Belgium's greenhouse gas inventory (1990-2014)

National Inventory Report
submitted under the United Nations Framework Convention on Climate Change

Preamble

According to Decision 13/CP.20 of the Conference of the Parties to the UNFCCC, the CRF Reporter version 5.0.0 was not functioning in order to enable Annex I Parties to submit their CRF tables. In the same Decision, the Conference of the Parties reiterated that Annex I Parties may submit their CRF tables after April 15 2015, but no longer than the corresponding delay in the CRF Reporter availability.
Decisions 20/CP.21 and 10/CMP.11 further noted that the CRF reporter was still not functioning.

"Functioning" software means that the data on the greenhouse emissions/removals are reported accurately both in terms of reporting format tables and XML format. The CRF reporter version 5.14.0, released on 3th May 2016, as well as its subsequent hotfixes, still may contain issues in the reporting format tables and XML formats and cannot therefore be considered yet as functioning to allow perfect submission of all the information required under Kyoto Protocol and the Convention. Nevertheless, recalling the invitation of the Conference of Parties for Parties to submit as soon as practically possible, and considering that CRF reporter 5.14.2 allows sufficiently accurate reporting, Belgium decide to provide the present report.

In 2015, Belgium made an inventory submission under UNFCCC, but not under the Kyoto Protocol because the CRF Reporter could not deliver CRF tables for Kyoto Protocol LULUCF activities without errors. The present report is the official inventory submission of Belgium for the year 2016 under the UNFCCC and for the years 2015 and 2016 under the Kyoto Protocol, in spite of the remaining deficiencies in the CRF Reporter and underlying CRF tables. Belgium should not be held liable for errors caused by the CRF Reporter in the review of the submitted information. The inventory data reported in the 2015 submission under the UNFCCC have been revised in this submission. Therefore, the 2016 submission should also be considered as a resubmission of the estimates with regard to the 2015 UNFCCC submission.

June 15, 2016

Prepared by:

Flemish Environment Agency (VMM)
Alfons Van de Maelestraat 96, 9320 Erembodegem, Belgium
Telephone +32 (0)53 72.66.52
Fax +32 (0)53 70.63.44
http://www.vmm.be
E-Mail: m.dheer@vmm.be, i.vanvynckt@vmm.be, m.vandenhende@vmm.be, c.debosscher@vmm.be, e.debrabanter@vmm.be, r.vercruysse@vmm.be and s.maene@vmm.be

Flemish institute for technological research (VITO)
Boeretang 200, 2400 Mol, Belgium
Telephone + 32 (0)14 33 55 11
Fax + 32 (0)14 33 55 99
http://www.vito.be
E-Mail: kristien.aernouts@vito.be and kaat.jespers@vito.be

Walloon Agency for Air and Climate (AWAC)
Walloon Public Service
Av. Princes de Liège 7, 5100 Jambes, Belgium
Telephone +32 (0) 81-33 59 33
Fax +32 (0) 81 33 59 32
http://www.awac.be
E-Mail: isabelle.higuet@spw.wallonie.be and andre.guns@spw.wallonie.be

Brussels Environment (IBGE-BIM)
Site de Tour & Taxis, Avenue du Port 86C/3000, 1000
Telephone +32 (0)2 775 7681
Fax +32 (0)2 775 7621
http://www.ibgebim.be
E-Mail: fgoor@environnement.brussels

Federal Public Service of Health, Food Chain Safety and Environment
DG Environment - Climate Change Section
Place Victor Horta 40 box 10, 1060 Brussels, Belgium
Telephone +32 (0)2 524 95 36
Fax +32 (0)2 524 96 01
http://www.climatechange.be
E-Mail: climate@health.fgov.be

Belgian Interregional Environment Agency (IRCEL-CELINE)
Avenue des Arts/Kunstlaan 10-11, 1210 Brussels, Belgium
Telephone +32 (0)2 227 56 77
Fax +32 (0)2 227 56 99
http://www.irceline.be
E-mail: biernaux@irceline.be

ECONOTEC
Rue du Delta 35, 7000 Mons, Belgium
Telephone +32(0)65 31 63 43
Fax +32(0)65 84 30 91
http://www.econotec.be
E-Mail: francis.altdorfer@econotec.be

EXECUTIVE SUMMARY

ES.1 Background information on greenhouse gas inventories, climate change and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

ES.1.1 Background information on climate change (e.g. as it pertains to the national context)

Countries that have signed and ratified the Kyoto Protocol are legally bound to reduce their greenhouse gas emissions by an agreed amount. A single European Union Kyoto Protocol reduction target for greenhouse gas emissions of -8% compared to base-year levels was negotiated for the first commitment period, and a Burden Sharing Agreement allocated the target between Member States of the European Union. Under this agreement, the Belgium's quantified emission limitation was 92.5 % on base-year levels. The first commitment period of the Kyoto Protocol was from 2008 to 2012 and Belgium complied with its commitments reducing its emissions (expressed on an annual basis) by 13.9 %.

The second commitment period of the Kyoto Protocol will run for eight years, from 2013 to 2020 inclusive. For this second commitment period, alongside the EU and its member States, Belgium communicated an independent quantified economy-wide emission reduction target of a 20 percent emission reduction by 2020 compared with 1990 levels (base year). The target for the European Union and its Member States is based on the understanding that it will be fulfilled jointly with the European Union and its Member States. The 20 percent emission reduction target by 2020 is unconditional and supported by legislation in place since 2009 (Climate and Energy Package). As ratification is not yet complete the exact details of the Belgian's target for the second commitment period are still being finalised.

ES.1.2 Background information on greenhouse gas inventories

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 Report (NIR) submitted in 2016. It contains GHG emissions estimates for the period 1990 to 2014, and describes the methodology on which the estimates are based. This report and the attached Common Reporting Format (CRF) have been compiled in accordance with decision 24/CP.19[1] and includes elements required for reporting under the Kyoto Protocol.

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

The inventory covers the seven direct greenhouse gases (or groups of gases) under the Kyoto Protocol. These are as follows:

- Carbon dioxide;
- Methane;
- Nitrous oxide;
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs) ;

[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

- Sulphur hexafluoride (SF_6) and
- Nitrogen trifluoride (NF_3).

These gases contribute directly to climate change owing to their positive radiative forcing effect. Also reported are three indirect greenhouse gases and SO_2:

- Nitrogen oxides (reported as NO_2);
- Carbon monoxide;
- 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.
- Chapter 3 to 7 provide detailed descriptions per inventory sector (energy, industrial processes, solvent and other product use, 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.
- Chapter 10 provides information on the KP-LULUCF.
- Chapter 11 provides information on accounting of Kyoto units.
- Chapter 12 to 14 provide information on changes in national system and national registry, and on adverse impacts and other.

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

The Belgian inventory provides data to assess progress with the Belgian's commitments under the Kyoto Protocol and the Belgian's contribution to the EU's targets under the Kyoto Protocol.

ES.1.3 Background information on supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol.

Background information on supplementary information required under Article 7, Paragraph 1 of the Kyoto Protocol is presented in Chapter 10.
Belgium has not elected grassland and cropland management under Article 3.4 for inclusion in its accounting for the first commitment period nor for the 2nd commitment period.
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ES.2 Summary of national emission and removal related trends, and emissions and removals from KP-LULUCF activities

ES.2.1 GHG Inventory

Table ES2.1 presents the Belgian Greenhouse Gas Inventory totals by gas, both including and excluding net emissions from LULUCF. The largest contribution to total emissions is CO_2, which contributed 84.6% in 2014 (excluding LULUCF). Emissions of CH_4 account for the next largest share with 7.1% and emissions of N_2O make up a further 5.5%.

When excluding LULUCF, emissions of all gases have decreased since 1990, contributing to an overall decrease of 22.0% and 23.0% if you consider the base year for the fluorinated gases (1995).

When including LULUCF, the overall decrease since 1990 is of 23.4% and 24.3% if you consider the base year for the fluorinated gases (1995).

Emissions per capita (excluding LULUCF) amount to 10.2 tonnes CO_2 equivalent in 2014 and has decreased by 30.8% since 1990.

Table ES2.1: Emissions of GHGs in terms of carbon dioxide equivalent emissions, 1990-2014 (Gg CO_2 Equivalent) _part 1

Table ES2.1	**Gg CO_2 Equivalent**												
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
CO_2 emissions excluding net CO_2 from LULUCF	119 983	123 131	122 218	121 157	124 427	125 519	129 010	123 496	129 737	124 208	126 315	125 649	126 015
CO_2 emissions including net CO_2 from LULUCF	117 628	121 010	119 801	118 834	122 097	123 366	127 066	121 280	127 602	122 097	124 515	123 772	122 654
CH_4 emissions excluding CH_4 from LULUCF	12 040	11 999	11 886	11 838	11 867	11 948	11 802	11 690	11 525	11 265	10 827	10 386	9 957
CH_4 emissions including CH_4 from LULUCF	12 041	12 000	11 887	11 839	11 867	11 948	11 829	11 690	11 525	11 265	10 827	10 386	9 957
N_2O emissions excluding N_2O from LULUCF	10 232	10 106	9 859	10 129	10 525	10 997	11 415	11 183	11 057	11 071	10 353	9 964	9 613
N_2O emissions including N_2O from LULUCF	10 245	10 124	9 882	10 159	10 559	11 031	11 677	11 230	11 111	11 128	10 415	10 032	9 689
HFCs	NA,NO	NA,NO	484	484	496	502	602	727	881	936	1 128	1 212	1 438
PFCs	2 191	2 096	2 285	2 196	2 637	2 914	2 767	1 529	844	429	446	276	101
SF_6	1 575	1 493	1 653	1 589	1 931	2 140	2 060	539	296	154	144	139	116
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Total (excluding LULUCF)	**146 021**	**148 826**	**148 385**	**147 393**	**151 882**	**154 020**	**157 657**	**149 163**	**154 340**	**148 062**	**149 213**	**147 626**	**147 240**
Total (including LULUCF)	**143 679**	**146 724**	**145 991**	**145 100**	**149 587**	**151 900**	**156 002**	**146 995**	**152 260**	**146 009**	**147 475**	**145 817**	**143 955**

Table ES2.1: Emissions of GHGs in terms of carbon dioxide equivalent emissions, 1990-2014 (Gg CO_2 Equivalent)_part 2.

Table ES2.1	**Gg CO_2 Equivalent**												**% Changes**
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**1990-2014**
CO_2 emissions excluding net CO_2 from LULUCF	127 524	128 640	125 118	122 320	118 027	120 363	107 283	114 155	104 946	100 932	101 745	96 325	-19.7
CO_2 emissions including net CO_2 from LULUCF	124 173	125 506	122 015	117 944	113 870	116 425	103 297	110 066	100 905	96 746	97 610	92 179	-21.6
CH_4 emissions excluding CH_4 from LULUCF	9 372	9 319	9 075	8 983	8 948	8 737	8 669	8 625	8 369	8 236	8 098	8 048	-33.2
CH_4 emissions including CH_4 from LULUCF	9 373	9 319	9 075	8 983	8 948	8 737	8 669	8 625	8 378	8 236	8 098	8 048	-33.2
N_2O emissions excluding N_2O from LULUCF	8 713	8 850	8 581	7 591	7 094	7 103	7 229	7 760	6 564	6 471	6 281	6 279	-38.6
N_2O emissions including N_2O from LULUCF	8 794	8 933	8 670	7 685	7 194	7 208	7 340	7 873	6 755	6 592	6 404	6 407	-37.5
HFCs	1 609	1 693	1 745	1 877	2 079	2 207	2 391	2 509	2 614	2 733	2 703	2 812	0.0
PFCs	259	378	193	200	224	253	146	107	226	278	432	307	-86.0
SF_6	102	90	91	77	79	87	93	102	112	110	116	95	-94.0
Total (excluding LULUCF)	**147 579**	**148 971**	**144 803**	**141 047**	**136 451**	**138 750**	**125 812**	**133 258**	**122 833**	**118 761**	**119 375**	**113 867**	**-22.0**
Total (including LULUCF)	**144 309**	**145 919**	**141 788**	**136 765**	**132 394**	**134 917**	**121 937**	**129 282**	**118 992**	**114 696**	**115 364**	**109 848**	**-23.5**

ES.2.2 KP-LULUCF activities

KP-LULUCF activities relate to estimated emissions and removals from:

- **Article 3.3**, the net emissions or removals of 'Afforestation, Reforestation and Deforestation (ARD)' since 1990.
- **Article 3.4**, the net emissions or removals of 'Forest Management (FM)' since 1990 (mandatory for the second commitment period). Accounting for emissions/removals from FM is on the basis of the Forest Management Reference Level (projected emissions/removals 2013-2020 under business-as-usual). Any additions to the Belgian's assigned amount resulting from Forest Management (removals exceeding the reference level) are capped at 3.5% of the national total emissions excluding LULUCF in 1990 times eight (the number of years in the second commitment period).
- Afforestation/Reforestation (AR) and Forest Management (FM) total emissions now include carbon stock changes in the Harvested Wood Products pool.

Table ES2.2 details the emissions and removals from these activities which are included in the Belgium's emissions total for reporting under the Kyoto Protocol

Table ES2.2: Emissions of GHGs in terms of carbon dioxide equivalent emissions

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	NET EMISSIONS/REMOVALS			Accounting parameters	Accounting quantity
	2013	2014	Total		
A. Article 3.3 activities	-110.75	-160.41	-271.16		-271.16
A.1. Afforestation/reforestation	-436.42	-488.75	-925.17		-925.17
A.2. Deforestation	325.67	328.34	654.01		654.01
B. Article 3.4 activities			-6082.65		-1084.65
B.1. Forest management			-6082.65		-1084.65
Net emissions/removals	-3041.06	-3041.59	-6082.65		
Forest management reference level (FMRL)				-2499.00	
Technical corrections to FMRL				not estimated	
Forest management cap				40885.95	-1084.65

ES.3 Overview of source and sink category emission estimates and trends, including KP-LULUCF activities

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 2014 this contributed 72% 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 20%. Energy industries and manufacturing industries are both responsible for almost 40% in this decrease while transport increases by 22%.

Industrial processes and product use make up the second largest source of greenhouse gases in Belgium, contributing 17.4% to the national total in 2014 (excluding LULUCF). Emissions of all seven direct greenhouse gases occur from this sector and have declined by 24%. All the sectors are concerned but the metal industry has experienced the most severe decrease.

The third largest source of greenhouse gases is agriculture with 8.7%. Emissions from this sector arise mainly for both CH_4 and N_2O. A few CO_2 emissions arise from liming. Since 1990, emissions from this sector have decreased by 18%, 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 contains sinks as well as sources of CO_2 emissions. LULUCF is a net sink in 2014 as it is for the complete time series. Emissions from this sector occur for CO_2, CH_4 and N_2O.

The remaining sources that contribute to direct greenhouse gas emission totals are waste. In 2014, waste contributed around 1.6 % 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 and wastewater handling. Emissions from this sector have steadily declined and are 59% below 1990 levels in 2014.

Total net emissions (including LULUCF) have decreased by 23.4% since 1990. A more detailed analysis of the evolution of sectors (without LULUCF) is provided in Chapter 2.3 of NIR.

Table ES3.1: Aggregated emission trends per source category, 1990-2014(Gg CO_2 equivalent).

Table ES3.1	Gg CO_2 Equivalent												
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1. Energy	103 194	106 974	105 323	105 234	106 786	107 048	111 362	105 535	109 907	104 557	105 454	105 905	105 842
2. Industrial Processes and product use	26 220	25 243	26 344	25 489	28 478	30 165	29 676	26 943	28 090	27 204	28 416	27 014	26 807
3. Agriculture	12 164	12 010	11 995	12 118	11 983	12 193	12 095	12 105	11 902	12 114	11 272	11 060	10 930
4. Land Use, Land-Use Change and Forestry	-2 342	-2 102	-2 393	-2 293	-2 296	-2 120	-1 655	-2 168	-2 080	-2 054	-1 738	-1 809	-3 285
5. Waste	4 444	4 599	4 723	4 553	4 637	4 615	4 524	4 581	4 441	4 188	4 070	3 646	3 662
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	**143 679**	**146 724**	**145 991**	**145 100**	**149 587**	**151 900**	**156 002**	**146 995**	**152 260**	**146 009**	**147 475**	**145 817**	**143 955**

Table ES3.1	Gg CO_2 Equivalent												% Changes
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	1990-2014
1. Energy	107 068	107 477	104 979	102 176	99 187	101 454	94 270	98 995	89 716	87 534	87 723	82 291	-20.3
2. Industrial Processes and product use	26 639	27 662	26 393	25 670	23 903	24 281	18 559	21 422	20 582	19 009	19 818	19 811	-24.4
3. Agriculture	10 558	10 466	10 244	10 029	10 218	10 072	10 224	10 171	10 082	9 846	9 837	9 942	-18.3
4. Land Use, Land-Use Change and Forestry	-3 270	-3 052	-3 015	-4 282	-4 058	-3 832	-3 875	-3 977	-3 841	-4 065	-4 012	-4 018	71.6
5. Waste	3 314	3 366	3 187	3 172	3 143	2 943	2 760	2 670	2 454	2 372	1 999	1 823	-59.0
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA
Total (including LULUCF)	**144 309**	**145 919**	**141 788**	**136 765**	**132 394**	**134 917**	**121 937**	**129 282**	**118 992**	**114 696**	**115 364**	**109 848**	**-23.5**

ES.3.2 KP-LULUCF Activities

Table ES3.2 presents the base year, 2013 and 2014 emissions calculated from the 2016 inventory submission. KP LULUCF activities are defined differently under the second commitment period: article 3.4 (Forest Management) now reports emissions and removals relative to the Forest Management Reference Level (FMRL).

ES.3.3 Emissions trends and KP-commitment

Emissions in 2014 (with KP LULUCF article 3.3 and 3.4) are 23.4 % under base year emissions. Under the Kyoto Protocol and the EU 'burden sharing' agreement, Belgium is committed to reduce its GHG emissions by 20%.

Table ES3.2: Kyoto basket of emissions, and emissions associated with Article 3.3 and 3.4 for the second commitment period (in Gg CO_2 equivalent)

Table ES3.2	**Gg CO_2 Equivalent**											**% Changes**	
	Base Year	**1990**	**1995**	**2000**	**2005**	**2010**	**2008**	**2009**	**2010**	**2013**	**2014**	**1990-2014**	**Base Year - 2014**
CO_2	119 983	119 983	125 519	126 315	125 118	114 155	120 363	107 283	114 155	101 745	96 325	-19.72%	-19.72%
CH_4	12 040	12 040	11 948	10 827	9 075	8 625	8 737	8 669	8 625	8 098	8 048	-33.16%	-33.16%
N_2O	10 232	10 232	10 997	10 353	8 581	7 760	7 103	7 229	7 760	6 281	6 279	-38.64%	-38.64%
HFCs	502	NA,NO	502	1 128	1 745	2 509	2 207	2 391	2 509	2 703	2 812	NA	460.13%
PFCs	2 914	2 191	2 914	446	193	107	253	146	107	432	307	-85.99%	-89.47%
SF_6	2 140	1 575	2 140	144	91	102	87	93	102	116	95	-93.95%	-95.55%
NF_3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	1	1	1	1	1	1	NA	NA
Total	**147 811**	**143 679**	**151 900**	**147 475**	144 803	133 257	**138 749**	**125 811**	**133 257**	**119 374**	**113 866**	**-20.75%**	**-22.97%**
Article 3.3										-110.75	-160.41		
Article 3.4										-542.06	-542.59		
Kyoto Protocol Total	**147 811**									**118 721**	**113 163**		
% KP Total compared to Base Year Emissions										**-19.68%**	**-23.44%**		

Footnotes:

- The data in this table are all taken from the 2016 inventory submission (1990 – 2014).
- The base year emissions are made up of 1990 emissions for CO2, CH4 and N2O, and 1995 for the F-Gases
- Emissions are presented as Gg CO2 equivalent, using GWP values taken from the IPCC's Fourth Assessment Report (AR4).

Emissions and removals associated with KP-LULUCF enter the table only through the rows labelled Article 3.3, Article 3.4. No technical correction (TC) to the FMRL has been calculated for the 2016 inventory, see section 10.5.3.4

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 60% and up to 80% for NO_x) except for NMVOC where the industrial processes and product use sector is most significant (31%).

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

Table ES4.1: Emissions of Indirect Greenhouse Gases in Belgium, 1990-2014 (in kt).

Gases	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
NO_x	411.03	400.34	389.36	383.39	383.29	381.69	370.89	359.82	363.00	337.97	342.49	332.85	321.12
CO	1412.52	1371.81	1344.01	1257.48	1143.44	1126.42	1101.06	1002.08	960.13	882.40	937.81	891.23	879.83
NMVOC	378.55	360.65	356.26	343.73	336.61	331.02	312.71	306.49	296.48	286.91	265.53	262.50	249.06
SO_2	365.38	367.82	359.07	333.39	290.74	258.05	248.38	226.67	212.87	173.89	173.37	166.96	157.51

Gases	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	% Changes
NO_x	319.52	330.76	315.51	296.66	284.23	268.20	241.20	248.35	230.43	211.56	204.39	194.94	-52.6
CO	850.70	812.25	762.79	702.37	660.88	672.52	446.95	523.79	420.03	370.63	552.62	351.28	-75.1
NMVOC	246.01	229.41	227.14	227.06	210.82	204.41	195.32	193.26	183.63	178.76	176.33	171.90	-54.6
SO_2	153.01	155.25	142.46	133.42	123.90	96.21	74.08	60.45	52.85	47.15	44.54	42.09	-88.5

PART I: ANNUAL INVENTORY SUBMISSION

1 INTRODUCTION

1.1 Background information on greenhouse gas inventories, climate change and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

This 14th National Inventory Report documents 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 and 18/CP.8 of the *Conference of the Partie*s, and the Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC and for the implementing of the Kyoto Protocol.

The greenhouse gas inventory presented here contains information on anthropogenic emissions by sources and removals by sinks for direct greenhouse gases (CO_2, CH_4, N_2O, PFCs, HFCs, NF_3 and SF_6), indirect greenhouse gases (CO, NO_x, NMVOCs) and SO_2. It covers the period 1990-2014. Inventory data for the years 1990 to 2013 have been recalculated/optimized where necessary and in accordance with the new IPCC 2006 guidelines.
During this 2016 submission Belgium took into account informal list of recommendations of 26 November 2015 of the trial review of the 2015 greenhouse gas inventory of Belgium under the Effort Sharing Decision.
The revision of the Belgian greenhouse gas inventory for the complete time series 1990-2013 is attached in annex 3 of this National Inventory Report, together with the new estimates of greenhouse gas emissions for 2014 for Belgium.

This 14th National Inventory Report is presented according to the annotated outline of the NIR as set out in *the updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11*, noted by the SBSTA at its 25th session.

Complete CRF tables (performed by using the version 5.12.5 of the CRF Reporter software - a new vesion is expected on 3th May 2016 and consequently new CRF tables will be provided later) for the years 1990 to 2014, are provided in annex 3 to this report, under electronic format. Next to the emission data, the CRF-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 report 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.

Annex I parties that are also Parties to the Kyoto Protocol are also required to report supplementary information required under article 7, paragraph 1, of the Kyoto Protocol, with the inventory submission due under the Convention, in accordance with paragraph 3(a) of decision 15/CMP.1.

This supplementary information includes:

- information on anthropogenic GHG emissions by sources and removals by sinks from land-use, land-use change and forestry (LULUCF) activities under article 3, paragraph 3, and, if any elected activities

under article 3, paragraph 4, of the Kyoto Protocol, as set out in section I.D of the annex to decision 15/CMP.1: see chapters 9.3 and 9.4 for more information.
- information on Kyoto-units (emission reduction units, assigned amount units (AAUs) and removal units (RMUs), as set out in section I.E of the annex to the decision 15/CMP.1: see chapter 11 for more information.
- changes in national systems in accordance with article 5, paragraph 1, and set out in section I.F of the annex to decision 15/CMP.1: the actualized national system of Belgium is attached to the submission of April 15th 2010 to the UNFCCC-secretariat. No differences compared to the previous version are performed. The national system is in line with the developed QA/QC-plan of Belgium. Both documents are attached to this NIR 2016 in annex 3.
- changes in national registries as set out in section I.G of the annex to the decision 15/CMP.1: see chapter 13 for more information.
- information on minimization of adverse impacts in accordance with article 3, paragraph 14: see chapter 14 for more information.
- some other information i.e. information on legal entities authorised to participate in mechanisms under articles 6, 12 and 17 of the Kyoto Protocol.

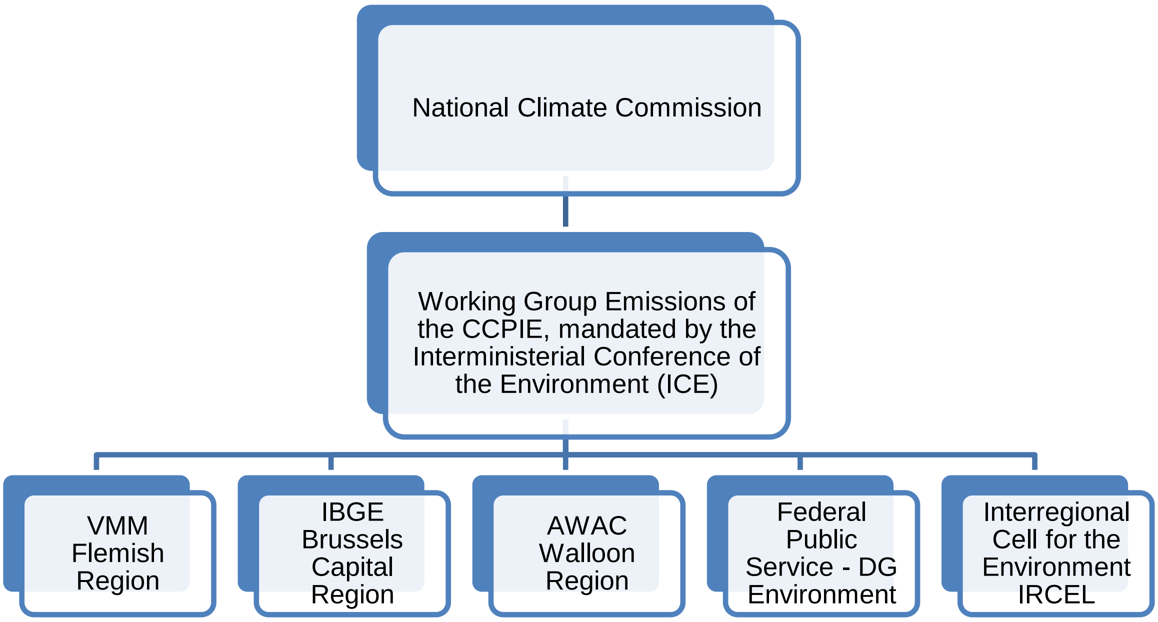
1.2 A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management

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 *Interregional Environment Unit* (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 than 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 European Parliament and Council Regulation (EU) No 525/2013 concerning a Mechanism for Monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC.

1.2.1 Overview of institutional, legal and procedural arrangements for compiling GHG inventory and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

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 later compiled to produce the Belgian GHG inventory. The main regional institutions involved are:

The Department Air, Environment and Communication of the Flemish Environment Agency (VMM) in the Flemish Region;
The Walloon Agency for Air and Climate (AWAC) in the Walloon Region;
Brussels Environment (BIM-IBGE) 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 for Health, Food Chain Safety and the Environment (FPS - DG Environment) is involved in its capacity of UNFCCC National Focal Point of Belgium and registry administrator.

The Directorate General Energy 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.

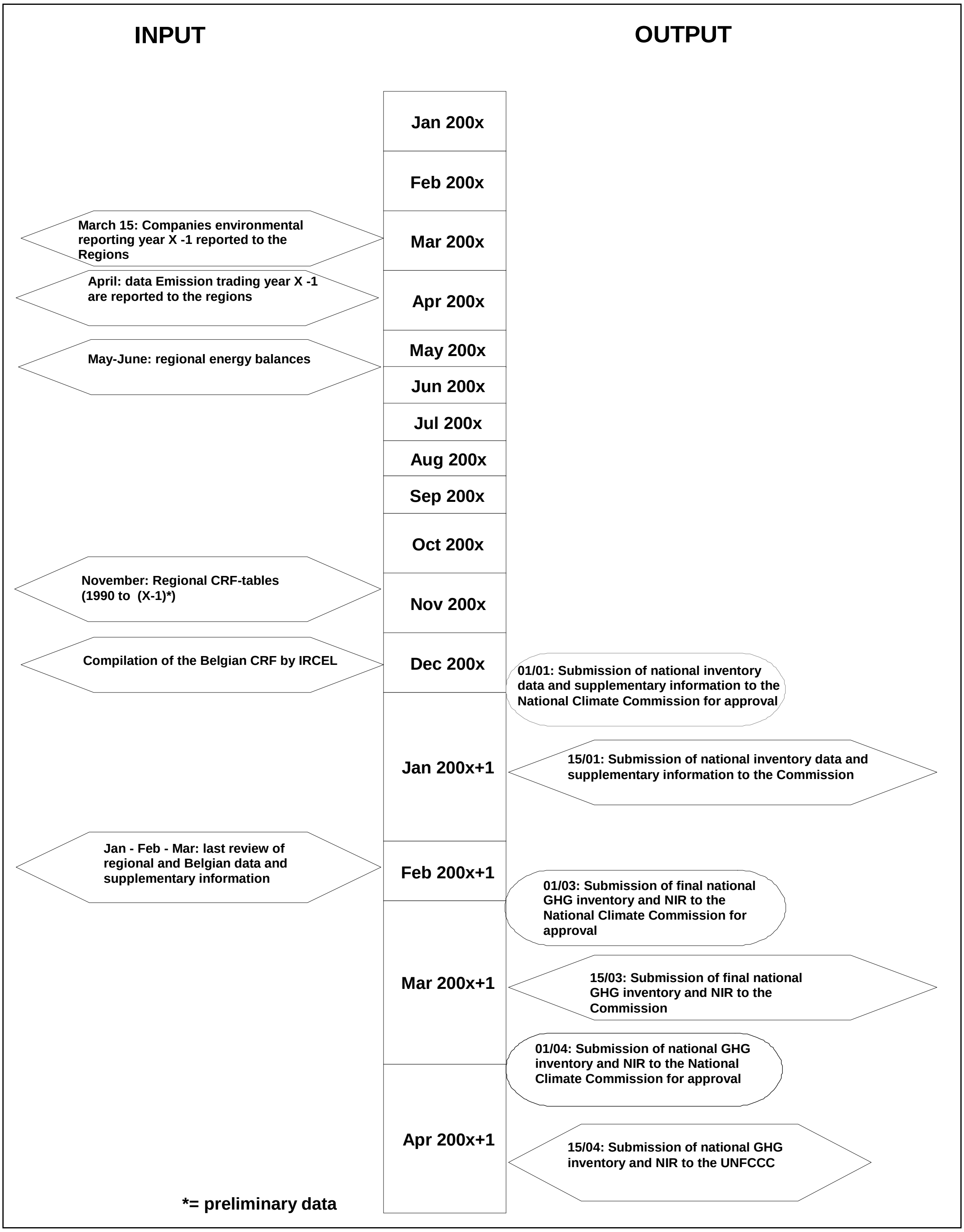
The Belgian Interregional Environment Agency (IRCEL-CELINE) is the single national entity with overall responsibility for the preparation of the Belgian GHG inventory. IRCEL-CELINE operates as national compiler of greenhouse gas emissions in Belgium.

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

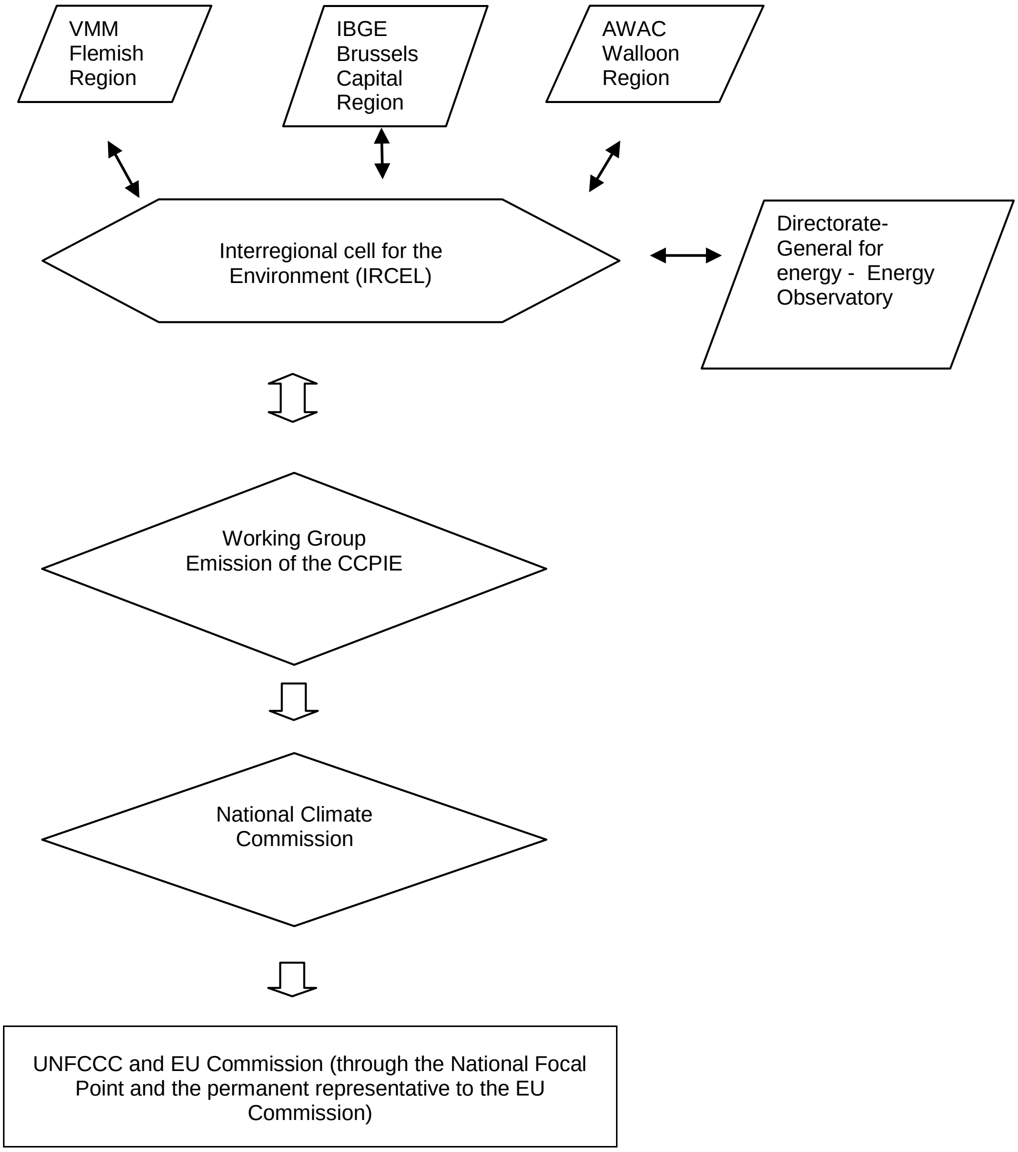
1.2.2 Overview of inventory planning

The schedule below is the schedule that Belgian experts try to follow as much as possible. Because of the extension of the tasks last years it’s sometimes hard to follow this tight schedule.
A real exception to this rule was the reporting year 2015 in which the deadlines were moved up strongly because of the bad functioning of the new UNFCCC CRF Reporter software.

Writing this line, the current software (v5.12.5) is still deficient and even if a new version is scheduled for May 3, past experience of these two years shows that it is unlikely that the entirety of the problems will be solved . It is therefore possible that the schedule 2016 will be disturbed.


INPUT
OUTPUT
Jan 200x
Feb 200x
March 15: Companies environmental reporting year X -1 reported to the Regions
Mar 200x
April: data Emission trading year X -1 are reported to the regions
Apr 200x
May-June: regional energy balances
May 200x
Jun 200x
Jul 200x
Aug 200x
Sep 200x
Oct 200x
November: Regional CRF-tables (1990 to (X-1)*)
Nov 200x
Compilation of the Belgian CRF by IRCEL
Dec 200x
01/01: Submission of national inventory data and supplementary information to the National Climate Commission for approval
Jan 200x+1
15/01: Submission of national inventory data and supplementary information to the Commission
Jan - Feb - Mar: last review of regional and Belgian data and supplementary information
Feb 200x+1
01/03: Submission of final national GHG inventory and NIR to the National Climate Commission for approval
Mar 200x+1
15/03: Submission of final national GHG inventory and NIR to the Commission
01/04: Submission of national GHG inventory and NIR to the National Climate Commission for approval
Apr 200x+1
15/04: Submission of national GHG inventory and NIR to the UNFCCC
*= preliminary data

1.2.3 Overview of inventory preparation and management, including for supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol



The regional GHG inventories are transmitted by in November in the shape of xml-files (output of CRF Reporter) to IRCEL, the national inventory compiler. IRCEL makes the compilation of the three regional inventories into the national one, under the CRF format by the 15th of December. 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 Observatory of the Directorate-General for Energy and transmitted to IRCEL. The national CRF-tables are cross-checked by the CCIEP-WG Emissions and then transmitted to the National Climate Commission for the official approval (first approval by the 1st of January, 2nd approval by the 1st of March and final approval by the 31st of March). After approval by the National Climate Commission, the national GHG inventory is submitted to the EU Commission via the EIONET - Central Data Repository (CDR) http://cdr.eionet.europa.eu/be/eu/mmr/art07_inventory/ of the European Environment Agency (EEA) by the 15th of January and the 15th of March and to the UNFCCC secretariat through the UNFCCC National Focal Point by the 15th of April.

1.3 Inventory preparation

1.3.1 GHG inventory *and KP-LULUCF inventory*

The mains 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 (both under UNFCCC and KP reporting) follows the steps and timing described in the present chapter.

The fluorinated gases (categories 2B, 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 responsibles. Methodologies and emission results are discussed in a steering group with representatives of the different regions and the federal government.

1.3.2 Data collection, processing and storage, *including for KP-LULUCF inventory*

The data flows for the key sources are described in Annex 5.

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

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

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 usable.
category 4: LULUCF	- full consistency between regions - land-use (change) matrix by Gembloux Agro Biotech University
category 1A3b: road transport	emissions based on 'fuels sold' (federal petroleum balance)

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 presentation of the national inventory in Belgium has been applied in the chapters 3 to 7 for each of the IPCC categories and for fluorinated gases (see section 4.5).

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 this submission.

In section 4.3.2, 4.6, 4.7 and 4.8 the methodologies and data sources used when estimating the **emissions of the fluorinated gases** are described. For the estimation of these emissions another approach is used compared to the other greenhouse gases.

One of the basic activity data in the **LULUCF-inventory** is the land-use change matrix. This matrix is delivered through a study by the Gembloux Agro Biotech University. 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 is 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, IBGE) to prepare their estimates of emissions and removals.
The method used to develop the land-use change matrix is described in chapter 10 of this document.
Another main source of data are the regional forest inventories, described in chapter 6.2. of the NIR, 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 a soil organic carbon. IPCC default values are used for some parameters.

The emissions and removals are calculated at the regional level following IPCC Good Practice Guidance on LULUCF and using a common template. 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 revised in detail in 2010, to address the supplementary information to be delivered in the commitment period. Supplementary and as a result of the UNFCCC in-country review in September 2012, Belgium did revise its estimates of deforestation and resubmitted the CRF tables for KP-LULUCF in line with decision 15/CMP.1 and 16/CMP.1 and with the IPCC good practice guidance for LULUCF (Chapter 4.1), correcting the problem in the reporting of the activity data for deforestation.

Contrary to all other sectors in the Belgian emission inventory, the greenhouse gas emissions from **road traffic** are not calculated as the sum of the emissions of the 3 regional models (see section 3.2.8 for further information). These emissions are calculated in Belgium based on the fuels sold, reported in the federal petroleum balance statistics. The distribution of the emissions between the 3 regions in Belgium is based on the results of the regional Copert-models. These 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 by the end of 2006 to the secretariat of UNFCCC. An update of the Belgian National Inventory System was carried out during the 2010 submission to the UNFCCC-secretariat and is included in annex 3 of this report.

1.4.1 GHG inventory

1.4.1.1 Flemish region

Data source used	Sector
regional energy balance	to estimate all energetic emissions except for some special cases (see below)
yearly integrated environmental reports (IMJV)	Mainly energy industries (1A1) and Chemical industry (2B) and industrial process emissions (2) 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 ETS-emissions are included in the 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), agriculture (3) and SWDS (5A)

In Flanders, the greenhouse gas inventory is set up by the team Air Emission Inventory of the *Department Air, Environment and Communication* of the *Flemish Environment Agency* (VMM).
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 emissions when exceeding a defined threshold value.
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 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 halones 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 industrial database 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.

In the Flemish region all (approximately 220) industrial installations falling under the scope of ETS-Directive 2003/87/EC are obliged to report their emissions yearly in an ETS emissions report[2]. The way CO_2 emissions are calculated 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] .which needs to formulate an independent judgment about the reported CO_2-emissions.

[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.

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.

This 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 [1] 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 in 2013) the Flemish Region obliges installations falling under ETS, 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. The necessary communication that these detailed data would be shared with inventory people and people responsible for setting up the energy balance was done in advance.

A comparison between emission data of CO_2 reported in the national CRF-tables and reported under the ETS-Directive can be found in annex 10 of this report for the year 2014.

emissions of CO_2

Energetic CO_2 emissions are calculated on the basis of the energy balance, which is annually established by the VITO [1] funded by the Flemish region. Setting up the energy balance is one of the reference tasks of the VITO in the frame work of EMIS (the Energy and Environment-Information system of the Flemish region). This is based on available statistical data and models, on the information coming from the obliged annual emission reporting of industrial companies (mainly class I and class II companies and for emissions exceeding a given threshold value, compulsory since 1993 and extended with greenhouse gas emissions since 2004) and on a survey among energy suppliers, federations and individual consumers. The last years the ETS-data reported by the companies become a more important source to draw up the Flemish energy balance.
The methodology used to set up the energybalances, the energy balances themselves for the complete time series as well as all relevant information can be found on the website http://emis.vito.be/rapporten-energiebalans-vlaanderen.
Last update was February 2016. The estimation of the energetic greenhouse gas emissions reported during the 2016 submisison are based on the provisional version of the Flemish energy balance of July 2015.

An important element in this Flemish energy balance is that for the intermediary years 1991 to 1993 another methodology was used to set up this energy balance because of lack of resources. This means that for these years the so-called ‘difference methodology’ was used (Flemish energy balance

= Belgian energy balance minus Walloon energy balance minus Brussels energy balance) instead of the independent methodology (bottom-up).

Starting from this energy balance, the CO_2 emissions are calculated, when no more accurate emissions are available, using CO_2 emission factors, as described above, emissions from ETS are used from 2013 on. These are mainly the default IPCC emission factors from the IPCC 2006 Guidelines. For some special products (blast furnace gas, coke oven gas, refinery gas, waste products) and sectors (refineries, electricity production) more accurate, country-specific factors are used. See section 3.2. for more information.
The other CO_2 emissions (non-energy consumption, waste incineration without electricity production, process emissions, iron and steel production and the chemical industry) are calculated by using a country-specific methodology.

emissions of CH_4 and N_2O

The energetic emissions of CH_4 and N_2O are mostly calculated by multiplying the activity data (fuel consumption) with an emission factor. The emission factors used are mainly the IPCC default factors of 2006. In some cases country specific emission factors are used. See section 3.2 for more information.
The methodology used by the Flemish region to calculate the emissions of road transport was until the 2013 submission based on the so called MIMOSA-model and was mainly developed for policy objectives. This MIMOSA IV - model calculated the traffic emissions based on the COPERT 4 methodology and on data of mobility per road segment. These emissions were calculated based on counts on the roads in the Flemish region, which means that a geographical distribution is possible.
From the 2014 submission on a tuning between the 3 regions was obtained by switching to the Copert 4-model in all 3 regions. See section 3.2.8. for more information.
Emissions of air traffic are calculated using the methodology as described in the EMEP/EEA guidebook [3].
Industrial process emissions are estimated using specific plant information combined with specific (or default) emission factors or by using the results of monitoring work carried out in the plants. An important source for estimating these emissions is the yearly reporting obligations by the industrial companies via the integrated environmental reports.
Country-specific methodologies are developed for calculating the emissions of navigation and transport via railways, for non-road mobile machinery, for agriculture (reference [6] for CH_4 and [7] for N_2O), for solid waste disposal [8] and for distribution, transmission and storage of natural gas.
See the respective chapters (3 till 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) and agriculture (4) and SWDS (6A)

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 CRF-tables and reported under the ETS-Directive can be found in annex 11 of this report for the years 2013.

This year, a new inventory software was developed in Wallonia (WAPI) improving the quality of the regional and the national inventory. Until the last submission, Wallonia used the database Collecter to manage the inventory data's (one collecter database by year). But this year, a new air emission software (WAPI) was developed. This software allows the seeing of all data's 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 which was submitted to the secretariat of UNFCCC at the end of 2006. An update of the Belgian National Inventory System was carried out during the 2010 submission to the UNFCCC-secretariat and attached in annex 3 of this report.

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) and agriculture (4)

The greenhouse gases emission inventory in the Brussels region is compiled by the *Brussels Environment Institute* (IBGE-BIM) on the basis of the IPCC-methodology 1996 [28] and the methodology described in the EMEP/EEA guidebook.
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 (CRF 1A, except road transport) the activity data come from the regional energy balance annually performed by the same consultant as in the Walloon region, ICEDD (www.icedd.be) for IBGE-BIM. The emissions from road transport are calculated using a regional model combined with the COPERT IV software. The other emissions types are calculated using source-specific activity data and/or in-situ measurements.

1.4.2 KP-LULUCF inventory

The KP-LULUCF inventory is prepared by the 3 regional agencies presented in chapter 1.4.1 (VMM, AWAC and IBGE-BIM).
A general description of methodologies and data sources used is described in chapter 10.

1.5 Brief description of key categories

KEY CATEGORY ANALYSIS was performed under CRF REPORTER v.5.12.5. As the CRF Tables changed again under v.5.14.1, all the calculation settings need to be revised again. Belgium decided not to repeat these calculations. As some small corrections occurred in the LULUCF sector, it may provoke some discrepancies but without altering the meaning of the analysis.

1.5.1 GHG inventory (including LULUCF)

Key source categories are identified according to the Tier 1 methodology described in the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the IPCC Good Practice Guidance for LULUCF [10]. 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, 2013 and 2014 and trend analysis is carried out for the years 1990-2013 and 1990-2014. See annex 1 for more details.

The key source analysis is realised on the basis of table 5.4.1 as suggested in IPCC GPG for LULUCF. 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.

The level assessment with LULUCF for 2014 results in the identification of 55 key sources, covering 95%[4] of the total national aggregated emissions. These 55 key sources are to a large extent the same as those identified for the year 2013. There is a little bit more differences with the year 1990 (see annex 1). Differences are summarised in the table below:

[4] This threshold (95%) is recommended in the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*, 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.

IPPC categories - submission 2016	GHG	1990	2013	2014
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	x		
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2		x	x
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	x	x	
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	x		
1.A.2.a. Iron and Steel - Solid Fuels	CO2	x		
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2		x	x
1.A.2.c. Chemicals - Liquid Fuels	CO2	x		
1.A.2.c. Chemicals - Solid Fuels	CO2	x		
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	x		x
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	x		
1.A.2.f. Non-metallic minerals - Other Fuels	CO2		x	x
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2		x	x
1.B.1.a. Coal Mining and Handling	CH4	x		
2.B.9.a. By-product emissions	C2F6	x		
2.B.9.a. By-product emissions	CF4	x		
2.B.9.a. By-product emissions	SF6	x		
2.B.9.b Fugitive emissions	C5F12	x		
2.B.9.b Fugitive emissions	C6F14	x		
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125		x	x
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a		x	x
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a		x	x
4.A.2. Land converted to Forest Land CSC	CO2		x	x
4.B.1. Cropland remaining Cropland CSC	CO2		x	x
4.B.2. Land converted to Cropland CSC	CO2		x	x
4.C.2. Land converted to Grassland 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.C.1 Waste incineration / Non-biogenic	CO2	x	x	
5.D. Wastew ater treatment and discharge	CH4	x		
5.D. Wastew ater treatment and discharge	N2O			x

63 categories are identified as key source from the trend assessment with LULUCF 1990-2014 as those that contribute to 95% to the trend of the inventory. There is a slight difference in amount between the trend assessments with LULUCF for the years 1990-2013 (61 key sources) and 1990-2014 (see annex 1) and the identified key sources overlap to a large extent.

Differences are summarised in the table below:

IPPC categories - submission 2016	GHG	2013	2014
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2		x
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2		x
1.A.3.d. Navigation - Gas/Diesel Oil	CO2		x
3D1 Direct N2O emissions from managed soils	N2O	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), 74 key source categories are determined (Table 1.2). The absolute change in direct greenhouse gas emissions of these key sources over the period 1990-2014 is listed in Table 1.2 and shown in Figure 1.2.

CO_2 emissions from “road transportation - diesel oil and gasoline”, from “public electricity and heat production - solid fuels and gaseous fuels” and from “iron and steel production” are the first key sources (trend assessment with LULUCF) of greenhouse gas emissions in Belgium. They constitute the main drivers of 2014 emissions trends (annex 1). CO_2 emissions from road transportation (diesel oil), residential space heating (liquid fuels and gaseous fuels) and electricity production (gaseous fuels and solid fuels) are pointed out by the level assessment with LULUCF as the five main key source categories (together, these five sources cover around 43% of the total emissions in 2014 without LULUCF).

The three most important level key sources of non-CO_2 emissions in Belgium are direct N_2O emissions from managed soils (2.31% in 2014), CH_4 emissions from non-dairy cattle – enteric fermentation (2.27% in 2014) and CH_4 emissions from dairy cattle – enteric fermentation (1.39% in 2014).

One may finally notice that the five key source categories which displayed the most important absolute increase in their emissions over the period 1990-2014 (figure 1.2, table 1.2) are CO_2 emissions from "road transportation (diesel oil)" (category 1A3b, +9441 Gg CO_2-eq.), CO_2 emissions from "public electricity and heat production (gaseous fuels)" (category 1A1a, +4091 Gg CO_2-eq.), CO_2 process emissions from "petrochemical and carbon black production" (category 2B8, +1962 Gg CO_2-eq.), CO_2 emissions from "commercial & institutional (gaseous fuels)" (category 1A4a, +1652 Gg CO_2-eq.) and CO_2 process emissions from "chemical industry - other" (category 2B10, +1509 Gg CO_2-eq.).

On the contrary, CO_2 emissions from "electricity production (solid fuels)" (category 1A1a, -12906 Gg CO_2-eq.), CO_2 process emissions from the "iron and steel sector" (category 2C1, -6484 Gg CO_2-eq.), CO_2 emissions from "road transportation (gasoline)" (category 1A3b, -4609 Gg CO_2-eq.), CO_2 emissions from "residential space heating (liquid fuels)" (category 1A4b, -4432 Gg CO_2-eq.) and energetic emissions from the "iron and steel sector (solid fuels)" (category 1A2a, -3232 Gg CO_2-eq.) are the source categories that displayed the most important drop in GHG emissions between 1990 and 2014.

Concerning the LULUCF sector and considering the parameter "Carbon stock change", the following categories 4A1 'Forest Land remaining Forest Land', 4B1 'Cropland remaining Cropland', 4E2 'Land converted to Settlements', 4B2 'Land converted to Cropland', 4A2 'Land converted to Forest Land' and 4C2 'Land converted to Grasslands' are key sources in the level assessment for 2014 and for 2013.
4G 'Harvest wood products' is also a key source in the level assessment for 2014 and for 2013.

Qualitative analysis shows that for the pool "Carbon stock change", the subcategory 'net carbon stock change in soils' for each category listed above should be considered as a level key source. 'Net Carbon stock change in living biomass' is also a key source according qualitative analysis for 4A1 'Forest Land remaining Forest Land' and 4A2 'Land converted to Forest Land'.

IPCC source categories - Submission 2016	Gas	1990	2013	2014
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	x	x	x
4.A.2. Land converted to Forest Land 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.B.1. Cropland remaining 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.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.C.1. Grassland remaining Grassland CSC	CO2			
Net Carbon stock change in living biomass	CO2			
Net carbon stock change in dead organic matter	CO2			
Net carbon stock change in soils	CO2			
4.C.2. Land converted to Grassland 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.D.2. Land converted to Wetlands CSC	CO2			
Net Carbon stock change in living biomass	CO2			
Net carbon stock change in dead organic matter	CO2			
Net carbon stock change in soils	CO2			
4.E.2. Land converted to Settlements 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.G Harvest w ood products	CO2		x	x

Concerning the trend assessment for the years 1990 – 2014 and for the years 1990 – 2013, all the categories listed above for the level assessment are also key sources. Moreover, 4C1 'Grassland remaining Grassland' is also a key source.

TABLE 1.2 Level and trend assessment 1990-2014 with Lulucf_ summary

IPCC categories Submission 2016	direct greenhouse gas	1990 Estimate (non-Lulucf)	2014 Estimate (non-Lulucf)	criteria for identification		absolute emission trend 1990-2014
		Gg CO_2 eq	Gg CO_2 eq			Gg CO_2 eq
1.A.3.b. Road Transportation - Diesel Oil	CO2	10963.77	20404.82	T	L	9441.05
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	2764.79	6855.97	T	L	4091.18
2.B.8 Petrochemical and carbon black production	CO2	1882.42	3844.91	T	L	1962.49
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	1933.79	3585.87	T	L	1652.08
2.B.10 Other	CO2	285.15	1794.65	T	L	1509.50
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	674.22	1986.04	T	L	1311.82
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	684.19	1847.26	T	L	1163.06
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	13.89	1020.47	T	L	1006.58
1.A.4.b. Residential - Gaseous Fuels	CO2	5874.20	6848.94	T	L	974.75
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	0.00	912.09	T	L	912.09
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	0.00	866.03	T	L	866.03
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	0.00	825.27	T	L	825.27
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	67.38	763.11	T	L	695.73
2.B.1 Ammonia Production	CO2	422.74	1052.28	T	L	629.54
4.B.2. Land converted to Cropland CSC	CO2	63.14	558.55	T	L	495.40
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2532.33	2953.19	T	L	420.86
4.E.2. Land converted to Settlements CSC	CO2	237.42	619.51	T	L	382.09
4.G Harvest w ood products	CO2	0.00	336.31	T	L	336.31
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	357.60	676.61	T	L	319.01
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	186.18	383.96	T	L	197.78
1.A.3.b. Road Transportation - Diesel Oil	N2O	59.25	229.04	T		169.78
2.B.9.b Fugitive emissions	C4F10	25.40	175.19	T		149.79
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	361.87	414.25	T	L	52.38
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	281.82	312.14		L	30.32
3B1 Dairy Cattle	CH4	296.57	320.29		L	23.73
5.D. Wastew ater treatment and discharge	N2O	247.33	269.76		L	22.43
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	260.84	278.45		L	17.62
3B3 Sw ine	CH4	792.78	730.34		L	-62.44
3B1 Non-Dairy Cattle	N2O	417.22	353.10		L	-64.12
1.B.2.b. Natural Gas	CH4	617.71	517.70		L	-100.00
3A1 Non-Dairy Cattle	CH4	2721.79	2586.70	T	L	-135.10
1.A.2.g. Other - Gaseous Fuels	CO2	1203.94	1056.04	T	L	-147.90
4.C.1. Grassland remaining Grassland CSC	CO2	-43.32	-194.65	T		-151.34
2.A.1 Cement production	CO2	2823.78	2642.98	T	L	-180.80
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	220.47	38.48	T		-181.99
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1364.20	1174.70		L	-189.50
2.B.9.a. By-product emissions	C3F8	215.77	0.00	T		-215.77
2.B.9.a. By-product emissions	C4F10	228.60	0.00	T		-228.60
4.A.2. Land converted to Forest Land CSC	CO2	-17.43	-291.83	T	L	-274.41
3D2 Indirect N2O Emissions from managed soils	N2O	1051.55	724.05		L	-327.49
2.B.9.b Fugitive emissions	C5F12	351.53	0.02	T		-351.52
1.B.1.a. Coal Mining and Handling	CH4	355.74	0.00	T		-355.74
2.B.9.a. By-product emissions	CF4	368.01	9.84	T		-358.18
4.C.2. Land converted to Grassland CSC	CO2	84.55	-279.70	T	L	-364.25
1.A.2.c. Chemicals - Solid Fuels	CO2	401.51	2.86	T		-398.65
2.A.2 Lime production	CO2	2097.12	1641.59		L	-455.53
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1492.90	1006.90	T	L	-486.00
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	650.58	101.91	T		-548.67
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	4285.28	3711.08	T	L	-574.20
1.A.2.g. Other - Liquid Fuels	CO2	1578.69	969.88	T	L	-608.81
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	662.56	44.17	T		-618.39
5.D. Wastew ater treatment and discharge	CH4	834.95	207.09	T		-627.86
2.B.9.a. By-product emissions	C2F6	671.94	0.00	T		-671.94
3A1 Dairy Cattle	CH4	2304.38	1579.48	T	L	-724.90
3D1 Direct N2O emissions from managed soils	N2O	3356.10	2629.63		L	-726.47
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	2466.35	1720.17	T	L	-746.18
4.A.1. Forest Land remaining Forest Land CSC	CO2	-2929.62	-3707.01	T	L	-777.39
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	884.66	25.33	T		-859.34
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	2314.69	1195.84	T	L	-1118.85
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	1508.71	379.33	T	L	-1129.38
4.B.1. Cropland remaining Cropland CSC	CO2	238.92	-890.74	T	L	-1129.66
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	1688.70	258.97	T	L	-1429.73
2.B.9.a. By-product emissions	SF6	1487.59	0.00	T		-1487.59
1.A.4.b. Residential - Solid Fuels	CO2	1796.20	283.78	T	L	-1512.42
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	2516.45	931.35	T	L	-1585.11
1.A.2.c. Chemicals - Liquid Fuels	CO2	1851.70	146.38	T		-1705.32
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	1969.04	182.45	T		-1786.59
5.A. Solid Waste Disposal	CH4	3053.39	1064.32	T	L	-1989.07
2.B.2 Nitric Acid Production	N2O	3421.53	473.16	T	L	-2948.37
1.A.2.a. Iron and Steel - Solid Fuels	CO2	3283.95	51.83	T		-3232.12
1.A.4.b. Residential - Liquid Fuels	CO2	12800.51	8368.83	T	L	-4431.69
1.A.3.b. Road Transportation - Gasoline	CO2	8360.02	3750.89	T	L	-4609.13
2.C.1. Iron and Steel Production	CO2	10277.62	3793.75	T	L	-6483.87
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	19434.27	6528.04	T	L	-12906.23

TABLE 1.2 Level and trend assessment 1990-2014 with Lulucf_ summary

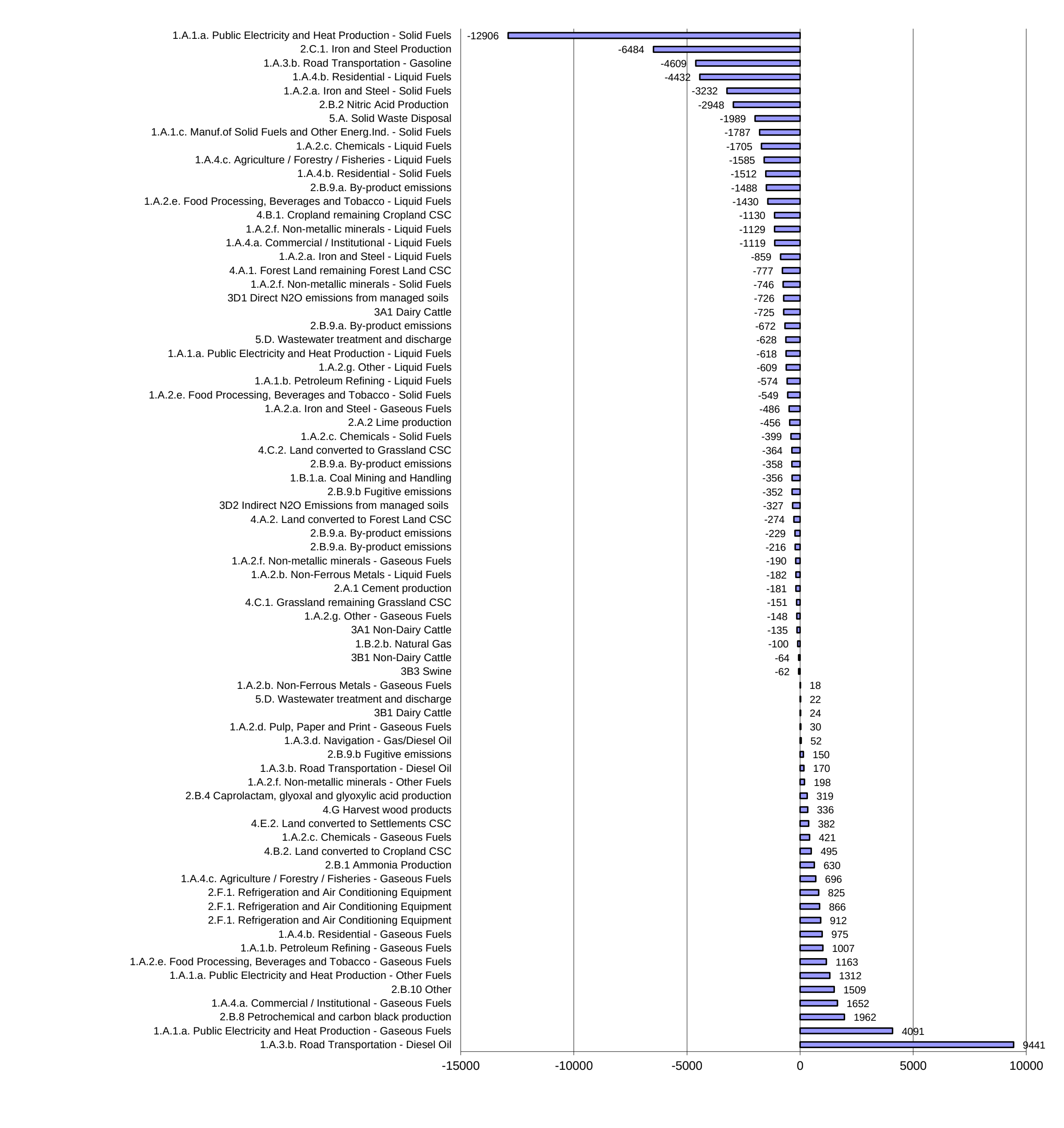


Figure 1.2: Key source category analysis: GHG Emission Trends 1990-2012 (Gg CO_2 equivalent).

1.5.2 KP-LULUCF inventory

The key source analysis on the KP-LULUCF has been performed according table 5.4.4. in the IPCC Good Practice Guidance for LULUCF.

In 2014, 4A1 'Forest Land remaining Forest Land', 4A2 'Land converted to Forest Land', 4B1 'Cropland remaining Cropland', 4B2 'Land converted into cropland', 4C1 'Grassland remaining Grassland', 4C2 'Land converted into grassland' and 4E2 'Land converted to Settlements' are key sources in the UNFCCC inventory. 'Afforestation and reforestation', 'Deforestation' and 'Forest management' are accounted under the KP for Belgium and thus should be considered potentially as key since these activities are related to these above IPCC source/sink categories for LULUCF

As the boundaries firstly between 'Forest management' and 4A1 'Forest Land remaining Forest Land' and secondly between 'Afforestation and reforestation' and 4A2 'Land converted to Forest Land' are similar, the parameter “Carbon stock change/net carbon stock change in soils” and “Carbon stock change/net Carbon stock change in living biomass” should be considered as key.

'Deforestation' accounts respectively only for 12.2% in 4B2, for -11.7% in 4C2 (because 4C2 is a sink and deforestation a source) but for 34.8% in 4E2. In addition, analysis of key sources in the UNFCCC inventory has showed that 'deforestation' is a key source in 2014.

Therefore, it appears that deforestation should be regarded as key category according qualitative analysis in the KP-LULUCF inventory. Particular attention should be given to the subcategory 4E2.1 'Forest Land converted to Settlements'.

