattle (Ca) from grazing large areas to pasture.

Category 3.D Agricultural soils

Recalculations in emissions of N_2O in category 3.D due to:

Flemish region:
No recalculations.

Walloon and Brussels regions:
Actualization of 3D15 activity data (areas) on the whole time series.

Category 3.G Liming

Recalculations in emissions of CO_2 in category 3.G due to:

Flemish and Brussels regions:
No recalculations.

Walloon region:
Actualization of activity data (areas) on the whole time series.

Category 3.H Urea Application

No recalculations took place in this category.

CRT 4 Land use, land-use change and forestry

In the three regions, following the revision of the surface of the country and all three regions by STATBEL (the Belgian statistical office) the extension factor determining the surface associated to each point of the LULUCF matrix was revised to match with the updated surface for the whole time series. All subcategories in this sector are affected.

Brussels Region:

- Revision of land use changes in the LULUCF matrix for the period 2016-2018;
- Revision of the C/N ratio for forest lands from 19.254 to 17 on the basis of analysis from the regional Good Soil measurement campaigns.

CRT 5 Waste

Category 5A Solid Waste Disposal

In Wallonia, biogas recovery data of 2021 have been updated with new data from site owners. In 2023 submission, the data were partly provisional.

No recalculations took place in the Flemish and Brussels regions.

Category 5B Biological treatment of waste

In the Brussels-Capital region, activity data (amount of waste used for composting) is revised during this 2024 submission from 2018 on. Consequently, differences in emissions occurred in 2018-2021.

Category 5C Incineration and open burning waste

No recalculations took place in this category in the 3 regions.

Category 5D Wastewater treatment and discharge

In the Flemish region the amounts of N influent at WWTP as well as the amount of N effluent (from inhabitants not connected to WWTP) are updated during this submission from 2011 on, resulting in small, not significant, differences in emissions compared to previous submission for these years.

In Wallonia and the Brussels-Capital region recalculations took place for the period 2010-2021 due to new data available from the Food and Agriculture Organization of the United Nations regarding the consumption of protein per inhabitant in Belgium.

In Wallonia, the N content in sludge has been updated from 2016 on to improve the coherency with data coming from agricultural sector.

9.1.2 ESR Review in 2023

During this submission Belgium took into account the recommendations of the ESR Review carried out from 15/1 to 15/3/2023 as much as possible. Results of this review are available through the provided EMRT-tool.

9.1.3 UNFCCC centralized reviews

In 2022 the centralized review took place from 10 to 15 October 2022 in Bonn.

The UNFCCC individual review report about the 2022 submission was published on 17 April 2023. This UNFCCC review was carried out in accordance with paragraph 84 of the annex to decision 13/CP.20:

Results of this UNFCCC review are provided in annex3_arr2022_BEL_1.pdf.

9.2 Planned improvements to the inventory (e.g., institutional arrangements, inventory preparation), including for KP-LULUCF inventory

Optimization of the regional inventories is a continuous task for all experts involved. As review results over the years, have already shown, the Belgian greenhouse gas inventory is of good quality. The recommendations formulated in the review reports are yearly taking into account as much as possible by the regional experts to further improve their inventories. So far, the regional experts always did succeed in taken into account these recommendations. The Belgian experts each year list the planned improvements for the different sectors (chapters 3 to 7 in this document). When no unexpected problems occur (mainly cost-related), the Belgian experts include these improvements for the next submission. The Belgian experts have the opinion that this way of treating the recommendations and consequently improve the Belgian greenhouse gas inventory is an effective way to proceed.

Each region contributes to the improvement of the Belgian inventory in the same way, depending on the importance of the improvement in terms of share of emissions and of the available mains in the regions. Improvements detected in one region will always be discussed in the other regions within the CCIEP working group on Emissions to investigate if this proposed improvement can also be part of an improvement and applicable in the other regions.

Besides Belgium is reporting each year about the implementation of recommendations and adjustments in the framework of article 9 of the MMR_IR which obliges that member states shall report on the status of implementation of each recommendation listed in the most recent review report pursuant to article 35(2) in accordance with the tabular format specified in annex IV. This information can be found in annex 3 of the NID.

9.2.1 GHG inventory

Planned improvements are described in the respective chapters (chapter 3 to 7) of the different sectors.

An overview of the planned improvements is listed below per CRT-category:

In general: Planned improvements also will be depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

More specific for the different CRT-categories:

CRT 1A1

Some investigation is going on to improve the emissions of N_2O in the category 1A1a concerning waste incineration (also sludge) with electricity production in the Flemish region. Monitoring is started in this region in the course of 2020, results would become available in the course of 2021.
So far, in the course of 2022 and 2023, only limited results became available, too little to make a more accurate estimation of the emissions during this submission.

Besides a study started in the Flemish region at the end of 2023 to optimize the estimations of emissions in the complete waste sector including all subsectors and thus also including the waste incineration with electricity production (CRT 1A1a). The results obtained of this study will be investigated and included in the greenhouse gas inventory in the future.

CRT 1A3

In Flanders:

- The optimization of the EMMOSS model to calculate emissions from maritime navigation in all ports and in Belgian part of the sea, which started in 2022, is still under revision in 2024. New data will be integrated in the next submission.
- The EMMOSS model that also calculates emissions for ‘national’ navigation will be replaced by a new model (EISS). The methodology and model are currently being developed (revision started in 2022). New data will be integrated in the next submission.
- For domestic aviation, there is a study assignment for updating the calculation tool (EMMOL) and the emissions factors in it in the second half of 2024. It cannot be decided now whether emissions calculated with the updated tool will be included in submission 2025.
- Road transport : updating mileages with data from CarPass[36] and inspection centres.

CRT 2B

Flanders is investigating whether it is possible to make a distinction in allocation of the emissions reported in 2B10 based on the different product processes. Consequently, a part of the emissions that are now allocated to 2B10 Other (chemical industry) could possibly be reallocated to 2B8 (Petrochemical and Carbon Black production) or other categories.

[36] https://www.car-pass.be/en//

CRT 3

3A: In Flanders, at the end of 2018, a Working Group on Emissions was set up to examine (among other things) the possibility to give an evolution in time for some of the parameters needed to obtain a year-dependent IEF for non-dairy cattle. In 2019 a Steering Body 'Convenant Enteric Emissions' was set up by the Flemish Government as well as a Working Group 'Monitoring and assurance (of management and emissions)' which contains experts from different agricultural and environmental domains in Flanders. The goal of the Convenant is to reduce the CH_4-emissions from enteric fermentation (cattle) till 2030. The measures from the Convenant can be implemented on the farm since April 2022. Because the implementation rate was not yet available for the 2024 submission, the corresponding methane reductions could not yet be taken into account. The farmer can choose between several measures as can be found at the following link:
https://www.rundveeloket.be/CEER/maatregelen. At this moment 12 measures are available. They can be divided into 3 groups:

1. Adjustments at the feed ration
2. Farm management focused on longevity and the share of young stock
3. Genetics and selection

(1) use of feed additives by mixing it into the rations: for each measure, a methane reduction percentage was established by scientists. For lactating dairy cattle, nitrate (-10%), 3-NOP (-26%), canola meal (-5%), extruded linseed (-9%), beer draff/rapeseed meal (-8%) and the combination of nitrate-rapeseed meal (-14.5%) and nitrate-extruded linseed (-18.1%) can be used. For beef cattle, nitrate (-8%) can be used. The total methane emission of cattle that received these feed additives will be reduced by the mentioned percentage for the time period that the feed additive was applied.
(2-3) other measures, e.g. to increase longevity, will be reflected in the inventory through effects on animal numbers.

Flanders Environment Agency (VMM) engaged for the monitoring of the CH_4-emissions from the different animal categories (cattle) in Flanders.
In 2021-2023, the CH_4-emission model was revised taking into account the implementation of measures with CH_4-reducing potential and taking into account the before mentioned parameters. In this study not only the methodology for the estimation of CH_4-emissions from enteric fermentation processes was revised. Also, the methodology to calculate CH_4 and N_2O-emissions from manure management and N_2O-emissions from agricultural soils was taken into account. All parameters used (feed intake, digestibility of the feed…) and activity data were reexamined where necessary. Where possible/available an evolution of the parameters in time is given. Further analysis of region specific calculation factors is needed.

Also, the methodology to calculate the NO_x emissions from manure management and agricultural soils is revised. This new integrated model is an extension of the EMAV2.1-model and calculates NH_3- and NO-emissions and therefore follows the N-flow throughout the farm in a more integrated way. The model already foresees in the implementation of the calculation of the greenhouse gases in the future.
The study was performed by ILVO and was commissioned by the VMM. The Steering Body and Working Group replaces the Working Group on Emissions set up in 2018. The kick-off of the Steering Body was given January 18, 2021. This study was not yet finished for the 2024 submission. Because of the postponed delivery of the study, the results of the study have not yet been implemented in a new time series for the emission-inventory in Flanders. Flanders will examine whether implementation in the 2025 submission is possible. In Wallonia and Brussels, it is planned to update the methodology with the IPCC 2019 GL and potentially with the results of the Flemish study.
Small improvements are inherent to the inventory process and occur yearly. Also in 2024 a continuous control/update of the used activity data and parameters will occur where necessary. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3B: In Flanders, at the end of 2018, a Working Group on Emissions was set up to examine (among other things) the possibility to give an evolution in time for some of the parameters needed to obtain a year-dependent IEF for non-dairy cattle. In 2019 a Steering Body 'Convenant Enteric Emissions' was set up by the Flemish Government as well as a Working Group 'Monitoring and assurance (of management and emissions)' which contains experts from different agricultural and environmental domains in Flanders. The goal of the Convenant is to reduce the CH_4-emissions from enteric fermentation (cattle) till 2030. Flanders Environment Agency (VMM) engaged for the monitoring of the CH_4-emissions from the different animal categories (cattle) in Flanders.

Therefore in 2021-2023 the CH_4-emission model was revised taking into account the implementation of measures with CH_4-reducing potential and taking into account the before mentioned parameters. In this study not only the methodology and parameters for the estimation of CH_4-emissions from enteric fermentation processes were revised. Also the methodology and parameters to calculate CH_4- and N_2O-emissions from manure management and N_2O-emissions from agricultural soils were taken into account. All parameters used and activity data were reexamined where necessary. Where possible/available an evolution of the parameters in time is given. Further analysis of region specific calculation factors is needed.

Also, the methodology to calculate the NO_x emissions from manure management and agricultural soils is revised. This new integrated model is an extension of the EMAV2.1-model and calculates NH_3- and NO-emissions and therefore follows the N-flow throughout the farm in a more integrated way. The model already foresees in the implementation of the calculation of the greenhouse gases in the future.
The study was performed by ILVO and was commissioned by the VMM. The Steering Body and Working Group replaces the Working Group on Emissions set up in 2018. The kick-off of the Steering Body was given January 18, 2021. This study was not yet finished for the 2024 submission. Because of the postponed delivery of the study, the results of the study have not yet been implemented in a new time series for the emission-inventory in Flanders. Flanders will examine whether implementation in the 2025 submission is possible.
In Wallonia, the percentage of MMS and the fraction of livestock grazing are still data to update. Work has to be done for next submission. Also, it is foreseen to apply the IPCC 2019 GL methodology for next submission.
In all the three regions, small improvements are inherent to the inventory process and occur yearly. Also, in 2024 a continuous control/update of the used activity data and parameters will occur where necessary. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3D: In Flanders, at the end of 2018, a Working Group on Emissions was set up to examine (among other things) the possibility to give an evolution in time for some of the parameters needed to obtain a year-dependent IEF for non-dairy cattle. In 2019 a Steering Body 'Convenant Enteric Emissions' was set up by the Flemish Government as well as a Working Group 'Monitoring and assurance (of management and emissions)' which contains experts from different agricultural and environmental domains in Flanders. The goal of the Convenant is to reduce the CH_4-emissions from enteric fermentation (cattle) till 2030. Flanders Environment Agency (VMM) engaged for the monitoring of the CH_4-emissions from the different animal categories (cattle) in Flanders. Therefore in 2021-2023 the CH_4-emission model was revised taking into account the implementation of measures with CH_4-reducing potential and taking into account the before mentioned parameters. In this study not only the methodology for the estimation of CH_4-emissions from enteric fermentation processes was revised. Also, the methodology to calculate CH_4 and N_2O-emissions from manure management and N_2O-emissions from agricultural soils was taken into account. All parameters used and activity data were reexamined where necessary. Further analysis of region specific calculation factors is needed.

Also, the methodology to calculate the NOx emissions from manure management and agricultural soils is revised. This new integrated model is an extension of the EMAV2.1-model and calculates NH_3- and NO-emissions and therefore follow the N-flow throughout the farm in an integrated way. The model already foresees in the implementation of the calculation of the greenhouse gases in the future.
The study was performed by ILVO and was commissioned by the VMM. The Steering Body and Working Group replaces the Working Group on Emissions set up in 2018. The kick-off of the Steering Body was given January 18, 2021. This study was not yet finished for the 2024 submission. Because of the postponed delivery of the study, the results of the study have not yet been implemented in a new time series for the emission-inventory in Flanders. Flanders will examine whether implementation in the 2025 submission is possible.
In the 2025 submission, Flanders plans to update the 3D15 data (area coming from the LULUCF matrix) for the whole time series.
Small improvements are inherent to the inventory process and occur yearly. Also, in 2024 a continuous control/update of the used activity data and parameters will occur where necessary. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3G: In the 2025 submission, Flanders plans to update the area coming from the LULUCF matrix for the whole time series.
Small improvements are inherent to the inventory process and occur yearly. Also, in 2024 a continuous control/update of the used activity data and parameters (CH_4 and N_2O) will occur where necessary. No significant improvements are planned at this moment in the category 3G for the next submission. Planned

improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

3H: Small improvements are inherent to the inventory process and occur yearly. Also, in 2024 a continuous control/update of the used activity data and parameters (CH_4 and N_2O) will occur where necessary. No significant improvements are planned at this moment in the category 3H for the next submission. Planned improvements will be also depending on the outcomes of the reviews carried out at the European (EC) and international level (UNFCCC).

CRT 4

Flanders is planning to integrate a new land-use-matrix for the year 2018 and 2021 for the submission of 2025.

The Flemish region is currently setting up a LULUCF-action plan to investigate the challenges in terms of exchanging data and information within the region, to further optimize the emission inventory in this sector as well as tackling the challenges in terms of the implementation of the proposed measures on the terrain.

4A1: In Wallonia, the permanent inventory of forest resources (IPRFW) is carried out in cycles of more or less 10 years. The second phase of this inventory has not yet been completed and only one average value for dead wood is available. As soon as the new values are obtained, it will be possible to define the trend between the two inventory cycles and to provide estimates for dead wood pool.

4E: Belgium will strive, for the next submission, to review each occurrence of changes of land use to 'Settlements' and assign them to one of the subcategories according section 8.3.3.2. (vol.4, Ch.8 of IPCC 2006 guidelines). By following the guidelines, we should be able to provide new estimates of carbon losses in mineral soils and living biomass related to “subcategories” transitions.

CRT 5

In general: Investigations are going on to eventually optimize the estimations of the emissions in all subsectors of the waste sector. A study in this respect started in the Flemish region at the end of 2023. The possible application of the 2019 Refinement to the 2006 IPCC Guidelines will also be investigated during this study. Results will be included in next submissions if relevant.

For CRT-category 5C Incineration and open burning of waste: The UNFCCC expert review team noted in 2021 that the total amounts of waste incinerated sourced from incineration plants and reported in the CRT table 5.C (both biogenic and non-biogenic municipal solid waste, industrial solid waste and clinical waste, but excluding flaring in the chemical industry) (e.g. 44.8 kt for 2018) are much smaller than those of the Eurostat data (e.g. 1753.6 kt for 2018). During the review, Belgium explained that it is very likely that most of the quantities in the Eurostat data cannot be compared with activity data that the Party uses in this category since it is unclear how these Eurostat statistics are produced, including separation of energy recovery in waste incineration. Belgium added that making a robust comparison between these statistics and the CRT figures would require a lot of research.
However, the ERT recommends that Belgium conducts a research on the discrepancy between the amount of waste incinerated Belgium uses for its calculations and the Eurostat data, with the aim to verify the activity data used in category 5.C.1, and report on the results of the research in the NID.
Other reasoning for these differences could be differences in definitions of ‘waste’ between the IPCC guidelines and the Eurostat reporting and different allocations of incineration of waste in the sector categories between the CRT-tables and Eurostat.

The issue could not been resolved yet for the 2024 submission, nevertheless the recommendation has been addressed and regional waste statistics experts have been contacted by the inventory team. Concerning the

Walloon region, it is known that the data reported to Eurostat are overestimated. The only waste incinerated without energy recovery are the animals in the animal incinerators and the waste in the municipal waste incineration plants without energy recovery. Discussions take place among experts to investigate the data in more detail.

10 INFORMATION ON CHANGES IN NATIONAL SYSTEM

The national system in Belgium has been actualized for this submission of March 15th 2024 to the European Commission and later for the submission to the UNFCCC-secretariat.

During the previous actualizations, Belgium did focus mainly on the jurisdiction changes in the Flemish region since January 2021 i.e. Flemish energy balance set up by the new Flemish Agency of Energy and Climate (VEKA) instead of the VITO in the past. At the same time VEKA became responsible for the climate and energy policy in this region (instead of the Department of Environment (AEKG) responsible for climate policy before).

During the submission in 2020 mostly the Brussels region performed some actualization mainly focused on their organization, their accreditation of the ETS-reporting and their approval of the Brussels energy balances.

The actualized NIS of March 2022 included:

The changes in the National System, compared to the 2019 version and regarding the elements described in Annex I of Decision 15/CMP.1 are the following:

Responsible institutes – at regional level: p.2: replacing 'Flemish institute for Technological Research (VITO)' by Flemish Agency for Energy and Climate (VEKA).

2.3.1 Regional responsibilities – The Flemish region: p.9: update of figure 2: Main institutions and organizations involved in the preparation of the Flemish GHG inventory.
3.1.2.4. Regional reporting of ETS data: p.13: update of text below.
3.1.4.1 Other region-specific data sources - The Flemish Region: p.17: small update in text.
3.3.1.1. Data flows - At regional level - The Flemish region: p.25: update of Figure 6 : Information flow between the parties concerned in the preparation of the Flemish GHG and update of text below.
3.4.2.1. Approval and submission procedures - At Regional level - THE FLEMISH REGION: update text.

The actualization of the NIS during the submission of 2024 mainly focus on:

- The passing away from the responsible inventory person of the greenhouse gas inventory in the Walloon region;
- The update of responsible persons of greenhouse gas inventory in the Flemish region
- Overall actualisations of review reports, entering into force of the new Governance Regulation in Europe: *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;*
- Optimization of the time schedule with respect to inventory planning in Belgium.

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ANNEXES

Annex 1: Key sources analysis

Level 1990 (with and without LULUCF)

IPCC source category Submission 2024	Gas	1990 estimate (non-Lulucf)	1990 estimate (Lulucf)	1990 estimate (Absolute value)	level assessment 1990 without LULUCF	Cumulative total without LULUCF	level assessment 1990 with LULUCF	Cumulative total with LULUCF
		Gg CO2eq	Gg CO2eq	Gg CO2eq	%	%	%	%
		145 849	**-2 940**	**149 784**				
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	21 165		21 165	14.51	14.51	14.13	14.13
1.A.3.b. Road Transportation	CO2	19 677		19 677	13.49	28.00	13.14	27.27
1.A.4 Other Sectors - Liquid Fuels	CO2	17 897		17 897	12.27	40.27	11.95	39.22
2.C.1. Iron and Steel Production	CO2	10 048		10 048	6.89	47.16	6.71	45.92
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	7 958.57		7 958.57	5.46	52.62	5.31	51.24
1.A.4 Other Sectors - Gaseous Fuels	CO2	7 865.39		7 865.39	5.39	58.01	5.25	56.49
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	7 846.28		7 846.28	5.38	63.39	5.24	61.73
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	7 396.73		7 396.73	5.07	68.46	4.94	66.67
3.A Enteric Fermentation	CH4	5 326.63		5 326.63	3.65	72.12	3.56	70.22
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	4 952.30		4 952.30	3.40	75.51	3.31	73.53
2.B.9 Fluorochemical Production	Aggregate F-gases	3 568.03		3 568.03	2.45	77.96	2.38	75.91
5.A. Solid Waste Disposal	CH4	3 323.27		3 323.27	2.28	80.24	2.22	78.13
2.B.2 Nitric Acid Production	N2O	3 042.64		3 042.64	2.09	82.32	2.03	80.16
3D1 Direct N2O emissions from managed soils	N2O	2 978.71		2 978.71	2.04	84.36	1.99	82.15
2.A.1 Cement production	CO2	2 823.78		2 823.78	1.94	86.30	1.89	84.03
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2 755.68		2 755.68	1.89	88.19	1.84	85.87
2.A.2 Lime production	CO2	2 097.12		2 097.12	1.44	89.63	1.40	87.27
1.A.4 Other Sectors - Solid Fuels	CO2	2 017.30		2 017.30	1.38	91.01	1.35	88.62
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2		-1 909.52	1 909.52	0.00	91.01	1.27	89.90
2.B.8 Petrochemical and carbon black production	CO2	1 882.42		1 882.42	1.29	92.30	1.26	91.15
4.G Harvest wood products	CO2		-1 516.10	1 516.10	0.00	92.30	1.01	92.16
3.B Manure Management	CH4	1 376.13		1 376.13	0.94	93.25	0.92	93.08
5.D. Wastewater treatment and discharge	CH4	1 041.95		1 041.95	0.71	93.96	0.70	93.78
3D2 Indirect N2O Emissions from managed soils	N2O	965.90		965.90	0.66	94.62	0.64	94.42
3.B Manure Management	N2O	810.08		810.08	0.56	95.18	0.54	94.96
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	794.59		794.59	0.54	95.72	0.53	95.50
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	674.22		674.22	0.46	96.18	0.45	95.95
1.B.1 Fugitive emissions from Solid Fuels	CH4	484.32		484.32	0.33	96.52	0.32	96.27
2.B.1 Ammonia Production	CO2	422.74		422.74	0.29	96.81	0.28	96.55
1.A.3.d. Navigation - Liquid Fuels	CO2	361.87		361.87	0.25	97.05	0.24	96.79
1.A.3.e. Other Transportation	CO2	333.95		333.95	0.23	97.28	0.22	97.02
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	318.00		318.00	0.22	97.50	0.21	97.23
5.C Incineration and Open Burning of Waste	CO2	299.50		299.50	0.21	97.71	0.20	97.43
2.B.10 Other	CO2	285.15		285.15	0.20	97.90	0.19	97.62
2.A.3 Glass production	CO2	262.62		262.62	0.18	98.08	0.18	97.79
1.A.3.c. Railways	CO2	227.07		227.07	0.16	98.24	0.15	97.94
4.B.1. Cropland remaining Cropland CSC	CO2		213.32	213.32	0.00	98.24	0.14	98.09
2.D.1 Lubricant use	CO2	198.92		198.92	0.14	98.37	0.13	98.22
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	186.18		186.18	0.13	98.50	0.12	98.34
2.G. Other Product Manufacture and Use	N2O	179.99		179.99	0.12	98.63	0.12	98.46
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	171.93		171.93	0.12	98.74	0.11	98.58
3G Liming	CO2	162.00		162.00	0.11	98.85	0.11	98.69

1.A.3.b. Road Transportation	CH4	155.96		155.96	0.11	98.96	0.10	98.79
4.E.2. Land converted to Settlements CSC	CO2		143.91	143.91	0.00	98.96	0.10	98.89
1.A.3.b. Road Transportation	N2O	139.61		139.61	0.10	99.06	0.09	98.98
2.A.4 Other process uses of carbonates	CO2	136.30		136.30	0.09	99.15	0.09	99.07
2.G. Other Product Manufacture and Use	Aggregate F-gases	133.18		133.18	0.09	99.24	0.09	99.16
1.A.4 Other Sectors - Solid Fuels	CH4	123.56		123.56	0.08	99.33	0.08	99.24
5.D. Wastewater treatment and discharge	N2O	122.77		122.77	0.08	99.41	0.08	99.33
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N2O	116.31		116.31	0.08	99.49	0.08	99.40
1.A.4 Other Sectors - Biomass	CH4	109.45		109.45	0.08	99.57	0.07	99.48
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CO2	83.83		83.83	0.06	99.62	0.06	99.53
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	53.16		53.16	0.04	99.66	0.04	99.57
4.C.2. Land converted to Grassland CSC	CO2		52.29	52.29	0.00	99.66	0.03	99.60
1.A.4 Other Sectors - Liquid Fuels	N2O	48.16		48.16	0.03	99.69	0.03	99.63
4.B.2. Land converted to Cropland CSC	CO2		41.51	41.51	0.00	99.69	0.03	99.66
1.A.4 Other Sectors - Liquid Fuels	CH4	39.61		39.61	0.03	99.72	0.03	99.69
2.C.7 Other	CO2	36.25		36.25	0.02	99.74	0.02	99.71
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N2O	35.92		35.92	0.02	99.77	0.02	99.74
4.C.1. Grassland remaining Grassland CSC	CO2		29.45	29.45	0.00	99.77	0.02	99.76
1.A.4 Other Sectors - Other Fuels	CO2	29.08		29.08	0.02	99.79	0.02	99.78
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	25.83		25.83	0.02	99.81	0.02	99.79
2.B.10 Other	N2O	24.38		24.38	0.02	99.82	0.02	99.81
1.A.4 Other Sectors - Gaseous Fuels	N2O	22.18		22.18	0.02	99.84	0.01	99.82
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH4	20.73		20.73	0.01	99.85	0.01	99.84
2.B.10 Other	CH4	19.80		19.80	0.01	99.87	0.01	99.85
3H Urea application	CO2	17.02		17.02	0.01	99.88	0.01	99.86
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	16.79		16.79	0.01	99.89	0.01	99.87
2.C.1. Iron and Steel Production	CH4	15.30		15.30	0.01	99.90	0.01	99.88
1.A.3.a Domestic Aviation- Aviation Gasoline	CO2	14.69		14.69	0.01	99.91	0.01	99.89
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	13.19		13.19	0.01	99.92	0.01	99.90
1.B.2.a. Fugitive Emissions from Fuels - Oil	CH4	12.75		12.75	0.01	99.93	0.01	99.91
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	11.63		11.63	0.01	99.94	0.01	99.92
4.A.2. Land converted to Forest Land CSC	CO2		-11.19	11.19	0.00	99.94	0.01	99.93
1.A.4 Other Sectors - Gaseous Fuels	CH4	10.93		10.93	0.01	99.94	0.01	99.93
4.D.2. Land converted to Wetlands CSC	CO2		10.91	10.91	0.00	99.94	0.01	99.94
1.A.3.c. Railways	N2O	10.79		10.79	0.01	99.95	0.01	99.95
2.C.6 Zinc Production	CO2	7.77		7.77	0.01	99.96	0.01	99.95
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	6.83		6.83	0.00	99.96	0.00	99.96
1.A.4 Other Sectors - Biomass	N2O	4.89		4.89	0.00	99.96	0.00	99.96
4(III).Direct N2O emissions from N mineralization/immobilization	N2O		4.83	4.83	0.00	99.96	0.00	99.96
1.A.4 Other Sectors - Solid Fuels	N2O	4.59		4.59	0.00	99.97	0.00	99.97
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N2O	4.31		4.31	0.00	99.97	0.00	99.97
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	N2O	3.81		3.81	0.00	99.97	0.00	99.97
1.A.4 Other Sectors - Other Fuels	CH4	3.68		3.68	0.00	99.98	0.00	99.98
5.B. Biological treatment of solid waste	N2O	3.51		3.51	0.00	99.98	0.00	99.98
1.A.1 Fuel combustion - Energy Industries - Biomass	N2O	3.47		3.47	0.00	99.98	0.00	99.98
1.A.3.a Domestic Aviation- Aviation Gasoline	N2O	3.27		3.27	0.00	99.98	0.00	99.98
2.D.2 Paraffin wax use	CO2	2.95		2.95	0.00	99.98	0.00	99.98
5.B. Biological treatment of solid waste	CH4	2.90		2.90	0.00	99.99	0.00	99.99
1.A.1 Fuel combustion - Energy Industries - Other Fuels	N2O	2.61		2.61	0.00	99.99	0.00	99.99
1.A.3.d. Navigation - Liquid Fuels	N2O	2.56		2.56	0.00	99.99	0.00	99.99
5.C Incineration and Open Burning of Waste	N2O	2.34		2.34	0.00	99.99	0.00	99.99
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH4	1.97		1.97	0.00	99.99	0.00	99.99
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CH4	1.91		1.91	0.00	99.99	0.00	99.99
1.A.3.e. Other Transportation	N2O	1.49		1.49	0.00	100.00	0.00	99.99

1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.49		1.49	0.00	100.00	0.00	100.00
4(IV) Indirect N2O Emissions from Managed Soils	N2O		1.09	1.09	0.00	100.00	0.00	100.00
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CO2	0.73		0.73	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.72		0.72	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH4	0.69		0.69	0.00	100.00	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	CH4	0.56		0.56	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N2O	0.54		0.54	0.00	100.00	0.00	100.00
1.A.4 Other Sectors - Other Fuels	N2O	0.46		0.46	0.00	100.00	0.00	100.00
1.A.3.c. Railways	CH4	0.39		0.39	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation	CH4	0.38		0.38	0.00	100.00	0.00	100.00
1.B.1 Fugitive emissions from Solid Fuels	CO2	0.33		0.33	0.00	100.00	0.00	100.00
4(V) Biomass Burning	CH4		0.14	0.14	0.00	100.00	0.00	100.00
4(V) Biomass Burning	N2O		0.07	0.07	0.00	100.00	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	CH4	0.07		0.07	0.00	100.00	0.00	100.00
2.B.1 Ammonia Production	CH4	0.02		0.02	0.00	100.00	0.00	100.00
1.B.2.a. Fugitive Emissions from Fuels - Oil	CO2	0.01		0.01	0.00	100.00	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.01		0.01	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Biomass	CH4	0.00		0.00	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CH4	0.00		0.00	0.00	100.00	0.00	100.00
5.C Incineration and Open Burning of Waste	CH4	0.00		0.00	0.00	100.00	0.00	100.00
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CH4	0.00		0.00	0.00	100.00	0.00	100.00
2.B.6 Titanium Dioxide Production	CO2	0.00		0.00	0.00	100.00	0.00	100.00
2.D.3 Other urea	CO2	0.00		0.00	0.00	100.00	0.00	100.00
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases	0.00		0.00	0.00	100.00	0.00	100.00
2.F.2. Foam Blowing Agents	Aggregate F-gases	0.00		0.00	0.00	100.00	0.00	100.00
2.F.3. Fire protection	Aggregate F-gases	0.00		0.00	0.00	100.00	0.00	100.00
2.F.4. Aerosols	Aggregate F-gases	0.00		0.00	0.00	100.00	0.00	100.00
2.E. Electronics Industry	Aggregate F-gases	0.00		0.00	0.00	100.00	0.00	100.00
2H. Other	CO2	0.00		0.00	0.00	100.00	0.00	100.00
4.D.1. Wetlands remaining Wetlands CSC	CO2		0.00	0.00	0.00	100.00	0.00	100.00
4.E.1. Settlements remaining settlements CSC	CO2		0.00	0.00	0.00	100.00	0.00	100.00
Key source according level assessment with LuLucf								
Not a key source according level assessment without LuLucf								

Level 2021 (with and without LULUCF)

IPCC source category Submission 2024	Gas	2021 estimate (non-Lulucf)	2021 estimate (Lulucf)	2021 estimate (Absolute value)	level assessment 2021 without LULUCF	Cumulative total without LULUCF	level assessment 2021 with LULUCF	Cumulative total with LULUCF
		Gg CO2eq	Gg CO2eq	Gg CO2eq	%	%	%	%
		110 196	-281	113 934				
1.A.3.b. Road Transportation	CO2	22 712.27		22 712.27	20.61	20.61	19.94	19.94
1.A.4 Other Sectors - Gaseous Fuels	CO2	14 768.32		14 768.32	13.40	34.01	12.96	32.90
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	10 286.11		10 286.11	9.33	43.35	9.03	41.93
1.A.4 Other Sectors - Liquid Fuels	CO2	8 763.30		8 763.30	7.95	51.30	7.69	49.62
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	8 139.36		8 139.36	7.39	58.69	7.14	56.77
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	4 482.97		4 482.97	4.07	62.75	3.94	60.70
3.A Enteric Fermentation	CH4	4 463.92		4 463.92	4.05	66.80	3.92	64.62
2.B.8 Petrochemical and carbon black production	CO2	3 580.56		3 580.56	3.25	70.05	3.14	67.76
2.C.1. Iron and Steel Production	CO2	3 473.55		3 473.55	3.15	73.21	3.05	70.81
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	3 291.29		3 291.29	2.99	76.19	2.89	73.70
2.A.1 Cement production	CO2	2 659.81		2 659.81	2.41	78.61	2.33	76.04
2.B.10 Other	CO2	2 261.40		2 261.40	2.05	80.66	1.99	78.02
3D1 Direct N2O emissions from managed soils	N2O	2 261.33		2 261.33	2.05	82.71	1.98	80.01
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases	2 172.84		2 172.84	1.97	84.68	1.91	81.91
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	2 141.68		2 141.68	1.94	86.63	1.88	83.79
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2		-1 691.67	1 691.67	0.00	86.63	1.48	85.28
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	1 627.82		1 627.82	1.48	88.10	1.43	86.71
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	1 516.35		1 516.35	1.38	89.48	1.33	88.04
3.B Manure Management	CH4	1 321.86		1 321.86	1.20	90.68	1.16	89.20
2.A.2 Lime production	CO2	1 221.97		1 221.97	1.11	91.79	1.07	90.27
2.B.1 Ammonia Production	CO2	996.98		996.98	0.90	92.69	0.88	91.15
3D2 Indirect N2O Emissions from managed soils	N2O	607.21		607.21	0.55	93.24	0.53	91.68
5.A. Solid Waste Disposal	CH4	584.75		584.75	0.53	93.77	0.51	92.19
3.B Manure Management	N2O	569.35		569.35	0.52	94.29	0.50	92.69
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	545.06		545.06	0.49	94.79	0.48	93.17
4.B.2. Land converted to Cropland CSC	CO2		533.43	533.43	0.00	94.79	0.47	93.64
4.E.2. Land converted to Settlements CSC	CO2		511.79	511.79	0.00	94.79	0.45	94.09
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	505.61		505.61	0.46	95.24	0.44	94.53
1.A.3.e. Other Transportation	CO2	421.52		421.52	0.38	95.63	0.37	94.90
1.A.3.d. Navigation - Liquid Fuels	CO2	388.96		388.96	0.35	95.98	0.34	95.24
4.A.2. Land converted to Forest Land CSC	CO2		-302.51	302.51	0.00	95.98	0.27	95.51
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	289.47		289.47	0.26	96.24	0.25	95.76
1.A.4 Other Sectors - Biomass	CH4	283.84		283.84	0.26	96.50	0.25	96.01
2.B.9 Fluorochemical Production	Aggregate F-gases	274.42		274.42	0.25	96.75	0.24	96.25
5.C Incineration and Open Burning of Waste	CO2	263.95		263.95	0.24	96.99	0.23	96.48
5.D. Wastewater treatment and discharge	CH4	255.55		255.55	0.23	97.22	0.22	96.71
2.B.2 Nitric Acid Production	N2O	240.77		240.77	0.22	97.44	0.21	96.92
1.A.3.b. Road Transportation	N2O	222.71		222.71	0.20	97.64	0.20	97.12
4.C.1. Grassland remaining Grassland CSC	CO2		218.37	218.37	0.00	97.64	0.19	97.31
2.A.4 Other process uses of carbonates	CO2	202.07		202.07	0.18	97.82	0.18	97.48
1.A.4 Other Sectors - Gaseous Fuels	CH4	195.09		195.09	0.18	98.00	0.17	97.66
4.G Harvest wood products	CO2		157.08	157.08	0.00	98.00	0.14	97.79
2.A.3 Glass production	CO2	155.78		155.78	0.14	98.14	0.14	97.93
3G Liming	CO2	132.72		132.72	0.12	98.26	0.12	98.05
1.A.4 Other Sectors - Other Fuels	CO2	120.94		120.94	0.11	98.37	0.11	98.15
4.B.1. Cropland remaining Cropland CSC	CO2		114.71	114.71	0.00	98.37	0.10	98.25
5.D. Wastewater treatment and discharge	N2O	105.73		105.73	0.10	98.47	0.09	98.35