The situation is comparable for the year 2013.

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 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 during the first week 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 revised during the 2010 submission to the UNFCCC-secretariat.

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 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;
IBGE-BIM: Brussels Environment Institute.

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 the 2010 submission to the UNFCCC-secretariat (see annex 3).

The compilation of the Belgian emission inventory is performed by a new employee since the 2010 submission. This was a big step forward in terms of quality improvement in the compilation of the Belgian greenhouse gas emission inventory and related tasks.

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 the national inventory responsible for European and international obligations related to air emissions reporting.

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 submission takes 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 national inventory 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 and the Kyoto Protocol.

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/GP1/0.011: 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 (not yet fully implemented);
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.

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, are part of a certified ISO 9001 system since July 2005. At that time the certification was only valid for parts of the

[5] Certificate number 08376-2003-AQ-ROT-BELCERT.

VITO and not for the complete organisation. Since 2007, this certificate is part of the Environmental and Quality System of the VITO certified with ISO 9001 and ISO 14001 standards. A re-certification process was performed in January 2010.

The quality system consists of quality procedures and planning activities. Specific for the preparation of the energy balance, there are 7 procedures in place.

EMIS-PRO 021	Energy balance Flanders	General procedure with methodology to prepare an energy balance for a specific year.
EMIS-PRO 022	Survey of industry	The procedure describes the methodology to carry out a survey in the industrial sectors in a specific year.
EMIS-PRO 023	Extrapolation of industry	The procedure describes the methodology to extrapolate the energy consumptions from the survey in the industry to a global energy consumption for the industry in Flanders for a specific year.
EMIS-PRO 024	Survey of service sector	The procedure describes the methodology to carry out a survey in the service sectors in a specific year.
EMIS-PRO 025	Extrapolation of service sector	The procedure describes the methodology to extrapolate the energy consumptions from the survey in the service sector to a global energy consumption for the service sector in Flanders for a specific year.
EMIS-PRO 026	Transformation sector	The procedure describes the methodology to compose the transformation sector in the energy balance.
EMIS-PRO 027	Survey of electricity sector	The procedure describes the methodology to carry out the survey for electricity and heat-production in cooperation with ANRE (the Administration of Natural Resources and Energy) and implementation of the resolution.

Procedure EMIS-PRO 021 describes the general methodology used to establish a yearly energy balance for Flanders. Purpose of this procedure is to give information and instructions to be able to establish in a coherent way an energy balance for Flanders in a specific year. The procedure refers where appropriate to the other procedures for specific sectors.

The mentioned EMIS-procedures for the preparation of the energy balance for Flanders are part of the covering quality system of the expertise centre IMS (Integral Environmental Studies) in the VITO. The quality handbook of the expertise centre gives an overview on the global quality system with references to the specific procedures of specific activities. An example of a general procedure is ‘ALG-PRO 011 Continuous quality improvement, quality renewal and control of aberrations’. This procedure describes the responsibilities and actions to be taken of all staff members in case aberrations occur.

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.

Procedures on secondary data

The energy balance in the Walloon region is established by an independent institute, ICEDD (http://www.icedd.be), 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

The Brussels energy balance was, up to 2013, established by ICEDD (http://www.icedd.be), whose activities are covered by an ISO 9001 certification. This work is strictly planned in order to get the information needed for updating the inventory against the stipulated deadline.

Uncertainties analyses on energy balances for the Brussels Region have been conducted by ICEDD. The last version was achieved in Augustus 2015 for the year 2013.

[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 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, QC checks related to primary data collection and 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 gives an overview of the QC checks that are performed on the regional and national level in Belgium.
These QC checks can be provided on request.

Table 1: Tier 1 QC checks

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)	October 31 (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)	October 31 (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 CRF Reporter.	October 31 (year X-1) March 31 (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)	October 31 (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.	October 31 (year X-1) March 31 (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.	October 31 (year X-1) March 31 (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 31 (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 31 (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.	October 31 (year X-1) March 31 (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.	October 31 (year X-1) March 31 (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 31 (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	October 31 (year X-1) March 31 (year X)

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 by the responsible of the quality system of the greenhouse gas inventory in Flanders. The next audit in the Flemish region will be performed in October 2016.

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 always respect 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 already has been conducted since 2007 on a yearly basis.

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

In 2014 and 2015 several reviews of the Belgian inventory took place by experts of the European Commission in collaboration with the topic centre ETC/ACM and by experts of UNFCCC:

- EU QA/QC Communication tool (1st round: NE-notation keys) by the EC (06/02/2014 – 14/02/2014);
- EU QA/QC Communication tool (2nd round: outlier checks) by the EC (28/02/2014-15/03/2014);
- EU QA/QC Communication tool (3rd round: issues for clarification) by the EC (26/03//2014-31/03/2014);
- UNFCCC initial checks of the 2014 inventory (received in May 2014);
- UNFCCC Synthesis & Assessment Report (Part I) for annex I Parties (received in June 2014);
- UNFCCC Synthesis & Assessment Report (Part II, preliminary analysis Belgium) (received in June 2014);
- UNFCCC centralized review in September 2014: Although no Saturday Paper was sent, Belgium did perform a re-submission of the inventory during the review week. A recalculation was made for the estimation of the emissions of SF_6 of electrical equipment (see chapter 4 'Industrial processes' for more information). The draft results of this centralized review became available only in April 2015;
- ESD-review (on a voluntary basis) by the EC in November 2015. Informal list of recommendations for Belgium at November 27, 2016.
- EC initial checks of submission January 15, 2016 (February 5, 2016).

All the questions of the Belgian greenhouse gas inventory during these reviews were commented by the Belgian experts in due time.
During this 2016 reporting Belgian experts have taken the results of these reviews into account as much as possible.

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 do consider that the verification process is part of the QA process.

Actually, this is already performed by the secretariat of UNFCCC itself, which regularly establishes comparisons among national inventories and issues questions to inventory experts. Also 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.

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 Good Practice Guidance 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 2014 as submitted in the spring of 2016 to UNFCCC and to the European Commission.
A trend uncertainty analysis is performed for the years 1990 and 2014.

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 done 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 (no draft ARR was received so far - March 2013) 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 for the next years.

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 [45] for the most recent published report of emissions of F-gases incl. the uncertainty calculations.

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 [3] and studies on uncertainty in emission inventories conducted in other member states, in the case where 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], 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 [42] 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'.*

The Tier 1 analysis for 2014 gives an overall uncertainty of 4.17% and a trend uncertainty 1990-2014 of 2.16%.

Almost 84% of Belgian total emissions in 2014 (CO_2 emissions compared to total with LULUCF) has a very small uncertainty of 2.19%. Even with the contribution of CH_4 (CO_2 and CH_4 together represent 91% of the total emissions) the uncertainty is still very low, 2.22%. Together, their contribution to variance is about 24%. 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 uncertainty considered separately amounts to alsmost 60% and the contribution to variance in total emissions represent 70% of the total variance but theses emissions represent only 5.8% of total emissions in 2014. The influence of F-gas emissions (with high uncertainty – 35% taken separately) is low since they account for only a very limited percentage of the total emissions (2.92%).

1.7.2 KP-LULUCF inventory (e.g. assumptions, expert judgement, data)

NOT YET UPDATED SINCE submission 2014 (MARCH 2016)

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 source:

-CO_2 urea application (3H): first estimates are below the threshold of significance. Regional experts will try to collect accurate activity data for the next submission in 2017.

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.

Some emissions of greenhouse gases are newly reported during the 2015 submission:

- use of SCR: emissions of CO_2: in category 1A3b road transport before, in category 2D3 during this 2016 submission.
- in 2C7 non-ferro sector / other non-specified: emissions of CO_2 (in Flemish region)
- in 2D1 lubricant use (all sectors incl. lubricant use in road transport (all vehicles except 2-stroke engines which are reported in 1A3b iv): emissions of CO_2
- in 2D2 paraffin wax use: emissions of CO_2
- in 3B2.5 indirect emissions of manure management: emissions of N_2O

More detail can be found in the reporting of emissions in certain categories in line with the IPCC 2006 guidelines. This is the case for:
- 1A2f non-metallic minerals and 1A2g (vi) textile and leather
- emissions of off-road are now reported separately; in the categories 1A2g (vii) manufacturing industry and construction, 1A3e (ii) other transportation (ports, airports and terminals), 1A4b (ii) residential, 1A4c (ii) agriculture, forestry & fishing and 1A5b other/mobile (defense).
- 1A3b Road transportation where the emissions are spilt into the different vehicle categories
- emissions of fishing activities are now reported separately in 1A4c (iii)

Re-allocation of emissions can be found in the following categories:

- Offgas-emissions/recovered fuels from cracking units and some other processes (non-energy use) emissions were allocated during the 2015 submission to the category 2B8 Petrochemical and Carbon Black Production/2B8b Ethylene instead of category 1A2c before.
- Use of SCR: emissions of CO_2 were allocated to the category 1A3b road transport before and to the category 2D3 during this 2016 submission.

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 are reported in the Belgian inventory.

Geographic coverage

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

1.8.2 KP-LULUCF inventory

CRF reporter version 5.12.5 still contains, besides other functional problems, problems in the reporting format tables and XML format in relation to Kyoto Protocol requirements, and it is therefore not yet functioning to allow submission of all the information required under Kyoto Protocol. However, a full submission (with KP CRF tables) is planned for 15^{th} June 2016.

1.9. Assigned amount

Belgium's base year is 1990 for CO_2, CH_4 and N_2O and 1995 for HFCs, PFCs, SF_6 and NF_3.

Full details will be soon available in its initial report (Belgium’s report to facilitate the calculation of the assigned amount according to Decision 2/CMP.8, “Implications of the implementation of decisions 2/CMP.7 to 5/CMP.7 on the previous decisions on methodological issues related to the Kyoto Protocol, including those relating to Articles 5, 7 and 8 of the Kyoto Protocol”).

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. 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 sixth National Communication (you can find an English version on http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/bel_nc6_rev_eng.pdf).

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

Total greenhouse gas emissions (without LULUCF) in Belgium amounted to 113.9 Mt eq. CO_2 in 2014 (Table 2.1.) and to 110.1 Mt eq. CO_2 (with LULUCF).

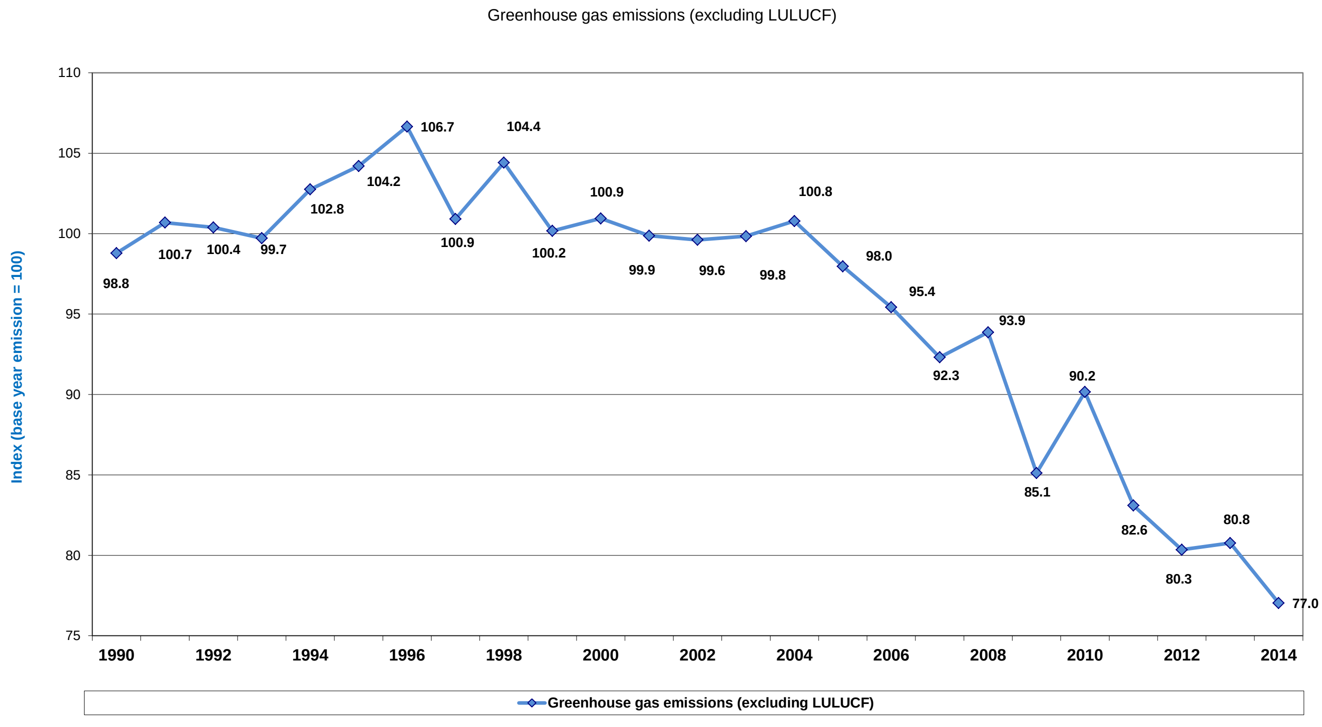


Figure 2-1 : Belgium GHG emissions 1990-2014 (excl. LULUCF). Unit: Index point (base year emissions = 100). For the fluorinated gases, the base year is 1995.

The following figure present emissions in tonnes CO_2 equivalent per capita.

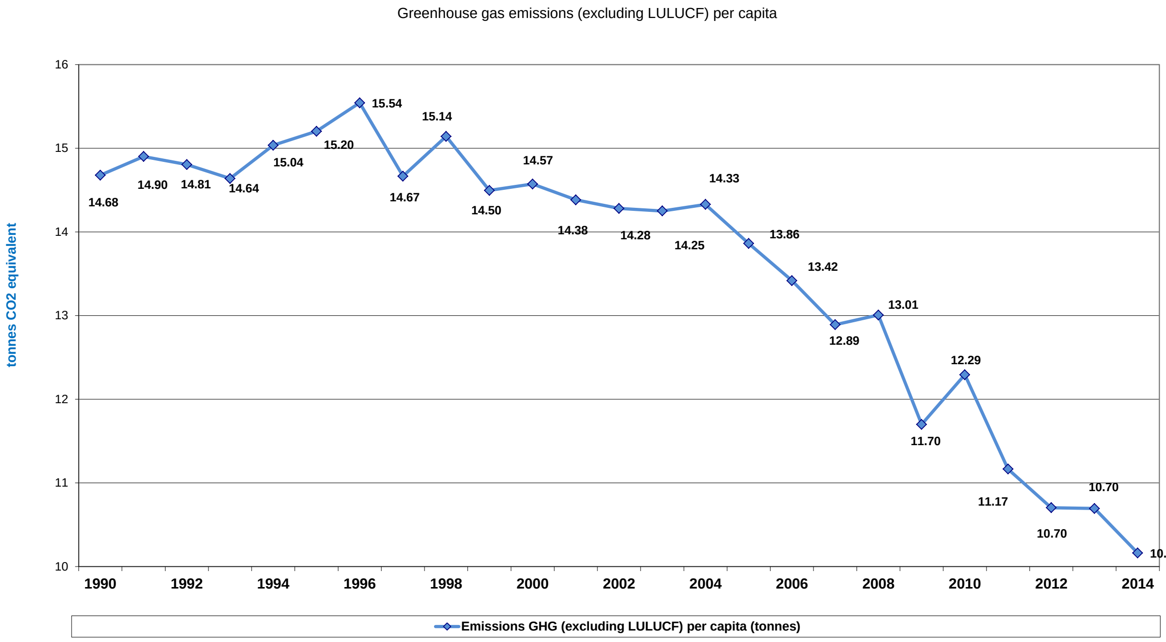


Figure 2-2bis : Belgium GHG emissions per capita 1990-2014 (excl. LULUCF).

Table 2-1 : Overview of Belgium GHG emissions and removals from 1990 to 2014 (Gg CO_2 equivalents)

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CO2 emissions without net CO2 from LULUCF	119 983	123 131	122 218	121 157	124 427	125 519	129 010	123 496	129 737	124 208	126 315	125 649	126 015	127 524	128 640	125 118	122 320	118 027	120 363	107 283	114 155	104 946	100 932	101 745	96 325
CO2 emissions with net CO2 from LULUCF	117 628	121 010	119 801	118 834	122 097	123 366	127 066	121 280	127 602	122 097	124 515	123 772	122 654	124 173	125 506	122 015	117 944	113 870	116 425	103 297	110 066	100 905	96 746	97 610	92 179
CH4 emissions without CH4 from LULUCF	12 040	11 999	11 886	11 838	11 867	11 948	11 802	11 690	11 525	11 265	10 827	10 386	9 957	9 372	9 319	9 075	8 983	8 948	8 737	8 669	8 625	8 369	8 236	8 098	8 048
CH4 emissions with CH4 from LULUCF	12 041	12 000	11 887	11 839	11 867	11 948	11 829	11 690	11 525	11 265	10 827	10 386	9 957	9 373	9 319	9 075	8 983	8 948	8 737	8 669	8 625	8 378	8 236	8 098	8 048
N2O emissions without N2O from LULUCF	10 232	10 106	9 859	10 129	10 525	10 997	11 415	11 183	11 057	11 071	10 353	9 964	9 613	8 713	8 850	8 581	7 591	7 094	7 103	7 229	7 760	6 564	6 471	6 281	6 279
N2O emissions with N2O from LULUCF	10 245	10 124	9 882	10 159	10 559	11 031	11 677	11 230	11 111	11 128	10 415	10 032	9 689	8 794	8 933	8 670	7 685	7 194	7 208	7 340	7 873	6 755	6 592	6 404	6 407
HFCs	NA,NO	NA,NO	484	484	496	502	602	727	881	936	1 128	1 212	1 438	1 609	1 693	1 745	1 877	2 079	2 207	2 391	2 509	2 614	2 733	2 703	2 812
PFCs	2 191	2 096	2 285	2 196	2 637	2 914	2 767	1 529	844	429	446	276	101	259	378	193	200	224	253	146	107	226	278	432	307
Unspecified mix of HFCs and PFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
SF6	1 575	1 493	1 653	1 589	1 931	2 140	2 060	539	296	154	144	139	116	102	90	91	77	79	87	93	102	112	110	116	95
NF3	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.67	0.57	1.32	2.48	1.12	1.24	0.69
Total (without LULUCF)	**146 021**	**148 826**	**148 385**	**147 393**	**151 882**	**154 020**	**157 657**	**149 163**	**154 340**	**148 062**	**149 213**	**147 626**	**147 240**	**147 579**	**148 971**	**144 803**	**141 047**	**136 451**	**138 750**	**125 812**	**133 258**	**122 833**	**118 761**	**119 375**	**113 867**
Total (with LULUCF)	**143 679**	**146 724**	**145 991**	**145 100**	**149 587**	**151 900**	**156 002**	**146 995**	**152 260**	**146 009**	**147 475**	**145 817**	**143 955**	**144 309**	**145 919**	**141 788**	**136 765**	**132 394**	**134 917**	**121 937**	**129 282**	**118 992**	**114 696**	**115 364**	**109 848**
Total (without LULUCF, with indirect)	**146 021**	**148 826**	**148 385**	**147 393**	**151 882**	**154 020**	**157 657**	**149 163**	**154 340**	**148 062**	**149 213**	**147 626**	**147 240**	**147 579**	**148 971**	**144 803**	**141 047**	**136 451**	**138 750**	**125 812**	**133 258**	**122 833**	**118 761**	**119 375**	**113 867**
Total (with LULUCF, with indirect)	**143 679**	**146 724**	**145 991**	**145 100**	**149 587**	**151 900**	**156 002**	**146 995**	**152 260**	**146 009**	**147 475**	**145 817**	**143 955**	**144 309**	**145 919**	**141 788**	**136 765**	**132 394**	**134 917**	**121 937**	**129 282**	**118 992**	**114 696**	**115 364**	**109 848**

Table 2-2 : Overview of GHG emissions and removals in the main sectors from 1990 to 2014 (Gg CO_2 equivalents)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1. Energy	103 194	106 974	105 323	105 234	106 786	107 048	111 362	105 535	109 907	104 557	105 454	105 905	105 842	107 068	107 477	104 979	102 176	99 187	101 454	94 270	98 995	89 716	87 534	87 723	82 291
2. Industrial processes and product use	26 220	25 243	26 344	25 489	28 478	30 165	29 676	26 943	28 090	27 204	28 416	27 014	26 807	26 639	27 662	26 393	25 670	23 903	24 281	18 559	21 422	20 582	19 009	19 818	19 811
3. Agriculture	12 164	12 010	11 995	12 118	11 983	12 193	12 095	12 105	11 902	12 114	11 272	11 060	10 930	10 558	10 466	10 244	10 029	10 218	10 072	10 224	10 171	10 082	9 846	9 837	9 942
4. Land use, land-use change and forestry	-2 342	-2 102	-2 393	-2 293	-2 296	-2 120	-1 655	-2 168	-2 080	-2 054	-1 738	-1 809	-3 285	-3 270	-3 052	-3 015	-4 282	-4 058	-3 832	-3 875	-3 977	-3 841	-4 065	-4 012	-4 018
5. Waste	4 444	4 599	4 723	4 553	4 637	4 615	4 524	4 581	4 441	4 188	4 070	3 646	3 662	3 314	3 366	3 187	3 172	3 143	2 943	2 760	2 670	2 454	2 372	1 999	1 823
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	143 679	146 724	145 991	145 100	149 587	151 900	156 002	146 995	152 260	146 009	147 475	145 817	143 955	144 309	145 919	141 788	136 765	132 394	134 917	121 937	129 282	118 992	114 696	115 364	109 848

2.2 Description and interpretation of emission trends by gas

The major greenhouse gas in Belgium is carbon dioxide (CO_2), which accounted for 84.6% of total GHG emissions in 2014. Methane (CH_4) accounts for 7.1%, nitrous oxide (N_2O) for 5.5%, and fluorinated gases for 2.8% (Figure 2.2). Emissions of CO_2 decreased by 19.7% during 1990-2014, while CH_4, N_2O and fluorinated gas emissions have dropped with respectively 33.2%, 38.6% and 42.1%[7] during the same period.

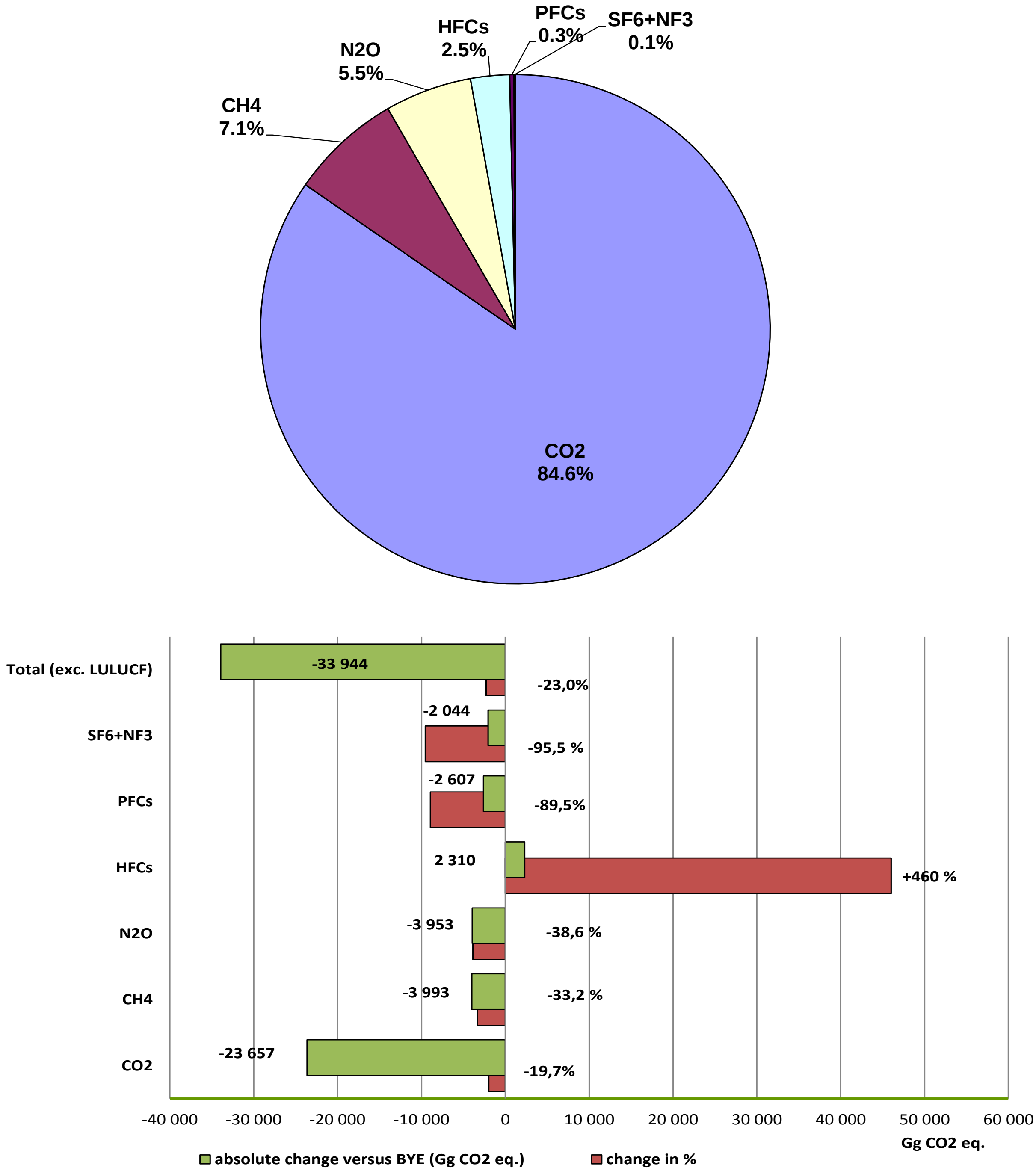


Figure 2-3 : Share of greenhouse gases in Belgium (2014) and changes compared to base year (1990 for CO_2, CH_4 and N_2O; 1995 for F-gases)

[7] compared to 1995 emissions

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 in Figure 2.3. Transport, energy industries, manufacturing industry (process) and space heating are the most important sectors in the total GHG emissions in 2014.

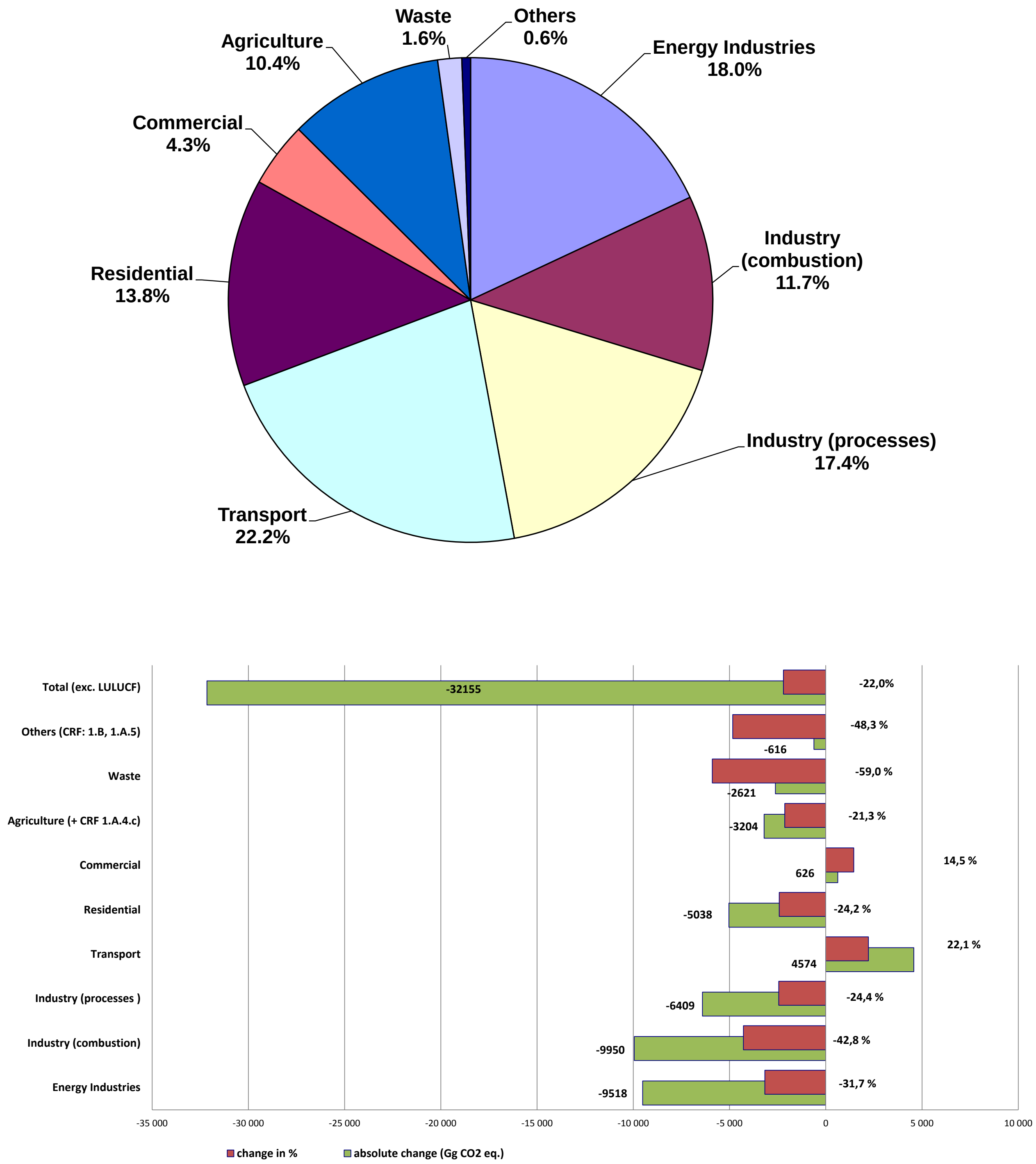


Figure 2-4 : GHG emissions: share of main sectors in 2014 and changes from 1990 to 2014.

Figure 2.3 summarises the impact of the main sectors on the national trend. It clearly shows the sharp increase in road transport on the one hand but also the increase of emissions from buildings in the commercial sector on the other hand. Since 1990, those two sectors together grew by 20.8% and have been responsible for a 3.6% increase in total emissions. In 2014, the residential sector has decreased (emissions from the residential sector depends more strongly on the winter weather and 2014 has been a relatively mild year) and emissions are the lowest for all the time series.

This trend is counterbalanced by the 30.9% decrease in emissions in the other sectors, particularly manufacturing industry (combustions recorded a 42.8% decrease since 1990 explaining 6.8% of decrease in total emissions) and energy industries (emissions recorded a 31.7% decrease since 1990 explaining 6.5% of decrease in total emissions), giving an overall decrease of -22.02% compared to 1990 (for all gases).

The drivers of these trends are analysed and commented, sector by sector, in the chapters 3 to 7 of this NIR.

2.4 Description and interpretation of emission trends for indirect greenhouse gases and SO_2

Emissions of ozone precursors (CO, NO_X, NMVOCs) and SO_2 are presented in Figure 2.5 (share of sectors and changes 1990-2014). These data are commented below.
During the 2016 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 the 15^{th} of February 2016.
This year Belgium reported the revised emissions of these pollutants under CLRTAP for the complete time series.

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

2.4.1 Nitrogen oxides (NO_X)

The primary NO_x emitting source in Belgium is transport (54% in 2014), followed by industry process (12%) and agriculture (10%). Total NO_x emissions have substantially decreased (-53% in 2014 compared with 1990), mainly as a result of improved performances in the production of electricity and in the transport sector (the greatest contributors to NOx emissions). Emissions from transport have decreased with 49% between 1990 and 2014 thanks to the use of catalytic converters on cars (since 1993-94); the same technology explains the decrease of emissions from energy industries (-81%) as well the switch of fuels.

2.4.2 Carbon monoxide (CO)

CO emissions in Belgium come mainly from industry process (39%), space heating in residential and commercial (33%) and transport (19%).
Between 1990 and 2014, national CO emissions fell by 75%, 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

NMVOC emissions are caused mainly by industry process and product use (31%) followed by biogenic emissions from forests (29%) and agriculture (19%). Overall, these emissions decreased by 55% between 1990 and 2014 (decrease of 63% without LULUCF), as a result of altered vehicle emission standards, reduced fugitive emissions and prevention of solvent use. The annual changes of biogenic emissions are mainly driven by temperature and light exposure, considering that the areas and species change at a slower pace.

2.4.4 Sulphur dioxide (SO_2)

SO_2 emissions produced by the energy sector, industry and space heating sectors decreased sharply in Belgium between 1990 and 2014, leading to a general drop of these emissions by 88%. These reductions are the result of fuel substitution and reduced sulphur content in the oil products used. The energy sector accounts for 22% of SO_2 emissions, but industry process is higher with 41%. Residential and commercial sector accounts for 20% and enrgy use in the industry for 14%.
In the transport sector, sulphur dioxide emissions have dropped (-97% in 2014 compared with 1990), mainly due to the constant reduction in the sulphur content of fuels since 1996.

2.4.5 Ammonia (NH_3)

In Belgium, over 90% of the NH_3 emissions are attributed to agricultural activities. 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 44% between 1990 and 2014. In Flanders, more than half of this reduction is attributed to the emission reduction of swine. 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.

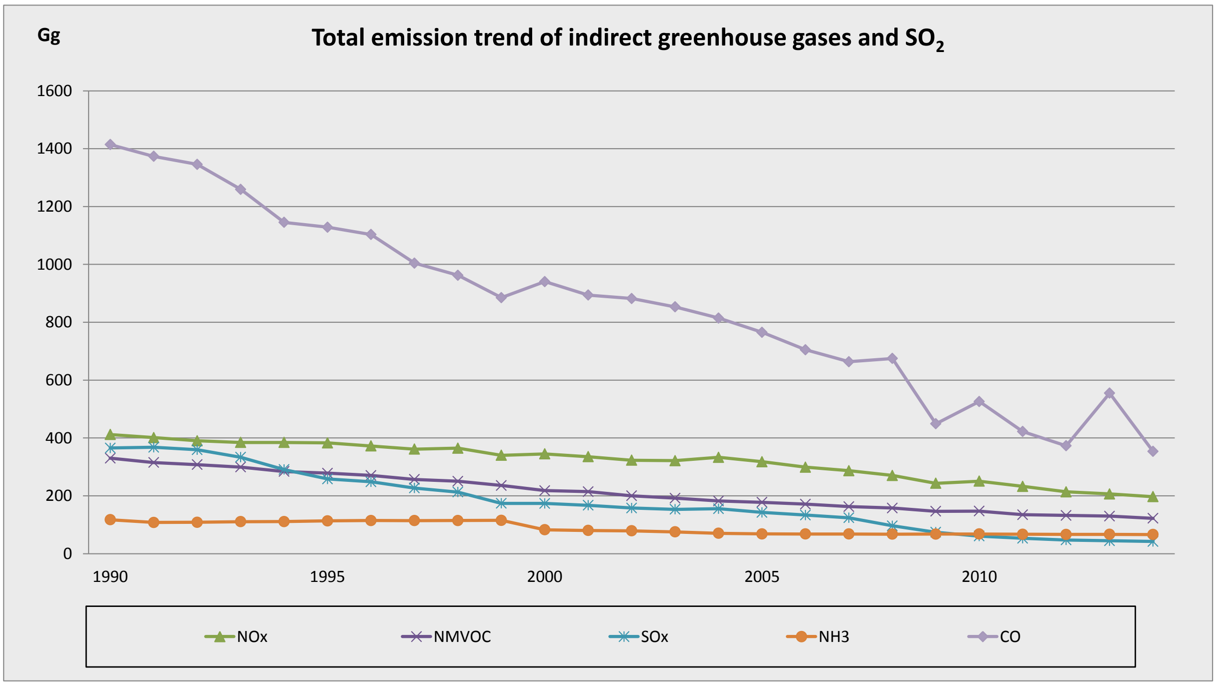


Figure 2-4 : Total emission trend of main pollutants 1990-2014. Source: IIR 2016 (excluding LULUCF).

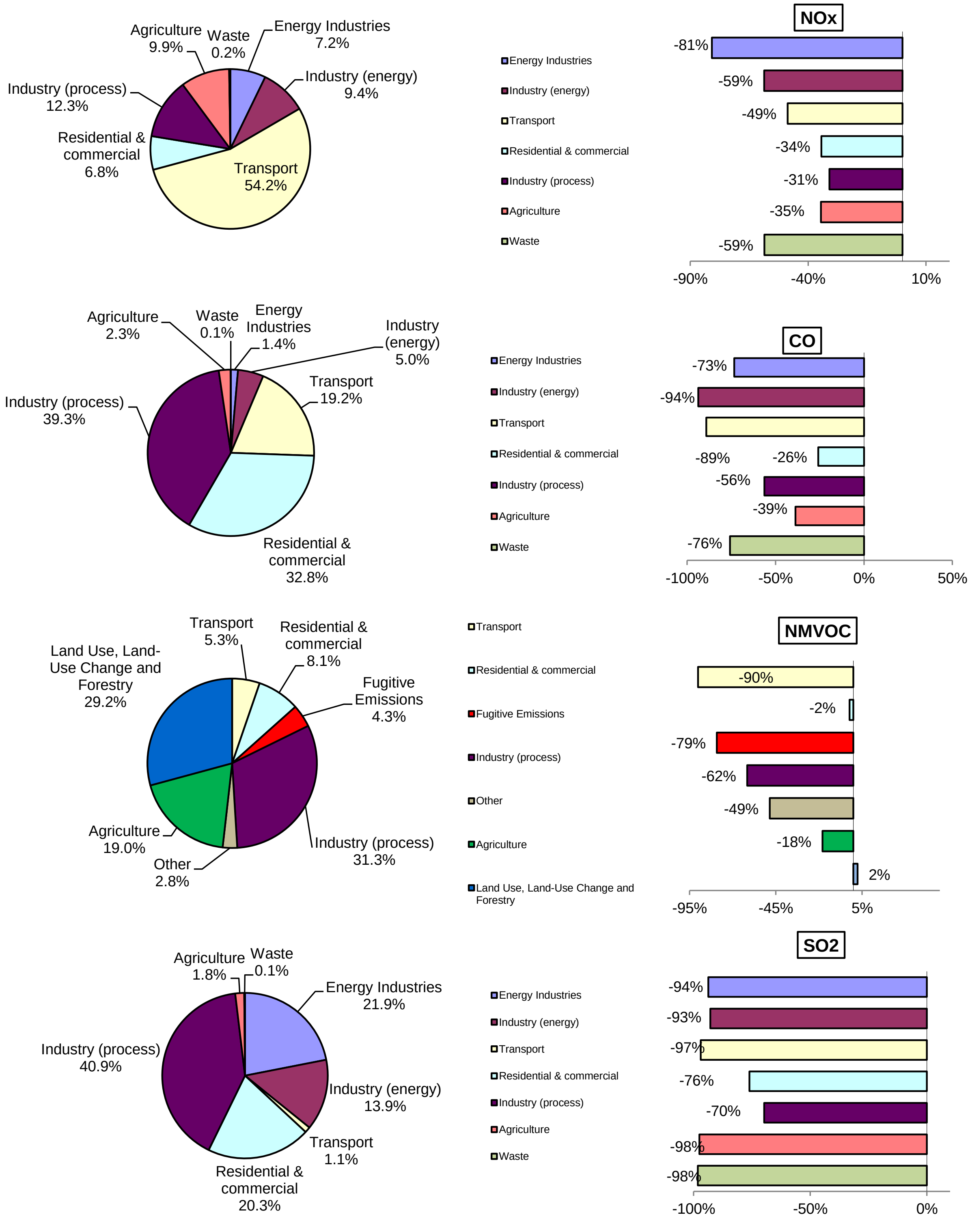


Figure 2-5 : Indirect GHG emissions and SO_2: share in 2014 and changes 1990-2014.

3 ENERGY (CRF SECTOR 1)

3.1 Overview of sector

3.1.1 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 and not the Belgian energy balance (top-down) because of the regional responsibilities to set up the air emission inventories in Belgium.

One exception on this general rule is the calculation of the greenhouse gas emissions originating from road transport. These emissions are calculated in Belgium based on the fuels sold, reported in the federal petroleum balance statistics. The distribution of the emissions between the 3 regions in Belgium is based on the results of regional COPERT model runs. These are based on fuel consumption of the vehicles that travel within the region’s territory (see sections 1.4 and 3.2 for further details).

The use of regional energy balances instead of federal data is the main reason of differences between the reference approach and the sectoral approach.
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 below 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).

3.1.2 Trend assessment

3.1.2.1 Energy industries (1A1)

The main source for this sector is public electricity and heat generation (1A1a), which accounted for 76% of sectoral emissions in 2014. Petroleum refining (1A1b) and manufacture of solid fuels (1A1c) accounted for 23% and 1% respectively.

Emissions from the manufacturing of solid fuels have decreased by 90% since 1990 (-1840 Gg CO_2 equivalent) due to the closure of six coke plants in respectively 1993, 1995, 1997, 2000, 2005 and 2010. Emissions in 2014 from petroleum refining are 8.7% 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 the case in 2011 for one of the biggest refineries.

As mentioned above, the main driver in this sector is still public electricity and heat generation although the sector is experiencing a sharp decline since 2010 (-31%). While electricity and heat production have risen by 24% between 1990 and 2014, emissions have decreased (-34%) 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.

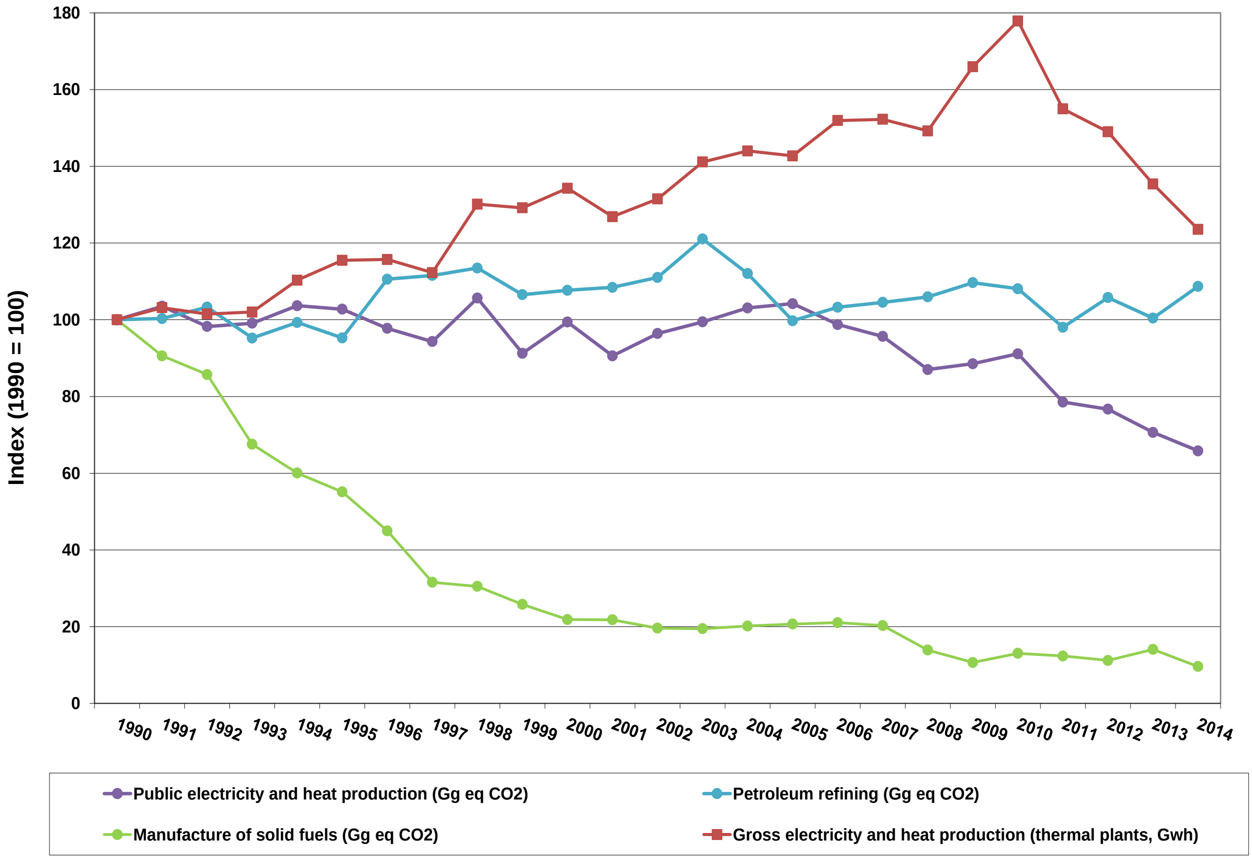


Figure 3-1 : GHG emissions from public electricity and heat generation, in relation to gross electricity generation

3.1.2.2 Manufacturing industries (1A2)

In the manufacturing industries, added value[8] has increased by 41% in 2014 since 1990, while greenhouse gas emissions (combustions) decreased by 57% in the same period.

[8] Gross added value of sector 1A2, estimates in chained euros (reference year 2005) - Federal Planning Bureau

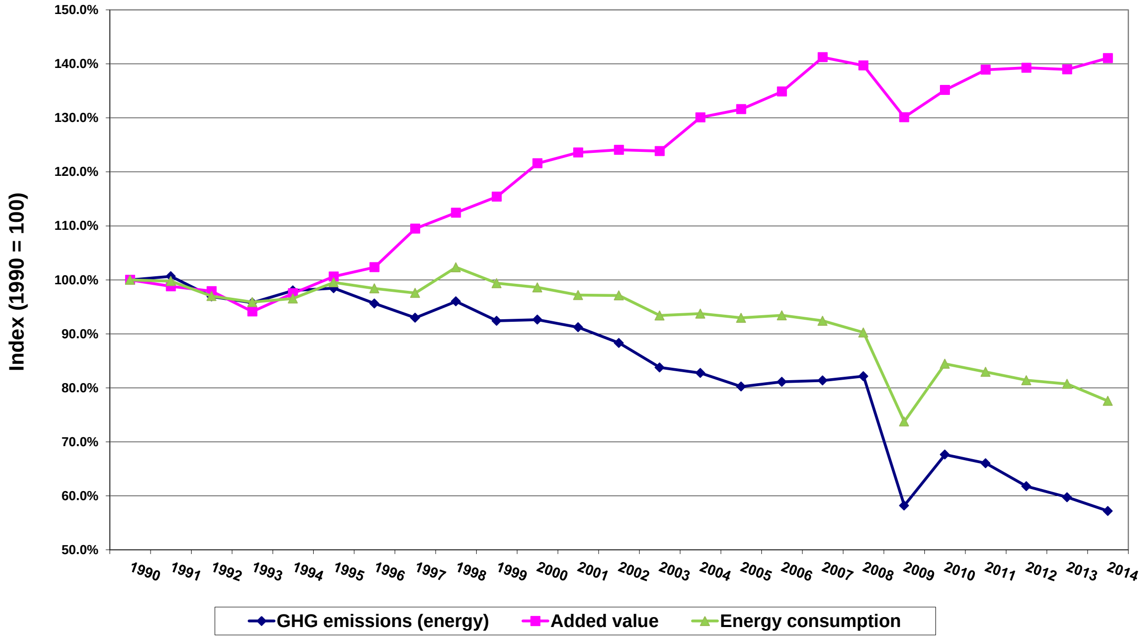


Figure 3-2 : Manufacturing industries: index of GHG emissions, energy consumption and added value

As seen in Figure 3.2., fuel energy consumption decreased by 22% between 1990 and 2014 (and by 26% if we consider 2009). 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 electricity consumption by the sector increased by 28% from 1990 to 2002 [1]. 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 8% of the energy consumption through combustions in 2014 by the manufacturing industries and consequently its impact on the global trend has decreased.

In the chemical sector, fuel consumption (non-energy use of fuels are excluded) has decreased by 10% between 1990 and 2006, compared to 65% growth in added value [1]. This major decoupling is linked to both rational energy use and high added-value products. In 2014, this sector represents 24% of energy consumption in the manufacturing industries.

Food processing and beverages represented 11.6% of energy consumption in the manufacturing industries in 2006, but 13 to 14% of added value [1]. 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 (2014) used for 73% of clinkers production compared to 61% in 1990.

Figure 3.2 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 3.3.

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 46% of their energy consumption in 2014 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 and not accounted for in the national emissions.

The half of the biomass fuels used in Belgium comes from the pulp and paper sector, where part of the woody raw material has always been used as fuel in pulp paper plants. The consumption increased by 288% from 1990 to 2014 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.

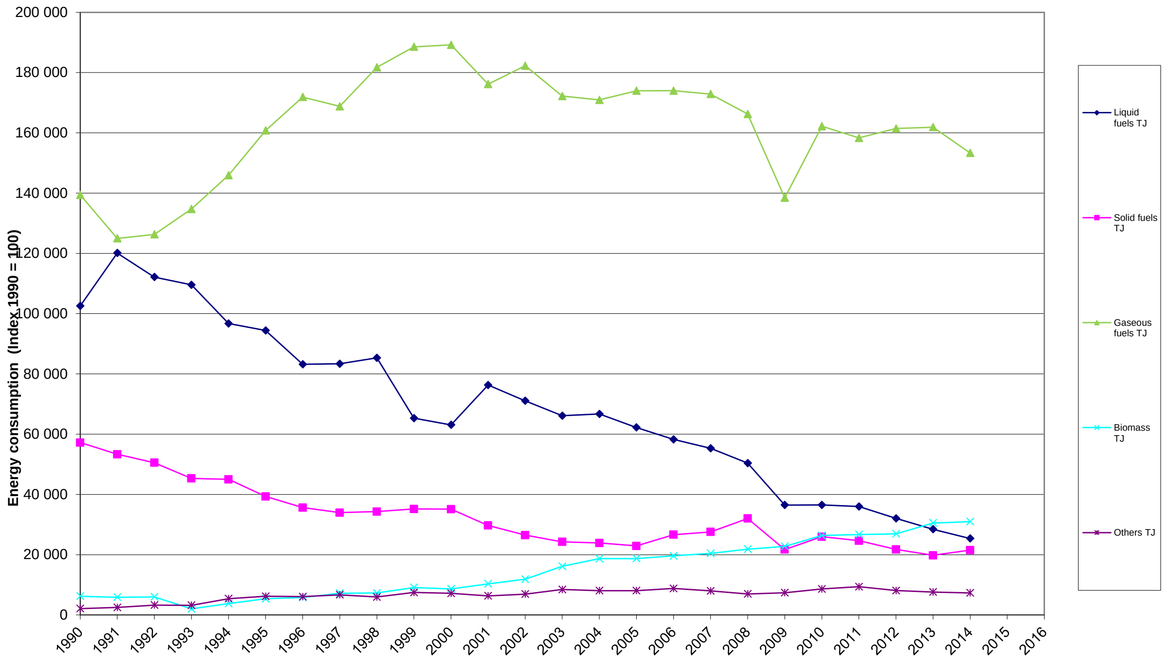


Figure 3-3 : Type of fuels used in the manufacturing industries.

3.1.2.3 Transport (1A3)

Transport emissions accounted for 14.1% of total GHG emissions in 1990 and 21.1% in 2014. This increasing share is due to road transport, which represents 97.9% of total emissions by the sector in 2014 (without 1.AA.3.e sector 'other transportation').

Emissions from domestic navigation are fairly stable and represent almost 1.6% of transport total emissions in 2014. Emissions from railways (0.4% in 2014) 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 (2014): the number of vehicles has increased by 54% since 1990 (44% for only passenger cars) [4a], together with traffic (vehicle km) which has risen in the meantime by 46% [4b]. During quite the same period, the road freight traffic grew by 82% (ton-kilometer-2012) while the number of passengers carried by cars increased by only 27%.

There is a marked switch from petrol engines to diesel. The number of petrol engines (all vehicles) has dropped between 1990 and 2014 (-15%) while the number of diesel engines has tripled (+ 302%) for the same period. This is reflected in their respective traffic figures for personnal car(- 49% for petrol engines and +296% for diesel engines [4b]) and in their respective emissions as well (Figure 3.4).

The average engine capacity has also 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. The average age of the cars has increased (improved rust protection and overall resistance), as has the average distance travelled which is now being stabilized.

The number of vehicles using LPG has increased by 93% between 1990 and 2002 and then decreased by 62% and is representing now in 2014 a decrease of 15% over 1990. The progres encountered during the early 2000s (thanks to subsidies and best prices) have now completely disappeared. Private cars using LPG represent only 0.34% of total private cars in 2014 whereas it was 1.65% in 1987.

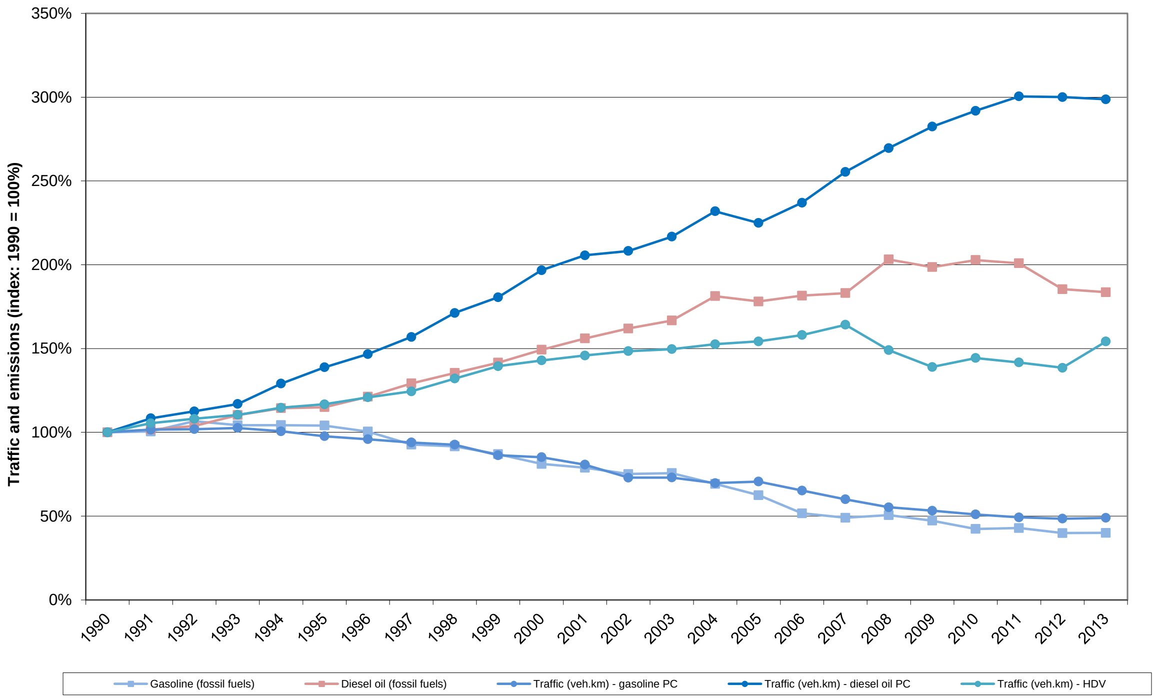


Figure 3-4 : Emission trends in the transport sector (according "reference approach" for fuels)

Road transport is one of the 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 2014, it constitutes one of the main drivers of emissions trends. The absolute increase in CO_2 emissions from road transport between 1990 and 2014 is the second highest among the key sources for the trend assessment (+4794 Gg CO_2).

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 2014, these emissions represent 21% of national emissions, with maritime transport representing the most important source (84% of this category). Emissions from international aviation have increased by 24% since 1990, while emissions from maritime transport have risen by 51% (135 % of increase in 2008 since 1990 en then going down from 2009 due to economic crisis).

3.1.2.4 Residential and commercial (1A4)

In the residential sector, fuel consumption has increased by 12% between 1990 and 1999. 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[9], one of the key parameters used to analyse the sector energy consumption. This is particularly clear for 1996 and 2010 which were cold years with a marked peak of emissions from heating, but also for 2007, 2011 and 2014, three years with exceptionally mild winters, which caused a sharp drop in consumption. Recently, rising energy prices and improving building insulation have probably also contributed to reduce consumption. Since 1990, gaseous fuels consumption has increased in the residential sector (stationary combustion) from 34 to 48% of total energy consumption (without electricity and heat), together with a decrease in solid fuels and liquid fuels. Liquid fuels still account for 44 %, however. One explanation could be that the gas distribution network does not cover sparsely populated areas, thus hampering the switch from liquid to gaseous fuels, which is observed in other sectors.

In the commercial and institutional sector, fuel consumption has increased by 28% 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 29% (between 1993 and 2014). In the meantime, electricity consumption has also grown by 94% (between 1990 and 2013), mainly due to the development of Information Technologies and the increased use of refrigerated areas and air conditioning. The emissions from this final consumption of electricity are included in the energy sector emissions. These increases have been partially counterbalanced by a clear switch from liquid fuels to gaseous fuels observed since 1995 and natural gas represent now 75% 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 3.2.9.5) in the residential sector, biomass represents now 7.3%. In the commercial sector, a slow increase has been observed since 1998, but biomass represents only 3.8% 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).

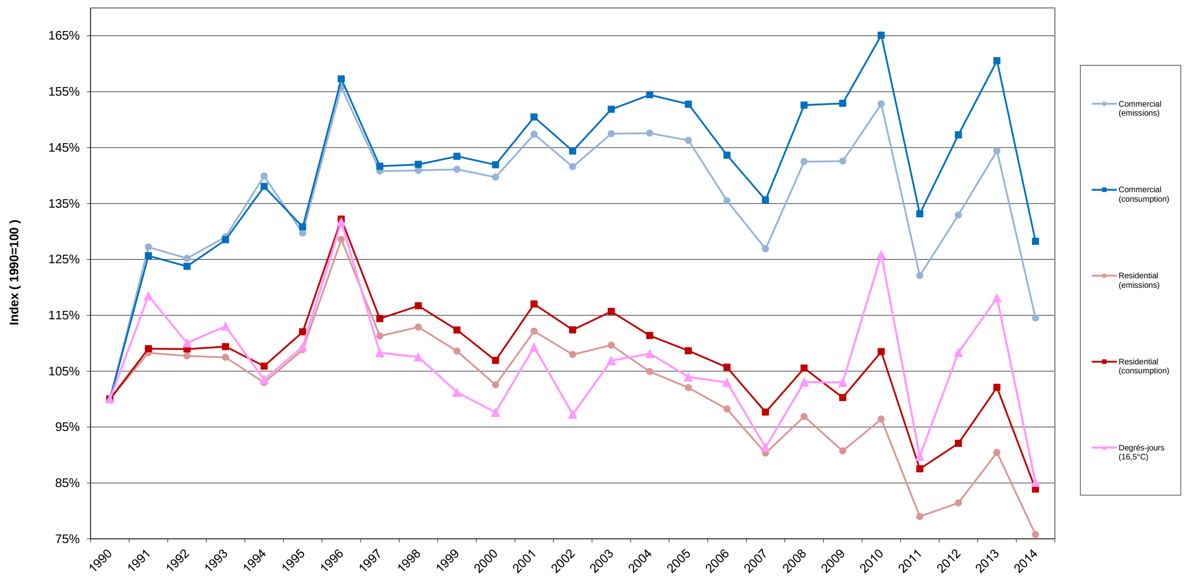


Figure 3-5 : Greenhouse gas emissions and energy consumption in the residential and commercial sectors.

[9] 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.

3.1.3 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 UNFCCC in November 2015.
Please note that an important reason for recalculations in the energy sector is the yearly update of the regional energy balances. The year 2013 is mainly affected.
The new IPCC 2006 guidelines were used since previous submission in 2015.

Category 1A1 Energy industries:

Recalculations in category 1A1 mainly due to:

All regions: optimization of regional energy balances.

Flemish region:

- A bug in the UNFCCC CRF Reporter software caused a double counting in emissions of CO_2 in the category 1A1a/solid fuels in the Flemish region during the 2015 submission for the years 1990 (-747 kton) and 1994 (-256 kton). Another correction was not taken by the CRF Reporter software during the 2015 submission for the year 2012 (-420 kton) and was corrected during this 2016 submission.
- Other corrections were made for the years 2008 (switch of allocation in 1A1a (CHP-installation) to 1A1b (self producer) before (-12 kton CO2).
- Corrections of emissions of CHP-installations in refineries: plant-specific emissions of refinery gas were reported during this submission instead of default emission factors before.
- Other small corrections of emissions in 2010 and 2012 in category 1A1a.

Walloon region:

- A correction was made for the CH_4 and N_2O emission factors for a TGV plant from 1999 to 2013.
- Some plants (4) were misallocated in the CRF codes. In the sectors 1A1a, 1A2c and 1A2gviii, the fuel consumption in some plants was misallocated during the years 2008 to 2012. For example, the fuel consumption was allocated in 1A2gviii before and in 1A1a during this submission.

Brussels region:

- A correction of historical values of natural gas consumption in the incinerator and CHP-installations.

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	0,00	0,00	-0,54	-0,41	-0,56	-2,54	-1,51	1,21
Flemish region	%	-3,13	-0,13	-0,02	-0,07	-0,18	-0,10	-2,17	0,10
Walloon region	%	0,00	0,00	0,02	0,02	0,36	0,04	0,01	-0,23
Belgium	%	-2,42	-0,10	-0,02	-0,06	-0,10	-0,10	-1,91	0,07

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO_2 eq.	0,00	0,00	-1,07	-1,09	-1,46	-6,13	-3,85	2,67
Flemish region	Gg CO_2 eq.	-747,00	-28,53	-5,40	-16,51	-39,84	-19,34	-443,50	18,98
Walloon region	Gg CO_2 eq.	0,00	0,00	0,87	0,99	13,99	1,19	0,31	-6,71
Belgium	Gg CO_2 eq.	-747,00	-28,54	-5,60	-16,61	-27,31	-24,29	-447,04	14,94

Category 1A2 Manufacturing Industry and construction:

Recalculations in category 1A2 mainly due to:

All regions:

- optimization regional energy balances
- optimization of the calorific values to country-specific values instead of default values for the fuels used in the OFFREM-model to calculate the emissions of off-road in this category.

Flemish and Walloon region:

Re-allocation between the energetic and the process emissions in the iron & steel sector since the 2015 submission.

Flemish region:

- Re-allocation since the 2015 submission of the offgas-emissions/recovered fuels from cracking units (biggest part) plus some other processes (non-energy use) emissions from the category 1A2c / other fuels to the category 2B8b Industrial Processes and Product Use / Chemical Industry / Petrochemical and Carbon Black Production / Ethylene during this submission as prescribed in the new IPCC 2006 guidelines.
- In the category 2C7 a re-allocation was made from process emissions to energetic emissions (category 1A2b) for the complete timeseries (for 1 company in this category the emissions from cokes and petroleumcokes were re-allocated to energy in accordance with the energy balance rules).

Walloon region:

- Some plants (4) were misallocated in the CRF codes. In the sectors 1A1a, 1A2c and 1A2gviii, the fuel consumption in some plants was misallocated during the years 2008 to 2012. For example, the fuel consumption was allocated in 1A2gviii before and in 1A1a during this submission.

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	0,11	0,12	0,14	0,19	0,30	0,31	0,27	-4,10
Flemish region	%	0,10	0,10	0,13	0,15	0,31	0,44	0,39	1,25
Walloon region	%	0,02	0,02	0,02	0,03	-1,03	-0,87	-0,88	-1,49
Belgium	%	0,06	0,06	0,07	0,09	-0,35	-0,22	-0,19	0,01

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO_2 eq.	0,15	0,14	0,17	0,19	0,19	0,19	0,19	-2,98
Flemish region	Gg CO_2 eq.	10,73	10,23	12,02	12,85	24,74	33,44	30,18	96,00
Walloon region	Gg CO_2 eq.	2,58	2,52	3,05	3,37	-79,46	-66,90	-58,16	-91,09
Belgium	Gg CO_2 eq.	13,44	12,89	15,24	16,41	-54,53	-33,27	-27,79	1,93

<u>Category 1A3 Transport</u>:

Recalculations in category 1A3 mainly due to:

All regions:

- recalculation of emissions in the category 1A3b (road transportation) for the entire time series with COPERT 4v11.3
- optimization of the calorific values to country-specific values instead of default values for the fuels used in the OFFREM-model to calculate the emissions of off-road in this category.
- The CO_2 emissions from the urea used as a catalyst are newly reported in the category 2D3 since the 2016 submission instead of category 1A3b before.