1.A.4 Other Sectors - Solid Fuels	CO2	105.52		105.52	0.10	98.57	0.09	98.44
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	98.79		98.79	0.09	98.65	0.09	98.53
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CO2	98.07		98.07	0.09	98.74	0.09	98.61
4(III).Direct N2O emissions from N mineralization/immobilization	N2O		89.09	89.09	0.00	98.74	0.08	98.69
2.G. Other Product Manufacture and Use	Aggregate F-gases	85.72		85.72	0.08	98.82	0.08	98.77
2.C.7 Other	CO2	85.10		85.10	0.08	98.90	0.07	98.84
4.C.2. Land converted to Grassland CSC	CO2		83.64	83.64	0.00	98.90	0.07	98.91
2.D.1 Lubricant use	CO2	73.91		73.91	0.07	98.97	0.06	98.98
1.A.3.c. Railways	CO2	73.54		73.54	0.07	99.03	0.06	99.04
2.B.10 Other	N2O	72.76		72.76	0.07	99.10	0.06	99.11
2.B.6 Titanium Dioxide Production	CO2	65.36		65.36	0.06	99.16	0.06	99.16
3H Urea application	CO2	49.86		49.86	0.05	99.20	0.04	99.21
2.F.2. Foam Blowing Agents	Aggregate F-gases	46.05		46.05	0.04	99.25	0.04	99.25
2.F.4. Aerosols	Aggregate F-gases	45.49		45.49	0.04	99.29	0.04	99.29
1.B.1 Fugitive emissions from Solid Fuels	CH4	44.22		44.22	0.04	99.33	0.04	99.33
2.G. Other Product Manufacture and Use	N2O	44.12		44.12	0.04	99.37	0.04	99.37
1.A.4 Other Sectors - Gaseous Fuels	N2O	42.75		42.75	0.04	99.41	0.04	99.40
2.E. Electronics Industry	Aggregate F-gases	42.41		42.41	0.04	99.44	0.04	99.44
1.A.4 Other Sectors - Liquid Fuels	N2O	41.46		41.46	0.04	99.48	0.04	99.48
1.A.1 Fuel combustion - Energy Industries - Biomass	N2O	37.45		37.45	0.03	99.52	0.03	99.51
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N2O	34.87		34.87	0.03	99.55	0.03	99.54
2.D.3 Other urea	CO2	33.73		33.73	0.03	99.58	0.03	99.57
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	33.05		33.05	0.03	99.61	0.03	99.60
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N2O	32.51		32.51	0.03	99.64	0.03	99.63
5.B. Biological treatment of solid waste	N2O	30.65		30.65	0.03	99.66	0.03	99.65
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	N2O	29.44		29.44	0.03	99.69	0.03	99.68
5.B. Biological treatment of solid waste	CH4	25.30		25.30	0.02	99.71	0.02	99.70
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N2O	23.76		23.76	0.02	99.74	0.02	99.72
1.A.4 Other Sectors - Liquid Fuels	CH4	20.31		20.31	0.02	99.75	0.02	99.74
1.A.3.b. Road Transportation	CH4	20.07		20.07	0.02	99.77	0.02	99.76
4(IV) Indirect N2O Emissions from Managed Soils	N2O		19.88	19.88	0.00	99.77	0.02	99.78
2H. Other	CO2	19.71		19.71	0.02	99.79	0.02	99.79
2.B.10 Other	CH4	17.79		17.79	0.02	99.81	0.02	99.81
1.A.4 Other Sectors - Biomass	N2O	17.64		17.64	0.02	99.82	0.02	99.82
1.A.1 Fuel combustion - Energy Industries - Biomass	CH4	17.46		17.46	0.02	99.84	0.02	99.84
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH4	15.59		15.59	0.01	99.85	0.01	99.85
1.A.4 Other Sectors - Other Fuels	CH4	15.51		15.51	0.01	99.87	0.01	99.87
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	13.88		13.88	0.01	99.88	0.01	99.88
2.D.2 Paraffin wax use	CO2	12.26		12.26	0.01	99.89	0.01	99.89
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	11.01		11.01	0.01	99.90	0.01	99.90
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH4	10.83		10.83	0.01	99.91	0.01	99.91
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	10.48		10.48	0.01	99.92	0.01	99.92
2.F.3. Fire protection	Aggregate F-gases	9.60		9.60	0.01	99.93	0.01	99.93
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CH4	8.77		8.77	0.01	99.94	0.01	99.93
1.A.1 Fuel combustion - Energy Industries - Other Fuels	N2O	8.56		8.56	0.01	99.94	0.01	99.94
1.B.2.a. Fugitive Emissions from Fuels - Oil	CH4	8.08		8.08	0.01	99.95	0.01	99.95
2.C.6 Zinc Production	CO2	7.68		7.68	0.01	99.96	0.01	99.96
1.A.3.a Domestic Aviation- Aviation Gasoline	CO2	7.35		7.35	0.01	99.97	0.01	99.96
1.A.4 Other Sectors - Solid Fuels	CH4	6.09		6.09	0.01	99.97	0.01	99.97
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH4	5.68		5.68	0.01	99.98	0.00	99.97
2.C.1. Iron and Steel Production	CH4	4.36		4.36	0.00	99.98	0.00	99.98
4.D.2. Land converted to Wetlands CSC	CO2		-4.03	4.03	0.00	99.98	0.00	99.98
1.A.3.e. Other Transportation	N2O	3.55		3.55	0.00	99.98	0.00	99.98
1.A.3.d. Navigation - Liquid Fuels	N2O	2.75		2.75	0.00	99.99	0.00	99.99

1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	2.19		2.19	0.00	99.99	0.00	99.99
1.A.3.a Domestic Aviation- Aviation Gasoline	N2O	1.97		1.97	0.00	99.99	0.00	99.99
1.A.4 Other Sectors - Other Fuels	N2O	1.96		1.96	0.00	99.99	0.00	99.99
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	1.94		1.94	0.00	99.99	0.00	99.99
1.A.3.c. Railways	N2O	1.75		1.75	0.00	99.99	0.00	99.99
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CH4	1.74		1.74	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N2O	1.49		1.49	0.00	100.00	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	0.90		0.90	0.00	100.00	0.00	100.00
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CO2	0.46		0.46	0.00	100.00	0.00	100.00
4(V) Biomass Burning	CH4		0.29	0.29	0.00	100.00	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	CH4	0.29		0.29	0.00	100.00	0.00	100.00
1.A.4 Other Sectors - Solid Fuels	N2O	0.28		0.28	0.00	100.00	0.00	100.00
4(V) Biomass Burning	N2O		0.25	0.25	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CH4	0.17		0.17	0.00	100.00	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.17		0.17	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation	CH4	0.14		0.14	0.00	100.00	0.00	100.00
1.A.3.c. Railways	CH4	0.13		0.13	0.00	100.00	0.00	100.00
5.C Incineration and Open Burning of Waste	N2O	0.11		0.11	0.00	100.00	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	CH4	0.04		0.04	0.00	100.00	0.00	100.00
2.B.1 Ammonia Production	CH4	0.02		0.02	0.00	100.00	0.00	100.00
1.B.2.a. Fugitive Emissions from Fuels - Oil	CO2	0.02		0.02	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH4	0.01		0.01	0.00	100.00	0.00	100.00
5.C Incineration and Open Burning of Waste	CH4	0.00		0.00	0.00	100.00	0.00	100.00
1.B.1 Fugitive emissions from Solid Fuels	CO2	0.00		0.00	0.00	100.00	0.00	100.00
4.D.1. Wetlands remaining Wetlands CSC	CO2		0.00	0.00	0.00	100.00	0.00	100.00
4.E.1. Settlements remaining settlements CSC	CO2		0.00	0.00	0.00	100.00	0.00	100.00
Key source according level assessment with LuLucf								
Not a key source according level assessment without LuLucf								

Level 2022 (with and without LULUCF)

IPCC source category Submission 2024	Gas	2022 estimate (non-Lulucf)	2022 estimate (Lulucf)	2022 estimate (Absolute value)	level assessment 2022 without LULUCF	Cumulative total without LULUCF	level assessment 2022 with LULUCF	Cumulative total with LULUCF
		Gg CO2eq	Gg CO2eq	Gg CO2eq	%	%	%	%
		103 576	**-419**	**107 164**				
1.A.3.b. Road Transportation	CO2	22 917.26		22 917.26	22.13	22.13	21.39	21.39
1.A.4 Other Sectors - Gaseous Fuels	CO2	11 863.48		11 863.48	11.45	33.58	11.07	32.46
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	8 725.43		8 725.43	8.42	42.00	8.14	40.60
1.A.4 Other Sectors - Liquid Fuels	CO2	7 809.82		7 809.82	7.54	49.54	7.29	47.89
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	7 456.05		7 456.05	7.20	56.74	6.96	54.85
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	5 218.38		5 218.38	5.04	61.78	4.87	59.72
3.A Enteric Fermentation	CH4	4 442.77		4 442.77	4.29	66.07	4.15	63.86
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	3 675.26		3 675.26	3.55	69.62	3.43	67.29
2.B.8 Petrochemical and carbon black production	CO2	3 575.99		3 575.99	3.45	73.07	3.34	70.63
2.C.1. Iron and Steel Production	CO2	3 416.89		3 416.89	3.30	76.37	3.19	73.82
2.A.1 Cement production	CO2	2 456.03		2 456.03	2.37	78.74	2.29	76.11
3D1 Direct N2O emissions from managed soils	N2O	2 133.59		2 133.59	2.06	80.80	1.99	78.10
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases	2 023.16		2 023.16	1.95	82.75	1.89	79.99
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	2 017.83		2 017.83	1.95	84.70	1.88	81.88
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	1 821.75		1 821.75	1.76	86.46	1.70	83.58
2.B.10 Other	CO2	1 769.66		1 769.66	1.71	88.17	1.65	85.23
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2		-1 679.47	1 679.47	0.00	88.17	1.57	86.79
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	1 317.26		1 317.26	1.27	89.44	1.23	88.02
3.B Manure Management	CH4	1 266.29		1 266.29	1.22	90.66	1.18	89.21
2.A.2 Lime production	CO2	1 115.02		1 115.02	1.08	91.74	1.04	90.25
2.B.1 Ammonia Production	CO2	866.19		866.19	0.84	92.58	0.81	91.05
1.A.3.e. Other Transportation	CO2	584.36		584.36	0.56	93.14	0.55	91.60
3D2 Indirect N2O Emissions from managed soils	N2O	572.05		572.05	0.55	93.69	0.53	92.13
3.B Manure Management	N2O	560.86		560.86	0.54	94.24	0.52	92.66
5.A. Solid Waste Disposal	CH4	556.72		556.72	0.54	94.77	0.52	93.18
4.B.2. Land converted to Cropland CSC	CO2		544.73	544.73	0.00	94.77	0.51	93.69
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	543.98		543.98	0.53	95.30	0.51	94.19
4.E.2. Land converted to Settlements CSC	CO2		515.12	515.12	0.00	95.30	0.48	94.67
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	481.27		481.27	0.46	95.76	0.45	95.12
1.A.3.d. Navigation - Liquid Fuels	CO2	354.79		354.79	0.34	96.11	0.33	95.45
4.A.2. Land converted to Forest Land CSC	CO2		-308.67	308.67	0.00	96.11	0.29	95.74
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	262.51		262.51	0.25	96.36	0.24	95.99
1.A.4 Other Sectors - Biomass	CH4	260.52		260.52	0.25	96.61	0.24	96.23
5.D. Wastewater treatment and discharge	CH4	245.70		245.70	0.24	96.85	0.23	96.46
1.A.3.b. Road Transportation	N2O	220.93		220.93	0.21	97.06	0.21	96.67
5.C Incineration and Open Burning of Waste	CO2	215.86		215.86	0.21	97.27	0.20	96.87
4.C.1. Grassland remaining Grassland CSC	CO2		208.81	208.81	0.00	97.27	0.19	97.06
2.A.4 Other process uses of carbonates	CO2	196.25		196.25	0.19	97.46	0.18	97.24
2.B.2 Nitric Acid Production	N2O	165.25		165.25	0.16	97.62	0.15	97.40
1.A.4 Other Sectors - Gaseous Fuels	CH4	152.92		152.92	0.15	97.77	0.14	97.54
2.B.9 Fluorochemical Production	Aggregate F-gases	150.03		150.03	0.14	97.91	0.14	97.68
2.A.3 Glass production	CO2	148.73		148.73	0.14	98.05	0.14	97.82
3G Liming	CO2	132.60		132.60	0.13	98.18	0.12	97.94
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CO2	110.59		110.59	0.11	98.29	0.10	98.05
4.B.1. Cropland remaining Cropland CSC	CO2		109.40	109.40	0.00	98.29	0.10	98.15
5.D. Wastewater treatment and discharge	N2O	101.90		101.90	0.10	98.39	0.10	98.24
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	96.34		96.34	0.09	98.48	0.09	98.33

1.A.4 Other Sectors - Solid Fuels	CO2	92.72		92.72	0.09	98.57	0.09	98.42
2.B.10 Other	N2O	90.95		90.95	0.09	98.66	0.08	98.51
4(III).Direct N2O emissions from N mineralization/immobilization	N2O		89.96	89.96	0.00	98.66	0.08	98.59
1.A.4 Other Sectors - Other Fuels	CO2	87.52		87.52	0.08	98.74	0.08	98.67
2.G. Other Product Manufacture and Use	Aggregate F-gases	86.85		86.85	0.08	98.83	0.08	98.75
4.C.2. Land converted to Grassland CSC	CO2		85.46	85.46	0.00	98.83	0.08	98.83
2.D.1 Lubricant use	CO2	77.68		77.68	0.08	98.90	0.07	98.91
2.C.7 Other	CO2	76.62		76.62	0.07	98.98	0.07	98.98
1.A.3.c. Railways	CO2	69.50		69.50	0.07	99.04	0.06	99.04
2.F.2. Foam Blowing Agents	Aggregate F-gases	68.64		68.64	0.07	99.11	0.06	99.11
2.B.6 Titanium Dioxide Production	CO2	68.14		68.14	0.07	99.17	0.06	99.17
2.G. Other Product Manufacture and Use	N2O	46.03		46.03	0.04	99.22	0.04	99.21
2.F.4. Aerosols	Aggregate F-gases	45.71		45.71	0.04	99.26	0.04	99.25
1.B.1 Fugitive emissions from Solid Fuels	CH4	43.90		43.90	0.04	99.31	0.04	99.30
2.E. Electronics Industry	Aggregate F-gases	43.82		43.82	0.04	99.35	0.04	99.34
3H Urea application	CO2	40.90		40.90	0.04	99.39	0.04	99.37
1.A.4 Other Sectors - Liquid Fuels	N2O	40.44		40.44	0.04	99.43	0.04	99.41
1.A.1 Fuel combustion - Energy Industries - Biomass	N2O	36.42		36.42	0.04	99.46	0.03	99.45
1.A.4 Other Sectors - Gaseous Fuels	N2O	33.72		33.72	0.03	99.49	0.03	99.48
2.D.3 Other urea	CO2	33.67		33.67	0.03	99.53	0.03	99.51
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N2O	33.32		33.32	0.03	99.56	0.03	99.54
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	N2O	31.87		31.87	0.03	99.59	0.03	99.57
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N2O	31.42		31.42	0.03	99.62	0.03	99.60
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	31.42		31.42	0.03	99.65	0.03	99.63
5.B. Biological treatment of solid waste	N2O	30.40		30.40	0.03	99.68	0.03	99.66
5.B. Biological treatment of solid waste	CH4	25.10		25.10	0.02	99.70	0.02	99.68
2H. Other	CO2	22.63		22.63	0.02	99.73	0.02	99.70
1.A.3.b. Road Transportation	CH4	21.80		21.80	0.02	99.75	0.02	99.72
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N2O	20.54		20.54	0.02	99.77	0.02	99.74
4(IV) Indirect N2O Emissions from Managed Soils	N2O		20.06	20.06	0.00	99.77	0.02	99.76
1.A.4 Other Sectors - Liquid Fuels	CH4	17.77		17.77	0.02	99.78	0.02	99.78
1.A.4 Other Sectors - Biomass	N2O	17.06		17.06	0.02	99.80	0.02	99.79
1.A.1 Fuel combustion - Energy Industries - Biomass	CH4	16.79		16.79	0.02	99.82	0.02	99.81
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH4	16.65		16.65	0.02	99.83	0.02	99.82
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	15.11		15.11	0.01	99.85	0.01	99.84
2.C.1. Iron and Steel Production	CH4	14.44		14.44	0.01	99.86	0.01	99.85
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	13.83		13.83	0.01	99.87	0.01	99.86
2.B.10 Other	CH4	13.14		13.14	0.01	99.89	0.01	99.88
2.D.2 Paraffin wax use	CO2	11.62		11.62	0.01	99.90	0.01	99.89
1.A.4 Other Sectors - Other Fuels	CH4	11.22		11.22	0.01	99.91	0.01	99.90
4.G Harvest wood products	CO2		10.77	10.77	0.00	99.91	0.01	99.91
2.F.3. Fire protection	Aggregate F-gases	10.09		10.09	0.01	99.92	0.01	99.92
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH4	9.90		9.90	0.01	99.93	0.01	99.93
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	8.88		8.88	0.01	99.94	0.01	99.93
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CH4	8.63		8.63	0.01	99.95	0.01	99.94
1.A.1 Fuel combustion - Energy Industries - Other Fuels	N2O	7.59		7.59	0.01	99.95	0.01	99.95
1.B.2.a. Fugitive Emissions from Fuels - Oil	CH4	7.54		7.54	0.01	99.96	0.01	99.96
1.A.3.a Domestic Aviation- Aviation Gasoline	CO2	7.50		7.50	0.01	99.97	0.01	99.96
2.C.6 Zinc Production	CO2	7.27		7.27	0.01	99.97	0.01	99.97
1.A.4 Other Sectors - Solid Fuels	CH4	4.92		4.92	0.00	99.98	0.00	99.98
4.D.2. Land converted to Wetlands CSC	CO2		-4.33	4.33	0.00	99.98	0.00	99.98
1.A.3.e. Other Transportation	N2O	3.63		3.63	0.00	99.98	0.00	99.98
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH4	2.68		2.68	0.00	99.98	0.00	99.99
1.A.3.d. Navigation - Liquid Fuels	N2O	2.52		2.52	0.00	99.99	0.00	99.99

1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	2.21		2.21	0.00	99.99	0.00	99.99
1.A.3.a Domestic Aviation- Aviation Gasoline	N2O	1.99		1.99	0.00	99.99	0.00	99.99
1.A.3.c. Railways	N2O	1.68		1.68	0.00	99.99	0.00	99.99
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N2O	1.66		1.66	0.00	99.99	0.00	99.99
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	1.52		1.52	0.00	100.00	0.00	100.00
1.A.4 Other Sectors - Other Fuels	N2O	1.42		1.42	0.00	100.00	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	0.89		0.89	0.00	100.00	0.00	100.00
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CO2	0.46		0.46	0.00	100.00	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	CH4	0.26		0.26	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation	CH4	0.22		0.22	0.00	100.00	0.00	100.00
1.A.4 Other Sectors - Solid Fuels	N2O	0.22		0.22	0.00	100.00	0.00	100.00
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CH4	0.20		0.20	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CH4	0.14		0.14	0.00	100.00	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.14		0.14	0.00	100.00	0.00	100.00
1.A.3.c. Railways	CH4	0.13		0.13	0.00	100.00	0.00	100.00
5.C Incineration and Open Burning of Waste	N2O	0.08		0.08	0.00	100.00	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	CH4	0.03		0.03	0.00	100.00	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH4	0.02		0.02	0.00	100.00	0.00	100.00
2.B.1 Ammonia Production	CH4	0.02		0.02	0.00	100.00	0.00	100.00
1.B.2.a. Fugitive Emissions from Fuels - Oil	CO2	0.02		0.02	0.00	100.00	0.00	100.00
5.C Incineration and Open Burning of Waste	CH4	0.00		0.00	0.00	100.00	0.00	100.00
4(V) Biomass Burning	CH4		0.00	0.00	0.00	100.00	0.00	100.00
4(V) Biomass Burning	N2O		0.00	0.00	0.00	100.00	0.00	100.00
1.B.1 Fugitive emissions from Solid Fuels	CO2	0.00		0.00	0.00	100.00	0.00	100.00
4.D.1. Wetlands remaining Wetlands CSC	CO2		0.00	0.00	0.00	100.00	0.00	100.00
4.E.1. Settlements remaining settlements CSC	CO2		0.00	0.00	0.00	100.00	0.00	100.00

Key source according level assessment with LuLucf

Not a key source according level assessment without LuLucf

Trend 1990-2021 (with LULUCF)

IPCC source category Submission 2024	Gas	1990 Estimate	2021 Estimate	trend assessment 1990-2021	contribution to trend	cumulative total
		Gg CO_2 eq	Gg CO_2 eq		%	%
		142 909.17	**109 915.24**	**0.973**		
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	21 165.05	4 482.97	0.1395	14.34	14.34
1.A.4 Other Sectors - Gaseous Fuels	CO2	7 865.39	14 768.32	0.1031	10.60	24.94
1.A.3.b. Road Transportation	CO2	19 676.94	22 712.27	0.0896	9.21	34.14
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2 755.68	8 139.36	0.0712	7.32	41.46
1.A.4 Other Sectors - Liquid Fuels	CO2	17 896.75	8 763.30	0.0592	6.08	47.54
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	7 958.57	1 627.82	0.0531	5.46	53.00
2.C.1. Iron and Steel Production	CO2	10 047.90	3 473.55	0.0503	5.17	58.18
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	7 846.28	10 286.11	0.0503	5.17	63.34
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	7 396.73	1 516.35	0.0494	5.07	68.41
2.B.9 Fluorochemical Production	Aggregate F-gases	3 568.03	274.42	0.0292	3.00	71.42
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases	0.00	2 172.84	0.0257	2.64	74.06
2.B.8 Petrochemical and carbon black production	CO2	1 882.42	3 580.56	0.0252	2.59	76.65
2.B.2 Nitric Acid Production	N2O	3 042.64	240.77	0.0248	2.55	79.20
2.B.10 Other	CO2	285.15	2 261.40	0.0242	2.48	81.68
5.A. Solid Waste Disposal	CH4	3 323.27	584.75	0.0233	2.40	84.08
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	674.22	2 141.68	0.0192	1.97	86.05
1.A.4 Other Sectors - Solid Fuels	CO2	2 017.30	105.52	0.0171	1.76	87.81
4.G Harvest wood products	CO2	-1 516.10	157.08	0.0156	1.61	89.42
2.B.1 Ammonia Production	CO2	422.74	996.98	0.0079	0.82	90.23
5.D. Wastewater treatment and discharge	CH4	1 041.95	255.55	0.0065	0.66	90.90
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	4 952.30	3 291.29	0.0061	0.63	91.53
4.B.2. Land converted to Cropland CSC	CO2	41.51	533.43	0.0059	0.61	92.14
2.A.1 Cement production	CO2	2 823.78	2 659.81	0.0058	0.59	92.73
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	186.18	545.06	0.0048	0.49	93.22
4.E.2. Land converted to Settlements CSC	CO2	143.91	511.79	0.0047	0.49	93.71
2.A.2 Lime production	CO2	2 097.12	1 221.97	0.0046	0.48	94.18
3.A Enteric Fermentation	CH4	5 326.63	4 463.92	0.0043	0.45	94.63
1.B.1 Fugitive emissions from Solid Fuels	CH4	484.32	44.22	0.0039	0.40	95.03
4.A.2. Land converted to Forest Land CSC	CO2	-11.19	-302.51	0.0035	0.36	95.38
3.B Manure Management	CH4	1 376.13	1 321.86	0.0031	0.32	95.70
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2	-1 909.52	-1 691.67	0.0026	0.27	95.97
1.A.4 Other Sectors - Biomass	CH4	109.45	283.84	0.0024	0.24	96.22
4.C.1. Grassland remaining Grassland CSC	CO2	29.45	218.37	0.0023	0.24	96.45
1.A.4 Other Sectors - Gaseous Fuels	CH4	10.93	195.09	0.0022	0.23	96.68
1.A.3.e. Other Transportation	CO2	333.95	421.52	0.0019	0.20	96.88
3D2 Indirect N2O Emissions from managed soils	N2O	965.90	607.21	0.0016	0.16	97.05
1.A.3.b. Road Transportation	N2O	139.61	222.71	0.0014	0.14	97.19
1.A.3.d. Navigation - Liquid Fuels	CO2	361.87	388.96	0.0013	0.13	97.32
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	794.59	505.61	0.0012	0.13	97.45
1.A.3.c. Railways	CO2	227.07	73.54	0.0012	0.12	97.57
1.A.3.b. Road Transportation	CH4	155.96	20.07	0.0012	0.12	97.69
1.A.4 Other Sectors - Other Fuels	CO2	29.08	120.94	0.0012	0.12	97.81
2.A.4 Other process uses of carbonates	CO2	136.30	202.07	0.0011	0.12	97.93
2.G. Other Product Manufacture and Use	N2O	179.99	44.12	0.0011	0.11	98.05
1.A.4 Other Sectors - Solid Fuels	CH4	123.56	6.09	0.0011	0.11	98.15

4(III) Direct N2O emissions from N mineralization/immobilization	N2O	4.83	89.09	0.0010	0.10	98.26
2.D.1 Lubricant use	CO2	198.92	73.91	0.0009	0.10	98.35
2.B.6 Titanium Dioxide Production	CO2	0.00	65.36	0.0008	0.08	98.43
2.C.7 Other	CO2	36.25	85.10	0.0007	0.07	98.50
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N2O	116.31	34.87	0.0006	0.07	98.57
2.B.10 Other	N2O	24.38	72.76	0.0006	0.07	98.64
3.B Manure Management	N2O	810.08	569.35	0.0006	0.07	98.70
4.B.1. Cropland remaining Cropland CSC	CO2	213.32	114.71	0.0006	0.06	98.76
2.A.3 Glass production	CO2	262.62	155.78	0.0005	0.06	98.82
2.F.2. Foam Blowing Agents	Aggregate F-gases	0.00	46.05	0.0005	0.06	98.87
2.F.4. Aerosols	Aggregate F-gases	0.00	45.49	0.0005	0.06	98.93
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	318.00	289.47	0.0005	0.05	98.98
4.C.2. Land converted to Grassland CSC	CO2	52.29	83.64	0.0005	0.05	99.04
2.E. Electronics Industry	Aggregate F-gases	0.00	42.41	0.0005	0.05	99.09
3H Urea application	CO2	17.02	49.86	0.0004	0.04	99.13
1.A.1 Fuel combustion - Energy Industries - Biomass	N2O	3.47	37.45	0.0004	0.04	99.17
2.D.3 Other urea	CO2	0.00	33.73	0.0004	0.04	99.22
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CO2	83.83	98.07	0.0004	0.04	99.26
5.C Incineration and Open Burning of Waste	CO2	299.50	263.95	0.0004	0.04	99.30
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	171.93	98.79	0.0004	0.04	99.34
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	53.16	10.48	0.0004	0.04	99.37
3D1 Direct N2O emissions from managed soils	N2O	2 978.71	2 261.33	0.0004	0.04	99.41
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N2O	4.31	32.51	0.0003	0.04	99.45
5.B. Biological treatment of solid waste	N2O	3.51	30.65	0.0003	0.03	99.48
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	6.83	33.05	0.0003	0.03	99.51
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	N2O	3.81	29.44	0.0003	0.03	99.55
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N2O	35.92	1.49	0.0003	0.03	99.58
1.A.4 Other Sectors - Gaseous Fuels	N2O	22.18	42.75	0.0003	0.03	99.61
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N2O	0.54	23.76	0.0003	0.03	99.64
5.B. Biological treatment of solid waste	CH4	2.90	25.30	0.0003	0.03	99.67
2H. Other	CO2	0.00	19.71	0.0002	0.02	99.69
4(IV) Indirect N2O Emissions from Managed Soils	N2O	1.09	19.88	0.0002	0.02	99.71
1.A.1 Fuel combustion - Energy Industries - Biomass	CH4	0.00	17.46	0.0002	0.02	99.73
2.G. Other Product Manufacture and Use	Aggregate F-gases	133.18	85.72	0.0002	0.02	99.75
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.72	15.59	0.0002	0.02	99.77
1.A.4 Other Sectors - Biomass	N2O	4.89	17.64	0.0002	0.02	99.79
1.A.4 Other Sectors - Other Fuels	CH4	3.68	15.51	0.0001	0.02	99.81
4.D.2. Land converted to Wetlands CSC	CO2	10.91	-4.03	0.0001	0.02	99.82
5.D. Wastewater treatment and discharge	N2O	122.77	105.73	0.0001	0.01	99.83
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH4	20.73	5.68	0.0001	0.01	99.85
1.A.4 Other Sectors - Liquid Fuels	CH4	39.61	20.31	0.0001	0.01	99.86
2.D.2 Paraffin wax use	CO2	2.95	12.26	0.0001	0.01	99.87
2.F.3. Fire protection	Aggregate F-gases	0.00	9.60	0.0001	0.01	99.88
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH4	1.97	10.83	0.0001	0.01	99.89
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	13.19	1.94	0.0001	0.01	99.90
3G Liming	CO2	162.00	132.72	0.0001	0.01	99.91
2.C.1. Iron and Steel Production	CH4	15.30	4.36	0.0001	0.01	99.92
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CH4	1.91	8.77	0.0001	0.01	99.93
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	11.63	2.19	0.0001	0.01	99.94
1.A.3.c. Railways	N2O	10.79	1.75	0.0001	0.01	99.95
1.A.1 Fuel combustion - Energy Industries - Other Fuels	N2O	2.61	8.56	0.0001	0.01	99.96

1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	25.83	13.88	0.0001	0.01	99.96
1.A.4 Other Sectors - Liquid Fuels	N2O	48.16	41.46	0.0001	0.01	99.97
1.A.3.a Domestic Aviation- Aviation Gasoline	CO2	14.69	7.35	0.0000	0.00	99.97
1.A.4 Other Sectors - Solid Fuels	N2O	4.59	0.28	0.0000	0.00	99.98
2.B.10 Other	CH4	19.80	17.79	0.0000	0.00	99.98
1.A.3.e. Other Transportation	N2O	1.49	3.55	0.0000	0.00	99.98
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	16.79	11.01	0.0000	0.00	99.99
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CH4	0.00	1.74	0.0000	0.00	99.99
1.B.2.a. Fugitive Emissions from Fuels - Oil	CH4	12.75	8.08	0.0000	0.00	99.99
2.C.6 Zinc Production	CO2	7.77	7.68	0.0000	0.00	99.99
5.C Incineration and Open Burning of Waste	N2O	2.34	0.11	0.0000	0.00	99.99
1.A.4 Other Sectors - Other Fuels	N2O	0.46	1.96	0.0000	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	N2O	2.56	2.75	0.0000	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	N2O	3.27	1.97	0.0000	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH4	0.69	0.01	0.0000	0.00	100.00
1.B.1 Fugitive emissions from Solid Fuels	CO2	0.33	0.00	0.0000	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.49	0.90	0.0000	0.00	100.00
1.A.3.c. Railways	CH4	0.39	0.13	0.0000	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CH4	0.00	0.17	0.0000	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.01	0.17	0.0000	0.00	100.00
1.A.3.e. Other Transportation	CH4	0.38	0.14	0.0000	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	CH4	0.56	0.29	0.0000	0.00	100.00
4(V) Biomass Burning	CH4	0.14	0.29	0.0000	0.00	100.00
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CO2	0.73	0.46	0.0000	0.00	100.00
4(V) Biomass Burning	N2O	0.07	0.25	0.0000	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	CH4	0.07	0.04	0.0000	0.00	100.00
1.B.2.a. Fugitive Emissions from Fuels - Oil	CO2	0.01	0.02	0.0000	0.00	100.00
2.B.1 Ammonia Production	CH4	0.02	0.02	0.0000	0.00	100.00
5.C Incineration and Open Burning of Waste	CH4	0.00	0.00	0.0000	0.00	100.00
4.D.1. Wetlands remaining Wetlands CSC	CO2	0.00	0.00	0.0000	0.00	100.00
4.E.1. Settlements remaining settlements CSC	CO2	0.00	0.00	0.0000	0.00	100.00
TOTAL		**142 909.17**	**109 915.24**			

Trend 1990-2021 (without LULUCF)