Flemish region:

- Because of a revision of the statistics of goods in the harbour of Antwerp for the complete timeseries, emissions were optimized accordingly in the category 1A3d.

Walloon region:

- The emissions of the aviation sector were recalculated from 2008 to 2013 as there was a mistake in the data for one airport.

Brussels region :

- A revision of mobility data took place for 2013 (new regional model available).

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	-1,59	-1,19	-1,04	-0,84	0,07	0,05	0,00	-8,72
Flemish region	%	-0,81	-0,50	-0,42	-0,15	-0,09	-0,24	-0,28	0,98
Walloon region	%	-1,07	-0,77	-0,29	-0,61	-0,65	-0,65	-0,63	-1,95
Belgium	%	-0,94	-0,63	-0,40	-0,34	-0,29	-0,37	-0,39	-0,43

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO_2 eq.	-17,62	-13,00	-11,64	-9,43	0,74	0,54	-0,03	-84,89
Flemish region	Gg CO_2 eq.	-102,75	-68,76	-61,91	-22,62	-14,10	-38,72	-42,88	147,59
Walloon region	Gg CO_2 eq.	-74,67	-62,42	-25,16	-58,41	-64,11	-62,60	-55,27	-168,97
Belgium	Gg CO_2 eq.	-195,06	-144,18	-98,71	-90,46	-77,47	-100,77	-98,18	-106,27

<u>Category 1A4 Other sectors</u>:

Recalculations in category 1A4 mainly due to:

All regions :

- optimization regional energy balances.
- optimization of the calorific values to country-specific values instead of default values for the fuels used in the OFFREM-model to calculate the emissions of off-road in this category.
- During the 2016 submission, emissions from off-road activities in the agricultural sector are revised for the years 2011-2013 in the Brussels region.

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	0,00	0,00	-0,04	0,00	0,00	0,00	0,00	1,72
Flemish region	%	0,01	0,01	0,10	0,01	0,03	0,04	-0,07	0,40
Walloon region	%	0,00	0,00	-0,01	0,00	-0,02	-0,02	-0,02	0,74
Belgium	%	0,01	0,01	0,06	0,01	0,02	0,02	-0,05	0,62

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO_2 eq.	0,06	0,05	-1,11	0,06	0,03	0,03	0,03	41,88
Flemish region	Gg CO_2 eq.	1,94	2,84	18,22	1,92	6,15	5,47	-10,03	66,19
Walloon region	Gg CO_2 eq.	0,30	-0,13	-0,44	-0,43	-1,69	-1,19	-1,48	58,56
Belgium	Gg CO_2 eq.	2,30	2,75	16,68	1,54	4,49	4,30	-11,48	166,62

<u>Category 1A5 Other</u>:

All regions:

- Optimization of the calorific values to country-specific values instead of default values for the fuels used in the OFFREM-model to calculate the emissions of off-road in this category.

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	3,09	3,09	3,09	3,09	3,09	3,09	3,09	3,09
Flemish region	%	2,08	1,82	2,77	2,79	2,81	2,82	2,84	2,70
Walloon region	%	0,03	0,06	0,07	0,06	0,10	0,11	0,16	-58,70
Belgium	%	0,07	0,12	0,15	0,12	0,21	0,23	0,31	-57,79

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flemish region	Gg CO_2 eq.	0,07	0,07	0,08	0,06	0,06	0,06	0,06	0,03
Walloon region	Gg CO_2 eq.	0,05	0,06	0,07	0,05	0,05	0,05	0,05	-47,36
Belgium	Gg CO_2 eq.	0,12	0,13	0,14	0,12	0,11	0,11	0,11	-47,33

Category 1A Overall recalculations:

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	-0,42	-0,33	-0,35	-0,26	-0,10	-0,22	-0,13	-1,18
Flemish region	%	-1,30	-0,13	-0,06	-0,04	-0,04	-0,03	-0,79	0,59
Walloon region	%	-0,20	-0,16	-0,06	-0,16	-0,44	-0,47	-0,45	-0,99
Belgium	%	-0,89	-0,15	-0,07	-0,09	-0,16	-0,17	-0,66	0,05

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO_2 eq.	-17,41	-14,55	-14,95	-11,34	-4,13	-7,54	-4,57	-43,95
Flemish region	Gg CO_2 eq.	-837,00	-84,15	-36,99	-24,31	-22,99	-19,10	-466,17	339,89
Walloon region	Gg CO_2 eq.	-71,74	-59,98	-21,61	-54,43	-131,22	-129,45	-114,54	-255,58
Belgium	Gg CO_2 eq.	-926,20	-158,69	-73,55	-90,07	-158,34	-156,09	-585,28	40,36

3.2 Fuel combustion (CRF 1.A)

In 2014 (Belgium’s apparent gross inland consumption rose to 53367 ktoe (thousands tonnes oil equivalent), i.e. approximately 4.8 toe per inhabitant. More than 70% of Belgium’s energy needs are met by the netto import of fossil fuels (39138 ktoe in 2014). This was made up of 3290 ktoe of solid fossil fuels, 23249 ktoe of oil (all petroleum products) and 12599 ktoe of natural gas.

In 2014, 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 (2.0% of electricity produced). The production of wind energy is also very limited but steadily increasing (6.3% of total electricity produced in 2014), 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 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, which states on page 2.8 « 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. Hence, the energy data reported in the Belgian greenhouse gas inventory (e.g. all CRF 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 Energy Observatory of 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 CRF-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 refineries 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 [10](all de 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 Processs' (iron and steel sector) in the regional approaches 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 Energy Observatory of the Directorate-General for Energy and have been optimized during this submission but there are still no 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.

For the submission 2016, all the time series have been revised according last statistics available provided to IEA and Eurostat (On January 14, 2016 last revision was made and sent by Belgium for the balances of 2014).

[10] Please note that this may lead to discrepancies with Eurostat data for energetic comparaisons 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.

The difference between the reference approach and the national inventory (sectoral approach corrected for the off gases produced in the blast furnaces and combusted/encoded under 1A2a or 1A1a (4702 kt CO_2 eq. in 2014) for all years is visualised in the figure 3.6 below. The comparison in Gg CO_2 with the sectoral approach (corrected Table 1AC) shows differences between -3% (in 2002) and 5.4% (in 2001). The difference in 2014 is about 1.5%.

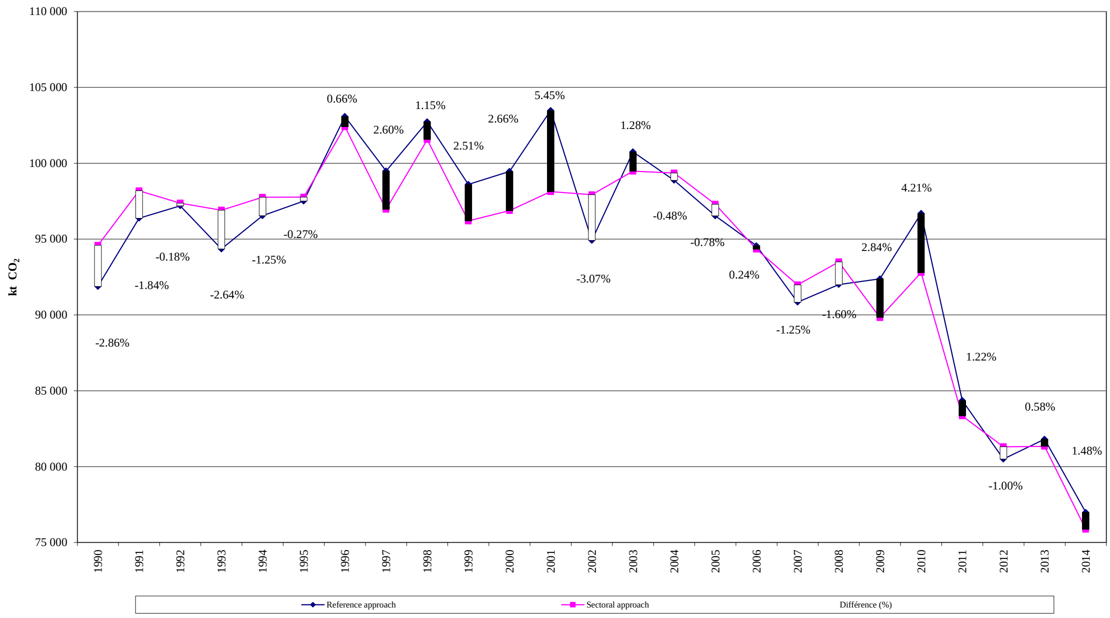


Figure 3-6 : Difference between the reference approach and the sectoral approach of the Belgian inventory (Gg CO_2) corrected for the off gases produced in the blast furnaces and combusted/encoded under 1A2a or 1A1a.

The following table represents the difference as encoded in the CRF tables.

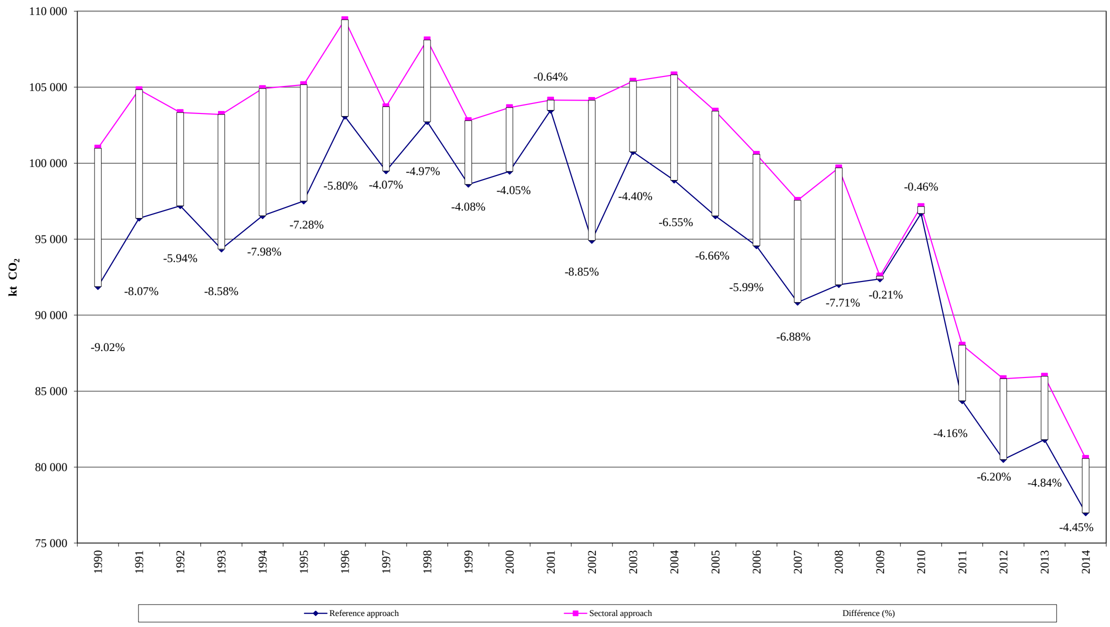


Figure 3-7bis : Difference between the reference approach and the sectoral approach of the Belgian inventory (Gg CO_2) <u>not corrected for the off gases produced in the blast furnaces and combusted/encoded under 1A2a or 1A1a</u>.

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 a value of 42.15 GJ/ton in the reference approach (for the year 2014). If this value is about 5% lower (40 GJ/ton) the reference approach would be 5070 kt CO_2 lower.

<u>Reason number 3:</u> In the reference approach, the AD and carbon excluded are based on the federal energy balance and the default values from IPCC while the emissions from non-energy use in the sectoral approach are 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 informations are 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 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 theses emissions are estimated directly with COPERT-model.

<u>Reason number 4</u>: emissions from solid fuels are mainly located under 'Industrial Processs' (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 hereabove) and provided a corrected comparison for this purpose.

<u>Reason number 5</u>: some data from the Energy Observatory of the Directorate-General for Energy are only available for the years 2009-2014 (as the amount of “Naphtha” which is transformed in “Other Oil” in the petrochemical industry).

A working group of Energy Balances under the National Climate Commission (Decision made on the 30^{th} of October 2003) is set up to improve harmonization of the regional and federal energy balances for the future.

Consultations have been going on in different areas:

- improvement of the basic data of the federal statistics with respect to extension of the number of companies involved, extension of non-energy operators, link with customs and excise taxes, electronic delivering of data;

- fine tuning of definitions and 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;
- arrangements related to yearly data exchange between the federal and regional authorities;
- succession and evaluation on a continuous basis.

Because consultations with different sectors are necessary in this process of harmonization and an adaption of the legislation is required in some cases (in October 2006 the Belgian legislation was adapted with respect to the collection of data for the federal petroleum balance), it is obvious that this process takes time. Regular meetings of the working group were held and the following work was performed:

- adjustments to the historical federal petroleum balances concerning the total amount of naphta used as non-energy feedstock, based on regional data.
- adjustments to the Belgian inventory renewables/waste, based on the regional data (including recovered fuels from the chemical sector)
- good exchange of data for the electricity and heat statistics from 2006 on between federal and regional administrations.
- procedures are in place since 2008 to help a better exchange of data for other energy sources (natural gas, renewables and waste, oil, solid fuels) from 2008 and on exchange of ideas to possibly help divide federal oil statistics into regional data (still ongoing).
- In 2014/2015 a harmonization of the end use of solid fossil fuels was performed leading to an increased number of reporting companies for the federal statistics.

In May 2009, it was decided within ENOVER/CONCERE (a consultative body that treats all matters concerning energy between the federal and regional authorities) that the existing (but dormant) working group on energy statistics will assemble again, to further the process on harmonizing energy statistics. A first meeting was held in December 2009.

In 2010, at the request of the Walloon Region the matter is passed from the ENOVER group of energy balances to ENOVER plenary sessions with the question of a guarantee obligation on fuel suppliers for regional reporting. The official report of ENOVER plenary sessions of January 2011 states: 'Solutions are proposed by Federal Public Service Energy: statistical data of the 'Excise' for the fuel (pump) and statement by region in the form 'petroleum balance' for the other fuels. Obligation to notify for the fuel oil distributors is not excluded. '

Within the ENOVER group of energy balances, proposals are discussed to collect data of transport and heating petroleum products (gasoline, road diesel, LPG and gasoil) on a regional level. The federal administration will organize the surveys, consolidate the results and transfer the aggregated data to the regions. The suppliers of transport petroleum products (public filling stations) will be treated first. Legislation has been recently modified (a Royal decree has been published on 25th March 2016) to ensure reporting obligations about the allocation of delivery for the distributors of gasoil and the suppliers to the petrol stations. It is expected that the procedures will be finished for reporting the first regional data of 2015 in 2017. During 2015 a survey has been sent out to the public filling stations on a voluntary basis as the adaption of the current legislation has not passed yet. During 2016, the voluntary survey will be repeated for the public and the private filling stations. Figures will be analysed for end 2016.

3.2.2 International bunker fuels

Category Memo Items

Emissions CO_2 International bunkering	Flemish region	Walloon region	Brussels region
Aviation	Total fuel supply all flights (domestic and international) from regional airports, all	Fuel supply international aviation from regional airports and emission factors IPCC 2006	NA

	kerosene allocated to international aviation except correction for small part kerosene allocated to domestic aviation, and emission factors IPCC 2006		
Marine	Total fuel supply from Belgian petroleum balance and emission factors IPCC 2006	NA	NA

No international bunker activities take place in the Brussels region.

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

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 Ocr 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 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. Emissions of CH_4 and N_2O are estimated by using the results of the model in the Flemish region (part international LTO), based on the methodology described in the EMEP/EEA air pollutant emission inventory guidebook 2009 handbook [3].
Concerning the marine bunkering activities, the emissions of CO_2 are also calculated in the Flemish region by using the IPCC 2006 emission factors and the energy data from the Flemish (= Belgian energy balance, as marine activities take only place in the Flemish region). Emissions of CH_4 and N_2O are calculated using the regional EMMOSS-model (international navigation). See also section 3.2.8 for more information.

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 estimated following a very simple methodology described on the table 8.2 in the EMEP/EEA air pollutant emission inventory guidebook 2009 [3]. 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 (emissions from recovered fuels from processes) are reported under categories 2B1, 2B8 and 2B10. During the 2015 submission a re-allocation of the offgas-emissions/recovered fuels from cracking units (biggest part) plus some other processes (non-energy use) emissions (reported in the category 1A2c / other fuels before), were moved to the category 2B8b Industrial Processes and Product Use / Chemical Industry / Petrochemical and Carbon Black Production / Ethylene during this submission as prescribed in the new IPCC 2006 guidelines.

Feedstocks and non-energy use of fuels	Flemish region	Walloon region	Brussels region
Category 2B8 (recovered fuels)	Applicable	NA	NA
Category 2B1 (production of NH_3)	Applicable	Applicable	NA
Category 2B10 (other chemical processes)	Applicable	NA	NA

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 [43]. 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 well 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 (see website http://www.chem.uu.nl/nws/www/nenergy/) and one of the conclusions of this network is that the new IPCC guidelines need to give more information on this subject. In our opinion, the guidelines are also not very clear on the allocation of the resulting emissions: in the CRF table 1.AD, as part of the reference approach, a country should specify in the documentation box where these emissions are allocated. This problem of allocation should be tackled too.
The result of the study made a recalculation possible for all years. The effect of the recalculation was greater in the more recent years because the petrochemical industry has expanded its activities in the beginning of the nineties (that's one of the reasons why this sector 2B8b is a key source for the trend assesment).
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 [1] and from emission estimates from 2013 on, these emissions are taken over from the reported emissions via the ETS-Directive.

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

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

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

Not applicable in Belgium for the time being.

3.2.5 Country-specific issues

3.2.5.1 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) in the Flemish region and by the 'Institut de Conseil et d'Etudes en Développement Durable' (ICEDD) in the Walloon region. In Brussels, the energy balances have been realised by ICEDD up to 2013, and then by a consortium of Climact / APERe energy consultants.

The regional energy balances are transferred to the energy sector (category 1 Energy) of the regional CRF-tables (CRF-Reporter) to report the energy consumption data. To obtain the national energy consumption data, the regional energy consumption data are added up.

Flemish energy balance:

Since the mid-nineties, VITO establishes in commission of the Flemish administration 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, some interpolation work was needed to complete these balances. As these years are not actualized any longer on a yearly basis, some questions raised by the ERT of UNFCCC or EC during the reviews remain partly unanswered. The Flemish energy balances, once approved by a committee with representatives of the Flemish administration, are available for the general public on the website http://www.emis.vito.be.

By obtaining more accurate and/or more detailed information or by adapting some methodologies the figures of the energy balances can change, even for the historical years.
The energy balance is performed by using the results of surveys carried out and reporting obligations (industrial sector (a.o. yearly integrated environmental reports) , the commercial and institutional sector and the transformation sector) and by using existing statistics. From 2013 on the energy data reported by companies via the ETS-Directive are taken over completely in the Flemish energy balance.

Below 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 the Belgian Electricity Federation until 2003. From 2004 on these figures are available from surveys and from reporting obligations (obliged annual reporting of grid operators of gas and electricity, auto-producers and operators of combined heat-power installations and of renewable energy).

The energy consumption of power installations for the production of electricity and/or heat is based on different data sources: 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 Environment, Nature & Energy, from May 2005 obliged reporting for the producers of renewable heat, combined heat & power installations and the auto-producers in the Flemish region. Also the data of the green stream certificates and CHP

certificates of the Flemish Regulation Authority for the Electricity and Gas market (the so-called VREG) are used.
This information is used to determine total input, output and own-use of the sector of electricity and heat. The data sources used for the energy consumption (energy content of waste) of waste installations with electricity production are also the annual obliged integrated environmental reports in combination with information about the green stream certificates of the VREG. Also information about the sorting analysis of the rubbish and the calorific values of the different fractions, available from the responsible waste institute in the Flemish region, are used. The waste is allocated to the input of the power installations when it concerns installations with energy recuperation. A part of the waste is considered as biomass. The not-renewable fraction is allocated to the category ‘other fuels’. The share of biomass is determined on the basis of the sorting analysis.
The fuel consumption of the auto-producers is not allocated to the transformation sector but to the sector where they belong to. The data sources of the fuel consumption and the electricity production originates from the obliged reporting of the auto-producers to the Flemish authority or from VREG, the Flemish Regulation Institute for the Electricity and Gas market (based on information of green energy or CHP certifiates as described above).

The figures of the refineries in Belgium (all refineries in Belgium are located in the Flemish region) are published in the petroleum balances of 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 petroleum balance. The output of refinery gas is the sum of the input in the transformation sector, the own-use of the refineries and the end-use of the gas (in the power installations or industry). The data sources of the figures of own-use of the refineries are from the Verification Office Benchmarking and from the annual integrated environmental reporting obligations. The combined heat-power installations of 2 refineries (Total and Esso) are installations in joint-venture with the electricity producers and are allocated to the sector of electricity and heat (1A1a). Since the end of 2009, one of these installations (at the Esso refinery) was completely renewed and is since then considered to be an auto-producer plant and consequently reported under 1A1b. A third refinery (BRC) has installed a large auto-producer CHP unit in 2010.
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. The losses on the electricity network are calculated as a fraction of the losses on the Belgian network based on the electricity consumption. The most recent figures are available for the year 2014.

2) Industry:

The non-energy use in the energy balance is the sum of feedstocks of the chemical industry (mainly naphtha, propane/LPG/butane) and some other products like white spirit, bitumes, solvents, … which are used in a non-energetic way. 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 federation. From that moment on, a yearly survey is carried out and sent to all companies involved. Information about rest fuels and their emissions of CO_2 as well as process emissions of CO_2 are asked.
The energy consumption of the industry is calculated on the basis of surveys carried out by the VITO, data from the companies which are entered to the benchmark covenant (delivered through the federations), data from the surveys carried out by the chemical federation (Essenscia) and the annual integrated environmental reports. There is also cooperation with the other federations [Agoria (technological sectors), Fedustria (textile, wood and furniture) and Centexbel (textile) and Fevia (food). The petroleum products are extrapolated on the basis of the data of electricity consumption (from the electricity grid operators). Since the liberalization of the gas and electricity market it became difficult to obtain the consumption data of gas and electricity per sector. From 2003 on the distribution grid operators of electricity are obliged to report on an annual basis what they take away of the network per sector. From 2005 on also the transport grid operator is obliged to report this information. These data together with the results of the surveys carried out by the VITO are used to estimate the consumption of electricity per subsector. Also since 2005 there is a reporting obligation of the distribution and transport grid operators of gas. These data together with the results of the surveys carried out by the VITO are used to estimate the consumption of gas per subsector.

Also since 2005 there is a reporting obligation for the producers of renewable energy, combined heat-power installations and auto-producers. These data are also used in the energy balance.
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 Essenscia. In most cases the consumptions in Joules or the emission factor is known. In some cases the energy consumption is calculated on the basis of the emissions of CO_2 with an estimated (expert judgement) emission factor of 70 kton CO_2/PJ.

3) Households:

The energy consumption of the households in the Flemish region for the base year 1990 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 the model. The housing stock is known via the population census (last one dates from 2001). This is performed every ten year and asked about the type of warming and the used fuels for the different types. The housing stock is corrected with the annual data of new building and demolished buildings originating from the national statistics.

For the years 1994 to 1999 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 added. An assumption is used of 85% of the energy consumption in households is climate-dependent. Also the degree-days are taken into account. The data of the Belgian Electricity Federation 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 survey ‘energy and energy efficient behaviour 2001’. The consumption in 2000 is calculated on the basis of the average consumption as a result of the survey, the national statistics about the number of households and an estimation of the percentage using a certain energy carrier. 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 energy carriers used in the buildings originating from the socio-economic survey of 2001. For 2000 and 2001 a correction is made based on the degree-days and 85% of the energy consumption is assumed to be climate-dependent. Again the data of the Belgian Electricity Federation and from FIGAS (federation of gas industry) are used for estimating the consumptions 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: gas, liquid fuel, coal and other fuels. 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 latest submission (November 2013), Flanders has made recalculations for the use of biomass (for 1990 to 2011) and the use of fuel oil (2002 – 2011) using new data.

- 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 [75]). In a report from 2013 [76], the methodology, that was agreed upon by the steering committee of the Flemish energy balance, is decribed. The methology uses the urbanisation degree and unweighted average uses of biomass as main heating source or as secondary heating source from the Eurostat survey to calculate the total biomass used for the period 1990 -2011.
- 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 [77] and taken into account since the 2014 submission.

- For coal, the same switch to natural gas was taken into account during this submission for the years from 2002 on.

4) Commercial and institutional sector:

The energy consumption in the service sector is calculated using the energy data of different sources (survey carried out in 2006 by the VITO, energy cooperation agreement with the communities and provinces, the annual integrated environment reporting). Since the liberalization of the energy market it also became more difficult in the service sector to obtain the consumption data of gas and electricity on a voluntary basis. 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 low voltage into the different subsectors of the service sector. In combination with the results of the surveys carried out by the VITO, some correction factors are used.

5) Agriculture:

The calculation of the energy consumption for the 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 is available from the national statistics and the services in the policy areas of agriculture and fishery of the Ministry of the Flemish Community. The national statistics publish on an annual basis detailed information about the agriculture counts (on the 1th of May).
Statistics about the hectares of agricultural crops and the number of animals are 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 is 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 are based on the specific parameters from literature.
Since the year 2007, a different approach is used. The Agricultural Monitoring Network (LMN - Landbouw Monitoring Network) collects since 2007 [74] 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. The LMN together with the VITO developed a methodology to extrapolate the collected data and incorporate the data from autoproducer (CHP) units for Flanders in total (for petroleum products, solid fuels). The total electricity and natural gas consumption is taken from the grid operators.
For the seafishery the methodology of prefixes is used. Basic data are used from the Service Seafishery of the Administration of Agriculture and Horticulture of the Flemish government. Energy consumption is based on type of fishery, the average of engines power, the number of vessels and the number of days at sea.

6) Transport:

road transport: Since the 2014 submission, the Copert model (COPERT 4) is used to harmonize the calculation of emissions from road transport between the 3 regions. The energy consumption calculated by COPERT is used as amount of fuels in the regional energy balance.
CO_2 emissions from road transport in Belgium are not calculated on the basis of this regional energy balances but on the federal petroleum statistics of fuels sales (reference approach).

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 driving until 2013. The energy consumption is calculated with EMMOSS model (see 3.2.8).

trams: The energy consumption of the trams (only electricity) in the Flemish region is based on the electricity consumption data from the grid operators for the total railway traffic (train + tram + trolley busses). The available statistics from the Flemish Transport Society (De Lijn) and the Society for the Inter-urban Transport in Brussels (MIVB) are also used.

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

air traffic: All the Flemish airports are reporting their fuel consumption (put in the tanks) of gasoline and kerosene for the civil air traffic. The fuel consumption of kerosene and gasoline used in military aviation are reported annually by the Ministry of Defence. It is not possible to split the energy consumption in air traffic between inland and foreign/abroad consumption. The assumption is made in the Flemish energy balance that all gasoline is used within the Flemish region and all kerosene is used abroad. The amount of kerosene in the Flemish air traffic is allocated entirely to the international bunkers. During the 2013 submission and as a result of the in-country review in September 2012, an optimization is made to this approach. A small underestimation of emissions from the use of kerosene for civil aviation was detected, based on flight movements of the Belgocontrol data and consequently corrected.

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 EMMOSS model (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.

transport through pipelines: 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 Flemish region is estimated based on the figures from Fluxys (the independent operator of the gas network in Belgium), Gasco (an operating Company engaged in the extraction of Natural Gas Liquids (NGL) from associated and natural gas) and the grid operators.

Walloon energy balance

The regional energy balance is prepared by ICEDD in convention with the 'Direction générale opérationnelle Aménagement du territoire, logement, patrimoine, énergie' (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 last energy balance (2014) 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 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.

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.

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 2001and on the basis of weather data. Since the latest submission (November 2013), 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 [75].

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 %).

5) agriculture:

The calculation of the energy consumption for the 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).

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 IV 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.

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.

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-kilometer.

pipelines: 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).

Brussels energy balance

Up to 2013, the Brussels energy balance was prepared by ICEDD by means of a convention with IBGE (Brussels Environment Institute). The 2014 energy balance was established on the basis of the same data sources and similar calculation hypotheses.

The reports of regional energy balance are available on the Brussels Environment website (http://www.environnement.brussels). As in the other regions, the energy balance is performed by using the results of surveys and existing statistics.

Hereunder 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 figures of electricity production are available from regulator’s press communications, statistics from SIBELGA (the only distribution network operator for electricity and natural gas in the Brussels-Capital Region), SPF EPMECME (federal public service) and annual surveys conducted by ICEDD.
The primary energy consumption of power installations for the production of electricity and/or heat is based on a survey conducted by ICEDD.

2) Industry:

The energy consumption of the industry sector is calculated on the basis of a survey conducted by ICEDD. This survey focuses on the biggest energy consumers. An extrapolation to the whole industry sector is then performed, on the basis of electricity consumptions.

3) Households:

The energy consumption of the households sector is calculated on the basis of regional data from SIBELGA and FeBuPro (for electricity and gas), national data from SPF EPMECME (for liquid and solid fuels), the national socio-economic survey of 2001, the energy consumption survey for Belgian households of 2011 and weather data.

4) Commercial and institutional sector:

The energy consumptions are evaluated separately for 'high-voltage' and 'low-voltage' consumers.
For high-voltage consumers, energy consumptions are calculated on the basis of a specific survey and direct contacts (including international public organisms).
For low-voltage consumers, energy consumptions (electricity and gas) are calculated using a top-down methodology. The consumption of oil products is estimated from known fuel/natural gas consumption ratios and national statistics.

5) Agriculture:

Agricultural activities are very limited in the Brussels region. The corresponding energy consumptions are not included in regional energy balances. Off-road transport emissions from the agriculture sector are nevertheless evaluated and reported in the CRF 1A4cii section.

6) Transport:

The evaluation of energy consumptions of transport is not limited to the transport sector itself but is extended to all persons and goods transporting activities. 'Static' consumptions from transport companies (buildings, storage areas...) are included elsewhere.
Different methodologies are used depending on the transport modes :
Road transport: for Belgium, CO_2 emissions from road transport are not calculated on the basis of regional energy balances but on the federal petroleum statistics of fuels sales. Regional calculations are nevertheless also performed, using the COPERT IV v11.1 software, for policy purposes and for the estimation of CH_4 and N_2O emissions.

railways: the energy consumption of trains services (electricity and gasoil) are calculated using data from the National Society of the Belgian Railways (SNCB).

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

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

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

Energetic greenhouse gas emissions of CO_2

In the 3 regions in Belgium the IPCC-default emission factors of 2006 are mainly used for calculating the emissions of CO_2 from combustion processes. 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
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	71,5
gas/diesel oil	74,1	74,1	74,1
lamp petroleum	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	56,1	56,1	56,1
coke oven gas	47,4 (till 2001) and 38-40 (from 2002) on(5)	44,4 (till 2002) and 36-47 (from 2003) on	44,4
blast furnace gas	250-265(5)	260 (till 2002) and 258-280 (from 2003) on	
other products	-2	38-40 (from 2002) on(5)	
biogas	66,749 (7)	75 (3)	
Waste gas	66,749 (7)	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[11]
(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)

The Net calorific value of these different products are mentioned in the annex 4 of this document and are the same as these used in the Energy Observatory of the Directorate-General for Energy in Belgium.

Energetic greenhouse gas emissions of CH_4 and N_2O

[11] 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 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 (CRF 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-generators are allocated to the IPCC category 1A1 (refineries, solid fuel producer), 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 do 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 <u>Public electricity and heat plants (category 1A1a)</u>

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 located in different sectors in Belgium (refineries, industry, agriculture and service sector). Also included in this sector are the waste incineration installations with energy recuperation (waste incineration installations without energy recuperation are allocated in the sector 5C waste incineration, see chapter 7).
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.

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 (electric power plants) and	Individual reporting of CO_2 via ETS Directive	Based on in situ measurements and IPCC 2006

		IPCC 2006 or individual plant reporting of CO_2 through ETS Directive		
	CH_4 and N_2O	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 as much as possible with ETS-data).

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 under ETS 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 CO_2 emission factor is based on in situ measurements, in combination with the default 2006 IPCC CO_2 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, there are some fluctuations on the time series for the CO2 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 CO2 (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 used in the sector of public electricity and heat plants are summarized in table 3.2.
In Flanders, emission factors from IPCC 2006, tier 1 [54] are mainly used to calculate the emissions of N_2O and CH_4 of the electric power installations. These emission factors are agreed with the electricity producers.
For the combined heat-power installations the Flemish region uses the IPCC 2006 emission factors:

1) in the industrial sector:
   for natural gas:
for CH_4 258 g CH_4/GJ for gas turbines and 4 g CH_4/GJ for the other installations
for N_2O 0.1 g CH_4/GJ for gas turbines and 1 g CH_4/GJ for the other installations
   for waste gas:
for CH_4 4 g CH_4/GJ for gas turbines and 3 g CH_4/GJ for the other installations
   for gasoil:
for N_2O 0.6 g CH_4/GJ for all installations

2) in the service sector and in the agriculture sector :
   for natural gas and biogas: 258 g CH_4/GJ and 0.1 g N_2O/GJ.

In Wallonia, emissions of CH_4 and N_2O are also calculated using emission factors of the 2006 IPCC guidelines for the energy industries (included the combined heat-power installations in the service sector).

In the Brussels region, waste incineration produces no emissions of CH_4, and the N_2O emission factor is country-specific (see table 3.2). On the other hand, CH_4 and N_2O emissions from the (small) extra natural gas supply to the waste incinerator are calculated using default 2006 IPCC emission factors.
For the smaller power plants, default 2006 IPCC emission factors are used.

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	2,5	0,3	1	0.1
natural gas	g/GJ	0,3	1	2,5	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		-		-	15 g/ton (2)	15 g/ton (2)	15 g/ton (2)
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)
(2) Source: Country-specific (measurements on 2 industrial sites)

3.2.6.2.2 Petroleum refining (category 1A1b)

Petroleum refining activities take only place in the Flemish region.

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

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	Total emissions CH_4
Category 1B2c	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).

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)
- 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.

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. 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 [2] 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 9g/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.

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 2015 (closure in 1995, 2000, 2005, 2010 and 2013)	1 coke plant until 1993

Activity data		Regional energy balances (based on individual cokes 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 cokes plants 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 N_2O negligible for the cokes plants and default IPCC 2006 for the other activities	EMEP/EEA (CH_4) and IPCC 2006 (N_2O)	EPA (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 cokes 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 2 plants, producing coking coal, are still operational in Belgium instead of 8 plants in the beginning of the nineties. One plant was closed in the Flemish region in 1996, 4 plants closed in the Walloon region in 1995, 2000, 2005 and 2010 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. Until 2004, the CO_2 emissions were calculated with the default IPCC 2006 emission factors. Since 2005, the CO_2 emissions have been giving directly by the plant under the ETS. 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 all plants are now closed in Wallonia.

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 EPA emission factors 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 the energetic emissions from the mine activities on the one hand and are also calculated by using the IPCC 2006 emission factors (see table 3.6). On the other hand the emissions of CH_4 from the cokes ovens in the Flemish region are also allocated in this category 1A1c .

During the submission in 2006 a revision of these last 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 cokes ovens operational that are heated via combustion rooms separated from the cokes 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.
Contacts with the relevant industry in Flanders indicate that no emissions of N_2O occur in this sector.

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 are the activity data of biomass (20%) and other fuels (5%). The uncertainty on emission factors originates from table 2.5 and page 2.15 of the IPCC Good Practice Guidance 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.

In the Walloon region, some QC-tests are performed in the course of 2012. In particular in the category 1A1a, a recalculation with the emission trading data is performed. In the complete sector 1A1, a comparison of activity data is performed between the Walloon CRF reporter data and the Walloon energy balance for the complete time series.

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

- 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).

- Use of IPCC default emission factors from 2006 guidelines since the 2015 submission instead of 1996 guidelines before.

- A bug in the UNFCCC CRF Reporter software caused a double counting in emissions of CO_2 in the category 1A1a/solid fuels in the Flemish region during the 2015 submission for the years 1990 (-747 kton) and 1994 (-256 kton) and was corrected during this 2016 submission.

- Other corrections were made in the Flemish region for the years 2008 (switch of allocation in 1A1a (CHP-installation) to 1A1b (self producer) before), for the years 1994-1996, 2005, 2008 and 2010 of emissions of CHP-installations in the refineries in 1A1a (plant-specific emissions of refinery gas were reported during this submission instead of default emission factors before) and some minor corrections for the years 2010 and 2012 in category 1A1a.

- In the Wallon region, a correction was made for the CH_4 and N_2O emission factors for a TGV plant from 1999 to 2013. Also, some plants (4) were misallocated in the CRF codes. In the sectors 1A1a, 1A2c and 1A2gviii, the fuel consumption in some plants was misallocated during the years 2008 to 2012. For example, the fuel consumption was allocated in 1A2gviii and now, it's allocated in 1A1a.

- In the Brussels Region, correction of historical values of natural gas consumption in the incinerator and CHPs for several years

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

No specific planned improvements are provided in the category 1A1 during the next submission.

3.2.7 Manufacturing industries and construction (CRF 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 according to the new IPCC 2006 guidelines.

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).
In general and until 2012, the emissions of CO_2 are calculated by using the IPCC 2006 default emission factors listed in table 3.1. For some specific fuels, some industries perform analyses of these fuels and also since 2004, more analyses of the fuels have been performed by the plants under the ETS-Directive 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 as much as possible. 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.
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 3.6).

In the categories where mainly commercial standard fuels are used, default IPCC 2006 emission factors are used to estimate the emissions (tier 1).

From the 2015 submission on and from the reporting of the emissions from 2013 on, ETS-data are taken over completely in the greenhouse gas inventory. As a consequence higher tiers are used. Non-ETS industrial emissions are calculated with default IPCC 2006 emission factors.

Iron and steel sector (category 1A2a)

Category 1A2a		Flemish region	Walloon region	Brussels region
Activity data		Regional energy balances (based on individual plant information)	Regional energy balances (based on individual plant information)	NA
Emission factors	CO_2	Based on monitoring results (consistent with ETS)	Based on monitoring results (from 2004 on, consistent with ETS) and IPCC 2006 default emission factors	NA

	CH_4 and N_2O	(1) and (2) and for N2O (integrated steel plant): measurements from 2004 on and best estimates for the years before	IPCC 2006 (2)	NA

(1) Emissions CH_4 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 have been operational since 2012.

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.

The CO_2-emissions from the iron and steel sector are put partly

- in category 1A2a (the energetic part except for the solid fuels that are re-allocated to the Industrial Process part in 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).
- in category 1A1c for the emissions from the use of cokes oven gas in the cokes ovens
- and in category 2C1 (process part): 2C1a and 2C1b 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.

See the respective chapters for more information.

- 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 2014 18,42 PJ of blast furnace gas was used in the category 1A1a which corresponds with an emission of 4702 kton CO_2.

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 are 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 as in the Flemish region) and the CO_2 emissions coming from the solid fuels used in the blast furnaces (2C1a), in the sinter plants (2C1d) and in the electric arc furnaces (2C1a). The emissions from solid fuels, coke gas and blast furnace gas are considered as process emissions behalve the emissions from coke gas and blast furnace gas used as energy purpose (boilers), these emissions are reported in 1A2a. All the carbon incorporated in the blast furnace is considered to be emitted in CO_2 emissions.

In the Flemish region the emissions of CO_2 for the biggest steel plant are revised for the complete time series during the 2011 submission mainly because of inconsistencies in emissions during the last years between the GHG inventory (estimates based on the Flemish energy balance) and the emissions reported under the ETS-Directive. As a consequence some missing fuels were added in the inventory from (cokes grid for the complete time series and anthracite from 2004 on). These changes resulted in an increase of the emissions of CO_2 mainly for the last years.
These 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). The emissions of CO_2 of the other (smaller) companies are calculated by using mainly IPCC 2006 emission factors. From last submission on, also for these companies the ETS-data were taken over.
Activity data for the blast furnace gas that is sold to the electricity producers in the Flemish region is allocated to the category 1A1a even as the corresponding emissions of CO_2.

Category where the Blast furnace gas (PJ) is used	1A1a Public Electricity
Flemish region 2013	17,96
Flemish region 2014	18,42

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)	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. There are no N_2O emissions foreseen in the categories 2C1a and 2C1d. As emissions of N_2O can 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 iron and steel sector are allocated in the categories 1A1c (production of cokes) and 2C1d (production of sinter), see these respective sections 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 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.

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 this submission from the category 1A2c / other fuels before to the category 2B8b (production of Ethylene) according to the new IPCC 2006 guidelines. See section 3.2.3. for more information.
These emissions are reported via a yearly survey carried out by the chemical federation in cooperation with the Vito (Flemish Institute for Technological Research). From 2013 on, these emissions are taken over completely by the reporting under the ETS-Directive. Measurements are carried out to obtain these emissions (tier 3).

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	Mainly IPCC 2006 and based on analyses (ETS-data)	IPCC 2006
	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 by using default IPCC 2006 emission factors.For recent years ETS-data are taken over in the greenhousegas inventory.

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 3.4). 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)

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 3.6 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	-	-	4	-
Biomass	g/GJ	30	-	-	4	-	-
LPG	g/GJ	1			0.1		

Table 3-6 : Emission factors of CH_4 and N_2O in the sector 1.A.2 Manufacturing Industries and Construction.

Source: IPCC 2006

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

During the 2012 submission, the industrial off-road emissions were included for the first time in the 3 regions for the complete time series.

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 during this submission.

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

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 a individual basis, these emissions are also included in 1A2gvii. These emissions aren’t calculated via the OFFREM-model.

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 (Monni and Syri, 2001) 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%.

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. A comparison of activity data is performed between the Walloon CRF Reporter data and the Walloon energy balance for the complete time series.

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

Recalculation of the 2014 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).

- Off road industry: optimization of the calorific values to country-specific values instead of default values for the fuels used in the OFFREM-model to calculate the emissions in this category.

- IPCC 2006 guidelines are used since the 2015 submission instead of the IPCC 1996 guidelines in previous submissions.

- Following the 2006 IPCC guidelines, the Walloon region had reallocated since the 2015 submission the emissions of CH_4 from sinter production from 1A2a to 2C1d and a part of the emissions from the solid fuels are reported in 2C1a and 2C1d.

- In the Walloon region, in the category 2B1: reallocation of the natural gas used in the denox unit since the 2015 submission. The natural gas was included in the natural gas used for the production of ammonia. This amount of natural gas is now in the category 1A2c to follow the emission trading guidelines.

- In the Walloon region, the CO_2 emitted from soda ash production originated from coke oxidation is included in the category 2B7 and no more in 1A2c since the 2015 submission.

- In the Walloon region, the CO_2 emissions from the coke used in the glass sector as a reducting agent were reallocated to the process sector since the 2015 submission.

- In the category 2C7 a re-allocation was made in the Flemish region from process emissions to energetic emissions (category 1A2b) for the complete timeseries (for 1 company in this category the emissions from petroleumcokes were re-allocated to energy in accordance with the energy balance rules).

- In the Walloon region, some plants (4) were misallocated in the CRF codes. In the sectors 1A1a, 1A2c and 1A2gviii, the fuel consumption in some plants was misallocated during the years 2008 to 2012. For example, the fuel consumption was allocated in 1A2gviii and now, it’s allocated in 1A1a.

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

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

3.2.8 Transport (CRF 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, located in the Flemish region, is very important for Belgium. It is the second largest European seaport, and one of the 5 largest in the world. The port of Antwerp 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. 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) are transported by railways for 10.2% of total achieved tonne-kilometres in Belgium, on navigable waterways for 12.1% and by road transport for 77.7% (2009[12]).

The reported emissions in the transport sector are reported in the categories 1A3a civil aviation, 1A3b road transportation, 1A3c railways, 1A3d navigation and 1A3e other transportation.
In the category 1A3e the emissions are allocated originating from the energy needed to transport the natural gas through pipelines as well as the off-road emissions from the categories harbours, airports and transhipment companies.

The emissions of CO_2 are calculated by using of IPCC 2006 emission factors. 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.

For the 2016 submission, estimation of CO_2 emissions from road transport is based on fuels sold, in combination with emission factors from the COPERT 4 model, version 11.3 - http://emisia.com/copert
The federal petroleum balance is the source of these activity data (fuels sold). 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 (see below).

No civil aviation 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.

Sea navigation takes only place in the Flemish region.

Emissions of international maritime (only Flemish region) and aviation bunkers are allocated to the 'memo items'.

3.2.8.2 Methodological issues

3.2.8.2.1 <u>Road transport (1A3b)</u>

[12] http://economie.fgov.be/fr/modules/publications/statistiques/circulation_et_transport/transports_routiers_de_marchandises_-_overview.jsp

Category 1A3b	Belgium
Activity data	Federal energy statistics (fuels sold)
Methodology emissions CO_2	Emission factors Copert 4 v11.3
Methodology emissions CH_4 and N_2O	Regional results from Copert models with correction fuel sold/fuel used

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 are multiplied with emission factors of COPERT 4 to calculate the emissions of CO_2. An overview of these 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)'. For gasoline, it is necessary to remove offroad consumptions (2 to 3 %) from federal energy statistics to avoid double counting. Consumptions of off-road activities are estimated with the OFFREM model (a complete detailed description about the OFFREM 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). This correction is implemented since 2014 submission.

Emissions of CH_4 and N_2O are since the 29th October 2012 submission also based on the amounts of fuel sold of the federal petroleum balance in combination with COPERT 4 emission factors. The compiled emissions of each region based on COPERT 4 v11.3 modelling are hereby corrected/increased according the ratio between the fuel used (consumptions compiled by regional models) and the fuel sold (provided by federal statistics) to get consistency with the methodology used to calculate the emissions of CO_2. This approach is of course carried out by fuel type and was approved by the ERT of the UNFCCC 2012 in-country review during the 'Saturday paper' process.

Emissions of CH_4 and N_2O from biomass (bio-gasoil and bio-ethanol) are reported separately for the first time during the 2013 submission consistently for the 3 regions. The emission factors are those of equivalent fossil fuels since COPERT does not enable fuel blends. Therefore, consumption modelling in COPERT is entirely based on the energy content of fossil fuels. A post-process correction based on specific fuel LHVs (Low Heated Values) has been considered since 2014 submission to reflect the percentage of biofuels included in the blend and to take into account its actual energy content. This correction slightly increase the "fuel used" consumption and therefore slightly affect the CH_4 and N_2O emissions (mainly for gasoline) through the ratio fuel used / fuel sold (see above).

It should be noticed that in COPERT 4 v11.3 consumptions increase due to the use of air-conditioning, the use of lube oil (CO_2 emissions allocated to category 1A3biv for 2-stroke engines and to category 2D1 for the other vehicles, emissions of CH_4 and N_2O are allocated to category 1A3b) and SCR (Selective Catalytic Reduction).

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:

- each region uses directly COPERT 4 to produce regional emissions and "fuel used" consumptions.
- each region use a common fleet module produced by TML (Transport and Mobility Leuven) which provide harmonised regional fleet files as input for COPERT.

- each region uses the same module to provide regional mobility data (produced by IRCEL-CELINE) as input for COPERT.
- each region uses the same module to do the post-processing of the COPERT-results

The 2 major determinants of COPERT modelling (fleet and mobility) are now fully harmonized across the 3 regions. However, some modelling parameters remain regional specific (such as driving mode and average speed).

3.2.8.2.2 Air transport (1A3a and 1A5)

Category 1A3a	Flemish region	Walloon region	Brussels region
Activity data	Regional energy balance (tanked fuels from individual airports, no distinguish between international and domestic aviation)	Regional energy balance (tanked fuels from individual airports, distinguish between international and domestic aviation)	NA
Methodology emissions CO_2	all kerosene is allocated to international and all gasoline to domestic aviation / IPCC 2006 EF + correction of missing kerosene for civil / domestic aviation	IPCC 2006	NA
Methodology emissions CH_4 and N_2O	EMEP/EEA	EMEP/EEA	NA

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 reported by the individual airports. See section 3.2.5 for more information.
The emissions and energy consumption data of the civil/domestic and military aviation are allocated respectively to the sectors 1A3a and 1A5. The emissions and energy consumption data of the international activities are allocated to the memo items 'international bunkers'.

Until the 2012 submission, in the Flemish region all reported kerosene in the air transport was assigned to the bunker fuels and all gasoline for air transport was allocated to domestic air transport (included military aviation). A default IPCC 1996 emission factor for CO_2 was used to calculate the corresponding emissions. This approach was used because no split in fuel consumption between civil/domestic and international activities is given by the individual Flemish airports. As a result of the UNFCCC in-country review in September 2012, some missing emissions of CO_2 in category 1A3a were detected, originating from the consumption of kerosene in the civil/domestic aviation. Belgocontrol-data did show some flights using kerosene for civil/domestic aviation (the Belgocontrol-data includes all aircraft movements (non-Visual Rule Flights) above the Belgian territory per year, LTO as well as fly over. Per flight the airport of origin and destination is mentioned and likewise the aircraft type). Consequently these emissions are newly estimated since the 29th October 2012 submission (at that time by using IPCC 1996 emission factors for the complete time series, during this submission by using IPCC 2006 emissions factors).

The non-CO_2-emissions are calculated for the Landing and Take-Off cycle. The methodology is mainly based on the methodology described in the EMEP/EEA air pollutant emission inventory guidebook 2009 [3]. These emissions are calculated for 4 airports for civil aviation (Antwerp, Ostend, Kortrijk-Wevelgem and Brussels Airportl) and for 6 airports for military aviation between 1990 and 1996 (Kleine Brogel, Brasschaat, Koksijde, Melsbroek, Sint-Truiden and Goetsenhoven and 4 airports for military aviation from 1997 until 2014 (Kleine Brogel, Brasschaat, Koksijde, Melsbroek). The Flemish region is making the split in emissions between 'domestic' and 'international' on the basis of the flight movements and uses different emission factors for different types of airplanes.

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.

Contacts were made during the month of March 2015 with EUROCONTROL to receive more detailed emissions data for Belgium/Flanders. This data will be used to optimize the methodology for the calculation of emissions from air transport.

In Wallonia, there are two main airports in Liège and Charleroi. The emissions from aviation are estimated following a very simple methodology described in the EMEP/EEA air pollutant emission inventory guidebook 2009 [3]. 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.
In the methodology, a distinction is made between emissions from domestic and international LTO and cruise activities. Emission factors used to estimate emissions from domestic and international traffic are also based on the table 8.2 in the EMEP/EEA guidebook [3]. The specific energy consumption by LTO is 105 kg fuel/LTO for the domestic flight. For the international flight in one of the two international airports, the specific energy consumption by LTO is 3400 kg fuel/LTO instead of 825 kg fuel/LTO as the planes are mainly cargo planes.
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'.
Until 2008, the airports didn't make the distinction between gasoline and kerosene. 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

Until the 2009 submission the greenhouse gas emissions from the railway traffic were estimated for the 3 regions in the same way:

In the 3 regions the fuel consumption is based on a proportional fraction of fuel used in Belgium for rail transportation. See also section 3.2.5.1 for more information about the energy consumption data in the regional energy balances. The emissions of CO_2 are estimated by using default IPCC 1996 emissions factors as recorded in table 3.1. 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 EMEP/EEA guidebook [3] (table 3.8.).

Fuel	**UNIT**	**CH_4**	**N_2O**
Diesel oil	g/GJ	4,3	29,3

Table 3-7 : Emissions factors per fuel in railways (EMEP/EEA)

In the Walloon an 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	4,5	28.6

Table 3-8 : Emissions factors per fuel in railways (2006 IPCC guidelines)

During the 2009 submission the emissions from railways in the Flemish region are recalculated using the EMMOSS-model (http://www.tmleuven.be/project/emmoss/index.htm). The emissions are calculated by using gross tonne-kilometres, specific end-energy use and emission factors. For the gross tonne-kilometres a distinction is made between services of trains (goods/persons) and different train types. The complete detailed description of this 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.

Since the 2015 submission the CO_2-emissions for the complete time-series were recalculated in Belgium using the IPCC 2006 instead of IPCC 1996 default emission factors.

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.

To calculate the emissions of CO_2, CH_4 and N_2O in Walloon and Brussels Region, the fuel consumption data are multiplied with IPCC 2006 default emission factors as reported in table 3.1.

During the 2009 submission the emissions from inland waterways (navigation) are recalculated with EMMOSS-model in the Flemish region (http://www.tmleuven.be/project/emmoss/index.htm). Energy use is calculated by using detailed information on the kilometres covered by inland waterway vessels per waterway. Other parameters are the rate of empty ships, age structure, speed, load. To calculate the emissions of CO_2, CH_4 en N_2O the fuel consumption data are multiplied with IPCC 2006 emission factors.
The calculation of the emissions from the sea navigation (departure and arrival in Belgian/Flemish sea ports) is done in the Flemish region by using the EMMOSS-model (for more information about the model see also: http://www.tmleuven.be/project/emmoss/index.htm). 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 (Klein, 2006, 'methoden voor de berekening van de emissies door mobiele bronnen in Nederland').
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 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	IPCC 2006	IPCC 2006
Emission factors CH_4 and N_2O	CITEPA 1990	CITEPA 1990	CITEPA 1990

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.

The emissions of CO_2 are estimated by using the IPCC 2006 default emission factors as reported in table 3.1 and the emissions of CH_4 en N_2O are calculated by using the emission factors from CITEPA90 [2] i.e. 0,3 g CH_4/GJ and 3 g N_2O/GJ.

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). During 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 newly allocated to this category 1A3e during the 2014 submission. They were allocated to the category 1A4a (commercial, institutional) before. Emissions are calculated with the country-specific OFFREM-model. The emissions of CO_2 are calculated with the use of IPCC 2006 emission factors. 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.

3.2.8.3 Uncertainties and time-series consistency

The uncertainty on activity data for CO_2 emissions from road transport is given 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 kilometres for passengers and 75% for goods are performed in an electrical way (2007). The rest of the locomotives uses diesel as fuel. In the absence of IPCC default value, the uncertainty on activity data is estimated at 6 %, considering that this data is collected and delivered yearly by one single national operator. The emissions factors are taken 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 [40], 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

- 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).

- Use of IPCC default emission factors from 2006 guidelines since the 2015 submission instead of 1996 guidelines before.

- In the category 1A3b road transport: further harmonization of the COPERT-based models is performed between the regions during the 2016 submission for the complete time-series. The process to transfer the basic data of the Belgian vehicle fleet to a fleet file that serves as input for the regional models was performed separately for the 3 regions before. Appointments were made to do this consistently for all 3 regions with the same assumptions. To harmonize this process completely, the results of a study to build one common fleet module that will serve as input for the COPERT-based models in the 3 regions was integrated during the 2014 submission. Another element of improvement was the harmonization of the actual energy content of fuels. Since COPERT does not permit fuel blends, modelling consumption is entirely based on the energy content of fossil fuels. A correction was considered to reflect the percentage of biofuels included in the blend in the energy content. This slightly affected the CH_4 and N_2O emissions from gasoline.

- The CO_2 emissions from the urea used as a catalyst are newly reported in the category 2D3 since the 2016 submission instead of category 1A3b before.

- Navigation Flemish Region (1A3d) : A revision of the statistics of goods in the harbour of Antwerp took place for the complete timeseries, as a consequence these emissions were optimized accordingly in this category 1A3d.

- In the Walloon region, the emissions of the aviation sector were recalculated from 2008 to 2013 as there was a mistake in the data of one airport.

- Optimization of the calorific values to country-specific values instead of default values for the fuels used in the OFFREM-model to calculate the emissions of off-road in this category.

- In the Brussels region a revision of mobility data took place for 2013 (new regional model available).

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 the category 1A3a civil aviation, Belgium recognizes that further harmonization between the regions need to be investigated by (1) doing efforts to try to get fuel amounts by type of flights (domestic/international) in the Flemish region to obtain same data sets as in the Walloon region, (2) investigating the necessity of including cruise emissions in the category 1A3a and (3) searching for the most suitable emission factors in the EMEP/EEA guidebook.
  In the course of 2015 a study started in the Flemish region to meet the above problems and to further optimize the emission estimates in the category 1A3a. Representatives of all regions were involved in this project. Contacts were made during the month of 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 end of December 2015. Data of the entire time series will be recalculated during 2016 and integrated in the 2017 Submission.

- In the category 1A3b road transport: further harmonisation by using the COPERT 4 v11.3 version is going on between the regions for some specific parameters. The activation of certain COPERT parameters (as CO_2 monitoring) should be further evaluated.

3.2.9 Other sectors (CRF 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 (1A4c).

Emissions of fishery activities are, in line with the IPCC 2006 guidelines, reported separately during the 2015 submission (category 1A4c iii).

Also the emissions of off-road activities are, in line with the IPCC 2006 guidelines, reported separately during the 2015 submission (categories 1A4b ii and 1A4c ii).

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'. Auto producer units in these sectors are allocated in the these same sectors.
To calculate the emissions of CO_2, all regions use the default IPCC 2006 emission factors except for some specific fuels (see table 3.1).

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

Fuel	Subsector 1A4	Unit	CH_4
Coal	commercial	g/GJ	10
	residential	g/GJ	300
	agriculture heating	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 Flanders	g/GJ	5
	farming vehicles in Wallonia	g/GJ	4.15
Fuel	fishing activities	g/GJ	5
Heavy fuel	commercial / residential	g/GJ	10
	agriculture heating	g/GJ	10

Propane/butane/LPG	commercial/residential	g/GJ	5
	agriculture heating	g/GJ	5
	auto producer	g/GJ	258
	Farming vehicles	g/GJ	10
Lamp petroleum	commercial	g/GJ	10
	agriculture heating	g/GJ	10
Bio liquid fuels	agriculture heating	g/GJ	10
Petrol	agriculture heating	g/GJ	10
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).

Fuel	**Subsector 1A4**	**Unit**	**N_2O**
Coal	commercial/residential	g/Gj	1.5
	agriculture heating	g/GJ	1,5
Natural gas	commercial/residential	g/GJ	0,1
	commercial in Wallonia (boilers)	g/GJ	1
	agriculture heating	g/GJ	0,1
Fuel/diesel oil	commercial/residential	g/GJ	0,6
	agriculture heating	g/GJ	0,6
	farming vehicles	g/GJ	0.6
	farming vehicles in wallonia	g/GJ	28.6
Fuel	fishing activities	g/GJ	0,6
Heavy fuel	commercial	g/GJ	0,6
	agriculture heating	g/GJ	0,6
Propane/butane/LPG	agriculture heating/commercial/residential	g/GJ	0,1
Lamp petroleum	commercial	g/GJ	0,6
	agriculture heating	g/GJ	0,6
Bio liquid fuels	agriculture heating	g/GJ	0,6
Petrol	agriculture heating	g/GJ	0,6
Biogas	agriculture heating/commercial	g/GJ	0,1
Wood	agriculture heating	g/GJ	4

Table 3-10 : Emission factors of N_2O for category 1A4 Other sectors (service, residential and agriculture sector).

During the 2012 submission the emissions from non-road mobile machinery ('off-road') are calculated for the first time for the complete territory of Belgium and for the complete time series.
During the 2014 submission a re-allocation of these emissions took place: emissions from machinery used in harbours, airports and transhipment companies are newly allocated to the category 1A3e instead of category 1A4a before, emissions of defence are re-allocated to the category 1A5b instead of 1A4a before.

During the 2016 submission, emissions from off-road activities in the agricultural sector are revised for the complete time series in the Brussels region.

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.

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 and takes into account the type 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 (see table 2.5 of the IPCC Good Practice Guidance).

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. A comparison of activity data is performed between the Walloon CRF reporter data and the Walloon energy balance for the complete time series.

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

- 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).
- Use of IPCC default emission factors from 2006 guidelines since the 2015 submission instead of 1996 guidelines before.
- During the 2016 submission, emissions from off-road activities were corrected with country-specific calorific values for all regions and a revision took place in the agricultural sector (1A4cii) for the complete time series in the Brussels region.
- During the 2016 submission, some small corrections were made in the Flemish region in the category 1A4a for fuels (liquid and gas) for the years 2007-2012.

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 planned improvements are foreseen in the category 1A4 in the near future in Belgium.

3.2.10 Other (CRF 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 this section the energetic activities and emissions originating from the military transport (domestic air transport) are allocated in the category 1A5b.

During the 2014 submission off-road emissions of defence are newly allocated in the category 1A5b instead of category 1A4a before.

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 / Air transport.

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.

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

- Use of IPCC default emission factors from 2006 guidelines since the 2015 submission instead of 1996 guidelines before.
- Optimization of the calorific values to country-specific values instead of default values for the fuels used in the OFFREM-model to calculate the emissions of off-road in this category.

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

In the course of 2015 a study started in the Flemish region to further optimize the emission estimates in the category 1A3a civil aviation and 1A5 for military aviation. Representatives of all regions were involved in this project. The improvement of the methodology was finished end of December 2015. Data of the entire time series will be recalculated during 2016 and integrated in the 2017 Submission.
See also chapter 3.2.8.6 for more information.

3.3 Fugitive emissions from solid fuels and oil and natural gas (CRF 1.B)

The tables below give the quantitative and qualitative recalculations in the category 1B compared to previous submission to UNFCCC in November 2015.
No major changes in emissions occurred in this category.

The recalculation for Brussels is due to the correction of a mistake in previous calculations of CH_4 emissions from natural gas transmission from 1993 onwards.

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	0,00	-2,14	-2,04	-2,61	-9,61	-6,29	-2,83	-2,04
Flemish region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,89
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	%	0,00	-0,24	-0,18	-0,18	-0,57	-0,37	-0,16	1,87

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO_2 eq.	0,00	-1,74	-1,31	-1,08	-3,63	-2,17	-0,91	-0,63
Flemish region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11,10
Walloon region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	Gg CO_2 eq.	0,00	-1,74	-1,30	-1,08	-3,63	-2,16	-0,91	10,47

3.3.1 Fugitive emissions from solid fuels (CRF 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 (only located in the Flemish region) in the years 1990-1992 are allocated. 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. The IPCC 2006 guidelines uses slightly different emission factors (m^3 CH_4/ton coal produced) compared to the IPCC 1996 guidelines. The underground mining activities are allocated to the category 1B1a (coal mining & handling). The emissions of CH_4 decrease from 14 kton in 1990 to 3 kton in 1992.

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 data 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.

No fugitive emissions take place during cokes production in the Flemish region. 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 cokes ovens via not completely hermetically closed walls. Emissions of CH4 occur from the produced cokes gas to the combustion room and consequently to the stack. Consequently no uncontrolled emissions take place in the Flemish cokesplant.

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 are performed in the category 1B1 during the 2016 submission.

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

No specific improvements are foreseen in the near future in the category 1B1.

3.3.2 Fugitive emissions from oil and natural gas (CRF 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 1B2a 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.
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 [2] 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 1B2a 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 1B2a 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 sectors

- 1A1a for the involved combined heat-power installations of the refineries;
- 1B2c 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.

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 neighbour 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.
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 (category 1.B.2.b 5/distribution) 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 186 500 for the year 2006 and is relatively stable for the following years (186 565 in 2010). 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.

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 is negligible. Consequently, the notation key ‘NO’ is used.
There is a large increase in emissions of CH_4 in 2014 in this category 1B.2.b.4 despite the fact that the activity data are decreasing. The reason for this decrease in emissions of CH_4 is a revision of the consumption data and the emissions of the control units at the different locations of Fluxys, responsable for the gastransport activities in Belgium (pneumatic control units, positioners, actuators, ...) in the course of 2014.

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

In Brussels, recalculation of CH_4 emissions from natural gas transmission from 1993 onward (correction of a mistake in previous calculations).

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

No specific improvements are planned in the category 1B2 in the near future.

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 good as possible, depending on the information (activity data) available in the different regions in Belgium.
Total emissions of CO_2 from biomass are also reported as a memo item in the CRF-tables in
1. Energy / 1.AA Fuel Combustion - Sectoral approach / Information item / Biomass.

3.5 International bunkers and multilateral operations

Emissions of international bunker activities are reported as a memo item in category 1D.

3.6 Comparison between data reported under the ETS-Directive and CRF-tables

The comparison between data reported under the ETS-Directive and CRF-Tables is presented in annex 10. The results of the year 2014 are presented in this annex. See also BE_Annex V_MMR-IRArticle10_Template_v4_EEA final.xlsx)

The sum of emissions in the GHG inventory from the relevant CRF 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 CRF sector are larger than the inventory data :

- The coke gas consumption is in 1A2a in the ETS data instead of 1A1c in the inventory data;
- In the sector chemical, some other fuels are considered as liquid fuels in the inventory data;

- In the paper pulp industry (1A2d), a part of the liquid fuels are used to produce lime and are in 1A2f 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;

- 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.

In Flanders, from 2013 on, because of the extention of the scope of ETS, the ETS-data are completely incorporated in energy statistics and CO_2 emission inventory.

Yet 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 CRF-tables in category 1A1a or in the relevant sector where they belong (industry, commercial sector, agriculture) when the unit is an autoproducer. This approach is not always the same in ETS data. Data from CHP units cannot be easily extracted from ETS-reporting. Other data sources (integrated environmental reports) need to be used to get these data.
- 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 CRF-tabels to different categories does not always correspond with ETS definitions.
- The allocation of blast furnace gas that is used for electricity production differs between the 2 reporting obligations.
- Specific units like a naphtha cracker situated at the site of the refinery is included in the refinery sector in ETS data, but in the energy statistics and in CRF, the unit is included in the chemical sector.
- In the ETS reports, calorific values for the conversion from tonnes to joules is not always listed, and specifically for waste products, recovered fuels etc, the default value can differ from reality.
- The use of biomass is only reported as a ‘memo item’ in the reports so far. Consequently these data are not always reported by all companies and also not for the complete time-series. Emissions from biomass are not calculated in the ETS-reports.
- There can be a different approach in calculating emissions for some sources: mass balance approach in ETS and consequently emissions not calculated based on energy use and emission factors per joule. These different approaches can give different results.

For some categories, more elaborate explanations are given concerning allocation matters.

1. Chemical industry

In the Flemish energy balance, data from the Essenscia yearly 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 the survey are allocated in 2 categories (waste 5C and 1A2c). The typology in ETS, data used from 2013 on, is not always completely comparable to the survey. All ETS emissions from other fuels than typical commercial fuels (like natural gas or fuel oil) are listed as ‘other fuels’, although they also possibly include some flaring emissions and waste incineration.

2. Refineries

Emissions from the refineries are taken from the integrated environmental reports in Flanders, and are comparable 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. Also, emissions from the use of natural gas to produce H_2, are considered to be process in ETS. In the energy balance, these amounts used in refineries are included as energy use.

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 almost completely in accordance with reported ETS-data. All consumed solid fuels (incl blast furnace gas and cokesovengas) are reported as procesemissions in category 2C1a (except for the cokesovengas used in the cokesfactory 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 sinterfactory are reported in category 2C1d and emissions from the use of electrodes are reported in the category 2C1f. Emissions from the use of gaseous and liquid fuels are reported in the category 1A2a.

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF 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 N_2O emissions from aerosols products and medical applications and the CO_2 emissions from the lubricant use and paraffin wax use are also included in this sector. The CO_2 emissions from the urea used as a catalyst are newly 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 [28], EMEP/EEA handbook [3], CITEPA [2] or other specific bibliographies. The activity data recorded in this category also derive mainly directly from the companies involved.

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 2014, these emissions of greenhouse gases were mainly caused by the chemical industry (41% of emissions of which 19% just for the petrochemical industry and 8% for nitric acid and ammonia production), the mineral products (23% of emissions of which 22% just for cement and lime production), the metal production (20% of emissions - sharply down from 2009 due to economic crisis).

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 41% in 2014 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).
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 steamcracking 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 62% in 2014 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 2.8% of total greenhouse gas emissions without LULUCF in 2014. 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.
SF_6 emissions originating from the production of acoustic double-glazing have been cut through the use of alternative products. However, SF_6 consumption emissions are likely to increase in the coming years due to the dismantling of existing equipment.

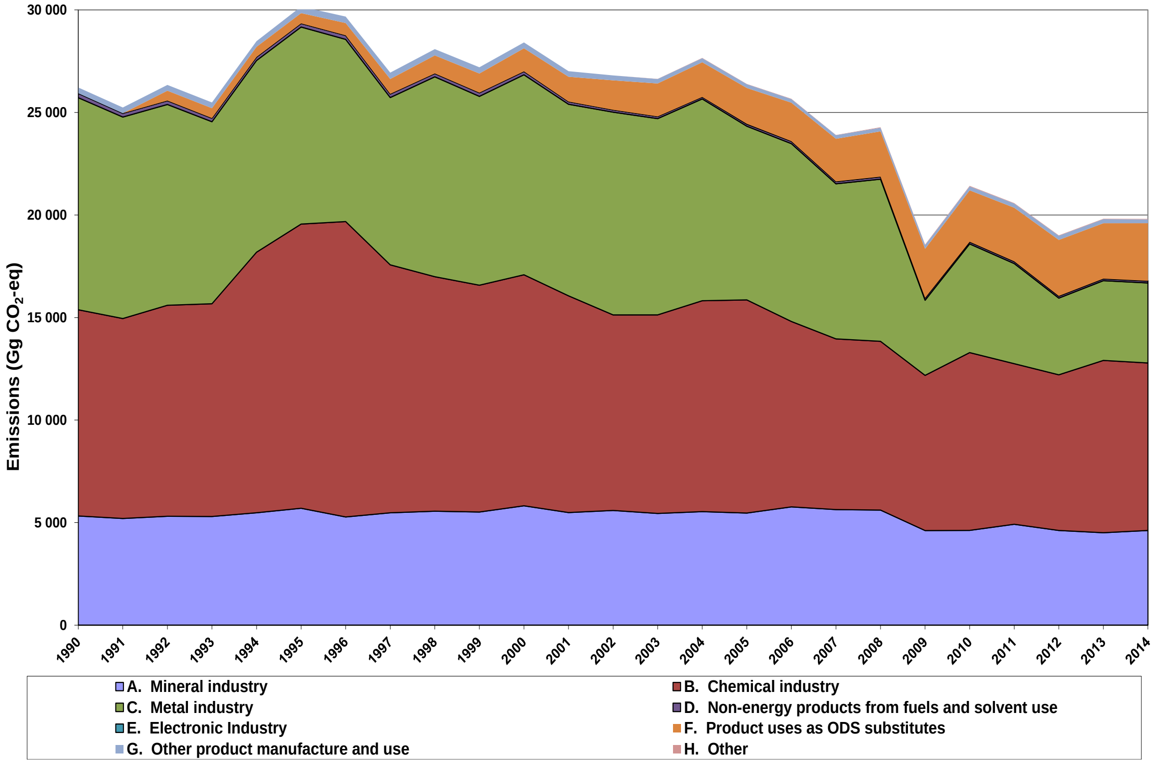


Figure 4-1 : GHG emissions in sector 2 'Industrial processes': changes from 1990 to 2014 (Gg CO_2 equivalent)

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) compared to previous submission in November 2015:

Recalculations in category 2A mainly due to:

- A correction in the 2016 submission in the Walloon region (the process emissions of a sugar plant were missing (gas desulfuration).
- An optimization of the procesemissions in the sectors of glass and ceramic took place in the Flemish region for the 2013.

2.A-Mineral Products,,,Emissions,Aggregate GHGs (CO2, CH4, N2O,),(Gg CO2 equivalent)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,78
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00
Belgium	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,03

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	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	1,29
Walloon region	Gg CO2 eq.	0,00	0,00	0,00	0,04	0,00	0,00	0,23	0,17
Belgium	Gg CO2 eq.	0,00	0,00	0,00	0,04	0,00	0,00	0,23	1,46

Recalculations in category 2B mainly due to:

In the Flemish region:

- Small corrections of procesemissions of CH_4 from 2004 on (category 2B10a).
- Completeness of emissions and activity data of the timeseries for the years 1992 and 1993 in the category 2B1 (production of NH_3).
- Re-allocation of emissions of 1 company of the chemical sector from category 2H3 (other) to 2B10a (chemical industry) before.

2.B-Chemical Industry Emissions,Aggregate GHGs (CO2, CH4, N2O,),(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	-0,03	1,11	2,41	2,33	3,44	2,38	2,98	2,38
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	%	-0,02	1,00	2,05	1,97	2,81	2,19	2,75	2,20

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	Gg CO2 eq.	-2,49	136,81	226,41	201,09	236,99	167,79	203,33	180,97
Walloon region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	Gg CO2 eq.	-2,49	136,81	226,41	201,09	236,99	167,79	203,33	180,97

2.C Metal Industry Emissions,Aggregate GHGs (CO2, CH4, N2O,),(Gg CO2 equivalent)

Recalculations in category 2C mainly due to:

In the Flemish region:

- In the category 2C7 a re-allocation was made from process emissions to energetic emissions (category 1A2b) for the complete timeseries (for 1 company in this category the emissions from cokes and petroleumcokes were re-allocated to energy in accordance with the energy balance rules).
- Still missing emissions of 1 company in category 2C7 were completed during the 2016 submission (7-10 kton CO2) for the entire timeseries.

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	-1,87	-2,04	-1,64	-1,68	-1,36	-1,78	-1,66	-1,99
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	%	-0,56	-0,67	-0,58	-0,92	-1,06	-1,38	-1,58	-1,93

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	Gg CO2 eq.	-72,42	-75,58	-68,01	-78,68	-56,80	-68,55	-60,14	-76,35
Walloon region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	Gg CO2 eq.	-58,75	-64,77	-56,51	-78,68	-56,80	-68,55	-60,14	-76,35

Recalculations in category 2D mainly due to:

- The CO_2 emissions from the use of lubricants were recalculated (category 2D1). A correction of the energy content (to 42,3 TJ/Gg) for the whole time series was taken into account. Emissions of CO_2 from lubricants use in 4-takt motors, calculated by the COPERT-model, was taken newly into account.

- The CO_2 emissions from the use of paraffin wax were newly estimated for the year 2009 to 2013 (category 2D2).

- The CO_2 emissions from the urea used as a catalyst are newly reported in the category 2D3 since the 2016 submission instead of category 1A3b before.

2.D- Non-energy Products from Fuels and Solvent Use,Aggregate GHGs (CO2, CH4, N2O,),(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	14,52	17,57	17,25	25,62	39,56	40,54	40,13	38,60
Flemish region	%	30,81	41,83	45,00	82,53	189,57	200,91	206,93	255,92
Walloon region	%	33,65	48,92	52,65	101,75	218,36	224,24	226,11	274,49
Belgium	%	23,81	35,04	38,13	74,94	171,58	179,45	183,20	224,87

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	2,31	2,04	1,83	1,32	1,26	1,32	1,27	1,02
Flemish region	Gg CO2 eq.	29,24	29,96	29,53	25,57	34,73	36,75	36,42	37,20
Walloon region	Gg CO2 eq.	18,05	19,79	19,42	17,72	22,38	22,93	22,22	22,28
Belgium	Gg CO2 eq.	41,16	45,54	45,23	42,05	57,35	59,98	58,97	59,84

Recalculations in category 2E mainly due to:

The only change made in this category for the period 1995-2013 is the adjustment of the the CF_4 emissions in 2013 in the Flemish region, based on updated information.

2.E- Electronics Industry, Aggregate GHGs (CO2, CH4, N2O,),(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%				NO	NO	NO	NO	NO
Flemish region	%				0,00	0,00	0,00	0,00	30,27
Walloon region	%				NO	NO	NO	NO	NO
Belgium	%				0,00	0,00	0,00	0,00	30,27

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.				NO	NO	NO	NO	NO
Flemish region	Gg CO2 eq.				0,00	0,00	0,00	0,00	2,75
Walloon region	Gg CO2 eq.				NO	NO	NO	NO	NO
Belgium	Gg CO2 eq.				0,00	0,00	0,00	0,00	2,75

Recalculations in category 2F mainly due to:

- The emissions of refrigeration and air conditioning installations have been revised for the whole time series, in order to improve the calculation of disposal emissions. The modification has essentially consisted in recalculating the ‘Amounts charged into new systems’.
- For rail transport, the time series has been adjusted. New information from the NMBS/SNCB made it possible to estimate the stock of HFCs in trains based on specific quantities of HFC per model of train.
- For room air conditioning emissions in 2012 and 2013 were adjusted to account for new statistics on the number of appliances.
- For refrigerated transport emissions in kt CO_2-eq have been adjusted, because an incorrect GWP value was used. Emissions in tonnes remain the same.
- 2013 HFC emissions for technical aerosols have been adjusted to take into account more recent information on consumption.

2.F- Product uses as substitutes for ODS ,(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%		0,77	0,83	0,21	5,24	5,88	7,71	7,03
Flemish region	%		0,72	0,76	0,19	4,88	5,44	7,39	6,74
Walloon region	%		0,77	0,80	0,21	5,47	6,02	8,04	7,15
Belgium	%		0,74	0,78	0,20	5,09	5,66	7,62	6,89

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	0,00	0,35	0,81	0,33	12,18	14,23	19,93	18,08
Flemish region	Gg CO2 eq.	0,00	2,13	5,04	2,01	70,17	80,65	111,38	100,37
Walloon region	Gg CO2 eq.	0,00	1,20	2,84	1,13	39,27	45,10	62,21	55,92
Belgium	Gg CO2 eq.	0,00	3,68	8,69	3,47	121,61	139,98	193,51	174,38

No recalculations took place in the category 2G during the 2016 submission.

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	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
Walloon region	%	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

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	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
Walloon region	Gg CO2 eq.	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

Recalculations in category 2H mainly due to:

In the Flemish region:

- Re-allocation of emissions of 1 company of the chemical sector from category 2H3 (other) to 2B10a (chemical industry) before
- Re-allocation of emissions of 1 company from category 2H3 (other) to 2H1 (pulp and paper) and completeness of the emissions of this company from 2003 on.

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	0,00	0,00	0,00	0.00	0,00	0,00	0,00	-88,03
Walloon region	%	NO	NO	NO	NO	NO	NO	NO	NO
Belgium	%								-88,03

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	Gg CO2 eq.	0,00	0,00	0,00	12,36	28,70	21,74	23,19	-151,45
Walloon region	Gg CO2 eq.	NO	NO	NO	NO	NO	NO	NO	NO
Belgium	Gg CO2 eq.	0,00	0,00	0,00	12,36	28,70	21,74	23,19	-151,45

4.2 Mineral products (CRF 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 sectors of industrial process emissions in Belgium and contributes now to 23% of sector emissions in 2014.

In Belgium, **cement production (category 2A1)** only take place in the Walloon region.

The Walloon region has 5 sites which produces cement clinker in 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 CRF 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. Since 2002, the emission factor has varied each year and has been calculated directly by the plant. Since 2004, plant data has included 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 taking 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 need.
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
Clinker production (kt)	4869	4694	4830
IEF clinker (kg CO_2/t)	543	541	547
CO_2 emissions (kt)	2642	2541	2643

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 assesment.

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 was coming 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's 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 kraft pulping process: the CO_2 liberated during the conversion of calcium carbonate to calcium oxide in the lime kiln in the kraft 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 kraft 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
Lime (kt)	1254	1609.2	1323
IEF lime (kg CO_2/t)	713	752.3	694
Dolomite lime (kt)	837	425.3	787
IEF dolomite lime (kg CO_2/t)	858	984.2	920
% dolomite lime prod	40	20.9	37
IEF global (kg CO_2/t)	772	800.7	778
CO_2 emissions (kt)	1612	1629.16	1641.6
CO_2 biomass emissions (kt)	65.85	61	74

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 have been calculated by the glass plant. 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 Directive 2003/87/EC. Some glass plants have already had 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. For some plant, it was applied until 2004 as we don't have plant data.
The recycled glass is part of the AD of table 4.5.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Flat glass (kt)	1142	898	1013	961	1103	1193	1157	1162	1163	1085	1157
IEF flat glass (kg CO_2/t)	143	143	143	143	143	143	143	143	143	143	143

Container glass (kt)	279	237	269	283	250	264	256	278	307	162	290
IEF container glass (kg CO_2/t)	102	102	102	102	102	102	102	102	102	102	102
Glass wool (kt)	82	76	94	96	101	117	127	133	111	129	140
IEF glass wool (kg CO_2/t)	89	89	89	89	89	89	89	89	89	89	89
IEF global (kg CO_2/t)	**132**	**132**	**131**	**130**	**132**	**132**	**132**	**131**	**131**	**133**	**131**
CO_2 emissions (kt)	199	159	181	175	192	208	203	206	207	183	207

Table 4-3

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Flat glass (kt)	1178	1291	1304	1150	1234	1418	1358	1317	1026	1169	1211
IEF flat glass (kg CO_2/t)	143	143	137	155	160	137	136	143	133	137	136
Container glass (kt)	158	166	215	213	216	231	244	227	211	186	198
IEF container glass (kg CO_2/t)	102	102	105	100	97	100	101	109	99	91	103
Glass wool (kt)	148	143	164	192	194	207	212	204	156	204	211
IEF glass wool (kg CO_2/t)	89	89	89	102	88	80	78	90	99	74	58
IEF global (kg CO_2/t)	**133**	**134**	**128**	**141**	**142.8**	**126.2**	**124.3**	**133**	124	**125**	**122**
CO_2 emissions (kt)	198	214	215	220	235	234	226	232	173	192	198

Table 4-4

	2012	**2013**	**2014**
Flat glass (kt)	1008	804	768.4
IEF flat glass (kg CO_2/t)	133	130.8	125.2
Container glass (kt)	193	249	219
IEF container glass (kg CO_2/t)	87	92.1	86.5
Glass wool (kt)	186	185	195.1
IEF glass wool (kg CO_2/t)	54	52.1	53.8
IEF global (kg CO_2/t)	**116**	**111.2**	**106**
CO_2 emissions (kt)	160	137.8	125.1

Table 4-5 : Glass production and related emissions of CO_2 in the Walloon region (1990-2014).

In the Flemish region these process emissions of CO_2 from the glass production were newly added in the 2006 submission 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 current of 2006 to 300 kg process CO_2/ton glass.
In the meantime 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.
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. 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 current 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.
During 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).
Aggregated data of production of glass and enamel and corresponding emissions of CO_2 are included in the table 4.6 below for the Flemish region. The recycled glass is part of the AD of the table 4.6.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
total glas ton	431919	400752	411482	409097	433029	439198	433666	371753	388377	328441	345516	365435	362734
total glasfiber ton	15723	18357	20214	21389	27000	25656	27000	28350	33078	28467	38206	32556	39463
total enamel ton	20745	20652	20301	19046	20111	15142	18335	19191	19042	18933	21236	21888	20863
tkton CO2 glass	64	54	55	56	58	59	60	51	53	45	46	47	48
kton CO2 glasfiber	2	2	3	3	3	3	3	4	4	4	5	4	5
kton CO2 enamel	1	1	1	1	1	1	1	1	1	1	2	1	1
total kton CO2	67	57	59	60	63	64	65	56	59	50	52	53	55
IEF glas (kg CO2/ton)	148	134	134	136	135	135	138	138	137	136	133	129	133
IEF glasfiber (kg CO2/ton)	125	125	125	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	71	64	69

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
total glas ton	352586	373781	377619	355885	350470	318377	278993	283490	268333	242696	237280	276166
total glasfiber ton	40680	42504	39913	47288	55269	59485	35266	53315	56993	50145	52262	57446

total enamel ton	**18475**	**20933**	**18743**	**21143**	**20479**	**18051**	**16900**	**17375**	**14541**	**13851**	**18764**	**18139**
tkton CO2 glass	**27**	**29**	**33**	**31**	**30**	**29**	**27**	**28**	**26**	**19**	**19**	**22**
kton CO2 glasfiber	**5**	**6**	**6**	**7**	**8**	**8**	**6**	**8**	**9**	**8**	**8**	**9**
kton CO2 enamel	**1**	**2**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**2**
total kton CO2	**34**	**37**	**40**	**40**	**40**	**39**	**33**	**37**	**35**	**28**	**29**	**32**
IEF glas (kg CO2/ton)	**78**	**78**	**88**	**86**	**86**	**92**	**95**	**98**	**95**	**78**	**80**	**78**
IEF glasfiber (kg CO2/ton)	**125**	**143**	**143**	**150**	**148**	**134**	**159**	**148**	**151**	**157**	**158**	**157**
IEF enamel (kg CO2/ton)	**73**	**76**	**74**	**79**	**77**	**83**	**76**	**73**	**90**	**86**	**79**	**90**

Table 4-6 : Glass (and enamel) production and related emissions of CO_2 in the Flemish region (1990-2014).

As mentioned above, the recycled glass are part of the production figures presented in table 4.5 and table 4.6.
These figures represent the amount of glass produced by 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 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 desulphurisation in these plants are also included in this category.

In consultation with the federations and companies involved, an estimate is given of the emissions of CO_2 in the Flemish region. This estimation is calculated in Flanders 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. No complete database of the production figures in this sector is available in the Flemish region for the complete time series. Table 4.7 gives an overview of the ceramic production figures and related emissions of CO_2 (process) in this sector.

Flemish region	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
ceramic production (kton)	2772	2641	2702	2746	2897	3224	2870	2872	2780	2687	2678
IEF (kg CO_2/t)	45	53	38	48	48	71	78	75	71	71	70
CO_2 emissions (kton)	124	141	103	131	138	229	223	214	198	191	189

Flemish region	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
ceramic production (kton)	2621	2624	2561	2613	2732	2797	2837	2598	2161	2225	2322	1984	1783	1792
IEF (kg CO_2/t)	67	57	60	68	71	72	71	79	80	55	61	69	69,6	70
CO_2 emissions (kton)	177	151	155	177	193	200	201	206	173	122	141	137	124	126

Table 4-7 : Ceramic production and related emissions of CO_2 in the Flemish region (1990-2014).

In the Walloon region, 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.

Since 2005, the CO_2 emission factors have been calculated by the ceramic plants. An average emission factor was established in 2005 by 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.

	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
Ceramic production (kt)	426	356	384
IEF (kg CO_2/kt)	22	51	59
CO_2 emissions (kt)	9,5	18.2	22.81

Table 4-8 : Ceramic production and related emissions of CO_2 in the Walloon region (1990-2014).

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-colored 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 didn't use the UN comtrade statitics 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 in the comtrade statistics report.

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.

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 NIR 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 data reported in the regional CRFReporter 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

Recalculations in category 2A mainly due to:

- A mistake in the 2016 submission in the Walloon region (the process emissions of a sugar plant were missing (gas desulfuration)) .

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.

4.3 Chemical industry (CRF 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% in 2014 of the emissions of greenhouse gases in this sector.
The chemical industry in Belgium are covered by categories 2B1 (ammonia production), 2B2 (nitric acid production), 2B4a (production of caprolactam), 2B8 (production of ethylene and vinyl chloride monomer), 2B9 (fluorochemical production) and by 2B10. This last category includes the emissions from the production of maleic anhydride in the Walloon region and some other process emissions reported by the chemical industry (f.e. the production of ethylene oxide, acrylic acid, cyclohexanone, …) in the Flemish region.

4.3.2 Methodological

4.3.2.1 Ammonia production (category 2B1)

Today ammonia production takes place in 2 companies in Belgium.

This source is a key category of CO_2 emissions in terms of emissions level and trend.

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 [1] (see also section 3.2.5 and 3.2.3 for more information). 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. 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 nitrophosphoric acid and afterwards for the production of lime. The produced lime is mainly used in the own branche/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. Not subtracting the emissions in the sector of industrial processes, results in a systematic double counting of these emissions. 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 at this site and sold in Belgium.

In the Walloon region, the same methodology is used. The amount of natural gas 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% per cent 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, plant has performed 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 (≈600 kg) based on a CH_4 analysis in 1999 on the scrubber of ammonia during the production of ammonia. In the last submissions, the natural gas used in the denox unit was included in the natural gas used for the production of ammonia. This amount of natural gas is now 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'.

The N_2O emissions from the production of nitric acid are estimated in Flanders until 2002 by using an emission factor of 8 kg N_2O/ton HNO_3 from CITEPA [2]. The three plants involved in Flanders agreed with this factor of 8 kg N_2O/ton HNO_3 since 1990 and give their nitric acid production figures each year. Since 2000 only one plant with 4 installations is still involved in this sector. From 2003 on lower emission factors in this plant are reported because of the gradually extension of the use of catalysts. The emissions are monitored since 2003.
This producer in the Flemish region has nowadays 4 installations involved and produces nitric acid via the dual pressure process (medium/high pressure) with SCR (emission of N_2O).
Although the closure of 2 plants in the Flemish region, in 1995 and in 2000 respectively, the production of nitric acid stabilized more or less after 2000, until 2008 and the emissions of N_2O decreases in time due to undertaken measures. The year 2009 was an exception due to the economic crisis and in the year 2010 a real boost took place in nitric acid production (an increase of 37% compared to 2009). In 2014 the lowest emission factor for the complete time series of 0.81 kg N_2O/ton HNO_3 was registered in the Flemish region.

A remark has to be made that the emissions reported in the category 2B2 also include small amounts of emissions of N_2O from the production of nitrofosforic acid.

In the Walloon region, there is only one producer of nitric acid (one plant with 3 installations). Each year, this plant provides the N_2O emissions for each installations based on on monitoring. The global emission factor used was 4,93 kg/t in 2008, 6,34 kg/t in 2009, 6,46 kg/t in 2010, 0,62 kg/t in 2011 and 0,68 kg/t in 2012, 0,75 kg/t in 2013, 0,7 kg/t in 2014. 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 resulted 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. 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.

Only one company is involved in Belgium in the Flemish region and 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). This company estimated the emissions of the previous years from 1990 on as accurate as possible. There is a strong increase of emissions of N_2O between 2009 and 2010 due to strong increase of production of caprolactam in that period (+20%). No emission factors and emissions of N_2O are presented in this report because only one company is involved in Belgium.

4.3.2.4 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.

4.3.2.5 Petrochemical and Carbon Black Production (category 2B8)

In this category the emissions from the production of ethylene **(category 2B8b)** are included. Untill the submission in 2014 these emissions were allocated to the category 1A2c / other fuels. The emissions are reported via a yearly survey carried out by the chemical federation in cooperation with the VITO (Flemish Institute for Technological Research). These emissions cover the recovered fuels in the steamcracking units in the petrochemical industry and other recovered fules from the chemical industry. Measurements are carried out to obtain these emissions. Last years ETS-data are reported.

The category 2B8c includes the productions of ethylene dichloride and vinyl chloride monomer. As it is very difficult to make a distinguish between the emissions of the different production installations, these emissions are allocated in the categories 2B8gi and 2B10.

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 CO_2 process emissions coming from the following chemical processes are allocated in **the category 2B8gi other (other non-specified)**:

- the production of 1,2 dichloromethane and vinychloride in the Walloon region (18,7 kt in 2014).
- the production of anhydride maleic and phtalic which was stopped in 2009 in the Walloon region.

4.3.2.6 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 SF_6, CF_4, C_2F_6, C_3F_8, C_4F_{10}, C_5F_{12} and C_6F_{14} as well as fluorinated greenhouse gases not covered by the Kyoto Protocol (among which CF_3SF_5, C_7F_{16}, C_8F_{18} and $C_8F_{16}O$). This plant produces a broad range of fluorochemical products, which are used as basic chemicals as well as end products, mainly in the electronic industry. The emissions of this emission source are partly fugitive and partly non-fugitive.

A gas incinerator with HF-recovery has been installed in 1997 to reduce the non-fugitive emissions. This has resulted in a drastic reduction of the emissions, which are estimated for 2014 at about 300 kt CO_2 equivalents (for the gases covered by the Kyoto Protocol), down from 4.9 Mton CO_2 equivalents in 1995.

The process used in this electro-fluorinated plant is unique in the EU (there are however some similar plants in the US). This means that there is no readily available documentation on the process used, neither on the reported emission factors. The emissions have been calculated by using mass balances in combination with measurements. These measurements are based on EPA Method 320 using FTIR (Fourier Transform Infra Red spectroscopy) and GC/MS (gas chromatography combined with mass spectrometry).

The emission estimates are complicated due to the fact that all emissions come from batch processes and that there are many reactors and process steps. For each process step (around 60 steps for the greenhouse gas emissions) an emission factor is reported. The emission factors are combined with detailed specific production data. Due to the complexity and for reasons of confidentiality, the detailed emission calculations are not made public.

An external audit was performed in 2005 on the emission inventory by CH2M HILL. One of the findings was: 'CH2M HILL finds that the company has been diligent in its effort to remove scientific uncertainty from the downstream emission estimates, the company has gone above and beyond the expectations outlined in the GHG Protocol in its attempts to reduce uncertainty, and the resulting emission estimates are transparent and provide a basis for consistent reporting of GHG emissions'. (August 2005).

There are large inter-annual variations in perfluorobutane (C4F10) emissions across the entire time series (ranging between –55.5 and 650.4 per cent) and also significant inter-annual fluctuations in perfluorohexane (C6F14) emissions across the entire time series (ranging between –81.3 and 316.9 per cent). These fugitive emissions occur when the waste gas incinerator used for abatement is out of order, which happens frequently, and also as a result of changes in the product mix of the plant.

4.3.2.7 Other (category 2B10)

The process emissions coming from the following chemical processes are allocated in **the category 2B10 other (other non-specified)** :

- the emissions of CO_2 emitted from soda ash production originated from coke oxidation (1990-1993) in the Walloon region;
- the reactivation of actif carbon in the Walloon region (30 kt in 2014);
- other process CO_2 emissions are reported by the chemical industry in Flanders (for example production of ethylene oxide, production of acrylic acid from propene, production of cyclohexanone from cyclo-hexane, production of paraxylene/meta-xylene production of carbon black etc). These CO_2 emissions result from surveys in the chemical sector in Flanders (see also sections 3.2.5. an 3.2.3 for more details). The emissions of this category 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 (18 kton CO_2 eq in 2014) and CH_4 (9 kton CO_2 eq in 2013) mainly in the chemical industry in the Flemish region. These emissions are reported by the industry via their annual environmental emission reporting obligations and are small process emissions from 1) for N_2O: a naphtha cracker, emissions from waste gas combustion (containing NH_3 from the production process), emissions from purging of bottles and purifying of bulk product N_2O, and from 2) for CH_4: emissions from an adsorption system of an oxidation unit, process emissions of naphtha cracker and leak losses from a relax station of natural gas.

4.3.3 Uncertainties and time-series consistency

The only references found for the ammonia production are the Norwegian uncertainty calculation [41] and the Irish NIR. 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 plant-specific emission factors are used in this sector. 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 also 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).

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 GHGs 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 a official verification by external experts.

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

In the Flemish region the following recalculations occurred in the category 2B:

- Small corrections of procesemissions of CH_4 from 2004 on (category 2B10a).
- Completeness of emissions and activity data of the timeseries for the years 1992 and 1993 in the category 2B1 (production of NH_3).
- Re-allocation of emissions of 1 company of the chemical sector from category 2H3 (other) to 2B10a (chemical industry) before.

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

No improvements are planned in the near future in the category 2B in the Belgian greenhouse gas inventory.

4.4 Metal industry (CRF 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 20% in 2014.

4.4.2 Methodological issues

4.4.2.1 Metal industry / Iron and steel production (category 2C1)

The category 2C1 includes the emissions of CH_4 from sinter production (2C1d) and the process emissions of CO_2 from the iron and steel sector (2C1a). The emissions from the use of limestone in the sinter factory are also allocated in this category (2C1d). Emissions from the use of electrodes are allocated to the category 2C1f.
The emissions from the solid fuels, the coke gas and the blast furnace gas are considered process emissions and are also allocated to this 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 (Flemish region).

This big change in re-allocation in the iron and steel sector is now 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.

The methodologies used to estimate the emissions of the iron and steel sector are described below for the 2 regions involved.

The **category 2C1a** includes all the process emissions from the iron and steel production (except coke production).

History: In Flanders, the calculation of the process CO_2 emissions from iron and steel production was based in previous submissions 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 in the iron and steel sector were completely revised in the Flemish region and based on the ETS-methodology instead of C-balance-approach in previous submissions. 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. As a consequence these process emissions were revised as well. The process emissions calculated from the approach of previous submissions were during the 2011 submission mainly completed with the use of lime directly and indirectly (via grinded ores & recovery products) in the sinter factory. These emissions were reported in category 2A3. These changes resulted in an increase of process emissions of CO_2. The

process emissions originates 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 and (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. From 2011 on, the company did install a converter gas installation in the steel plant for recuperation and valorisation of the converter 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.

As from this submission in 2015, emissions in the iron and steel sector are re-allocated (as mentioned above) according to the IPCC 2006 guidelines.

The biggest change in allocation is the move of the emissions from the solid fuels (cokes gas, blast furnace gas, cokes grid and anthracite) from the category 1A2a in previous submissions to the category 2C1a for the only big integrated steel plant in Flanders. This counts for a move of 2987 kton CO_2 in 2012 from 1A2a to 2C1a. The other process emissions remain allocated in the same way as in previous submissions.

The 2^{nd} company involved in this category in the Flemish region produces stainless steel. The process emissions in this company are rather small. Until the submission of 2012 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 is total process emissions in this company. During the 2013 submission this methodology is 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.

In the Walloon region, the last integrated iron and steel plant (blast furnace-oxygen furnace) was closed in 2011. A, electric arc furnace was closed in 2013 and now, four electric arc furnaces are operational in 2014.

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 were 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 carbone 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.

Concerning the electric arc furnaces, CO2 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. 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 have been included in 2C1a since this submission. 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 4.9a for the Walloon region. Table 4.9b 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**	**2001**	**2002**	**2003**	**2004**
Pig iron production (kt)	5959	5738	5719	4782	5437	5672	5085	4352	4827	5012	4835	4853	4298	4408	3908
Steel production by basic oxygen furnace (kt)	6652	6518	6184	5388	5976	6133	5402	4490	5099	5076	4984	5058	4529	4576	4073
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	69.7	59.6	56.7	48.5
Steel production by electric arc furnace (kt)	692	660	602	901	1170	1143	940	1757	1651	1555	2171	2149	2406	2155	2087
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	75.3	99.3	104.4	92.6
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	161.8	238.9	224.9	193.3

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Pig iron production (kt)	3132	3197	2664	3290	337	874	779	0	0	0
Steel production by basic oxygen furnace (kt)	3139	3376	2885	3373	331	900	891	0	0	0
Solid fuels in the iron and steel sector (process) TJ	41.3	39.9	33.2	41.7	5.2	12.0	11.6	1.2	0.5	0.4
Steel production by electric arc furnace (kt)	1844	2584	2836	2569	1884	2162	2176	2222	1825	1778
CO_2 emission factor (kg/t steel) electric arc furnace	108.8	82.9	82.1	83.8	75.3	76.9	72.1	79.7	68.6	68.3
CO_2 emissions (kt) electric arc furnace	200.7	214.3	232.7	215.3	141.9	166.3	156.9	177.2	125.1	121.6

Table 4-9a : Data reported in the iron and steel sector in the Walloon region (Source: plant specific /Institut Wallon)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Pig iron production (kt)	3456	3598	2943	3295	3522	3526	3537	3715	3716	3698	3640	2816	3656	3406	4316
Steel production by basic oxygen furnace (kt)	3911	4052	3254	3639	3932	3933	4001	4137	4137	4221	4127	3137	4096	3907	4923
Sinter production (kt)	5267	5250	4461	4803	5260	5230	5160	5468	5541	5366	5601	4524	5752	5195	6300
Solid fuels in the iron and steel sector (process) PJ	66	57	47	49	62	61	62	64	67	64	65	52	67	67	78
Steel production by electric arc furnace (kt)	315	318	401	387	443	484	513	543	565	572	559	521	525	770	913
CO_2 emission factor (kg/t steel) electric arc furnace	41	41	41	41	53	53	54	52	50	50	51	52	54	55	56
CO_2 emissions (kt) electric arc furnace	13	13	16	16	24	26	28	28	28	29	28	27	28	42	51
total CO_2 emissions (kt) in category 2C1	3748	3566	3403	3505	3472	3565	3533	3588	3745	3677	4010	3285	4115	4074	5158

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Pig iron production (kt)	4054	4317	3914	3690	2751	3814	3892	4078	3892	4388
Steel production by basic oxygen furnace (kt)	4616	5005	4511	4182	3044	4394	4470	4759	4470	5019
Sinter production (kt)	6300	5800	6500	5336	3659	5248	5349	5044	5349	5041
Solid fuels in the iron and steel sector (process) TJ	71	71	60	57	50	59	57	55	62	60
Steel production by electric arc furnace (kt)	865	935	795	793	491	677	613	516	536	623
CO_2 emission factor (kg/t steel) electric arc furnace	55	52	54	71	63	46	44	42	42	45
CO_2 emissions (kt) electric arc furnace	47	49	43	57	31	31	27	22	22	28
total CO_2 emissions (kt) in category 2C1	4473	4764	4238	4150	3124	4017	3677	3445	3674	3672

Table 4-10b : 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 and on monitoring results from 2001 on. Emissions of CH_4 are measured 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 remaining years are negligible.

Emissions of CO2 originating from the use of limestone directly in the sinter factory to fix the alkalinity of the slags is allocated to the category 2C1d.

In the Walloon region, there is no more sinter plant. Since 1990, sinter production has declined sharply. In 1990, there were 4 sinter plants and in 2011, the last sinter plant was closed.

Since this submission, the combustion emissions are reported in the process sector.

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. 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 4.12. 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 form the use of electrodes in the stainless steel plant in the Flemish region.

4.4.2.2 Metal industry / Other (category 2C7)

The emissions reported in the category 2C7 are the emissions mainly originating from the non-ferro sector in the Flemish region. These data are reported by the individual plants involved.

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 CRF Reporter databases and the emission trading data.

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

Recalculations in category 2C are mainly due to:

- In the category 2C7 a re-allocation was made in the Flemish region from process emissions to energetic emissions (category 1A2b) for the complete timeseries (for 1 company in this category the emissions from petroleumcokes were re-allocated to energy in accordance with the energy balance rules).

- Still missing emissions of 1 company in category 2C7 in the Flemish region were completed during the 2016 submission (7-10 kton CO2) for the entire timeseries.

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.

4.5 Non-energy Products from Fuels and Solvent Use (CRF 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 IPCC Tier 1 methodology is used.
The activity data on non-energy products are collected from the national energy statistics. The amount of lubricants used as fuel in 2-strokes engines is calculated with COPERT4 v11.3 software and subtracted from the national statistics.

The activity data (TJ) and emissions from lubricants use in 4-strokes motors are also calculated with the COPERT-model.

The emission factor for lubricant use (except for 4-strokes engines) is calculated with a carbon content of 20 kg C/GJ and an oxidation fraction of 0.2.

4.5.2.2 Paraffin wax use (category 2D2)

The IPCC Tier 1 methodology is used.
The activity data on 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 an oxidation fraction of 0.2.
As no paraffin wax consumption is reported in the national energy statistics between 2009 and 2014 and because of the small differences from one year to another, the average annual paraffin wax consumption in the period 2003-2008 was used to estimated the annual paraffin wax consumption in Belgium from 2009 to 2014.

4.5.2.3 Other (category 2D3)

The emissions of CO_2 from the **category 2D3** (Solvent use) are not applicable.

The 3 regions in Belgium are using comparable methodologies to estimate the emissions of solvent and other product use.
The emissions of NMVOC in Flanders are estimated by using the results of a study started by the University of Gent in 1998 and continued by the Flemish Environment Agency (VMM).
In Wallonia, the calculation is based on a methodology established by Econotec [39].
In the Brussels region, the emissions are calculated by using the results of the research projects [16], [17] - [20] and [60].
Because of the less importance of these emissions in the greenhouse gas story, only a general view of how these emissions are calculated in Belgium is given below.

Broadly speaking, emissions of NMVOC are estimated in Belgium based on:

- production figures that are given by the specific industry or professional federations. The emission factors used, are mainly the solvent content of the product.
- information gathered in the industrial databases mainly originating from the yearly reporting obligations of the industrial companies.

More information is provided in the IIR (Informative Inventory Report) as part of the emep/lrtap-reporting. Activity data are not provided for these sectors because there are too many different sources of emissions for which activity data are confidential, not additional or sometimes even unknown. NE is therefore encoded. NA is encoded for CO_2 emissions because activities exist but no direct CO_2 emissions occur. There is no estimation carried out in Belgium of the CO_2 equivalents calculated out of the emissions of NMVOC of the solvent consumption, according to 2006 IPCC Guidelines.

The emissions of CO_2 from the **category 2D3** (urea used as a catalyst in road transport) are estimated by using COPERT4 v11.3 software. These emissions were previously allocated in 1A3b.

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

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

- The CO_2 emissions from the use of lubricants were recalculated (correction of the energy content to 42,3 TJ/Gg) for the whole time series. Activity data (TJ) and emissions of CO_2 from lubricants use in 4-strokes motors, calculated by the COPERT-model, were taken newly into account.

- The CO2 emissions from the use of paraffin wax were newly estimated for the year 2009 to 2013.

- The CO_2 emissions from the urea used as a catalyst are newly reported in this category since the 2016 submission instead of category 1A3b before.

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.

4.6 Electronics industry (CRF 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 taken up 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. The average emission factor is 15 to 20% for the sum of F-gases.

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).

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

The only change made to the inventory data for the period 1995-2013 is the following:

- the CF4 emissions in 2013 were adjusted, based on updated information.

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.

4.7 Product uses as substitutes for ODS (CRF 2.F)

4.7.1 Source category description

In this category are mainly HFC emissions from refrigeration and air conditioning. 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][28] and updated every year and further optimised by ECONOTEC in collaboration with the VITO [45].

No systematic emission inventories of fluorinated greenhouse gases were made for the years 1990-1994, because it is very 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 CRF-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 2014 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 and stationary air conditioning installations, household refrigerators, refrigerated transport, 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 4 car manufacturers.

The HFC emissions from household refrigerators are rather negligible. They have been calculated separately for the 3 regions together with the emissions of CFCs and HCFCs from these applications.

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 reported under '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 inquiry among refrigerant suppliers on their national supply of each refrigerant mixture. The estimated supply for refilling vehicles is subtracted. Assumptions are made on the average loss rates. .No distinction is made between industrial refrigeration, commercial refrigeration and air conditioning 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.

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 cooling '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 50%. 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 HFC134a, the main gas concerned up to now, the total amount recovered over the period 2002-2011 was 79 tonnes, while the corresponding total "amount in systems at time of disposal" was estimated at 127 tonnes. This shows that the assumption of a disposal loss factor of 50% for "Commercial refrigeration" is not unrealistic and rather on the conservative side.

The refrigerant consumption and emissions of 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 airconditioning
- the percentage of new registrations with airconditioning: this is not constant throughout the entire time series but is since 2010 96% which we assumes 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 airconditioning 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 airconditioning 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.

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 2014 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. Emissions of HFCs from this sector arise both during manufacturing and as a result of their use. The emissions during manufacturing are based on data obtained from the manufacturer. The emissions of HFCs contained in polyurethane cans sold in Belgium are based on estimates of the evolution of the number of cans consumed, the share of cans containing HFCs, the average quantity of HFC per can and the relative shares of HFC 134a and HFC 152a.

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[13] and based on data from the leading German installer and fliler, 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 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.

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

Standard QA/QC and verification activities take place.

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[13] 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).

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

The main changes made to the inventory data for the period 1995-2013 are the following:

- The emissions of refrigeration and air conditioning installations have been revised for the whole time series, in order to improve the calculation of disposal emissions. The modification has essentially consisted in recalculating the 'Amounts charged into new systems'.
- For rail transport, the time series has been adjusted. New information from the NMBS/SNCB made it possible to estimate the stock of HFCs in trains based on specific quantities of HFC per model of train.
- For room air conditioning emissions in 2012 and 2013 were adjusted to account for new statistics on the number of appliances.
- For refrigerated transport emissions in kt CO_2-eq have been adjusted, because an incorrect GWP value was used. Emissions in tonnes remain the same.
- 2013 HFC emissions for technical aerosols have been adjusted to take into account more recent information on consumption.

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.

4.8 Other Product Manufacture and Use (CRF 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.

4.8.2 Methodological issues

4.8.2.1 Electrical equipment (category 2G1)

SF_6 emissions from the electricity sector are small (11,4 kt CO2-eq in 2014). 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[14], 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 2012, the

[14] 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.

corresponding emission factors are 0.11%, 0.93% and 0.03% respectively. As the equipment lifetime is assumed to be 40 years [78] disposal emissions are not expected before 2015, except for those of one significant plant in the transport sector that has been dismantled in 2011.

4.8.2.2 SF6 and PFC from other product use (category 2G2)

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 SF6 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 SF6 and C3F8 (PFC-218) have been estimated.

2G2e SF6 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%).

2G3a medical applications

From 1990 to 1995, the emission calculation for the emission of N_2O from anaesthesia is based on the number of hospital beds in Wallonia 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.
From 2005 to 2014, 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).
From 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 emissions from aerosol cans are estimated on the basis of the average European consumption (number of food aerosol can/inhab) obtained from DETIC (Belgian-Luxembourg Association of producers and distributors of soaps, cosmetics, detergents, cleaning products, hygiene and toiletries, glues, and related products) for the year 2012. Because of a lack of activity data before 2012, this average consumption is assumed to be constant for the complete time series 1990-2014. The activity data (number of aerosol cans) is then calculated for the complete time series on the basis of the number of inhabitant. The emission factor for N_2O is 7,6 g/can (as estimated in the Netherlands on the basis of data provided by one producer) and is assumed to be constant over time.

4.8.3 Uncertainties and time-series consistency

2G3a N_2O emissions from anaesthesia

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 is used to calculate the emissions. Consequently, the uncertainty for this sector has been reduced.

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

No recalculations took place in the category 2G in Belgium during this submission.

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

Not applicable.

5 AGRICULTURE (CRF SECTOR 3)

5.1 Overview of the sector

5.1.1 Description of the sector

The evolution (1990-2014) in Belgium of the main categories of livestock and cultivation business 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 2014 extends to 1333398 hectares (Table 5.1) or 47% of Belgium. In 2014, the number of agricultural and horticultural businesses amounted to 37194. This number had dropped by 40% since 2000. The disappearing 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. Nevertheless the land area used for agricultural purposes remained more or less the same during this period. In 2014 Wallonia has 54% of the land used for agriculture, but 65% of agricultural businesses are situated in Flanders. The land area used for farming is on average 25 ha per farm in the Flemish region and 55 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) do not exceed 0.02% off the national figure.
Detailed information for the three regions can be found in Annex 9, table 9.1(a-c). Camels, llamas and buffalo do not occur in Belgium. Therefore they are not taken up in the inventory.

Organic farming and the businesses in transition towards this type of farming only represent 5% of the total area in 2014 (92% in Wallonia, 8 % in Flanders, see http://www.bioforum.be). The evolution of the Belgian agricultural sector is of course directly related to the Common Agricultural Policy of the European Union.

	1990	1995	2000	2005	2010	2011	2012	2013	2014
Number of businesses	86962	72660	61705	51540	42854	39528	38559	37761	37194
Usable agricultural area (ha)	1357366	1368135	1394083	1385582	1358019	1337303	1333913	1338566	1333398
Cropland	760559	851770	864076	842999	834388	824783	802772	816120	817117
Grains (ha) (without maize)	327226	282427	277702	267975	276571	255654	274605	263955	270753
Wheat (ha)	205050	196828	204022	204209	209532	190875	206639	192047	197214
Sugarbeet (ha)	107837	98810	90858	85527	59303	62199	61165	60191	58602
Potatoes (ha)	49255	57417	65845	64952	81760	82341	66975	75315	80370
Maize (ha)	140066	183274	202120	218081	238844	245565	237688	251411	240947
Permanent Grassland (ha)	578626	495253	506946	519096	499687	488924	507237	498195	492042

Table 5-1 : Main types of cultivation in Belgium in 1990-2014.

	1990	1995	2000	2005	2010	2011	2012	2013	2014
Cattle	3248780	3286233	2993819	2664101	2627401	2572148	2504438	2510824	2515744
Dairy cattle	838697	684464	581462	494743	464448	456134	456394	444817	451990
Non-dairy cattle	2410083	2601769	2412358	2169358	2162953	2116014	2048044	2066007	2063754
Sheep	192133	157570	123943	118644	104705	98612	106372	107791	110966
Goats	8700	8872	13226	24021	30880	32688	34836	38959	41401
Horses	21141	23944	41440	43668	52579	51009	54234	59936	58161
Mules and asses	189	259	4878	6539	8778	8792	8921	8966	8645
Swine	6700422	7268492	6895306	6161195	6626631	6602009	6675233	6727928	6516338
Poultry (total)	27166776	33381390	36860444	32036898	32594108	32415965	33953944	36371586	37868067
other	23745	31293	76187	54884	64500	61189	63799	66091	72200

Table 5-2 : Number of heads in the main livestock categories in Belgium in 1990-2014.

Climate:
With an average temperature of 11.9°C in 2014 (http://www.meteo.be/meteo/view/nl/18606670-2014.html), Belgium as a whole has a 'cool' climate.

5.1.2 Allocation of emissions

Four 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

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. Emissions from the application of urea are reported NE. When applying the method with the only data source available (http://ifadata.fertilizer.org), Belgium found that the CO_2 emissions in 2014 would be 15.94 kt CO_2 while the threshold of significance is 57 kt CO_2 eq. Considering some partial regional data, it appears very unlikely that the AD level for Belgium is larger than that indicated in "fertilizer.org". Therefore, Belgium prefers to keep the notation key "NE" waiting to collect more accurate data from the regional administrations for the 2017 submission.

5.1.3 Trend assessment

GHG emissions from agriculture (without fuels used) account in 2014 for 8.5% of the total emissions in Belgium. Overall (including emissions from energy sector 1A4c), they have decreased by 21.3% between 1990 and 2014.

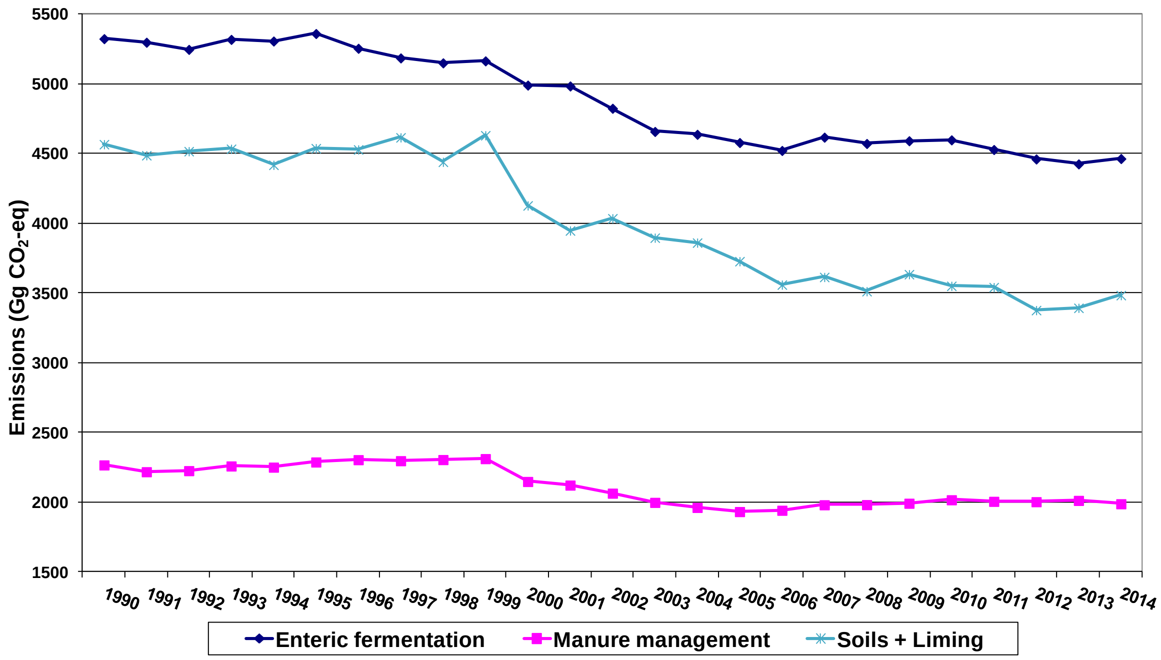


Figure 5-1 : Emission trends in agriculture

45.0% of these emissions (without fuel used) are CH_4 emissions from enteric fermentation (category 3A) in 2013, cattle are for 93% responsible for these emissions. As can be seen in figure 5.1 those emissions decreased by 16% since 1990. This is mainly due to a general livestock reduction [6], 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 2014 of which swine accounts for the biggest part (58%). 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.

33.7% of the emissions in the agriculture are originating from N_2O emissions from soils. Those have decreased by 24%, due to the smaller quantities of nitrogen from mineral fertiliser applied on the one hand and to the livestock reduction (nitrogen excreted on pasture and from organic fertiliser 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' [26] (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 are questioned.

However, since 2015, the agricultural census is no longer as detailed as needed. Therefore, Wallonia uses regional statistics from 2013 data. Flanders uses from 2000 on data from the Manure Bank of the Flemish Land Agency (VLM). In Brussels, regional statistics are used from 2011 for agricultural surfaces (cropland and grassland). Livestock heads from Statbel are also corrected from 2011 on.

Further detail on the agricultural census methodology and QA/QC issues can be found on the Statbel website: http://economie.fgov.be/en/statistics/surveys-methodology/.

Edible crop production:
Data on edible crop production (area and production) are available on:
http://statbel.fgov.be/nl/statistieken/cijfers/economie/landbouw/. The cultivated area for each crop originates from the agriculture census of the 1st of may. The crop production originates from an additional survey performed in December.
Table 5.3 gives an overview of the production data of the main types of crops in Belgium from 1990-2014. Detailed information of the trend of the crop production in the three regions is given in annex 9, table 9.2(a-c).

Crop	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**
	Production kg/ha	Production kg/ha	Production kg/ha	Production kg/ha	Production kg/ha	Production kg/ha	Production kg/ha	Production kg/ha	Production kg/ha
Wheat	6175	7381	8008	8509	8827	8478	8524	9178	9202
Barley	5752	6639	6864	7548	8333	7695	8060	8339	9211
Maize	39950	35785	38723	38425	37362	35749	33804	35138	39336
Potatoes	34492	37502	44376	42813	42267	50142	41979	45155	50805
Sugar beet	59520	61540	67710	69957	75288	86962	78974	79900	87260
Fodder beet	90560	93650	99840	99118	95797	106376	89544	102047	100820

Table 5-3 : Production data of the main types of cultivation in Belgium in 1990-2014.

Livestock numbers:
The livestock numbers are the primary activity data used in the calculation of CH_4 and N_2O emissions. Until 1999 in Flanders and 2012 in Wallonia, the numbers originate from the agricultural census which is available on:
http://statbel.fgov.be/nl/modules/publications/statistiques/economie/downloads/agriculture_-_chiffres_d_agricole_de_2014.jsp. These data can be found in annex 9, table 9.1(a-c). Table 5.4 gives an overview of the origin of livestock number 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 (adapted from 2011 on)
2013-2014	Manure Bank (VLM)	Walloon Statistics (DGO3-Agriculture Administration)	STATBEL (adapted)

Table 5-4 : Origin of the livestock numbers in the three regions.

In Flanders, from 2000 on, input data as animal number, N-production e.o. are obtained by the Manure Bank of the Flemish Land Agency (VLM; http://www.vlm.be/landtuinbouwers/mestbank/aangifte/Pages/default.aspx). Unfortunately the reports and declarationforms 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. 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, 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 off course true that the animal number between Statbel and the manure bank is not exact 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 more detailed numbers for swine, ovine and goats for 2014, livestock figures come from Walloon agriculture department (DGO3). Comparisons were made on 2013 figures (yet available in STATBEL and also in Walloon statistics). Some categories of animal are very close (cattle) but for swine and poultry, significant differences are observed (Walloon statistics always higher than STATBEL). Theses differences may be explained by the difference in the methodology of collecting data: in STATBEL data are related to the number of places while in Wallonia data are related to the number of heads during the year. The impacts on emissions have been evaluated and reported in this report in the different recalculations sections. The Table 5-6 gives also the comparison of the activity data coming from the two sources for the year 2013.

Livestock categories	Heads from STATBEL	Heads from Walloon Statistics	Difference (%)
Dairy Cattle	202 080	183 002	-9%

Non dairy cattle	974 460	1 028 721	6%
Swine	326 786	422 127	29%
Ovines & Goats	59 040	60 242	2%
Poultry	4 348 365	6 597 151	52%

Table 5-6 : Comparison of 2013 livestock activity data with STATBEL and DGO3 in Wallonia.

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 2015.

Category 3.A Enteric fermentation:

Recalculations in emissions of CH_4 in category 3.A due to:

Flemish region: Revision of livestock and milk production (per cow) from 2007 on.
Walloon region: Revision of livestock from 2013 and revision of the methane conversion factor (Ym) over the time series
Brussels region: Revision of the methane conversion factor (Ym) over the time series

Relations to previous submission (%)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	-7,48	-7,58	-7,02	-7,30	-7,43	-7,32	-7,32	-7,31
Flemish region	%	0,00	0,00	0,00	0,00	-0,14	0,16	0,23	0,07
Walloon region	%	-7,61	-7,62	-7,61	-7,60	-7,59	-7,60	-7,58	-7,21
Belgium	%	-3,76	-3,76	-3,90	-4,00	-3,93	-3,78	-3,71	-3,51

Relations to previous submission (Gg CO_2-eq)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	-0,07	-0,08	-0,06	-0,05	-0,04	-0,04	-0,04	-0,04
Flemish region	Gg CO2 eq.	0,00	0,00	0,00	0,00	-3,31	3,62	5,33	1,64
Walloon region	Gg CO2 eq.	-208,22	-209,70	-202,68	-190,86	-184,84	-181,47	-177,10	-162,44
Belgium	Gg CO2 eq.	-208,29	-209,78	-202,74	-190,91	-188,18	-177,89	-171,82	-160,84

Category 3.B Manure management:
Recalculations in emissions of CH_4 and N_2O in category 3.B due to:

Flemish region: Revision of livestock and milk production (per cow) from 2007 on.
Correction of the feed digestibility for swine.
Update of NH_3-emissions from indoor stable from 2007 on.
Walloon region: Revision of livestock from 2013

Relations to previous submission (%)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flemish region	%	-23,50	-24,46	-26,76	-26,65	-27,13	-27,02	-27,09	-27,26
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,42
Belgium	%	-19,79	-20,83	-22,48	-22,08	-22,82	-22,82	-22,88	-22,49

Relations to previous submission (Gg CO_2-eq)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flemish region	Gg CO2 eq.	-553,31	-597,13	-621,23	-545,78	-594,68	-591,54	-592,88	-603,14
Walloon region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	20,73
Belgium	Gg CO2 eq.	-559,65	-602,23	-623,37	-547,78	-596,52	-593,32	-594,72	-584,28

Category 3.D Agricultural soils:

Recalculations in emissions of N_2O in category 3.D due to:

Flemish region: Revision of livestock and milk production (per cow) from 2007 on.
Update of NH_3-emissions from manure application on land, fertilizer use and emissions from grazing animals from 2007 on.
Change of region specific $Frac_{LEACH}$ to $Frac_{LEACH}$=0.30, default 2006 IPCC Guidelines.
Walloon region: Revision of livestock from 2013;
Change of $Frac_{LEACH}$ = 0 to $Frac_{LEACH}$=0.30, default 2006 IPCC Guidelines.
Brussels region: Change of $Frac_{LEACH}$ = 0 to $Frac_{LEACH}$=0.30, default 2006 IPCC Guidelines.

Relations to previous submission (%)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	29,89	29,52	30,46	29,52	28,62	20,26	19,36	19,58
Flemish region	%	13,69	12,39	9,69	7,39	13,09	14,06	14,79	12,22
Walloon region	%	18,08	18,03	18,27	18,37	18,19	18,38	18,25	19,42
Belgium	%	15,92	15,22	14,45	13,73	15,99	16,60	16,81	16,35

Relations to previous submission (Gg CO_2-eq)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	0,26	0,22	0,22	0,13	0,08	0,06	0,06	0,06
Flemish region	Gg CO2 eq.	255,92	235,20	150,25	98,45	166,22	169,42	170,19	145,85
Walloon region	Gg CO2 eq.	349,29	343,90	352,07	334,59	304,78	315,78	296,75	312,57
Belgium	Gg CO2 eq.	605,47	579,32	502,53	433,17	471,08	485,26	466,99	458,48

Category 3.G Liming:
Recalculations in emissions of N_2O in category 3.G due to:

Flemish region:
Walloon region:
Brussels region: revision of the agricultural surfaces, on the basis of regional data, from 2011 on.

Relations to previous submission (%)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	0,00	0,00	0,00	0,00	0,00	-18,36	-20,58	-20,00
Flemish region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Walloon region	%	0,18	0,49	0,82	1,17	6,35	8,21	10,13	10,13
Belgium	%	0,09	0,26	0,44	0,64	3,44	4,43	5,47	5,51

Relations to previous submission (Gg CO_2-eq)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	-0,01	-0,01	-0,01
Flemish region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Walloon region	Gg CO2 eq.	0,15	0,40	0,65	0,90	4,52	5,75	6,97	6,97
Belgium	Gg CO2 eq.	0,15	0,40	0,65	0,90	4,52	5,74	6,96	6,96

Category 3 Total Agriculture:

Relations to previous submission (%)

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	9,43	7,41	9,46	7,30	4,65	1,66	1,10	1,20
Flemish region	%	-4,19	-5,00	-7,28	-7,84	-7,35	-7,25	-7,33	-7,86
Walloon region	%	2,71	2,60	2,93	2,99	2,70	3,05	2,85	4,12
Belgium	%	-1,32	-1,87	-2,79	-2,89	-2,95	-2,70	-2,89	-2,76

Relations to previous submission (Gg CO_2-eq)

		1990	1995	2000	2005	2010	2011	2012	2013

Brussels region	Gg CO2 eq.	0,19	0,14	0,16	0,09	0,04	0,02	0,01	0,01
Flemish region	Gg CO2 eq.	-297,40	-361,93	-470,98	-447,33	-431,76	-418,49	-417,36	-455,65
Walloon region	Gg CO2 eq.	141,22	134,60	150,04	144,62	124,47	140,05	126,61	177,83
Belgium	Gg CO2 eq.	-162,32	-232,28	-322,93	-304,62	-309,09	-280,20	-292,58	-279,68

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 [54]. Enteric fermentation emissions from poultry are not estimated because the IPCC 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.
Camels, llamas and buffalo do not occur in Belgium. Therefore they are not taken up in the inventory.
Table 5.6 gives an overview of the methodologies used in the three regions.

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 5-7 : 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$_{\text{category x}}$) * animal number$_{\text{category x}}$

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. In Annex 3 of this report a copy of the calculation of the GE intake and emission factors in Flanders. The different steps and the formulas used are hereunder discussed in detail.

For Brussels, emission factors from Wallonia are used, considering the similarities of farms structure and agricultural practices in the two Regions.

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) originate in Flanders from the *Department Agriculture and Fisheries* and in Wallonia from average weights published by the federal finance department. 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 hereunder.

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	0.250	0.322	1
Dairy cows	600	0.650	0.386	0.8
Brood cows	600	0.650	0.386	0.8
Wallonia and Brussels				
Bovines under 6 months	164	0.700	0.322	1.2
Bovines between 6 months and 1 year: male	184	0.700	0.370	1.2
Bovines between 6 months and 1 year: female	184	0.650	0.322	0.8
Bovines more than 1 year for fattening: male	427	0.700	0.370	1
Bovines more than 1 year for reproduction: male	617	0.700	0.370	1.2
Bovines more than 1 year: female	501	0.650	0.322	0.8
Dairy cows	600	0.650	0.386	0.8
Brood cows	600	0.650	0.386	0.8

Table 5-8 : 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. For the calculation of the net energy for activity (NE_a) in Wallonia 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.

In Flanders for slaughter calves a coefficient (C_a) of 0% is used, considering the animals are kept inside their entire lifetime. In 2014 dairy cows spend 14% of the year on pasture, brood cows 55% and the other bovine 6%. Resulting in a coefficient (C_a) respectively of 2.38% and 9.35% and 1.02%. From 1990 till 2014, 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 1996-2000**	**C_a 2001-2005**	**C_a 2006-2010**	**C_a 2011-2014**
Slaughter calves	0	0	0	0	0
Bovine under 1 year	1.02	1.02	1.02	1.02	1.02
Bovine between 1 and 2 years	1.02	1.02	1.02	1.02	1.02
Bovine more than 2 years	0	0	0	0	0
Dairy cows	4.76	4.08	3.40	2.72	2.38

Brood cows	9.35	9.35	9.35	9.35	9.35

Table 5-9 : 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. Unfortunatly 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 5.11). 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 on the basis of data provided by the milk producers.