IPCC source category Submission 2024	Gas	1990 Estimate	2021 Estimate	trend assessment 1990-2021	contribution to trend	cumulative total
		Gg CO_2 eq	Gg CO_2 eq		%	%
		145 849.07	110 195.86	0.944		
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	21 165.05	4 482.97	0.1382	14.64	14.64
1.A.4 Other Sectors - Gaseous Fuels	CO2	7 865.39	14 768.32	0.1060	11.23	25.86
1.A.3.b. Road Transportation	CO2	19 676.94	22 712.27	0.0942	9.98	35.84
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2 755.68	8 139.36	0.0728	7.70	43.55
1.A.4 Other Sectors - Liquid Fuels	CO2	17 896.75	8 763.30	0.0572	6.05	49.60
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	7 958.57	1 627.82	0.0527	5.58	55.18
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	7 846.28	10 286.11	0.0523	5.54	60.72
2.C.1. Iron and Steel Production	CO2	10 047.90	3 473.55	0.0495	5.24	65.96
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	7 396.73	1 516.35	0.0489	5.18	71.14
2.B.9 Fluorochemical Production	Aggregate F-gases	3 568.03	274.42	0.0291	3.08	74.22
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases	0.00	2 172.84	0.0261	2.76	76.98
2.B.8 Petrochemical and carbon black production	CO2	1 882.42	3 580.56	0.0259	2.75	79.73
2.B.2 Nitric Acid Production	N2O	3 042.64	240.77	0.0247	2.62	82.35
2.B.10 Other	CO2	285.15	2 261.40	0.0246	2.60	84.95
5.A. Solid Waste Disposal	CH4	3 323.27	584.75	0.0231	2.45	87.40
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	674.22	2 141.68	0.0196	2.08	89.48
1.A.4 Other Sectors - Solid Fuels	CO2	2 017.30	105.52	0.0170	1.80	91.28
2.B.1 Ammonia Production	CO2	422.74	996.98	0.0081	0.86	92.14
5.D. Wastewater treatment and discharge	CH4	1 041.95	255.55	0.0064	0.68	92.82
2.A.1 Cement production	CO2	2 823.78	2 659.81	0.0063	0.67	93.49
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	4 952.30	3 291.29	0.0054	0.57	94.06
3.A Enteric Fermentation	CH4	5 326.63	4 463.92	0.0053	0.56	94.62
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	186.18	545.06	0.0049	0.51	95.13
2.A.2 Lime production	CO2	2 097.12	1 221.97	0.0044	0.46	95.60
1.B.1 Fugitive emissions from Solid Fuels	CH4	484.32	44.22	0.0039	0.41	96.00
3.B Manure Management	CH4	1 376.13	1 321.86	0.0034	0.36	96.36
1.A.4 Other Sectors - Biomass	CH4	109.45	283.84	0.0024	0.26	96.62
1.A.4 Other Sectors - Gaseous Fuels	CH4	10.93	195.09	0.0022	0.24	96.86
1.A.3.e. Other Transportation	CO2	333.95	421.52	0.0020	0.22	97.07
3D2 Indirect N2O Emissions from managed soils	N2O	965.90	607.21	0.0015	0.16	97.23
1.A.3.b. Road Transportation	N2O	139.61	222.71	0.0014	0.15	97.38
1.A.3.d. Navigation - Liquid Fuels	CO2	361.87	388.96	0.0014	0.15	97.52
2.A.4 Other process uses of carbonates	CO2	136.30	202.07	0.0012	0.13	97.65
1.A.4 Other Sectors - Other Fuels	CO2	29.08	120.94	0.0012	0.13	97.78
1.A.3.c. Railways	CO2	227.07	73.54	0.0012	0.12	97.90
1.A.3.b. Road Transportation	CH4	155.96	20.07	0.0012	0.12	98.03
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	794.59	505.61	0.0011	0.12	98.15
2.G. Other Product Manufacture and Use	N2O	179.99	44.12	0.0011	0.12	98.26
1.A.4 Other Sectors - Solid Fuels	CH4	123.56	6.09	0.0010	0.11	98.37
2.D.1 Lubricant use	CO2	198.92	73.91	0.0009	0.10	98.47
2.B.6 Titanium Dioxide Production	CO2	0.00	65.36	0.0008	0.08	98.55
2.C.7 Other	CO2	36.25	85.10	0.0007	0.07	98.63
2.B.10 Other	N2O	24.38	72.76	0.0007	0.07	98.70
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N2O	116.31	34.87	0.0006	0.07	98.76
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	318.00	289.47	0.0006	0.06	98.83

2.F.2. Foam Blowing Agents	Aggregate F-gases	0.00	46.05	0.0006	0.06	98.89
2.F.4. Aerosols	Aggregate F-gases	0.00	45.49	0.0005	0.06	98.94
3.B Manure Management	N2O	810.08	569.35	0.0005	0.05	99.00
2.A.3 Glass production	CO2	262.62	155.78	0.0005	0.05	99.05
2.E. Electronics Industry	Aggregate F-gases	0.00	42.41	0.0005	0.05	99.11
5.C Incineration and Open Burning of Waste	CO2	299.50	263.95	0.0005	0.05	99.15
3H Urea application	CO2	17.02	49.86	0.0004	0.05	99.20
1.A.1 Fuel combustion - Energy Industries - Biomass	N2O	3.47	37.45	0.0004	0.04	99.24
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CO2	83.83	98.07	0.0004	0.04	99.29
2.D.3 Other urea	CO2	0.00	33.73	0.0004	0.04	99.33
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	171.93	98.79	0.0004	0.04	99.37
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	53.16	10.48	0.0004	0.04	99.41
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N2O	4.31	32.51	0.0004	0.04	99.45
5.B. Biological treatment of solid waste	N2O	3.51	30.65	0.0003	0.04	99.48
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	6.83	33.05	0.0003	0.04	99.52
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	N2O	3.81	29.44	0.0003	0.03	99.55
1.A.4 Other Sectors - Gaseous Fuels	N2O	22.18	42.75	0.0003	0.03	99.58
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N2O	35.92	1.49	0.0003	0.03	99.62
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N2O	0.54	23.76	0.0003	0.03	99.65
5.B. Biological treatment of solid waste	CH4	2.90	25.30	0.0003	0.03	99.68
2H. Other	CO2	0.00	19.71	0.0002	0.03	99.70
1.A.1 Fuel combustion - Energy Industries - Biomass	CH4	0.00	17.46	0.0002	0.02	99.72
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.72	15.59	0.0002	0.02	99.74
2.G. Other Product Manufacture and Use	Aggregate F-gases	133.18	85.72	0.0002	0.02	99.76
1.A.4 Other Sectors - Biomass	N2O	4.89	17.64	0.0002	0.02	99.78
5.D. Wastewater treatment and discharge	N2O	122.77	105.73	0.0002	0.02	99.80
1.A.4 Other Sectors - Other Fuels	CH4	3.68	15.51	0.0002	0.02	99.81
3D1 Direct N2O emissions from managed soils	N2O	2 978.71	2 261.33	0.0001	0.01	99.83
3G Liming	CO2	162.00	132.72	0.0001	0.01	99.84
2.D.2 Paraffin wax use	CO2	2.95	12.26	0.0001	0.01	99.85
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH4	20.73	5.68	0.0001	0.01	99.86
1.A.4 Other Sectors - Liquid Fuels	CH4	39.61	20.31	0.0001	0.01	99.88
2.F.3. Fire protection	Aggregate F-gases	0.00	9.60	0.0001	0.01	99.89
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH4	1.97	10.83	0.0001	0.01	99.90
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	13.19	1.94	0.0001	0.01	99.91
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CH4	1.91	8.77	0.0001	0.01	99.92
2.C.1. Iron and Steel Production	CH4	15.30	4.36	0.0001	0.01	99.93
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	11.63	2.19	0.0001	0.01	99.94
1.A.1 Fuel combustion - Energy Industries - Other Fuels	N2O	2.61	8.56	0.0001	0.01	99.95
1.A.3.c. Railways	N2O	10.79	1.75	0.0001	0.01	99.95
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	25.83	13.88	0.0001	0.01	99.96
1.A.4 Other Sectors - Liquid Fuels	N2O	48.16	41.46	0.0001	0.01	99.97
1.A.3.a Domestic Aviation- Aviation Gasoline	CO2	14.69	7.35	0.0000	0.00	99.97
1.A.4 Other Sectors - Solid Fuels	N2O	4.59	0.28	0.0000	0.00	99.98
2.B.10 Other	CH4	19.80	17.79	0.0000	0.00	99.98
1.A.3.e. Other Transportation	N2O	1.49	3.55	0.0000	0.00	99.98
2.C.6 Zinc Production	CO2	7.77	7.68	0.0000	0.00	99.99
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CH4	0.00	1.74	0.0000	0.00	99.99
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	16.79	11.01	0.0000	0.00	99.99
5.C Incineration and Open Burning of Waste	N2O	2.34	0.11	0.0000	0.00	99.99
1.A.4 Other Sectors - Other Fuels	N2O	0.46	1.96	0.0000	0.00	99.99

1.B.2.a. Fugitive Emissions from Fuels - Oil	CH4	12.75	8.08	0.0000	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	N2O	2.56	2.75	0.0000	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH4	0.69	0.01	0.0000	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	N2O	3.27	1.97	0.0000	0.00	100.00
1.B.1 Fugitive emissions from Solid Fuels	CO2	0.33	0.00	0.0000	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.49	0.90	0.0000	0.00	100.00
1.A.3.c. Railways	CH4	0.39	0.13	0.0000	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CH4	0.00	0.17	0.0000	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.01	0.17	0.0000	0.00	100.00
1.A.3.e. Other Transportation	CH4	0.38	0.14	0.0000	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	CH4	0.56	0.29	0.0000	0.00	100.00
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CO2	0.73	0.46	0.0000	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	CH4	0.07	0.04	0.0000	0.00	100.00
1.B.2.a. Fugitive Emissions from Fuels - Oil	CO2	0.01	0.02	0.0000	0.00	100.00
2.B.1 Ammonia Production	CH4	0.02	0.02	0.0000	0.00	100.00
5.C Incineration and Open Burning of Waste	CH4	0.00	0.00	0.0000	0.00	100.00
TOTAL		**145 849.07**	**110 195.86**			

Trend 1990-2022 (with LULUCF)

IPCC source category Submission 2024	Gas	1990 Estimate	2022 Estimate	trend assessment 1990-2022	contribution to trend	cumulative total
		Gg CO_2 eq	Gg CO_2 eq		%	%
		142 909.17	**103 157.14**	**1.005**		
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	21 165.05	5 218.38	0.1351	13.44	13.44
1.A.3.b. Road Transportation	CO2	19 676.94	22 917.26	0.1170	11.64	25.09
1.A.4 Other Sectors - Gaseous Fuels	CO2	7 865.39	11 863.48	0.0830	8.27	33.35
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2 755.68	7 456.05	0.0734	7.31	40.66
1.A.4 Other Sectors - Liquid Fuels	CO2	17 896.75	7 809.82	0.0686	6.83	47.49
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	7 396.73	1 317.26	0.0540	5.38	52.86
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	7 958.57	1 821.75	0.0527	5.24	58.10
2.C.1. Iron and Steel Production	CO2	10 047.90	3 416.89	0.0515	5.13	63.23
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	7 846.28	8 725.43	0.0411	4.09	67.32
2.B.9 Fluorochemical Production	Aggregate F-gases	3 568.03	150.03	0.0326	3.24	70.56
2.B.8 Petrochemical and carbon black production	CO2	1 882.42	3 575.99	0.0298	2.96	73.53
2.B.2 Nitric Acid Production	N2O	3 042.64	165.25	0.0273	2.71	76.24
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases	0.00	2 023.16	0.0272	2.70	78.94
5.A. Solid Waste Disposal	CH4	3 323.27	556.72	0.0247	2.46	81.41
2.B.10 Other	CO2	285.15	1 769.66	0.0210	2.09	83.49
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	674.22	2 017.83	0.0206	2.05	85.54
1.A.4 Other Sectors - Solid Fuels	CO2	2 017.30	92.72	0.0183	1.82	87.36
4.G Harvest wood products	CO2	-1 516.10	10.77	0.0148	1.48	88.84
3.A Enteric Fermentation	CH4	5 326.63	4 442.77	0.0080	0.80	89.64
2.B.1 Ammonia Production	CO2	422.74	866.19	0.0075	0.75	90.39
4.B.2. Land converted to Cropland CSC	CO2	41.51	544.73	0.0069	0.69	91.08
5.D. Wastewater treatment and discharge	CH4	1 041.95	245.70	0.0068	0.68	91.75
2.A.1 Cement production	CO2	2 823.78	2 456.03	0.0056	0.56	92.31
4.E.2. Land converted to Settlements CSC	CO2	143.91	515.12	0.0055	0.55	92.86
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	186.18	543.98	0.0055	0.55	93.41
2.A.2 Lime production	CO2	2 097.12	1 115.02	0.0054	0.53	93.94
1.A.3.e. Other Transportation	CO2	333.95	584.36	0.0046	0.46	94.40
1.B.1 Fugitive emissions from Solid Fuels	CH4	484.32	43.90	0.0041	0.41	94.81
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2	-1 909.52	-1 679.47	0.0040	0.40	95.21
4.A.2. Land converted to Forest Land CSC	CO2	-11.19	-308.67	0.0040	0.40	95.61
3.B Manure Management	CH4	1 376.13	1 266.29	0.0037	0.36	95.98
4.C.1. Grassland remaining Grassland CSC	CO2	29.45	208.81	0.0025	0.25	96.23
1.A.4 Other Sectors - Biomass	CH4	109.45	260.52	0.0024	0.24	96.47
1.A.4 Other Sectors - Gaseous Fuels	CH4	10.93	152.92	0.0019	0.19	96.66
3D2 Indirect N2O Emissions from managed soils	N2O	965.90	572.05	0.0017	0.17	96.83
1.A.3.b. Road Transportation	N2O	139.61	220.93	0.0016	0.16	96.99
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	4 952.30	3 675.26	0.0013	0.13	97.12
2.A.4 Other process uses of carbonates	CO2	136.30	196.25	0.0013	0.13	97.26
1.A.3.c. Railways	CO2	227.07	69.50	0.0013	0.13	97.38
1.A.3.d. Navigation - Liquid Fuels	CO2	361.87	354.79	0.0013	0.13	97.51
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	794.59	481.27	0.0012	0.12	97.63
1.A.3.b. Road Transportation	CH4	155.96	21.80	0.0012	0.12	97.75
4(III) Direct N2O emissions from N mineralization/immobilization	N2O	4.83	89.96	0.0012	0.12	97.87
1.A.4 Other Sectors - Solid Fuels	CH4	123.56	4.92	0.0011	0.11	97.98
2.G. Other Product Manufacture and Use	N2O	179.99	46.03	0.0011	0.11	98.09

2.B.10 Other	N2O	24.38	90.95	0.0010	0.10	98.19
2.F.2. Foam Blowing Agents	Aggregate F-gases	0.00	68.64	0.0009	0.09	98.28
2.B.6 Titanium Dioxide Production	CO2	0.00	68.14	0.0009	0.09	98.37
1.A.4 Other Sectors - Other Fuels	CO2	29.08	87.52	0.0009	0.09	98.46
2.D.1 Lubricant use	CO2	198.92	77.68	0.0009	0.09	98.55
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N2O	116.31	20.54	0.0009	0.08	98.63
2.C.7 Other	CO2	36.25	76.62	0.0007	0.07	98.70
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CO2	83.83	110.59	0.0007	0.07	98.77
4.C.2. Land converted to Grassland CSC	CO2	52.29	85.46	0.0006	0.06	98.83
2.F.4. Aerosols	Aggregate F-gases	0.00	45.71	0.0006	0.06	98.89
4.B.1. Cropland remaining Cropland CSC	CO2	213.32	109.40	0.0006	0.06	98.95
2.E. Electronics Industry	Aggregate F-gases	0.00	43.82	0.0006	0.06	99.01
2.A.3 Glass production	CO2	262.62	148.73	0.0005	0.05	99.07
1.A.1 Fuel combustion - Energy Industries - Biomass	N2O	3.47	36.42	0.0005	0.05	99.11
2.D.3 Other urea	CO2	0.00	33.67	0.0005	0.04	99.16
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	318.00	262.51	0.0004	0.04	99.20
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N2O	0.54	31.42	0.0004	0.04	99.24
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N2O	4.31	33.32	0.0004	0.04	99.28
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	N2O	3.81	31.87	0.0004	0.04	99.32
3H Urea application	CO2	17.02	40.90	0.0004	0.04	99.36
5.B. Biological treatment of solid waste	N2O	3.51	30.40	0.0004	0.04	99.40
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	171.93	96.34	0.0004	0.04	99.43
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	6.83	31.42	0.0004	0.04	99.47
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N2O	35.92	1.66	0.0003	0.03	99.50
3.B Manure Management	N2O	810.08	560.86	0.0003	0.03	99.53
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	53.16	15.11	0.0003	0.03	99.56
5.B. Biological treatment of solid waste	CH4	2.90	25.10	0.0003	0.03	99.60
2H. Other	CO2	0.00	22.63	0.0003	0.03	99.63
4(IV) Indirect N2O Emissions from Managed Soils	N2O	1.09	20.06	0.0003	0.03	99.65
1.A.4 Other Sectors - Gaseous Fuels	N2O	22.18	33.72	0.0002	0.02	99.68
1.A.1 Fuel combustion - Energy Industries - Biomass	CH4	0.00	16.79	0.0002	0.02	99.70
3D1 Direct N2O emissions from managed soils	N2O	2 978.71	2 133.59	0.0002	0.02	99.72
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.72	16.65	0.0002	0.02	99.74
3G Liming	CO2	162.00	132.60	0.0002	0.02	99.76
1.A.4 Other Sectors - Biomass	N2O	4.89	17.06	0.0002	0.02	99.78
5.D. Wastewater treatment and discharge	N2O	122.77	101.90	0.0002	0.02	99.80
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH4	20.73	2.68	0.0002	0.02	99.81
4.D.2. Land converted to Wetlands CSC	CO2	10.91	-4.33	0.0002	0.02	99.83
1.A.4 Other Sectors - Liquid Fuels	CH4	39.61	17.77	0.0001	0.01	99.85
2.F.3. Fire protection	Aggregate F-gases	0.00	10.09	0.0001	0.01	99.86
2.D.2 Paraffin wax use	CO2	2.95	11.62	0.0001	0.01	99.87
2.G. Other Product Manufacture and Use	Aggregate F-gases	133.18	86.85	0.0001	0.01	99.88
1.A.4 Other Sectors - Other Fuels	CH4	3.68	11.22	0.0001	0.01	99.90
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH4	1.97	9.90	0.0001	0.01	99.91
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	13.19	1.52	0.0001	0.01	99.92
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CH4	1.91	8.63	0.0001	0.01	99.93
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	11.63	2.21	0.0001	0.01	99.94
1.A.3.c. Railways	N2O	10.79	1.68	0.0001	0.01	99.94
1.A.1 Fuel combustion - Energy Industries - Other Fuels	N2O	2.61	7.59	0.0001	0.01	99.95
1.A.4 Other Sectors - Liquid Fuels	N2O	48.16	40.44	0.0001	0.01	99.96
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	25.83	13.83	0.0001	0.01	99.97

2.C.1. Iron and Steel Production	CH4	15.30	14.44	0.0000	0.00	99.97
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	16.79	8.88	0.0000	0.00	99.97
1.A.3.a Domestic Aviation- Aviation Gasoline	CO2	14.69	7.50	0.0000	0.00	99.98
1.A.4 Other Sectors - Solid Fuels	N2O	4.59	0.22	0.0000	0.00	99.98
1.A.3.e. Other Transportation	N2O	1.49	3.63	0.0000	0.00	99.99
1.B.2.a. Fugitive Emissions from Fuels - Oil	CH4	12.75	7.54	0.0000	0.00	99.99
2.C.6 Zinc Production	CO2	7.77	7.27	0.0000	0.00	99.99
5.C Incineration and Open Burning of Waste	N2O	2.34	0.08	0.0000	0.00	99.99
2.B.10 Other	CH4	19.80	13.14	0.0000	0.00	99.99
1.A.4 Other Sectors - Other Fuels	N2O	0.46	1.42	0.0000	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	N2O	2.56	2.52	0.0000	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH4	0.69	0.02	0.0000	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	N2O	3.27	1.99	0.0000	0.00	100.00
5.C Incineration and Open Burning of Waste	CO2	299.50	215.86	0.0000	0.00	100.00
1.B.1 Fugitive emissions from Solid Fuels	CO2	0.33	0.00	0.0000	0.00	100.00
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CH4	0.00	0.20	0.0000	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.49	0.89	0.0000	0.00	100.00
1.A.3.c. Railways	CH4	0.39	0.13	0.0000	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	CH4	0.56	0.26	0.0000	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CH4	0.00	0.14	0.0000	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.01	0.14	0.0000	0.00	100.00
4(V) Biomass Burning	CH4	0.14	0.00	0.0000	0.00	100.00
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CO2	0.73	0.46	0.0000	0.00	100.00
1.A.3.e. Other Transportation	CH4	0.38	0.22	0.0000	0.00	100.00
4(V) Biomass Burning	N2O	0.07	0.00	0.0000	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	CH4	0.07	0.03	0.0000	0.00	100.00
1.B.2.a. Fugitive Emissions from Fuels - Oil	CO2	0.01	0.02	0.0000	0.00	100.00
2.B.1 Ammonia Production	CH4	0.02	0.02	0.0000	0.00	100.00
4.D.1. Wetlands remaining Wetlands CSC	CO2	0.00	0.00	0.0000	0.00	100.00
4.E.1. Settlements remaining settlements CSC	CO2	0.00	0.00	0.0000	0.00	100.00
5.C Incineration and Open Burning of Waste	CH4	0.00	0.00	0.0000	0.00	100.00
TOTAL		**142 909.17**	**103 157.14**			

Trend 1990-2022 (without LULUCF)

IPCC source category Submission 2024	Gas	1990 Estimate	2022 Estimate	trend assessment 1990-2022	contribution to trend	cumulative total
		Gg CO_2 eq	Gg CO_2 eq		%	%
		145 849.07	**103 576.13**	**0.972**		
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO2	21 165.05	5 218.38	0.1334	13.72	13.72
1.A.3.b. Road Transportation	CO2	19 676.94	22 917.26	0.1216	12.51	26.23
1.A.4 Other Sectors - Gaseous Fuels	CO2	7 865.39	11 863.48	0.0853	8.78	35.01
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO2	2 755.68	7 456.05	0.0748	7.69	42.70
1.A.4 Other Sectors - Liquid Fuels	CO2	17 896.75	7 809.82	0.0666	6.85	49.56
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO2	7 396.73	1 317.26	0.0535	5.50	55.06
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO2	7 958.57	1 821.75	0.0521	5.36	60.42
2.C.1. Iron and Steel Production	CO2	10 047.90	3 416.89	0.0506	5.20	65.62
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO2	7 846.28	8 725.43	0.0429	4.41	70.03
2.B.9 Fluorochemical Production	Aggregate F-gases	3 568.03	150.03	0.0324	3.33	73.36
2.B.8 Petrochemical and carbon black production	CO2	1 882.42	3 575.99	0.0304	3.13	76.50
2.F.1. Refrigeration and Air Conditioning	Aggregate F-gases	0.00	2 023.16	0.0275	2.83	79.33
2.B.2 Nitric Acid Production	N2O	3 042.64	165.25	0.0271	2.79	82.12
5.A. Solid Waste Disposal	CH4	3 323.27	556.72	0.0245	2.52	84.64
2.B.10 Other	CO2	285.15	1 769.66	0.0213	2.19	86.83
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CO2	674.22	2 017.83	0.0209	2.15	88.98
1.A.4 Other Sectors - Solid Fuels	CO2	2 017.30	92.72	0.0182	1.87	90.86
3.A Enteric Fermentation	CH4	5 326.63	4 442.77	0.0090	0.92	91.78
2.B.1 Ammonia Production	CO2	422.74	866.19	0.0077	0.79	92.57
5.D. Wastewater treatment and discharge	CH4	1 041.95	245.70	0.0067	0.69	93.26
2.A.1 Cement production	CO2	2 823.78	2 456.03	0.0061	0.63	93.89
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CO2	186.18	543.98	0.0056	0.58	94.47
2.A.2 Lime production	CO2	2 097.12	1 115.02	0.0051	0.52	94.99
1.A.3.e. Other Transportation	CO2	333.95	584.36	0.0047	0.49	95.48
1.B.1 Fugitive emissions from Solid Fuels	CH4	484.32	43.90	0.0041	0.42	95.90
3.B Manure Management	CH4	1 376.13	1 266.29	0.0039	0.40	96.30
1.A.4 Other Sectors - Biomass	CH4	109.45	260.52	0.0025	0.26	96.56
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO2	4 952.30	3 675.26	0.0022	0.22	96.78
1.A.4 Other Sectors - Gaseous Fuels	CH4	10.93	152.92	0.0020	0.20	96.98
1.A.3.b. Road Transportation	N2O	139.61	220.93	0.0017	0.17	97.15
3D2 Indirect N2O Emissions from managed soils	N2O	965.90	572.05	0.0015	0.16	97.31
2.A.4 Other process uses of carbonates	CO2	136.30	196.25	0.0014	0.14	97.45
1.A.3.d. Navigation - Liquid Fuels	CO2	361.87	354.79	0.0013	0.14	97.59
1.A.3.c. Railways	CO2	227.07	69.50	0.0012	0.13	97.72
1.A.3.b. Road Transportation	CH4	155.96	21.80	0.0012	0.12	97.84
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CH4	794.59	481.27	0.0011	0.12	97.96
1.A.4 Other Sectors - Solid Fuels	CH4	123.56	4.92	0.0011	0.12	98.07
2.G. Other Product Manufacture and Use	N2O	179.99	46.03	0.0011	0.11	98.19
2.B.10 Other	N2O	24.38	90.95	0.0010	0.10	98.29
2.F.2. Foam Blowing Agents	Aggregate F-gases	0.00	68.64	0.0009	0.10	98.39
2.B.6 Titanium Dioxide Production	CO2	0.00	68.14	0.0009	0.10	98.48
1.A.4 Other Sectors - Other Fuels	CO2	29.08	87.52	0.0009	0.09	98.58
2.D.1 Lubricant use	CO2	198.92	77.68	0.0009	0.09	98.66
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N2O	116.31	20.54	0.0008	0.09	98.75
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CO2	83.83	110.59	0.0007	0.07	98.82

2.C.7 Other	CO2	36.25	76.62	0.0007	0.07	98.89
2.F.4. Aerosols	Aggregate F-gases	0.00	45.71	0.0006	0.06	98.96
2.E. Electronics Industry	Aggregate F-gases	0.00	43.82	0.0006	0.06	99.02
2.A.3 Glass production	CO2	262.62	148.73	0.0005	0.05	99.07
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	318.00	262.51	0.0005	0.05	99.12
1.A.1 Fuel combustion - Energy Industries - Biomass	N2O	3.47	36.42	0.0005	0.05	99.17
2.D.3 Other urea	CO2	0.00	33.67	0.0005	0.05	99.22
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N2O	0.54	31.42	0.0004	0.04	99.26
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N2O	4.31	33.32	0.0004	0.04	99.30
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	N2O	3.81	31.87	0.0004	0.04	99.34
3H Urea application	CO2	17.02	40.90	0.0004	0.04	99.38
5.B. Biological treatment of solid waste	N2O	3.51	30.40	0.0004	0.04	99.42
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH4	6.83	31.42	0.0004	0.04	99.46
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	171.93	96.34	0.0004	0.04	99.50
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N2O	35.92	1.66	0.0003	0.03	99.53
5.B. Biological treatment of solid waste	CH4	2.90	25.10	0.0003	0.03	99.56
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N2O	53.16	15.11	0.0003	0.03	99.59
2H. Other	CO2	0.00	22.63	0.0003	0.03	99.63
3D1 Direct N2O emissions from managed soils	N2O	2 978.71	2 133.59	0.0002	0.03	99.65
1.A.4 Other Sectors - Gaseous Fuels	N2O	22.18	33.72	0.0002	0.03	99.68
3G Liming	CO2	162.00	132.60	0.0002	0.02	99.70
1.A.1 Fuel combustion - Energy Industries - Biomass	CH4	0.00	16.79	0.0002	0.02	99.72
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH4	0.72	16.65	0.0002	0.02	99.75
5.D. Wastewater treatment and discharge	N2O	122.77	101.90	0.0002	0.02	99.77
3.B Manure Management	N2O	810.08	560.86	0.0002	0.02	99.79
1.A.4 Other Sectors - Biomass	N2O	4.89	17.06	0.0002	0.02	99.81
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH4	20.73	2.68	0.0002	0.02	99.82
1.A.4 Other Sectors - Liquid Fuels	CH4	39.61	17.77	0.0001	0.01	99.84
2.F.3. Fire protection	Aggregate F-gases	0.00	10.09	0.0001	0.01	99.85
2.D.2 Paraffin wax use	CO2	2.95	11.62	0.0001	0.01	99.87
1.A.4 Other Sectors - Other Fuels	CH4	3.68	11.22	0.0001	0.01	99.88
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH4	1.97	9.90	0.0001	0.01	99.89
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH4	13.19	1.52	0.0001	0.01	99.90
2.G. Other Product Manufacture and Use	Aggregate F-gases	133.18	86.85	0.0001	0.01	99.91
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other fuels	CH4	1.91	8.63	0.0001	0.01	99.92
1.A.4 Other Sectors - Liquid Fuels	N2O	48.16	40.44	0.0001	0.01	99.93
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH4	11.63	2.21	0.0001	0.01	99.94
1.A.3.c. Railways	N2O	10.79	1.68	0.0001	0.01	99.95
1.A.1 Fuel combustion - Energy Industries - Other Fuels	N2O	2.61	7.59	0.0001	0.01	99.95
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N2O	25.83	13.83	0.0001	0.01	99.96
2.C.1. Iron and Steel Production	CH4	15.30	14.44	0.0000	0.00	99.97
5.C Incineration and Open Burning of Waste	CO2	299.50	215.86	0.0000	0.00	99.97
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N2O	16.79	8.88	0.0000	0.00	99.97
1.A.4 Other Sectors - Solid Fuels	N2O	4.59	0.22	0.0000	0.00	99.98
1.A.3.a Domestic Aviation- Aviation Gasoline	CO2	14.69	7.50	0.0000	0.00	99.98
1.A.3.e. Other Transportation	N2O	1.49	3.63	0.0000	0.00	99.99
2.C.6 Zinc Production	CO2	7.77	7.27	0.0000	0.00	99.99
5.C Incineration and Open Burning of Waste	N2O	2.34	0.08	0.0000	0.00	99.99
1.B.2.a. Fugitive Emissions from Fuels - Oil	CH4	12.75	7.54	0.0000	0.00	99.99
1.A.4 Other Sectors - Other Fuels	N2O	0.46	1.42	0.0000	0.00	99.99
2.B.10 Other	CH4	19.80	13.14	0.0000	0.00	100.00

1.A.3.d. Navigation - Liquid Fuels	N2O	2.56	2.52	0.0000	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH4	0.69	0.02	0.0000	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	N2O	3.27	1.99	0.0000	0.00	100.00
1.B.1 Fugitive emissions from Solid Fuels	CO2	0.33	0.00	0.0000	0.00	100.00
1.B.2.c. Fugitive Emissions from Fuels - Venting and Flaring	CH4	0.00	0.20	0.0000	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.49	0.89	0.0000	0.00	100.00
1.A.3.c. Railways	CH4	0.39	0.13	0.0000	0.00	100.00
1.A.1 Fuel combustion - Energy Industries - Other Fuels	CH4	0.00	0.14	0.0000	0.00	100.00
1.A.3.d. Navigation - Liquid Fuels	CH4	0.56	0.26	0.0000	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.01	0.14	0.0000	0.00	100.00
1.B.2.b. Fugitive Emissions from Fuels - Natural Gas	CO2	0.73	0.46	0.0000	0.00	100.00
1.A.3.e. Other Transportation	CH4	0.38	0.22	0.0000	0.00	100.00
1.A.3.a Domestic Aviation- Aviation Gasoline	CH4	0.07	0.03	0.0000	0.00	100.00
1.B.2.a. Fugitive Emissions from Fuels - Oil	CO2	0.01	0.02	0.0000	0.00	100.00
2.B.1 Ammonia Production	CH4	0.02	0.02	0.0000	0.00	100.00
5.C Incineration and Open Burning of Waste	CH4	0.00	0.00	0.0000	0.00	100.00
TOTAL		**145 849.07**	**103 576.13**			

Annex 2: Uncertainty estimates Belgium 2024

IPCC source category	Gas	Base year emissions or removals (1990) Sub 2024	2022 emissions or removals	Activity data uncertainty (%)	Emission factor uncertainty (%)	Combined uncertainty	Contribution to Variance by Category in 2022	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emision factor (or estimation parameter) uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data Note A	Input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G*D)^2}{(\sum D)^2}$	Note B	$\frac{D}{\sum C}$	$I*F$ Note C	$J*E*\sqrt{2}$ Note D	$\sqrt{K^2+L^2}$
		Gg CO_2 eq	Gg CO_2 eq	%	%	%		%	%	%	%	%
1.A.1.a. Public Electricity and Heat Production - Biomass	CH4	0.00	16.79	20.00	75.00	77.62	0.00	0.00	0.00	0.01	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	3.47	36.42	20.00	200.00	201.00	0.01	0.00	0.00	0.05	0.01	0.00
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	0.72	16.65	1.00	75.00	75.01	0.00	0.00	0.00	0.01	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	5.85	18.79	1.00	200.00	200.00	0.00	0.00	0.00	0.02	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	2739.19	6371.97	1.00	1.00	1.41	0.01	0.03	0.04	0.03	0.06	0.00
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.53	0.04	1.00	200.00	200.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.69	0.02	1.00	75.00	75.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	662.55	42.81	1.00	2.00	2.24	0.00	0.00	0.00	0.01	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CH4	0.00	0.14	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	2.61	7.59	5.00	200.00	200.06	0.00	0.00	0.00	0.01	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	674.22	2007.45	5.00	10.00	11.18	0.05	0.01	0.01	0.11	0.10	0.02
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	11.25	0.17	1.00	75.00	75.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	32.96	1.56	1.00	200.00	200.00	0.00	0.00	0.00	0.03	0.00	0.00
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	19148.00	5057.41	1.00	5.00	5.10	0.06	0.06	0.04	0.31	0.05	0.10
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	13.89	1084.08	1.00	1.00	1.41	0.00	0.01	0.01	0.01	0.01	0.00
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	110.46	1.75	5.00	50.00	50.25	0.00	0.00	0.00	0.03	0.00	0.00
1.A.1.b. Petroleum Refining - Liquid Fuels	N2O	0.00	31.38	5.00	50.00	50.25	0.00	0.00	0.00	0.01	0.00	0.00
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	4285.28	3632.45	5.00	2.00	5.39	0.04	0.00	0.03	0.01	0.18	0.03
1.A.1.b. Petroleum Refining - Other Fossil Fuels	CO2	0.00	10.37	5.00	2.00	5.39	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CH4	0.00	0.00	1.00	75.00	75.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	N2O	0.00	0.00	1.00	200.00	200.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CO2	2.61	0.00	1.00	1.00	1.41	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CH4	0.01	0.00	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	N2O	0.01	0.00	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CO2	4.47	0.00	5.00	2.00	5.39	0.00	0.00	0.00	0.00	0.00	0.00

1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	2.96	0.11	1.00	200.00	200.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	9.49	2.51	1.00	50.00	50.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	2017.05	160.96	1.00	2.00	2.24	0.00	0.01	0.00	0.02	0.00	0.00
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	1.08	0.63	2.00	75.00	75.03	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	48.03	5.41	2.00	200.00	200.01	0.00	0.00	0.00	0.04	0.00	0.00
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1492.90	940.30	2.00	1.00	2.24	0.00	0.00	0.01	0.00	0.02	0.00
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.69	0.01	2.00	75.00	75.03	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	1.49	0.01	2.00	200.00	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	884.66	17.35	2.00	2.00	2.83	0.00	0.00	0.00	0.01	0.00	0.00
1.A.2.a. Iron and Steel - Other fuels	CH4	0.00	0.00	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.a. Iron and Steel - Other fuels	N2O	0.00	0.00	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.a. Iron and Steel - Other fuels	CO2	0.00	4.53	5.00	10.00	11.18	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.a. Iron and Steel - Solid Fuels	CH4	0.53	0.04	2.00	75.00	75.03	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.a. Iron and Steel - Solid Fuels	N2O	0.53	0.06	2.00	200.00	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.a. Iron and Steel - Solid Fuels	CO2	3283.95	16.31	2.00	5.00	5.39	0.00	0.02	0.00	0.08	0.00	0.01
1.A.2.b. Non-Ferrous Metals - Biomass	CH4	0.00	0.00	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.b. Non-Ferrous Metals - Biomass	N2O	0.00	0.00	20.00	200.00	201.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.20	0.19	2.00	75.00	75.03	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.31	0.27	2.00	200.00	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	260.84	274.27	2.00	1.00	2.24	0.00	0.00	0.00	0.00	0.01	0.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.24	0.05	2.00	75.00	75.03	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.46	0.09	2.00	200.00	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	220.47	43.00	2.00	2.00	2.83	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.39	0.20	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.55	0.29	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	147.35	77.92	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.c. Chemicals - Biomass	CH4	0.00	0.69	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.c. Chemicals - Biomass	N2O	0.00	4.09	20.00	200.00	201.00	0.00	0.00	0.00	0.01	0.00	0.00
1.A.2.c. Chemicals - Gaseous Fuels	CH4	1.58	13.30	2.00	75.00	75.03	0.00	0.00	0.00	0.01	0.00	0.00
1.A.2.c. Chemicals - Gaseous Fuels	N2O	2.17	5.44	2.00	200.00	200.01	0.00	0.00	0.00	0.01	0.00	0.00
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2558.65	3156.48	2.00	1.00	2.24	0.00	0.01	0.02	0.01	0.06	0.00
1.A.2.c. Chemicals - Liquid Fuels	CH4	1.98	0.36	2.00	75.00	75.03	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.c. Chemicals - Liquid Fuels	N2O	3.76	0.60	2.00	200.00	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.c. Chemicals - Liquid Fuels	CO2	1851.70	417.63	2.00	2.00	2.83	0.00	0.01	0.00	0.01	0.01	0.00
1.A.2.c. Chemicals - Other Fuels	CO2	0.00	7.07	20.00	20.00	28.28	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.c. Chemicals - Other Fuels	CH4	1.91	5.95	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.c. Chemicals - Other Fuels	N2O	3.57	11.26	20.00	200.00	201.00	0.00	0.00	0.00	0.01	0.00	0.00
1.A.2.c. Chemicals - Solid Fuels	CH4	1.19	0.01	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.c. Chemicals - Solid Fuels	N2O	2.71	0.01	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.c. Chemicals - Solid Fuels	CO2	687.78	2.69	5.00	5.00	7.07	0.00	0.00	0.00	0.02	0.00	0.00
1.A.2.d. Pulp, Paper and Print - biomass	CH4	1.84	2.34	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00

1.A.2.d. Pulp, Paper and Print - biomass	N2O	4.14	5.96	20.00	200.00	201.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.14	0.42	2.00	75.00	75.03	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.13	0.49	2.00	200.00	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	281.82	310.24	2.00	1.00	2.24	0.00	0.00	0.00	0.00	0.01	0.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.21	0.00	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.43	0.00	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	234.59	4.84	5.00	2.00	5.39	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Other Fuels	CH4	0.00	1.35	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Other Fuels	N2O	0.00	1.70	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Other Fuels	CO2	0.00	152.60	5.00	10.00	11.18	0.00	0.00	0.00	0.01	0.01	0.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.38	0.26	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.54	0.37	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	127.50	79.74	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	0.12	1.02	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	0.16	1.18	20.00	200.00	201.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0.42	12.59	2.00	75.00	75.03	0.00	0.00	0.00	0.01	0.00	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0.61	2.39	2.00	200.00	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	684.19	2035.64	2.00	1.00	2.24	0.00	0.01	0.01	0.01	0.04	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	1.75	0.14	6.00	75.00	75.24	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	3.36	0.28	6.00	200.00	200.09	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	1688.70	124.35	6.00	2.00	6.32	0.00	0.01	0.00	0.02	0.01	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	1.92	0.02	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	2.72	0.04	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	650.58	41.88	5.00	5.00	7.07	0.00	0.00	0.00	0.01	0.00	0.00
1.A.2.f. Non-metallic minerals - biomass	CH4	0.00	1.84	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.f. Non-metallic minerals - biomass	N2O	0.00	17.05	20.00	200.00	201.00	0.00	0.00	0.00	0.02	0.00	0.00
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N2O	1.34	0.76	2.00	200.00	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH4	2.82	2.34	2.00	75.00	75.03	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1364.20	1268.99	2.00	1.00	2.24	0.00	0.00	0.01	0.00	0.03	0.00
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH4	1.66	0.17	8.00	75.00	75.43	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.f. Non-metallic minerals - Liquid Fuels	N2O	4.05	1.79	8.00	200.00	200.16	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	1508.75	278.11	8.00	2.00	8.25	0.00	0.01	0.00	0.01	0.02	0.00
1.A.2.f. Non-metallic minerals - Other Fuels	CH4	0.00	1.23	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.f. Non-metallic minerals - Other Fuels	N2O	0.25	18.77	5.00	200.00	200.06	0.00	0.00	0.00	0.03	0.00	0.00
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	186.18	365.51	5.00	5.00	7.07	0.00	0.00	0.00	0.01	0.02	0.00
1.A.2.f. Non-metallic minerals - Solid Fuels	CH4	8.70	0.93	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.f. Non-metallic minerals - Solid Fuels	N2O	9.61	8.04	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	2466.35	1079.85	5.00	5.00	7.07	0.01	0.00	0.01	0.02	0.05	0.00
1.A.2.g. Other - biomass	CH4	0.01	4.00	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.g. Other - biomass	N2O	0.01	5.05	20.00	200.00	201.00	0.00	0.00	0.00	0.01	0.00	0.00
1.A.2.g. Other - Gaseous Fuels	CH4	0.60	1.94	2.00	75.00	75.03	0.00	0.00	0.00	0.00	0.00	0.00

1.A.2.g. Other - Gaseous Fuels	N2O	0.57	0.35	2.00	200.00	200.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.g. Other - Gaseous Fuels	CO2	1203.67	739.52	2.00	1.00	2.24	0.00	0.00	0.01	0.00	0.01	0.00
1.A.2.g. Other - Liquid Fuels	CH4	5.09	1.48	8.00	75.00	75.43	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.g. Other - Liquid Fuels	N2O	12.29	11.06	8.00	200.00	200.16	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.g. Other - Liquid Fuels	CO2	1569.69	936.48	8.00	2.00	8.25	0.01	0.00	0.01	0.00	0.07	0.01
1.A.2.g. Other - Other Fuels	CH4	0.00	0.11	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.g. Other - Other Fuels	N2O	0.00	0.14	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.g. Other - Other Fuels	CO2	0.00	14.27	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.g. Other - Solid Fuels	CH4	0.09	0.05	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.g. Other - Solid Fuels	N2O	0.13	0.07	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.g. Other - Solid Fuels	CO2	33.22	18.87	5.00	5.00	7.07	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.04	0.02	7.50	140.00	140.20	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	3.11	1.50	7.50	5.00	9.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	2.96	1.83	7.50	200.00	200.14	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.03	0.01	7.50	140.00	140.20	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.31	0.16	7.50	200.00	200.14	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	11.58	6.00	7.50	5.00	9.01	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - Biomass	CH4	0.00	1.93	5.00	40.00	40.31	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - Biomass	N2O	0.00	24.83	5.00	100.00	100.12	0.00	0.00	0.00	0.02	0.00	0.00
1.A.3.b. Road Transportation - Diesel Oil	CH4	25.53	1.73	5.00	40.00	40.31	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - Diesel Oil	N2O	53.91	183.89	5.00	100.00	100.12	0.03	0.00	0.00	0.10	0.01	0.01
1.A.3.b. Road Transportation - Diesel Oil	CO2	11026.94	16376.04	5.00	2.00	5.39	0.73	0.06	0.11	0.12	0.81	0.67
1.A.3.b. Road Transportation - Gaseous fuels	N2O	0.00	0.12	5.00	100.00	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - Gaseous fuels	CH4	0.00	0.20	5.00	40.00	40.31	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - Gaseous fuels	CO2	0.00	43.49	5.00	2.00	5.39	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - Gasoline	N2O	85.69	10.73	5.00	100.00	100.12	0.00	0.00	0.00	0.04	0.00	0.00
1.A.3.b. Road Transportation - Gasoline	CH4	129.21	17.27	5.00	40.00	40.31	0.00	0.00	0.00	0.02	0.00	0.00
1.A.3.b. Road Transportation - Gasoline	CO2	8479.39	6227.80	5.00	2.00	5.39	0.11	0.00	0.04	0.00	0.31	0.09
1.A.3.b. Road Transportation - LPG	N2O	0.00	0.37	5.00	100.00	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - LPG	CH4	1.23	0.41	5.00	40.00	40.31	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - LPG	CO2	169.32	129.41	5.00	2.00	5.39	0.00	0.00	0.00	0.00	0.01	0.00
1.A.3.b. Road Transportation - Other fossil fuels	CH4	0.00	0.27	5.00	40.00	40.31	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - Other fossil fuels	N2O	0.00	0.98	5.00	100.00	100.12	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.b. Road Transportation - Other fossil fuels	CO2	0.00	139.76	5.00	2.00	5.39	0.00	0.00	0.00	0.00	0.01	0.00
1.A.3.b. Road Transportation - Other liquid fuels - Lubricants	CO2	1.29	0.77	5.00	2.00	5.39	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.c. Railways - Liquid Fuels	CH4	0.39	0.13	6.00	100.00	100.18	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.c. Railways - Liquid Fuels	N2O	10.79	1.68	6.00	125.00	125.14	0.00	0.00	0.00	0.01	0.00	0.00
1.A.3.c. Railways - Liquid Fuels	CO2	227.07	69.50	6.00	2.00	6.32	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.56	0.26	10.00	75.00	75.66	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.d. Navigation - Gas/Diesel Oil	N2O	2.56	2.52	10.00	125.00	125.40	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	361.87	354.79	10.00	2.00	10.20	0.00	0.00	0.00	0.00	0.04	0.00

1.A.3.e. Other Transportation - Gaseous Fuels	CH4	0.10	0.14	10.00	75.00	75.66	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.e. Other Transportation - Liquid Fuels	N2O	0.09	0.13	10.00	125.00	125.40	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.e. Other Transportation - Liquid Fuels	CO2	196.77	279.20	10.00	2.00	10.20	0.00	0.00	0.00	0.00	0.03	0.00
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.29	0.08	5.00	75.00	75.17	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	1.40	3.50	5.00	200.00	200.06	0.00	0.00	0.00	0.00	0.00	0.00
1.A.3.e. Other Transportation - Gaseous Fuels	CO2	137.18	305.16	5.00	1.00	5.10	0.00	0.00	0.00	0.00	0.02	0.00
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	0.00	0.92	20.00	200.00	201.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.a. Commercial / Institutional - Biomass	CH4	0.00	4.54	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	2.71	14.08	4.00	75.00	75.11	0.00	0.00	0.00	0.01	0.00	0.00
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	5.41	11.13	4.00	200.00	200.04	0.00	0.00	0.00	0.01	0.00	0.00
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	1936.20	3866.98	4.00	1.00	4.12	0.02	0.02	0.03	0.02	0.15	0.02
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	5.16	2.38	10.00	75.00	75.66	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	4.36	1.91	10.00	200.00	200.25	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	2314.69	935.84	10.00	2.00	10.20	0.01	0.01	0.01	0.01	0.09	0.01
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	0.46	1.42	20.00	200.00	201.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	3.68	11.22	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	29.08	87.52	20.00	20.00	28.28	0.00	0.00	0.00	0.01	0.02	0.00
1.A.4.a. Commercial / Institutional - Solid Fuels	CH4	0.03	0.00	15.00	75.00	76.49	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.a. Commercial / Institutional - Solid Fuels	N2O	0.03	0.00	15.00	200.00	200.56	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.a. Commercial / Institutional - Solid Fuels	CO2	9.01	0.01	15.00	5.00	15.81	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b. Residential - Biomass	N2O	4.89	15.74	65.00	200.00	210.30	0.00	0.00	0.00	0.02	0.01	0.00
1.A.4.b. Residential - Biomass	CH4	109.45	255.67	65.00	75.00	99.25	0.06	0.00	0.00	0.09	0.16	0.04
1.A.4.b. Residential - Gaseous Fuels	CH4	8.18	8.19	4.00	75.00	75.11	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b. Residential - Gaseous Fuels	N2O	16.45	22.03	4.00	200.00	200.04	0.00	0.00	0.00	0.01	0.00	0.00
1.A.4.b. Residential - Gaseous Fuels	CO2	5861.72	6858.03	4.00	1.00	4.12	0.08	0.02	0.05	0.02	0.27	0.07
1.A.4.b. Residential - Liquid Fuels	N2O	10.76	6.53	10.00	200.00	200.25	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b. Residential - Liquid Fuels	CH4	22.01	12.95	10.00	75.00	75.66	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b. Residential - Liquid Fuels	CO2	12824.67	5826.60	10.00	2.00	10.20	0.33	0.02	0.04	0.05	0.58	0.33
1.A.4.b. Residential - Solid Fuels	N2O	4.14	0.17	15.00	200.00	200.56	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.b. Residential - Solid Fuels	CH4	122.66	4.82	15.00	75.00	76.49	0.00	0.00	0.00	0.04	0.00	0.00
1.A.4.b. Residential - Solid Fuels	CO2	1796.20	67.89	15.00	5.00	15.81	0.00	0.01	0.00	0.04	0.01	0.00
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	CH4	0.00	0.31	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	N2O	0.00	0.40	20.00	200.00	201.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	0.03	130.65	4.00	75.00	75.11	0.01	0.00	0.00	0.07	0.01	0.00
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.32	0.56	4.00	200.00	200.04	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	67.46	1138.47	4.00	1.00	4.12	0.00	0.01	0.01	0.01	0.05	0.00
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	12.43	2.44	10.00	75.00	75.66	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	33.04	32.00	10.00	200.00	200.25	0.00	0.00	0.00	0.01	0.00	0.00
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	2757.40	1047.37	10.00	2.00	10.20	0.01	0.01	0.01	0.01	0.10	0.01
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	0.42	0.05	15.00	200.00	200.56	0.00	0.00	0.00	0.00	0.00	0.00
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	0.88	0.10	15.00	75.00	76.49	0.00	0.00	0.00	0.00	0.00	0.00

1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	212.09	24.83	15.00	5.00	15.81	0.00	0.00	0.00	0.00	0.00	0.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.01	0.14	20.00	75.00	77.62	0.00	0.00	0.00	0.00	0.00	0.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.49	0.89	20.00	100.00	101.98	0.00	0.00	0.00	0.00	0.00	0.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	171.93	96.34	20.00	2.00	20.10	0.00	0.00	0.00	0.00	0.02	0.00
1.B.1.a. Coal Mining and Handling	CH4	443.26	43.90	5.00	60.00	60.21	0.00	0.00	0.00	0.12	0.00	0.01
1.B.1.b. Solid Fuel Transformation	CO2	0.33	0.00	5.00	60.00	60.21	0.00	0.00	0.00	0.00	0.00	0.00
1.B.1.b. Solid Fuel Transformation	CH4	41.06	0.00	5.00	60.00	60.21	0.00	0.00	0.00	0.01	0.00	0.00
1.B.2.a. Oil	CO2	0.01	0.02	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1.B.2.a. Oil	CH4	12.75	7.54	5.00	50.00	50.25	0.00	0.00	0.00	0.00	0.00	0.00
1.B.2.b. Natural Gas	CO2	0.73	0.46	10.00	30.00	31.62	0.00	0.00	0.00	0.00	0.00	0.00
1.B.2.b. Natural Gas	CH4	794.59	481.27	10.00	30.00	31.62	0.02	0.00	0.00	0.02	0.05	0.00
1.B.2.c Venting and Flaring	CH4	0.00	0.20	5.00	50.00	50.25	0.000000	0.000001	0.000001	0.000070	0.000010	0.000000
1.B.2.c Venting and Flaring	CO2	83.83	110.59	1.00	10.00	10.05	0.000116	0.000350	0.000774	0.003504	0.001094	0.000013
2.A.1 Cement production	CO2	2823.78	2456.03	5.00	5.00	7.07	0.028337	0.002921	0.017186	0.014605	0.121523	0.014981
2.A.2 Lime production	CO2	2097.12	1115.02	5.00	2.00	5.39	0.003387	0.002791	0.007802	0.005582	0.055170	0.003075
2.A.3 Glass production	CO2	262.62	148.73	5.00	5.00	7.07	0.000104	0.000286	0.001041	0.001429	0.007359	0.000056
2.A.4 Other process uses of carbonates	CO2	136.30	196.25	5.00	5.00	7.07	0.000181	0.000685	0.001373	0.003424	0.009710	0.000106
2.B.1 Ammonia Production	CH4	0.02	0.02	2.00	5.00	5.39	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2.B.1 Ammonia Production	CO2	422.74	866.19	1.50	1.50	2.12	0.000317	0.003926	0.006061	0.005888	0.012858	0.000200
2.B.10 Other	CH4	19.80	13.14	20.00	75.00	77.62	0.000098	0.000008	0.000092	0.000603	0.002601	0.000007
2.B.10 Other	N2O	24.38	90.95	20.00	100.00	101.98	0.008083	0.000513	0.000636	0.051328	0.018001	0.002959
2.B.10 Other	CO2	285.15	1769.66	20.00	5.00	20.62	0.125049	0.010942	0.012383	0.054712	0.350246	0.125666
2.B.2 Nitric Acid Production	N2O	3042.64	165.25	2.00	7.50	7.76	0.000155	0.014211	0.001156	0.106579	0.003271	0.011370
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	318.00	262.51	2.00	7.50	7.76	0.000390	0.000231	0.001837	0.001729	0.005196	0.000030
2.B.6 Titanium Dioxide Production	CO2	0.00	68.14	2.00	5.00	5.39	0.000013	0.000477	0.000477	0.002384	0.001349	0.000008
2.B.8 Petrochemical and carbon black production	CO2	1882.42	3575.99	20.00	5.00	20.62	0.510613	0.015512	0.025023	0.077558	0.707749	0.506924
2.B.9.a. By-product emissions	C5F12	38.28	0.00	26.00	0.00	26.00	0.000000	0.000193	0.000000	0.000000	0.000000	0.000000
2.B.9.a. By-product emissions	C3F8	217.48	0.00	26.00	0.00	26.00	0.000000	0.001099	0.000000	0.000000	0.000000	0.000000
2.B.9.a. By-product emissions	C4F10	237.37	0.00	26.00	0.00	26.00	0.000000	0.001199	0.000000	0.000000	0.000000	0.000000
2.B.9.a. By-product emissions	CF4	330.17	70.60	26.00	0.00	26.00	0.000317	0.001174	0.000494	0.000000	0.018165	0.000330
2.B.9.a. By-product emissions	C2F6	611.35	0.00	26.00	0.00	26.00	0.000000	0.003088	0.000000	0.000000	0.000000	0.000000
2.B.9.a. By-product emissions	SF6	1533.26	0.00	26.00	0.00	26.00	0.000000	0.007744	0.000000	0.000000	0.000000	0.000000
2.B.9.b Fugitive emissions	HFC-152a	0.00	0.00	26.00	0.00	26.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2.B.9.b Fugitive emissions	HFC-134	0.00	0.00	26.00	0.00	26.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2.B.9.b Fugitive emissions	HFC-32	0.00	0.00	26.00	0.00	26.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2.B.9.b Fugitive emissions	HFC-134a	0.00	0.01	26.00	0.00	26.00	0.000000	0.000000	0.000000	0.000000	0.000003	0.000000
2.B.9.b Fugitive emissions	HFC-143a	0.00	0.01	26.00	0.00	26.00	0.000000	0.000000	0.000000	0.000000	0.000003	0.000000
2.B.9.b Fugitive emissions	HFC-227ea	0.00	4.17	26.00	0.00	26.00	0.000001	0.000029	0.000029	0.000000	0.001074	0.000001
2.B.9.b Fugitive emissions	SF6	0.00	0.54	26.00	0.00	26.00	0.000000	0.000004	0.000004	0.000000	0.000139	0.000000
2.B.9.b Fugitive emissions	CF4	0.00	0.20	26.00	0.00	26.00	0.000000	0.000001	0.000001	0.000000	0.000050	0.000000
2.B.9.b Fugitive emissions	C2F6	0.00	0.65	26.00	0.00	26.00	0.000000	0.000005	0.000005	0.000000	0.000168	0.000000

2.B.9.b Fugitive emissions	NF3	0.00	0.88	26.00	0.00	26.00	0.000000	0.000006	0.000006	0.000000	0.000226	0.000000
2.B.9.b Fugitive emissions	HFC-236fa	0.00	0.03	26.00	0.00	26.00	0.000000	0.000000	0.000000	0.000000	0.000007	0.000000
2.B.9.b Fugitive emissions	C3F8	0.00	1.63	26.00	0.00	26.00	0.000000	0.000011	0.000011	0.000000	0.000420	0.000000
2.B.9.b Fugitive emissions	HFC-125	0.00	4.77	26.00	0.00	26.00	0.000001	0.000033	0.000033	0.000000	0.001227	0.000002
2.B.9.b Fugitive emissions	HFC-23	0.00	55.91	26.00	0.00	26.00	0.000199	0.000391	0.000391	0.000000	0.014385	0.000207
2.B.9.b Fugitive emissions	C4F10	26.38	8.69	26.00	0.00	26.00	0.000005	0.000072	0.000061	0.000000	0.002235	0.000005
2.B.9.b Fugitive emissions	C6F14	245.62	1.94	26.00	0.00	26.00	0.000000	0.001227	0.000014	0.000000	0.000498	0.000000
2.B.9.b Fugitive emissions	C5F12	328.12	0.01	26.00	0.00	26.00	0.000000	0.001657	0.000000	0.000000	0.000002	0.000000
2.C.1. Iron and Steel Production	CH4	15.30	14.44	2.00	5.00	5.39	0.000001	0.000024	0.000101	0.000119	0.000286	0.000000
2.C.1. Iron and Steel Production	CO2	10047.90	3416.89	2.00	5.00	5.39	0.031810	0.026829	0.023909	0.134144	0.067626	0.022568
2.C.6 Zinc Production	CO2	7.77	7.27	20.00	5.00	20.62	0.000002	0.000012	0.000051	0.000058	0.001438	0.000002
2.C.7 Other	CO2	36.25	76.62	20.00	5.00	20.62	0.000234	0.000353	0.000536	0.001765	0.015164	0.000233
2.D.1 Lubricant use	CO2	198.92	77.68	5.00	5.00	7.07	0.000028	0.000461	0.000544	0.002306	0.003844	0.000020
2.D.2 Paraffin wax use	CO2	2.95	11.62	5.00	5.00	7.07	0.000001	0.000066	0.000081	0.000332	0.000575	0.000000
2.D.3 Other urea	CO2	0.00	33.67	5.00	5.00	7.07	0.000005	0.000236	0.000236	0.001178	0.001666	0.000004
2.E.1 Integrated Circuit or Semiconductor	HFC-41	0.00	0.00	0.00	100.00	100.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2.E.1 Integrated Circuit or Semiconductor	HFC-125	0.00	0.08	0.00	100.00	100.00	0.000000	0.000001	0.000001	0.000053	0.000000	0.000000
2.E.1 Integrated Circuit or Semiconductor	HFC-32	0.00	0.02	0.00	100.00	100.00	0.000000	0.000000	0.000000	0.000014	0.000000	0.000000
2.E.1 Integrated Circuit or Semiconductor	c-C4F8	0.00	0.32	0.00	100.00	100.00	0.000000	0.000002	0.000002	0.000222	0.000000	0.000000
2.E.1 Integrated Circuit or Semiconductor	NF3	0.00	1.33	0.00	100.00	100.00	0.000002	0.000009	0.000009	0.000932	0.000000	0.000001
2.E.1 Integrated Circuit or Semiconductor	HFC-23	0.00	2.06	0.00	100.00	100.00	0.000004	0.000014	0.000014	0.001440	0.000000	0.000002
2.E.1 Integrated Circuit or Semiconductor	C2F6	0.00	11.82	0.00	100.00	100.00	0.000131	0.000083	0.000083	0.008274	0.000000	0.000068
2.E.1 Integrated Circuit or Semiconductor	CF4	0.00	11.77	0.00	100.00	100.00	0.000130	0.000082	0.000082	0.008233	0.000000	0.000068
2.E.1 Integrated Circuit or Semiconductor	SF6	0.00	16.42	0.00	100.00	100.00	0.000253	0.000115	0.000115	0.011493	0.000000	0.000132
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.00	0.00	0.00	75.00	75.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-23	0.00	10.49	0.00	75.00	75.00	0.000058	0.000073	0.000073	0.005503	0.000000	0.000030
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-32	0.00	112.25	0.42	66.37	66.37	0.005215	0.000785	0.000785	0.052132	0.000470	0.002718
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	0.00	481.54	1.72	73.72	73.74	0.118452	0.003370	0.003370	0.248392	0.008189	0.061765
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	0.00	629.65	43.06	38.28	57.61	0.123630	0.004406	0.004406	0.168659	0.268271	0.100415
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	0.00	789.23	0.95	52.42	52.43	0.160870	0.005523	0.005523	0.289500	0.007398	0.083865
2.F.2. Foam Blowing Agents	HFC-245fa	0.00	0.14	15.00	5.00	15.81	0.000000	0.000001	0.000001	0.000005	0.000021	0.000000
2.F.2. Foam Blowing Agents	HFC-227ea	0.00	7.87	15.00	5.00	15.81	0.000001	0.000055	0.000055	0.000275	0.001168	0.000001
2.F.2. Foam Blowing Agents	HFC-365mfc	0.00	12.63	15.00	5.00	15.81	0.000004	0.000088	0.000088	0.000442	0.001875	0.000004
2.F.2. Foam Blowing Agents	HFC-152a	0.00	9.12	15.00	5.00	15.81	0.000002	0.000064	0.000064	0.000319	0.001354	0.000002
2.F.2. Foam Blowing Agents	HFC-134a	0.00	38.88	15.00	5.00	15.81	0.000035	0.000272	0.000272	0.001360	0.005771	0.000035
2.F.3. Fire protection	HFC-125	0.00	0.63	10.00	50.00	50.99	0.000000	0.000004	0.000004	0.000221	0.000063	0.000000
2.F.3. Fire protection	HFC-227ea	0.00	9.45	10.00	50.00	50.99	0.000022	0.000066	0.000066	0.003308	0.000936	0.000012
2.F.4. Aerosols	HFC-152a	0.00	0.07	0.00	200.00	200.00	0.000000	0.000001	0.000001	0.000100	0.000000	0.000000
2.F.4. Aerosols	HFC-227ea	0.00	1.78	25.00	50.00	55.90	0.000001	0.000012	0.000012	0.000623	0.000441	0.000001
2.F.4. Aerosols	HFC-134a	0.00	43.86	24.13	48.76	54.41	0.000535	0.000307	0.000307	0.014964	0.010474	0.000334
2.G.1. Electrical equipment	SF6	6.81	10.89	0.00	50.00	50.00	0.000028	0.000042	0.000076	0.002092	0.000000	0.000004

2.G.2 SF6 and PFCs from other product use	SF6	126.37	75.95	0.00	100.00	100.00	0.005420	0.000107	0.000531	0.010689	0.000000	0.000114
2G3. N2O from Product Uses	N2O	179.99	46.03	28.85	15.86	32.92	0.000216	0.000587	0.000322	0.009314	0.013140	0.000259
2H. Other	CO2	0.00	22.63	20.00	5.00	20.62	0.000020	0.000158	0.000158	0.000792	0.004480	0.000021
3A1 Dairy Cattle	CH4	2068.53	1810.11	5.00	20.00	20.62	0.130831	0.002217	0.012666	0.044332	0.089563	0.009987
3A1 Non-Dairy Cattle	CH4	2922.11	2305.95	5.00	20.00	20.62	0.212323	0.001374	0.016136	0.027487	0.114097	0.013774
3A2 Sheep	CH4	43.04	30.53	5.00	20.00	20.62	0.000037	0.000004	0.000214	0.000076	0.001510	0.000002
3A3 Swine	CH4	281.42	241.54	5.00	20.00	20.62	0.002330	0.000269	0.001690	0.005371	0.011951	0.000172
3A4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	11.53	54.64	5.00	20.00	20.62	0.000119	0.000324	0.000382	0.006483	0.002704	0.000049
3B1 Dairy Cattle	N2O	187.75	98.08	10.00	90.00	90.55	0.007411	0.000262	0.000686	0.023590	0.009706	0.000651
3B1 Dairy Cattle	CH4	260.87	374.49	10.00	40.00	41.23	0.022399	0.001303	0.002620	0.052105	0.037059	0.004088
3B1 Non-Dairy Cattle	CH4	207.38	141.68	10.00	40.00	41.23	0.003206	0.000056	0.000991	0.002246	0.014021	0.000202
3B1 Non-Dairy Cattle	N2O	364.66	256.68	10.00	90.00	90.55	0.050758	0.000046	0.001796	0.004140	0.025400	0.000662
3B2 Sheep	CH4	1.02	0.73	10.00	40.00	41.23	0.000000	0.000000	0.000005	0.000004	0.000072	0.000000
3B2 Sheep	N2O	0.88	0.64	10.00	90.00	90.55	0.000000	0.000000	0.000005	0.000005	0.000064	0.000000
3B3 Swine	N2O	75.41	46.06	10.00	90.00	90.55	0.001634	0.000059	0.000322	0.005278	0.004558	0.000049
3B3 Swine	CH4	887.91	714.24	10.00	40.00	41.23	0.081479	0.000513	0.004998	0.020501	0.070680	0.005416
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	N2O	9.05	18.84	10.00	90.00	90.55	0.000274	0.000086	0.000132	0.007751	0.001865	0.000064
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	18.95	35.16	10.00	40.00	41.23	0.000197	0.000150	0.000246	0.006012	0.003479	0.000048
3B5 Indirect N2O emissions	N2O	172.33	140.56	30.00	250.00	251.79	0.117681	0.000113	0.000984	0.028257	0.041728	0.002540
3D1 Direct N2O emissions from managed soils	N2O	2978.71	2133.59	15.48	129.00	129.92	7.219603	0.000117	0.014930	0.015135	0.326837	0.107052
3D2 Indirect N2O Emissions from managed soils	N2O	965.90	572.05	23.88	199.03	200.46	1.235404	0.000876	0.004003	0.174412	0.135201	0.048699
3G Liming	CO2	162.00	132.60	100.00	50.00	111.80	0.020648	0.000109	0.000928	0.005474	0.131215	0.017247
3H Urea application	CO2	17.02	40.90	100.00	50.00	111.80	0.001964	0.000200	0.000286	0.010008	0.040470	0.001738
4(IV) Indirect N2O Emissions from Managed Soils	N2O	0.98	18.22	30.00	250.00	251.79	0.001977	0.000123	0.000127	0.030636	0.005408	0.000968
4.A.1 biomass burning	N2O	0.07	0.00	30.00	70.00	76.16	0.000000	0.000000	0.000000	0.000026	0.000000	0.000000
4.A.1 biomass burning	CH4	0.14	0.00	30.00	70.00	76.16	0.000000	0.000001	0.000000	0.000050	0.000000	0.000000
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2	-1909.52	-1679.47	0.00	20.39	20.39	0.110196	0.002106	0.011752	0.042950	0.000000	0.001845
4.A.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.00	0.02	30.00	250.00	251.79	0.000000	0.000000	0.000000	0.000032	0.000006	0.000000
4.A.2. Land converted to Forest Land CSC	CO2	-11.19	-308.67	0.00	42.63	42.63	0.016266	0.002103	0.002160	0.089663	0.000000	0.008039
4.B.1. Cropland remaining Cropland CSC	CO2	213.32	109.40	0.00	29.02	29.02	0.000947	0.000312	0.000766	0.009054	0.000000	0.000082
4.B.2. Direct N2O emissions from N mineralization/immobilisation	N2O	1.40	39.53	18.00	150.00	151.08	0.003352	0.000270	0.000277	0.040434	0.007042	0.001684
4.B.2. Land converted to Cropland CSC	CO2	41.51	544.73	0.00	42.01	42.01	0.049210	0.003602	0.003812	0.151333	0.000000	0.022902
4.C.1. Direct N2O emissions from N mineralization/immobilisation	N2O	1.80	15.38	30.00	250.00	251.79	0.001409	0.000099	0.000108	0.024631	0.004566	0.000628
4.C.1 biomass burning	CH4	0.00	0.00	30.00	100.00	104.40	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4.C.1 biomass burning	N2O	0.00	0.00	30.00	100.00	104.40	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4.C.1. Grassland remaining Grassland CSC	CO2	29.45	208.81	0.00	33.06	33.06	0.004477	0.001312	0.001461	0.043386	0.000000	0.001882
4.C.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.06	3.44	30.00	250.00	251.79	0.000071	0.000024	0.000024	0.005953	0.001022	0.000036
4.C.2. Land converted to Grassland CSC	CO2	52.29	85.46	0.00	30.28	30.28	0.000629	0.000334	0.000598	0.010111	0.000000	0.000102
4.D.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.00	0.02	30.00	250.00	251.79	0.000000	0.000000	0.000000	0.000037	0.000007	0.000000
4.D.2. Land converted to Wetlands CSC	CO2	10.91	-4.33	0.00	32.89	32.89	0.000002	0.000085	0.000030	0.002808	0.000000	0.000008
4.E.2. Direct N2O emissions from N mineralization/immobilisation	N2O	1.08	22.57	30.00	250.00	251.79	0.003033	0.000152	0.000158	0.038118	0.006699	0.001498

4.E.2. Land converted to Settlements CSC	CO2	143.91	515.12	0.00	50.78	50.78	0.064274	0.002878	0.003605	0.146107	0.000000	0.021347
4.G Harvest wood products	CO2	-1516.10	10.77	50.00	50.00	70.71	0.000054	0.007735	0.000075	0.386740	0.005328	0.149596
5.A. Solid Waste Disposal	CH4	3323.27	556.72	30.00	40.00	50.00	0.072798	0.012889	0.003896	0.515557	0.386668	0.415310
5.B. Biological treatment of solid waste	CH4	2.90	25.10	30.00	200.00	202.24	0.002420	0.000161	0.000176	0.032194	0.007450	0.001092
5.B. Biological treatment of solid waste	N2O	3.51	30.40	30.00	250.00	251.79	0.005506	0.000195	0.000213	0.048750	0.009026	0.002458
5.C.1 Waste incineration / Biogenic	CH4	0.00	0.00	20.00	75.00	77.62	0.000000	0.000000	0.000000	0.000001	0.000000	0.000000
5.C.1 Waste incineration / Biogenic	N2O	1.24	0.04	20.00	200.00	201.00	0.000000	0.000006	0.000000	0.001191	0.000009	0.000001
5.C.1 Waste incineration / Non-biogenic	CH4	0.00	0.00	5.00	100.00	100.12	0.000000	0.000000	0.000000	0.000001	0.000000	0.000000
5.C.1 Waste incineration / Non-biogenic	N2O	1.10	0.03	5.00	200.00	200.06	0.000000	0.000005	0.000000	0.001064	0.000002	0.000001
5.C.1 Waste incineration / Non-biogenic	CO2	299.50	215.86	19.17	19.18	27.11	0.003218	0.000002	0.001510	0.000048	0.040939	0.001676
5.D. Wastewater treatment and discharge	N2O	122.77	101.90	20.00	110.00	111.80	0.012194	0.000093	0.000713	0.010212	0.020167	0.000511
5.D. Wastewater treatment and discharge	CH4	1041.95	245.70	20.00	70.00	72.80	0.030060	0.003544	0.001719	0.248074	0.048628	0.063905
TOTAL		**142 909.17**	**103 157.14**				12.225053					3.331845
				percentage uncertainty in total inventory:			**3.496**			**Trend uncertainty (%)**		**1.825**

Annex 3: Supplementary documents attached to the Belgian National Inventory Report

- National CRT tables (ETF-GHG) for the years 1990-2022 reported under GWP-values from the IPCC 5th Assessment Report.