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 http://www.rivm.nl/bibliotheek/rapporten/680125001.html (reference [52], page 19, table 3.14) from the Netherlands. This is a neighbouring country with comparable feeding situations. Table 5.9 gives an overview of the feed digestibility of the different feed types.

Feed	**DE%**
Calf milk replacer	90%
Concentrates	80%
Maize	72%
Grass silage	72%
Fresh grass (grazing animals)	79%

Table 5-10 : Digestibility of the feed of cattle in %.

Feeding situation Flanders

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 the milk production has strongly increased from 11kg milk/day/cow in 1990 to 23kg milk/day/cow in 2014 (see also table 5.11.). For non-dairy cattle the feeding situation is not yet specified, a DE% of 75% is used.

Feeding situation Wallonia

In Wallonia 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.

Implied Emission Factor
In all regions a methane conversion factor (Y_m) of 6% 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 Y_m 0% is used, from 2007 on Y_m is taken 0.84% (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. Because this is the case in the three regions, Y_m of 6% is used.
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 109.90 kg CH_4/head in 1990 to 139.78 kg CH_4/head in 2014. The implied emission factor for non-dairy cattle increases from 45.17 kg CH_4/head in 1990 to 50.14 kg CH_4/head in 2014.

Table 5.10 shows the emission factors used in the three regions for the different cattle types in 2014. 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	3.98
Bovine under 1 year	31.47
Bovine between 1 and 2 years	47.27
Bovine more than 2 years	47.69
Brood cows	91.88
Dairy cattle	144.75
Wallonia and Brussels	
Bovine under 6 months	20.23
Bovine between 6 months and 1 year: male	27.27
Bovine between 6 months and 1 year: female	26.91
Bovine more than 1 year for fattening: male	53.44
Bovine more than 1 year for reproduction: male	67.59
Bovine more than 1 year: female	57.03
Brood cows	91.15
Dairy cattle	132.61

Table 5-11 : Emission factor for each animal category (2014) in Belgium.

Dairy cattle	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**
Flanders									
Milk production	10.99	12.81	15.99	19.00	22.74	23.19	22.96	22.99	23.15
Fat %	4.23	4.29	4.33	4.35	4.33	4.32	4.35	4.31	4.28
IEF for methane	109.09	114.99	123.39	132.95	144.08	145.20	144.75	144.47	144.75
Wallonia and Brussels									
Milk production	11.35	12.59	13.54	15.86	17.41	18.18	17.55	17.33	18.55
Fat %	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
IEF for methane	110.86	114.60	117.48	124.47	129.17	131.47	129.58	128.92	132.61

Table 5-12 : Milk production (kg milk/head/day), % fat and IEF (kg CH_4/head/yr) for dairy cattle in Belgium (1990-2014).

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 5-13 : 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.
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 Flanders, animal numbers are updated for 2007-2013, resulting in a minor change in CH_4 emissions from enteric fermentation (category 3.A) ranging from +0.01% (0.28kton CO_2-eq) in 2010 to +0.23% (5.20kton CO_2-eq) in 2012 compared to the previous submission.
- In Flanders, due to the change in animal numbers, the milk production per head per year changed slightly. Resulting in a minor change in CH_4 emissions from enteric fermentation (category 3.A) ranging from +0.06% (1.37kton CO_2-eq) in 2007 to -0.15% (-3.58kton CO_2-eq) in 2010.
- In Wallonia, animal numbers were updated from 2013 (DGO3 statistics), resulting in a minor increase of the Walloon emissions of +0.39% (8.74kton CO2-eq) in 2013.

- In Wallonia and Brussels, the methane conversion factor (Ym) has been updated (from 6.5% in the last submission to 6%) to improve consistency between the regions. Furthermore it was the 6% value that was used in the previous submissions, coming from the IPCC 2000 GPG. This results in a decrease of the emissions of 7.6% in Wallonia (-171.97kton CO2-eq) in 2013.

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

No source-specific improvements are planned in the near future.

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. Table 5.13 gives an overview of the methodologies used in the three regions.

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 1)		

Table 5-14 : 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 methodology used in the three regions to estimate N_2O emissions from manure management is based on the IPCC 2006 Guidelines.
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.

$$VS \text{ (kg dm/day)} = [GE_{intake} \text{ (MJ/day)} * (1\text{-}DE\%/100) + (UE * GE)] * [(1\text{-}ASH\%/18.45)]$$

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 2014. 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 0.04GE 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: <u>http://www.nitrawal.be/upload_files/3.1.1%20PGDA/AGW%20PGDA%2031%2003%2011.pdf</u>.
For Flanders these data originate from the <u>www.varkensloket.be</u>. This portal is the information centre for Flanders pig farmers.

As can be seen in table 5.14, the IEF for dairy cattle in Flanders (36.59 kg CH_4/head in 2014) is considerably higher than in Wallonia and Brussels (16.44 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 2014 this is 23.15 kg milk/cow/day. In Wallonia and Brussels this is 18.55 kg milk/cow/day. This has an important effect on the gross energy (GE) intake, which is 368 MJ/day in Flanders, 337 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.
Annex 9.3 gives an overview of the GE / VS / IEF used in the three regions for each subcategory of cattle and swine for the entire time series.

Subcategories	GE (MJ/day)	ASH (%)	VS (kg dm/day)	Bo (m^3/kg of VS)	Implied Emission Factor (kg CH_4/head)
Flanders					
Slaughter calves	72	8	0.50	0.18	4.22
Bovines under 1 year	80	8	1.16	0.18	1.37
Bovines between 1 and 2 years	120	8	1.74	0.18	9.36
Bovines more than 2 years	121	8	1.75	0.18	3.90
Dairy cattle	368	8	5.24	0.24	36.59
Brood cattle	233	8	3.38	0.18	2.63
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 and Brussels					
Bovines under 6 months	51	8	0.74	0.18	0.84
Bovines between 6 months and 1 year: male	69	8	1.00	0.18	1.04
Bovines between 6 months and 1 year: female	68	8	0.99	0.18	1.12
Bovines more than 1 year for fattening: male	136	8	1.96	0.18	2.22
Bovines more than 1 year for reproduction: male	172	8	2.48	0.18	3.74
Bovines more than 1 year: female	145	8	2.10	0.18	3.15
Dairy cattle	337	8	4.87	0.24	16.44
Brood cattle	232	8	3.35	0.18	3.39
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

Table 5-15 : Overview of the factors used in 2014 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 two 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 11,1°C.

Manure Management System	MCF
MCF pit storage below animal confinements*	19%
MCF daily spread	0,10%
MCF dry lot	1%
MCF solid storage*	2%
MCF poultry manure	1.5
MCF pasture, range and paddock	1%

Table 5-16 : 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 Department of Agriculture and Fisheries (dLV). 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 on tables 5.17 and 5.18 under nitrous oxide emissions.

<u>Non key sub-source categories</u>
Sheep, goats, poultry, horses, mules and asses are not key source categories. The Tier 1 methodology from the IPCC 2006 GL is used in each region.

<u>Trend in implied emission factor</u>
The table below gives a summary of the evolution of the IEF's of the key source categories in the 3 regions. The IEF for manure management of dairy cattle increased significantly between 1990 and 2014. 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	1995	2000	2005	2010	2011	2012	2013	2014
Flanders									
Dairy cattle	15.87	16.72	21.25	26.46	32.53	36.71	36.59	36.52	36.59
Non-dairy cattle	3.97	3.86	4.12	4.19	4.57	4.44	4.45	4.45	4.47
Swine	4.69	4.56	4.71	4.64	4.54	4.51	4.50	4.48	4.47
Wallonia and Brussels									
Dairy cattle	12.12	12.53	14.56	15.43	16.01	16.29	16.06	15.98	16.44
Non-dairy cattle	2.20	2.25	2.39	2.48	2.50	2.50	2.54	2.51	2.51
Swine	5,56	5,59	5,22	4,94	4,73	4,71	4,70	4,67	4.66

Table 5-17 : Methane IEF (kg CH_4/head/yr) for manure management for the key source categories (1990-2014) in the three regions.

5.3.2.2 Nitrous oxide

Direct nitrous oxide emissions from animal manure are calculated 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.

The model used for the calculation of the emissions has been developed in a simple excel format. A copy of the excel file can be found in annex 3 of this report and is similar for the three regions and given for Flanders. The model integrates the N_2O sources: emissions from manure management, discussed here, and N_2O emissions from managed soils discussed below in 5.4.2.

Direct N_2O emissions from manure management: 3.B.2.1 – 3.B.2.4

<u>N-excretion factors</u>:
The N_2O emission estimation from manure management is based on the nitrogen excreted by each animal category, estimated through local production 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.
The three regions use different N-excretion factors. Therefore tables 5.17a-c give an overview of the nitrogen excretion factors used in the three regions.

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. The N-excretion factors of cattle, sheep, goats, horses, mules and rabbits used in 2014 are

described in the manure decree (or MAP5):
http://www.vlm.be/SiteCollectionDocuments/Publicaties/mestbank/bemestingsnormen_2014.pdf.
Unfortunately no translation in English is available.
For dairy cows, in MAP5, these N-excretion factors depend on the average milk production per cow.

Wallonia
In Wallonia N-excretion factors were first determined in the PGDA (Walloon program for sustainable use of nitrogen) for the implementation of the CE Nitrates Directive 91/676 (see annexes of the decree downloadable on
http://www.nitrawal.be/upload_files/3.1.1%20PGDA/AGW%20PGDA%2031%2003%2011.pdf)
but were representing the nitrogen *after* deduction of the atmospheric losses, so new factors were calculated on this basis for the purposes of estimating atmospheric emissions.

Brussels
In Brussels, the same approach and factors as implemented in Wallonia are used.

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 5.17 and 5.18 hereunder.

Flanders
In Flanders the allocation of animals to AWMS originate form thedepartment of Agriculture and Fisheries. Table 5.17 gives an overview of the different systems used for each detailed animal category.

Category	N ex (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	116	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	2.29	99% pit storage 1% dry lot

Fattening pigs from 20 to 110 kg	11.09	ditto
Fattening pigs more than 110 kg	21.38	98% pit storage 2% dry lot
Boars	20.98	69% pit storage 15% solid storage 16% dry lot
Sows including piglets less than 7 kg	21.42	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	7.42	100% solid storage
Rabbits for breeding	3.16	ditto
Rabbits for fattening	0.66	ditto
Furred animals		ditto
Furred animals closed housing	2.3	ditto
Furred animals for breeding		ditto
Furred animals for fattening	0.7	ditto
Poultry		
Broilers (for breeding)	0.42	100% poultry manure with litter
Broilers (parental animals)	1.14	87% poultry manure with litter 13% poultry manure without litter
Broilers (for fattening)	0.53	100% poultry manure with litter
Laying hens (for breeding)	0.33	36% poultry manure with litter 64% poultry manure without litter
laying hens	0.80	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 5-18 : Nitrogen excretion factors and allocation of animals to AWMS for each category in Flanders (2014).

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 near 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
		Solid manure	Liquid manure	Solid manure	Liquid manure	Stable vs pasture
	(kg N/animal/yr)	(%)	(%)	(%)	(%)	(%)
Bovines under 6 months	13,4	86	14	87	13	100
Bovines between 6 months and 1 year: male	37,5	94	6	90	10	50
Bovines between 6 months and 1 year: female	30,8	88	12	87	13	50
Bovines more than 1 year for fattening: male	97,8	88	12	87	13	50
Bovines more than 1 year for reproduction: male	84,4	78	22	77	23	50
Bovines more than 1 year: female	58,9	78	22	77	23	50
Brood cows	97,8	93	7	91	9	50
Dairy cows	120,5	63	37	56	44	56
Piglet under 20 kg	4,7	20	80	25	75	100
Piglet between 20 and 50 kg	10,4	20	80	25	75	100
Fattening pigs more than 50 kg	16,1	20	80	25	75	100
Sows	37,5	54	46	42	58	100
Breeding males	42,9	45	55	43	57	100
Lambs	4,4	100	0	100	0	100
Sheep <1 year	4,4	100	0	100	0	50
Sheep >1year	8,8	100	0	100	0	50
Goats <1year	4,4	100	0	100	0	50
Goat > 1 year	8,8	100	0	100	0	50
Horses	75	100	0	100	0	50
Broilers	0,4	78	22	89	11	100
Laying hens	0,8	3	97	6	94	100
Other poultry	0,6	48	52	26	74	100

Table 5-19 : 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 Tier1 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.

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 [51]. 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. The rate for NO volatilisation is 1.5% and stays constant over the entire time series. 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 2014.

Wallonia and Brussels
In Wallonia and Brussels, the IPCC default value of 0.2 is used (IPCC 2006 GL table 11-3) for the entire time series.

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 similar to the uncertainty 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 N2O 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 Flanders, animal numbers are updated for 2007-2013, resulting in a minor change in CH_4 emissions from manure management (category 3.B.1) ranging from +0.002% (0.03kton CO_2-eq) in 2007 to +0.29% (4.87kton CO_2-eq) in 2012.
- In Flanders, due to the change in animal numbers, the milk production per head per year changed slightly. Resulting in a minor change in CH_4 emissions from manure management (category 3.B.1) ranging from +0.03% (0.31kton CO_2-eq) in 2007 to -0.08% (-0.81kton CO_2-eq) in 2010.
- In Flanders, due to a correction of the feed digestibility for swine (from 70% to 85%), the volatile solid excretion per day on a dry weight basis changed significantly. Resulting in a strong reduction of the CH_4 emission from manure management (category 3.B.1) for the entire time series ranging from -34% (-533kton CO_2-eq) in 1991 to -36% (-621kton CO_2-eq) in 2000.
- In Flanders, animal numbers are updated for 2007-2013, resulting in a minor change in N_2O emissions from manure management (category 3.B.2) ranging from +0.01% (0.07kton CO_2*-eq) in 2007 to +0.23% (1.2kton CO_2-eq) in 2012.
- Also in Flanders, NH_3-emissions from indoor stable are updated from 2007 to 2013. This update results in an minor change of the indirect N_2O emission (category 3.B.2) ranging between -0.07% (-0.38kton CO_2-eq) in 2009 and +0.035% (0.18kton CO_2-eq) in 2012.
- In Wallonia, livestock data have been updated in 2013, resulting in an increase of Walloon CH_4 emissions of 4.4% (8.07kt CO_2-eq) in 2013.

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

In Flanders, an actualisation of the ammonia model is ongoing. A new time series is expected till the end of july 2016. This will have an effect on the category 3.B.2.5.

5.4 Managed soils (CRF 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 (3.D.1.1, 3.D.1.2, 3.D.1.4 - 3.D.1.6);
- Emissions from animal production by grazing animals (3.D.1.3);
- Indirect emissions from N-leaching and run-off and from atmospheric N deposition (3.D.2);

Table 5.19 gives an overview of the methodologies used in the three regions to calculate the N_2O emissions from managed soils.

<table>
<tr><th>Used methodology</th><th>Flanders</th><th>Wallonia</th><th>Brussels</th></tr>
<tr><td colspan="4">Direct N_2O emissions 3.D.1</td></tr>
<tr><td>Emissions from application of inorganic fertilizers, animal manure and sewage sludge 3.D.1.1 en 3.D.1.2</td><td colspan="3" rowspan="5">IPCC 2006 GL (Tier 1)</td></tr>
<tr><td>Emissions from grazing 3.D.1.3</td></tr>
<tr><td>Emissions from crop residues 3.D.1.3</td></tr>
<tr><td>Emissions from mineral soils 3.D.1.5</td></tr>
<tr><td>Emissions from cultivation of organic soils 3.D.1.6</td></tr>
<tr><td colspan="4">Indirect N_2O emissions 3.D.2</td></tr>
<tr><td>Emissions from atmospheric deposition 3.D.2.1</td><td rowspan="2">IPCC 2006 GL (Tier 2)</td><td colspan="2" rowspan="2">IPCC 2006 GL (Tier 1)</td></tr>
<tr><td>Emissions from nitrogen leaching and run-off 3.D.2.2</td></tr>
</table>

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. In annex 3 of this report a copy of the excel file can be found for Flanders.

$$N_2O_{direct}\text{-}N = [(F_{SN} + F_{ON} + F_{CR} + F_{SOM}) * EF_1] + [F_{OS,CG,Temp} * EF_{2CG,Temp}] + [(F_{PRP,CPP} * EF_{3PRP,CPP}) + (F_{PRP,SO} * EF_{3PRP,SO})]$$

where:
F_{SN} = amount of synthetic fertilizer nitrogen applied to soils
F_{ON} = amount of animal manure nitrogen, 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).

Application of Synthetic fertilizer: F_{SN} (3.D.1.1)
Table 5.20. 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 5.21. 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: Department of Agriculture and Fisheries	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 *Department of Agriculture and Fisheries* conducts surveys on a representative sample of different types of agricultural businesses and produces yearly weighted average values on the fertiliser use, taking into account manure pressure and soil type [49] (table 5.21).

Wallonia
In Wallonia, the fertilizer use (N) is obtained by the department of Natural and agricultural land of the the Ministry of environment and agriculture (Direction of the agricultural economy analysis).

Brussels
In Brussels the amount of synthetic fertiliser applied (kg N/ha) is considered the same as in Wallonia.

	Synthetic fertilizer use (kg N /ha)
Wallonia and Brussels	103
Flanders	
Dunes	142
Kempen area	73
Sandy area	109
Sand Loam area	111
Loamy area	96
Polders	142
Luikse Meadow area	73

Table 5-22 : The amount (kg N) of synthetic fertilizer use (per ha) (2014) in each Region.

Application of animal manure: F_{ON} (3.D.1.2)
The N_2O emissions from animal manure application are calculated in the same way as N_2O emission from mineral fertiliser 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) = 0;
F_{OOA} = amount of other organic amendments used as fertiliser (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 of for feed. This is indicated with the notation key 'NO' and $Frac_{FUEL}$, $Frac_{CNST}$ 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 5.22. 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}	NO	NO
F_{OOA}	NO	NO
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 witch 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 fertiliser 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: http://www.vlm.be/lijsten/publicaties/Pages/MB_Voortgangsrapporten.aspx. Unfortunately, there is no translation in English available. So, in other words, manure that is not applied to the soils in Flanders, can not 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 to are France, the Netherlands and Germany. Export from Flanders to Wallonia is prohibited. In the Netherlands manure coming from Flanders is taken into account for the calculation of N_2O direct and indirect. So the method used in Flanders to take into account the net exported manure (output minus input) for the calculation of N_2O direct and indirect is the same as in the Netherlands

(http://www.emissieregistratie.nl/ERPUBLIEK/documenten/Lucht%20(Air)/Landbouw%20en%20Natuur%20(Agriculture%20and%20Nature)/Emissies%20naar%20lucht%20excl%20ammoniak/Nitrous%20oxide%20from%20agricultural%20soils.pdf).
For France and Germany this still must be checked. In annex 3 a table can be found in which the set up of the manure balance numbers in Flanders is described for 2014.

Wallonia
In Wallonia, the amount of sludge spread on agricultural soils is reported every year to the Soils & Waste Department. Analyses of the sludge are conducted to certify that they have the good composition for agricultural use (agronomic parameters) and they satisfy environmental norms.

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 tables 5.17.). 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 5.23. 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: department of 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.

$$F_{CR} = \sum Crop_{(T)} * (Area_{(T)} - Areaburnt_{(T)} * C_f) * Frac_{Renew(T)} * [R_{AG(T)} * N_{AG(T)} * (1-Frac_{Remove(T)}) + R_{BG(T)} * N_{BG(T)}]$$

Where
$Crop_{(T)}$ = harvested annual dry matter yield for crop T (kg dm/ha);
$Area_{(T)}$ = annual area harversted of crop T (ha);
$Areaburnt_{(T)}$ = area of crop T burnt (ha);
C_f = combustion factor;
$Frac_{Renew(T)}$ = fraction of total area under crop T that is renewed annualy = 1;
$R_{AG(T)}$ = 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 5.24. 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 (1990-2014) 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.

Table 5.25. 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

	Dry matter content (%) used in Flanders
Winter barley	89
Spring barley	89
Oats	89
Triticale	88
Chicory	91
Flax	90
Winter rape	90
Summer rape	90
Tobacco	
Vetch	90
Hop	
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
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.

Mineralisation associated with loss of soil organic matter: F_{SOM} (3.D.1.5)
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 5.26. 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 3.D.1.5 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 3.D.1.5; 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 (Gg C) for mineral soils in cropland remaining cropland, the following formula is used:
*annual loss of soil carbon (Gg 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 region: -0.019 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 represents 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, where the only recorded organic soils are part of a nature reserve.

Table 5.27. 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. In annex 3 of this report a copy of the excel file can be found.

<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 fertiliser 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 grazin animals on pasture, range and paddock (kg N);
$Frac_{GASM}$ = fraction of applied organic fertiliser, urine and dung deposited by grazing animals nitrogen that volatilizes as NH_3 and NO_x;
EF_4 = kg N_2O-N / kg NH_3-N + NO_x-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 5.28. 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 fertiliser use ($Frac_{GASF}$ and $Frac_{GASM}$) is derived from the model used to calculate the respective NH_3 emissions [51]. 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.

F_{GASF}: the average rate for NH_3 volatilisation from synthetic fertiliser use in 2014 is 4.0% (1.7% in 1990). The increase between 1990 and 2014 can partly be explained by the change in fertiliser type from ammoniumnitrate to liquid fertilisers which has a higher emission coefficient. And by the increase of the average fertiliser use per ha. The rate of NO volatilisation of synthetic fertiliser use is 1.5% and stays constant over the entire time series.

Table 5.29. gives an overview of the evolution of the different types of synthetic fertiliser used in Flanders.

Fertiliser use in Flanders	Ammonium sulphate (%)	Ammonium nitrate (%)	Urea (%)	Nitrogen sollutions (%)	Other synthetic fertilisers (%)
1990	1	73	1	0	26
1995	2	69	1	7	20
2000	3	67	3	11	17
2005	5	67	3	14	12
2010	5	62	1	25	8
2013	2	63	5	21	9
2014	2	63	5	21	9

Table 5-30 : Fertiliser use in Flanders (1990-2014)

F_{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 0,31 kg(NH_3-N+NO-N)/kg Nex in 1990 to 0,18 kg(NH_3-N+NO-N)/kg Nex in 2014. 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

F_{GASF} and F_{GASM}: In Wallonia, the IPCC default values are used (IPCC 2006 GL table 11-3) for the entire time series.

Leaching/runoff of applied or deposited nitrogen: $N_2O_{(L)}$ (3.D.2.2)
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 grazin 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 fertiliser or manure N (table 11.3 of the IPCC 2006 Guidelines)[15].

IEF & Fraction used	Flanders/Wallonia/Brussels
$Frac_{LEACH}$	0.3
EF_5	0.0075

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 fertilisers, 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, [41]), 509 % (UK, in IPCC Good Practice Guidance), 200 % (France and the Netherlands, NIR 2003), 100 % (Ireland, NIR 2003), 75 % (Finland, overall uncertainty for AD*EF, [40]), 24 % (Austria, NIR 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 Flanders, animal numbers are updated for 2007-2013, resulting in a minor change in N_2O emissions from agricultural soils (category 3.D), less than 0.2% or 1.7kton CO_2-eq..
- Also in Flanders, NH_3-emissions from manure application on land, fertilizer use and emissions from grazing animals are updated from 2007 to 2013. As well as the amount of fertilizer used

[15] According to the note under table 11.3 : FRACleach is taken as zero except for the regionx where soil water-holding capacity is exceeded

from 1990 to 2013. This update results, depending of the year, in a decrease or increase of the N_2O emission from agricultural soils (category 3.D) ranging between -3.8% (-53kton CO_2-eq) in 2003 and +2.4% (+27kton CO_2-eq) in 2012.

- In Wallonia, livestock data have been updated in 2013, resulting in an increase of Walloon N_2O emissions of 1.5% (27.79kt CO_2-eq) in 2013.
- In all three regions, $Frac_{LEACH}$ = 0.30 from the 2006 IPCC Guidelines is used. Before $Frac_{LEACH}$ was in Wallonia and Brussels 0 and in Flanders depending of the year between 0.09 and 0.12. This results in a sixfold multiplication of the emissions from 3.D.2.2, with a maximum of 600kton CO_2-eq.

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, an actualisation of the ammonia model is ongoing. A new time series is expected till the end of july 2016. This will have an effect on the category 3.D.

5.5 Liming (CRF 3.G)

5.5.1 Source category description

Liming is a common practice on cropland and grassland to maintain soil pH. 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).

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

Brussels region: revision of the agricultural surfaces, on the basis of regional data, from 2011 on.

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

No specific changes are planned in the near future.

6 LULUCF (CRF SECTOR 4)

6.1 Overview of sector

Belgium has a temperate maritime climate, with moderate temperature variability, prevailing westerly winds, heavy cloud cover and regular rain.
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

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.

The distribution of forests in Belgium is shown in table 6.1.

Regions	**Forest cover**	**% of the total**
	%	**Belgian forest area**
Wallonia	28,4%	75,4%
Flanders	13,1%	24,3%
Brussels Capital	12,3%	0,3%
Belgium	20,6%	100%

Table 6-1 : Forest cover in Belgium (source: National Institute of Statistics and regional forest inventories)

6.1.1 General consideration on the methodological issues

Belgium follows the methodology described in the Good Practice Guidance for Land Use, Land-Use Change and forestry (GPG LULUCF 2003) to establish the LULUCF inventory.
The LUC matrix was determined by the Gembloux University (Gembloux Agro Bio Tech), a study conducted specifically for the LULUCF reporting in Belgium [55]. 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 2003 GPG. 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 (orthophotoplans or images satellite 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 (figure 6.1). 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 orthophotoplans.

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 images 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 level. This first estimate was further refined during the 2011 submission. Last estimates by Gembloux Agrobiotech were delivered in December 2011. The matrix is now produced by the Regions; Further details are presented in section 10.2.

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.

Further details on the methodology are presented in chapter 9.2.

		1990						Total 2014	
		F	**C**	**G**	**W**	**S**	**O**		
2014	**F**	**690.2**	0.1	1.0	0.9	0.6	0.0	**725.3**	**23.8%**
	C	0.1	**957.6**	1.5	0.1	0.1	0.0	**983.0**	**32.2%**
	G	0.2	1.4	**716.9**	-0.1	0.0	0.0	**642.1**	**21.0%**
	W	-0.1	0.2	-0.1	**29.0**	0.0	0.0	**48.5**	**1.6%**
	S	0.0	-0.8	-1.1	0.0	**558.9**	0.0	**653.9**	**21.4%**
	O	24.0	24.0	24.0	24.0	0.0	**0.0**	**0.0**	**0.0%**
Total 1990	**Area (kha)**	**714.5**	**982.5**	**742.3**	**53.9**	**559.6**	**0.0**	**3053**	
		23.4%	**32.2%**	**24.3%**	**1.8%**	**18.3%**	**0.0%**		

Table 6-2 : Land Use Change matrix in Belgium (1990 and 2014) [55].

6.1.2 Trend assessment

As seen in Figure 6.1, forests are in Belgium, a major sink of carbon rather stable over time which gives 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 are also a sink while croplands become from 2006 onwards. This is in line with the new data available for carbon stock in soils (see 6.3.2.1 hereunder).

The area of settlements increased steadily since 1990 (17% growth between 1990 and 2014). This is of course only increased urbanized areas that explained this growth and the conversion from lands to settlements provoke emissions from carbon stock in soils. Other lands are no more present in the trend assessment as they were reclassified, in response to recommendation by the ERT (see section 9.2.2.3 for details).

The result of these evolutions generates negative net emissions fairly stable for the whole LULUCF in Belgium, in the range of -2000 Gg eq. CO_2 between 1990 and 2000 and in the range of -4000 Gg eq. CO_2 between 2006 and 2014 (-4018 Gg eq. CO_2 in 2014).

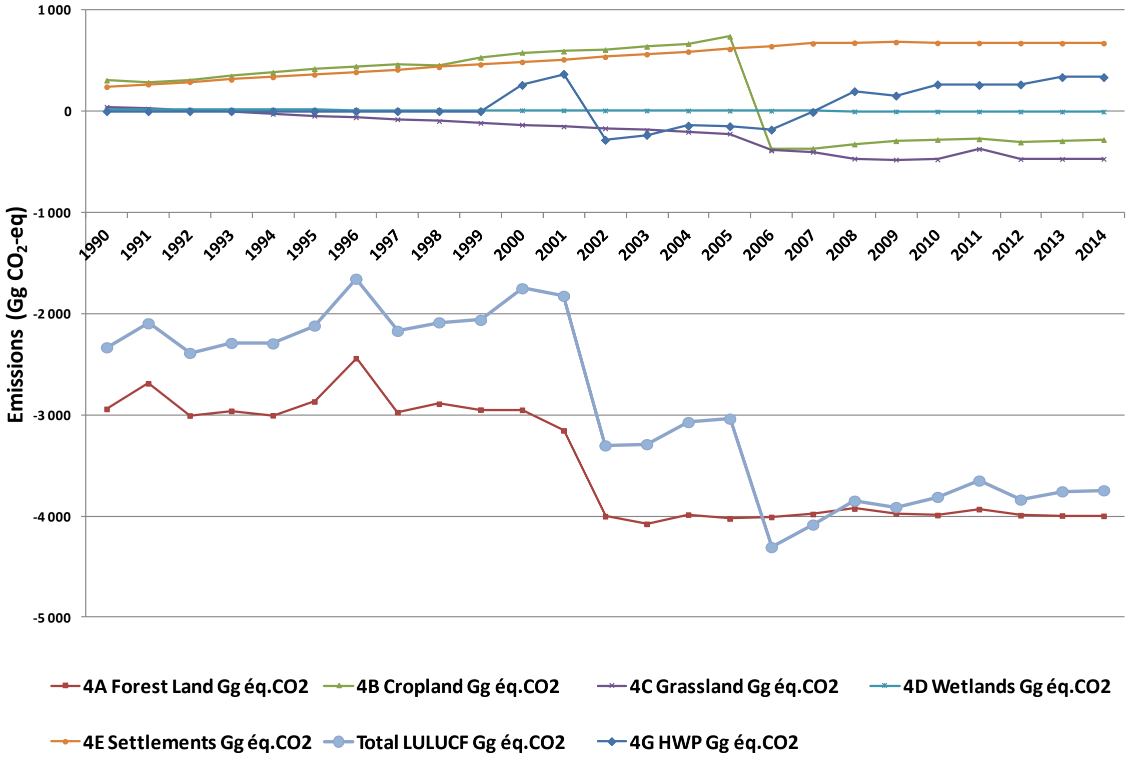


Figure 6-1 : Emission and removal trends in LULUCF sector

Emissions of N_2O and CH_4 increase steadily from 2-3% in 1990 to about 14% of total sector sources mainly because of Direct N_2O Emissions from N Mineralization/Immobilization (except in 1996 with 34.5% and 2011 with 20.3% due to large forest fires).

If we look at the compartments rather than sub-sectors (see Figure 6.2), we find there is an accumulation of carbon in living biomass relatively stable and linked to the forest. As explained above, the level of this sink is related with some methodological aspects (see 6.2.1.1). Soil carbon is also a sink relatively stable which doubles from 2006 onwards because of new data for grasslands and croplands (see 6.3.2.1). Emissions from biomass burning '5(V)' have been significant only in 1996 (+500 Gg eq. CO_2) and 2011 (+161 Gg eq. CO_2).

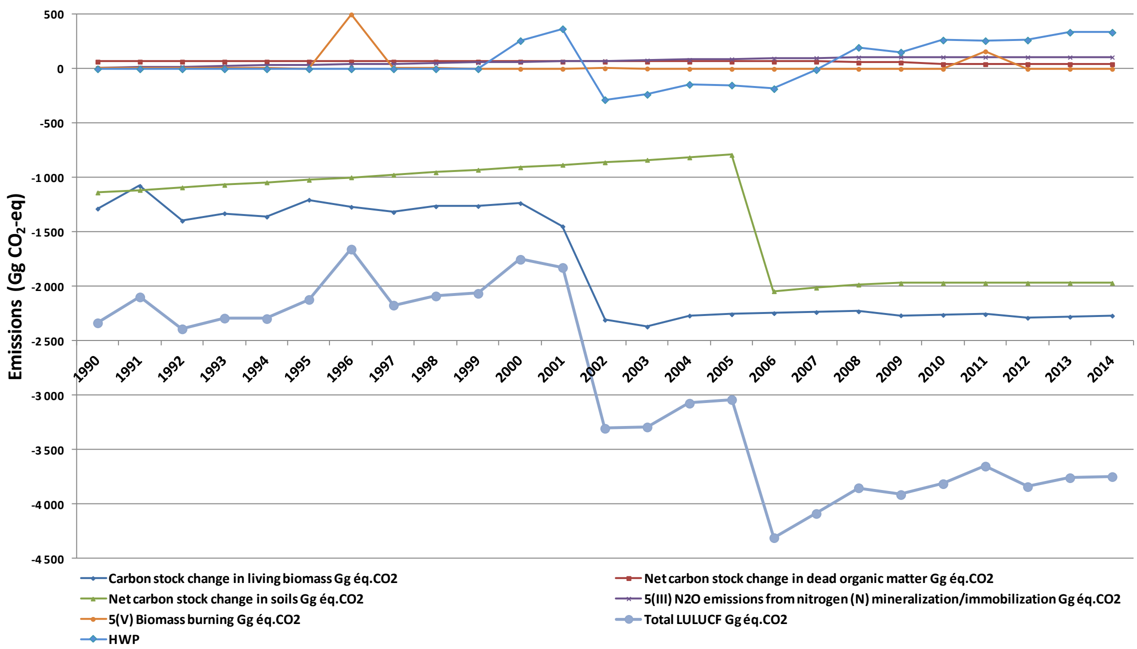


Figure 6-2 : Emission and removal trends in LULUCF compartments

6.1.3 Overall recalculations in the LULUCF-sector

In Wallonia, N2O emissions from soil mineralization were overestimated, as the calculation was also applied to land-use changes where the overall carbon stocks were increasing (e.g. conversion from cropland to forest, etc...). This has been corrected, as according to IPCC guidelines, those emissions only occur when the change in land-use leads to a net decrease of carbon in soils. This correction decreases the overall emissions from sector 5 by 115,43 kt CO_2-eq. in 2013.

Areas for the LU-matrix were updated in the three regions according to the new data available.

6.2 Forest land (CRF 4.A)

6.2.1 Source category description

This category includes all land with woody vegetation consistent with thresholds used to define forest land as described in paragraph 6.1 above. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category.

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 centre of a sampling plot. (Lecomte & Rondeux, 1994; AB&G, 2001).

Sampling plots are circular and of 10 are each. 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 7.1.). 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 (Dagnelie et al., 1999).

The first Walloon forest inventory was conducted between 1979 and 1984 (central year is 1981). The current permanent systematic sampling of the permanent forest inventory was conducted between 1994 and 2008 (central year is 2001) and covers each year 10 % of the approximately 11000 sampling points (Lecomte & Rondeux, 1994). The third cycle of the forest inventory started in 2008 and the last results include the year 2012 (central year is 2010).

In Flanders, 2665 plots were sampled in the framework of the first forest inventory, which was constituted in the period 1997-1999 (Ministerie van de Vlaamse Gemeenschap, Afdeling Bos & Groen, 2001). 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 is currently being set up, including detailed information of the first five years of the second forest inventory (around 50% of sampling data). Methods for data analysis based on the results are being investigated.

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).

With more than 13000 plots over a territory of 30528 km2, 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 (Laitat et al., 2000). In comparison, one plot represents 2400 ha of forest land in the U.S. (Brown, 2002).

6.2.2 Methodological issues

6.2.2.1 Forest land remaining forest land

A. Change in carbon stocks in living biomass

Total solid wood volumes and carbon stocks

Based on the information of the regional forest inventories (see 6.2.1), the total solid wood volumes (TSW) of each species, spread over three age classes, were calculated for Flanders and Wallonia, as given in table 6.1. Values for Belgium were calculated by summing up the Flemish and Walloon forest areas and wood volumes.

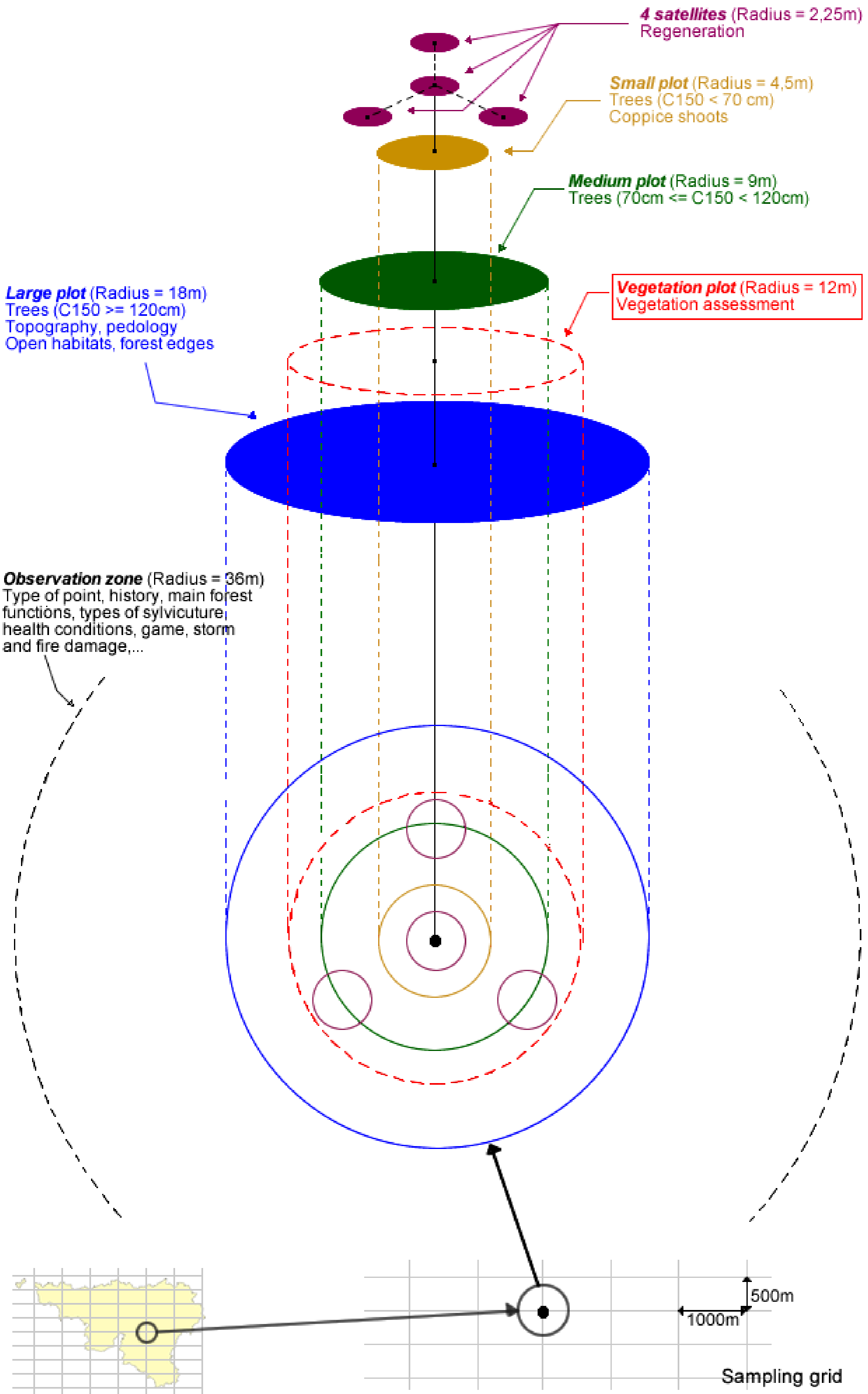


Figure 6-3 : scheme of a sampling unit and data collected (Rondeux et al*, 2005)*

Species	Wallonia 2001	Wallonia 2010	Flanders 2000
Picea abies (Norway Spruce)	53,9	50,3	0,5
Quercus petraea et Q. robur (Oaks)	26,2	28,9	3,6
Fagus silvatica (Beech)	16,9	20,4	2,4
Pinus silvestris (Scots Pine)	2,9	2,8	8,6
Populus sp (Poplars)	2,5	2,0	5,1
Betula sp (Birch)	3,5	3,9	1,4
Pinus laricio (Corsican Pine)	0,4	0,4	3,9
Fraxinus excelsior (Ash)	3,5	4,5	0,4
Larix sp (Larch)	2,6	2,8	0,8
Pseudotsuga menziesii (Douglas fir)	4,8	7,1	0,4
Other species	9,9	13,7	4,5
Total	**127,1**	136,8	**31,7**

Table 6-3 : Volume per species in the forest inventories. Years 2001 and 2010 for Wallonia and year 2000 for Flanders (TSW in Mm^3)

The calculation of the amount of carbon stored in the biomass of trees is based on biomass expansion factors, applying equation 3.2.3 of the IPCC LULUCF GPG (2003). 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 Wallonia are those used for the 2010 Forest Resource Assessment of the FAO.

Species	BEF 2 Biomass expansion factor	R Root to shoot ratio	Basic Wood density	Carbon fraction of dry matter
Picea abies (Norway Spruce)	1,3	0,2	0,40	0,5
Quercus petraea et Q. robur (Oaks)	1,39	0,3	0,6	0,5
Fagus silvatica (Beech)	1,42	0,23	0,58	0,5
Pinus silvestris (Scots Pine)	1,23	0,2	0,42	0,5
Populus sp (Poplars)	1,40	0,23	0,35	0,5
Betula sp (Birch)	1,29	0,23	0,52	0,5
Pinus laricio (Corsican Pine)	1,23	0,2	0,42	0,5
Fraxinus excelsior (Ash)	1,29	0,23	0,52	0,5
Larix sp (Larch)	1,30	0,2	0,45	0,5
Pseudotsuga menziesii (Douglas fir)	1,29	0,2	0,46	0,5
Other deciduous	1,40	0,2	0,55	0,5
Other coniferous	1,40	0,2	0,55	0,5

Table 6-4 : Conversion factors used to derive forest inventory data for deciduous and coniferous forests in Wallonia (Laurent, Lecomte, pers. com., 2010)

Changes in carbon stock

As the complete results of the second permanent inventory cycle are available in Wallonia, since the 2010 submission the evolution of the carbon stock is based on the stock change method for the full time series. The results of the first 5 years of the 3rd cycle are also used. Central years for the 3 cycles are 1981, 2001 and 2010 (see 6.2.1). See Tables 6.3 and 6.4 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 6.3 (volumes), large changes were observed in Wallonia for the main species between 2001 and 2010, 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 2010. Annual changes in carbon stocks are calculated using equation 2.8 of the 2006 IPCC GL (formerly equation 3.2.3. from the IPCC GPG on LULUCF), with t1 and t2 being respectively 1981-2001 and 2001-2010. Stock change approach is recommended when very accurate forest inventories are carried out (GPG page 3.25), and this is the case in Wallonia as mentioned in section 6.2.1.

In Flanders, as the results of the 2nd Forest inventory cycle are not yet available, the carbon stock change method cannot be applied. For this reason, the default IPCC methodology is used, applying equation 3.2.2. of the IPCC GPG on LULUCF (growth/increment minus losses/harvest). The implied C-uptake factors for the different tree species are taken over from the Walloon inventories (average increment) and optimized to the Flemish situation (weighted average following the distribution in Flanders). Annual increase in carbon stocks is calculated applying equation 3.2.4. of the IPCC GPG, with two values of average annual increment for respectively coniferous and deciduous species.

The Flemish region plans to use the stock change approach in the future when the results of the 2nd Flemish Forest inventory become available. Currently, a database system is being set up including detailed information of the first five years of the second forest inventory (around 50% of sampling data). Methods for data analysis based on the results are being investigated.

In Brussels-Capital region, the emissions and removals were estimated by applying the annual biomass increment data and soil carbon data observed in beech forest of Wallonia (75% of the Brussels forest is beech) to the total forest area of the Brussels-Capital region determined by the study by Gembloux and applying equation 3.2.2. of the IPCC GPG on LULUCF. 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, although region-specific methodology is foreseen in the future if the necessary data become available.

The annual increments and harvest are presented in table 6.5 and 6.6. 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)	14,7
Quercus petraea et Q. robur (Oaks)	3,5
Fagus silvatica (Beech)	6,9
Pinus silvestris (Scots Pine)	13,3
Populus sp (Poplars)	4,6
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	13,5
Average deciduous	4,7

Table 6-5 : Annual increment for different tree species (based on Walloon Forest Inventories)

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
3 237	3 298	2 664	3 507	4 914	4 858	4 443	4 159	3 982	4 047	3 927	3 777	4 206	5 128

Table 6-6 : Historical harvest rate as reported in the Belgian Forest Resources Assessment Report 2015, in 1000 m³ (http://www.fao.org/forestry/fra/fra2015/en/).

The table 6.7 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 6-7 : confidence interval associated with the volume estimation per species (2000 forest inventory in Flanders, 2001 inventory in Wallonia).

B. Carbon in dead organic matter

The definition of deadwood applied in the inventory's methodology is all standing dead trees and fallen logs and branches. A dead tree is considered as fallen when it tilts at a vertical angle equal or superior to 45°. Veteran trees are taken into account in the living trees section.
The objectives of the collection of deadwood information consist in estimating the volume of standing dead trees and fallen logs and branches, contributing to the estimation of the carbon-stock in Wallonia's forests and estimating biodiversity indicators throughout the importance of deadwood.
The collecting method varies according to the type of deadwood.
Entire dead trees (snags) and broken dead trees (candles) are both taken into account by the inventory. Trees of different sizes are taken into account in each circular plot according to the same rules as for living trees. This means that a standing dead tree is included in a circular plot according to its circumference. Dead trees under 20 cm of circumference are not taken into account (threshold of the inventory).
Fallen logs and branches are taken into account in a circular plot for which the size varies depending on the average circumference (C average) of the living stand. If the unit is located in a clear cut, clearing or impenetrable stands for which no stand measurements are performed, downed deadwood is taken into account in the 9m plot. Logs of at least 1 m long and 20 cm circumference are considered by the Inventory and their volume is estimated by volume functions. Crown (logging residue) is also taken into account (as deadwood) if it is 3 years old. Logs and branches inferior to 20 cm circumference are taken into account by the Inventory and their volume is considered by visual estimation.
For the carbon in deadwood pool, the forestry practices evolve according two contradictory tendencies: increased harvest of the residues in the zones without important constraint of biological

conservation (i.e. bio-energy) and more deadwood left in forest in the zones where dominating conservation of the biodiversity (zones Natura 2000, which represent more than 30% of forest area).

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)[N. Latte, in 55].

For the carbon in litter pool, the values were also updated using the same study as for deadwood. The litter C stock is assumed stable over the period, with 7,56 t C/ha.. Consequently, no variation of the C stock for this category has been calculated.

For both deadwood and litter, consistent with IPCC guidelines under Tier 1 (page 3.33 and 3.34 of the IPCC GPG on LULUCF) the carbon stock per area is assumed stable over time, with inputs balanced by outputs. Hence, the only variation over time is due to the changes of the areas of forest land, multiplied by the country specific carbon stocks values presented above.

C. Soil organic carbon in soils

The soil organic carbon in Wallonia was recalculated by Latte et al. in 2011 in the framework of the study by Gembloux University (Gembloux Agro Bio Tech)[N. Latte, in 55]: the mean carbon content in forest soils (0-30 cm) is estimated at 110 t C/ha in 2000, compared to 96 t in a previous estimate from 2005. The 1960 figure has also be revised in Wallonia, following a comparable approach. This results in a lower annual carbon removal in forest soil than in previous estimates.The SOC evolution between 1990 and 2000 is estimated at 0,55t C /ha.yr in Wallonia (Gembloux Agro Bio Tech, in [55] and personnal communication) and 0,425 t C/ha.yr in Flanders, where the organic content in forest soils is generally lower than in Wallonia (Lettens et al., 2005).

Soil carbon estimates in cropland an grassland are described in chapter 6.3.

The average carbon stocks in 2000 are given in table 6.8

Carbon stocks in soil (t C/ha)	Wallonia & Brussels	Flanders
A. Forest Land	110	89,5
B. Cropland	44	52
C. Grassland	88	86
D. Wetland	100	100
E. Settlements	48	48
F. Other land	48	48

Table 6-8 : Average carbon stocks in soils (t C/ha, 0-30 cm) in 2000.

D. N_2O emissions from fertilization and drainage (Categories 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 (2008, see http://wallex.wallonie.be/index.php?doc=11597) 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.

E. N_2O emissions from N mineralisation associated with the loss of soil organic matter (4.A.2.)

N2O Emissions are caused by two sources: nitrogen fertilization and mineralisation of soil organic matter. Only the emissions linked with the mineralization of organic matter are considered here, as emissions from nitrogen fertilization are estimated under agriculture sector. Emissions from mineralisation of organic matter in cropland remaining cropland are reported under Agriculture (sector 3.D.1.5). Emissions from all other land uses or changes of land use are reported under LULUCF, sector 4(III). Emissions are caused by the nitrogen cycle, intimately linked to carbon cycle.

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.

$F_{SOM} = \Delta C_{Mineral,LU} * 1/R * 1000$

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 average loss of soil carbon (Gg C) is calculated using the formula:
annual loss of soil carbon (Gg 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 19,25 for forest (based on measurements conducted within the Walloon forest inventory) and default IPCC values of 15 for grassland and 10 for cropland. For wetlands and settlements, the same C/N ratio of 10 was used

Based on FSOM, N2O emissions were calculated using the IPCC default value for the implied emission factor of 0.01 kg N2O-N/kg N.

N2O 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.

F. Emissions from wildfires (Category 4.A.1)

Emissions from fires are calculated using the current available data, which cover the period 1990-2013.

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 (2008, see http://wallex.wallonie.be/index.php?doc=11597, and
http://www.natuurenbos.be/nl-BE/Natuurbeleid/Bos/Wetgeving_en_vergunning/Bosdecreet.aspx.

Areas affected by wildfires in Belgium are extremely variable from one year to another. On average, 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.

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 3.2.9 of the IPCC GPG on LULUCF was applied for CO_2 emissions, using country specific average biomass stock as calculated in section A above and the default value of 0,1 for f_{BL} (table 3A.1.11, temperate intensively managed forests). . Default IPCC factors (table 3.A.1.15) were used to calculate the emissions of other air pollutants applying equation 3.2.19 of the IPCC GPG on LULUCF. A distinction was made between forest land and grassland, as some recent fires mostly occurred on areas without trees. For the latter, a value of 11,5 t DM /ha is used (table 3.A.1.13, Shrublands/Calluna).

6.2.2.2 Land converted to forest land

The areas of land converted to forest land are estimated following the methodology described in chapter 6.1.1.

Changes in carbon stocks in living biomass on land converted to forest are estimated using equations 3.2.25, 3.2.23 and 3.2.24 of the IPCC GPG LULUCF.

The annual increase in carbon stocks in living biomass due to growth in land converted to forest land (G in equation 3.2.24) 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.

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 (delta $C_{LF\ conversion}$ in equation 3.2.25) 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 21,7 t C/ha was considered for carbon stock in living biomass in orchards (Pessler Christiane, Carbon Storage in Orchards, Master / Diploma Thesis - Institut für Waldökologie (IFE), BOKU-Universität für Bodenkultur, pp 105, 2012. https://zidapps.boku.ac.at/abstracts/download.php?dataset_id=10179&property_id=107). This is the only estimate found for the time being, in a country where the orchard seem comparable. No default value is provided in the IPCC guidelines and no country specific value was found. These percentages and average carbon stocks were then multiplied by the annual area of cropland converted to FL.

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.

The estimates of the soil C stock changes of land use change areas to forest land is calculated according to equation 3.2.31 of the IPCC GPG on LULUCF, assuming a 20 years duration of the transition from $SOC_{Non\ Forest\ Land}$ to SOC_{Forest} .

Consistent with Tier 1 presented in IPCC GPG on LULUCF, section 3.2.2.2.1.2, page 3.59, it is assumed that carbon stocks in litter and deadwood of non-forest land converted to forest land are stable. Consequently, “NO” was reported. As carbon stock of dead wood in forest land is higher than those in other land uses in Belgium, Belgium applies conservative Tier 1 method for this carbon pool in AR activity. The same rationale (higher litter in forest) is applicable for litter.

6.2.3 Uncertainties and time-series consistency

A Tier 1 uncertainty analysis for the LULUCF sector is performed since the 2012 submission. The uncertainties on areas were determined by the study on land-use change [55]. The uncertainty on total areas is 2% for forest land, grassland and settlements, 1% for cropland, 8% for wetlands and 15% for other lands. The uncertainty on total solid wood volume is estimated by the regional forest inventory (personal communication), and varies from 1.6 to 12.4 % depending on tree species. Uncertainties of conversion factors were taken from the IPCC GPG on LULUCF. The uncertainty on SOC is estimated at 63% for forest soils (Lettens et al, 2008) and 29% and 33% for cropland and grassland (Goidts , 2009). SOC uncertainty on other land use was estimated at 100%.

Uncertainties were combined using equations 6.3 and 6.4 of the IPCC Good Practice Guidance and taking into account the recommendations of chapter 5.2 of the IPCC GPG for LULUCF.

Uncertainties on N_2O and CH_4 emissions from biomass burning are estimated following default values proposed for N2O in the IPCC GPG on LULUCF, namely 30% for AD (area burned, which are all measured by the forestry service, given the small occurence of fires) and 70% for EF.

6.2.4 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 [73].

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

- Update of areas in the three regions following last data available (2008-2014).
- In Wallonia, N2O emissions from soil mineralization were overestimated, as the calculation was applied to land-use changes where the overall carbon stocks were increasing (e.g. conversion from cropland to forest, etc...). This has been corrected, as according to IPCC guidelines, those emissions only occur when the change in land-use leads to a net decrease of carbon in soils. This correction decreases the overall emissions from sector 5 by 115,43 kt CO2-eq. in 2013.
-In Wallonia, new data on land-use regarding cropland and grassland for the year 2014 were made available on March 3, 2016. These data are integrated in the June 15th, 2016 submission

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

- Changes in Carbon stock in living biomass: the Flemish region will investigate the possibility to use the stock change approach, based on the preliminary results (50% of sampling data) of the 2nd Flemish Forest inventory. A database containing detailed information is currently being developed and methods for data analysis are being investigated.

6.3 Cropland and grassland (CRF 4.B and 4.C)

6.3.1 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.

Grasslands includes rangelands and pasture land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold used in the forest land category and are not expected to exceed, without human intervention, the threshold used in the forest land category.

6.3.2 Methodological issues

6.3.2.1 Cropland remaining cropland and grassland remaining grassland

A. Change in carbon stocks in living biomass

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 are estimated assuming an average carbon stock of 21,7 t C/ha for carbon stock in living biomass in orchards, using data from a study in Austria (Pessler Christiane, Carbon Storage in Orchards. Master / Diploma Thesis - Institut für Waldökologie (IFE), BOKU-Universität für Bodenkultur, pp 105, 2012. https://zidapps.boku.ac.at/abstracts/download.php?dataset_id=10179&property_id=107). This is the only estimate found for the time being,in a country where the orchard seem comparable.No default value is provided in the IPCC guidelines and no country specific value was found. The carbon stock is assumed stable overtime, as tree growth is balanced by trimming of the fruit trees Given that the overall orchard area increased significantly since 1990 (fig 6.4), this subcategory is a net sink over time.

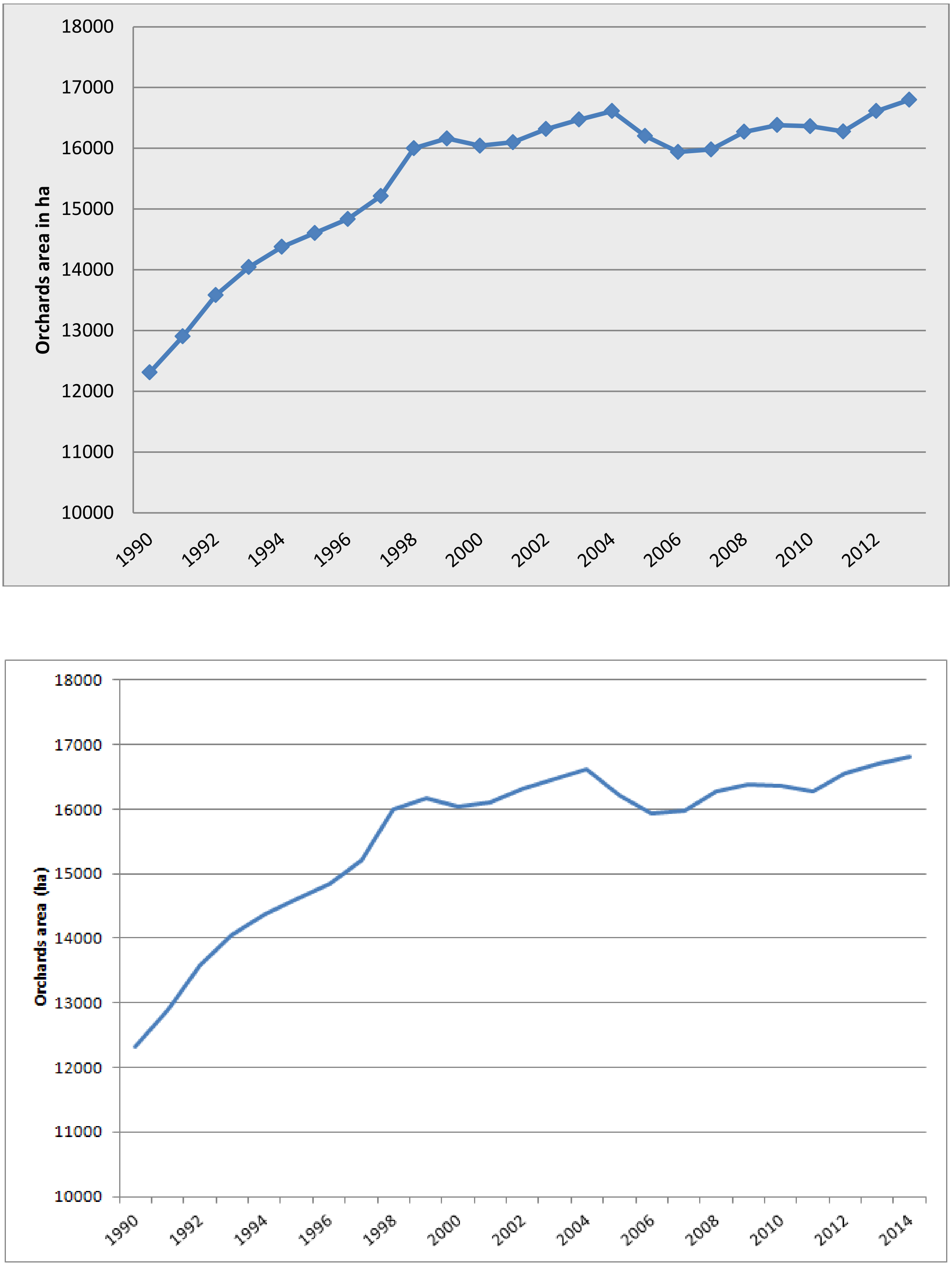


Figure 6-4 : Orchard area in Belgium, according to the agricultural census (1990-2014).

B. Change in carbon stocks in soils

Change in carbon stocks in soils are estimated using equations 3.3.2 and 3.4.7 of the IPCC GPG on LULUCF. The methodology for mineral soils and organic soils is detailed hereunder. Emissions from lime application are presented under section D below.

Mineral soils

Each region applies equations 3.3.3 and 3.4.8 to estimates changes in carbon stocks. The source of data regarding soil carbon content is explained below. The average carbon stocks in 2000 are given in table 6.8 (section 6.2.2.1)
.
The Belgian territory was divided into landscape units (LSU) by the topological intersection of the 1990 version of the Corine Land Cover (CLC) geo-dataset (European Commission 1993) and the digitized Soil Association map of Tavernier et al. (1972). The CLC geo-dataset has been produced by manual digitization of printed LANDSAT-images, taking into account a minimal mapping unit of 25 hectares. The 34 of the 44 possible classes of the original legend that occur in Belgium were aggregated into the 11 broader classes: (i) cropland, (ii) grassland (both permanent and temporary), (iii) broadleaf forest, (iv) coniferous forest, (v) mixed forest, (vi) fallow land, (vii) heath land, (viii) inland marshes, poplar in pasture, rush and reed vegetation, (ix) clay pits, mineral extraction sites and excavated soils, (x) peat bogs, (xi) not specified. The Soil Association map (1:500,000) represents broad zones with similar topsoil texture and drainage conditions in 64 soil associations. The overlay of both geo-datasets resulted in 567 landscape units (LSU), each characterized by one soil association and one land use class, scattered over 101,376 polygons.

Flanders
The methodology uses the stock change method for estimating CO_2 fluxes from the LSUs i.e. soil organic carbon (SOC) stocks of different years are compared. It is assumed that the per-LSU and total CO_2 flux is equal to the observed change in SOC stock in CO_2 equivalents over a certain time span and that the per-LSU-fluxes can be aggregated to yield total fluxes at regional or national levels. SOC stocks for LSUs are computed for the years 1960, 1990 and 2000. The SOC estimations are based on a number of heterogeneous databases and modelling efforts. Three cases can be distinguished when computing per-LSU SOC values.
When elementary point measurements are available, they are attributed to the LSU in a process called matching (Van Orshoven et al., 1993). Through matching, points are attributed to the LSU either based upon their location within the boundaries of the LSU ('geomatching') or based upon corresponding soil and land use characteristics as the LSU ('class matching'). Class matching may be completely independent of the point’s location. In our approach class matching was restrained by stratification by soil association.
With regard to agriculture, a number of data sources provide an average SOC-percentage per municipality or other type of administrative unit. These data can be considered to be indirectly geo-referenced to the administrative units, functioning as alternative LSUs (further termed ALSU) that do not correspond spatially with the LSUs to which we want to attribute the data. Therefore, the measurements are first disaggregated to the intersection of the ALSU and the LSU and then re-aggregated to the LSU.

The soil C values in mineral soils (0-30cm) for cropland and grassland have been updated in 2015, through a new study by Dr. Meersmans (Meersmans, 2015, based on Meersmans et al., 2011) [79]. In the previous submission, the factors used for SOC evolution were -0,44 ton/ha/year for cropland and -0,81 ton/ha/yr for grassland. These relatively large assumed annual losses of carbon from mineral soils resulted in substantial estimated emissions from mineral soils in cropland remaining cropland and grassland remaining grassland. Following the recommendations by the UNFCCC expert review team and after consultation with Flemish soil experts, these values have now been reviewed. The new values used in the calculations are summarised in table 6.x below.

	SOC mass per surface unit (ton/ha)		*SOC changes (ton/ha/yr)*
Land use	1960	2006	***2006-1960***
cropland	54,59	53,87	***-0,016***
grassland	74,57	73,70	***-0,019***

Table 6.x. 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 (Meersmans, 2015, based on Meersmans et al., 2011).

Compared to the previous submission, the use of these new factors has resulted in significantly lower (and more realistic) emissions from cropland remaining cropland and grassland remaining grassland for the entire time series 1990-2013 in the Flemish Region.

Wallonia

In Wallonia, the data come from a study [56][57], entitled 'Soil organic carbon evolution at the regional scale ».The study area covers the Walloon region and was stratified into landscapes unit (LSU) based on the following criteria: the agricultural land use (cropland or permanent grassland), the agricultural region, and the soil type (soil texture and drainage). For each LSU, the SOC stock was available from the National Soil Survey (NSS) undertaken in Belgium between 1950 and 1970. In a first campaign, soil profiles of the 9 LSU having the highest potential for SOC change detection were re-sampled (LSU 1 to 9 sampled between Augustus 2004 and Augustus 2005). In order to improve the analysis of the SOC evolution and to initiate a SOC stock monitoring network of agricultural soils (so called \CARBOSOL'), new field campaigns were conducted for 6 additional LSU (LSU 10 to 15 sampled between October 2006 and May 2007).