- The quality management system used in the Flemish region with the more technical procedures and an example of the forms used to control the data and the calculation of the emissions ("Annex3_NID_QMS Flanders.zip"): no differences compared to previous submission.

- A list of the parameters used in the preparation of the Belgian inventory for agriculture at the regional level ("Annex3_NID_List parameters Inventory Agri.xlsx").

- Information related to the calculation of the Manure Balance in Flanders ("Annex3_NID_Manure Balance data_Flanders_2022.doc").

- Revision of the EMAV2.1 model_2020 in agricultural sector in the Flemish region ("Annex3_revision of the EMAV2.1 model_2020_english summary.docx).

- National Inventory System of March 2024: ("Annex3_NIS Belgium 15032024.pdf")

- Belgian QA/QC-plan of April 2017: ("Annex3_QAQC_Belgium 15042017.pdf"): no differences compared to previous submission.

- The UNFCCC individual review report about the 2022 submission and published on 17 April 2023: This UNFCCC review of the 2022 annual submission of Belgium was conducted at 10-15 October 2022 in accordance with paragraph 84 of the annex to decision 13/CP.20: ("Annex3_arr2022_BEL_1.pdf").

- Overview of activity data and emissions of CO_2 for 2013-2016 in iron & steel on the regional and the national level "Annex3_NID_overview data from iron_steel_2013-2016.xlsx": no differences compared to previous submission.

- Reporting on implementation of recommendations and adjustments: see "Annex3_BE_2024_Article 10_AnnexVIII_Recommandations_16012024.xlsx".

- Emissions factors used in the Flemish region in stationary residential, commercial and agricultural_forestry_fishery sectors and emission factors used in CHP installations and autoproducer installations in the commercial and in the agricultural sectors: see "Annex3_EF in the Flemish region 1A4_2022.zip".

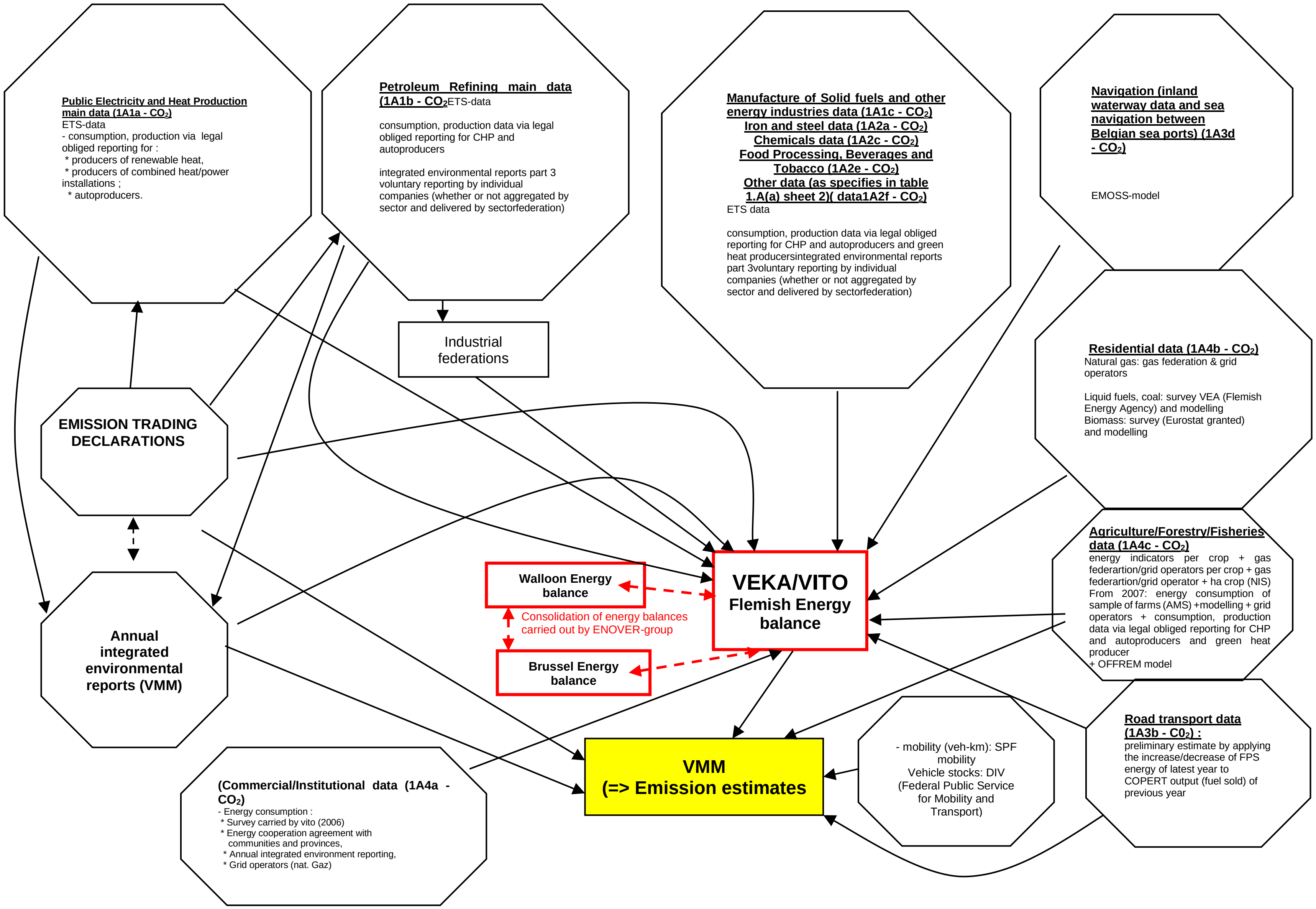
- Note on fossil carbon content in biofuels : ("Annex3_Note on fossil carbon content in biofuels v2.docx")

Annex 4: Net calorific values of the main products

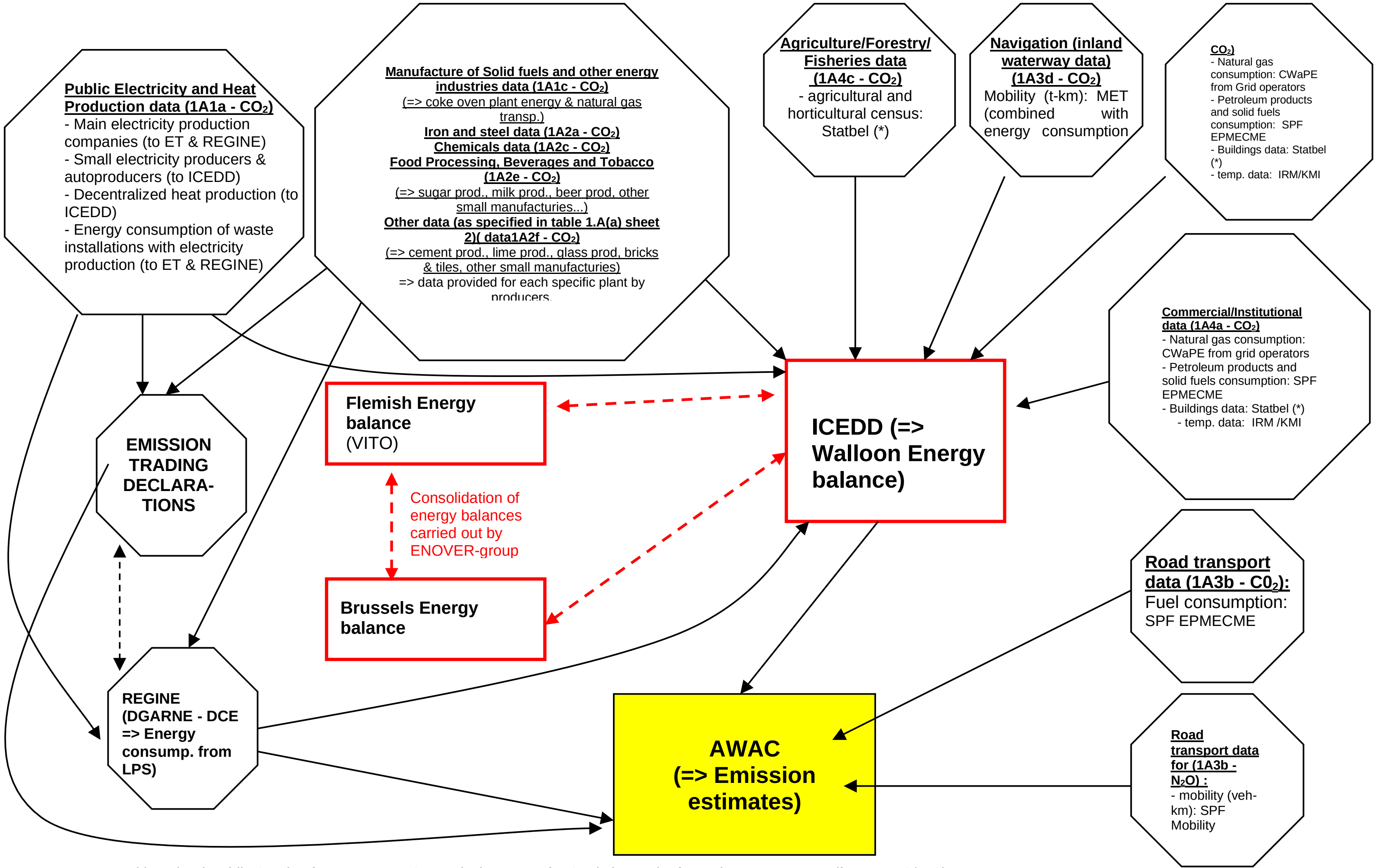
Annex 4: Net calorific values used for sectoral and reference approach in case no plant-specific values are available:		
	Sectoral Approach	**Reference Approach**
Products	Source: former Ministry of Economic Affairs	Source: : FOD Economy - Directorate-General for Energy:
		- COALAQ (Coal Information - IEA) - frequently revision - finished petroleumproducts (IEA/Eurostat) and raw materials (based on production and weighted averages) - natural gas (Fluxys)
Crude Oil		42,21
charcoal		29,3
Coking Coal	29,3	29,25
Coal Tar		37,65
Anthracite		28,43
coke oven coke	29,3	29,31
Bituminous Coal		26,27
BKB		20,68
Refinery Feedstocks		42,21
Refinery Gas		49,5
Butane	45,73	
Propane	46,14	
LPG	45,95	46
Natural Gas Liquids		45,2
Naphta		44
Bioethanol/biogasoline	28,8	28,8
Biodiesel	37,3	37,7
White Spirit		43,6
Lubricants		42
Bitumen		39
Paraffin Wax		40
Other Oil Products		40
Patent Fuel		30,48
gasoil	42,279	42,6
lamp petroleum	43,12	
residual fuel oil	40,604	40
petroleum coke	plant specific	32
gasoline	43,774	44
Aviation Gasoline	41,87	44
kerosene	43,116	43
Coke gas	plant specific	
Blast furnace gas	plant specific	
Natural gas	plant specific or for high calorific gas: 0,0388524 GJ/m³ and for low calorific gas: 0,032923 GJ/m³	34,179 MJ/m3

Annex 5: Key sources: flows of activity data

ENERGY- Key Sources - flow of activity data - Flanders

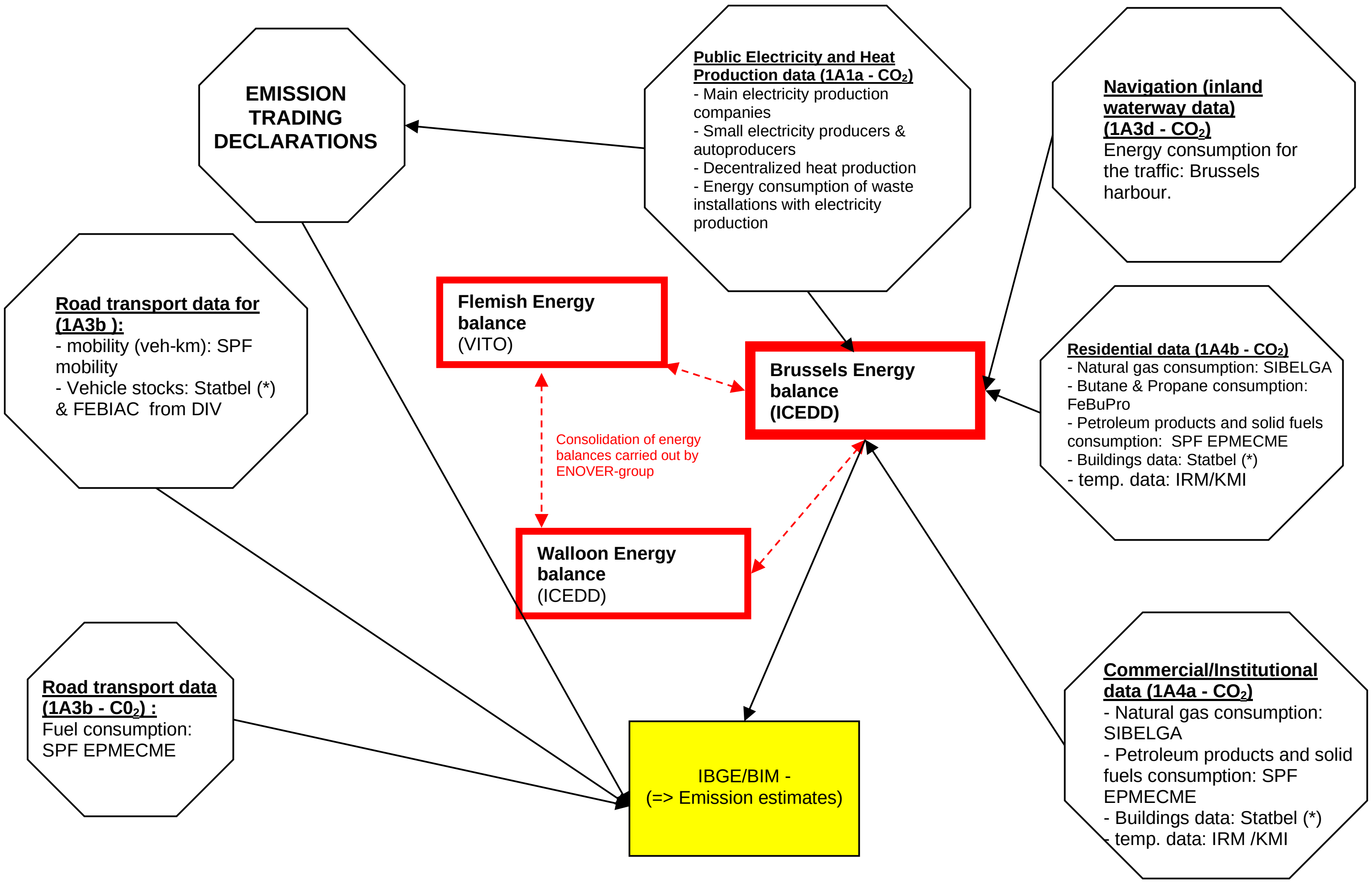


ENERGY- Key Sources - flow of activity data Wallonia



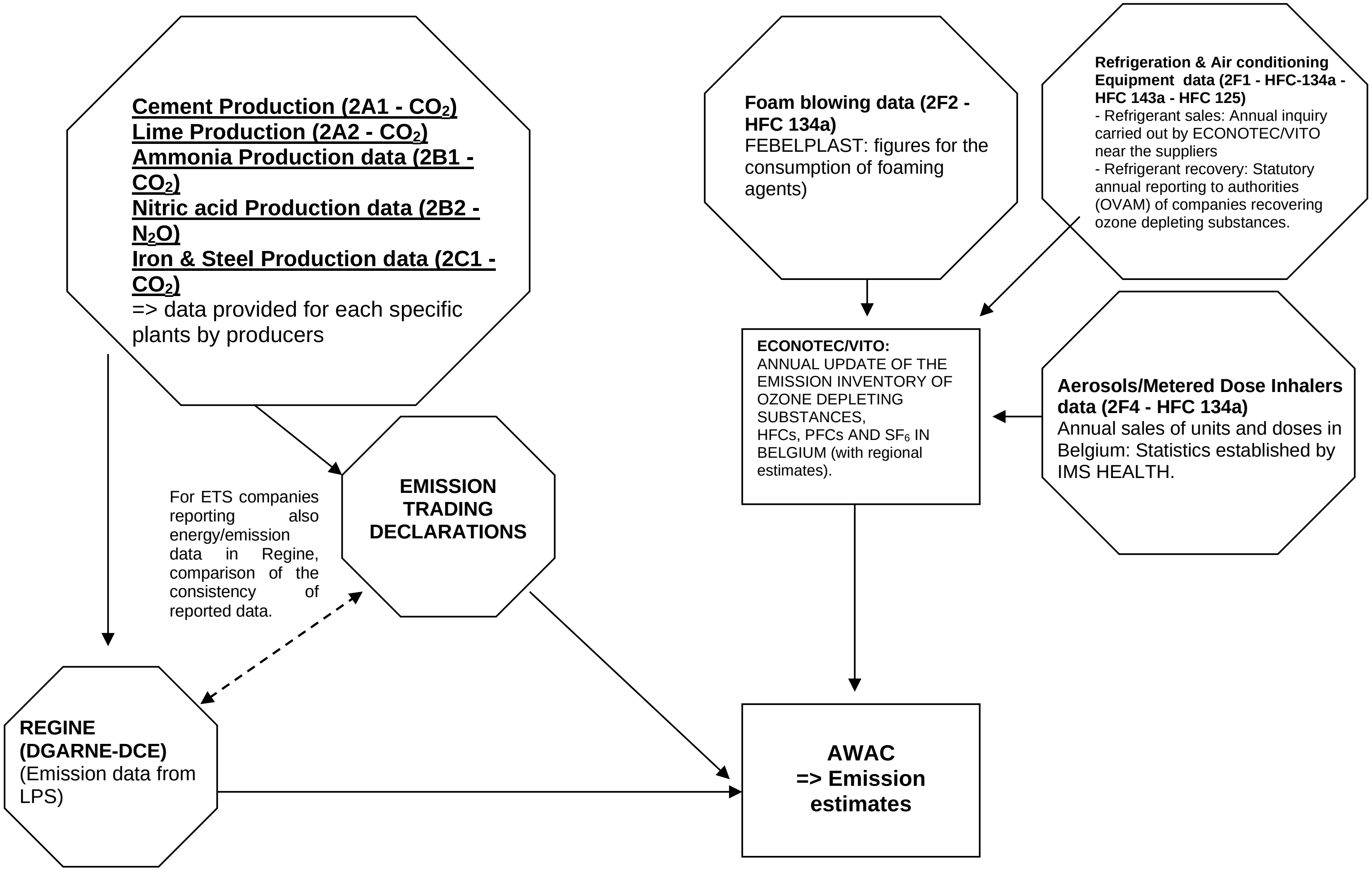
(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

ENERGY- Key Sources - flow of activity data - Brussels

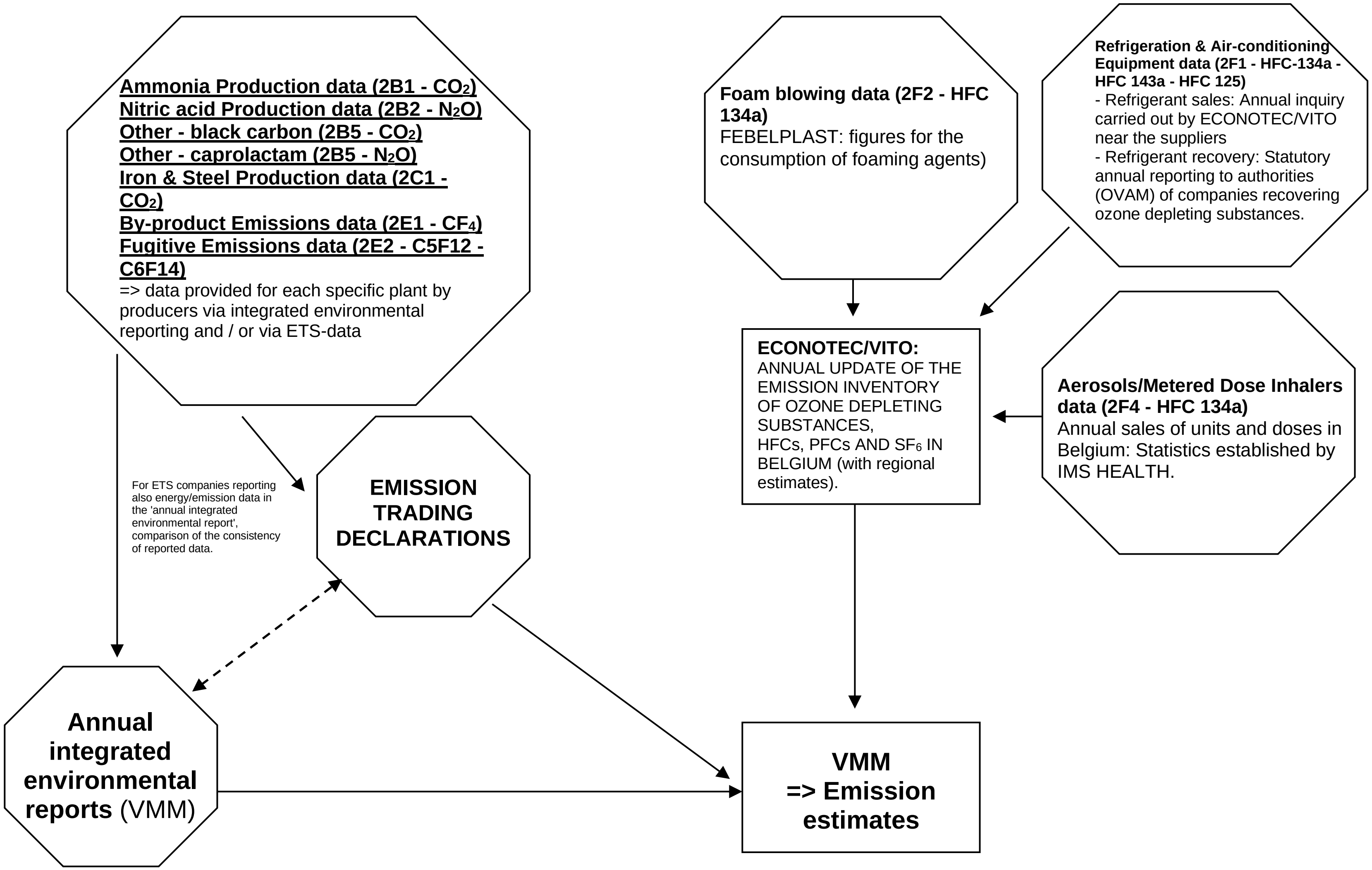


(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

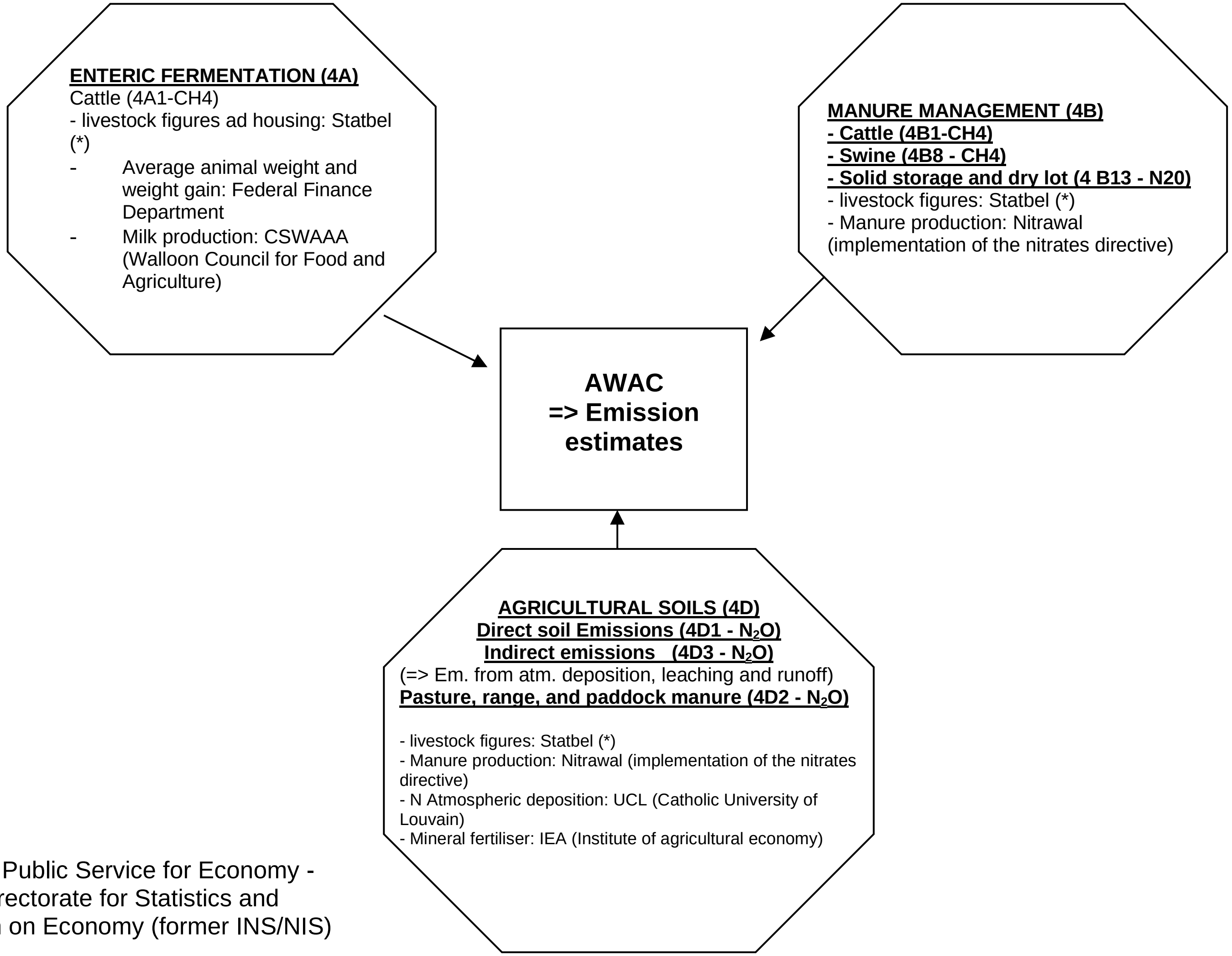
INDUSTRY - Key Sources - Flow of activity data - Wallonia



INDUSTRY - Key Sources - Flow of activity data - Flanders



AGRICULTURE - Key Sources - Flow of activity data - Wallonia



(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

AGRICULTURE - Key Sources - Flow of activity data - Flanders

ENTERIC FERMENTATION (4A)
Cattle (4A1-CH4)
- livestock figures: Statbel (*)
- Average animal weight, milkproduction, feeding situation and weight gain: Flemish Department of Agriculture and Fisheries

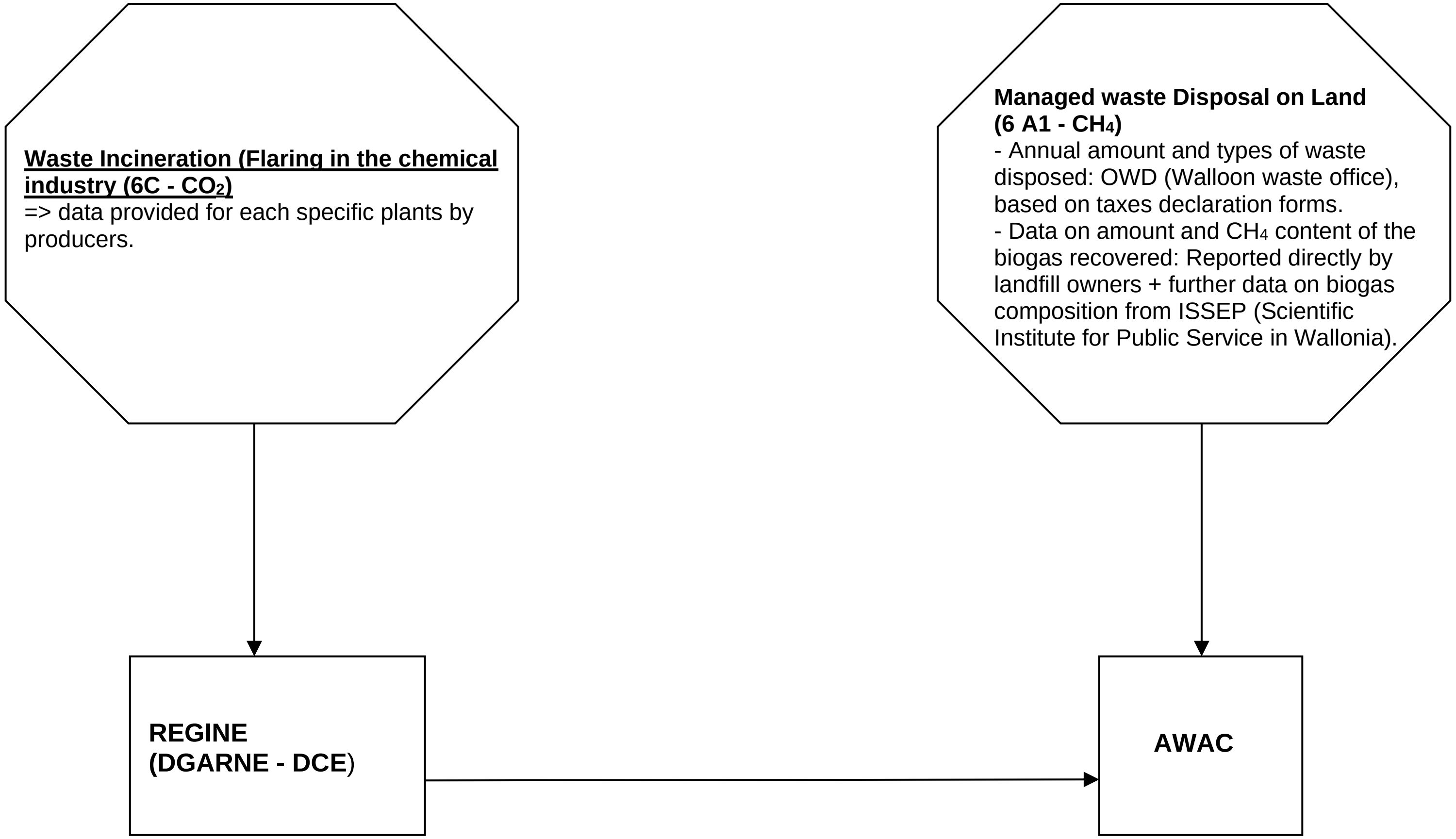
VMM
=> Emission estimates

MANURE MANAGEMENT (4B)
- Cattle (4B1-CH4)
- Swine (4B8 - CH4)
- Solid storage and dry lot (4 B13 - N_20)
- livestock figures: Statbel (*)
- average weight: Department of Agriculture and Fisheries.
- Integrator: Flemish Land Agency
- Manure production: Flemish Land Agency (& Cascada & Safley)
- Amount of manure processed: Manure bank of the Flemish Land Agency
- Allocation to AWMS: Flemish Land Agency

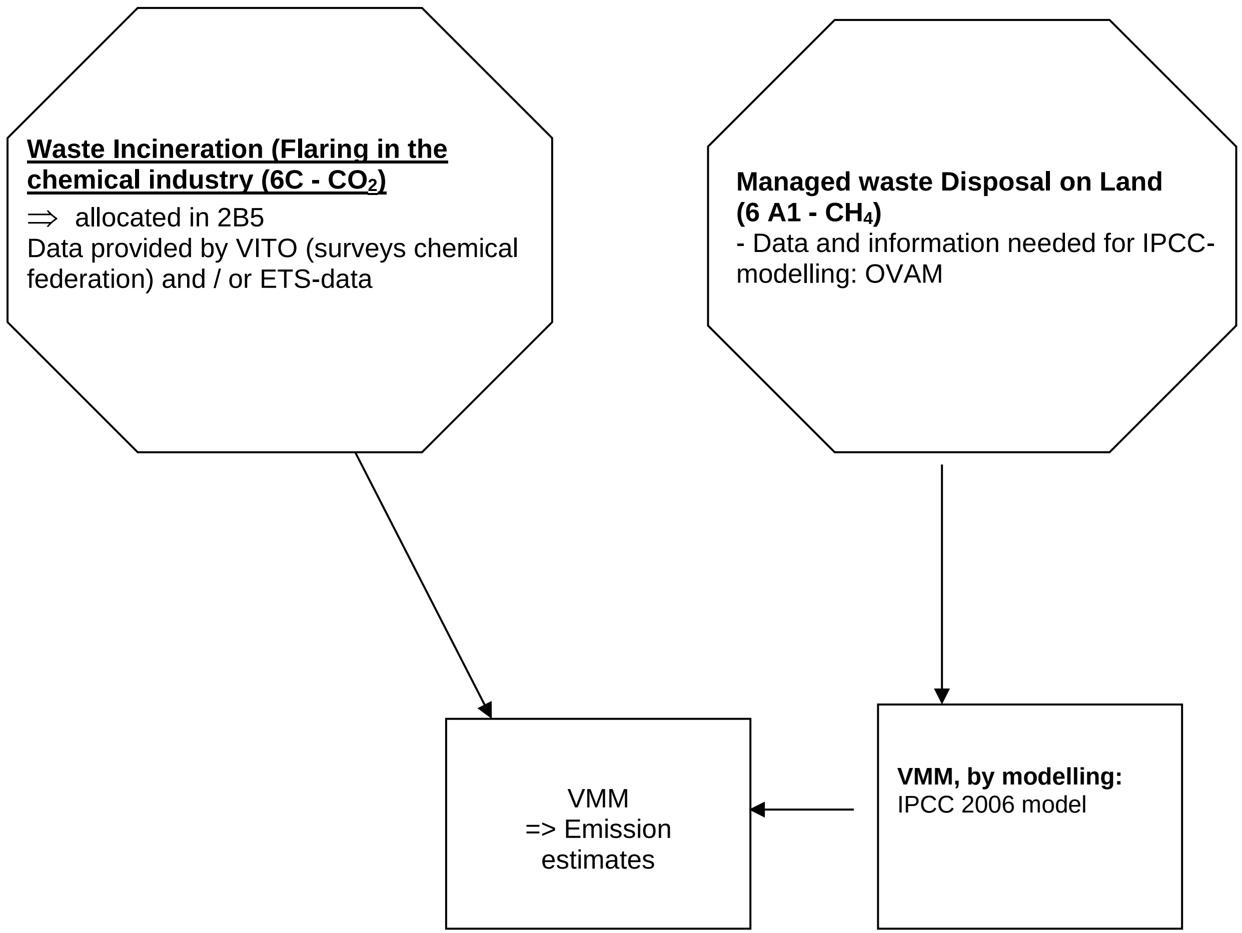
AGRICULTURAL SOILS (4D)
Direct soil Emissions (4D1 - N_2O)
Indirect emissions (4D3 - N_2O)
(=> Em. from atm. deposition, leaching and runoff)
Pasture, range,and paddock manure (4D2 - N_2O)
- Area organic soils: University of Leuven
- Nitrogen leaching & run-off and N-atmosperic deposition: VMM
- livestock figures, agricultural land area, edible crop production: Statbel (*)
- Fertilizer use: Department and Institute for agricultural & Fisheries research
- Amount of manure exported or processed: Flemish Land Agency