About 54% of the agricultural area is covered by the 15 LSU's having on average 28 soil profiles each (i.e. a sampling density of 0.03 plots/ km²). Theses soil profiles have not undergone any land use change since the NSS, and the SOC stock change in the soil surface (i.e. the plough layer for cropland and the 0-30 cm layer for grassland) was estimated for each one based on equivalent mass to correct for changes in the soil bulk density or in the rock fragment content. [56][57] The soil C values have been updated in 2015, through a new study Carbiosol

Land Unit	Number of samples	1955 - 2005		2005 - 2013		1955 - 2013	
		ΔCOSst (tC.ha-1)	rΔCOSCst (tC.ha-1.year-1)	ΔCOSst (tC.ha-1)	rΔCOSCst (tC.ha-1.year-1)	ΔCOSst (tC.ha-1)	rΔCOSCst (tC.ha-1.year-1)
Cropland	42	* -4.2	-0.08	4.9 **	0.61	0.7	0.01
Grassland	19	* 2.6	0.05	1.3	0.16	3.9	0.07

Table 6-9 : Wallonia, Soil carbon variation – Carbiosol study. CARBIOSOL [Carbiosol - Chartin C., Kruger I., Stevens A, Bas Van Wesemael B., Carnol M. Janvier 2015. Carbone organique, biomasse et activité microbienne des sols: Vers un indicateur de la qualité des sols en Wallonie"]
]

* Significant (P < 0.05); ** highly significant (P < 0.01)

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 s 3.3.5 and 3.4.10 of the IPCC GPG on LULUCF. Default IPCC emission factors from tables 3.3.5 and 3.4.6 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).

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. The EF are applied on these area of grassland in Wallonia.

C. Emissions from wildfires (Category 4.C.1)

Emissions from fires are calculated using the current available data, which cover the period 1990-2013.

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 (2008, see http://wallex.wallonie.be/index.php?doc=11597, and http://www.natuurenbos.be/nl-BE/Natuurbeleid/Bos/Wetgeving_en_vergunning/Bosdecreet.aspx).

Areas affected by wildfires in Belgium are extremely variable from one year to another. On average, the occurrence of fires is low, given the usually wet and cool Belgian climate. Fires do no occur every year, therefore notation key "NO" is used for years where no fire has been observed.

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 3.2.9 of the IPCC GPG on LULUCF was applied for CO_2 emissions, using country specific average biomass stock as calculated in section A above and the default value of 0,1 for f_{BL} (table 3A.1.11, temparate intensively managed forests). Default IPCC factors (table 3.A.1.15) were used to calculate the emissions of other air pollutants applying equation 3.2.19 of the IPCC GPG on LULUCF. A distinction was made between forest land and grassland, as some recent fires mostly occurred on areas without trees. For the latter, a value of 11,5 t DM /ha is used (table 3.A.1.13, Shrublands/Calluna) as most fires occured in natural reserves.

D. N_2O emissions from N mineralisation associated with the loss of soil organic matter (4.B;2, 4.C.2 .)

6.3.2.2 Land converted to cropland or grassland

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 is 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.

The estimates of the soil C stock changes of land use change areas to grassland or cropland is calculated according to equation 3.3.12 of the IPCC GPG on LULUCF, assuming a 20 years duration of the transition from $SOC_{previous}$ land use to $SOC_{grassland\ or\ cropland}$.

N_2O emissions from disturbance associated with land-use conversion to cropland

N2O Emissions are caused by two sources: nitrogen fertilization and mineralisation of soil organic matter. Only the emissions linked with the mineralization of organic matter are considered here, as emissions from nitrogen fertilization are estimated under agriculture sector.

Two parameters are taken into account in equations 11.8 from 2006 IPCC Guidelines: FE1 = 0,0125 kg N2O -N/kg N and C/N ratio of the converted land. Emissions are caused by the nitrogen cycle, intimately linked to carbon cycle. The C/N ratio are 19,25 for forest (based on measurements conducted within the regional forest inventory) and default IPCC values of 15 for grassland and 10 for cropland.

N2O emissions are calculated for all conversions to cropland. However, if the conversion to cropland 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 for settlements and other lands, where the Soil C was estimated similar to the cropland soil C.

Please also refer to section 6.2.2.1.E for additional information.

6.3.3 Uncertainties and time-series consistency

See paragraph 6.2.3.

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 proposed for N2O in the IPCC GPG on LULUCF, namely 30% for AD (area burned, which are all measured by the forestry service, given the small occurence of fires) and 70% for EF.

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.

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

Source-specific QA/QC and verification is planned for the next submission.

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

In Wallonia, N2O emissions from soil mineralization were overesestimated, as the calculation was applied to land-use changes where the overall carbon stocks were increasing (e.g. conversion from cropland to forest, etc...). This has been corrected, as according to IPCC guidelines, those emissions only occur when the change in land-use leads to a net decrease of carbon in soils. This correction decreases the overall emissions from sector 5 by 115,43 kt CO2-eq. in 2013.

Emisisons from liming are now reported under the agricultural sector

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

- In Wallonia, new data on land-use regarding cropland and grassland for the year 2014 were made available on March 3, 2016. These data will be used to update the land-Use Matrix as soon as possible. Belgium will strive to include these changes in the April 15th, 2016 submission.

6.4 Wetland, settlement and other lands (CRF 4.D, 4.E and 4.F)

6.4.1 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 GPG 2003.

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 NIR chapter 10.2.2.1. 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.

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.

6.4.2 Methodological issues

Wetlands

The areas of land converted to wetland are estimated by the study described in chapter 7.1.1.

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.

The estimates of the soil C stock changes of land use areas converted to wetland is calculated according to equation 3.2.31 of the IPCC GPG on LULUCF, assuming a 20 years duration of the transition from $SOC_{\text{Non Wetland}}$ to SOC_{wetland}

The SOC of peat land was estimated at 100 t C/ha by Van Wesemael (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.

Settlements and other lands

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.

Emissions from soil carbon for forest land converted to settlements and for forest land converted to other lands are calculated using the tier 2 method, using a transition period of 20 years, as in other land-use changes.

In the absence of default values in the IPCC guidelines, average soil carbon content under settlements and other lands was estimated at 48 t C/ha. 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 settlement 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 mainly covered by concrete. This is consistent with appendix 3.a4.1.1 of the IPCC GPG on LULUCF which states ‘When estimating emissions for settlements, it is assumed that changes in carbon stocks occur only in tree biomass’.

Finally, no more areas are reported under other lands, as these were reclassified (see 10.2.3)

N_2O emissions from N mineralisation associated with the loss of soil organic matter (4.D.2, 4.E.2 .) :

Please refer to section 6.2.2.1.E. and section 6.3.3.2.

6.4.3 Uncertainties and time-series consistency

See paragraph 6.2.3.

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

Source-specific QA/QC and verification is planned for the next submission.

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

In Wallonia, N2O emisisons from soil mineralization were overestimated, as the calculation was applied to land-use changes where the overall carbon stocks were increasing (e.g. conversion from cropland to forest, etc...). This has been corrected, as according to IPCC guidelines, those emissions only occur when the change in land-use leads to a net decrease of carbon in soils. This correction decreases the overall emissions from sector 5 by 115,43 kt CO2-eq. in 2013.

In Wallonia, new data on land-use regarding cropland and grassland for the year 2014 were made available on March 3, 2016. These data are integrated in the June 15th, 2016 submission.

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

7 WASTE (CRF 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 (33.1 million tons or 48% of all waste produced in 2012) and the construction sector (24.6 million tons or 36% in 2012)[16].
Regarding municipal waste, the total volume collected amounted to 4.89 million tons in 2014, which corresponds to 438 kg per inhabitant. In 2014, the recycling rate was 34% and the incineration rate was 45%, in most cases with energy recovery[17]. 21% of the collected municipal waste was composted (organic waste).

The waste policy in Belgium evolved during the past 25 years 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 waste are defined in the report MiNa [Flemish Environmental Policy Plan 2011-2015]. 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 Wallonia waste plan 'Horizon 2010', adopted in 1998, contains a series of 70 actions targeted on the prevention, the recycling and the recovery of energy, and the elimination of waste.

In Brussels-Capital Region, the 4th version of the "Waste Plan" has been launched in 2010. According to the 2008/98/CE Directive, the new plan implements a 5-steps waste management approach : prevention > (preparation for) reuse > recycling > valorisation > elimination. The plan is evaluated every 5 years (first evaluation in 2013)[18].

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.

[16] http://statbel.fgov.be/fr/statistiques/chiffres/environnement/dechets/production/ - These data are collected every 2 years. The most recent data available relate to 2012
[17] http://statbel.fgov.be/fr/statistiques/chiffres/environnement/dechets/municipaux/
[18] http://www.environnement.brussels/thematiques/dechets-ressources/action-de-la-region/plan-dechets

Regarding wastewater handling, more than 70% of the population was connected to a public wastewater treatment plant in 2008, and the total capacity of public wastewater treatment plants was around 10 million inhabitants-equivalents[19].

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 region.

Regarding waste incineration, the emissions from municipal waste incineration plants working with energy recovery are allocated under category 1A1a.

7.1.3 Trend assessment

GHG emissions from waste (excluding waste incineration with energy recovery) accounted for 1.60% of total national emissions in 2014, compared to 3.04% in 1990. This decrease is mainly due to CH_4 emissions from solid waste disposal on land, which represents 58% of total emissions from the waste sector in 2014. 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. Emissions in solid waste disposal on land have dropped by 65% in 2014 since 1990.

[19] http://statbel.fgov.be/fr/statistiques/chiffres/environnement/eau/pollu/

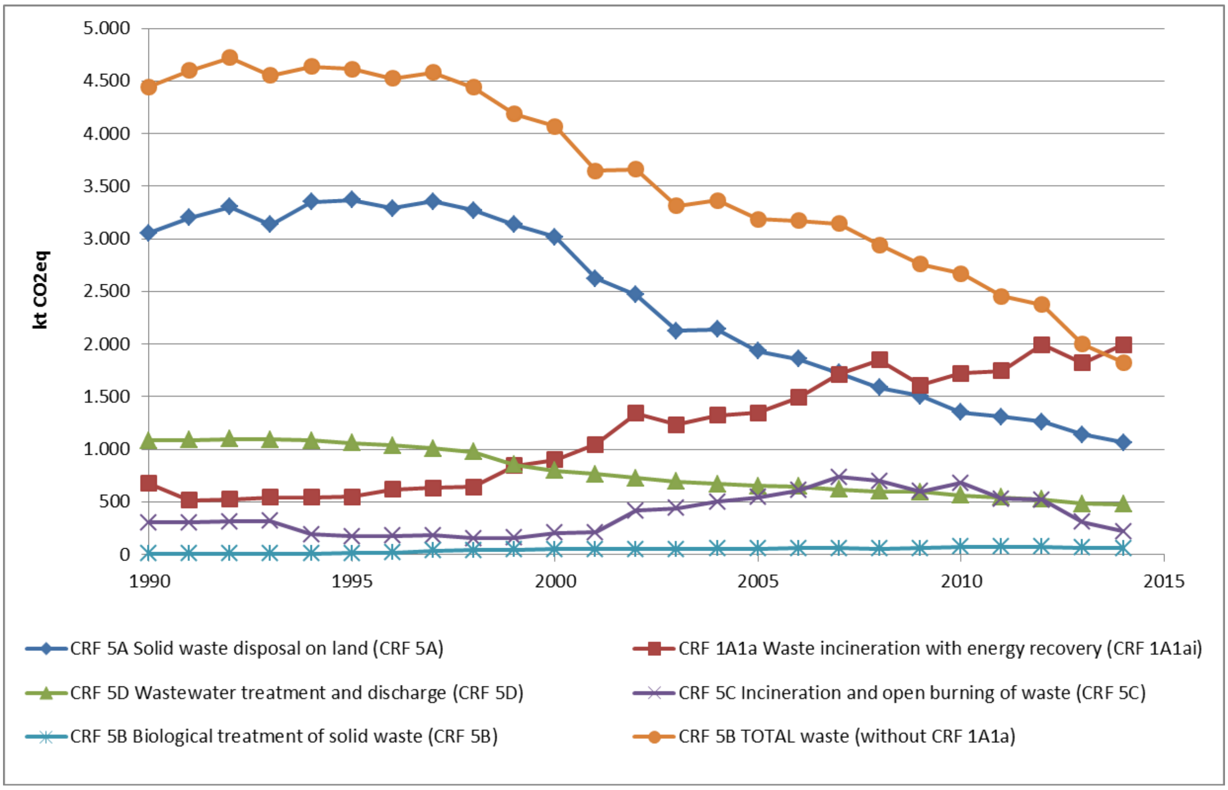


Figure 7-1 : Emission trends (1990-2014) in the waste sector (CRF 5), and non-biogenic GHG emissions from MSW incineration (CRF 1A1ai)

The remaining 42% of GHG emissions stems from three sources: waste incineration, wastewater handling and composting. Emissions from waste incineration in this sector covers mainly flaring (and after-combustion) activities in the chemical industry while emissions of municipal waste incineration without energy recuperation decrease significantly. Hospital waste is also included following the IPCC guidelines till 2004. Emissions of municipal waste incineration are thus mainly allocated in the energy sector as almost all the municipal waste incineration plants are also electricity producers (except for some plants in the beginning of the nineties). However, the non-biogenic CO_2 emissions from the municipal solid waste incineration with energy recovery are added in fig 7.1 to give a complete overview of the greenhouse gas emissions of the waste sector (kton CO_2 eq).

7.1.4 Overall recalculations in the waste sector

The table below shows the recalculations between the submissions 2015 and 2016 in the waste sector in Belgium.

In the Flemish region some missing emissions of CO_2 from flaring activities in the chemical sector were added for the years 1990-2001 in the category 5C1.2b1 (flaring in chemical industry) during this 2016 submission. Besides a the activity data (composting amouts) in category 5B were actualized for the year 2013 an consequently also the emissions.

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flemish region	%	0,44	0,69	1,41	0,00	0,00	0,00	0,00	-0,08
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	%	0,27	0,43	0,92	0,00	0,00	0,00	0,00	-0,05

		1990	1995	2000	2005	2010	2011	2012	2013
Brussels region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flemish region	Gg CO2 eq.	12,11	19,80	36,95	0,00	0,00	0,00	0,00	-1,10
Walloon region	Gg CO2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	Gg CO2 eq.	12,11	19,80	36,95	0,00	0,00	0,00	0,00	-1,10

7.2 Solid Waste Disposal (CRF 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 Region.

No CO_2 emissions are reported in the CRF 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 applied 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 Walloon Region, 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 used the IPCC Waste Model spreadsheet. The choice of emission factors and parameters was 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 as far back as 1950 were estimated using IPCC default methods in both regions.
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

Region and Climate zone

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: 1950.

DOC_f (fraction of DOC dissimilated)

The recommended IPCC default value for DOC_f was used: 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.

The IPCC default value of 0 for managed (but not covered with aerated material), unmanaged and uncategorised SWDS was used for the oxidation factor (OX).

Amounts of waste deposited

The IPCC 2006 Waste model requires historical data as far back as 1950. 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) in combination with the IPCC default values for waste generation and % of waste which goes to SWDS.

From 1970 onwards, country-specific data are available on the amounts of MSW, industrial waste, inert wastes and sludge deposited (study conducted by the VITO [71] 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 (kton, including inert wastes and sludge) at SWDS in the Flanders and Walloon region since 1990. The evolution for Belgium is shown in figure 7.2.

	MSW			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
1991	959	1 248	2 208	1 131	1 385	2 516	2 090	2 633	4 724
1992	1 006	1 264	2 271	1 422	1 392	2 815	2 429	2 657	5 085
1993	955	1 275	2 230	1 436	1 333	2 770	2 391	2 608	5 000
1994	909	1 314	2 224	1 453	1 428	2 881	2 362	2 743	5 105
1995	963	1 303	2 267	1 280	1 345	2 625	2 243	2 648	4 892
1996	870	1 274	2 144	1 112	1 135	2 247	1 982	2 409	4 391
1997	694	1 079	1 772	968	1 254	2 222	1 662	2 333	3 994
1998	543	969	1 513	888	1 187	2 075	1 431	2 156	3 588
1999	502	907	1 409	937	1 238	2 175	1 439	2 145	3 584
2000	284	873	1 157	1 071	1 068	2 139	1 354	1 941	3 295
2001	192	797	990	971	1 075	2 046	1 163	1 873	3 036
2002	163	687	850	677	1 197	1 875	841	1 884	2 725
2003	170	628	799	709	1 055	1 764	879	1 683	2 562
2004	149	741	889	612	850	1 463	761	1 591	2 352
2005	116	659	775	719	823	1 542	835	1 482	2 317
2006	31	616	647	752	742	1 494	783	1 358	2 141
2007	36	565	601	536	768	1 304	572	1 334	1 906
2008	31	0	31	420	1 078	1 498	451	1 078	1 529
2009	30	0	30	259	902	1 161	290	902	1 191
2010	27	0	27	244	510	755	271	510	782
2011	30	0	30	258	618	876	288	618	906
2012	22	0	22	254	720	973	276	720	995
2013	17	0	17	415	722	1 137	432	722	1 154
2014	18	0	18	257	789	1.047	275	789	1.064

Table 7-1 : Amounts of waste disposed (including inert wastes and sludge, kton) in Belgium since 1990. FL = Flanders Region, WAL = Walloon Region, BE = Belgium.

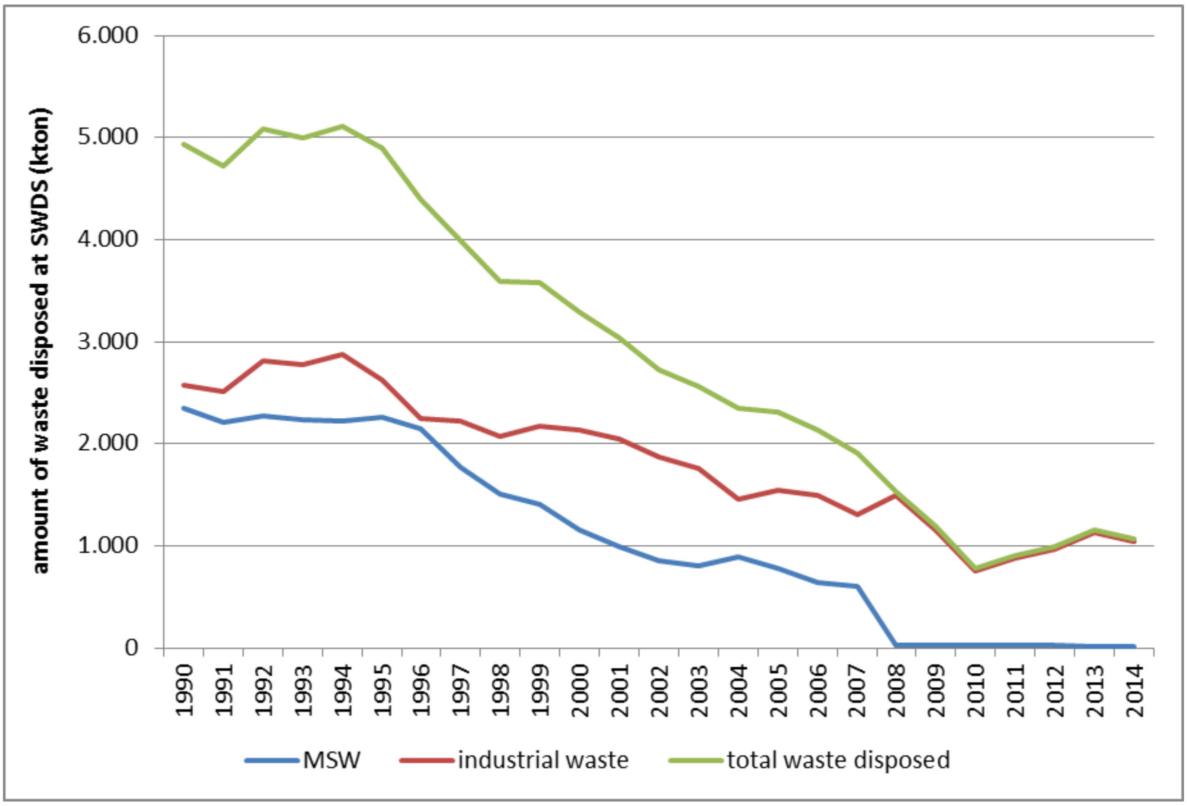


Figure 7-2 : Evolution of the amount of municipal solid waste (MSW), industrial waste and total waste disposed at SWDS in Belgium (in kton, including inert wastes and sludge) from 1990 to 2014.

Thanks to the different waste plans in Belgium, the amounts of waste disposed have decreased significantly from 1995 onwards in both regions. In 2014, the total amount of waste disposed in Belgium was 78% less compared to 1995. 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 1950-2014 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 [71] 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[20] and bulky waste[21]”);
- sludge;
- inert materials (“asbest cement waste”, “ceramics, stone and china”, etc.);
- mixed building and demolition waste;
- 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: IPCC default value: DOC = 0.19
- 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 to be conservative.

20 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.

21 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.

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 taxes 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).

Table 7.2 shows the evolution in DOC for MSW and industrial waste in the Flemish and Walloon region in the period 1990-2014.

	DOC MSW		DOC industrial waste*	
	FL	WAL	FL	WAL
1990	0,17	0,18	0,15	0,03
1991	0,17	0,18	0,15	0,03
1992	0,17	0,18	0,15	0,03
1993	0,17	0,18	0,15	0,03
1994	0,17	0,18	0,15	0,03
1995	0,17	0,18	0,15	0,03
1996	0,16	0,17	0,15	0,03
1997	0,16	0,16	0,15	0,03
1998	0,16	0,15	0,15	0,03
1999	0,15	0,15	0,15	0,02
2000	0,15	0,14	0,15	0,02
2001	0,15	0,13	0,15	0,02
2002	0,15	0,12	0,15	0,02
2003	0,15	0,13	0,15	0,02
2004	0,14	0,10	0,15	0,02
2005	0,14	0,07	0,15	0,02
2006	0	0,08	0,15	0,02
2007	0	0,08	0,15	0,02
2008	0	0	0,15	0,03
2009	0	0	0,15	0,03
2010	0	0	0,15	0,03
2011	0	0	0,15	0,02
2012	0	0	0,15	0,02
2013	0	0	0,15	0,02
2014	0	0	0,15	0,02

Table 7-2 : Evolution of DOC for MSW and industrial waste in the Flemish Region (FL) and Walloon Region (WAL), 1990-2014.
**For industrial waste, the Flemish Region has used the IPCC default value for the entire time series.*

Following the implementation of the Wallonia Waste Plan, the 'green waste' are 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 gross household and municipal waste can be disposed in landfills[22].

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 m³ of landfill gas, as landfill gas contains only a fraction of CH_4 (IPCC default value: 50% methane content).

[22] **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**

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.

Recovery: Flemish Region

In the Flemish Region, since 1995, the landfill gas produced at SWDS must be 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 'Flanders Energy Balance'. These data are available from 2001 onwards. They are obtained through the mandatory reports to the 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%. 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 landfills 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 DGARNE[23].

7.2.2.3 Evolution of CH_4 generation, recovery and emissions (1990-2014)

[23] http://environnement.wallonie.be/data/dechets/cet/

Table 7.3 and Figure 7.3 show the evolution of CH_4 generation, recovery and emissions for SWDS in Belgium in the period 1990-2014.

The evolution of CH_4 generated is very similar for the Flemish and Walloon region. 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 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 1990-2014, 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 utilisation.

	CH_4 generated			CH_4 recovery (R)			CH_4 emission		
	FL	WAL	BE	FL	WAL	BE	FL	WAL	BE
1990	66,1	56,1	122,1	0	0	0	66,1	56,1	122,1
1991	69,3	58,6	128,0	0	0	0	69,3	58,6	128,0
1992	71,0	61,1	132,2	0	0	0	71,0	61,1	132,2
1993	73,5	63,5	137,0	0	11,7	11,7	73,5	51,8	125,3
1994	75,6	65,7	141,2	0	7,2	7,2	75,6	58,5	134,0
1995	77,4	67,9	145,3	0	10,6	10,6	77,4	57,3	134,7
1996	78,6	69,8	148,5	0	16,8	16,8	78,6	53,0	131,7
1997	78,9	70,9	149,8	0	15,6	15,6	78,9	55,3	134,2
1998	77,7	70,8	148,5	0	17,7	17,7	77,7	53,1	130,8
1999	76,0	69,9	145,8	0	20,5	20,5	76,0	49,4	125,3
2000	74,4	68,5	142,9	0	22,2	22,2	74,4	46,3	120,7
2001	73,4	66,8	140,2	1,7	33,6	35,3	71,7	33,2	104,9
2002	71,5	64,7	136,2	2,1	35,4	37,5	69,5	29,3	98,7
2003	68,5	62,1	130,6	11,5	34,0	45,5	57,0	28,1	85,1
2004	65,8	59,6	125,5	11,7	28,2	39,9	54,1	31,5	85,6
2005	62,9	57,1	120,1	16,0	26,7	42,7	47,0	30,4	77,4
2006	60,5	54,1	114,5	13,9	26,4	40,3	46,6	27,6	74,3
2007	58,0	51,2	109,2	14,1	26,1	40,2	43,9	25,1	69,0
2008	55,0	48,5	103,5	13,8	26,2	40,0	41,1	22,3	63,5
2009	51,7	45,2	96,9	11,8	24,9	36,7	39,9	20,3	60,3
2010	48,0	42,1	90,1	11,9	24,1	36,0	36,1	18,0	54,1
2011	44,6	38,8	83,4	9,2	22,0	31,1	35,4	16,9	52,3
2012	41,3	35,9	77,2	7,9	19,0	26,8	33,4	17,0	50,4
2013	38,3	33,1	71,4	7,4	18,3	25,8	30,8	14,8	45,6
2014	35,4	30,7	66,0	7,0	16,5	23,5	28,4	14,2	42,6

Table 7-3 : Evolution of CH_4 generation, recovery and emissions (kton) from solid waste disposal sites in Belgium, 1990-2014. FL = Flanders Region, WAL = Walloon Region, BE = Belgium.

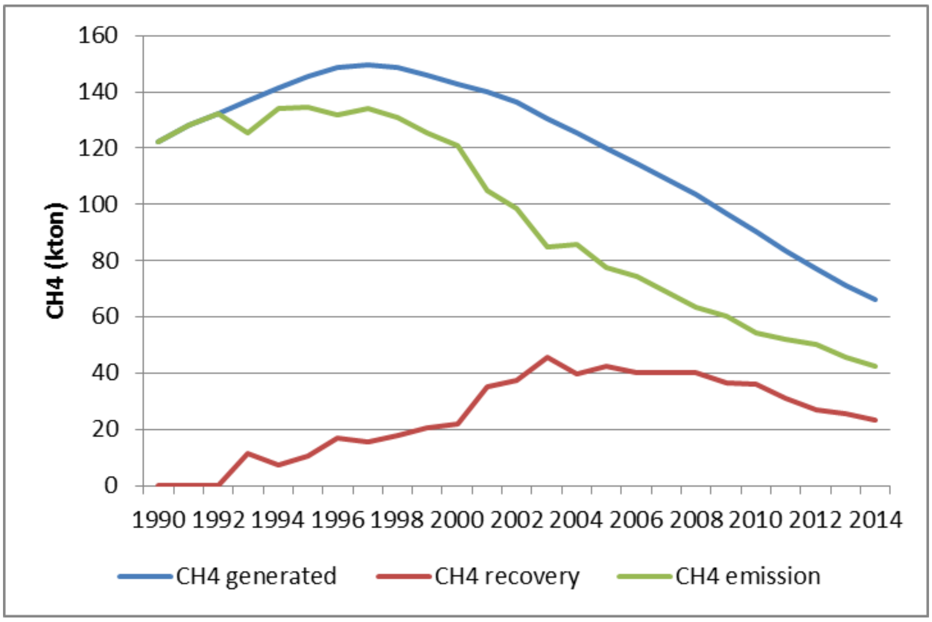


Figure 7-3 : Evolution of CH_4 generation, recovery and emissions (kton) from solid waste disposal sites in Belgium, 1990-2014.

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.

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 new IPCC Waste Model (MS Excel spreadsheet) from the 2015 submission on. This methodology entirely replaces the previous methodology in which the Flanders and Walloon region each used a separate model / models based on the IPCC 2000 Guidelines. Furthermore, the choice of emission factors and parameters has now been fully harmonized between the two regions. This new approach has greatly improved transparency of the methodology and comparability of model results between the 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

No recalculations took place in the category 5A during this submission in Belgium.

7.2.6 Source-specific planned improvements

No planned improvements are foreseen in the near future.

7.3 Biological treatment of solid waste (CRF 5.B)

7.3.1 Source category description

Emissions of CH_4 and N_2O from the composting of organic waste (5B1) are put under this category

7.3.2 Methodological issues

CH_4 and N_2O emissions from composting of organic waste are estimated using regional activity data combined with default 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 N2O and CH4 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.

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.

	ton waste composted in Flanders	ton waste composted in Wallonia	ton waste composted in Brussels
1990	138 001		-
1991	138 001		-
1992	171 271		-
1993	180 016		-
1994	216 076		-
1995	271 636		-
1996	400 241		-
1997	607 985	182 938	-
1998	659 923	200 153	-
1999	738 760	213 088	-
2000	828 873	265 560	-
2001	780 683	250 606	-
2002	818 639	271 357	6 085
2003	744 372	352 107	9 724
2004	805 291	370 565	13 113
2005	768 967	416 404	13 462
2006	764 782	462 244	12 365
2007	797 844	493 922	12 696
2008	750 444	438 897	14 477
2009	635 249	604 508	17 701
2010	736 369	777 148	19 262
2011	714 897	862 273	18 400
2012	732 436	785 515	18 869

2013	709280	610 000	18 438
2014	709280	580 721	17 100

Table 7-4 : Amounts of ton waste composted in Belgium (1990-2014) (figures for 2014 are provisional)

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

Emissions of N_2O from composting activities are newly added in the greenhouse gas inventory during the 2015 submission.

7.3.6 Source-specific planned improvements, if applicable

No improvements are planned in the future in the category 5B in the Belgian greenhouse gas inventory.

7.4 Incineration and open burning waste (CRF 5.C)

7.4.1 Source category description

The waste incineration category (category 5C) includes incineration of municipal and industrial waste, and incineration of hospital waste (5C1). Emissions originating from flaring activities are allocated partly to the sectors 1B2 (Flemish region, refineries, see section 3.3.2 for more information), and partly to the sector 5C (Flemish and Walloon regions, chemical industry). 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 2014 in the Brussels region. The corresponding emissions are allocated to the category 1A1a. The other incineration plants in this region (without energy recovery) were closed in 1997 and 1998.

7.4.2 Methodological issues

Waste incineration

The N_2O emission factor for municipal waste incineration has been recalculated using is 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.
Emissions of CH_4 are not relevant here, 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)[24].

[24] http://www.ipcc-nggip.iges.or.jp/public/gp/english/5_Waste.pdf

To estimate the CO_2 emissions, each region applies its own methodology according to the available activity data.

Flanders

In Flanders, only the fraction of organic-synthetic waste is taken into consideration (assuming that organic waste does not give any net CO_2 emissions). For the municipal waste, the institute responsible for waste management in Flanders (OVAM) is given the analysis of the different fractions in the waste. Based on this information, the amount of non-biogenic waste (excluding the inert fraction) is determined. The carbon emission factor is based on data from literature for the different fractions involved. For industrial waste, the amount 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 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 %.

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 5C.

The activity data (total amount of waste incinerated) in the Flemish region for the complete time series is shown in the table 7.5 below.

	AD other fuels (PJ)	AD other fuels (PJ)	organic content (%)	organic content (%)
	with energy recovery (1A1a)	without energy recovery (6C1)	household waste	industrial waste
1990	4,02	2,19	37	65,5
1991	4,02	2,19	37	65,5
1992	4,02	2,19	37	65,5
1993	4,02	2,19	37	65,5
1994	2,58	1,29	57,49	65,5
1995	2,54	0,72	56,4	65,5
1996	2,67	0,77	56,07	65,5
1997	2,97	1,01	56,07	65,5
1998	2,99	0,69	56,07	65,5
1999	4,27	0,75	55,78	65,5
2000	5,01	0,86	55,78	65,5
2001	6,36	1,12	58,32	65,5
2002	6,90	1,17	58,32	65,5
2003	6,69	1,21	58,32	65,5
2004	6,86	0,63	58,32	65,5
2005	7,12	0	58,32	65,5
2006	8,43	0	58,32	65,5
2007	9,70	0	58,32	65,5
2008	10,58	0	58,32	65,5
2009	9,60	0	58,32	65,5
2010	9,20	0	58,32	65,5
2011	8,80	0	58,32	65,5
2012	9,75	0	58,32	65,5

2013	9.90	0	58.32	65.5
2014	9.88	0	58.32	65.5

Table 7-5 : Amounts of waste incinerated (PJ) in the Flemish region (1990-2014)

Different technologies used in the waste incineration plants in the Flemish region can be found on the OVAM-website: http://www.ovam.be and via http://www.vlaanderen.be/nl/publicaties/detail/inventaris-van-de-vlaamse-afvalverbrandingssector.

A complete inventory of the Flemish waste incineration sector is published on that site.

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 CRF 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 6C, 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. In 2014, the incinerated waste without energy recovery represents 2% 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 (http://www.ipalle.be/Lesdéchets/Outilsdetraitement/LecentredevalorisationdesdéchetsdeThumaide/Déchetshospitaliers.aspx). 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 (6C)**		**TOTAL**	
	Amount (ton)	**Organic content (%)**	**Amount (ton)**	**Organic content (%)**	**Amount (ton)**	**Organic content (%)**
1990	199 249	68	157 614	68	356 863	68
1991	210 740	68	161 864	68	372 604	68
1992	201 748	68	167 660	68	369 408	68
1993	195 009	68	174 391	68	369 400	68
1994	215 945	68	184 552	68	400 497	68
1995	210 217	68	181 914	68	392 131	68
1996	238 143	68	193 000	68	431 143	68
1997	238 354	68	166 399	68	404 753	68
1998	266 525	68	125 669	68	392 194	68
1999	256 471	68	122 975	68	379 446	68
2000	242 817	68	82 042	68	324 859	68
2001	269 808	21	71 501	38	341 309	24
2002	408 493	27	46 555	35	455 048	28
2003	461 164	33	58 899	35	520 062	33
2004	512 311	32	44 301	35	556 612	33
2005	476 685	30	21 716	41	498 401	31
2006	553 663	31	17 000	41	570 663	31
2007	579 360	33	17 000	41	596 360	33
2008	623 185	38	11 665	41	634 850	38
2009	587 198	47	36 064	41	623 262	47
2010	859 075	50	17 231	41	876 306	50
2011	893 029	50	13 426	41	906455	50
2012	919 463	47	12 600	41	932063	47
2013	786 350	55	193 331	57	979 681	55
2014	979 868	56	19 249	58	999 118	56

Table 7-6 : Amounts of waste incinerated (ton) and organic content (%) in the Walloon region (1990-2014).

Brussels 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 content (biomass) of incinerated waste.

The evolution of the corresponding amount of waste incinerated and of its organic content are presented in Table 7.7.

	Municipal waste incineration with energy recovery (1A1a)	
	Amount (tons)	Organic content (%)
1990	511 528	62
1991	519 852	62
1992	532 476	62
1993	526 918	61
1994	526 194	59
1995	528 850	58
1996	531 194	57
1997	515 349	56
1998	505 837	54
1999	515 967	53
2000	535 000	53
2001	536 624	53
2002	531 621	53
2003	517 407	53
2004	510 682	53
2005	509 363	53
2006	505 940	53
2007	499 624	53
2008	501 141	53
2009	496 739	53
2010	461 940	56
2011	447 617	56
2012	469 806	56
2013	449 514	56
2014	431 742	56

Table 7-7 : Amounts of municipal waste (tons) incinerated in the Brussels Region with energy recovery (category 1A1a)

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 7.8. 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 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 7-8 : Amounts of municipal and hospital waste (tons) incinerated in the Brussels Region without energy recovery (category 5C)

Flaring in the chemical industry

Flaring activities in the chemical industry take only place in the Flemish and Walloon region.

The emissions of CO_2 from the flaring in the chemical industry are reported in category 5C according to the IPCC Guidelines. 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, NIR from others MS and the IPCC guidelines), these emissions are not estimated in Belgium.

7.4.3 Uncertainties and time-series consistency

For N_2O, an uncertainty of 100% 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 %.

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

No specific recalculations were made in this category 5C in Belgium during this submission.

7.4.6 Source-specific planned improvements, if applicable

No improvements are planned in the future in the category 5C in the Belgian greenhouse gas inventory.

7.5 Wastewater treatment and discharge (CRF 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 waste water 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.

<u>CH_4 emissions</u>
IPCC 2006 guidelines (equation 6.3) are used to estimate the emissions of CH_4 originating from the use of septic tanks. As a consequence the emissions were strongly increasing (about factor 3 in the Flemish region) during the 2015 submission.

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 anaerobical digestion of the sludge recover the CH_4 for energy purposes.

In Brussels, the anaerobic wastewater treatment plant (www.aquiris.be) generates yearly around 6665000 m³ of biogas. This biogas is valorised in a cogeneration installation, producing 25 MWh/day of electricity and 25 MWh/day of 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 anaerobical 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 waste water of the zoning are generally poured in the sewage system. As for industrial waste water, 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 waste water. According to the data resulting from the service of taxation of industrial waste water, industrial water represented 205.000 EH in 2003, that is to say approximately 10% of the load treated by public wastewater treatment plants.

The energy balance in the Flemish region reports 29 installations of waste water treatment that use the biogas to produce electricity (15 installations with biogas of sewage sludge of municipal waste water treatment installations and 14 installations with anaerobical water treatment). In 2011 490 GJ biogas was produced and used for electricity production (compare with 515 GJ from SWDS) . The emissions linked to the energy recovered by these treatment plants are also included in the energy sector (category 1A1a, biomass fuels).

N_2O emissions

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 FAO 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 7.9 gives an overview of the AD and factors used for 2014.

	Belgium
Protein consumption (kg/capita/yr)	36.90
Population	11150516
N fraction in protein (kgN/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 7-9 : Factors used in Belgium to calculate the N_2O-human sewage in 2014

5D2. Industrial wastewater

Regarding the emissions from industrial wastewater handling and treatment: emissions from industrial waste water treatment are not included in the Belgian greenhouse gas inventory because most of the industrial waste water 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 waste water anaerobically. Consequently no or negligible amounts of emissions take place. The notation key 'NA' is encoded in the CRF tables because an activity occurs which do not result in emissions. 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 ('NE' is encoded).

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 N2O 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 3 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

No specific recalculations took place in the category 5D in Belgium during this submission.

7.5.6 Source-specific planned improvements, if applicable

The emissions from biogas valorisation in the anaerobic wastewater treatment plant of Brussels will be added to category 1A1a during the next submission.

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 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.

No indirect emissions of CO_2 are reported in the Belgian inventory as in the previous submissions.

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 are described in the respective chapters (chapter 3 to 7) of the different sectors.

Besides the reporting on recalculations of emissions for the base year and the year (x-3) is reported as a separate annex to this submission as part of the Implementing Regulation Article 8 Reporting on recalculations of the MMR.

Reporting on major changes to methodological descriptions (Annex VIII) of MMR is also annexed to this submission.

9.1.2 ESD Review in 2015

In November 27, 2015 Belgium received the results' informal list of recommendations, including potential technical corrections' of the 2015 trial review under the Effort Sharing Decision (ESD).

The TERT reviewed the GHG emission inventory estimates of Belgium for the year 2013 submitted in 2015 under the MMR on 4/11/2015.
During the centralized review carried out between 16 and 20 November the TERT received responses from Belgium to all questions raised.
The TERT formulated non-binding recommendations for improvements of Belgium's GHG inventory (see Table 2). The implementation of these recommendations is not legally binding as the trial review was a voluntary exercise for the MS involved. However, all issues not solved during the trial review will be followed-up by the review team in 2016.
The TERT did not identify any issue concerning an over- or underestimate above the significance threshold (potential technical correction).

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. 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.

9.2.1 GHG inventory

Planned improvements are described in the respective chapters (chapter 3 to 7) of the different sectors.

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

10 KP-LULUCF

The information provided in this chapter follows in content and structure the «Guidelines
For the preparation of the information required under article 7 of the Kyoto Protocol» (Annex to decision 15/CMP.1, FCCC/KP/CMP/2005/8/Add.) and the Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol

10.1 General information

10.1.1 Definition of forest and any other criteria

Belgium adopted the following forest definition for use in accounting for its activities under 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**

These choices allow to use the results of the actual 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 2010 Forest Resource Assessment (FRA 2010).
Belgium intends to account for the entire commitment period for all its activities under Article 3(3) of the Kyoto Protocol.

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).

10.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

Belgium has not elected grassland and cropland management under Article 3.4 for inclusion in its accounting for the first commitment period nor for the 2nd commitment period.

10.1.3 Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

All the data regarding the land use change matrix come from the study by the Gembloux University (Gembloux Agro Bio Tech). The elaboration of a coherent representation of the land use between

1990 and the commitment period is the main objective of the study [55]. The methodology is presented in chapter 6.1.1.

The emissions and removals are calculated at the regional level following IPCC Good Practice Guidance on LULUCF 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, to address the supplementary information to be delivered in the commitment period under Art. 7.1.

10.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified.

Not relevant for Belgium. Forest management is the only activity under Art 3.4.

10.2 Land-related information

10.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

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 2003 GPG. 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 (see 10.2.3.); layers images (orthophotoplans or images satellite with very high-resolution).

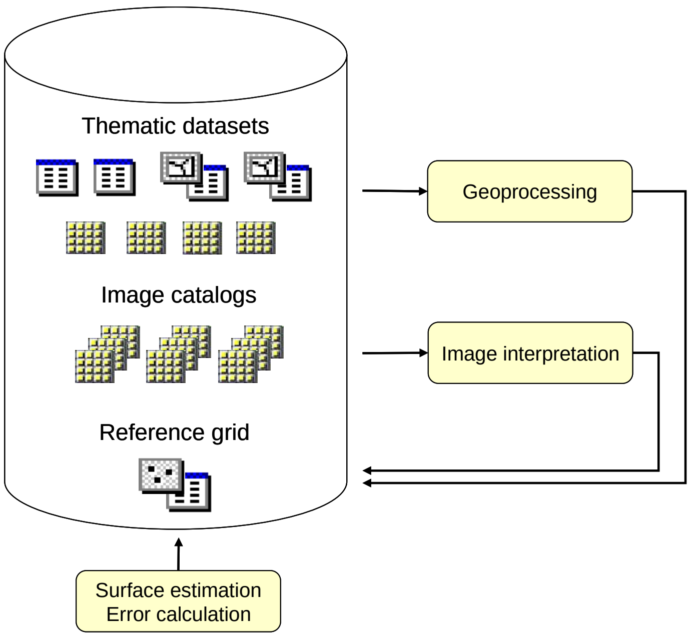


Figure 10-1 : Main steps of the spatial assessment [55]

10.2.2 Methodology used to develop the land transition matrix

10.2.2.1 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 geotraitement, 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 vectorial 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 9.2).

The steps of the photo-interpretation within OrthoViewer are the following ones:
1. Posting of the orthophotoplan 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 orthophotoplan 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).

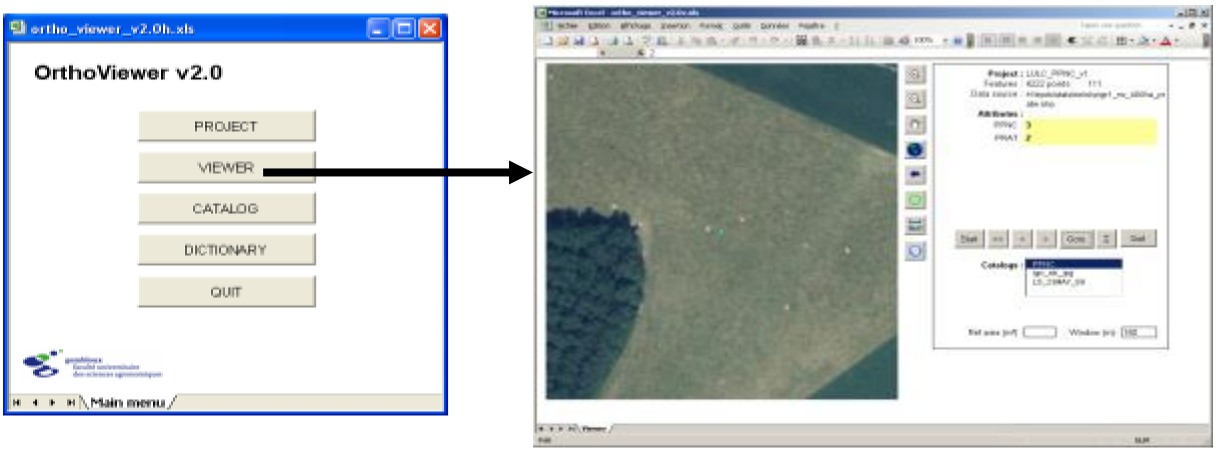


Figure 10-2 : Ortho-viewer functionalities facilitating the work of image-interpretation

10.2.2.2 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 geoprocessed 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 2009, 2010 and 2011 (Flanders and Wallonia)

The method of estimation of areas of the six land use categories used for 2009 and most recent years is the same as the one used for 1990 and 2008. The first step is to inventory the land use of the points of the sampling grid for 2009 based on the map closest to 2009. Then, if necessary, a second interpolation step and / or extrapolation is performed using information from 2008 and 2009 to obtain a land use updated 2009.

The interpolation-extrapolation procedure is used to estimate the land use of a region of Belgium for the years without inventory. This procedure can be decomposed into three steps:

1. Determine the annual land use change between two years inventoried (e.g. 1990 and 2008)
2. Update of land use for a 'base year for the interpolation-extrapolation' (necessary step if the maps do not cover all of the same year for one year inventoried)
3. Creating changes in land use from the 'base year for the interpolation-extrapolation' through the annual land use change.

The methodology is described in details in [55] An example is given below :

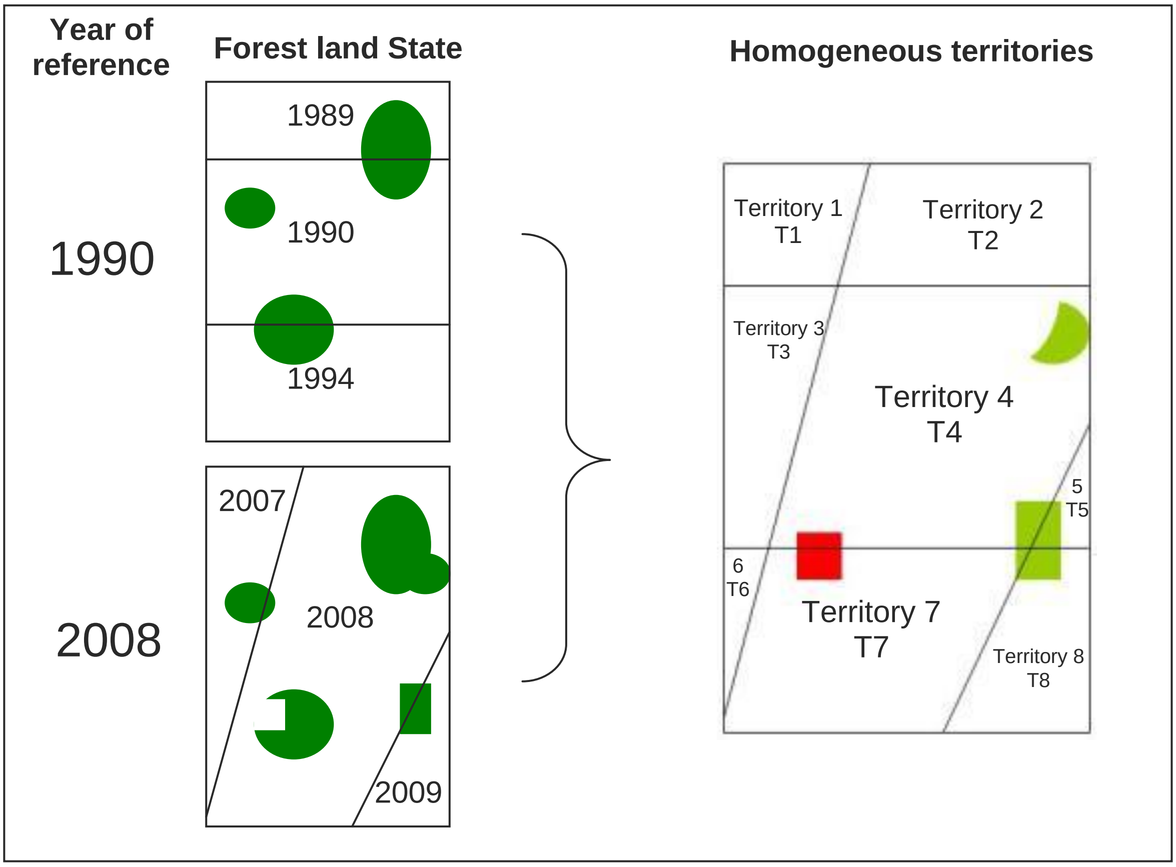


Figure 10-3 : Theoretical territory with its forest land in 1990 and 2008 (on the left). The layers that were used to draw up 1990 land inventory are from 1989, 1990 and 1994. Whereas, the 2008 land inventory are from 2007, 2008 and 2009. On the right hand side, the superposition of the 1990 and 2008 land use state makes 8 portions of homogenous territory with land use change occurring in between these two years.

Year 2013 and period 2009-2012 (Brussels)

The land use matrix for Brussels was updated for 2013, by photo-interpretation of all sampling locations.
The annual values for the period 2009-2012 were then recalculated by interpolation between 2008 and 2013.

Year 2015

In Wallonia, a first classificiation 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 unconsistent classification , 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.

In Flanders and Brussels-Capital Region, new data are currently collected and will be used for the 2017 submisison.

10.2.2.3 Reclassification of “Other lands” (submission 2015)

Belgium is a small country and all land is managed.

In previous reportings, 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 now 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.

10.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

A first inventory of the numerical data available on the land use of the 3 regions was drawn up [55]. Only the data entering the process of inventory are presented here. Tables 9.1 and 9.2 present the batches of data used for the inventory of 1990, table 9.3 indicates the data employed for 2008, and table 9.4 indicates the data used for the years 2009 and 2010.

Table 10-1 : Thematic data layers used for 1990 (V = vectorial et R = raster)

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
Landbouwgebruiks-percelen	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 10-2 : Thematic data used for 1990 (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	
Région Bruxelles-Capitale					
Carte topographique IGN/NGI 1/10 000 (Top10r)	R	1994 et 2003	1994 et 2003	~1991-1993	

Table 10-3 : Thematic data layers used for 2008 (V = vectorial et 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 Comon Agricultural Policy PAC. Statistics added to a layer from othophotoplans. 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 10-4 : Geographical data used for the 2009 and 2010 land use inventory.

Donnée source	Reference year	Description
Couches thématiques		
Région flamande		
Landbouwgebruikspercelen (LPC)	2009	Statistiques annuelles des déclarations des surfaces agricoles pour les aides financières liées à la PAC.
Région wallonne		
Système intégré de gestion et de contrôle (SIGEC)	2009	Statistiques annuelles des déclarations des surfaces agricoles pour les aides financières liées à la PAC. Les statistiques sont intégrées dans une base de données reprenant un parcellaire établi à partir d'othophotoplans. Echelle 1/10 000
Région Bruxelles-Capitale		
/		
Couches images		
Région flamande		
Orthophotos couleur	2009	Echelle de 1/10 000 à 1/15 000, résolution 25 cm
Région wallonne		
Orthophotos IR du DGA	2009-2010	Résolution 25 cm
Région Bruxelles-Capitale		
Orthophotos couleur de la Région de Bruxelles-Capitale	2012 + interpolation of the 2008-2012 tendency	Résolution 40 cm

Table 10-5 : Geographical data used for the 2015 land use inventory

Donnée source	Reference year	Description
Couches thématiques		
Région flamande		
		New data are currently collected and will be used for the 2017 submisison.
Région wallonne		
Système intégré de gestion et de contrôle (SIGEC)	2015	Annual area declaration for financial support for the Comon Agricultural Policy PAC. Statistics added to a layer from othophotoplans. Scale 1/10 000
IPRFW	2015	Regional Walloon forest inventory
PICC	2015	Projet Informatique de Cartographie Continue: Allidentiable elements from the landscape are recored with x,Y,Z coordinates
PDS	2015	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.
Région Bruxelles-Capitale		
/		
Couches images		
Région flamande		
		New data are currently collected and will be used for the 2017 submisison.
Région wallonne		
Orthophotos IR du DGA	2015	Résolution 25 cm
Région Bruxelles-Capitale		
Orthophotos couleur de la Région de Bruxelles-Capitale	2012 + extrapolation to 2015 of the 2008-2012 tendency	Résolution 40 cm

10.2.4 Areas under ARD

The resulting general LUC matrix was presented in table 6.2 (chapter 6).

Regarding Afforestation, Reforestation and Deforestation, the cumulated areas under ARD in the commitment period are presented in table 10.6.

There is an overall balance between afforested and deforested areas, as confirmed by the stable forest area observed in forest inventories. However, due to accounting rules (instantaneous oxidation in the case of deforestation), this results in net CO_2 emissions under Art 3.3.

	2008	2009	2010	2011	2012	2013	2014
Afforestation and reforestation	18.79	19.64	23.27	26.90	30.54	34.17	37.80
Deforestation	18.66	19.49	21.09	22.68	24.28	25.87	27.47

Table 10-6 : Cumulated areas under ARD

10.3 Activity-specific information

10.3.1 Methods for carbon stock change and GHG emission and removal estimates

10.3.1.1 Description of the methodologies and the underlying assumptions used

Belgium uses the same methodologies and data to estimate emissions and removals from the LULUCF sector under the Convention (section 6) and from KP-LULUCF under the Kyoto Protocol (present section 10), so the methods are those described in chapter 6.2. and chapter 6.3., for both afforestation and deforestation. All carbon stocks changes from the different subcategories and carbon pools are taken into account.

The areas under afforestation/deforestation are presented in section 10.2.4. 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 4.2.5.3 of the IPCC GPG on LULUCF. For deforestation, the emissions are estimated assuming that all the carbon stocks in living biomass is emitted in the year.

These values (annual growth in above-ground and below-ground living biomass and average carbon stocks in forest) are presented in table 10.6. 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)	Deforestation (average carbon stocks in living biomass in Forest land, t C/ha)
Brussels	2.53	150.6
Flanders	2.53	119
Wallonia	3.3	116

Table 10-5 : Average regional values for living biomass growth (t C/ha.year) and carbon stocks in living biomass (t C/ha)

Emissions and removals from soil organic carbon are calculated as presented in sections 6.2.2.2 and 6.3.2.1/B. The soil C stock changes of land use change areas to forest land are calculated according to equation 3.2.31 of the IPCC GPG on LULUCF, assuming a 20 years duration of the transition from $SOC_{Non\ Forest\ Land}$ to SOC_{Forest} . For forest land converted to non forest land, change in carbon stocks in soils are estimated using equations 3.3.2 and 3.4.7 of the IPCC GPG on LULUCF. The emissions and removal depend on the type of conversion, following the soil carbon content presented in table 6.8.

Emissions from liming are estimated in the case of deforestation, applying the methodology described in section 7.3.2.1/D to the areas deforested.

Emissions of N_2O from land converted to cropland and grassland are calculated for all the conversion from forest land to cropland. Two parameters are taken into account in equations 3.3.14 et 3.3.15 from IPCC Guidelines: FE1 = 0,0125 kg N2O -N/kg N and C/N ratio of the converted land. Emissions are caused by the nitrogen cycle, intimately linked to carbon cycle. The C/N ratios are 19,25 for forest (based on measurements conducted within the regional forest inventory) and default IPCC values of 15 for grassland and 10 for cropland.

In cropland converted to forest (afforestation) emissions due to the conversion of orchard to forest land are estimated following the methodology described in section 6.3.2.1/A. This is aplied to the whole time series, but in practice, no such conversion occurred since 2010, so no such emissions are reported under the KP, although they are reported under UNFCCC for the years 1990-2009.

10.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

No carbon pool has been omitted.

Regarding deadwood and litter, Belgium opted for a conservative approach in its 2014 submission, considering IPCC GPG 2003 tier 1, where no change in carbon stock is considered in these pools in the case of afforestation/deforestation. Instead of a zero value, notation key NR was reported in the KP-LULUCF table to express that the pool is not reported, as this pool is not a source.

In the case of **deforestation**, all carbon from deadwood and litter is considered emitted in the year of deforestation.

CO_2 emissions from fires are estimated following methodologies described in chapter 7. Regarding fires, given the very limited areas of forest land with occurrence of fires, which were mostly situated in nature reserves, it was assumed that all these fires took place on forest land remaining forest land. Hence no emissions from fires are reported under KP LULUCF.

10.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

No factoring out of the indirect or natural emissions has been performed on the data.
However, no natural afforestation/reforestation occurs in Belgium. These areas are planted, so the tree growing is directly human-induced.

10.3.1.4 Changes in data and methods since the previous submission (recalculations)

See chapter 6.2.5 for recalculations in the LULUCF sectors, which include land reported under the KP.

In Wallonia, new data on land-use regarding cropland and grassland for the year 2014 were made available on March 3, 2016. These data are integrated in the June 15th, 2016 submission.

Following the recommendations of the 2013 UNFCCC in-country review, emissions and removals from liming in land deforested and converted to cropland or grassland (deforestation) were recalculated, as well as emission from the losses of orchard in cropland converted to forest land (afforestation). Only the liming has an influence on the years of the commitment period.

Activity data	**Unit**	**2008**	**2009**	**2010**	**2011**	**2012**
Total amount of lime applied	Mg/yr	717.01	756.64	796.26	835.88	875.51
Limestone	Mg/yr	506.13	534.10	562.07	590.04	618.01
Dolomite	Mg/yr	210.89	222.54	234.19	245.85	257.50
Emissions						
Carbon	Gg C	0.086	0.091	0.096	0.100	0.105
Limestone	Gg C	0.061	0.064	0.067	0.071	0.074
Dolomite	Gg C	0.025	0.027	0.028	0.030	0.031
Emissions CO_2						
Total	Gg CO2	0.315	0.333	0.350	0.368	0.385
Limestone	Gg CO2	0.223	0.235	0.247	0.260	0.272
Dolomite	Gg CO2	0.093	0.098	0.103	0.108	0.113

Table 10-8 : Emissions from lime application

10.3.1.5 Uncertainty estimates

Regarding KP-LULUCF, the uncertainties on emissions and removals and deforestation are estimated respectively at 59,3 % for removals following afforestation and 48,5 % for emissions from deforestation emissions. See also paragraph 6.2.3.

10.3.1.6 The year of the onset of an activity, if after 2008

Not relevant in this submission.

10.4 Article 3.3

10.4.1 Information that demonstrates that activities under article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

No natural forest occurs in Belgium.

In Wallonia, half of the total forest is owned by public institutions and managed by the DGO Agriculture, Natural Resources and Environment - Nature and Forest Department. 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 DGOARNE to the private owners in this view.

In Wallonia, it is also planned that activities of afforestation and deforestation on agricultural land and forest land will be subject to permits delivered by regional authorities. The legal text regarding this issue is prepared and should be officially adopted soon.

The situation is similar in Flanders.

In this regard, all activities under Article 3.3 are considered human-induced in Belgium.

10.4.2 Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Given the time period since 1990, it is assumed that forest has been planted and can be recognized on all areas that have been harvested or have been subject to other human disturbance but for which it was expected that a forest would be replanted. In this view no plantation is expected on areas identified as deforested.

About one third of the deforested areas were replaced by settlements, for which no re-establishment of forest will occur.

As explained in chapter 10.2.2, each point identified by the geoprocessing tool as being subject to LUC between 1990 and 2008 is verified through photo-interpretation to confirm the interpretation. Some young plantations on land harvested between 1990 and 2008 have been identified by this process, as well as other potential interpretation errors (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). No case of natural disturbance has been identified for the time being.

Regarding emissions/removals from lands harvested during the first commitment period following afforestation and reforestation on these units of land since 1990 (paragraph 8(c) of decision 16/CMP1), no such unit of land has been identified for the time being. Given the usual age of maturity in the Belgian tree species, an harvest during the commitment period on a land afforested in 1990, which means at maximum 22 years old, appears very unlikely in the normal forest management cycle, except for some poplar cultivars. Special cases of LUC, such as harvesting for settlement, should also be rather limited, but are highly unpredictable.

10.4.3 Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

No such areas were identified for the time being.

10.5 Article 3.4

10.5.1 Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Forests in Belgium were managed long before 1 January 1990 , so all forest land management is considered human-induced.

10.5.2 Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

Not relevant for Belgium.

10.5.3 Information relating to Forest Management

10.5.3.1 Conformity with the definition in item 11.1 above

The areas under Forest management are determined following the strict application of the criteria presented in section 10.1, regarding Minimum tree crown cover, land area and height at maturity.

10.5.3.2 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

In Wallonia, the Forest Code (Decree of 15 July 2008) has introduced a certain number of constraints in favour 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. This new standard is part of more dynamic forestry than that practised 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.[25] 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.

[25] de Potter B., 2011. Prise en compte des changements globaux pour la gestion des pessières en Wallonie [Taking into account global changes in the management of spruce in Wallonia]. Forêt Wallonne 114: 17-25

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 (Forest Decree of 13 June 1990 and 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).

10.5.3.3. 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.

10.5.3.4. 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.

The recommendation received in the technical assessment of the FMRL highlighted the need to make a “technical adjustment to the FMRL when final agreement on the HWP estimation is reached”. Meanwhile, new historical data (e.g. land-use matrix and update of the forest inventory data) also became available since the submission of the FMRL in 2011. Hence, **Belgium foresees the application of a technical correction to its FMRL, in the 2017 submission.**

10.5.3.5. 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 10-9 : Calculation of the background level and margin for Natural Disturbances (wildfires) in Belgium, following §33 and footnote 7 of Decision 2/CMP.7

The backgound 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 10-9, 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 CO_2-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 10-9, 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

10.5.3.6. Harvested Wood Products

The method that had been applied in the FMRL (i.e. flux data method) is presented in detail in Rüter (2011). 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). As the method applied for estimating the HWP contribution to FMRL is not in line with the guidance provided in 2013 IPCC KP Supplement, Chapter 2.8 (e.g. following the method for estimating HWP from domestic origin and excluding HWP from Deforestation), Belgium intends to submit a new estimate when the data will be available.

Ref.: Rüter, S. (2011) Projection of Net Emissions from Harvested Wood Products in European Countries: For the period 2013-2020. Thünen-Institute of Wood Research, Report No: 2011/01, 63 p. *http://literatur.vti.bund.de/digbib_extern/dn048901.pdf*

10.6 Other information

10.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

Key category analysis for article 3.3 activities is carried out in chapter 1.5

11 INFORMATION ON ACCOUNTING OF KYOTO UNITS

Information about the transactions of the Kyoto-units is attached in annex to this document.

11.1 Summary of information reported in the SEF tables

The SEF (standard electronic format) report is attached to this report.

11.2 Discrepancies and notifications

(not applicable; empty lists)

11.3 Publicly accessible information

No change has been made to the publication of the publicly accessible information. This information remains available at:

https://ets-registry.webgate.ec.europa.eu/euregistry/BE/public/reports/publicReports.xhtml

A link to this public information and additional public information is however still provided via the general public website of the Belgian registry:

http://www.climateregistry.be/ (reports section)

11.4 Calculation of the [CP1] commitment period reserve (CPR)

The CP1-CPR is calculated as five times the total GHG emissions in the most recently reviewed national inventory or 90 per cent of the assigned amount whichever is the lowest.

For Belgium, 90 per cent of the CP1 assigned amount is 606.595.975 units, while five times the total GHG emissions in the last reviewed inventory (116.520,32 Gg CO2 eq annual GHG emissions for the inventory year 2012) is equal to 582.601.577 ton CO2 equivalent.

The CP1-CPR for Belgium is hence 582.601.577 ton CO2 equivalent.

11.5 KP-LULUCF accounting

(not applicable; empty lists)

11.6 Other

Additional information on the accounting of Kyoto units as set out in section I.E. of the annex to decision 15/CMP.1 (the numbering below refers to decision 15/CMP.1):

12. No discrepant transactions occurred for the reporting period, pursuant of 15/CMP.1 Annex I.E paragraph 12.

13-14. No CDM notifications were received in 2015.