(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

WASTE - Key Sources - Flow of activity data - Wallonia



WASTE - Key Sources - Flow of activity data - Flanders



Annex 6: Glossary

Organisms and sources of information

AWAC	Walloon Agency for Air and Climate, in charge of GHG inventories
CELINE/IRCEL	Belgian interregional environmental agency a.o. in charge of national GHG inventory compilation.
CSWAAA	Walloon council for agriculture, agrofood and food
CWaPE	Walloon Commission for Energy (energy markets regulator)
DCE	Part of the DGARNE responsible of the coordination of environmental matters.
DGARNE	Walloon Ministry for Agriculture, Natural Resources and Environment (formerly DGRNE)
DGTRE	Walloon Ministry for technologies, R&D and energy
DIV	National office for the licensing of vehicles
ECONOTEC	Energy and environmental consultants a.o. in charge of F-gas emission inventory for Belgium (with VITO)
FEBIAC	Belgian federation of automobile and bicycles
FeBuPro	Federation Butane Propane
FIGAS/FIGAZ	Federation of natural gas suppliers and equipment manufacturers
IBGE/BIM	Brussels institute for environmental management a.o. in charge of GHG inventories
ICEDD	Private company in charge of energy balances in the Walloon and Brussels regions
IEA	International Energy Agency
IMS Health	Private company collecting pharmaceutical market data
IRM/KMI	Royal meteorological institute
MET	Ministry of equipment and transports in the Walloon region
OVAM	Flemish office for Waste Management
REGINE	Databank of industrial atmospheric emissions in Wallonia
STATBEL	Name of the web-site of the federal public service of Economy (SPF Économie - Direction générale Statistique et Information économique, former INS/NIS) where Belgian offcial statistics are published
VEA	Flemish Energy Agency
VITO	Flemish Institute for Technological Research a.o. in charge of energy balances for Flanders and of F-gases inventories (with ECONOTEC)
VLM	Flemish agency for Land Management (databank for manure management)
VMM	Flemish agency for environment a.o. in charge of GHG emission inventory
VREG	Flemish Commission for Energy (energy markets regulator)

Acronyms

CCIEP	Coordination Committee for International Environmental Policy
COP	Conference of Parties
CRT	Common Reporting Format
EC	European Commission
EMAS	Eco Management and Audit Scheme
ERT	Expert Review Team
ET	Emission Trading
GHG	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change

ISO	International Organisation for Standardization
LPS	Large Point Sources
MOP	Meeting Of the Parties
QA	Quality Assurance
QC	Quality Control
SPF/FOD	Federal Public Service
SPF EPMECME	Federal Public Service for Economy, SME, middle class and Energy (Service public fédéral Economie, PME, classes moyennes et Energie)
UNFCCC	United Nations Framework Convention on Climate Change

Annex 7: Activity data and emissions of CO_2 for road transport in Belgium (category 1A3b)

	Gasoline	Diesel Oil	LPG	Lubricants (2 stroke engines)	CNG	Biomass	Fossil in biofuels	TOTAL kt CO2_excl bio	Gasoline	Diesel Oil	LPG	Lubricants (2 stroke engines)	CNG	Biomass	Fossil in biofuels
	TJ	TJ	TJ	TJ	TJ	TJ	TJ	kt CO_2	kt CO_2	kt CO_2	kt CO_2	kt CO_2	kt CO_2	kt CO_2	kt CO_2
1990	117 809	148 540	2 608	18				19677	8479	11027	169	1.29			
1991	118 312	150 954	2 189	18				19870	8520	11206	142	1.29			
1992	125 530	154 125	2 095	19				20619	9040	11442	136	1.40			
1993	122 732	163 863	1 863	19	10			21131	8844	12164	121	1.41	0.59		
1994	122 749	169 869	2 421	20	12			21615	8846	12610	157	1.45	0.67		
1995	122 476	170 795	2 794	20	21			21692	8829	12679	181	1.50	1.19		
1996	118 357	180 126	2 980	20	19			22108	8540	13372	194	1.47	1.07		
1997	109 442	191 851	3 399	19	16			22360	7894	14242	221	1.40	0.92		
1998	108 432	201 181	4 377	19	16			23047	7826	14935	284	1.41	0.93		
1999	103 256	210 251	4 470	19	14			23353	7453	15608	290	1.39	0.82		
2000	96 722	221 686	4 144	19	15			23711	6983	16457	269	1.37	0.83		
2001	94 146	231 662	4 750	19	12			24307	6799	17197	308	1.40	0.70		
2002	89 806	240 469	4 330	19	13			24621	6486	17851	281	1.40	0.73		
2003	90 598	247 590	3 865	20	13			25176	6543	18380	251	1.43	0.72		
2004	83 031	269 211	3 725	18	12			26228	5999	19985	242	1.35	0.69		
2005	76 873	265 606	3 539	16	13			25503	5554	19717	230	1.19	0.75		
2006	71 384	279 439	3 399	17	12			26124	5158	20744	221	1.23	0.71		
2007	67 382	294 553	2 934	17	13			26928	4869	21866	190	1.24	1		
2008	61 690	301 299	2 701	16	12			27002	4458	22367	175	1.20	1		
2009	58 497	294 998	2 468	16	13	5 315	251	26306	4225	21899	160	1.17	1	395	19
2010	52 150	289 119	2 235	15	6	14 416	678	25428	3767	21463	145	1.11	0	1071	51
2011	49 929	286 226	2 328	14	8	13 948	654	25056	3606	21248	151	1.05	0	1036	50
2012	48 636	277 284	2 235	13	11	13 880	654	24294	3513	20584	145	0.96	1	1032	50
2013	48 551	271 195	1 956	12	16	13 777	649	23817	3507	20132	127	0.91	1	1024	49
2014	52 173	271 962	2 049	12	50	16 498	835	24158	3769	20189	133	0.88	3	1236	63
2015	55 451	290 464	2 701	11	94	10 304	485	25787	4006	21563	175	0.83	5	766	37
2016	59 944	282 153	2 747	10	200	17 363	874	25534	4331	20946	178	0.76	11	1300	66
2017	60 029	274 191	2 491	9	362	18 795	957	24947	4337	20355	162	0.68	21	1379	72
2018	67 200	268 583	2 338	10	603	18 438	1 325	25078	4855	19938	152	0.73	34	1351	98
2019	75 399	256 468	2 319	10	829	18 637	1 408	24790	5449	19039	151	0.72	47	1361	103
2020	62 050	212 592	1 998	10	733	27 189	1 904	20574	4481	15782	130	0.73	42	1993	139
2021	75 665	227 748	1 984	11	735	29 793	2 288	22712	5467	16907	129	0.83	42	2179	166
2022	86 193	220 596	1 993	11	761	31 421	1 917	22917	6228	16376	129	0.77	43	2086	140

Annex 8: Regional energy balances and national energy balance

Belgium

Energy balance 2021 & 2022 **as provided to Eurostat** http://ec.europa.eu/eurostat/web/energy/data/database

ktoe

Belgium ktoe 2021	Total	Solid fossil fuels	Manufac-tured gases	Peat and peat products	Oil shale and oil sands	Oil and petroleum products	Natural gas	Renewables and biofuels	Non-renewable waste	Nuclear heat	Heat	Electricity
+ Primary production	17.369,9	0,0	Z	0,0	0,0	0,0	4,0	4.165,4	660,5	12.223,2	316,8	Z
+ Recovered & recycled products	67,6	30,8	Z	0,0	0,0	36,9	Z	0,0	Z	Z	Z	Z
+ Imports	81.202,5	2.470,8	0,0	0,0	0,0	58.497,8	17.646,4	1.280,3	0,7	Z	0,0	1.306,4
- Exports	35.614,2	70,2	0,0	0,0	0,0	30.813,1	2.424,7	322,5	0,0	Z	0,0	1.983,7
+ Change in stock	1.342,4	161,1	0,0	0,0	0,0	1.169,1	12,2	0,0	0,0	Z	Z	Z
= Gross available energy	**64.368,1**	**2.592,5**	**0,0**	**0,0**	**0,0**	**28.890,7**	**15.237,9**	**5.123,2**	**661,2**	**12.223,2**	**316,8**	**-677,3**
- International maritime bunkers	7.575,1	0,0	0,0	0,0	0,0	7.569,3	5,9	0,0	Z	Z	Z	Z
= Gross inland consumption	**56.793,0**	**2.592,5**	**0,0**	**0,0**	**0,0**	**21.321,4**	**15.232,0**	**5.123,2**	**661,2**	**12.223,2**	**316,8**	**-677,3**
- International aviation	1.512,0	Z	Z	Z	Z	1.512,0	Z	0,0	Z	Z	Z	Z
= Total energy supply	**55.281,0**	**2.592,5**	**0,0**	**0,0**	**0,0**	**19.809,4**	**15.232,0**	**5.123,2**	**661,2**	**12.223,2**	**316,8**	**-677,3**
Transformation input	**63.729,5**	**2.923,7**	**412,4**	**0,0**	**0,0**	**40.153,0**	**3.418,3**	**3.443,9**	**501,3**	**12.223,2**	**547,9**	**105,8**
+ Electricity & heat generation	19.855,2	4,3	412,4	0,0	0,0	25,4	3.374,8	2.660,1	501,3	12.223,2	547,9	105,8
+ Coke ovens	1.158,4	1.158,4	0,0	0,0	0,0	0,0	0,0	0,0	Z	Z	Z	Z
+ Blast furnaces	1.804,7	1.761,1	0,0	0,0	0,0	0,0	43,5	0,0	Z	Z	Z	Z
+ Gas works	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	Z	Z	Z
+ Refineries & petrochemical industry	40.127,6	Z	Z	Z	Z	40.127,6	Z	Z	Z	Z	Z	Z
+ Patent fuel plants	0,0	0,0	0,0	0,0	0,0	0,0	Z	0,0	0,0	Z	Z	Z
+ BKB & PB plants	0,0	0,0	0,0	0,0	0,0	Z	Z	0,0	0,0	Z	Z	Z
+ Coal liquefaction plants	0,0	0,0	0,0	0,0	0,0	Z	Z	Z	Z	Z	Z	Z
+ For blended natural gas	6,8	Z	0,0	Z	Z	0,0	Z	6,8	Z	Z	Z	Z
+ Liquid biofuels blended	777,0	Z	Z	Z	Z	Z	Z	777,0	Z	Z	Z	Z
+ Charcoal production plants	0,0	Z	Z	Z	Z	Z	Z	0,0	Z	Z	Z	Z
+ Gas-to-liquids plants	0,0	Z	Z	Z	Z	Z	0,0	Z	Z	Z	Z	Z
+ Not elsewhere specified	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	Z	Z
Transformation output	**52.087,5**	**917,6**	**817,2**	**0,0**	**Z**	**40.204,7**	**6,7**	**777,0**	**Z**	**Z**	**725,9**	**8.638,5**
+ Electricity & heat generation	9.364,4	Z	Z	Z	Z	Z	Z	Z	Z	Z	725,9	8.638,5
+ Coke ovens	1.140,0	917,6	222,4	Z	Z	Z	Z	Z	Z	Z	Z	Z
+ Blast furnaces	594,8	0,0	594,8	Z	Z	Z	Z	Z	Z	Z	Z	Z
+ Gas works	0,0	0,0	0,0	Z	Z	Z	Z	Z	Z	Z	Z	Z
+ Refineries & petrochemical industry	40.092,9	Z	Z	Z	Z	40.092,9	Z	0,0	Z	Z	Z	Z
+ Patent fuel plants	0,0	0,0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
+ BKB & PB plants	0,0	0,0	Z	0,0	Z	Z	Z	Z	Z	Z	Z	Z
+ Coal liquefaction plants	0,0	Z	Z	Z	Z	0,0	Z	Z	Z	Z	Z	Z
+ Blended in natural gas	6,7	Z	Z	Z	Z	Z	6,7	Z	Z	Z	Z	Z
+ Liquid biofuels blended	777,0	Z	Z	Z	Z	Z	Z	777,0	Z	Z	Z	Z
+ Charcoal production plants	0,0	Z	Z	Z	Z	Z	Z	0,0	Z	Z	Z	Z
+ Gas-to-liquids plants	0,0	Z	Z	Z	Z	0,0	Z	Z	Z	Z	Z	Z
+ Not elsewhere specified	111,8	0,0	0,0	0,0	Z	111,8	Z	Z	Z	Z	Z	Z
Energy sector	**2.360,7**	**0,0**	**244,5**	**0,0**	**0,0**	**990,7**	**621,8**	**13,9**	**12,2**	**Z**	**0,6**	**476,9**
+ Own use in electricity & heat generation	365,7	0,0	0,0	0,0	0,0	1,0	8,4	13,9	12,2	Z	0,0	330,2
+ Coal mines	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	0,0	0,0
+ Oil & natural gas extraction plants	0,0	Z	Z	Z	Z	0,0	0,0	0,0	Z	Z	0,0	0,0

+ Patent fuel plants	0,0	0,0	0,0	0,0	0,0	Z	Z	0,0	0,0	Z	0,0	0,0
+ Coke ovens	95,3	0,0	95,1	0,0	0,0	0,2	0,0	0,0	0,0	Z	0,0	0,0
+ BKB & PB plants	0,0	0,0	0,0	0,0	0,0	Z	Z	0,0	0,0	Z	0,0	0,0
+ Gas works	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	0,0	0,0
+ Blast furnaces	149,6	0,0	149,4	0,0	0,0	0,2	0,0	0,0	0,0	Z	0,0	0,0
+ Petroleum refineries (oil refineries)	1.716,5	0,0	0,0	0,0	0,0	989,2	591,0	0,0	0,0	Z	0,0	136,3
+ Nuclear industry	0,0	Z	Z	Z	Z	Z	Z	Z	Z	Z	0,0	0,0
+ Coal liquefaction plants	0,0	0,0	0,0	0,0	0,0	Z	Z	Z	Z	Z	0,0	0,0
+ Liquefaction & regasification plants (LNG)	27,5	Z	Z	Z	Z	Z	22,5	Z	Z	Z	0,0	5,0
+ Gasification plants for biogas	0,0	Z	Z	Z	Z	Z	Z	0,0	0,0	Z	0,0	0,0
+ Gas-to-liquids (GTL) plants	0,0	Z	Z	Z	Z	Z	0,0	Z	Z	Z	0,0	0,0
+ Charcoal production plants	0,0	Z	Z	Z	Z	Z	Z	0,0	0,0	Z	0,0	0,0
+ Not elsewhere specified (energy)	6,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	0,6	5,5
Distribution losses	**371,6**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**23,3**	**0,9**	**0,0**	**Z**	**37,2**	**310,1**
Available for final consumption	**40.906,8**	**586,4**	**160,3**	**0,0**	**0,0**	**18.870,4**	**11.175,3**	**2.441,4**	**147,7**	**0,0**	**456,9**	**7.068,4**
Final non-energy consumption	**7.542,2**	**214,1**	**0,0**	**0,0**	**0,0**	**6.304,1**	**1.023,9**	**0,0**	**Z**	**Z**	**Z**	**Z**
Final energy consumption	**33.173,5**	**415,9**	**180,3**	**0,0**	**0,0**	**12.384,9**	**10.151,4**	**2.441,5**	**147,7**	**Z**	**455,9**	**6.995,9**
+ Industry	10.578,8	364,2	180,3	0,0	0,0	1.459,8	4.080,8	720,6	118,8	Z	366,8	3.287,5
+ Iron & steel	1.034,4	18,6	180,3	0,0	0,0	13,0	453,1	0,0	1,7	Z	0,0	367,7
+ Chemical & petrochemical	4.201,2	9,3	0,0	0,0	0,0	1.197,8	1.433,6	8,7	1,0	Z	284,8	1.266,1
+ Non-ferrous metals	298,0	0,0	0,0	0,0	0,0	5,3	113,9	0,0	0,0	Z	0,0	178,8
+ Non-metallic minerals	1.317,0	301,4	0,0	0,0	0,0	94,9	485,4	147,2	99,7	Z	8,2	180,2
+ Transport equipment	110,3	0,0	0,0	0,0	0,0	8,3	37,3	0,0	0,0	Z	0,2	64,5
+ Machinery	278,8	0,0	0,0	0,0	0,0	12,9	135,3	4,3	0,0	Z	0,0	126,3
+ Mining & quarrying	53,9	0,0	0,0	0,0	0,0	1,6	15,9	0,0	0,0	Z	0,0	36,4
+ Food, beverages & tobacco	1.688,8	16,7	0,0	0,0	0,0	16,9	994,2	93,3	0,0	Z	49,5	518,2
+ Paper, pulp & printing	641,3	18,1	0,0	0,0	0,0	9,7	141,7	275,0	14,9	Z	21,1	160,9
+ Wood & wood products	285,6	0,0	0,0	0,0	0,0	10,2	22,8	181,9	1,7	Z	0,0	69,0
+ Construction	223,2	0,0	0,0	0,0	0,0	62,2	76,1	0,0	0,0	Z	0,0	84,9
+ Textile & leather	162,1	0,0	0,0	0,0	0,0	1,6	79,6	0,0	0,0	Z	0,2	80,8
+ Not elsewhere specified (industry)	279,1	0,0	0,0	0,0	0,0	25,4	92,0	5,2	0,0	Z	2,8	153,8
+ Transport	8.528,1	0,1	0,0	0,0	0,0	7.503,0	96,9	772,1	0,0	Z	Z	156,1
+ Rail	153,8	0,1	0,0	0,0	0,0	22,8	Z	0,0	0,0	Z	Z	131,0
+ Road	8.215,0	Z	Z	Z	Z	7.351,5	69,6	772,1	0,0	Z	Z	21,9
+ Domestic aviation	3,7	Z	Z	Z	Z	3,7	Z	0,0	Z	Z	Z	Z
+ Domestic navigation	124,9	0,0	0,0	0,0	0,0	124,9	Z	0,0	0,0	Z	Z	Z
+ Pipeline transport	30,1	Z	Z	Z	Z	0,0	26,8	0,0	Z	Z	Z	3,2
+ Not elsewhere specified (transport)	0,6	0,0	0,0	0,0	0,0	0,1	0,5	0,0	0,0	Z	Z	0,0
+ Other	14.066,6	51,6	0,0	0,0	0,0	3.422,1	5.973,7	948,8	28,9	Z	89,2	3.552,3
+ Commercial & public services	4.543,4	0,0	0,0	0,0	0,0	618,8	1.990,4	80,1	28,7	Z	73,4	1.752,1
+ Households	8.592,2	41,8	0,0	0,0	0,0	2.446,1	3.599,4	833,5	0,0	Z	14,7	1.656,7
+ Agriculture & forestry	867,5	9,9	0,0	0,0	0,0	297,6	384,0	35,0	0,2	Z	1,1	139,6
+ Fishing	29,1	0,0	0,0	0,0	0,0	29,1	0,0	0,0	0,0	Z	0,0	0,0
+ Not elsewhere specified (other)	34,5	0,0	0,0	0,0	0,0	30,5	0,0	0,1	0,0	Z	0,0	3,9
Statistical differences	**191,2**	**-43,7**	**-20,0**	**0,0**	**0,0**	**181,4**	**0,0**	**-0,0**	**-0,0**	**0,0**	**0,9**	**72,5**
Gross electricity production	8.594,9	3,8	170,6	0,0	0,0	15,5	1.936,1	2.034,1	107,5	4.327,3	Z	Z
Gross heat production	494,7	0,0	0,0	0,0	0,0	0,6	359,1	85,4	49,7	0,0	Z	0,0

Belgium ktoe 2022	Total	Solid fossil fuels	Manufac-tured gases	Peat and peat products	Oil shale and oil sands	Oil and petroleum products	Natural gas	Renewables and biofuels	Non-renewable waste	Nuclear heat	Heat	Electricity
+ Primary production	15.879,6	0,0	Z	0,0	0,0	0,0	10,4	4.275,8	603,1	10.697,6	292,8	Z
+ Recovered & recycled products	69,8	28,3	Z	0,0	0,0	41,5	Z	0,0	Z	Z	Z	Z
+ Imports	82.123,4	2.804,1	0,0	0,0	0,0	56.207,1	20.278,2	1.416,6	11,6	Z	0,0	1.405,8
- Exports	37.807,5	81,3	0,0	0,0	0,0	28.073,6	7.208,8	390,6	0,0	Z	0,0	2.053,1
+ Change in stock	-338,2	-13,6	0,0	0,0	0,0	-210,1	-114,5	0,0	0,0	Z	Z	Z
= Gross available energy	**59.927,1**	**2.737,5**	**0,0**	**0,0**	**0,0**	**27.964,9**	**12.965,2**	**5.301,8**	**614,7**	**10.697,6**	**292,8**	**-647,2**
- International maritime bunkers	7.646,3	0,0	0,0	0,0	0,0	7.642,2	4,1	0,0	Z	Z	Z	Z
= Gross inland consumption	**52.280,9**	**2.737,5**	**0,0**	**0,0**	**0,0**	**20.322,7**	**12.961,1**	**5.301,8**	**614,7**	**10.697,6**	**292,8**	**-647,2**
- International aviation	1.751,3	Z	Z	Z	Z	1.751,3	Z	0,0	Z	Z	Z	Z
= Total energy supply	**50.529,5**	**2.737,5**	**0,0**	**0,0**	**0,0**	**18.571,4**	**12.961,1**	**5.301,8**	**614,7**	**10.697,6**	**292,8**	**-647,2**
Transformation input	**60.767,2**	**3.108,3**	**464,5**	**0,0**	**0,0**	**38.334,3**	**3.389,5**	**3.638,3**	**459,3**	**10.697,6**	**518,1**	**157,4**
+ Electricity & heat generation	18.506,6	5,0	464,5	0,0	0,0	39,7	3.344,7	2.820,4	459,3	10.697,6	518,1	157,4
+ Coke ovens	1.172,9	1.172,9	0,0	0,0	0,0	0,0	0,0	0,0	Z	Z	Z	Z
+ Blast furnaces	1.975,3	1.930,5	0,0	0,0	0,0	0,0	44,8	0,0	Z	Z	Z	Z
+ Gas works	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	Z	Z	Z
+ Refineries & petrochemical industry	38.294,5	Z	Z	Z	Z	38.294,5	Z	Z	Z	Z	Z	Z
+ Patent fuel plants	0,0	0,0	0,0	0,0	0,0	0,0	Z	0,0	0,0	Z	Z	Z
+ BKB & PB plants	0,0	0,0	0,0	0,0	0,0	Z	Z	0,0	0,0	Z	Z	Z
+ Coal liquefaction plants	0,0	0,0	0,0	0,0	0,0	Z	Z	Z	Z	Z	Z	Z
+ For blended natural gas	12,2	Z	0,0	Z	Z	0,0	Z	12,2	Z	Z	Z	Z
+ Liquid biofuels blended	805,7	Z	Z	Z	Z	Z	Z	805,7	Z	Z	Z	Z
+ Charcoal production plants	0,0	Z	Z	Z	Z	Z	Z	0,0	Z	Z	Z	Z
+ Gas-to-liquids plants	0,0	Z	Z	Z	Z	Z	0,0	Z	Z	Z	Z	Z
+ Not elsewhere specified	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	Z	Z
Transformation output	**49.803,6**	**923,8**	**847,5**	**0,0**	**Z**	**38.311,3**	**12,2**	**805,7**	**Z**	**Z**	**653,4**	**8.249,7**
+ Electricity & heat generation	8.903,1	Z	Z	Z	Z	Z	Z	Z	Z	Z	653,4	8.249,7
+ Coke ovens	1.153,2	923,8	229,4	Z	Z	Z	Z	Z	Z	Z	Z	Z
+ Blast furnaces	618,1	0,0	618,1	Z	Z	Z	Z	Z	Z	Z	Z	Z
+ Gas works	0,0	0,0	0,0	Z	Z	Z	Z	Z	Z	Z	Z	Z
+ Refineries & petrochemical industry	38.206,7	Z	Z	Z	Z	38.206,7	Z	0,0	Z	Z	Z	Z
+ Patent fuel plants	0,0	0,0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
+ BKB & PB plants	0,0	0,0	Z	0,0	Z	Z	Z	Z	Z	Z	Z	Z
+ Coal liquefaction plants	0,0	Z	Z	Z	Z	0,0	Z	Z	Z	Z	Z	Z
+ Blended in natural gas	12,2	Z	Z	Z	Z	Z	12,2	Z	Z	Z	Z	Z
+ Liquid biofuels blended	805,7	Z	Z	Z	Z	Z	Z	805,7	Z	Z	Z	Z
+ Charcoal production plants	0,0	Z	Z	Z	Z	Z	Z	0,0	Z	Z	Z	Z
+ Gas-to-liquids plants	0,0	Z	Z	Z	Z	0,0	Z	Z	Z	Z	Z	Z
+ Not elsewhere specified	104,6	0,0	0,0	0,0	Z	104,6	Z	Z	Z	Z	Z	Z
Energy sector	**2.170,8**	**0,0**	**256,9**	**0,0**	**0,0**	**1.046,2**	**404,4**	**8,1**	**5,6**	**Z**	**0,0**	**449,6**
+ Own use in electricity & heat generation	335,1	0,0	0,0	0,0	0,0	0,9	6,0	8,1	5,6	Z	0,0	314,4
+ Coal mines	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	0,0	0,0
+ Oil & natural gas extraction plants	0,0	Z	Z	Z	Z	0,0	0,0	0,0	Z	Z	0,0	0,0
+ Patent fuel plants	0,0	0,0	0,0	0,0	0,0	Z	Z	0,0	0,0	Z	0,0	0,0
+ Coke ovens	95,9	0,0	95,7	0,0	0,0	0,2	0,0	0,0	0,0	Z	0,0	0,0
+ BKB & PB plants	0,0	0,0	0,0	0,0	0,0	Z	Z	0,0	0,0	Z	0,0	0,0
+ Gas works	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	0,0	0,0
+ Blast furnaces	161,3	0,0	161,1	0,0	0,0	0,2	0,0	0,0	0,0	Z	0,0	0,0
+ Petroleum refineries (oil refineries)	1.470,1	0,0	0,0	0,0	0,0	1.044,8	301,5	0,0	0,0	Z	0,0	123,7
+ Nuclear industry	0,0	Z	Z	Z	Z	Z	Z	Z	Z	Z	0,0	0,0
+ Coal liquefaction plants	0,0	0,0	0,0	0,0	0,0	Z	Z	Z	Z	Z	0,0	0,0
+ Liquefaction & regasification plants (LNG)	106,0	Z	Z	Z	Z	Z	96,9	Z	Z	Z	0,0	9,1

+ Gasification plants for biogas	0,0	Z	Z	Z	Z	Z	Z	0,0	0,0	Z	0,0	0,0
+ Gas-to-liquids (GTL) plants	0,0	Z	Z	Z	Z	Z	0,0	Z	Z	Z	0,0	0,0
+ Charcoal production plants	0,0	Z	Z	Z	Z	Z	Z	0,0	0,0	Z	0,0	0,0
+ Not elsewhere specified (energy)	2,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	Z	0,0	2,4
Distribution losses	**346,6**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**25,2**	**0,9**	**0,0**	**Z**	**31,9**	**288,6**
Available for final consumption	**37.048,6**	**553,0**	**126,1**	**0,0**	**0,0**	**17.502,3**	**9.154,3**	**2.460,1**	**149,8**	**0,0**	**396,3**	**6.706,9**
Final non-energy consumption	**6.522,0**	**219,4**	**0,0**	**0,0**	**0,0**	**5.485,3**	**817,3**	**0,0**	**Z**	**Z**	**Z**	**Z**
Final energy consumption	**30.383,4**	**339,9**	**151,1**	**0,0**	**0,0**	**11.989,1**	**8.314,5**	**2.460,0**	**149,8**	**Z**	**396,3**	**6.582,7**
+ Industry	9.580,6	301,8	151,1	0,0	0,0	1.300,4	3.477,3	709,1	125,8	Z	311,9	3.203,2
+ Iron & steel	967,1	15,0	151,1	0,0	0,0	12,2	408,0	0,0	1,7	Z	0,0	379,1
+ Chemical & petrochemical	3.699,4	9,1	0,0	0,0	0,0	1.062,6	1.171,1	7,9	0,5	Z	236,6	1.211,7
+ Non-ferrous metals	285,5	0,0	0,0	0,0	0,0	4,0	113,5	0,0	0,0	Z	0,0	168,0
+ Non-metallic minerals	1.261,3	245,3	0,0	0,0	0,0	81,0	466,1	151,9	103,6	Z	8,2	205,4
+ Transport equipment	103,8	0,0	0,0	0,0	0,0	6,2	44,0	1,2	0,0	Z	0,4	52,1
+ Machinery	267,7	0,0	0,0	0,0	0,0	11,6	119,0	2,5	0,0	Z	0,0	134,6
+ Mining & quarrying	50,4	0,0	0,0	0,0	0,0	1,1	12,1	0,0	0,0	Z	0,0	37,1
+ Food, beverages & tobacco	1.508,6	18,3	0,0	0,0	0,0	13,6	836,0	96,4	0,0	Z	33,6	510,7
+ Paper, pulp & printing	619,0	14,1	0,0	0,0	0,0	10,0	124,9	266,7	18,4	Z	21,1	163,8
+ Wood & wood products	252,0	0,0	0,0	0,0	0,0	7,6	10,7	170,7	1,7	Z	12,1	49,2
+ Construction	185,0	0,0	0,0	0,0	0,0	56,8	48,6	0,8	0,0	Z	0,0	78,7
+ Textile & leather	128,5	0,0	0,0	0,0	0,0	1,0	57,5	0,0	0,0	Z	0,0	69,9
+ Not elsewhere specified (industry)	250,6	0,0	0,0	0,0	0,0	32,8	65,8	9,3	0,0	Z	0,0	142,7
+ Transport	8.660,7	0,1	0,0	0,0	0,0	7.587,6	87,4	802,2	0,0	Z	Z	183,4
+ Rail	151,3	0,1	0,0	0,0	0,0	23,6	Z	0,0	0,0	Z	Z	127,6
+ Road	8.340,1	Z	Z	Z	Z	7.433,4	63,5	802,2	0,0	Z	Z	41,0
+ Domestic aviation	3,8	Z	Z	Z	Z	3,8	Z	0,0	Z	Z	Z	Z
+ Domestic navigation	126,7	0,0	0,0	0,0	0,0	126,7	Z	0,0	0,0	Z	Z	Z
+ Pipeline transport	38,5	Z	Z	Z	Z	0,0	23,6	0,0	Z	Z	Z	14,8
+ Not elsewhere specified (transport)	0,4	0,0	0,0	0,0	0,0	0,1	0,3	0,0	0,0	Z	Z	0,0
+ Other	12.142,1	38,0	0,0	0,0	0,0	3.101,1	4.749,7	948,7	24,0	Z	84,4	3.196,1
+ Commercial & public services	3.988,7	0,0	0,0	0,0	0,0	522,7	1.582,2	84,4	23,9	Z	72,5	1.702,9
+ Households	7.299,4	28,1	0,0	0,0	0,0	2.174,6	2.860,4	830,1	0,0	Z	11,0	1.395,2
+ Agriculture & forestry	786,5	9,9	0,0	0,0	0,0	340,7	307,0	34,2	0,1	Z	0,8	93,8
+ Fishing	29,7	0,0	0,0	0,0	0,0	29,6	0,1	0,0	0,0	Z	0,0	0,0
+ Not elsewhere specified (other)	37,8	0,0	0,0	0,0	0,0	33,5	0,0	0,1	0,0	Z	0,0	4,2
Statistical differences	**143,3**	**-6,2**	**-25,1**	**0,0**	**0,0**	**27,8**	**22,5**	**0,1**	**0,0**	**0,0**	**-0,0**	**124,2**
Gross electricity production	8.213,8	4,4	194,9	0,0	0,0	25,2	1.886,7	2.219,3	110,4	3.772,9	Z	Z
Gross heat production	428,1	0,0	0,0	0,0	0,0	0,3	306,3	80,7	40,8	0,0	Z	0,0

Walloon Region

Energy balance 2021 (GWh PCI)

2021	Charbon et agglomérés de houille	Coke	Lignite	Fioul léger et pétr.lampant	Fioul lourd	Coke de pétrole	Essence Kérosène	Butane, propane, GPL	Autres prod. pétroliers	Gaz naturel	Bois, sciure écorces, sous-produits végétaux	Liqueur noire	Biogaz	Biodiesel	Bioéthanol	Autre biocarburant	Déchets solides renouvelables	Autre biomasse	Autres combustibles
Production primaire	--	--	--	--	--	--	--	--	--	46,5	6.612,80	418,7	844,3	--	2.094,90	5,1	1.737,20	89,9	2.476,80
Récupération	319,2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solde des échanges	1.285,20	893,5	1.698,30	35.394,30	234,1	395,3	14.809,20	1.479,90	1.760,70	44.851,40	489,7	1.674,70	--	2.181,90	-1.540,10	--	778,5	116,3	575,8
Consom.intér.brute	1.604,40	893,5	1.698,30	35.394,30	234,1	395,3	14.809,20	1.479,90	1.760,70	44.897,90	7.102,50	2.093,30	844,3	2.181,90	554,8	5,1	2.515,80	206,2	3.052,60
Entrées en transform.	--	--	--	16,6	1,1	--	--	0,3	--	11.629,20	1.076,00	285,6	539,5	--	--	1,1	958,7	89,9	1.720,30
TGV	--	--	--	--	--	--	--	--	--	9.297,00	--	--	--	--	--	--	--	--	--
Turbojets TAG	--	--	--	2	--	--	--	--	--	457	--	--	--	--	--	--	--	--	--
Incinérateurs	--	--	--	12,2	--	--	--	--	--	--	--	--	--	--	--	--	958,7	--	1.714,80
Incinérateurs (récup E)				12,2													938,46		1.657,58
Produc élec Autres										46,813			85,102						
Produc cogen/chaleur				0,898						13,599	309,007		277,716			89,891			
Autop elec													27,692						
Alim (Aut)								0		501,9245101	141,822768		53,06			1,03			0,00
Autres industrie (Aut)								0,093853137		3,754378258	0								0,00
Bois (Aut)								0		6,396166878	514,1090264								0,00
Chimie (Aut)								0,014521634		1128,450282	0								5,53
Fab metal (Aut)								0		7,328105993	5,849482033								0,00
MNM (Aut)								0		7,270378223	0								0,00
Papier (Aut)					1,112			0,002759296		48,12160973	83,51117905	285,591	4,73						0,00
Verre (Aut)								0		5,934131125	0								0,00
Agriculture (Aut)				0,044						22,753	5,8		63,726						
Residentiel (Aut)										0,251	0,056								
Tertiaire (Aut)				0,334				0,152		86,998	21,683		27,449			0,028			
Pertes de distribution	--	--	--	--	--	--	--	--	--	112,8	0,3	--	8,4	--	--	--	--	--	--

Energy balance 2021 (GWh PCI)

	Charbon et agglomérés de houille	Coke	Lignite	Fioul léger et pétr.lampant	Fioul lourd	Coke de pétrole	Essence kérosène	Butane, propane, GPL	Autres prod. pétroliers	Gaz naturel	Bois, sciure écorces, sous-produits végétaux	Liqueur noire	Biogaz	Biodiesel	Bioéthanol	Autre biocarburant	Déchets solides renouvelable s	Autre biomasse	Autres combustibles
Consom.intér.brute	1.604,40	893,5	1.698,30	35.394,30	234,1	395,3	14.809,20	1.479,90	1.760,70	44.897,90	7.102,50	2.093,30	844,3	2.181,90	554,8	5,1	2.515,80	206,2	3.052,60
Consommation finale	1.604,40	893,5	1.698,30	35.377,70	233	395,3	14.809,20	1.479,60	1.760,70	33.082,10	6.026,20	1.807,70	222,6	2.181,90	554,8	4	1.557,10	116,3	1.332,30
Cons.finale énergét.	1.595,20	893,5	1.698,30	35.377,70	233	395,3	14.809,20	1.479,60	--	30.782,10	6.026,20	1.807,70	222,6	2.181,90	554,8	4	1.557,10	116,3	1.332,30
Industrie	1.457,60	893,5	1.698,30	2.005,70	233	395,3	11,7	109,2	--	15.879,00	2.709,80	1.807,70	166,5	--	0,6	3,9	1.557,10	--	1.332,30
Sidérurgie	46,7	64	--	112,9	--	3,5	--	--	--	2.631,50	--	--	--	--	--	--	--	--	--
Non ferreux	--	--	--	9,9	--	--	--	0	--	143,4	--	--	--	--	--	--	--	--	--
Chimie	8,7	--	--	215,74	28,4	--	--	3,3	--	5.088,31	644,89	--	2,8	--	--	3,9	--	--	86,2
Chimie (offroad)	--	--	--	0,448															
Minéraux non métalliques	1.402,10	750,9	1.698,30	490,92	50,3	391,9	0	3,3	--	3.453,10	--	--	--	--	--	--	1.557,10	--	1.246,10
MNM (offroad)				10,98															
Alimentation (- chemical plant)	--	41,5	--	215,69	--	--	--	11,1	--	3.042,69	323,5	--	133,8	--	--		--	--	--
Alimentation (offroad)				8,516															
Textile	--	--	--	23,7	--	--	--	0,1	--	72,9	--	--	--	--	--	--	--	--	--
Papier	--	--	--	35,66	154,1	--	--	13,2	--	556,8	528,6	1.807,70	30	--	--	--	--	--	--
Papier (offroad)				21,74															
Fabrications métalliques	--	37,1	--	231,1	0,1	--	4,3	17,2	--	587,3	26,5	--	--	--	--	--	--	--	--
Autres industries	--	--	--	614,41	0	--	7,4	61	--	303	1.186,30	--	--	--	0,6	--	--	--	--
Autres industries (offroad)	--	--	--	13,89															
Transport	--	--	--	19.728,80	--	--	14.625,60	208,4	--	196,1	--	--	--	2.181,90	539,8	--	--	--	--
dont de marchandises	--	--	--	11.199,70	--	--	7.334,20	--	--	--	--	--	--	1.231,00	8,2	--	--	--	--
dont de personnes	--	--	--	8.529,10	--	--	7.291,30	208,4	--	196,1	--	--	--	950,9	531,6	--	--	--	--
Ferroviaire	--	--	--	50,4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trains de marchandises	--	--	--	33,2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trains de voyageurs	--	--	--	17,2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Routier	--	--	--	19.530,40	--	--	6.251,50	208,4	--	196,1	--	--	--	2.181,90	539,8	--	--	--	--
Transport de marchandises	--	--	--	11.018,60	--	--	95,5	--	--	--	--	--	--	1.231,00	8,2	--	--	--	--
Transport de personnes	--	--	--	8.511,80	--	--	6.156,10	208,4	--	196,1	--	--	--	950,9	531,6	--	--	--	--
Aérien	--	--	--	--	--	--	8.374,00	--	--	--	--	--	--	--	--	--	--	--	--
Civil de marchandises	--	--	--	--	--	--	7.238,80	--	--	--	--	--	--	--	--	--	--	--	--
Civil de voyageurs	--	--	--	--	--	--	1.012,50	--	--	--	--	--	--	--	--	--	--	--	--
Militaire	--	--	--	--	--	--	122,7	--	--	--	--	--	--	--	--	--	--	--	--
Navigation intérieure	--	--	--	147,9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Domestique et équivalents	137,6	--	--	13.643,20	--	--	171,9	1.161,90	--	14.706,90	3.316,40	--	56,1	--	14,3	0,1	--	116,3	--
Agriculture (stat)				158,70															
Agriculture (offroad)				1.044,22			60,4								5				
Agriculture (moteur)										96,7			41						
Logement (stat)				10.276,30	--	--		1.032,50	--	9.839,50	3.188,60	--	--	--		--	--	116,3	
Logement (offroad)							110,7								9,2				
Tertiaire				2.164,00	--	--		129,4	--	4.770,70	122	--	15,1	--		0,1	--	--	--
Tertiaire (stat)				2.085,70															
Tertiaire (offroad)	--	--	--	78,3			0,9								0,1				
Consommation finale non-énergét	9,2	--	--	--	--	--	--	--	1.760,70	2.300,10	--	--	--	--	--	--	--	--	--
Transport	--	--	--	--	--	--	--	--	29,6	--	--	--	--	--	--	--	--	--	--
Domestique et équivalents	--	--	--	--	--	--	--	--	46	--	--	--	--	--	--	--	--	--	--
Chimie	9,2	--	--	--	--	--	--	--	0,7	2.300,10	--	--	--	--	--	--	--	--	--
Autres secteurs	--	--	--	--	--	--	--	--	1.684,40	--	--	--	--	--	--	--	--	--	--

Energy balance 2022 (provisional values) (GWh PCI)

GWh	Charbon et agglomérés de houille	Coke	Lignite	Fioul léger et pétr.lampant	Fioul lourd	Coke de pétrole	Essence kérosène	Butane, propane, GPL	Autres prod. pétroliers	Gaz naturel	Bois, sous-prod. Bois, charb. bois, céréales	Liqueur noire	Biogaz	Biodiesel	Bioéthanol	Autre biocarburant	Déchets solides renouvelables	Charbon de bois	Autre biomasse	Autres combustibles
Production primaire	--	--	--	--	--	--	--	--	--	133,5	6.683,30	405,5	952	--	2.040,90	4,5	1.701,40	--	87,4	2.372,90
Récupération	319,2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solde des échanges	812	660,5	936	33.247,20	339,2	326,9	15.228,60	1.605,60	1.751,00	41.035,40	408,4	1.622,10	--	2.117,30	-1.466,70	--	785,3	109,5	--	744
Consom.intér.brute	1.131,20	660,5	936	33.247,20	339,2	326,9	15.228,60	1.605,60	1.751,00	41.168,80	7.091,80	2.027,70	952	2.117,30	574,2	4,5	2.486,70	109,5	87,4	3.117,00
Entrées en transform.	--	--	--	53,6	17,8	--	--	1,8	--	12.135,50	1.036,30	274,8	536,6	--	--	0,9	916,1	--	87,4	1.639,10
Centrales électriques	--	--	--	53,6	17,8	--	--	1,8	--	12.135,50	1.036,30	274,8	536,6	--	--	0,9	916,1	--	87,4	1.639,10
TGV TAG	--	--	--	0,5	--	--	--	--	--	9.672,30	--	--	--	--	--	--	--	--	--	--
Turbojets	--	--	--	3,9	--	--	--	--	--	613,7	--	--	--	--	--	--	--	--	--	--
Incinérateurs	--	--	--	11,4	--	--	--	--	--	--	--	--	--	--	--	--	916,1	--	--	1.632,50
Cogén. publiques et partenariat	--	--	--	36,3	--	--	--	--	--	6,9	325,5	--	309,7	--	--	--	--	--	87,4	--
Cogén. Autoprod. (elec. et chal vendue)	--	--	--	0,4	17,8	--	--	1,8	--	1.709,10	710,7	274,8	119,9	--	--	0,9	--	--	--	6,6
Autres sources de production	--	--	--	1,1	--	--	--	--	--	133,5	--	--	107	--	--	--	--	--	--	--
Pertes de distribution	--	--	--	--	--	--	--	--	--	110,4	--	--	8,4	--	--	--	--	--	--	--
Disponible pour la consommation finale	1.131,20	660,5	936	33.193,60	321,4	326,9	15.228,60	1.603,80	1.751,00	29.070,60	6.055,50	1.752,90	259,3	2.117,30	574,2	3,5	1.570,60	109,5	--	1.477,90
Différence statistique	--	--	--	--	--	--	--	--	--	--	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	--	*0*
Consommation finale	1.131,20	660,5	936	33.193,60	321,4	326,9	15.228,60	1.603,80	1.751,00	29.070,60	6.055,50	1.752,90	259,3	2.117,30	574,2	3,5	1.569,60	109,5	--	1.477,90
Cons.finale énergét.	1.122,40	660,5	936	33.193,60	321,4	326,9	15.228,60	1.603,80	--	26.885,80	6.055,50	1.752,90	259,3	2.117,30	574,2	3,5	1.569,60	109,5	--	1.477,90
Industrie	1.021,70	660,5	936	1.785,50	321,4	326,9	3,3	392,1	--	13.954,70	2.695,20	1.752,90	178,1	--	0,4	3,4	1.569,60	--	--	1.477,90
Sidérurgie	32,6	53	--	102,2	--	2,4	--	--	--	2.419,80	--	--	--	--	--	--	--	--	--	--
Chimie	7,9	--	--	195,4	26,1	--	--	368,3	--	4.865,40	18,6	--	--	--	--	--	--	--	--	103,4
Minéraux non métalliques	981,1	523,3	936	454,3	35,9	324,5	--	3,3	--	3.580,70	--	--	--	--	--	--	1.569,60	--	--	1.204,10
Alimentation	--	41,8	--	203,3	127,2	--	0	0,7	--	2.001,50	714,1	--	128	--	--	3,4	--	--	--	--
Autres	--	42,4	--	830,3	132,2	--	3,3	19,7	--	1.087,30	1.962,50	1.752,90	50,2	--	0,4	--		--	--	170,4
Transport	--	--	--	19.151,30	--	--	15.053,60	209,9	--	237,1	--	--	--	2.117,30	558,7	--	--	--	--	--
Ferroviaire	--	--	--	49,6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Routier	--	--	--	18.952,20	--	--	6.470,50	209,9	--	237,1	--	--	--	2.117,30	558,7	--	--	--	--	--
Aérien	--	--	--	--	--	--	8.583,10	--	--	--	--	--	--	--	--	--	--	--	--	--
Navigation intérieure	--	--	--	149,5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Domestique & équival.	100,7	--	--	12.256,80	--	--	171,7	1.001,70	--	12.694,00	3.360,30	--	81,1	--	15,1	0,1	--	109,5	--	--
Agriculture	--	--	--	1.139,80	--	--	60,2	--	--	56,8	5,9	--	66,4	--	5,2	--	--	--	--	--
Logement	100,7	--	--	9.295,50	--	--	110,7	890	--	7.744,30	3.201,80	--	--	--	9,8	--	--	109,5	--	--
Tertiaire	0	--	--	1.821,50	--	--	0,9	111,7	--	4.892,80	152,6	--	14,8	--	0,1	0,1	--	--	--	--
Cons.fin.non-énergét.	8,8	--	--	--	--	--	--	--	1.751,00	2.184,80	--	--	--	--	--	--	--	--	--	--
Transport									29,6											
Domestique & équival.									46											
Chimie	8,8	--	--	--	--	--	--	--	0,6	2.184,80	--	--	--	--	--	--	--		--	--
Autres secteurs industriels	--	--	--	--	--	--	--	--	1.674,80	--	--	--	--	--	--	--	--		--	--

Brussels Region

Energy balance 2021 (TJ NCV)

2021 - TJ PCI	Charbon et dérivés (n.c.)	Gaz de pétrole liquéfié	Essence	Carbu -réacteur type kérosène	Diesel routier	Mazout de chauffage	Gazole non-routier	Fioul lourd (n.c.a.)	Lubrifiant	Gaz naturel (n.c.a.)	Propane/ Butane	Gaz naturel comprimé	Déchets ménagers et assimilés (non organiques)	Déchets ménagers et assimilés (organiques)	Gaz de boue d'eaux usées	Bois de chauffage, résidus de bois et sous-produits (n.c.)	Charbon de bois	Bioéthanol	Biodiesel	Huile de Colza	Total
Production d'électricité et de chaleur																					**6,559.32**
Incinérateur										124.63			1,937.62	2,660.52							4,722.77
Turbojets				5.49																	5.49
Cogénération										1,677.99										1.26	1,679.25
Stations d'épuration															151.82						151.82
Cokerie																					
Industrie						242.54		9.78		973.60	0.14										**1,226.06**
Tertiaire						1,616.33				12,308.25	1.14										**13,925.73**
Résidentiel	82.79					4,236.59				18,436.65	25.19					196.73	40.55				**23,018.49**
Transport routier		38.14	4,194.64		6,641.70				0.36			50.56						283.45	714.16		**11,923.02**
Voitures		38.14	4,089.11		3,459.37							44.03						276.32	371.97		8,278.95
Utilitaires légers (<3.5t)			45.41		1,470.95													3.07	158.17		1,677.59
Véhicules lourds et bus			0.00		1,710.90							6.53						0.0	183.97		1,901.40
2-roues motorisés			60.12		0.48				0.36									4.06	0.05		65.08
Transport ferroviaire							32.85														**32.85**
Transport fluvial							14.51														**14.51**
Transport par conduites										10.50											**10.50**
Off-road		3.09	27.26				422.37											2.27			**454.99**
Agriculture, sylviculture et pêche		0.00	0.65				1.81											0.05			2.51
Industrie		3.07	8.37				409.24											0.70			421.39
Transport et entreposage		0.01	0.00				11.27											0.00			11.28
Résidentiel			18.24															1.52			19.76
Défense							0.05														0.05

Brussels Region

Energy balance 2022 (TJ NCV)

2022 - TJ PCI	Charbon et dérivés (n.c.)	Gaz de pétrole liquéfié	Essence	Carbu -réacteur type kérosène	Diesel routier	Mazout de chauffage	Gazole non-routier	Fioul lourd (n.c.a.)	Lubrifiant	Gaz naturel (n.c.a.)	Propane/ Butane	Gaz naturel comprimé	Déchets ménagers et assimilés (non organiques)	Déchets ménagers et assimilés (organiques)	Gaz de boue d'eaux usées	Bois de chauffage, résidus de bois et sous-produits (n.c.)	Charbon de bois	Bioéthanol	Biodiesel	Huile de Colza	Total
Production d'électricité et de chaleur																					**5,985.00**
Incinérateur										180.87			1,763.93	2,453.67							4,398.47
Turbojets				15.92																	15.92
Cogénération										1,425.44											1,425.44
Stations d'épuration															145.17						145.17
Cokerie																					
Industrie						311.40		8.00		701.77	0.11										**1,021.27**
Tertiaire						1,623.68				10,400.52	0.93										**12,025.14**
Résidentiel	73.53					4,252.55				14,817.18	25.39					194.50	37.88				**19,401.04**
Transport routier		38.77	4,607.49		6,154.35				0.36			54.26						310.06	709.95		**11,875.24**
Voitures		38.77	4,497.31		3,030.97							39.92						302.64	349.65		8,259.25
Utilitaires légers (<3.5t)			48.94		1,456.63													3.29	168.03		1,676.89
Véhicules lourds et bus			0.00		1,666.30							14.33						0.0	192.22		1,872.86
2-roues motorisés			61.25		0.46				0.36									4.12	0.05		66.24
Transport ferroviaire							27.35														**27.35**
Transport fluvial							14.86														**14.86**
Transport par conduites										7.46											**7.46**
Off-road		3.08	24.49				354.76											2.04			**384.36**
Agriculture, sylviculture et pêche		0.00	0.59				1.80											0.05			2.43
Industrie		3.07	5.67				342.84											0.47			352.05
Transport et entreposage		0.01	0.00				10.07											0.00			10.08
Résidentiel			18.23															1.52			19.74
Défense							0.05														0.05

Flemish region

Energy Balance 2021 (PJ)

2021		Koolteer [PJ]	Kolen [PJ]	Cokes [PJ]	Totaal kolen [PJ]	Aardolie en interm. prod. [PJ]	Raff. gas [PJ]	LPG [PJ]	Benzine [PJ]	Kerosine [PJ]	Gas-en dieselolie [PJ]	Lamppetroleum [PJ]	Zware stookolie [PJ]	Nafta [PJ]	Petroleum-cokes [PJ]	Andere petro. prod. [PJ]	Totaal petro. producten [PJ]	Aard-en mijngas [PJ]	Cokes-ovengas [PJ]	Hoog-ovengas [PJ]	Totaal gas [PJ]	Totaal fossiele brandstoffen [PJ]	Andere brandst. [PJ]	Biomassa [PJ]	Elektriciteit [PJ]	Warmte [PJ]	Nucleaire warmte [PJ]	Totaal [PJ]
Primaire produktie		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	88,1	46,5	24,3	16,8	0,0	175,6
Netto invoer		7,4	74,1	8,6	90,1	1.311,8	0,0	43,9	-87,2	2,4	-341,3	-1,2	155,2	46,1	-20,9	-168,9	939,8	442,8	-0,3	0,0	442,4	1.472,3	0,0	33,0	19,7	0,0	244,5	1.769,5
		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	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
Primair verbruik		7,4	74,1	8,6	90,1	1.311,8	0,0	43,9	-87,2	2,4	-341,3	-1,2	155,2	46,1	-20,9	-168,9	939,8	442,8	-0,3	0,0	442,4	1.472,3	88,1	79,4	44,0	16,8	244,5	1.945,1
		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	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
Internationale bunkers		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	33,8	60,5	0,0	252,5	0,0	0,0	0,0	346,8	0,2	0,0	0,0	0,2	347,0	0,0	0,0	0,0	0,0	0,0	347,0
	scheepvaart	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	60,5	0,0	252,5	0,0	0,0	0,0	313,0	0,2	0,0	0,0	0,2	313,3	0,0	0,0	0,0	0,0	0,0	313,3
	luchtvaart	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	33,8	0,0	0,0	0,0	0,0	0,0	0,0	33,8	0,0	0,0	0,0	0,0	33,8	0,0	0,0	0,0	0,0	0,0	33,8
		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	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
Bruto consumptie		7,4	74,1	8,6	90,1	1.311,8	0,0	43,9	-87,2	-31,4	-401,8	-1,2	-97,3	46,1	-20,9	-168,9	593,0	442,5	-0,3	0,0	442,2	1.125,3	88,1	79,4	44,0	16,8	244,5	1.598,1
		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	0,0	0,00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Transformatie input		0,0	43,9	0,0	43,9	1.311,8	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	1.312,1	75,8	0,0	17,3	93,1	1.449,0	11,9	29,1	0,0	0,0	244,5	1.734,5
		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	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
Elektriciteit en warmte		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,3	75,8	0,0	17,3	93,1	93,3	11,9	29,1	0,0	0,0	244,5	378,8
* Elektriciteit		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	0,0	0,1	36,8	0,0	17,3	54,1	54,1	0,1	14,6	0,0	0,0	244,5	313,3
	Thermische centrales	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	0,0	0,1	36,8	0,0	17,3	54,1	54,1	0,1	14,6	0,0	0,0	0,0	68,8
	Kerncentrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	244,5	244,5
* WKK		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	0,2	38,9	0,0	0,0	38,9	39,1	11,8	14,5	0,0	0,0	0,0	65,4
* Warmte		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	0,0	0,0	0,1	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,1
Raffinaderijen		0,0	0,0	0,0	0,0	1.311,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1.311,8	0,0	0,0	0,0	0,0	1.311,8	0,0	0,0	0,0	0,0	0,0	1.311,8
Andere transformatie		0,0	43,9	0,0	43,9	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	0,0	0,0	43,9	0,0	0,0	0,0	0,0	0,0	43,9
	Cokesfabrieken	0,0	43,9	0,0	43,9	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	0,0	0,0	43,9	0,0	0,0	0,0	0,0	0,0	43,9
	Andere	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	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	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Transformatie output		1,6	0,0	32,8	34,4	0,0	36,9	50,2	138,8	31,4	623,7	1,5	99,9	113,6	33,6	177,8	1.307,2	0,0	9,5	0,0	9,5	1.351,1	0,0	0,0	140,6	19,8	0,0	1.511,5
		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	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
Elektriciteit en warmte		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	140,6	19,8	0,0	160,4
* Elektriciteit		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	119,1	0,0	0,0	119,1
	Thermische centrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	31,7	0,0	0,0	31,7
	Kerncentrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	87,4	0,0	0,0	87,4
* WKK		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	21,5	19,7	0,0	41,2
* Warmte		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,1
Raffinaderijen		0,0	0,0	0,0	0,0	0,0	36,9	50,2	138,8	31,4	623,7	1,5	99,9	113,6	33,6	177,8	1.307,2	0,0	0,0	0,0	0,0	1.307,2	0,0	0,0	0,0	0,0	0,0	1.307,2
Andere transformatie		1,6	0,0	32,8	34,4	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	9,5	0,0	9,5	43,9	0,0	0,0	0,0	0,0	0,0	43,9
	Cokesfabrieken	1,6	0,0	32,8	34,4	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	9,5	0,0	9,5	43,9	0,0	0,0	0,0	0,0	0,0	43,9
	Andere	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	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	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eigenverbruik transformatiesector		0,0	0,0	0,0	0,0	0,0	36,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	11,7	0,0	48,6	32,2	4,0	0,0	36,2	84,8	0,1	0,0	6,1	1,4	0,0	92,4
		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	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
Elektriciteit en warmte		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,7	1,3	0,0	8,0
* Elektriciteit		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,2	0,0	0,0	6,2
	Thermische centrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	0,0	0,0	1,4
	Kerncentrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,8	0,0	0,0	4,8
		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	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
* WKK		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	1,3	0,0	1,8
* Warmte		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	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

Raffinaderijen		0,0	0,0	0,0	**0,0**	0,0	36,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	11,7	0,0	**48,6**	32,2	0,0	0,0	**32,2**	**80,8**	0,1	0,0	-0,8	0,1	0,0	**80,2**
		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	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**
Andere transformatie		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	0,0	**0,0**	0,0	4,0	0,0	**4,0**	**4,0**	0,0	0,0	0,2	0,0	0,0	**4,2**
	Cokesfabrieken	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	0,0	**0,0**	0,0	4,0	0,0	**4,0**	**4,0**	0,0	0,0	0,2	0,0	0,0	**4,2**
	Andere	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	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	**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**	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	**0,0**	**0,0**	0,0	**0,0**	**0,0**	**0,0**
Verliezen		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	0,0	**0,0**	0,6	0,0	0,0	**0,6**	**0,6**	0,0	0,0	8,7	0,2	0,0	**9,5**
		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	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**
Beschikbaar voor finale consumptie		9,0	30,2	41,4	**80,6**	0,0	0,0	94,0	51,7	0,0	221,6	0,3	2,5	159,6	1,0	8,8	**539,6**	333,9	5,1	-17,3	**321,8**	**942,0**	76,2	50,4	169,8	34,9	0,0	**1.273,2**
		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	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
Statistisch verschil in Joule		0,0	-7,1	0,0	**-14,2**	0,0	0,0	-14,2	7,1	-1,6	56,8	-0,1	-4,4	0,0	-0,3	8,9	**0,0**	0,0	0,0	0,0	**0,0**	**0,0**	0,0	-7,1	0,0	7,1	0,0	**-227,4**
		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**	**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
Finaal verbruik		9,0	30,2	41,4	**80,6**	0,0	0,0	94,0	51,7	0,0	221,6	0,3	2,5	159,6	1,0	8,8	**539,6**	333,9	5,1	-17,3	**321,8**	**942,0**	76,2	50,4	169,8	34,9	0,0	**1.273,2**
		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**	**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
Niet energetisch finaal verbruik		9,0	0,0	0,0	**9,0**	0,0	0,0	87,3	0,0	0,0	0,0	0,0	1,1	159,6	1,0	8,8	**257,7**	34,6	0,0	0,0	**34,6**	**301,3**	0,0	0,0	0,0	0,0	0,0	**301,3**
	* Chemie	9,0	0,0	0,0	**9,0**	0,0	0,0	87,3	0,0	0,0	0,0	0,0	1,1	159,6	1,0	0,0	**248,9**	34,6	0,0	0,0	**34,6**	**292,5**	0,0	0,0	0,0	0,0	0,0	**292,5**
	* Andere	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	8,8	**8,8**	0,0	0,0	0,0	**0,0**	**8,8**	0,0	0,0	0,0	0,0	0,0	**8,8**
		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**	**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
Energetisch finaal verbruik		**0,0**	**30,2**	**41,4**	71,6	**0,0**	**0,0**	**6,8**	**51,7**	**0,0**	**221,6**	**0,3**	**1,5**	**0,0**	**0,0**	**0,0**	281,8	**299,4**	**5,1**	**-17,3**	287,2	640,6	**76,2**	**50,4**	**169,8**	34,9	**0,0**	971,9
* Industrie		0,0	29,7	41,4	**71,1**	0,0	0,0	2,6	0,1	0,0	7,2	0,0	1,1	0,0	0,0	0,0	**11,1**	117,4	5,1353 7	- 17,2674 4	**105,2**	**187,4**	74,3	9,7	91,5	26,2	0,0	**389,2**
	IJzer en staal	0,0	28,2	40,3	**68,5**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,1	0,0	0,0	0,0	**0,1**	11,5	5,1	-17,3	**-0,6**	**68,0**	0,1	0,0	7,8	0,0	0,0	**75,9**
	Non-ferro	0,0	0,0	0,9	**0,9**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,3	0,0	0,0	0,0	**0,5**	4,616	0,0	0,0	**4,6**	**6,0**	0,0	0,0	6,7	0,0	0,0	**12,7**
	Chemie	0,0	0,0	0,0	**0,0**	0,0	0,0	2,5	0,0	0,0	0,2	0,0	0,7	0,0	0,0	0,0	**3,4**	44,4	0,0	0,0	**44,4**	**47,7**	72,4	0,3	39,5	0,0	0,0	**160,0**
	Voeding, dranken en tabak	0,0	0,5	0,0	**0,5**	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,0	0,0	0,0	**0,5**	27,4	0,0	0,0	**27,4**	**28,4**	0,0	1,4	13,8	0,0	0,0	**43,7**
	Papier en uitgeverijen	0,0	0,8	0,0	**0,8**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	3,8	0,0	0,0	**3,8**	**4,7**	1,4	4,8	2,9	0,0	0,0	**13,7**
	Minerale niet-metaalprodukten	0,0	0,2	0,0	**0,2**	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	**0,2**	10,3	0,0	0,0	**10,3**	**10,7**	0,5	0,8	2,6	0,0	0,0	**14,5**
	Metaalverwerkende nijverheid	0,0	0,0	0,2	**0,2**	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	**0,2**	5,4	0,0	0,0	**5,4**	**5,7**	0,0	0,1	6,0	0,0	0,0	**11,8**
	Textiel, leder en kleding	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	**0,1**	3,2	0,0	0,0	**3,2**	**3,3**	0,0	0,0	2,8	0,0	0,0	**6,1**
	Andere industrieën	0,0	0,0	0,0	**0,0**	**0,0**	**0,0**	**0,0**	**0,1**	**0,0**	**5,9**	**0,0**	**0,1**	**0,0**	**0,0**	**0,0**	**6,1**	**6,8**	**0,0**	**0,0**	**6,8**	**12,9**	**0,1**	**2,4**	**9,3**	**0,0**	**0,0**	**24,6**
	Waarvan zelfproducenten industrie	0,0	1,3	0,0	**1,3**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	17,5	0,0	0,0	**17,5**	**18,8**	1,4	5,5	0,0	9,6	0,0	**35,3**
	IJzer en staal	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	0,0	**0,0**	0,0000 0	0,0	0,0	**0,0**	**0,0**	0,0	0,0	0,0	0,0	0,0	**0,0**
	Non-ferro	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	0,0	**0,0**	0,9849 9	0,0	0,0	**1,0**	**1,0**	0,0	0,0	0,0	1,1	0,0	**2,1**
	Chemie	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	0,0	**0,0**	9,4	0,0	0,0	**9,4**	**9,4**	0,1	0,0	0,0	8,5	0,0	**17,9**
	Voeding, drank en tabak	0,0	0,4	0,0	**0,4**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	4,9495 2	0,0	0,0	**4,9**	**5,4**	0,0	0,7	0,0	0,0	0,0	**6,1**
	Papier en uitgeverijen	0,0	0,8	0,0	**0,8**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	1,6162 5	0,0	0,0	**1,6**	**2,5**	1,4	4,8	0,0	0,0	0,0	**8,6**
	Minerale niet-metaalprodukten	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	0,0	**0,0**	0,2250 7	0,0	0,0	**0,2**	**0,2**	0,0	0,0	0,0	0,0	0,0	**0,2**
	Metaalverwerkende nijverheid	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	0,0	**0,0**	0,0999 2	0,0	0,0	**0,1**	**0,1**	0,0	0,0	0,0	0,0	0,0	**0,1**
	Textiel, leder en kleding	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	0,0	**0,0**	0,0735 8	0,0	0,0	**0,1**	**0,1**	0,0	0,0	0,0	0,0	0,0	**0,1**
	Andere industrie	**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**	**0,0**	0,0	**0,2**	**0,0**	**0,0**	0,2	0,2	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	0,2
*Residentiële en gelijkgestelde sectoren		0,0	0,5	0,0	**0,5**	0,0	0,0	3,0	1,0	0,0	59,3	0,3	0,3	0,0	0,0	0,0	**63,8**	177,8	0,0	0,0	**177,8**	**242,1**	1,9	20,4	74,5	8,7	0,0	**347,6**
	Huishoudelijke sector, handel, administratie, …	0,0	0,3	0,0	**0,3**	0,0	0,0	2,9	0,9	0,0	49,7	0,0	0,0	0,0	0,0	0,0	**53,5**	151,9	0,0	0,0	**151,9**	**205,7**	1,8	18,3	79,6	8,6	0,0	**314,1**
	Tertiaire sector, handel en administratie	0,0	0,0	0,0	**0,0**	0,0	0,0	0,3	0,0	0,0	8,6	0,0	0,0	0,0	0,0	0,0	**8,9**	52,7	0,0	0,0	**52,7**	**61,6**	1,8	3,2	39,9	2,0	0,0	**108,4**
	hotels en restaurants	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0	**0,4**	4,6	0,0	0,0	**4,6**	**5,0**	0,0	0,0	3,1	0,0	0,0	**8,1**
	gezondheidszorg	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	**0,1**	7,7	0,0	0,0	**7,7**	**7,8**	0,0	0,0	3,7	0,0	0,0	**11,5**
	onderwijs	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	0,0	0,0	**0,2**	5,5	0,0	0,0	**5,5**	**5,7**	0,0	0,0	1,7	0,0	0,0	**7,4**
	kantoren en administraties	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	1,1	0,0	0,0	0,0	0,0	0,0	**1,1**	17,1	0,0	0,0	**17,1**	**18,2**	0,0	0,0	11,7	0,0	0,0	**29,9**
	handel	0,0	0,0	0,0	**0,0**	0,0	0,0	0,1	0,0	0,0	0,9	0,0	0,0	0,0	0,0	0,0	**1,0**	9,7	0,0	0,0	**9,7**	**10,7**	0,0	0,0	10,9	0,0	0,0	**21,6**

andere diensten	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	5,9	0,0	0,0	0,0	0,0	0,0	6,2	8,1	0,0	0,0	8,1	14,2	1,8	3,1	8,7	0,0	0,0	27,9
waarvan zelfproducenten	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,1	1,2	0,0	0,0	1,2	1,3	1,8	3,1	0,0	0,0	0,0	6,3
Huishoudens	0,0	0,3	0,0	0,3	0,0	0,0	2,568	0,9	0,0	41,2	0,0	0,0	0,0	0,0	0,0	44,6	99,2	0,0	0,0	99,2	144,1	0,0	15,2	39,8	6,7	0,0	205,6639
Land- en tuinbouw, zeevisserij, bosbouw, groenvoorziening	0,0	0,3	0,0	0,3	0,0	0,0	0,098	0,1	0,0	9,6	0,3	0,3	0,0	0,0	0,0	10,3	25,9	0,0	0,0	25,9	36,4	0,0	2,1	-5,1	0,0	0,0	33,5
akkerbouw + intensieve veehouderij	0,0	0,0	0,0	0,0	0,0	0,0	0,078	0,0	0,0	4,6	0,2	0,0	0,0	0,0	0,0	4,9	0,3	0,0	0,0	0,3	5,2	0,0	1,0	1,5	0,0	0,0	7,7
graasdierhouderij	0,0	0,0	0,0	0,0	0,0	0,0	0,005	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0	2,6	0,0	0,0	0,0	0,0	2,6	0,0	1,0	0,5	0,0	0,0	4,0
glastuinbouw	0,0	0,2	0,0	0,2	0,0	0,0	0,005	0,0	0,0	0,4	0,0	0,2	0,0	0,0	0,0	0,7	25,3	0,0	0,0	25,3	26,1	0,0	0,1	-7,8	0,0	0,0	18,4
vollegrondstuinbouw + blijvende teelten	0,0	0,1	0,0	0,1	0,0	0,0	0,010	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,8	0,3	0,0	0,0	0,3	1,2	0,0	0,0	0,7	0,0	0,0	1,9
zeevisserij	0,0	0,0	0,0	0,0	0,0	0,0	0,000	0,0	0,0	1,2	0,0	0,0	0,0	0,0	0,0	1,2	0,0	0,0	0,0	0,0	1,2	0,0	0,0	0,0	0,0	0,0	1,2
bosbouw	0,0	0,0	0,0	0,0	0,0	0,0	0,000	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,1
groenvoorziening	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	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
waarvan zelfproducenten	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	0,0	0,0	23,6	0,0	0,0	23,6	23,6	0,0	2,0	0,0	0,0	0,0	25,6
* Transport	0,0	0,0	0,0	0,0	0,0	0,0	1,2	50,6	0,0	155,1	0,0	0,1	0,0	0,0	0,0	206,9	4,2	0,0	0,0	4,2	211,1	0,0	20,2	3,8	0,0	0,0	235,1
Wegvervoer	0,0	0,0	0,0	0,0	0,0	0,0	1,2	50,5	0,0	149,5	0,0	0,0	0,0	0,0	0,0	201,2	2,2	0,0	0,0	2,2	203,4	0,0	20,2	0,8	0,0	0,0	224,5
Spoorvervoer	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,8	0,0	0,0	2,6	0,0	0,0	3,4
Luchtvaart	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	0,0	0,1	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,1
Scheepvaart	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,8	0,0	0,1	0,0	0,0	0,0	4,9	0,0	0,0	0,0	0,0	4,9	0,0	0,0	0,0	0,0	0,0	4,9
Transport door pijpleidingen	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**1,97**	**0,00**	**0,00**	**1,97**	**1,97**	**0,00**	**0,00**	**0,34**	**0,00**	**0,00**	**2,3**
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,0
*Waarvan off-road totaal	0,00	0,00	0,00	0,00	0,00	0,00	0,09	1,07	0,00	12,17	0,00	0,00	0,00	0,00	0,00	13,34	0,00	0,00	0,00	0,00	13,34	0,00	0,00	0,14	0,00	0,00	13,5
*Waarvan off-road Industrie	0,00	0,00	0,00	0,00	0,00	0,00	0,09	0,12	0,00	5,08	0,00	0,00	0,00	0,00	0,00	5,29	0,00	0,00	0,00	0,00	5,29	0,00	0,00	0,07	0,00	0,00	5,4
*Waarvan off-road tertiaire sector	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3,80	0,00	0,00	0,00	0,00	0,00	3,81	0,00	0,00	0,00	0,00	3,81	0,00	0,00	0,00	0,00	0,00	3,8
*Waarvan off-road huishoudens	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,88	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,88	0,00	0,00	0,00	0,00	0,88	0,00	0,00	0,06	0,00	0,00	0,9
*Waarvan off-road Land- en tuinbouw, zeevisserij, bosbouw, groenvoorziening	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,07	0,00	3,29	0,00	0,00	0,00	0,00	0,00	3,36	0,00	0,00	0,00	0,00	3,36	0,00	0,00	0,00	0,00	0,00	3,4