15. No non-replacements occurred in 2015.

16. No invalid units to list for 2015.

17. No actions were needed to correct any problems that caused a discrepancy to occur, any changes required to the national registry to prevent a discrepancy from reoccurring, or the resolution of any previously identified questions of implementation pertaining to transactions.

18. (see section on the calculation of the commitment period reserve (CPR))

19. (no requests received from expert review teams)

20. *(not applicable)*

12 INFORMATION ON CHANGES IN NATIONAL SYSTEM

The national system in Belgium has been actualized for the submission of April 15th 2009 to UNFCCC-secretariat. No major changes are performed since that time. The revised national system is in line with the developed QA/QC-plan. Both documents are attached in annex 3 of this National Inventory Report.

13 INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of Belgium have occurred in 2015.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	*None*
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There was no change to the database structure as it pertains to KP functionality in 2015. Versions of the CSEUR released after 6.3.3.2 (the production version at the time of the last Chapter 14 submission) introduced minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. The database model is provided in Annex A. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex B. Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing will be carried out in February 2016 and the test report will be submitted thereafter. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex B. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing was carried out in February 2016 and the result report is attached to this submission.

14 INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

Preliminary remark: the text presented below is similar to the text presented in previous reports. The only changes are (1) the deletion of the paragraphs on the flexibility mechanisms (given that the purchase programs have been finalized at this stage) and (2) additional information on governance implemented to ensure coherence between different policies.

Under Article 3.14 of the Kyoto Protocol and UNFCCC Decision 31/CMP.1, Annex I Parties are invited to report on how they are striving to implement their commitment while minimizing adverse social, environmental and economic impacts on developing country parties.

Actions taken in the framework of the Kyoto Protocol commitments are intended to contribute to preventing dangerous anthropogenic interference with the climate system. Adverse impacts of potential climate changes on developing countries are thus globally reduced when Annex I countries (and Belgium among them) take measures aiming to reduce GHG emissions through energy savings and the promotion of renewable energy sources. Furthermore, most of those actions contribute to reduce air pollution related to fossil fuels uses for the benefit of all countries.

Most actions taken by Belgium in order to respect its commitments try to present no direct or indirect adverse effects for developing countries. Belgian policies and measures address not only fossil fuel combustion but also emissions of all gases covered by the Kyoto Protocol, such as methane and nitrogen protoxide from agriculture and waste management or F-gases in refrigeration systems, thus ensuring a balanced distribution of efforts and limiting the potential impact of single too specific measures.

Belgium is a Member State of the European Union and, as such, designs and implements most of its policies in the framework of EC directives, regulations, decisions and recommendations. For instance, Belgium has implemented the European liberalisation of electricity and natural gas markets and is involved in the European Emission Trading Scheme, all actions aiming to address market imperfections and to better reflect externalities in energy/CO_2 prices.
Belgium has suppressed subsidies supporting the use of coal and other fossil fuels for energy production. It also applies strict rules in accordance to EC recommendations for State aid to environmental and energy saving measures, in order to maintain an undistorted free competitive market across Europe. It has never taken any action nor expressed any recommendation in favour of one energy carrier over others and has always been very careful to collaborate equally with all actors of the energy production and distribution sectors.

The Belgian agricultural policies and the promotion of bio-fuels are developed within the European common policies. The new EC common policy for agriculture now tends to support quality products and environmental respect instead of large volumes of production, and should create market conditions more accessible to products from developing countries. Concerning bio-fuels, acknowledging that their development could create pressures on food prices and on land and forest management, especially in developing countries, the EC has established strict sustainability criteria which in particular include not supporting bio-fuels from land with high biodiversity value (primary forest and wooded land, protected areas or highly bio-diversed grasslands), or from land converted from wetlands, peat lands or continuously forested areas. It will also be very cautious about any broader environmental and social aspects such as air, water and soil quality and labour conditions.

Another way to strive to minimize potential adverse social, environmental and economic impacts of Belgian policies on developing country parties, is the Policy Coherence for Development (PCD) process that is currently being implemented. This process intends to ensure that policy decisions from several areas contribute positively or at least neutrally to the objectives of development cooperation.
The Belgian Development Cooperation Act (March 2013) provides a legal basis for PCD and its Art. 8 states that promoting policy coherence should occur not only within the various areas of the Belgian development policy, but also within various other policy areas. Food security, migration, trade & finance, security and climate change are identified as priority areas in the framework of PCD.
In order to achieve PCD objectives, the federal state has established an Interdepartmental Commission for Policy Coherence for development (ICPC) as well as an Advisory Committee (http://www.ccpd-abco.be/en/)

REFERENCES

[1] VITO Vlaamse Instelling voor Technologisch Onderzoek = Flemish Institute for Technological Research, Boeretang 200, B-2400 MOL (www.emis.vito.be).
[2] CITEPA Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique, rue du Faubourg Poissonnière 10, F-75010 PARIS – Emission Inventory of CH_4 and N_2O in the European Community 10/10/1990.
[3] EMEP/EEA air pollutant emission inventory guidebook, technical report N°6 of June 2009.
[4] TNO Institute of Environmental Sciences, P.O. Box 342, 7300 Apeldoorn.
[4a] http://statbel.fgov.be/fr/statistiques/chiffres/circulation_et_transport/circulation/parc/
[4b] Federal Public Service Mobility and Transport, http://www.mobilit.belgium.be/fr/
[5] Copert III, Computer Programme to calculate Emissions from Road Transport, European Environment Agency, Technical reports n°49 & 50, Leonidas Ntziachristos and Zissis Samaras ETC/AEM – November 2000.
[6] [7] IPCC 2006 Guidelines
[8] Greenhouse gas emissions from municipal and industrial wastes, W. Debruyn and J. Van Rensbergen ENE.RA9410 Energy division – October 1994.
[9] TEMAT model: Onderzoeksopdracht 'Milieu-impactbepaling van het ontwerp Mobiliteitsplan Vlaanderen d.m.v. strategische m.e.r' - Deelrapport 1: Conceptontwikkeling voor strategische milieueffectrapportage van mobiliteitsplannen (UA, september 2001).
[10] IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and IPCC Good Practice Guidance for LULUCF
[11] Bilans énergétiques de la Région de Bruxelles-Capitale ; 11 rapports finaux ; Institut Wallon ; 1990-2001.
[12] Collecte des données sur les émissions atmosphériques liées à des consommations énergétiques en Région de Bruxelles-Capitale, rapport final ; Institut Wallon ; décembre 1997.
[13] Recensement de la circulation, Ministère des Communications et de l'Infrastructure, 1990-2000.
[14] Collecte des données sur les émissions atmosphériques liées au transport routier en Région de Bruxelles-Capitale, 6 rapports finaux ; Institut Wallon ; 1995-2000.
[15] Ntziachristos L., Samaras Z, 2000. COPERT III, Computer programme to calculate Emissions from Road transport, Methodology and emissions factors. European Environment Agency, Technical report N°49.
[16] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des imprimeries ; Aries ; Décembre 1997.
[17] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des nettoyage à sec ; Aries ; Décembre 1997.
[18] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des stations-services; Aries ; Décembre 1997.
[19] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des incinérateurs; Aries ; Décembre 1997.
[20] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des carrosseries ; Aries ; Décembre 1997.
[21] DGTRE (2001), Bilan énergétique de la région wallonne 1999, rapport juillet 2001, réalisé par l'Institut Wallon.
[22] Econotec (1997), Analyse prévisionnelle des émissions de gaz à effet de serre, CH_4, N_2O et CO_2 en Région wallonne à l'horizon 2000-2005, Etude réalisée pour le Ministère de la Région Wallonne, DGRNE, Namur.
[23] Econotec (2001), Analyse prévisionnelle des émissions atmosphériques liées au secteur du transport en région wallonne. Etude réalisée pour le Ministère de la Région wallonne, DGRNE, Namur.

[24] EMEP/CORINAIR Emission Inventory Guidebook - 3rd edition (2001), European Environment Agency.
[25] FEDIEX (1990), Phone contact between the DGRNE and the Fediex (Fédération Belge des Industries Extractives).
[26] Statistics Belgium (2013) - agriculture census may 2013 , http://statbel.fgov.be/nl/modules/publications/statistiques/economie/downloads/landbouw_landbouwgegevens_van_2013.jsp#.VSZIBTgcTFo and crop production 2013 http://statbel.fgov.be/nl/modules/publications/statistiques/economie/downloads/production_des_cultures_agricoles.jsp , Directorate-general Statistics and Economic information, Statistics Belgium.
[27] INS-transport (2001), 'parc des véhicules à moteur au 1er août 1999', Ministère des affaires économiques, Institut national de statistiques.
[28] IPCC (1996), revised 1996 IPCC Guidelines for National Greenhouse Gas inventories.
[29] MCI (2000), Recensement de la circulation en 1999. N° 17. Ministère des communications et de l'infrastructure Août 2000.
[30] Siterem (2001), 'Estimation des émissions dans l'air de CH_4, NH_3 et N_2O par le secteur agricole en région wallonne'. Rapport final demandé par le Ministère de la Région Wallonne, Direction Générale des Ressources Naturelles et de l'Environnement.
[31] ULG (1998), Inventaire des émissions atmosphériques en Région Wallonne pour 1996 réalisé par l'Université de Liège.
[32] Vasel J.L. (1992), La fosse septique. Les dispositifs d'épuration individuel, Tribune de l'eau, n°560/6-Nov.Déc.1992.
[33] Perrin D. and al., Calculation on the impacts of forestation, afforestation and reforestation on the C-sequestration potential in Belgian forests ecosystems, Biotechnol. Agron. Soc. Environ. 2000 (4), 259-262.
[34] Econotec (2000), Update of the emission inventory of ozone depleting substances, HFCs, PFCs and SF_6 for 1998 and 1999, Study carried out for the Vlaamse Milieu Maatschappij.
[35] Econotec, Ecolas (1999), Développement d'une méthodologie d'inventaire des émissions des substances détruisant la couche d'ozone et des gaz à effet de serre HFC, PFC et SF_6, Etude réalisée pour le compte des Services Fédéraux des Affaires environnementales et de la Vlaamse Milieu Maatschappij.
[36] IPPC (1999), Best Available Techniques Reference Document on the Production of Iron and Steel.
[37] Centre Entreprise-Environnement, UCL, (2000), « analyse des déchets ménagers et de certains flux de déchets non ménagers à haut potentiel recyclable », rapport demandé par l' IBGE.
[38] Bilan energétique de la Belgique - energiebalans België 1999 (comparaison entre le bilan du Ministère des Affaire Economiques et le bilan agrégé des bilans régionaux, pour le compte du Ministère des Affaires Economiques), November 2002.
[39] Econotec (1997), Inventaire 1996 des émissions atmosphériques en région wallonne, groupes 2, 5 et 6 de la nomenclature snap, Etude réalisée pour le Ministère de la Région Wallonne, DGRNE, Namur.
[40] S. Monni and S. Syri, (2001) Uncertainties in the Finish greenhouse gas emission inventory. VTT research notes 2209 (www.vtt.fi/inf/pdf).
[41] K. Rypdal and L-C. Zhang (200) Uncertainties in the Norwegian greenhouse gas emission inventory. Report 2000/13 , Statistics Norway.
[42] Rypdal, K. and Winiwarter, W. (2001) Uncertainties in greenhouse gas inventories – evaluation, comparability and implications. Environmental Science and Policy, Vol 4. Issue, 2-3, pp 107-116.
[43] Theunis et al., Vlaamse koolstofbalans voor het niet-energetisch verbruik, VITO rapport 2003/IMS/R/185.
[44] Joint EMEP/CORINAIR Atmospheric emission inventory guidebook, third edition, prepared by the EMEP Task Force on Emission Inventories and Projections – September 2004.
[45] ECONOTEC, VITO (2009), Update of the emission inventory of ozone depleting substances, HFCs, PFCs and SF_6 for 2010 in Belgium, Final report, study commissioned by the Federal Public Service of Public Health, Food Chain Safety and Environment on behalf of the National Climate Commission, 14 February 2012.
[46] Van Amstel et al., Methane: the other greenhouse gas, RIVM Report 481507001, 58-59, 1993.
[47] Verschut et al., Broeikasgassen uit vuilstorts in Nederland, TNO Report 91-444, 1991.

[48] IBGE, « Le projet de plan de prévention et de gestion des déchets » , septembre 1991.
[49] Campens V. en Lauwers L.: Kunstmestgebruik en gewasproductie als determinanten van de nutriëntenemissie, uitgevoerd door de VMM en CLE, 2002.
[50] Pauwelyn J. & Depuydt S. (1997): Studie der kwantificering van de nutriëntenverliezen per stroombekken naar het oppervlaktewater door landbouwactiviteiten in Vlaanderen: een praktijkgericht onderzoek ter ondersteuning van het milieu- en landbouwbeleid. Instituut voor Scheikundig Onderzoek. 54p.
[51] Foqué D. & Demeyer P. (2009). *Optimalisering en actualisering van de emissie-inventaris ammoniak landbouw.* Instituut voor Landbouw- en Visserijonderzoek. Studie uitgevoerd in opdracht van de Vlaamse Milieumaatschappij. Mededeling ILVO nr 69, 147 p.
[52] Smink W. & all (2004). *Methaanproductie als gevolg van pensfermentatie bij rundvee berekend middles de IPCC-GPG Tier 2 methode*. Feed Innovation Services. Studie uitgevoerd in opdracht van SenterNovem, Utrecht. Rapport FIS: FS 04 12, 45 p.
[53] Safley L.M. Jr. & Casada M.E. (1992). *Global methane emissions from livestock and poultry manure.* EPA report, 145 p.
[54] IPCC (2006), IPCC Guidelines for National Greenhouse Gas inventories.
[55] Bauwens S. (2010) Inventaire sur l'affectation des terres et du changement d'affectation des terres et la foresterie (LULUCF) de la Belgique, Rapport intermédiaire 2 février 2010 Gemboux Agro Biotech. Bauwens S. (2011) Inventaire sur l'affectation des terres et du changement d'affectation des terres et la foresterie (LULUCF) de la Belgique, Rapport final Mai 2011Gemboux Agro Biotech. Bauwens S. (2011) Optimalisatie emissie-inventaris lucht: sector landgebruik en verandering in landgebruik, Final Report, December 2011. Gembloux Agro Biotech.
[56] Goidts E., 2009. Soil organic carbon evolution at the regional scale: Overcoming uncertainties & quantifying driving forces. PhD thesis, Université Catholique de Louvain. http://edoc.bib.ucl.ac.be:81/ETD-db/collection/available/BelnUcetd-02052009-114737/
[57] Goidts E., Van Wesemael B., Van Oost K. (2009), Driving forces of soil organic carbon evolution at the landscape and regional scale using data from a stratified soil monitoring, Global Change Biology, 15(12), 2981-3000. Online at:
http://www3.interscience.wiley.com/journal/122303434/abstract?CRETRY=1&SRETRY=0
[58]Goidts E. and Van Wesemael B. (2007), Regional assessment of soil organic carbon changes under agriculture in Southern Belgium (1955–2005), Geoderma, 141, 341–354. Online at www.sciencedirect.com; (http://198.81.200.2/science?_ob=ArticleURL&_udi=B6V67-4PHSFKV-1&_user=10&_coverDate=10%2F15%2F2007&_alid=1240533772&_rdoc=1&_fmt=high&_orig=search&_cdi=5807&_docanchor=&view=c&_ct=1&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=a4fa54ef721f5ae4400b2be18969df04)
[59] SPW – DGARNE (2010), Tableau de bord de l'environnement wallon. Online at http://etat.environnement.wallonie.be
[60] Arcadis, NMVOC emissions through domestic solvent use and the use of paints in the Brussels Capital Region, Etude réalisée pour Bruxelles Environnement, 2010.
[61] SPF Economie, PME, classes moyennes et Energie, Le marché de l'énergie en 2008, février 2011, http://statbel.fgov.be/fr/modules/publications/statistiques/energie/le_marche_de_l_energie_-_overview.jsp
[62] Lettens et al, 2008. Organic carbon stocks and stock changes of forest biomass in Belgium derived from forest inventory data in a spatially explicit approach. Ann. For. Sci (2008),604.
[63] VLAREM II. 1995. Besluit van de Vlaamse Regering van 1 juni 1995 houdende algemene en sectorale bepalingen inzake milieuhygiëne. Via http://www.lne.be/themas/vergunningen/regelgeving
[64] MIRA 2012,a Indicatorfiche 'Hoeveelheid huishoudelijk afval, versie december 2012, www.milieurapport.be (feiten & cijfers > afval)
[65] MIRA 2012,b Indicatorfiche 'Verwerking van huishoudelijk afval, versie december 2012, www.milieurapport.be (feiten & cijfers > afval)
[66] OVAM, 2011. Michele Kuppens, Luk Umans, Anne Adriaens, Walter Werquin & Bart Vangilbergen. Tarieven en capaciteiten voor storten en verbranden – Actualisatie tot 2011. OVAM-publicatie D/2012/5024/68. Mechelen, OVAM Bestuur, 35 p.
[67] Van Amstel, A., Swart, R.J., Krol, M.S., Beck, J.P., Bouwman, A.F. & Hoek, K.W. 1993. Methane: the other greenhouse gas. RIVM Rapport 481507001.
[68] Verschut, C., Oonk, J. & Mulder, W. 1993. Broeikasgassen uit vuilstorts in Nederland. TNO-rapport 91-444.
[69] Parken & Owen, 1986.

[70] OVAM, 1996. Vanacker, L., Braeckevelt, A. & Vandenbroek, K. Sorteeranalyse-onderzoek huishoudelijke afvalstoffen 1995-1996. OVAM-publicatie D/1996/5024/20. Mechelen, OVAM Bestuur, 60 p. + bijlagen.
[71] VITO, 1999. Technisch-economisch onderzoek naar de haalbaarheid en de implementatie van emissiereductiestrategieën voor CH_4 en N_2O broeikasgassen. Deel 4: Methaanemissies uit stortplaatsen. Briffaerts K., Siebens K. & Wouters G.
[72] OVAM, 2012. Sorteeranalyse grofvuil en analyse grofvuilinzameling. OVAM-publicatie D/2012/5024/20. Mechelen, OVAM Bestuur, 48 p.
[73] Onkelinx T., Van Calster H., Quataert P. (2010). Schaduwmeetnet bosinventarisatie. Studie uitgevoerd in opdracht van het Agentschap voor Natuur en Bos. INBO.R.2010.43. 42p.
[74] Lenders S. & Jespers K. (2009) *Energieverbruik in de Vlaamse landbouwsector 1990-2007, nieuwe methode en resultaten,* Beleidsdomein Landbouw en Visserij, Afdeling Monitoring en Studie, Brussel. http://lv.vlaanderen.be/nlapps/docs/default.asp?id=1426

[75] EUROSTAT_sech,
(http://www.energiesparen.be/node/880)
[76] Dams et al. , Methodologie Energiebalans residentiële sector met focus op houtverbruik, VITO rapport 2013/TEM/R/90, oktober 2013
[77] Aernouts et al., Nota huishoudelijk stookolieverbruik, VITO rapport 2014/TEM/R/2, januari 2014.
[78] Schwarz. W. et al. (2011), Preparatory study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases, Final Report, prepared for the European Commission, September 2011.
[79] Calculation of soil organic carbon evolution in croplands and grasslands in the Flemish Region. Dr. Jeroen Meersmans, Dept. Of Geography, College of Life and Environmental Sciences, University of Exeter (2015). Based on Meersmans, J., Van Wesemael, B., Goidts, E., Van Molle, M., De Baets, S. and De Ridder, F. (2011), Spatial analysis of soil organic carbon evolution in Belgian croplands and grasslands, 1960–2006, Global Change Biology 17: 466–479.

ANNEXES

Annex 1: Key sources analysis

LEVEL ASSESSMENT 1990 with and without LULUCF

IPCC categories Submission 2016	Direct GHG	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 CO_2eq	Gg CO_2eq	Gg CO_2eq	%	%	%	%
		146 021.24	**-2 333.27**	**149 668.69**				
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	19 434.27		19434.27	13.31	13.31	12.98	12.98
1.A.4.b. Residential - Liquid Fuels	CO2	12 800.51		12800.51	8.77	22.08	8.55	21.54
1.A.3.b. Road Transportation - Diesel Oil	CO2	10 963.77		10963.77	7.51	29.58	7.33	28.86
2.C.1. Iron and Steel Production	CO2	10 277.62		10277.62	7.04	36.62	6.87	35.73
1.A.3.b. Road Transportation - Gasoline	CO2	8 360.02		8360.02	5.73	42.35	5.59	41.32
1.A.4.b. Residential - Gaseous Fuels	CO2	5 874.20		5874.20	4.02	46.37	3.92	45.24
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	4 285.28		4285.28	2.93	49.30	2.86	48.10
2.B.2 Nitric Acid Production	N2O	3 421.53		3421.53	2.34	51.65	2.29	50.39
3D1 Direct N2O emissions from managed soils	N2O	3 356.10		3356.10	2.30	53.95	2.24	52.63
1.A.2.a. Iron and Steel - Solid Fuels	CO2	3 283.95		3283.95	2.25	56.20	2.19	54.83
5.A. Solid Waste Disposal	CH4	3 053.39		3053.39	2.09	58.29	2.04	56.87
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2		-2 929.62	2929.62		58.29	1.96	58.82
2.A.1 Cement production	CO2	2 823.78		2823.78	1.93	60.22	1.89	60.71
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	2 764.79		2764.79	1.89	62.11	1.85	62.56
3A1 Non-Dairy Cattle	CH4	2 721.79		2721.79	1.86	63.98	1.82	64.38
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2 532.33		2532.33	1.73	65.71	1.69	66.07
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	2 516.45		2516.45	1.72	67.44	1.68	67.75
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	2 466.35		2466.35	1.69	69.12	1.65	69.40
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	2 314.69		2314.69	1.59	70.71	1.55	70.94
3A1 Dairy Cattle	CH4	2 304.38		2304.38	1.58	72.29	1.54	72.48
2.A.2 Lime production	CO2	2 097.12		2097.12	1.44	73.72	1.40	73.88
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	1 969.04		1969.04	1.35	75.07	1.32	75.20
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	1 933.79		1933.79	1.32	76.40	1.29	76.49

2.B.8 Petrochemical and carbon black production	CO2	1 882.42		1882.42	1.29	77.69	1.26	77.75
1.A.2.c. Chemicals - Liquid Fuels	CO2	1 851.70		1851.70	1.27	78.95	1.24	78.99
1.A.4.b. Residential - Solid Fuels	CO2	1 796.20		1796.20	1.23	80.18	1.20	80.19
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	1 688.70		1688.70	1.16	81.34	1.13	81.32
1.A.2.g. Other - Liquid Fuels	CO2	1 578.69		1578.69	1.08	82.42	1.05	82.37
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	1 508.71		1508.71	1.03	83.45	1.01	83.38
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1 492.90		1492.90	1.02	84.48	1.00	84.38
2.B.9.a. By-product emissions	SF6	1 487.59		1487.59	1.02	85.50	0.99	85.37
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1 364.20		1364.20	0.93	86.43	0.91	86.28
1.A.2.g. Other - Gaseous Fuels	CO2	1 203.94		1203.94	0.82	87.25	0.80	87.09
3D2 Indirect N2O Emissions from managed soils	N2O	1 051.55		1051.55	0.72	87.97	0.70	87.79
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	884.66		884.66	0.61	88.58	0.59	88.38
5.D. Wastewater treatment and discharge	CH4	834.95		834.95	0.57	89.15	0.56	88.94
3B3 Swine	CH4	792.78		792.78	0.54	89.70	0.53	89.47
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	684.19		684.19	0.47	90.16	0.46	89.92
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	674.22		674.22	0.46	90.63	0.45	90.37
2.B.9.a. By-product emissions	C2F6	671.94		671.94	0.46	91.09	0.45	90.82
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	662.56		662.56	0.45	91.54	0.44	91.27
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	650.58		650.58	0.45	91.98	0.43	91.70
1.B.2.b. Natural Gas	CH4	617.71		617.71	0.42	92.41	0.41	92.11
2.B.1 Ammonia Production	CO2	422.74		422.74	0.29	92.70	0.28	92.40
3B1 Non-Dairy Cattle	N2O	417.22		417.22	0.29	92.98	0.28	92.67
1.A.2.c. Chemicals - Solid Fuels	CO2	401.51		401.51	0.27	93.26	0.27	92.94
2.B.9.a. By-product emissions	CF4	368.01		368.01	0.25	93.51	0.25	93.19
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	361.87		361.87	0.25	93.76	0.24	93.43
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	357.60		357.60	0.24	94.00	0.24	93.67
1.B.1.a. Coal Mining and Handling	CH4	355.74		355.74	0.24	94.25	0.24	93.91
2.B.9.b Fugitive emissions	C5F12	351.53		351.53	0.24	94.49	0.23	94.14
5.C.1 Waste incineration / Non-biogenic	CO2	299.50		299.50	0.21	94.69	0.20	94.34
3B1 Dairy Cattle	CH4	296.57		296.57	0.20	94.90	0.20	94.54
2.B.9.b Fugitive emissions	C6F14	288.78		288.78	0.20	95.09	0.19	94.73
2.B.10 Other	CO2	285.15		285.15	0.20	95.29	0.19	94.92
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	281.82		281.82	0.19	95.48	0.19	95.11
2.A.3 Glass production	CO2	266.17		266.17	0.18	95.66	0.18	95.29
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	260.84		260.84	0.18	95.84	0.17	95.46
3A3 Swine	CH4	251.27		251.27	0.17	96.01	0.17	95.63
5.D. Wastewater treatment and discharge	N2O	247.33		247.33	0.17	96.18	0.17	95.80
4.B.1. Cropland remaining Cropland CSC	CO2		238.92	238.92		96.18	0.16	95.96
4.E.2. Land converted to Settlements CSC	CO2		237.42	237.42		96.18	0.16	96.12
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	234.59		234.59	0.16	96.34	0.16	96.27

3B1 Dairy Cattle	N2O	233.60		233.60	0.16	96.50	0.16	96.43
2.B.9.a. By-product emissions	C4F10	228.60		228.60	0.16	96.66	0.15	96.58
1.A.3.c. Railways - Liquid Fuels	CO2	222.45		222.45	0.15	96.81	0.15	96.73
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	220.47		220.47	0.15	96.96	0.15	96.88
3B5 Indirect N2O emissions	N2O	218.32		218.32	0.15	97.11	0.15	97.02
2.B.9.a. By-product emissions	C3F8	215.77		215.77	0.15	97.26	0.14	97.17
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	212.09		212.09	0.15	97.41	0.14	97.31
2.D.1 Lubricant use	CO2	211.11		211.11	0.14	97.55	0.14	97.45
1.A.3.e. Other Transportation - Gaseous Fuels	CO2	196.77		196.77	0.13	97.69	0.13	97.58
2G3. N2O from Product Uses	N2O	196.48		196.48	0.13	97.82	0.13	97.71
3B1 Non-Dairy Cattle	CH4	188.42		188.42	0.13	97.95	0.13	97.84
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	186.18		186.18	0.13	98.08	0.12	97.96
1.A.3.b. Road Transportation - LPG	CO2	169.32		169.32	0.12	98.19	0.11	98.08
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	166.99		166.99	0.11	98.31	0.11	98.19
3G Liming	CO2	161.57		161.57	0.11	98.42	0.11	98.30
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	147.35		147.35	0.10	98.52	0.10	98.39
1.A.4.b. Residential - Solid Fuels	CH4	142.18		142.18	0.10	98.62	0.09	98.49
2.A.4 Other process uses of carbonates	CO2	135.72		135.72	0.09	98.71	0.09	98.58
1.A.3.b. Road Transportation - Gasoline	N2O	135.27		135.27	0.09	98.80	0.09	98.67
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	127.50		127.50	0.09	98.89	0.09	98.76
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	124.21		124.21	0.09	98.97	0.08	98.84
1.A.3.b. Road Transportation - Gasoline	CH4	96.77		96.77	0.07	99.04	0.06	98.90
3B3 Swine	N2O	91.91		91.91	0.06	99.10	0.06	98.96
4.C.2. Land converted to Grassland CSC	CO2		84.55	84.55		99.10	0.06	99.02
1.B.2.c Venting and Flaring	CO2	83.83		83.83	0.06	99.16	0.06	99.08
2.G.2 SF6 and PFCs from other product use	SF6	79.77		79.77	0.05	99.22	0.05	99.13
1.A.4.b. Residential - Biomass	CH4	71.24		71.24	0.05	99.26	0.05	99.18
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	67.38		67.38	0.05	99.31	0.05	99.22
4.B.2. Land converted to Cropland CSC	CO2		63.14	63.14		99.31	0.04	99.26
1.A.3.b. Road Transportation - Diesel Oil	N2O	59.25		59.25	0.04	99.35	0.04	99.30
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	54.02		54.02	0.04	99.39	0.04	99.34
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CO2	50.62		50.62	0.03	99.42	0.03	99.37
2.C.7 Other	CO2	50.43		50.43	0.03	99.46	0.03	99.41
1.A.4.b. Residential - Liquid Fuels	CH4	43.67		43.67	0.03	99.49	0.03	99.44
4.C.1. Grassland remaining Grassland CSC	CO2		-43.32	43.32		99.49	0.03	99.47
2.B.9.a. By-product emissions	C5F12	41.01		41.01	0.03	99.52	0.03	99.49
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	38.43		38.43	0.03	99.54	0.03	99.52
3A2 Sheep	CH4	38.43		38.43	0.03	99.57	0.03	99.54
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	37.25		37.25	0.03	99.59	0.02	99.57
1.B.1.b. Solid Fuel Transformation	CH4	36.66		36.66	0.03	99.62	0.02	99.59

1.A.2.g. Other - Solid Fuels	CO2	33.22		33.22	0.02	99.64	0.02	99.62
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	30.70		30.70	0.02	99.66	0.02	99.64
1.A.4.b. Residential - Liquid Fuels	N2O	30.31		30.31	0.02	99.68	0.02	99.66
1.A.3.e. Other Transportation - Liquid Fuels	CO2	29.12		29.12	0.02	99.70	0.02	99.68
2.B.9.b Fugitive emissions	C4F10	25.40		25.40	0.02	99.72	0.02	99.69
1.A.3.b. Road Transportation - Diesel Oil	CH4	22.39		22.39	0.02	99.74	0.01	99.71
4.D.2. Land converted to Wetlands CSC	CO2		17.85	17.85		99.74	0.01	99.72
4.A.2. Land converted to Forest Land CSC	CO2		-17.43	17.43		99.74	0.01	99.73
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	16.96		16.96	0.01	99.75	0.01	99.74
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	16.82		16.82	0.01	99.76	0.01	99.75
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	14.88		14.88	0.01	99.77	0.01	99.76
1.A.2.g. Other - Liquid Fuels	N2O	13.91		13.91	0.01	99.78	0.01	99.77
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	13.89		13.89	0.01	99.79	0.01	99.78
2.C.1. Iron and Steel Production	CH4	13.66		13.66	0.01	99.80	0.01	99.79
1.A.4.b. Residential - Gaseous Fuels	CH4	13.08		13.08	0.01	99.81	0.01	99.80
1.A.3.c. Railways - Liquid Fuels	N2O	12.14		12.14	0.01	99.81	0.01	99.81
1.B.2.a. Oil	CH4	11.38		11.38	0.01	99.82	0.01	99.82
1.A.4.b. Residential - Biomass	N2O	11.32		11.32	0.01	99.83	0.01	99.82
1.A.2.f. Non-metallic minerals - Solid Fuels	N2O	10.81		10.81	0.01	99.84	0.01	99.83
3A4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	10.65		10.65	0.01	99.85	0.01	99.84
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	N2O	10.18		10.18	0.01	99.85	0.01	99.85
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	10.02		10.02	0.01	99.86	0.01	99.85
1.A.4.a. Commercial / Institutional - Solid Fuels	CO2	9.01		9.01	0.01	99.87	0.01	99.86
2.B.10 Other	N2O	8.94		8.94	0.01	99.87	0.01	99.86
1.A.2.a. Iron and Steel - Solid Fuels	N2O	8.66		8.66	0.01	99.88	0.01	99.87
1.A.4.b. Residential - Solid Fuels	N2O	8.47		8.47	0.01	99.88	0.01	99.88
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	8.21		8.21	0.01	99.89	0.01	99.88
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	7.86		7.86	0.01	99.89	0.01	99.89
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	7.80		7.80	0.01	99.90	0.01	99.89
1.A.2.f. Non-metallic minerals - Solid Fuels	CH4	7.77		7.77	0.01	99.90	0.01	99.90
2.G.1. Electrical equipment	SF6	7.75		7.75	0.01	99.91	0.01	99.90
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	7.59		7.59	0.01	99.92	0.01	99.91
1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	5.57		5.57	0.00	99.92	0.00	99.91
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	4.87		4.87	0.00	99.92	0.00	99.91
4.A.1 biomass burning	N2O		4.68	4.68		99.92	0.00	99.92
1.A.2.d. Pulp, Paper and Print - biomass	N2O	4.66		4.66	0.00	99.93	0.00	99.92
1.A.2.f. Non-metallic minerals - Liquid Fuels	N2O	4.55		4.55	0.00	99.93	0.00	99.92
1.A.2.g. Other - Liquid Fuels	CH4	4.55		4.55	0.00	99.93	0.00	99.93
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	4.31		4.31	0.00	99.93	0.00	99.93
1.A.2.c. Chemicals - Liquid Fuels	N2O	4.22		4.22	0.00	99.94	0.00	99.93

4.E.2. Direct N2O emissions from N mineralization/immobilisation	N2O		4.06	4.06		99.94	0.00	99.93
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CO2	3.98		3.98	0.00	99.94	0.00	99.94
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	3.95		3.95	0.00	99.94	0.00	99.94
5.B. Biological treatment of solid waste	N2O	3.95		3.95	0.00	99.95	0.00	99.94
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	3.78		3.78	0.00	99.95	0.00	99.95
4.B.2. Direct N2O emissions from N mineralization/immobilisation	N2O		3.73	3.73		99.95	0.00	99.95
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	3.28		3.28	0.00	99.95	0.00	99.95
1.A.2.a. Iron and Steel - Solid Fuels	CH4	3.22		3.22	0.00	99.95	0.00	99.95
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	3.14		3.14	0.00	99.96	0.00	99.95
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	3.13		3.13	0.00	99.96	0.00	99.96
1.A.4.b. Residential - Gaseous Fuels	N2O	3.12		3.12	0.00	99.96	0.00	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	3.06		3.06	0.00	99.96	0.00	99.96
1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	2.99		2.99	0.00	99.96	0.00	99.96
2.D.2 Paraffin wax use	CO2	2.95		2.95	0.00	99.97	0.00	99.96
1.A.3.d. Navigation - Gas/Diesel Oil	N2O	2.88		2.88	0.00	99.97	0.00	99.97
5.B. Biological treatment of solid waste	CH4	2.59		2.59	0.00	99.97	0.00	99.97
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH4	2.51		2.51	0.00	99.97	0.00	99.97
4.C.1. Direct N2O emissions from N mineralization/immobilisation	N2O		1.94	1.94		99.97	0.00	99.97
1.A.2.c. Chemicals - Liquid Fuels	CH4	1.77		1.77	0.00	99.97	0.00	99.97
1.A.2.c. Chemicals - Solid Fuels	N2O	1.75		1.75	0.00	99.97	0.00	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	1.71		1.71	0.00	99.97	0.00	99.97
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	1.67		1.67	0.00	99.98	0.00	99.98
1.A.2.d. Pulp, Paper and Print - biomass	CH4	1.64		1.64	0.00	99.98	0.00	99.98
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.61		1.61	0.00	99.98	0.00	99.98
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	1.56		1.56	0.00	99.98	0.00	99.98
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH4	1.48		1.48	0.00	99.98	0.00	99.98
5.C.1 Waste incineration / Biogenic	N2O	1.40		1.40	0.00	99.98	0.00	99.98
1.A.2.c. Chemicals - Other Fuels	CH4	1.39		1.39	0.00	99.98	0.00	99.98
1.A.2.c. Chemicals - Gaseous Fuels	N2O	1.37		1.37	0.00	99.98	0.00	99.98
5.C.1 Waste incineration / Non-biogenic	N2O	1.24		1.24	0.00	99.98	0.00	99.98
1.A.2.c. Chemicals - Gaseous Fuels	CH4	1.15		1.15	0.00	99.98	0.00	99.98
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N2O	1.14		1.14	0.00	99.99	0.00	99.99
1.A.3.b. Road Transportation - LPG	CH4	1.09		1.09	0.00	99.99	0.00	99.99
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	1.03		1.03	0.00	99.99	0.00	99.99
1.A.3.b. Road Transportation - LPG	N2O	1.01		1.01	0.00	99.99	0.00	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	1.00		1.00	0.00	99.99	0.00	99.99
3B2 Sheep	N2O	0.99		0.99	0.00	99.99	0.00	99.99
1.A.2.c. Chemicals - Solid Fuels	CH4	0.99		0.99	0.00	99.99	0.00	99.99
3B2 Sheep	CH4	0.91		0.91	0.00	99.99	0.00	99.99
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CH4	0.88		0.88	0.00	99.99	0.00	99.99

1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	0.75		0.75	0.00	99.99	0.00	99.99
1.B.2.b. Natural Gas	CO2	0.73		0.73	0.00	99.99	0.00	99.99
1.A.2.c. Chemicals - Other Fuels	N2O	0.66		0.66	0.00	99.99	0.00	99.99
1.A.2.g. Other - Gaseous Fuels	N2O	0.64		0.64	0.00	99.99	0.00	99.99
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	0.64		0.64	0.00	99.99	0.00	99.99
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.62		0.62	0.00	99.99	0.00	99.99
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.62		0.62	0.00	99.99	0.00	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.61		0.61	0.00	99.99	0.00	99.99
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.60		0.60	0.00	99.99	0.00	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.57		0.57	0.00	100.00	0.00	99.99
4.A.1 biomass burning	CH4		0.57	0.57		100.00	0.00	99.99
1.A.2.g. Other - Gaseous Fuels	CH4	0.54		0.54	0.00	100.00	0.00	100.00
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	0.52		0.52	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.51		0.51	0.00	100.00	0.00	100.00
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.50		0.50	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.48		0.48	0.00	100.00	0.00	100.00
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0.44		0.44	0.00	100.00	0.00	100.00
1.A.3.c. Railways - Liquid Fuels	CH4	0.35		0.35	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.34		0.34	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation - Liquid Fuels	N2O	0.34		0.34	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.34		0.34	0.00	100.00	0.00	100.00
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0.30		0.30	0.00	100.00	0.00	100.00
1.A.2.f. Non-metallic minerals - Other Fuels	N2O	0.28		0.28	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.21		0.21	0.00	100.00	0.00	100.00
4.C.2. Direct N2O emissions from N mineralization/immobilisation	N2O		0.21	0.21		100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.19		0.19	0.00	100.00	0.00	100.00
1.A.3.b. Road Transportation - Other liquid fuels - Lubricants	CO2	0.19		0.19	0.00	100.00	0.00	100.00
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	0.18		0.18	0.00	100.00	0.00	100.00
1.A.2.g. Other - Solid Fuels	N2O	0.15		0.15	0.00	100.00	0.00	100.00
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	0.15		0.15	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.15		0.15	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.14		0.14	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.13		0.13	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.12		0.12	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.11		0.11	0.00	100.00	0.00	100.00
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	0.11		0.11	0.00	100.00	0.00	100.00
1.A.2.g. Other - Solid Fuels	CH4	0.08		0.08	0.00	100.00	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.07		0.07	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.05		0.05	0.00	100.00	0.00	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	N2O	0.04		0.04	0.00	100.00	0.00	100.00

1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.04		0.04	0.00	100.00	0.00	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	N2O	0.03		0.03	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.03		0.03	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation - Gaseous Fuels	CH4	0.03		0.03	0.00	100.00	0.00	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	CH4	0.02		0.02	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	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
4.A.2. Direct N2O emissions from N mineralization/immobilisation	N2O		0.0149	0.0149		100.00	0.00	100.00
1.B.2.a. Oil	CO2	0.0143		0.0143	0.00	100.00	0.00	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	N2O	0.0096		0.0096	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.0090		0.0090	0.00	100.00	0.00	100.00
1.A.2.g. Other - biomass	N2O	0.0089		0.0089	0.00	100.00	0.00	100.00
1.A.2.g. Other - biomass	CH4	0.0063		0.0063	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	N2O	0.0049		0.0049	0.00	100.00	0.00	100.00
4.D.2. Direct N2O emissions from N mineralization/immobilisation	N2O		0.0046	0.0046		100.00	0.00	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CH4	0.0040		0.0040	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	CH4	0.0031		0.0031	0.00	100.00	0.00	100.00
1.A.2.f. Non-metallic minerals - Other Fuels	CH4	0.0025		0.0025	0.00	100.00	0.00	100.00
Key source according level assessment with LuLucf								
Not a key source according level assessment without LuLucf								
Supplementary key sources (according qualitative analysis)								
4.A.1. FL remaining FL / Net Carbon stock change in living biomass	CO2		-1 597.40					
4.A.1. FL remaining FL / Net carbon stock change in soils	CO2		-1 370.86					

LEVEL ASSESSMENT 2013 with and without LULUCF

IPCC categories Submission 2016	Direct GHG	2013 estimate (non-Lulucf)	2013 estimate (Lulucf)	2013 estimate (Absolute value)	level assessment 2013 without LULUCF	Cumulative total without LULUCF	level assessment 2013 with LULUCF	Cumulative total with LULUCF
		Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%	%	%	%
		119 375.30	**-3 756.53**	**126 372.27**				
1.A.3.b. Road Transportation - Diesel Oil	CO2	20 043.14		20 043.14	16.79	16.79	15.86	15.86
1.A.4.b. Residential - Liquid Fuels	CO2	9 331.05		9 331.05	7.82	24.61	7.38	23.24
1.A.4.b. Residential - Gaseous Fuels	CO2	8 782.50		8 782.50	7.36	31.96	6.95	30.19
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	7 543.94		7 543.94	6.32	38.28	5.97	36.16
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	7 159.61		7 159.61	6.00	44.28	5.67	41.83
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	4 541.71		4 541.71	3.80	48.09	3.59	45.42
2.C.1. Iron and Steel Production	CO2	3 799.05		3 799.05	3.18	51.27	3.01	48.43
2.B.8 Petrochemical and carbon black production	CO2	3 737.97		3 737.97	3.13	54.40	2.96	51.39
4.A.1. Forest Land remaining Forest Land CSC	CO2		-3 707.63	3 707.63	0.00	54.40	2.93	54.32
1.A.3.b. Road Transportation - Gasoline	CO2	3 458.83		3 458.83	2.90	57.30	2.74	57.06
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	3 458.27		3 458.27	2.90	60.19	2.74	59.79
1.A.2.c. Chemicals - Gaseous Fuels	CO2	3 207.36		3 207.36	2.69	62.88	2.54	62.33
3A1 Non-Dairy Cattle	CH4	2 584.58		2 584.58	2.17	65.05	2.05	64.38
3D1 Direct N2O emissions from managed soils	N2O	2 555.63		2 555.63	2.14	67.19	2.02	66.40
2.A.1 Cement production	CO2	2 541.37		2 541.37	2.13	69.32	2.01	68.41
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	1 865.99		1 865.99	1.56	70.88	1.48	69.89
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	1 814.22		1 814.22	1.52	72.40	1.44	71.32
2.B.10 Other	CO2	1 739.14		1 739.14	1.46	73.85	1.38	72.70
2.A.2 Lime production	CO2	1 629.16		1 629.16	1.36	75.22	1.29	73.99
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	1 581.52		1 581.52	1.32	76.54	1.25	75.24
3A1 Dairy Cattle	CH4	1 535.41		1 535.41	1.29	77.83	1.21	76.46
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	1 522.21		1 522.21	1.28	79.11	1.20	77.66
1.A.2.g. Other - Gaseous Fuels	CO2	1 344.97		1 344.97	1.13	80.23	1.06	78.72
2.B.1 Ammonia Production	CO2	1 246.58		1 246.58	1.04	81.28	0.99	79.71
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1 154.40		1 154.40	0.97	82.24	0.91	80.62
5.A. Solid Waste Disposal	CH4	1 140.58		1 140.58	0.96	83.20	0.90	81.53
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	1 111.19		1 111.19	0.93	84.13	0.88	82.41
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	987.11		987.11	0.83	84.96	0.78	83.19
1.A.2.g. Other - Liquid Fuels	CO2	936.67		936.67	0.78	85.74	0.74	83.93
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	914.27		914.27	0.77	86.51	0.72	84.65

4.B.1. Cropland remaining Cropland CSC	CO2		-901.21	901.21	0.00	86.51	0.71	85.36
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	867.26		867.26	0.73	87.23	0.69	86.05
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	861.28		861.28	0.72	87.96	0.68	86.73
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	823.28		823.28	0.69	88.65	0.65	87.38
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	816.86		816.86	0.68	89.33	0.65	88.03
3B3 Swine	CH4	756.15		756.15	0.63	89.96	0.60	88.63
3D2 Indirect N2O Emissions from managed soils	N2O	706.28		706.28	0.59	90.55	0.56	89.19
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	680.33		680.33	0.57	91.12	0.54	89.73
4.E.2. Land converted to Settlements CSC	CO2		618.76	618.76	0.00	91.12	0.49	90.22
4.B.2. Land converted to Cropland CSC	CO2		557.07	557.07	0.00	91.12	0.44	90.66
2.B.2 Nitric Acid Production	N2O	555.28		555.28	0.47	91.59	0.44	91.10
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	527.82		527.82	0.44	92.03	0.42	91.51
1.B.2.b. Natural Gas	CH4	440.52		440.52	0.37	92.40	0.35	91.86
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	429.80		429.80	0.36	92.76	0.34	92.20
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	422.47		422.47	0.35	93.11	0.33	92.54
1.A.4.b. Residential - Solid Fuels	CO2	359.71		359.71	0.30	93.42	0.28	92.82
3B1 Non-Dairy Cattle	N2O	356.44		356.44	0.30	93.71	0.28	93.10
4.G Harvest wood products	CO2		336.31	336.31	0.00	93.71	0.27	93.37
3B1 Dairy Cattle	CH4	312.12		312.12	0.26	93.98	0.25	93.62
5.C.1 Waste incineration / Non-biogenic	CO2	310.07		310.07	0.26	94.24	0.25	93.86
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	296.92		296.92	0.25	94.48	0.23	94.10
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	293.36		293.36	0.25	94.73	0.23	94.33
4.A.2. Land converted to Forest Land CSC	CO2		-287.98	287.98	0.00	94.73	0.23	94.56
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	282.18		282.18	0.24	94.97	0.22	94.78
4.C.2. Land converted to Grassland CSC	CO2		-281.44	281.44	0.00	94.97	0.22	95.003
5.D. Wastewater treatment and discharge	N2O	268.53		268.53	0.22	95.19	0.21	95.22
3A3 Swine	CH4	252.30		252.30	0.21	95.40	0.20	95.41
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	240.12		240.12	0.20	95.60	0.19	95.60
2.B.9.b Fugitive emissions	C4F10	227.17		227.17	0.19	95.79	0.18	95.78
1.A.3.b. Road Transportation - Diesel Oil	N2O	219.49		219.49	0.18	95.98	0.17	95.96
5.D. Wastewater treatment and discharge	CH4	215.19		215.19	0.18	96.16	0.17	96.13
1.A.2.c. Chemicals - Liquid Fuels	CO2	204.08		204.08	0.17	96.33	0.16	96.29
1.A.4.b. Residential - Biomass	CH4	197.37		197.37	0.17	96.49	0.16	96.45
4.C.1. Grassland remaining Grassland CSC	CO2		-194.25	194.25	0.00	96.49	0.15	96.60
2.B.9.b Fugitive emissions	C6F14	191.31		191.31	0.16	96.65	0.15	96.75
3B5 Indirect N2O emissions	N2O	187.18		187.18	0.16	96.81	0.15	96.90
3B1 Non-Dairy Cattle	CH4	180.05		180.05	0.15	96.96	0.14	97.04
2.A.4 Other process uses of carbonates	CO2	170.21		170.21	0.14	97.11	0.13	97.18
2.A.3 Glass production	CO2	165.11		165.11	0.14	97.24	0.13	97.31
3G Liming	CO2	133.40		133.40	0.11	97.36	0.11	97.41

1.A.3.e. Other Transportation - Gaseous Fuels	CO2	126.71		126.71	0.11	97.46	0.10	97.51
1.B.2.c Venting and Flaring	CO2	118.50		118.50	0.10	97.56	0.09	97.61
1.A.3.b. Road Transportation - LPG	CO2	116.07		116.07	0.10	97.66	0.09	97.70
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	101.99		101.99	0.09	97.74	0.08	97.78
2.G.2 SF6 and PFCs from other product use	SF6	101.03		101.03	0.08	97.83	0.08	97.86
3B1 Dairy Cattle	N2O	100.83		100.83	0.08	97.91	0.08	97.94
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	99.95		99.95	0.08	98.00	0.08	98.02
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	98.72		98.72	0.08	98.08	0.08	98.10
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	97.09		97.09	0.08	98.16	0.08	98.17
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	93.81		93.81	0.08	98.24	0.07	98.25
1.A.2.d. Pulp, Paper and Print - Other Fuels	CO2	92.38		92.38	0.08	98.32	0.07	98.32
1.A.3.c. Railways - Liquid Fuels	CO2	88.42		88.42	0.07	98.39	0.07	98.39
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	86.41		86.41	0.07	98.46	0.07	98.46
2G3. N2O from Product Uses	N2O	83.73		83.73	0.07	98.53	0.07	98.53
2.F.4. Aerosols	HFC-134a	81.80		81.80	0.07	98.60	0.06	98.59
3B3 Swine	N2O	78.38		78.38	0.07	98.67	0.06	98.65
2.C.7 Other	CO2	73.96		73.96	0.06	98.73	0.06	98.71
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	70.10		70.10	0.06	98.79	0.06	98.77
1.A.3.e. Other Transportation - Liquid Fuels	CO2	64.13		64.13	0.05	98.84	0.05	98.82
2.D.1 Lubricant use	CO2	63.38		63.38	0.05	98.89	0.05	98.87
1.A.2.g. Other - Other Fuels	CO2	59.73		59.73	0.05	98.94	0.05	98.91
4.E.2. Direct N2O emissions from N mineralization/immobilisation	N2O		52.49	52.49	0.00	98.94	0.04	98.96
4.B.2. Direct N2O emissions from N mineralization/immobilisation	N2O		51.21	51.21	0.00	98.94	0.04	99.00
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	50.98		50.98	0.04	98.99	0.04	99.04
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	48.46		48.46	0.04	99.03	0.04	99.07
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-32	44.53		44.53	0.04	99.06	0.04	99.11
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	42.97		42.97	0.04	99.10	0.03	99.14
2.F.2. Foam Blowing Agents	HFC-134a	39.53		39.53	0.03	99.13	0.03	99.18
5.B. Biological treatment of solid waste	N2O	38.27		38.27	0.03	99.17	0.03	99.21
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	36.72		36.72	0.03	99.20	0.03	99.23
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	35.71		35.71	0.03	99.23	0.03	99.26
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	34.31		34.31	0.03	99.26	0.03	99.29
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	34.09		34.09	0.03	99.28	0.03	99.32
3A4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	34.08		34.08	0.03	99.31	0.03	99.34
1.A.4.b. Residential - Liquid Fuels	CH4	31.99		31.99	0.03	99.34	0.03	99.37
1.A.4.b. Residential - Biomass	N2O	31.37		31.37	0.03	99.37	0.02	99.39
1.A.4.b. Residential - Solid Fuels	CH4	28.52		28.52	0.02	99.39	0.02	99.42
1.A.2.a. Iron and Steel - Solid Fuels	CO2	26.77		26.77	0.02	99.41	0.02	99.44
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	26.70		26.70	0.02	99.43	0.02	99.46

5.B. Biological treatment of solid waste	CH4	25.08	25.08	0.02	99.46	0.02	99.48
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	24.75	24.75	0.02	99.48	0.02	99.50
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	24.70	24.70	0.02	99.50	0.02	99.52
1.A.4.b. Residential - Liquid Fuels	N2O	22.26	22.26	0.02	99.52	0.02	99.54
3A2 Sheep	CH4	21.56	21.56	0.02	99.53	0.02	99.55
1.A.4.a. Commercial / Institutional - Biomass	CH4	21.08	21.08	0.02	99.55	0.02	99.57
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	CH4	21.04	21.04	0.02	99.57	0.02	99.59
2H. Other	CO2	20.60	20.60	0.02	99.59	0.02	99.60
2.F.2. Foam Blowing Agents	HFC-152a	19.83	19.83	0.02	99.60	0.02	99.62
1.A.4.b. Residential - Gaseous Fuels	CH4	19.57	19.57	0.02	99.62	0.02	99.63
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	18.88	18.88	0.02	99.63	0.01	99.65
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	18.42	18.42	0.02	99.65	0.01	99.66
2.B.10 Other	N2O	16.71	16.71	0.01	99.66	0.01	99.68
2.D.3 Other urea	CO2	16.70	16.70	0.01	99.68	0.01	99.69
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	N2O	16.37	16.37	0.01	99.69	0.01	99.70
2.C.1. Iron and Steel Production	CH4	15.83	15.83	0.01	99.71	0.01	99.71
1.A.2.d. Pulp, Paper and Print - biomass	N2O	14.60	14.60	0.01	99.72	0.01	99.73
1.A.2.g. Other - Liquid Fuels	N2O	14.32	14.32	0.01	99.73	0.01	99.74
1.A.2.g. Other - Solid Fuels	CO2	13.74	13.74	0.01	99.74	0.01	99.75
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	12.92	12.92	0.01	99.75	0.01	99.76
2.G.1. Electrical equipment	SF6	12.41	12.41	0.01	99.76	0.01	99.77
1.A.3.b. Road Transportation - Gasoline	N2O	11.89	11.89	0.01	99.77	0.01	99.78
1.A.3.b. Road Transportation - Biomass	N2O	11.81	11.81	0.01	99.78	0.01	99.79
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	11.68	11.68	0.01	99.79	0.01	99.80
1.A.3.b. Road Transportation - Gasoline	CH4	11.30	11.30	0.01	99.80	0.01	99.81
2.F.3. Fire protection	HFC-227ea	10.94	10.94	0.01	99.81	0.01	99.81
1.A.2.f. Non-metallic minerals - Solid Fuels	CH4	10.77	10.77	0.01	99.82	0.01	99.82
1.A.2.f. Non-metallic minerals - Solid Fuels	N2O	9.63	9.63	0.01	99.83	0.01	99.83
1.A.1.a. Public Electricity and Heat Production - Biomass	CH4	9.14	9.14	0.01	99.84	0.01	99.84
1.A.2.f. Non-metallic minerals - biomass	N2O	8.31	8.31	0.01	99.84	0.01	99.84
1.A.2.c. Chemicals - Other Fuels	CO2	8.24	8.24	0.01	99.85	0.01	99.85
1.A.2.f. Non-metallic minerals - Other Fuels	N2O	7.74	7.74	0.01	99.86	0.01	99.86
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	7.25	7.25	0.01	99.86	0.01	99.86
1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	7.23	7.23	0.01	99.87	0.01	99.87
1.A.2.d. Pulp, Paper and Print - biomass	CH4	6.61	6.61	0.01	99.87	0.01	99.87
2.D.2 Paraffin wax use	CO2	6.37	6.37	0.01	99.88	0.01	99.88
1.B.2.a. Oil	CH4	6.24	6.24	0.01	99.88	0.00	99.88
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	5.06	5.06	0.00	99.89	0.00	99.89

1.A.2.c. Chemicals - Biomass	N2O	4.85		4.85	0.00	99.89	0.00	99.89
1.A.2.c. Chemicals - Other Fuels	CH4	4.78		4.78	0.00	99.90	0.00	99.90
1.A.4.b. Residential - Gaseous Fuels	N2O	4.66		4.66	0.00	99.90	0.00	99.90
2.B.10 Other	CH4	4.56		4.56	0.00	99.90	0.00	99.90
1.A.3.b. Road Transportation - Diesel Oil	CH4	4.44		4.44	0.00	99.91	0.00	99.91
4.D.2. Land converted to Wetlands CSC	CO2		-4.24	4.24	0.00	99.91	0.00	99.91
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	4.10		4.10	0.00	99.91	0.00	99.91
1.B.1.b. Solid Fuel Transformation	CH4	4.04		4.04	0.00	99.91	0.00	99.92
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	4.01		4.01	0.00	99.92	0.00	99.92
2.B.9.a. By-product emissions	CF4	3.92		3.92	0.00	99.92	0.00	99.92
1.A.3.c. Railways - Liquid Fuels	N2O	3.77		3.77	0.00	99.92	0.00	99.93
1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	3.58		3.58	0.00	99.93	0.00	99.93
1.A.3.d. Navigation - Gas/Diesel Oil	N2O	3.41		3.41	0.00	99.93	0.00	99.93
2.E.1 Integrated Circuit or Semiconductor	C2F6	3.34		3.34	0.00	99.93	0.00	99.93
2.E.1 Integrated Circuit or Semiconductor	CF4	3.30		3.30	0.00	99.94	0.00	99.94
1.A.2.c. Chemicals - Solid Fuels	CO2	3.11		3.11	0.00	99.94	0.00	99.94
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	2.91		2.91	0.00	99.94	0.00	99.94
4.C.2. Direct N2O emissions from N mineralization/immobilisation	N2O		2.86	2.86	0.00	99.94	0.00	99.94
1.A.2.f. Non-metallic minerals - biomass	CH4	2.74		2.74	0.00	99.94	0.00	99.94
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	2.73		2.73	0.00	99.95	0.00	99.95
1.A.2.g. Other - Liquid Fuels	CH4	2.72		2.72	0.00	99.95	0.00	99.95
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	2.41		2.41	0.00	99.95	0.00	99.95
1.A.2.f. Non-metallic minerals - Other Fuels	CH4	2.39		2.39	0.00	99.95	0.00	99.95
2.E.1 Integrated Circuit or Semiconductor	SF6	2.31		2.31	0.00	99.95	0.00	99.95
1.A.2.c. Chemicals - Other Fuels	N2O	2.28		2.28	0.00	99.96	0.00	99.96
2.F.1. Refrigeration and Air Conditioning Equipment	C3F8	2.13		2.13	0.00	99.96	0.00	99.96
1.A.2.c. Chemicals - Gaseous Fuels	N2O	2.02		2.02	0.00	99.96	0.00	99.96
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	2.02		2.02	0.00	99.96	0.00	99.96
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	1.99		1.99	0.00	99.96	0.00	99.96
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	1.86		1.86	0.00	99.96	0.00	99.96
1.A.4.b. Residential - Solid Fuels	N2O	1.70		1.70	0.00	99.97	0.00	99.97
1.A.2.b. Non-Ferrous Metals - Other fuels	CO2	1.68		1.68	0.00	99.97	0.00	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	1.62		1.62	0.00	99.97	0.00	99.97
2.E.1 Integrated Circuit or Semiconductor	HFC-23	1.44		1.44	0.00	99.97	0.00	99.97
1.A.2.c. Chemicals - Gaseous Fuels	CH4	1.43		1.43	0.00	99.97	0.00	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	1.35		1.35	0.00	99.97	0.00	99.97
1.A.2.g. Other - biomass	N2O	1.33		1.33	0.00	99.97	0.00	99.97
1.A.2.f. Non-metallic minerals - Liquid Fuels	N2O	1.32		1.32	0.00	99.97	0.00	99.97
1.A.3.b. Road Transportation - Gaseous fuels	CO2	1.25		1.25	0.00	99.97	0.00	99.98
2.E.1 Integrated Circuit or Semiconductor	NF3	1.24		1.24	0.00	99.98	0.00	99.98

4.C.1. Direct N2O emissions from N mineralization/immobilisation	N2O		1.14	1.14	0.00	99.98	0.00	99.98
1.A.2.d. Pulp, Paper and Print - Other Fuels	N2O	1.12		1.12	0.00	99.98	0.00	99.98
2.F.3. Fire protection	HFC-125	1.04		1.04	0.00	99.98	0.00	99.98
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	1.02		1.02	0.00	99.98	0.00	99.98
1.A.3.b. Road Transportation - Biomass	CH4	0.96		0.96	0.00	99.98	0.00	99.98
1.A.4.a. Commercial / Institutional - Biomass	N2O	0.93		0.93	0.00	99.98	0.00	99.98
1.A.2.c. Chemicals - Biomass	CH4	0.91		0.91	0.00	99.98	0.00	99.98
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0.87		0.87	0.00	99.98	0.00	99.98
1.A.3.b. Road Transportation - LPG	N2O	0.86		0.86	0.00	99.98	0.00	99.98
1.A.2.g. Other - biomass	CH4	0.84		0.84	0.00	99.98	0.00	99.98
1.A.3.e. Other Transportation - Liquid Fuels	N2O	0.82		0.82	0.00	99.98	0.00	99.98
2.F.2. Foam Blowing Agents	HFC-245fa	0.80		0.80	0.00	99.98	0.00	99.98
1.A.2.g. Other - Other Fuels	N2O	0.80		0.80	0.00	99.99	0.00	99.99
2.F.2. Foam Blowing Agents	HFC-365mfc	0.74		0.74	0.00	99.99	0.00	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	N2O	0.74		0.74	0.00	99.99	0.00	99.99
1.A.2.g. Other - Gaseous Fuels	N2O	0.72		0.72	0.00	99.99	0.00	99.99
1.A.2.d. Pulp, Paper and Print - Other Fuels	CH4	0.70		0.70	0.00	99.99	0.00	99.99
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	0.68		0.68	0.00	99.99	0.00	99.99
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N2O	0.62		0.62	0.00	99.99	0.00	99.99
1.A.2.g. Other - Gaseous Fuels	CH4	0.60		0.60	0.00	99.99	0.00	99.99
2.F.4. Aerosols	HFC-227ea	0.56		0.56	0.00	99.99	0.00	99.99
3B2 Sheep	N2O	0.55		0.55	0.00	99.99	0.00	99.99
3B2 Sheep	CH4	0.51		0.51	0.00	99.99	0.00	99.99
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH4	0.50		0.50	0.00	99.99	0.00	99.99
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.50		0.50	0.00	99.99	0.00	99.99
1.A.2.g. Other - Other Fuels	CH4	0.50		0.50	0.00	99.99	0.00	99.99
5.C.1 Waste incineration / Biogenic	N2O	0.49		0.49	0.00	99.99	0.00	99.99
1.B.2.b. Natural Gas	CO2	0.48		0.48	0.00	99.99	0.00	99.99
1.A.2.c. Chemicals - Liquid Fuels	N2O	0.48		0.48	0.00	99.99	0.00	99.99
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	0.46		0.46	0.00	99.99	0.00	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.46		0.46	0.00	99.99	0.00	99.99
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH4	0.42		0.42	0.00	99.99	0.00	99.99
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	0.40		0.40	0.00	99.99	0.00	99.99
5.C.1 Waste incineration / Non-biogenic	N2O	0.37		0.37	0.00	99.99	0.00	99.99
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.37		0.37	0.00	99.99	0.00	99.99
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.35		0.35	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	0.34		0.34	0.00	100.00	0.00	100.00
1.A.3.b. Road Transportation - LPG	CH4	0.34		0.34	0.00	100.00	0.00	100.00