Flemish region

Energy Balance 2022 (provisional data) (PJ)

2022		Kooltee r [PJ]	Kole n [PJ]	Coke s [PJ]	Totaa l kolen [PJ]	Aardoli e en interm. prod. [PJ]	Raff. gas [PJ]	LPG [PJ]	Benzin e [PJ]	Kerosin e [PJ]	Gas-en dieseloli e [PJ]	Lamppetr o- leum [PJ]	Zware stookoli e [PJ]	Naft a [PJ]	Petroleu m- cokes [PJ]	Ander e petro. prod. [PJ]	Totaal petro. producte n [PJ]	Aard- en mijnga s [PJ]	Cokes- ovenga s [PJ]	Hoog- ovengas [PJ]	Totaa l gas [PJ]	Totaal fossiele brandstoffe n [PJ]	Andere brands t. [PJ]	Biomass a [PJ]	Elek- tricitei t [PJ]	Warmt e [PJ]	Nucleair e warmte [PJ]	Totaal [PJ]
Primaire produktie		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	85,1	44,4	29,4	17,4	0,0	176,3
Netto invoer		7,5	74,7	14,3	96,4	1.228,3	0,0	42,5	-71,6	-29,1	-279,8	-1,0	168,3	54,1	-18,7	-157,8	935,2	366,5	-0,3	0,0	366,1	1.397,7	0,4	34,6	3,2	0,0	236,5	1.672,5
		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	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
Primair verbruik		7,5	74,7	14,3	96,4	1.228,3	0,0	42,5	-71,6	-29,1	-279,8	-1,0	168,3	54,1	-18,7	-157,8	935,2	366,5	-0,3	0,0	366,1	1.397,7	85,5	79,0	32,6	17,4	236,5	1.848,8
		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	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
Internationale bunkers		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	43,1	61,3	0,0	258,6	0,0	0,0	0,0	363,1	0,2	0,0	0,0	0,2	363,3	0,0	0,0	0,0	0,0	0,0	363,3
	scheepvaart	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	61,3	0,0	258,6	0,0	0,0	0,0	320,0	0,2	0,0	0,0	0,2	320,1	0,0	0,0	0,0	0,0	0,0	320,1
	luchtvaart	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	43,1	0,0	0,0	0,0	0,0	0,0	0,0	43,1	0,0	0,0	0,0	0,0	43,1	0,0	0,0	0,0	0,0	0,0	43,1
		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	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
Bruto consumptie		7,5	74,7	14,3	96,4	1.228,3	0,0	42,5	-71,6	-72,2	-341,1	-1,0	-90,4	54,1	-18,7	-157,8	572,1	366,3	-0,3	0,0	366,0	1.034,5	85,5	79,0	32,6	17,4	236,5	1.485,6
		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	0,0	0,00	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Transformatie input		0,0	43,5	0,0	43,5	1.228,3	0,0	0,0	0,0	0,0	0,2	0,1	0,0	0,0	0,0	0,0	1.228,6	75,3	0,0	19,4	94,8	1.366,9	10,7	30,2	0,0	0,0	236,5	1.644,2
		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	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
Elektriciteit en warmte		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,1	0,0	0,0	0,0	0,0	0,3	75,3	0,0	19,4	94,8	95,1	10,7	30,2	0,0	0,0	236,5	372,5
* Elektriciteit		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,2	39,0	0,0	19,4	58,4	58,6	0,1	15,0	0,0	0,0	236,5	310,2
	Thermische centrales	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,2	39,0	0,0	19,4	58,4	58,6	0,1	15,0	0,0	0,0	0,0	73,6
	Kerncentrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	236,5	236,6
* WKK		0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,1	36,3	0,0	0,0	36,3	36,5	10,6	15,2	0,0	0,0	0,0	62,2
* Warmte		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	0,0	0,0	0,1	0,0	0,0	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,1
Raffinaderijen		0,0	0,0	0,0	0,0	1.228,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1.228,3	0,0	0,0	0,0	0,0	1.228,3	0,0	0,0	0,0	0,0	0,0	1.228,3
Andere transformatie		0,0	43,5	0,0	43,5	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	0,0	0,0	43,5	0,0	0,0	0,0	0,0	0,0	43,5
	Cokesfabrieken	0,0	43,5	0,0	43,5	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	0,0	0,0	43,5	0,0	0,0	0,0	0,0	0,0	43,5
	Andere	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	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	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Transformatie output		1,7	0,0	32,0	33,7	0,0	41,2	32,8	129,9	72,2	553,3	1,4	92,4	100,6	31,6	166,4	1.221,7	0,0	9,7	0,0	9,7	1.265,1	0,0	0,0	139,6	17,0	0,0	1.421,8
		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	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
Elektriciteit en warmte		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	139,6	17,0	0,0	156,6
* Elektriciteit		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	118,6	0,0	0,0	118,6
	Thermische centrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	34,1	0,0	0,0	34,1
	Kerncentrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	84,5	0,0	0,0	84,5
* WKK		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	21,0	17,0	0,0	38,0
* Warmte		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	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
Raffinaderijen		0,0	0,0	0,0	0,0	0,0	41,2	32,8	129,9	72,2	553,3	1,4	92,4	100,6	31,6	166,4	1.221,7	0,0	0,0	0,0	0,0	1.221,7	0,0	0,0	0,0	0,0	0,0	1.221,7
Andere transformatie		1,7	0,0	32,0	33,7	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	9,7	0,0	9,7	43,5	0,0	0,0	0,0	0,0	0,0	43,5
	Cokesfabrieken	1,7	0,0	32,0	33,7	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	9,7	0,0	9,7	43,5	0,0	0,0	0,0	0,0	0,0	43,5
	Andere	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	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	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Eigenverbruik transformatiesect or		0,0	0,0	0,0	0,0	0,0	41,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	12,0	0,0	53,2	19,4	4,0	0,0	23,4	76,7	0,4	0,0	5,5	1,4	0,0	84,0
		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	0,0	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
Elektriciteit en warmte		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,4	1,2	0,0	7,7
* Elektriciteit		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,0	0,0	0,0	6,0
	Thermische centrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,4	0,0	0,0	1,4
	Kerncentrales	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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,6	0,0	0,0	4,6
		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	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
* WKK		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	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4	1,2	0,0	1,7
* Warmte		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	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

Raffinaderijen		0,0	0,0	0,0	**0,0**	0,0	41,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	12,0	0,0	**53,2**	19,4	0,0	0,0	**19,4**	**72,6**	0,4	0,0	-1,1	0,2	0,0	**72,1**
		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	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**
Andere transformatie		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	0,0	**0,0**	0,0	4,0	0,0	**4,0**	**4,0**	0,0	0,0	0,2	0,0	0,0	**4,2**
	Cokesfabrieken	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	0,0	**0,0**	0,0	4,0	0,0	**4,0**	**4,0**	0,0	0,0	0,2	0,0	0,0	**4,2**
	Andere	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	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	**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**	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	**0,0**	**0,0**	0,0	**0,0**	**0,0**	0,0
Verliezen		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	0,0	**0,0**	0,6	0,0	0,0	**0,6**	**0,6**	0,0	0,0	7,9	0,2	0,0	**8,6**
		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	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**
Beschikbaar voor finale consumptie		9,2	31,2	46,3	**86,7**	0,0	0,0	75,3	58,3	0,0	211,8	0,2	2,1	154,6	0,9	8,6	**511,9**	271,0	5,4	-19,4	**256,9**	**855,5**	74,4	48,9	158,9	32,8	0,0	**1.170,5**
		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	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
Statistisch verschil in Joule		0,0	7,1	0,0	**14,2**	0,0	0,0	0,0	-7,1	5,4	0,0	0,1	2,7	0,0	1,1	-5,3	**-56,8**	0,0	0,0	0,0	**0,0**	**0,0**	-14,2	-7,1	0,0	-7,1	0,0	**-227,4**
		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**	**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
Finaal verbruik		9,2	31,2	46,3	**86,7**	0,0	0,0	75,3	58,3	0,0	211,8	0,2	2,1	154,6	0,9	8,6	**511,9**	271,0	5,4	-19,4	**256,9**	**855,5**	74,4	48,9	158,9	32,8	0,0	**1.170,5**
		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**	**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
Niet energetisch finaal verbruik		9,2	0,0	0,0	**9,2**	0,0	0,0	68,8	0,0	0,0	0,0	0,0	0,9	154,6	0,9	8,6	**233,8**	26,8	0,0	0,0	**26,8**	**269,9**	0,0	0,0	0,0	0,0	0,0	**269,9**
	* Chemie	9,2	0,0	0,0	**9,2**	0,0	0,0	68,8	0,0	0,0	0,0	0,0	0,9	154,6	0,9	0,0	**225,2**	26,8	0,0	0,0	**26,8**	**261,3**	0,0	0,0	0,0	0,0	0,0	**261,3**
	* Andere	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	8,6	**8,6**	0,0	0,0	0,0	**0,0**	**8,6**	0,0	0,0	0,0	0,0	0,0	**8,6**
		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**	**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
Energetisch finaal verbruik		**0,0**	**31,2**	**46,3**	77,5	**0,0**	**0,0**	**6,5**	**58,3**	**0,0**	**211,8**	**0,2**	**1,1**	**0,0**	**0,0**	**0,0**	278,1	**244,1**	**5,4**	**-19,4**	**230,1**	585,6	**74,4**	**48,9**	**158,9**	32,8	**0,0**	900,6
* Industrie		0,0	30,7	46,3	**76,9**	0,0	0,0	2,8	0,1	0,0	9,1	0,0	0,9	0,0	0,0	0,0	**12,9**	97,8	5,3762 7	- 19,4258 3	**83,8**	**173,5**	73,1	9,5	86,1	23,4	0,0	**365,6**
	IJzer en staal	0,0	28,9	45,3	**74,2**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,1	0,0	0,0	0,0	**0,2**	8,0	5,4	-19,4	**-6,1**	**68,3**	0,1	0,0	8,2	0,0	0,0	**76,5**
	Non-ferro	0,0	0,0	0,7	**0,7**	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,4	0,0	0,0	0,0	**0,5**	4,447	0,0	0,0	**4,4**	**5,7**	0,0	0,0	6,3	0,0	0,0	**12,0**
	Chemie	0,0	0,0	0,0	**0,0**	0,0	0,0	2,7	0,0	0,0	0,6	0,0	0,4	0,0	0,0	0,0	**3,7**	35,5	0,0	0,0	**35,5**	**39,2**	70,8	0,2	37,0	0,0	0,0	**147,2**
	Voeding, dranken en tabak	0,0	0,4	0,1	**0,4**	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0	**0,5**	25,9	0,0	0,0	**25,9**	**26,8**	0,0	1,5	12,8	0,0	0,0	**41,1**
	Papier en uitgeverijen	0,0	0,9	0,0	**0,9**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	3,5	0,0	0,0	**3,5**	**4,4**	1,6	5,1	2,8	0,0	0,0	**13,9**
	Minerale niet-metaalprodukten	0,0	0,4	0,0	**0,4**	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0	**0,5**	9,6	0,0	0,0	**9,6**	**10,5**	0,5	0,7	3,0	0,0	0,0	**14,8**
	Metaalverwerkende nijverheid	0,0	0,0	0,2	**0,2**	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	**0,3**	4,2	0,0	0,0	**4,2**	**4,7**	0,0	0,1	5,6	0,0	0,0	**10,4**
	Textiel, leder en kleding	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	**0,1**	2,2	0,0	0,0	**2,2**	**2,3**	0,0	0,0	2,4	0,0	0,0	**4,7**
	Andere industrieën	0,0	0,0	0,0	0,0	**0,0**	**0,0**	**0,0**	**0,1**	**0,0**	**6,9**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**7,1**	**4,5**	**0,0**	**0,0**	**4,5**	**11,6**	**0,1**	**2,0**	**7,9**	**0,0**	**0,0**	**21,5**
	Waarvan zelfproducenten industrie	0,0	1,3	0,0	**1,3**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	19,0	0,0	0,0	**19,0**	**20,3**	1,6	6,7	0,0	9,2	0,0	**37,9**
	IJzer en staal	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	0,0	**0,0**	0,0000 0	0,0	0,0	**0,0**	**0,0**	0,0	0,0	0,0	0,0	0,0	**0,0**
	Non-ferro	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	0,0	**0,0**	0,5888 9	0,0	0,0	**0,6**	**0,6**	0,0	0,0	0,0	1,1	0,0	**1,7**
	Chemie	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	0,0	**0,0**	10,2	0,0	0,0	**10,2**	**10,2**	0,0	0,2	0,0	8,2	0,0	**18,6**
	Voeding, drank en tabak	0,0	0,3	0,0	**0,3**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	6,2820 1	0,0	0,0	**6,3**	**6,6**	0,0	1,3	0,0	0,0	0,0	**8,0**
	Papier en uitgeverijen	0,0	0,9	0,0	**0,9**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	1,4838 4	0,0	0,0	**1,5**	**2,4**	1,6	5,1	0,0	0,0	0,0	**9,1**
	Minerale niet-metaalprodukten	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	0,0	**0,0**	0,2364 4	0,0	0,0	**0,2**	**0,2**	0,0	0,0	0,0	0,0	0,0	**0,3**
	Metaalverwerkende nijverheid	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	0,0	**0,0**	0,0559 3	0,0	0,0	**0,1**	**0,1**	0,0	0,1	0,0	0,0	0,0	**0,1**
	Textiel, leder en kleding	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	0,0	**0,0**	0,0402 4	0,0	0,0	**0,0**	**0,0**	0,0	0,0	0,0	0,0	0,0	**0,0**
	Andere industrie	**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**	**0,0**	0,0	**0,1**	**0,0**	**0,0**	0,1	0,1	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	0,1
*Residentiële en gelijkgestelde sectoren		0,0	0,5	0,0	**0,5**	0,0	0,0	2,5	1,0	0,0	52,4	0,2	0,2	0,0	0,0	0,0	**56,3**	139,5	0,0	0,0	**139,5**	**196,4**	1,3	18,5	68,0	9,4	0,0	**293,6**
	Huishoudelijke sector, handel, administratie, …	0,0	0,3	0,0	**0,3**	0,0	0,0	2,4	0,9	0,0	43,1	0,0	0,0	0,0	0,0	0,0	**46,4**	119,3	0,0	0,0	**119,3**	**166,0**	1,3	16,5	72,7	9,4	0,0	**265,9**
	Tertiaire sector, handel en administratie	0,0	0,0	0,0	**0,0**	0,0	0,0	0,2	0,0	0,0	8,0	0,0	0,0	0,0	0,0	0,0	**8,2**	40,5	0,0	0,0	**40,5**	**48,7**	1,3	3,4	40,3	2,2	0,0	**95,9**
	hotels en restaurants	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0	**0,4**	3,1	0,0	0,0	**3,1**	**3,5**	0,0	0,0	3,0	0,0	0,0	**6,5**
	gezondheidszorg	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	**0,1**	6,3	0,0	0,0	**6,3**	**6,4**	0,0	0,0	3,8	0,0	0,0	**10,2**
	onderwijs	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	**0,1**	4,0	0,0	0,0	**4,0**	**4,2**	0,0	0,0	1,8	0,0	0,0	**6,0**
	kantoren en administraties	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	**1,0**	13,7	0,0	0,0	**13,7**	**14,7**	0,0	0,0	11,8	0,0	0,0	**26,5**
	handel	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	**0,8**	6,8	0,0	0,0	**6,8**	**7,6**	0,0	0,0	10,5	0,0	0,0	**18,1**

andere diensten	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	5,7	0,0	0,0	0,0	0,0	0,0	5,9	6,5	0,0	0,0	6,5	**12,3**	1,3	3,3	9,4	0,0	0,0	**26,4**
waarvan zelfproducenten	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	**0,1**	1,3	0,0	0,0	**1,3**	**1,4**	1,3	3,3	0,0	0,0	0,0	**6,1**
Huishoudens	0,0	0,3	0,0	**0,3**	0,0	0,0	2,213	0,9	0,0	35,1	0,0	0,0	0,0	0,0	0,0	**38,2**	78,9	0,0	0,0	**78,9**	**117,4**	0,0	13,1	32,4	7,1	0,0	**169,9973**
Land- en tuinbouw, zeevisserij, bosbouw, groenvoorziening	0,0	0,3	0,0	**0,3**	0,0	0,0	0,082	0,1	0,0	9,3	0,2	0,2	0,0	0,0	0,0	**9,9**	20,2	0,0	0,0	**20,2**	**30,3**	0,0	2,0	-4,7	0,0	0,0	**27,7**
akkerbouw + intensieve veehouderij	0,0	0,0	0,0	**0,0**	0,0	0,0	0,065	0,0	0,0	4,4	0,2	0,0	0,0	0,0	0,0	**4,7**	0,3	0,0	0,0	**0,3**	**5,0**	0,0	0,9	1,0	0,0	0,0	**6,9**
graasdierhouderij	0,0	0,0	0,0	**0,0**	0,0	0,0	0,004	0,0	0,0	2,5	0,0	0,0	0,0	0,0	0,0	**2,5**	0,0	0,0	0,0	**0,0**	**2,5**	0,0	1,0	0,3	0,0	0,0	**3,7**
glastuinbouw	0,0	0,2	0,0	**0,2**	0,0	0,0	0,004	0,0	0,0	0,4	0,0	0,2	0,0	0,0	0,0	**0,6**	19,6	0,0	0,0	**19,6**	**20,4**	0,0	0,1	-6,5	0,0	0,0	**14,0**
vollegrondstuinbouw + blijvende teelten	0,0	0,1	0,0	**0,1**	0,0	0,0	0,008	0,0	0,0	0,7	0,0	0,0	0,0	0,0	0,0	**0,8**	0,3	0,0	0,0	**0,3**	**1,2**	0,0	0,0	0,5	0,0	0,0	**1,7**
zeevisserij	0,0	0,0	0,0	**0,0**	0,0	0,0	0,000	0,0	0,0	1,2	0,0	0,0	0,0	0,0	0,0	**1,2**	0,0	0,0	0,0	**0,0**	**1,2**	0,0	0,0	0,0	0,0	0,0	**1,2**
bosbouw	0,0	0,0	0,0	**0,0**	0,0	0,0	0,000	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,1**	0,0	0,0	0,0	**0,0**	**0,1**	0,0	0,0	0,0	0,0	0,0	**0,1**
groenvoorziening	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	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**
waarvan zelfproducenten	**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**	**0,0**	**0,0**	**18,1**	**0,0**	**0,0**	**18,1**	**18,1**	**0,0**	**1,8**	**0,0**	**0,0**	**0,0**	**19,9**
* Transport	0,0	0,0	0,0	**0,0**	0,0	0,0	1,2	57,2	0,0	150,4	0,0	0,1	0,0	0,0	0,0	**208,9**	6,8	0,0	0,0	**6,8**	**215,7**	0,0	20,9	4,9	0,0	0,0	**241,4**
Wegvervoer	0,0	0,0	0,0	**0,0**	0,0	0,0	1,2	57,2	0,0	144,8	0,0	0,0	0,0	0,0	0,0	**203,1**	1,9	0,0	0,0	**1,9**	**205,0**	0,0	20,9	1,3	0,0	0,0	**227,2**
Spoorvervoer	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	**0,8**	0,0	0,0	0,0	**0,0**	**0,8**	0,0	0,0	2,5	0,0	0,0	**3,3**
Luchtvaart	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	0,0	**0,1**	0,0	0,0	0,0	**0,0**	**0,1**	0,0	0,0	0,0	0,0	0,0	**0,1**
Scheepvaart	0,0	0,0	0,0	**0,0**	0,0	0,0	0,0	0,0	0,0	4,8	0,0	0,1	0,0	0,0	0,0	**4,9**	0,0	0,0	0,0	**0,0**	**4,9**	0,0	0,0	0,0	0,0	0,0	**4,9**
Transport door pijpleidingen	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**4,94**	**0,00**	**0,00**	**4,94**	**4,94**	**0,00**	**0,00**	**1,00**	**0,00**	**0,00**	**5,9**
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,0
*Waarvan off-road totaal	0,00	0,00	0,00	0,00	0,00	0,00	0,09	1,07	0,00	12,17	0,00	0,00	0,00	0,00	0,00	13,34	0,00	0,00	0,00	0,00	13,34	0,00	0,00	0,14	0,00	0,00	13,5
*Waarvan off-road Industrie	0,00	0,00	0,00	0,00	0,00	0,00	0,09	0,12	0,00	5,08	0,00	0,00	0,00	0,00	0,00	5,29	0,00	0,00	0,00	0,00	5,29	0,00	0,00	0,07	0,00	0,00	5,4
*Waarvan off-road tertiaire sector	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3,80	0,00	0,00	0,00	0,00	0,00	3,81	0,00	0,00	0,00	0,00	3,81	0,00	0,00	0,00	0,00	0,00	3,8
*Waarvan off-road huishoudens	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,88	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,88	0,00	0,00	0,00	0,00	0,88	0,00	0,00	0,06	0,00	0,00	0,9
*Waarvan off-road Land- en tuinbouw, zeevisserij, bosbouw, groenvoorziening	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,07	0,00	3,29	0,00	0,00	0,00	0,00	0,00	3,36	0,00	0,00	0,00	0,00	3,36	0,00	0,00	0,00	0,00	0,00	3,4

Annex 9: Activity data on livestock numbers and crop production in Belgium

Tables 9.1a-c give the evolution (1990-2022) of the livestock number in the three regions.

Livestock number Flanders	**1990**	**2000**	**2005**	**2010**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Cattle												
Slaughter calves	134863	171501	164827	175951	162377	170280	168840	170627	173457	173864	175734	170935
Bovine < 1yr	424150	342386	284837	274949	280161	280800	269386	262556	259382	259822	257564	252053
Bovine between 1 and 2 yr	372193	353901	278343	264993	265365	265519	266246	255384	248677	246072	246546	244683
Bovine > 2yr	220321	141327	148253	199894	175649	169810	171424	167099	158854	150541	141391	140238
Brood cows	111451	186467	175192	173167	164572	164380	155604	147497	142243	132990	129744	125992
Dairy cows	452794	314740	264304	249681	279819	290715	295328	303994	307801	315107	318116	321066
Swine												
Piglet < 20kg	1767168	1637063	1498616	1629182	1651612	1587196	1584429	1578257	1535736	1573955	1565892	1457405
Fattening pigs > 20kg	3900149	4355488	3810790	4159835	4202715	4118800	4064954	4019864	3953969	3990155	3933038	3602830
Breeding males	20079	10866	7670	6071	5335	4688	4982	4420	4239	4213	4005	3717
Sows	708401	574439	478424	438905	4202715	370467	366376	364673	352006	356924	351845	324076
Poultry												
Laying hens	9394876	12407521	10039716	9024029	10257391	10195449	10114884	10299899	9663004	10388981	10549661	10076847
Broilers	16047766	20205510	16667926	18131863	22793740	24150758	25490050	26813985	27023762	28468939	29014447	29556939
Other	357443	448358	300270	163966	333722	366308	414586	410391	414540	421582	457115	441078
Sheep	122649	66096	62236	57096	63069	63944	64111	63765	65835	65921	67601	70118
Goats	4981	5529	13796	20978	35957	44577	50640	53675	57897	62413	69379	73622
Horses	12034	30960	31948	38215	41722	43205	43716	44610	45723	47385	50324	52216
Mules and asses	1971	4878	6539	8778	9401	9716	9829	10012	10491	10899	11261	12071
Other (rabbits, furred animals)	23745	76187	54884	64500	74584	67337	67975	56552	48003	37116	10426	10429

Table 9.1a: Evolution of livestock numbers in Flanders (1990-2022)

Livestock number Wallonia	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022
Cattle												
Bovine under 6 months	278 816	264 798	212 796	196 679	6 837	9 507	10 033	10 432	10 300	9 658	11 683	11 356
Male bovine between 6 months and 1 year	56 609	51 859	46 557	43 167	103 945	102 994	92 803	96 014	94 967	88 431	86 888	84 769
Female bovine between 6 months and 1 year	105 092	106 244	92 344	91 462	193 603	192 658	176 006	182 118	180 354	180 404	179 271	175 072
Fattening male bovine more than 1 year	80 373	66 228	64 872	58 936	49 920	47 681	48 264	45 814	45 592	44 306	43 673	43 816
Bovines more than 2 years for reproduction: male	28 980	24 161	18 465	17 218	22 855	21 805	15 928	16 375	15 397	15 191	15 105	14 681
Bovines female between 1 and 2 years	230 015	216 982	194 471	194 249	185 884	186 400	179 402	173 352	174 515	171 752	168 914	168 158
Bovines female more than 2 yrs	164 164	160 252	181 784	171 666	175 282	171 900	170 346	174 245	164 176	159 561	150 220	148 223
Brood cow	202 670	325 880	306 370	300 457	240 233	245 908	226 651	226 649	221 890	212 797	211 065	205 897
Dairy cattle	385 775	266 657	230 374	214 695	202 825	195 232	186 903	188 905	189 205	186 896	184 740	185 110
Swine												
Piglet under 20 kg	89 065	59 965	54 022	49 539	39 964	43 813	41 963	44 440	43 334	48 732	48 775	46 909
Piglet between 20 and 50 kg	74 878	94 768	87 948	97 914	97 577	65 852	95 419	90 622	96 395	68 917	95 731	77 104
Fattening pigs more than 50 kg	98 922	131 769	198 880	226 749	231 547	252 278	220 199	230 065	226 987	254 873	226 376	227 448
Swine	28 302	23 723	19 116	13 972	11 109	10 109	9 956	9 074	9 268	9 891	9 710	9 223
Fully grown male and female pigs	13 444	7 208	5 727	4 254	2 776	2 084	2 386	2 465	2 124	2 790	2 251	2 177
Others												
Lambs	9 125	10 721	8 307	7 449	8 172	8 628	9 465	9 766	10 594	8 467	9 980	9 756
Sheep under 1 year	19 106	12 078	16 373	12 637	15 553	16 421	18 014	18 586	20 163	16 115	18 994	18 567
Sheep more than 1 year	41 171	34 749	31 712	27 508	31 676	33 445	36 689	37 855	41 066	32 820	38 685	37 816
Goat under 1 year	1 010	2 462	2 720	2 616	3 355	3 542	3 886	4 009	4 349	4 793	4 881	4 670
Goat more than 1 year	2 705	5 233	7 495	7 271	8 399	8 868	9 728	10 037	10 888	12 001	12 221	11 691
Horses	7 307	10 456	11 659	14 335	21 905	22 878	23 267	23 658	24 459	24 459	24 459	24 459
Poultry												
Broilers	609 870	2 864 647	3 439 718	3 588 891	3 907 768	5 185 494	4 759 087	5 129 370	5 614 139	6 321 857	6 512 451	6 318 611
Laying hens	390 171	778 920	1 444 120	1 425 057	1 323 599	1 832 478	1 514 206	1 630 180	1 784 283	1 787 322	1 876 937	1 787 681
Other poultry	168 043	329 714	280 304	234 959	379 205	318 466	384 213	371 820	413 848	377 359	376 449	373 431

Table 9.1b: Evolution of the livestock numbers in Wallonia (1990-2022)

Livestock number Brussels	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022
Cattle												
Dairy cattle	131	64	65	73	70	71	69	71	72	72	72	72
Brood cattle	76	64	70	11	32	33	30	30	29	28	27	27
Other female bovine > 2 years	24	38	44	27	31	30	30	30	28	27	25	25
Heifers for slaughter > 2 years	16	7	20	20	10	9	8	9	8	9	8	8
Male bovine > 2 years	11	56	2	4	6	5	4	4	4	3	3	3
Female bovine between 1 and 2 years	20	54	23	25	31	30	30	29	29	29	28	28
Heifers for slaughter between 1 and 2 years	31	0	7	15	5	13	13	12	12	12	12	12
Male bovine between 1 and 2 years	64	34	33	4	10	9	9	9	8	8	8	8
Slaughter calves	15	0	1	1	1	1	1	1	1	1	1	1
Other female bovine < 1 year	65	63	63	57	66	70	65	67	67	67	67	65
Other male bovine < 1 year	76	50	25	2	10	9	9	9	9	8	8	8
Swine												
Piglets < 20 kg	0	0	0	0	0	0	0	0	0	0	0	0
Sows	3	0	0	0	0	0	0	0	0	0	0	0
Breeding males	0	0	0	0	0	0	0	0	0	0	0	0
Swine >=50 kg	11	12	2	5	3	3	3	3	3	3	3	3
Goats												
Female goats	4	2	8	8	16	17	20	22	24	26	28	30
Other goats	0	0	2	7	8	8	8	9	9	10	10	11
Sheep												
Female sheep	42	214	10	5	11	8	8	9	9	10	11	11
Other sheep	40	85	6	10	15	11	12	12	13	14	15	15
Poultry												
Laying hens	30	110	8	1	8	10	8	9	10	11	11	12
Laying hens for eggs	37	12	165	155	186	197	180	211	197	214	215	207
Pullets	16	0	5	3	4	3	4	4	5	5	5	5
Broilers	250	160	480	200	443	526	500	601	631	691	687	688
Ducks	63	25	3	12	9	5	5	6	6	7	7	8
Turkeys	18	3	5	4	5	6	6	6	7	7	7	7
Geese	9	10	3	11	8	6	6	5	5	5	4	4
Other poultry	3	4	117	10	12	7	13	14	14	6	14	15
Horses												
Horses	18	21	55	21	34	31	31	31	31	31	31	31

Table 9.1c: Evolution of the livestock numbers in Brussels (1990-2022)

Tables 9.2a-c give the evolution (1990-2022) of the crop production in the three regions.

Crop production Flanders (ton dm)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022
Clover	568	513	1170	727	4755	4134	3476	2346	1219	946	866	539
Alfalfa	2463	1323	3038	2421	9817	9357	8004	8294	9363	10662	12050	10507
Dry beans	1246	572	400	591	4	12	5	0	16	71	719	6430
Horse beans	277	232	227	322	897	810	1665	1862	2569	2226	2280	2423
Peas	18681	24109	19613	14861	21673	18680	20904	19429	17969	17793	16886	12884
Green beans	8266	30737	42732	40643	13590	19458	25507	29298	26805	31188	30423	24101
Rape	6909	3150	552	720	IE	IE	IE	IE	IE	IE	IE	IE
Winter wheat	399574	510293	548112	603211	603910	431625	493352	458444	548982	475412	469440	513705
Spring wheat	5836	11241	7842	7189	8715	3958	3409	2056	2179	3834	4022	8649
Rye	10241	3741	1598	931	992	681	662	908	1553	1106	1728	1344
Spelt	251	817	1491	2780	10331	3789	6437	6613	7188	8689	9853	8089
Brewing barley	778	985	748	1511	61	51	90	125	109	59	93	295
Winter barley	145203	63969	63547	84524	116943	99751	110830	99484	122685	102979	97327	110954
Spring barley	8041	8803	7749	4290	7897	4353	3689	3409	3180	5943	4206	8344
Oat	11701	7379	5722	4404	3947	2613	2374	1945	1926	1951	1741	2049
Chicory	21194	141951	117107	69325	51081	45403	51446	69033	/	/	/	/
Flax	27029	34229	33459	18924	23074	25925	18652	21838	26759	20753	22782	16325
Winter rape	154	334	471	2394	2289	1462	2221	1978	2115	1645	2174	2606
Grain mais	41557	329249	523830	605825	539745	377682	482137	342065	408248	394335	432463	430894
Silage mais	2866381	4141483	4531040	4803379	4810474	3416606	4709083	3544315	4327720	4269789	4694627	4141892
Other mais	91752	73176	58246	60600	IE	IE	IE	IE	IE	IE	IE	IE
Sugarbeet	593687	586210	579648	402625	379446	333910	487833	409546	410535	408136	386302	399465
Fodderbeet	125824	80833	44779	43617	46061	35486	52711	34542	45634	47414	54079	57129
Seed potatoes	3235	3763	6354	10274	8578	7786	10395	7083	8577	8502	8370	7058
Early potatoes	47469	91715	75542	91650	70539	71723	79856	42639	78181	56459	52660	51806
Bintje (variety of potato)	192442	250851	213788	193495	IE	IE	IE	IE	IE	IE	IE	IE
Other potatoes	32171	73335	79762	134721	364174	332363	443277	306482	422663	423070	410779	382554

Table 9.2a: Evolution of the crop production (ton of dry matter, harvested products) in Flanders (1990-2022)

Crop production in Wallonia (ton dm)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022
Grains	86 710	106 749	118 632	89 338	165 940	74 443	119 863	113 406	127 667	134 998	141 823	111 408
Beans & pulses	0	5 419	4 895	84 006	18 761	20 873	24 771	27 536	33 439	45 354	52 171	81 813
Tubers	103 884	222 839	236 276	326 285	361 048	335 718	436 182	312 107	374 351	374 054	377 590	343 983
Root crops, other	3 943 080	4 458 833	4 385 406	3 050 777	3 219 995	2 914 825	4 295 987	3 929 693	3 870 194	3 601 002	3 488 024	3 737 652
N-fixing forages	28 047	28 939	34 587	38 965	66 967	54 254	63 541	64 649	53 697	53 150	50 319	49 915
Non-N-fixing forages	1 793 855	2 130 694	2 255 392	2 547 029	2 260 136	1 855 647	2 059 614	1 874 252	1 962 287	1 952 875	2 283 018	1 863 172
Perennial grasses	0	0	0	159 289	276 957	327 932	325 654	328 208	331 535	332 042	329 742	334 693
Maize	6 153	16 674	26 308	53 492	62 036	39 864	46 522	42 415	52 011	56 927	71 650	88 807
Wheat	711 895	915 732	973 971	1 063 139	1 098 973	807 509	933 726	928 498	1 047 703	964 468	886 172	1 023 024
Barley	319 974	222 670	196 205	242 585	260 308	202 616	223 283	181 178	226 540	181 555	163 551	208 776

Table 9.2b: Evolution of the crop production (ton of dry matter, harvested products) in Wallonia (1990-2022)

Crop production Brussels (ton dm)	1990	2000	2005	2010	2015	2016	2017	2018	2019	2020	2021	2022
Grains	30	169	138	54	87	41	62	59	67	69	74	59
Beans & pulses	0	0	0	0	0	0	0	0	0	0	0	0
Tubers	1560	360	971	913	1169	1086	1409	972	1285	1254	1235	1142
Root crops, other	2545	2255	1066	144	699	632	933	815	797	751	715	745
N-fixing forages	0	0	9	12	27	22	21	22	19	17	16	13
Non-N-fixing forages	2604	4029	2303	1471	1914	1430	1851	1471	1723	1717	1928	1700
Perennial grasses	58	329	0	0	4	4	4	4	4	4	4	4
Maize	19	83	170	189	152	106	134	97	116	114	128	132
Wheat	1210	1012	467	561	638	464	534	519	597	539	508	577
Barley	524	395	79	75	100	80	88	74	92	75	69	85

Table 9.2c: Evolution of the crop production (ton of dry matter, harvested products) in Brussels (1990-2022)