1.A.3.b. Road Transportation - Other liquid fuels - Lubricants	CO2	0.33		0.33	0.00	100.00	0.00	100.00
4.D.2. Direct N2O emissions from N mineralization/immobilisation	N2O		0.33	0.33	0.00	100.00	0.00	100.00
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	0.29		0.29	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.28		0.28	0.00	100.00	0.00	100.00
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	0.26		0.26	0.00	100.00	0.00	100.00
2.G.2 SF6 and PFCs from other product use	C6F14	0.22		0.22	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.22		0.22	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.20		0.20	0.00	100.00	0.00	100.00
1.A.2.c. Chemicals - Liquid Fuels	CH4	0.20		0.20	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.19		0.19	0.00	100.00	0.00	100.00
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	0.17		0.17	0.00	100.00	0.00	100.00
1.B.2.c Venting and Flaring	CH4	0.17		0.17	0.00	100.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor	c-C4F8	0.17		0.17	0.00	100.00	0.00	100.00
2.F.4. Aerosols	HFC-152a	0.16		0.16	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.16		0.16	0.00	100.00	0.00	100.00
2.F.2. Foam Blowing Agents	HFC-227ea	0.14		0.14	0.00	100.00	0.00	100.00
1.A.3.c. Railways - Liquid Fuels	CH4	0.14		0.14	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.13		0.13	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Solid Fuels	N2O	0.13		0.13	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.13		0.13	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.11		0.11	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.11		0.11	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	N2O	0.10		0.10	0.00	100.00	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.09		0.09	0.00	100.00	0.00	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	0.08		0.08	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.07		0.07	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	CH4	0.06		0.06	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	0.06		0.06	0.00	100.00	0.00	100.00
1.A.2.g. Other - Solid Fuels	N2O	0.06		0.06	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.05		0.05	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Solid Fuels	CH4	0.05		0.05	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.04		0.04	0.00	100.00	0.00	100.00
2.E.4 Heat Transfer Fluid	HFC-125	0.04		0.04	0.00	100.00	0.00	100.00
2.B.9.b Fugitive emissions	C5F12	0.04		0.04	0.00	100.00	0.00	100.00
4.A.2. Direct N2O emissions from N mineralization/immobilisation	N2O		0.04	0.04	0.00	100.00	0.00	100.00
1.A.2.g. Other - Solid Fuels	CH4	0.03		0.03	0.00	100.00	0.00	100.00
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.03		0.03	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.03		0.03	0.00	100.00	0.00	100.00
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.03		0.03	0.00	100.00	0.00	100.00

1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	0.03	0.03	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.02	0.02	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation - Gaseous 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.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.02	0.02	0.00	100.00	0.00	100.00
1.B.2.a. Oil	CO2	0.02	0.02	0.00	100.00	0.00	100.00
1.A.2.c. Chemicals - Solid Fuels	N2O	0.0149	0.0149	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Biomass	N2O	0.0130	0.0130	0.00	100.00	0.00	100.00
1.A.3.b. Road Transportation - Gaseous fuels	CH4	0.0117	0.0117	0.00	100.00	0.00	100.00
1.A.2.c. Chemicals - Solid Fuels	CH4	0.0083	0.0083	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Biomass	CH4	0.0082	0.0082	0.00	100.00	0.00	100.00
2.E.4 Heat Transfer Fluid	HFC-32	0.0070	0.0070	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.0045	0.0045	0.00	100.00	0.00	100.00
1.A.3.b. Road Transportation - Gaseous fuels	N2O	0.0020	0.0020	0.00	100.00	0.00	100.00
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CH4	0.0007	0.0007	0.00	100.00	0.00	100.00
Key source according level assessment with LuLucf							
Key source according level assessment without LuLucf							
Supplementary key sources (according qualitative analysis)							
4.A.1. FL remaining FL / Net Carbon stock change in living biomass	CO2	-2385.61					
4.A.1. FL remaining FL / Net carbon stock change in soils	CO2	-1335.891					
4.A.2. Land converted to FL / Net Carbon stock change in living biomass	CO2	-180.5649					
4.A.2. Land converted to FL / Net carbon stock change in soils	CO2	-107.4106					
4.B.1. Cropland remaining Cropland / Net carbon stock change in soils	CO2	-886.2477					
4.B.2. Land converted to Cropland / Net carbon stock change in soils	CO2	499.6683					
4.C.2. Land converted to Grassland / Net carbon stock change in soils	CO2	-350.0387					
4.E.2. Land converted to Settlements / Net carbon stock change in soils	CO2	430.1737					

LEVEL ASSESSMENT 2014 with and without LULUCF

IPCC categories Submission 2016	Direct GHG	2014 estimate (non-Lulucf)	2014 estimate (Lulucf)	2014 estimate (Absolute value)	level assessment 2014 without LULUCF	Cumulative total without LULUCF	level assessment 2014 with LULUCF	Cumulative total with LULUCF
		Gg CO_2eq	Gg CO_2eq	Gg CO_2eq	%	%	%	%
		113 866.62	**-3 746.31**	**120 857.49**				
1.A.3.b. Road Transportation - Diesel Oil	CO2	20 404.82		20 404.82	17.92	17.92	16.88	16.88
1.A.4.b. Residential - Liquid Fuels	CO2	8 368.83		8 368.83	7.35	25.27	6.92	23.81
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	6 855.97		6 855.97	6.02	31.29	5.67	29.48
1.A.4.b. Residential - Gaseous Fuels	CO2	6 848.94		6 848.94	6.01	37.31	5.67	35.15
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	6 528.04		6 528.04	5.73	43.04	5.40	40.55
2.B.8 Petrochemical and carbon black production	CO2	3 844.91		3 844.91	3.38	46.42	3.18	43.73
2.C.1. Iron and Steel Production	CO2	3 793.75		3 793.75	3.33	49.75	3.14	46.87
1.A.3.b. Road Transportation - Gasoline	CO2	3 750.89		3 750.89	3.29	53.04	3.10	49.97
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	3 711.08		3 711.08	3.26	56.30	3.07	53.04
4.A.1. Forest Land remaining Forest Land CSC	CO2		-3 707.01	3 707.01	0.00	56.30	3.07	56.11
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	3 585.87		3 585.87	3.15	59.45	2.97	59.08
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2 953.19		2 953.19	2.59	62.04	2.44	61.52
2.A.1 Cement production	CO2	2 642.98		2 642.98	2.32	64.36	2.19	63.71
3D1 Direct N2O emissions from managed soils	N2O	2 629.63		2 629.63	2.31	66.67	2.18	65.88
3A1 Non-Dairy Cattle	CH4	2 586.70		2 586.70	2.27	68.95	2.14	68.02
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	1 986.04		1 986.04	1.74	70.69	1.64	69.67
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	1 847.26		1 847.26	1.62	72.31	1.53	71.20
2.B.10 Other	CO2	1 794.65		1 794.65	1.58	73.89	1.48	72.68
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	1 720.17		1 720.17	1.51	75.40	1.42	74.10
2.A.2 Lime production	CO2	1 641.59		1 641.59	1.44	76.84	1.36	75.46
3A1 Dairy Cattle	CH4	1 579.48		1 579.48	1.39	78.23	1.31	76.77
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	1 195.84		1 195.84	1.05	79.28	0.99	77.76
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1 174.70		1 174.70	1.03	80.31	0.97	78.73
5.A. Solid Waste Disposal	CH4	1 064.32		1 064.32	0.93	81.24	0.88	79.61
1.A.2.g. Other - Gaseous Fuels	CO2	1 056.04		1 056.04	0.93	82.17	0.87	80.49
2.B.1 Ammonia Production	CO2	1 052.28		1 052.28	0.92	83.10	0.87	81.36
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	1 020.47		1 020.47	0.90	83.99	0.84	82.20
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1 006.90		1 006.90	0.88	84.88	0.83	83.03
1.A.2.g. Other - Liquid Fuels	CO2	969.88		969.88	0.85	85.73	0.80	83.84
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	931.35		931.35	0.82	86.55	0.77	84.61

2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	912.09		912.09	0.80	87.35	0.75	85.36
4.B.1. Cropland remaining Cropland CSC	CO2		-890.74	890.74	0.00	87.35	0.74	86.10
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	866.03		866.03	0.76	88.11	0.72	86.82
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	825.27		825.27	0.72	88.83	0.68	87.50
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	763.11		763.11	0.67	89.50	0.63	88.13
3B3 Swine	CH4	730.34		730.34	0.64	90.14	0.60	88.73
3D2 Indirect N2O Emissions from managed soils	N2O	724.05		724.05	0.64	90.78	0.60	89.33
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	676.61		676.61	0.59	91.37	0.56	89.89
4.E.2. Land converted to Settlements CSC	CO2		619.51	619.51	0.00	91.37	0.51	90.41
4.B.2. Land converted to Cropland CSC	CO2		558.55	558.55	0.00	91.37	0.46	90.87
1.B.2.b. Natural Gas	CH4	517.70		517.70	0.45	91.83	0.43	91.30
2.B.2 Nitric Acid Production	N2O	473.16		473.16	0.42	92.24	0.39	91.69
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	414.25		414.25	0.36	92.61	0.34	92.03
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	383.96		383.96	0.34	92.94	0.32	92.35
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	379.33		379.33	0.33	93.28	0.31	92.66
3B1 Non-Dairy Cattle	N2O	353.10		353.10	0.31	93.59	0.29	92.95
4.G Harvest wood products	CO2		336.31	336.31	0.00	93.59	0.28	93.23
3B1 Dairy Cattle	CH4	320.29		320.29	0.28	93.87	0.27	93.50
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	312.14		312.14	0.27	94.14	0.26	93.76
4.A.2. Land converted to Forest Land CSC	CO2		-291.83	291.83	0.00	94.14	0.24	94.00
1.A.4.b. Residential - Solid Fuels	CO2	283.78		283.78	0.25	94.39	0.23	94.23
4.C.2. Land converted to Grassland CSC	CO2		-279.70	279.70	0.00	94.39	0.23	94.46
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	278.45		278.45	0.24	94.64	0.23	94.69
5.D. Wastewater treatment and discharge	N2O	269.76		269.76	0.24	94.87	0.22	94.92
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	258.97		258.97	0.23	95.10	0.21	95.13
3A3 Swine	CH4	244.36		244.36	0.21	95.32	0.20	95.33
1.A.3.b. Road Transportation - Diesel Oil	N2O	229.04		229.04	0.20	95.52	0.19	95.52
5.C.1 Waste incineration / Non-biogenic	CO2	220.30		220.30	0.19	95.71	0.18	95.70
5.D. Wastewater treatment and discharge	CH4	207.09		207.09	0.18	95.89	0.17	95.88
4.C.1. Grassland remaining Grassland CSC	CO2		-194.65	194.65	0.00	95.89	0.16	96.04
3B5 Indirect N2O emissions	N2O	187.57		187.57	0.16	96.06	0.16	96.19
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	182.45		182.45	0.16	96.22	0.15	96.34
3B1 Non-Dairy Cattle	CH4	180.01		180.01	0.16	96.38	0.15	96.49
2.B.9.b Fugitive emissions	C4F10	175.19		175.19	0.15	96.53	0.14	96.64
2.A.4 Other process uses of carbonates	CO2	173.79		173.79	0.15	96.68	0.14	96.78
2.A.3 Glass production	CO2	157.33		157.33	0.14	96.82	0.13	96.91
1.A.2.c. Chemicals - Liquid Fuels	CO2	146.38		146.38	0.13	96.95	0.12	97.03
1.A.4.b. Residential - Biomass	CH4	141.25		141.25	0.12	97.07	0.12	97.15
3G Liming	CO2	132.50		132.50	0.12	97.19	0.11	97.26
1.A.3.b. Road Transportation - LPG	CO2	126.99		126.99	0.11	97.30	0.11	97.36

2.B.9.b Fugitive emissions	C6F14	114.30		114.30	0.10	97.40	0.09	97.46
1.A.2.d. Pulp, Paper and Print - Other Fuels	CO2	107.81		107.81	0.09	97.50	0.09	97.55
3B1 Dairy Cattle	N2O	102.65		102.65	0.09	97.59	0.08	97.63
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	102.35		102.35	0.09	97.68	0.08	97.72
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	101.91		101.91	0.09	97.77	0.08	97.80
1.B.2.c Venting and Flaring	CO2	97.10		97.10	0.09	97.85	0.08	97.88
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	96.21		96.21	0.08	97.94	0.08	97.96
2G3. N2O from Product Uses	N2O	92.48		92.48	0.08	98.02	0.08	98.04
1.A.3.c. Railways - Liquid Fuels	CO2	88.42		88.42	0.08	98.09	0.07	98.11
2.C.7 Other	CO2	88.06		88.06	0.08	98.17	0.07	98.18
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	87.74		87.74	0.08	98.25	0.07	98.26
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	85.47		85.47	0.08	98.32	0.07	98.33
2.G.2 SF6 and PFCs from other product use	SF6	80.40		80.40	0.07	98.39	0.07	98.39
2.F.4. Aerosols	HFC-134a	78.06		78.06	0.07	98.46	0.06	98.46
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	77.25		77.25	0.07	98.53	0.06	98.52
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	73.31		73.31	0.06	98.59	0.06	98.58
3B3 Swine	N2O	72.09		72.09	0.06	98.66	0.06	98.64
1.A.3.e. Other Transportation - Liquid Fuels	CO2	66.50		66.50	0.06	98.72	0.06	98.70
2.D.1 Lubricant use	CO2	64.95		64.95	0.06	98.77	0.05	98.75
1.A.3.e. Other Transportation - Gaseous Fuels	CO2	58.89		58.89	0.05	98.83	0.05	98.80
4.E.2. Direct N2O emissions from N mineralization/immobilisation	N2O		52.43	52.43	0.00	98.83	0.04	98.84
1.A.2.a. Iron and Steel - Solid Fuels	CO2	51.83		51.83	0.05	98.87	0.04	98.89
4.B.2. Direct N2O emissions from N mineralization/immobilisation	N2O		51.22	51.22	0.00	98.87	0.04	98.93
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-32	50.26		50.26	0.04	98.92	0.04	98.97
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	44.17		44.17	0.04	98.95	0.04	99.01
1.A.2.g. Other - Other Fuels	CO2	43.78		43.78	0.04	98.99	0.04	99.04
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	41.16		41.16	0.04	99.03	0.03	99.08
2.F.2. Foam Blowing Agents	HFC-134a	38.90		38.90	0.03	99.06	0.03	99.11
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	38.48		38.48	0.03	99.10	0.03	99.14
5.B. Biological treatment of solid waste	N2O	37.39		37.39	0.03	99.13	0.03	99.17
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	36.72		36.72	0.03	99.16	0.03	99.20
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	33.99		33.99	0.03	99.19	0.03	99.23
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	33.77		33.77	0.03	99.22	0.03	99.26
3A4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	33.51		33.51	0.03	99.25	0.03	99.29
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	31.02		31.02	0.03	99.28	0.03	99.31
1.A.4.b. Residential - Liquid Fuels	CH4	28.78		28.78	0.03	99.30	0.02	99.34
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	27.65		27.65	0.02	99.33	0.02	99.36
2H. Other	CO2	25.96		25.96	0.02	99.35	0.02	99.38
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	25.59		25.59	0.02	99.37	0.02	99.40
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	25.33		25.33	0.02	99.39	0.02	99.42

5.B. Biological treatment of solid waste	CH4	24.51	24.51	0.02	99.42	0.02	99.44
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	24.39	24.39	0.02	99.44	0.02	99.46
1.A.1.a. Public Electricity and Heat Production - Biomass	CH4	22.65	22.65	0.02	99.46	0.02	99.48
1.A.4.b. Residential - Solid Fuels	CH4	22.50	22.50	0.02	99.48	0.02	99.50
1.A.4.b. Residential - Biomass	N2O	22.45	22.45	0.02	99.50	0.02	99.52
3A2 Sheep	CH4	22.19	22.19	0.02	99.52	0.02	99.54
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	CH4	21.46	21.46	0.02	99.54	0.02	99.55
2.C.1. Iron and Steel Production	CH4	21.08	21.08	0.02	99.55	0.02	99.57
1.A.4.b. Residential - Liquid Fuels	N2O	20.01	20.01	0.02	99.57	0.02	99.59
1.A.4.a. Commercial / Institutional - Biomass	CH4	19.41	19.41	0.02	99.59	0.02	99.60
2.D.3 Other urea	CO2	19.09	19.09	0.02	99.61	0.02	99.62
2.F.2. Foam Blowing Agents	HFC-152a	19.01	19.01	0.02	99.62	0.02	99.64
2.B.10 Other	N2O	18.34	18.34	0.02	99.64	0.02	99.65
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	17.00	17.00	0.01	99.65	0.01	99.67
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	N2O	16.61	16.61	0.01	99.67	0.01	99.68
1.A.4.b. Residential - Gaseous Fuels	CH4	15.26	15.26	0.01	99.68	0.01	99.69
1.A.2.g. Other - Liquid Fuels	N2O	15.17	15.17	0.01	99.69	0.01	99.70
1.A.2.d. Pulp, Paper and Print - biomass	N2O	15.14	15.14	0.01	99.71	0.01	99.72
1.A.3.b. Road Transportation - Biomass	N2O	14.58	14.58	0.01	99.72	0.01	99.73
1.A.2.c. Chemicals - Other Fuels	CO2	14.42	14.42	0.01	99.73	0.01	99.74
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	13.32	13.32	0.01	99.74	0.01	99.75
1.A.2.g. Other - Solid Fuels	CO2	12.39	12.39	0.01	99.76	0.01	99.76
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	11.72	11.72	0.01	99.77	0.01	99.77
1.A.2.f. Non-metallic minerals - Solid Fuels	N2O	11.71	11.71	0.01	99.78	0.01	99.78
1.A.3.b. Road Transportation - Gasoline	CH4	11.65	11.65	0.01	99.79	0.01	99.79
1.A.3.b. Road Transportation - Gasoline	N2O	11.62	11.62	0.01	99.80	0.01	99.80
2.F.3. Fire protection	HFC-227ea	11.46	11.46	0.01	99.81	0.01	99.81
2.G.1. Electrical equipment	SF6	11.36	11.36	0.01	99.82	0.01	99.82
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	10.73	10.73	0.01	99.83	0.01	99.83
1.A.2.f. Non-metallic minerals - biomass	N2O	10.00	10.00	0.01	99.83	0.01	99.84
2.B.9.a. By-product emissions	CF4	9.84	9.84	0.01	99.84	0.01	99.85
2.B.10 Other	CH4	8.76	8.76	0.01	99.85	0.01	99.85
1.A.2.f. Non-metallic minerals - Other Fuels	N2O	8.13	8.13	0.01	99.86	0.01	99.86
1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	7.95	7.95	0.01	99.87	0.01	99.87
1.B.2.a. Oil	CH4	7.01	7.01	0.01	99.87	0.01	99.87
1.A.2.d. Pulp, Paper and Print - biomass	CH4	6.96	6.96	0.01	99.88	0.01	99.88
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	6.66	6.66	0.01	99.88	0.01	99.88
2.D.2 Paraffin wax use	CO2	6.37	6.37	0.01	99.89	0.01	99.89
1.A.2.c. Chemicals - Biomass	N2O	4.96	4.96	0.00	99.89	0.00	99.89

1.A.3.b. Road Transportation - Gaseous fuels	CO2	4.91		4.91	0.00	99.90	0.00	99.90
4.D.2. Land converted to Wetlands CSC	CO2		-4.65	4.65	0.00	99.90	0.00	99.90
1.A.2.c. Chemicals - Other Fuels	CH4	4.65		4.65	0.00	99.90	0.00	99.90
1.A.2.a. Iron and Steel - Other fuels	CO2	4.27		4.27	0.00	99.91	0.00	99.91
1.A.3.b. Road Transportation - Diesel Oil	CH4	4.07		4.07	0.00	99.91	0.00	99.91
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	3.98		3.98	0.00	99.91	0.00	99.91
2.F.2. Foam Blowing Agents	HFC-365mfc	3.88		3.88	0.00	99.92	0.00	99.92
1.A.3.c. Railways - Liquid Fuels	N2O	3.77		3.77	0.00	99.92	0.00	99.92
1.A.4.b. Residential - Gaseous Fuels	N2O	3.64		3.64	0.00	99.92	0.00	99.92
2.E.1 Integrated Circuit or Semiconductor	SF6	3.45		3.45	0.00	99.93	0.00	99.93
2.E.1 Integrated Circuit or Semiconductor	C2F6	3.42		3.42	0.00	99.93	0.00	99.93
1.A.3.d. Navigation - Gas/Diesel Oil	N2O	3.29		3.29	0.00	99.93	0.00	99.93
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	2.97		2.97	0.00	99.93	0.00	99.93
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	2.93		2.93	0.00	99.94	0.00	99.94
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	2.91		2.91	0.00	99.94	0.00	99.94
1.A.2.c. Chemicals - Solid Fuels	CO2	2.86		2.86	0.00	99.94	0.00	99.94
1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	2.81		2.81	0.00	99.94	0.00	99.94
4.C.2. Direct N2O emissions from N mineralization/immobilisation	N2O		2.78	2.78	0.00	99.94	0.00	99.95
1.A.2.g. Other - Liquid Fuels	CH4	2.60		2.60	0.00	99.95	0.00	99.95
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	2.51		2.51	0.00	99.95	0.00	99.95
1.A.2.c. Chemicals - Other Fuels	N2O	2.22		2.22	0.00	99.95	0.00	99.95
2.E.1 Integrated Circuit or Semiconductor	CF4	2.17		2.17	0.00	99.95	0.00	99.95
1.A.2.c. Chemicals - Gaseous Fuels	N2O	2.00		2.00	0.00	99.95	0.00	99.96
2.F.2. Foam Blowing Agents	HFC-227ea	1.94		1.94	0.00	99.96	0.00	99.96
2.E.1 Integrated Circuit or Semiconductor	HFC-23	1.93		1.93	0.00	99.96	0.00	99.96
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	1.90		1.90	0.00	99.96	0.00	99.96
2.F.1. Refrigeration and Air Conditioning Equipment	C3F8	1.90		1.90	0.00	99.96	0.00	99.96
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	1.86		1.86	0.00	99.96	0.00	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	1.75		1.75	0.00	99.96	0.00	99.97
1.A.2.b. Non-Ferrous Metals - Other fuels	CO2	1.54		1.54	0.00	99.97	0.00	99.97
1.B.1.b. Solid Fuel Transformation	CH4	1.49		1.49	0.00	99.97	0.00	99.97
1.A.2.f. Non-metallic minerals - Other Fuels	CH4	1.39		1.39	0.00	99.97	0.00	99.97
1.A.2.f. Non-metallic minerals - Liquid Fuels	N2O	1.37		1.37	0.00	99.97	0.00	99.97
1.A.4.b. Residential - Solid Fuels	N2O	1.34		1.34	0.00	99.97	0.00	99.97
1.A.2.c. Chemicals - Gaseous Fuels	CH4	1.31		1.31	0.00	99.97	0.00	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	1.27		1.27	0.00	99.97	0.00	99.97
1.A.2.g. Other - biomass	N2O	1.18		1.18	0.00	99.97	0.00	99.97
1.A.2.d. Pulp, Paper and Print - Other Fuels	N2O	1.16		1.16	0.00	99.97	0.00	99.98
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	1.13		1.13	0.00	99.98	0.00	99.98

4.C.1. Direct N2O emissions from N mineralization/immobilisation	N2O		1.11	1.11	0.00	99.98	0.00	99.98
1.A.3.e. Other Transportation - Liquid Fuels	N2O	1.10		1.10	0.00	99.98	0.00	99.98
1.A.2.f. Non-metallic minerals - biomass	CH4	1.10		1.10	0.00	99.98	0.00	99.98
2.F.3. Fire protection	HFC-125	1.03		1.03	0.00	99.98	0.00	99.98
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	0.93		0.93	0.00	99.98	0.00	99.98
1.A.2.c. Chemicals - Biomass	CH4	0.89		0.89	0.00	99.98	0.00	99.98
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0.88		0.88	0.00	99.98	0.00	99.98
1.A.3.b. Road Transportation - LPG	N2O	0.88		0.88	0.00	99.98	0.00	99.98
2.F.2. Foam Blowing Agents	HFC-245fa	0.83		0.83	0.00	99.98	0.00	99.98
1.A.2.g. Other - Other Fuels	N2O	0.82		0.82	0.00	99.98	0.00	99.98
1.A.2.f. Non-metallic minerals - Solid Fuels	CH4	0.81		0.81	0.00	99.98	0.00	99.98
1.A.3.b. Road Transportation - Biomass	CH4	0.78		0.78	0.00	99.98	0.00	99.99
1.A.2.g. Other - biomass	CH4	0.74		0.74	0.00	99.99	0.00	99.99
1.A.2.d. Pulp, Paper and Print - Other Fuels	CH4	0.73		0.73	0.00	99.99	0.00	99.99
2.E.1 Integrated Circuit or Semiconductor	NF3	0.69		0.69	0.00	99.99	0.00	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	N2O	0.66		0.66	0.00	99.99	0.00	99.99
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	0.62		0.62	0.00	99.99	0.00	99.99
1.A.2.g. Other - Gaseous Fuels	N2O	0.62		0.62	0.00	99.99	0.00	99.99
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N2O	0.62		0.62	0.00	99.99	0.00	99.99
1.A.4.a. Commercial / Institutional - Biomass	N2O	0.60		0.60	0.00	99.99	0.00	99.99
3B2 Sheep	N2O	0.57		0.57	0.00	99.99	0.00	99.99
2.F.4. Aerosols	HFC-227ea	0.56		0.56	0.00	99.99	0.00	99.99
3B2 Sheep	CH4	0.53		0.53	0.00	99.99	0.00	99.99
1.A.2.g. Other - Gaseous Fuels	CH4	0.52		0.52	0.00	99.99	0.00	99.99
1.A.2.g. Other - Other Fuels	CH4	0.52		0.52	0.00	99.99	0.00	99.99
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH4	0.51		0.51	0.00	99.99	0.00	99.99
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.48		0.48	0.00	99.99	0.00	99.99
1.B.2.b. Natural Gas	CO2	0.47		0.47	0.00	99.99	0.00	99.99
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	0.44		0.44	0.00	99.99	0.00	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.41		0.41	0.00	99.99	0.00	99.99
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	0.40		0.40	0.00	99.99	0.00	99.99
1.A.3.b. Road Transportation - LPG	CH4	0.36		0.36	0.00	99.99	0.00	99.99
1.A.2.c. Chemicals - Liquid Fuels	N2O	0.35		0.35	0.00	99.99	0.00	99.99
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	0.35		0.35	0.00	99.99	0.00	99.99
4.D.2. Direct N2O emissions from N mineralization/immobilisation	N2O		0.34	0.34	0.00	99.99	0.00	100.00
1.A.3.b. Road Transportation - Other liquid fuels - Lubricants	CO2	0.34		0.34	0.00	100.00	0.00	100.00
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.33		0.33	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.30		0.30	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Solid Fuels	N2O	0.28		0.28	0.00	100.00	0.00	100.00

1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.27		0.27	0.00	100.00	0.00	100.00
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	0.26		0.26	0.00	100.00	0.00	100.00
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	0.25		0.25	0.00	100.00	0.00	100.00
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH4	0.22		0.22	0.00	100.00	0.00	100.00
2.B.9.b Fugitive emissions	HFC-125	0.22		0.22	0.00	100.00	0.00	100.00
2.F.4. Aerosols	HFC-152a	0.21		0.21	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.19		0.19	0.00	100.00	0.00	100.00
1.B.2.c Venting and Flaring	CH4	0.18		0.18	0.00	100.00	0.00	100.00
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	0.17		0.17	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.17		0.17	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.16		0.16	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.16		0.16	0.00	100.00	0.00	100.00
1.A.2.c. Chemicals - Liquid Fuels	CH4	0.15		0.15	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.15		0.15	0.00	100.00	0.00	100.00
1.A.3.c. Railways - Liquid Fuels	CH4	0.14		0.14	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.14		0.14	0.00	100.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor	c-C4F8	0.13		0.13	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	N2O	0.12		0.12	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.12		0.12	0.00	100.00	0.00	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.09		0.09	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.08		0.08	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	CH4	0.08		0.08	0.00	100.00	0.00	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.06		0.06	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Solid Fuels	CH4	0.05		0.05	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.05		0.05	0.00	100.00	0.00	100.00
5.C.1 Waste incineration / Biogenic	N2O	0.05		0.05	0.00	100.00	0.00	100.00
1.A.2.g. Other - Solid Fuels	N2O	0.05		0.05	0.00	100.00	0.00	100.00
2.E.4 Heat Transfer Fluid	HFC-125	0.05		0.05	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	0.05		0.05	0.00	100.00	0.00	100.00
2.B.9.b Fugitive emissions	HFC-23	0.04		0.04	0.00	100.00	0.00	100.00
1.A.3.b. Road Transportation - Gaseous fuels	CH4	0.04		0.04	0.00	100.00	0.00	100.00
5.C.1 Waste incineration / Non-biogenic	N2O	0.04		0.04	0.00	100.00	0.00	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.04		0.04	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.03		0.03	0.00	100.00	0.00	100.00
4.A.2. Direct N2O emissions from N mineralization/immobilisation	N2O		0.03	0.03	0.00	100.00	0.00	100.00
1.A.2.g. Other - Solid Fuels	CH4	0.03		0.03	0.00	100.00	0.00	100.00
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.03		0.03	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	0.03		0.03	0.00	100.00	0.00	100.00
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.0197		0.0197	0.00	100.00	0.00	100.00
1.B.2.a. Oil	CO2	0.0183		0.0183	0.00	100.00	0.00	100.00

2.B.9.b Fugitive emissions	C5F12	0.0183	0.0183	0.00	100.00	0.00	100.00
2.B.1 Ammonia Production	CH4	0.0150	0.0150	0.00	100.00	0.00	100.00
1.A.2.c. Chemicals - Solid Fuels	N2O	0.0149	0.0149	0.00	100.00	0.00	100.00
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.0140	0.0140	0.00	100.00	0.00	100.00
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.0129	0.0129	0.00	100.00	0.00	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	0.0119	0.0119	0.00	100.00	0.00	100.00
1.A.3.e. Other Transportation - Gaseous Fuels	CH4	0.0080	0.0080	0.00	100.00	0.00	100.00
2.E.4 Heat Transfer Fluid	HFC-32	0.0078	0.0078	0.00	100.00	0.00	100.00
1.A.2.c. Chemicals - Solid Fuels	CH4	0.0075	0.0075	0.00	100.00	0.00	100.00
1.A.3.b. Road Transportation - Gaseous fuels	N2O	0.0074	0.0074	0.00	100.00	0.00	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.0050	0.0050	0.00	100.00	0.00	100.00
2.B.9.b Fugitive emissions	HFC-134a	0.0014	0.0014	0.00	100.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor	HFC-32	0.0011	0.0011	0.00	100.00	0.00	100.00
Key source according level assessment with LuLucf							
Supplementary key sources (according qualitative analysis)							
4.A.1. FL remaining FL / Net Carbon stock change in living biomass	CO2	-2385.61					
4.A.1. FL remaining FL / Net carbon stock change in soils	CO2	-1335.271					
4.A.2. Land converted to FL / Net Carbon stock change in living biomass	CO2	-184.0003					
4.A.2. Land converted to FL / Net carbon stock change in soils	CO2	-107.8345					
4.B.1. Cropland remaining Cropland / Net carbon stock change in soils	CO2	-886.3564					
4.B.2. Land converted to Cropland / Net carbon stock change in soils	CO2	500.96914					
4.C.2. Land converted to Grassland / Net carbon stock change in soils	CO2	-348.8245					
4.E.2. Land converted to Settlements / Net carbon stock change in soils	CO2	428.60165					

Trend assessment 1990-2013 without LULUCF

IPCC categories Submission 2016	direct GHG	1990 Estimate (non-Lulucf)	2013 Estimate (non-Lulucf)	trend assessment 1990-2013	contribution to trend	cumulative total
		Gg CO_2 eq	Gg CO_2 eq		%	%
		146 021.24	**119 375.30**	**0.8176**		
1.A.3.b. Road Transportation - Diesel Oil	CO2	10 963.77	20 043.14	0.1135	13.89	13.89
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	19 434.27	7 159.61	0.0894	10.94	24.82
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	2 764.79	7 543.94	0.0541	6.62	31.45
2.C.1. Iron and Steel Production	CO2	10 277.62	3 799.05	0.0472	5.77	37.21
1.A.4.b. Residential - Gaseous Fuels	CO2	5 874.20	8 782.50	0.0408	4.99	42.20
1.A.3.b. Road Transportation - Gasoline	CO2	8 360.02	3 458.83	0.0346	4.23	46.43
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	1 933.79	4 541.71	0.0303	3.71	50.14
1.A.2.a. Iron and Steel - Solid Fuels	CO2	3 283.95	26.77	0.0272	3.33	53.48
2.B.2 Nitric Acid Production	N2O	3 421.53	555.28	0.0230	2.81	56.28
2.B.8 Petrochemical and carbon black production	CO2	1 882.42	3 737.97	0.0225	2.76	59.04
2.B.10 Other	CO2	285.15	1 739.14	0.0154	1.89	60.93
5.A. Solid Waste Disposal	CH4	3 053.39	1 140.58	0.0139	1.70	62.63
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	1 969.04	282.18	0.0136	1.66	64.29
1.A.2.c. Chemicals - Liquid Fuels	CO2	1 851.70	204.08	0.0134	1.64	65.93
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	684.19	1 865.99	0.0134	1.64	67.57
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	674.22	1 814.22	0.0129	1.58	69.15
2.B.9.a. By-product emissions	SF6	1 487.59	0.00000	0.0125	1.52	70.68
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2 532.33	3 207.36	0.0117	1.43	72.10
1.A.4.b. Residential - Liquid Fuels	CO2	12 800.51	9 331.05	0.0116	1.42	73.52
1.A.4.b. Residential - Solid Fuels	CO2	1 796.20	359.71	0.0114	1.39	74.91
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	1 688.70	293.36	0.0111	1.36	76.27
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	2 516.45	1 111.19	0.0097	1.19	77.46
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	13.89	914.27	0.0093	1.13	78.59
2.B.1 Ammonia Production	CO2	422.74	1 246.58	0.0092	1.13	79.72
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	0.00	861.28	0.0088	1.08	80.80
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	0.00	823.28	0.0084	1.03	81.83
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	0.00	816.86	0.0084	1.02	82.86
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	67.38	867.26	0.0083	1.02	83.87
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	1 508.71	527.82	0.0072	0.88	84.76
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	884.66	35.71	0.0070	0.86	85.62

2.B.9.a. By-product emissions	C2F6	671.94	0.00000	0.0056	0.69	86.31
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	662.56	18.88	0.0054	0.66	86.96
5.D. Wastewater treatment and discharge	CH4	834.95	215.19	0.0048	0.59	87.55
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	2 466.35	1 581.52	0.0045	0.54	88.09
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	650.58	97.09	0.0045	0.54	88.64
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	357.60	680.33	0.0040	0.49	89.12
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	2 314.69	1 522.21	0.0038	0.46	89.59
1.A.2.g. Other - Gaseous Fuels	CO2	1 203.94	1 344.97	0.0037	0.45	90.04
3A1 Non-Dairy Cattle	CH4	2 721.79	2 584.58	0.0037	0.45	90.49
1.A.2.g. Other - Liquid Fuels	CO2	1 578.69	936.67	0.0036	0.44	90.93
3A1 Dairy Cattle	CH4	2 304.38	1 535.41	0.0036	0.44	91.37
1.A.2.c. Chemicals - Solid Fuels	CO2	401.51	3.11	0.0033	0.41	91.78
2.B.9.a. By-product emissions	CF4	368.01	3.92	0.0030	0.37	92.15
1.B.1.a. Coal Mining and Handling	CH4	355.74	0.00000	0.0030	0.36	92.52
2.B.9.b Fugitive emissions	C5F12	351.53	0.04	0.0029	0.36	92.88
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	186.18	422.47	0.0028	0.34	93.21
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1 492.90	987.11	0.0024	0.29	93.51
2.A.1 Cement production	CO2	2 823.78	2 541.37	0.0024	0.29	93.80
2.B.9.b Fugitive emissions	C4F10	25.40	227.17	0.0021	0.26	94.06
3D1 Direct N2O emissions from managed soils	N2O	3 356.10	2 555.63	0.0019	0.24	94.29
2.B.9.a. By-product emissions	C4F10	228.60	0.00	0.0019	0.23	94.53
2.B.9.a. By-product emissions	C3F8	215.77	0.00	0.0018	0.22	94.75
1.A.3.b. Road Transportation - Diesel Oil	N2O	59.25	219.49	0.0018	0.21	94.96
3D2 Indirect N2O Emissions from managed soils	N2O	1 051.55	706.28	0.0016	0.19	95.15
1.A.4.b. Residential - Biomass	CH4	71.24	197.37	0.0014	0.17	95.33
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	212.09	36.72	0.0014	0.17	95.50
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	361.87	429.80	0.0014	0.17	95.67
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	220.47	48.46	0.0014	0.17	95.83
2.D.1 Lubricant use	CO2	211.11	63.38	0.0011	0.14	95.97
3B3 Swine	CH4	792.78	756.15	0.0011	0.14	96.11
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	166.99	34.09	0.0010	0.13	96.23
1.A.3.b. Road Transportation - Gasoline	N2O	135.27	11.89	0.0010	0.12	96.36
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	0.15	93.81	0.0010	0.12	96.48
1.A.3.c. Railways - Liquid Fuels	CO2	222.45	88.42	0.0010	0.12	96.59
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	234.59	98.72	0.0010	0.12	96.71
1.A.2.d. Pulp, Paper and Print - Other Fuels	CO2	0.00	92.38	0.0009	0.12	96.82
3B1 Dairy Cattle	N2O	233.60	100.83	0.0009	0.11	96.94
1.A.4.b. Residential - Solid Fuels	CH4	142.18	28.52	0.0009	0.11	97.05
2.A.2 Lime production	CO2	2 097.12	1 629.16	0.0009	0.11	97.15
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	260.84	296.92	0.0009	0.10	97.26

2.F.4. Aerosols	HFC-134a	0.00	81.80	0.0008	0.10	97.36
2G3. N2O from Product Uses	N2O	196.48	83.73	0.0008	0.10	97.46
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	30.70	101.99	0.0008	0.10	97.55
3B1 Dairy Cattle	CH4	296.57	312.12	0.0007	0.09	97.64
1.A.3.b. Road Transportation - Gasoline	CH4	96.77	11.30	0.0007	0.08	97.73
5.D. Wastewater treatment and discharge	N2O	247.33	268.53	0.0007	0.08	97.81
5.C.1 Waste incineration / Non-biogenic	CO2	299.50	310.07	0.0007	0.08	97.89
1.B.2.b. Natural Gas	CH4	617.71	440.52	0.0007	0.08	97.97
1.A.2.g. Other - Other Fuels	CO2	0.00	59.73	0.0006	0.07	98.05
2.A.4 Other process uses of carbonates	CO2	135.72	170.21	0.0006	0.07	98.12
2.A.3 Glass production	CO2	266.17	165.11	0.0005	0.07	98.19
1.B.2.c Venting and Flaring	CO2	83.83	118.50	0.0005	0.06	98.25
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	3.95	50.98	0.0005	0.06	98.31
3A3 Swine	CH4	251.27	252.30	0.0005	0.06	98.37
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	4 285.28	3 458.27	0.0005	0.06	98.43
2.B.9.b Fugitive emissions	C6F14	288.78	191.31	0.0005	0.06	98.48
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-32	0.00	44.53	0.0005	0.06	98.54
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CO2	50.62	0.00000	0.0004	0.05	98.59
1.A.3.e. Other Transportation - Liquid Fuels	CO2	29.12	64.13	0.0004	0.05	98.64
2.F.2. Foam Blowing Agents	HFC-134a	0.00	39.53	0.0004	0.05	98.69
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1 364.20	1 154.40	0.0004	0.05	98.74
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	7.86	42.97	0.0004	0.05	98.78
2.G.2 SF6 and PFCs from other product use	SF6	79.77	101.03	0.0004	0.04	98.83
5.B. Biological treatment of solid waste	N2O	3.95	38.27	0.0004	0.04	98.87
1.A.3.e. Other Transportation - Gaseous Fuels	CO2	196.77	126.71	0.0003	0.04	98.92
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	147.35	86.41	0.0003	0.04	98.96
2.B.9.a. By-product emissions	C5F12	41.01	0.00000	0.0003	0.04	99.00
2.C.7 Other	CO2	50.43	73.96	0.0003	0.04	99.04
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	124.21	70.10	0.0003	0.04	99.08
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	37.25	4.01	0.0003	0.03	99.11
3B1 Non-Dairy Cattle	CH4	188.42	180.05	0.0003	0.03	99.15
1.B.1.b. Solid Fuel Transformation	CH4	36.66	4.04	0.0003	0.03	99.18
3A4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	10.65	34.08	0.0003	0.03	99.21
5.B. Biological treatment of solid waste	CH4	2.59	25.08	0.0002	0.03	99.24
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	4.87	26.70	0.0002	0.03	99.27
1.A.3.b. Road Transportation - LPG	CO2	169.32	116.07	0.0002	0.03	99.30
1.A.4.b. Residential - Biomass	N2O	11.32	31.37	0.0002	0.03	99.32
1.A.4.a. Commercial / Institutional - Biomass	CH4	0.00	21.08	0.0002	0.03	99.35
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	CH4	0.00	21.04	0.0002	0.03	99.38
2H. Other	CO2	0.00	20.60	0.0002	0.026	99.40

2.F.2. Foam Blowing Agents	HFC-152a	0.00	19.83	0.0002	0.025	99.43
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	54.02	24.75	0.0002	0.024	99.45
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	0.75	18.42	0.0002	0.022	99.47
2.D.3 Other urea	CO2	0.00	16.70	0.0002	0.021	99.49
3B1 Non-Dairy Cattle	N2O	417.22	356.44	0.0002	0.019	99.51
1.A.3.b. Road Transportation - Diesel Oil	CH4	22.39	4.44	0.0001	0.017	99.53
1.A.2.g. Other - Solid Fuels	CO2	33.22	13.74	0.0001	0.017	99.55
1.A.3.b. Road Transportation - Biomass	N2O	0.00	11.81	0.0001	0.015	99.56
2.F.3. Fire protection	HFC-227ea	0.00	10.94	0.0001	0.014	99.58
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	16.96	24.70	0.0001	0.014	99.59
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	16.82	2.91	0.0001	0.014	99.60
1.A.2.d. Pulp, Paper and Print - biomass	N2O	4.66	14.60	0.0001	0.014	99.62
3A2 Sheep	CH4	38.43	21.56	0.0001	0.012	99.63
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	281.82	240.12	0.0001	0.012	99.64
2.B.10 Other	N2O	8.94	16.71	0.0001	0.012	99.65
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	4.31	12.92	0.0001	0.012	99.67
1.A.1.a. Public Electricity and Heat Production - Biomass	CH4	0.00	9.14	0.0001	0.011	99.68
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	3.28	11.68	0.0001	0.011	99.69
1.A.4.b. Residential - Gaseous Fuels	CH4	13.08	19.57	0.0001	0.0111	99.70
3B5 Indirect N2O emissions	N2O	218.32	187.18	0.0001	0.0109	99.71
1.A.2.f. Non-metallic minerals - biomass	N2O	0.00	8.31	0.0001	0.0104	99.72
1.A.2.c. Chemicals - Other Fuels	CO2	0.00	8.24	0.0001	0.0103	99.73
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	N2O	10.18	16.37	0.0001	0.0101	99.74
1.A.2.f. Non-metallic minerals - Other Fuels	N2O	0.28	7.74	0.0001	0.0094	99.75
1.A.4.a. Commercial / Institutional - Solid Fuels	CO2	9.01	0.00000	0.0001	0.0092	99.76
1.A.2.a. Iron and Steel - Solid Fuels	N2O	8.66	0.13	0.0001	0.0087	99.77
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	10.02	2.02	0.0001	0.0077	99.78
1.A.3.c. Railways - Liquid Fuels	N2O	12.14	3.77	0.0001	0.0077	99.78
2.G.1. Electrical equipment	SF6	7.75	12.41	0.0001	0.0076	99.79
1.A.2.d. Pulp, Paper and Print - biomass	CH4	1.64	6.61	0.0001	0.0066	99.80
1.A.4.b. Residential - Solid Fuels	N2O	8.47	1.70	0.0001	0.0066	99.80
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	14.88	7.25	0.0001	0.0062	99.81
1.A.2.c. Chemicals - Biomass	N2O	0.00	4.85	0.0000	0.0061	99.82
1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	2.99	7.23	0.0000	0.0060	99.82
2.C.1. Iron and Steel Production	CH4	13.66	15.83	0.0000	0.0058	99.83
2.B.10 Other	CH4	0.00	4.56	0.0000	0.0057	99.83
1.A.2.f. Non-metallic minerals - Solid Fuels	CH4	7.77	10.77	0.0000	0.0055	99.84
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	127.50	99.95	0.0000	0.0054	99.85
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	8.21	2.73	0.0000	0.0050	99.85

2.D.2 Paraffin wax use	CO2	2.95	6.37	0.0000	0.0050	99.86
1.A.4.b. Residential - Liquid Fuels	CH4	43.67	31.99	0.0000	0.0046	99.86
1.A.2.c. Chemicals - Other Fuels	CH4	1.39	4.78	0.0000	0.0046	99.86
2.E.1 Integrated Circuit or Semiconductor	C2F6	0.00	3.34	0.0000	0.0042	99.87
2.E.1 Integrated Circuit or Semiconductor	CF4	0.00	3.30	0.0000	0.0041	99.87
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CO2	3.98	0.00000	0.0000	0.0041	99.88
3B3 Swine	N2O	91.91	78.38	0.0000	0.0041	99.88
1.B.2.a. Oil	CH4	11.38	6.24	0.0000	0.0038	99.88
1.A.2.c. Chemicals - Liquid Fuels	N2O	4.22	0.48	0.0000	0.0037	99.89
1.A.2.g. Other - Liquid Fuels	N2O	13.91	14.32	0.0000	0.0037	99.89
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	38.43	34.31	0.0000	0.0036	99.90
1.A.2.f. Non-metallic minerals - biomass	CH4	0.00	2.74	0.0000	0.0034	99.90
1.A.2.a. Iron and Steel - Solid Fuels	CH4	3.22	0.05	0.0000	0.0032	99.90
1.A.4.b. Residential - Liquid Fuels	N2O	30.31	22.26	0.0000	0.0032	99.91
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	3.13	0.08	0.0000	0.0031	99.91
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	3.78	0.68	0.0000	0.0030	99.91
1.A.2.f. Non-metallic minerals - Liquid Fuels	N2O	4.55	1.32	0.0000	0.0030	99.91
1.A.2.f. Non-metallic minerals - Other Fuels	CH4	0.00	2.39	0.0000	0.0030	99.92
2.E.1 Integrated Circuit or Semiconductor	SF6	0.00	2.31	0.0000	0.0029	99.92
2.F.1. Refrigeration and Air Conditioning Equipment	C3F8	0.00	2.13	0.0000	0.0027	99.92
1.A.4.b. Residential - Gaseous Fuels	N2O	3.12	4.66	0.0000	0.0026	99.93
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	7.59	4.10	0.0000	0.0026	99.93
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	3.06	0.46	0.0000	0.0026	99.93
1.A.2.c. Chemicals - Other Fuels	N2O	0.66	2.28	0.0000	0.0022	99.93
1.A.2.b. Non-Ferrous Metals - Other fuels	CO2	0.00	1.68	0.0000	0.0021	99.94
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	1.03	2.41	0.0000	0.0020	99.94
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH4	2.51	0.50	0.0000	0.0019	99.94
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	0.18	1.62	0.0000	0.0018	99.94
2.E.1 Integrated Circuit or Semiconductor	HFC-23	0.00	1.44	0.0000	0.0018	99.94
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	0.52	1.86	0.0000	0.0018	99.94
1.A.2.c. Chemicals - Solid Fuels	N2O	1.75	0.01	0.0000	0.0018	99.95
1.A.2.g. Other - biomass	N2O	0.01	1.33	0.0000	0.0017	99.95
3G Liming	CO2	161.57	133.40	0.0000	0.0016	99.95
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	1.67	0.06	0.0000	0.0016	99.95
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	7.80	5.06	0.0000	0.0016	99.95
1.A.2.c. Chemicals - Liquid Fuels	CH4	1.77	0.20	0.0000	0.0016	99.95
1.A.3.b. Road Transportation - Gaseous fuels	CO2	0.00	1.25	0.0000	0.0016	99.96
2.E.1 Integrated Circuit or Semiconductor	NF3	0.00	1.24	0.0000	0.0016	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	1.71	0.26	0.0000	0.0014	99.96
1.A.2.d. Pulp, Paper and Print - Other Fuels	N2O	0.00	1.12	0.0000	0.0014	99.96

1.A.3.d. Navigation - Gas/Diesel Oil	N2O	2.88	3.41	0.0000	0.0013	99.96
2.F.3. Fire protection	HFC-125	0.00	1.04	0.0000	0.0013	99.96
1.A.2.g. Other - Liquid Fuels	CH4	4.55	2.72	0.0000	0.0012	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0.44	1.35	0.0000	0.0012	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	1.56	0.29	0.0000	0.0012	99.97
1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	5.57	3.58	0.0000	0.0012	99.97
1.A.3.b. Road Transportation - Biomass	CH4	0.00	0.96	0.0000	0.0012	99.97
1.A.4.a. Commercial / Institutional - Biomass	N2O	0.00	0.93	0.0000	0.0012	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	0.11	1.02	0.0000	0.0012	99.97
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.61	0.40	0.0000	0.0012	99.97
1.A.2.c. Chemicals - Biomass	CH4	0.00	0.91	0.0000	0.0011	99.97
1.A.2.c. Chemicals - Gaseous Fuels	N2O	1.37	2.02	0.0000	0.0011	99.98
1.A.2.g. Other - biomass	CH4	0.01	0.84	0.0000	0.0010	99.98
2.F.2. Foam Blowing Agents	HFC-245fa	0.00	0.80	0.0000	0.0010	99.98
1.A.2.g. Other - Other Fuels	N2O	0.00	0.80	0.0000	0.0010	99.98
1.A.2.c. Chemicals - Solid Fuels	CH4	0.99	0.01	0.0000	0.0010	99.98
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH4	1.48	0.42	0.0000	0.0010	99.98
1.A.2.f. Non-metallic minerals - Solid Fuels	N2O	10.81	9.63	0.0000	0.0010	99.98
2.F.2. Foam Blowing Agents	HFC-365mfc	0.000	0.745	0.0000	0.0009	99.98
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	N2O	0.000	0.742	0.0000	0.0009	99.98
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CH4	0.878	0.00000	0.0000	0.0009	99.98
1.A.2.d. Pulp, Paper and Print - Other Fuels	CH4	0.000	0.702	0.0000	0.0009	99.98
5.C.1 Waste incineration / Biogenic	N2O	1.395	0.489	0.0000	0.0008	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	1.002	0.174	0.0000	0.0008	99.99
5.C.1 Waste incineration / Non-biogenic	N2O	1.238	0.375	0.0000	0.0008	99.99
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0.305	0.875	0.0000	0.0008	99.99
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	3.136	1.994	0.0000	0.0007	99.99
2.F.4. Aerosols	HFC-227ea	0.000	0.557	0.0000	0.0007	99.99
1.A.3.b. Road Transportation - LPG	CH4	1.091	0.336	0.0000	0.0007	99.99
1.A.3.e. Other Transportation - Liquid Fuels	N2O	0.340	0.821	0.0000	0.0007	99.99
1.A.2.g. Other - Other Fuels	CH4	0.000	0.502	0.0000	0.0006	99.99
1.A.2.c. Chemicals - Gaseous Fuels	CH4	1.149	1.426	0.0000	0.0006	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.613	0.016	0.0000	0.0006	99.99
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.616	0.024	0.0000	0.0006	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.573	0.029	0.0000	0.0006	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.036	0.461	0.0000	0.0005	99.99
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.513	0.108	0.0000	0.0004	99.99
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N2O	1.139	0.621	0.0000	0.0004	100.00

3B2 Sheep	N2O	0.991	0.552	0.0000	0.0003	100.00
3B2 Sheep	CH4	0.913	0.512	0.0000	0.0003	100.00
2.G.2 SF6 and PFCs from other product use	C6F14	0.000	0.223	0.0000	0.0003	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.479	0.190	0.0000	0.0003	100.00
1.A.2.g. Other - Gaseous Fuels	N2O	0.639	0.718	0.0000	0.0002	100.00
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	0.638	0.341	0.0000	0.0002	100.00
1.A.3.b. Road Transportation - Other liquid fuels - Lubricants	CO2	0.189	0.335	0.0000	0.0002	100.00
1.B.2.c Venting and Flaring	CH4	0.000	0.168	0.0000	0.0002	100.00
2.E.1 Integrated Circuit or Semiconductor	c-C4F8	0.000	0.166	0.0000	0.0002	100.00
1.A.2.g. Other - Gaseous Fuels	CH4	0.537	0.602	0.0000	0.0002	100.00
2.F.4. Aerosols	HFC-152a	0.000	0.159	0.0000	0.0002	100.00
2.F.2. Foam Blowing Agents	HFC-227ea	0.000	0.145	0.0000	0.0002	100.00
1.A.3.c. Railways - Liquid Fuels	CH4	0.353	0.143	0.0000	0.0002	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.616	0.366	0.0000	0.0002	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.215	0.045	0.0000	0.0002	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.110	0.218	0.0000	0.0002	100.00
1.B.2.b. Natural Gas	CO2	0.730	0.483	0.0000	0.0001	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	N2O	0.000	0.095	0.0000	0.0001	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.189	0.074	0.0000	0.0001	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.344	0.205	0.0000	0.0001	100.00
1.A.2.g. Other - Solid Fuels	N2O	0.151	0.056	0.0000	0.0001	100.00
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.499	0.348	0.0000	0.0001	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	CH4	0.000	0.060	0.0000	0.0001	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.009	0.052	0.0000	0.0001	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.139	0.157	0.0000	0.0001	100.00
2.E.4 Heat Transfer Fluid	HFC-125	0.000	0.040	0.0000	0.000050	100.00
1.A.2.g. Other - Solid Fuels	CH4	0.085	0.031	0.0000	0.000048	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.116	0.132	0.0000	0.000047	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.066	0.089	0.0000	0.000045	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	N2O	0.041	0.00000	0.0000	0.000042	100.00
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.000	0.027	0.0000	0.000034	100.00
1.A.3.b. Road Transportation - LPG	N2O	1.014	0.856	0.0000	0.000033	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	N2O	0.032	0.000	0.0000	0.000032	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.029	0.005	0.0000	0.000030	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	CH4	0.024	0.000	0.0000	0.000024	100.00
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.051	0.028	0.0000	0.000017	100.00
1.A.2.a. Iron and Steel - Biomass	N2O	0.000	0.013	0.0000	0.000016	100.00
1.A.3.b. Road Transportation - Gaseous fuels	CH4	0.000	0.012	0.0000	0.000015	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	0.021	0.027	0.0000	0.000012	100.00

1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.602	0.502	0.0000	0.000012	100.00
1.A.2.a. Iron and Steel - Biomass	CH4	0.0000	0.0082	0.0000	0.000010	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	N2O	0.0096	0.00000	0.0000	0.000010	100.00
2.E.4 Heat Transfer Fluid	HFC-32	0.0000	0.0070	0.0000	0.000009	100.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.3370	0.2807	0.0000	0.000007	100.00
2.B.1 Ammonia Production	CH4	0.0151	0.0170	0.0000	0.000006	100.00
1.A.3.e. Other Transportation - Gaseous Fuels	CH4	0.0266	0.0174	0.0000	0.000005	100.00
1.B.2.a. Oil	CO2	0.0143	0.0157	0.0000	0.000005	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	N2O	0.0049	0.0000	0.0000	0.000005	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CH4	0.0040	0.0000	0.0000	0.000004	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.1255	0.1057	0.0000	0.000004	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.1493	0.1251	0.0000	0.000004	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	CH4	0.0031	0.00000	0.0000	0.000003	100.00
1.A.3.b. Road Transportation - Gaseous fuels	N2O	0.0000	0.0020	0.0000	0.000003	100.00
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CH4	0.0000	0.0007	0.0000	0.000001	100.00

Trend assessment 1990-2013 with LULUCF

IPCC categories Submission 2016	direct GHG	1990 Estimate	2013 Estimate	trend assessment 1990-2013	contribution to trend	cumulative total
		Gg CO_2 eq	Gg CO_2 eq		%	%
		143 687.97	**115 618.78**	**0.8988**		
1.A.3.b. Road Transportation - Diesel Oil	CO2	10 963.77	20 043.14	0.1206	13.42	13.42
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	19 434.27	7 159.61	0.0911	10.14	23.56
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	2 764.79	7 543.94	0.0572	6.36	29.92
2.C.1. Iron and Steel Production	CO2	10 277.62	3 799.05	0.0481	5.35	35.27
1.A.4.b. Residential - Gaseous Fuels	CO2	5 874.20	8 782.50	0.0436	4.85	40.12
1.A.3.b. Road Transportation - Gasoline	CO2	8 360.02	3 458.83	0.0351	3.91	44.02
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	1 933.79	4 541.71	0.0321	3.57	47.59
1.A.2.a. Iron and Steel - Solid Fuels	CO2	3 283.95	26.77	0.0281	3.13	50.72
2.B.8 Petrochemical and carbon black production	CO2	1 882.42	3 737.97	0.0239	2.66	53.38
2.B.2 Nitric Acid Production	N2O	3 421.53	555.28	0.0236	2.63	56.01
2.B.10 Other	CO2	285.15	1 739.14	0.0162	1.81	57.81
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2	-2 929.62	-3 707.63	0.0145	1.61	59.43
5.A. Solid Waste Disposal	CH4	3 053.39	1 140.58	0.0141	1.57	61.00
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	684.19	1 865.99	0.0141	1.57	62.58
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	1 969.04	282.18	0.0140	1.56	64.13
1.A.2.c. Chemicals - Liquid Fuels	CO2	1 851.70	204.08	0.0138	1.54	65.67
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	674.22	1 814.22	0.0137	1.52	67.19
2.B.9.a. By-product emissions	SF6	1 487.59	0.00	0.0129	1.43	68.62
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2 532.33	3 207.36	0.0126	1.40	70.02
4.B.1. Cropland remaining Cropland CSC	CO2	238.92	-901.21	0.0118	1.31	71.33
1.A.4.b. Residential - Solid Fuels	CO2	1 796.20	359.71	0.0117	1.30	72.63
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	1 688.70	293.36	0.0115	1.27	73.90
1.A.4.b. Residential - Liquid Fuels	CO2	12 800.51	9 331.05	0.0104	1.16	75.06
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	2 516.45	1 111.19	0.0098	1.09	76.15
2.B.1 Ammonia Production	CO2	422.74	1 246.58	0.0097	1.08	77.24
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	13.89	914.27	0.0097	1.08	78.32
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	0.00	861.28	0.0093	1.03	79.35
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	0.00	823.28	0.0088	0.98	80.33
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	0.00	816.86	0.0088	0.98	81.31
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	67.38	867.26	0.0087	0.97	82.28

1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	1 508.71	527.82	0.0074	0.82	83.10
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	884.66	35.71	0.0073	0.81	83.91
2.B.9.a. By-product emissions	C2F6	671.94	0.00	0.0058	0.65	84.56
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	662.56	18.88	0.0055	0.61	85.17
4.B.2. Land converted to Cropland CSC	CO2	63.14	557.07	0.0054	0.61	85.78
5.D. Wastewater treatment and discharge	CH4	834.95	215.19	0.0049	0.55	86.32
4.E.2. Land converted to Settlements CSC	CO2	237.42	618.76	0.0046	0.51	86.84
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	650.58	97.09	0.0046	0.51	87.35
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	2 466.35	1 581.52	0.0043	0.48	87.83
3A1 Non-Dairy Cattle	CH4	2 721.79	2 584.58	0.0042	0.47	88.30
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	357.60	680.33	0.0042	0.47	88.77
1.A.2.g. Other - Gaseous Fuels	CO2	1 203.94	1 344.97	0.0040	0.45	89.22
4.C.2. Land converted to Grassland CSC	CO2	84.55	-281.44	0.0038	0.42	89.64
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	2 314.69	1 522.21	0.0037	0.41	90.04
4.G Harvest wood products	CO2	0.00	336.31	0.0036	0.40	90.45
1.A.2.g. Other - Liquid Fuels	CO2	1 578.69	936.67	0.0036	0.40	90.84
1.A.2.c. Chemicals - Solid Fuels	CO2	401.51	3.11	0.0034	0.38	91.23
3A1 Dairy Cattle	CH4	2 304.38	1 535.41	0.0034	0.38	91.61
2.B.9.a. By-product emissions	CF4	368.01	3.92	0.0031	0.35	91.96
1.B.1.a. Coal Mining and Handling	CH4	355.74	0.00	0.0031	0.34	92.30
2.B.9.b Fugitive emissions	C5F12	351.53	0.04	0.0030	0.34	92.64
4.A.2. Land converted to Forest Land CSC	CO2	-17.43	-287.98	0.0029	0.33	92.97
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	186.18	422.47	0.0029	0.33	93.29
2.A.1 Cement production	CO2	2 823.78	2 541.37	0.0029	0.32	93.61
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1 492.90	987.11	0.0023	0.26	93.87
2.B.9.b Fugitive emissions	C4F10	25.40	227.17	0.0022	0.25	94.12
2.B.9.a. By-product emissions	C4F10	228.60	0.00	0.0020	0.22	94.34
2.B.9.a. By-product emissions	C3F8	215.77	0.00	0.0019	0.21	94.55
1.A.3.b. Road Transportation - Diesel Oil	N2O	59.25	219.49	0.0018	0.21	94.75
4.C.1. Grassland remaining Grassland CSC	CO2	-43.32	-194.25	0.0017	0.19	94.94
3D1 Direct N2O emissions from managed soils	N2O	3 356.10	2 555.63	0.0016	0.17	95.11
1.A.4.b. Residential - Biomass	CH4	71.24	197.37	0.0015	0.17	95.28
3D2 Indirect N2O Emissions from managed soils	N2O	1 051.55	706.28	0.0015	0.17	95.45
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	361.87	429.80	0.0015	0.17	95.62
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	212.09	36.72	0.0014	0.16	95.78
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	220.47	48.46	0.0014	0.15	95.93
3B3 Swine	CH4	792.78	756.15	0.0013	0.14	96.07
2.D.1 Lubricant use	CO2	211.11	63.38	0.0011	0.13	96.20
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	166.99	34.09	0.0011	0.12	96.32
1.A.3.b. Road Transportation - Gasoline	N2O	135.27	11.89	0.0010	0.12	96.43

1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	0.15	93.81	0.0010	0.11	96.55
1.A.2.d. Pulp, Paper and Print - Other Fuels	CO2	0.00	92.38	0.0010	0.11	96.66
1.A.3.c. Railways - Liquid Fuels	CO2	222.45	88.42	0.0010	0.11	96.76
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	234.59	98.72	0.0010	0.11	96.87
3B1 Dairy Cattle	N2O	233.60	100.83	0.0009	0.10	96.98
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	260.84	296.92	0.0009	0.10	97.08
1.A.4.b. Residential - Solid Fuels	CH4	142.18	28.52	0.0009	0.10	97.18
2.F.4. Aerosols	HFC-134a	0.00	81.80	0.0009	0.10	97.28
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	30.70	101.99	0.0008	0.09	97.37
2G3. N2O from Product Uses	N2O	196.48	83.73	0.0008	0.09	97.46
3B1 Dairy Cattle	CH4	296.57	312.12	0.0008	0.09	97.55
5.D. Wastewater treatment and discharge	N2O	247.33	268.53	0.0007	0.08	97.63
5.C.1 Waste incineration / Non-biogenic	CO2	299.50	310.07	0.0007	0.08	97.72
1.A.3.b. Road Transportation - Gasoline	CH4	96.77	11.30	0.0007	0.08	97.80
2.A.4 Other process uses of carbonates	CO2	135.72	170.21	0.0007	0.07	97.87
1.A.2.g. Other - Other Fuels	CO2	0.00	59.73	0.0006	0.07	97.94
2.A.2 Lime production	CO2	2 097.12	1 629.16	0.0006	0.07	98.01
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1 364.20	1 154.40	0.0006	0.07	98.08
1.B.2.b. Natural Gas	CH4	617.71	440.52	0.0006	0.07	98.15
1.B.2.c Venting and Flaring	CO2	83.83	118.50	0.0005	0.06	98.21
3A3 Swine	CH4	251.27	252.30	0.0005	0.06	98.27
4.E.2. Direct N2O emissions from N mineralization/immobilisation	N2O	4.06	52.49	0.0005	0.06	98.33
2.A.3 Glass production	CO2	266.17	165.11	0.0005	0.06	98.38
4.B.2. Direct N2O emissions from N mineralization/immobilisation	N2O	3.73	51.21	0.0005	0.06	98.44
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	3.95	50.98	0.0005	0.06	98.50
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-32	0.00	44.53	0.0005	0.05	98.55
2.B.9.b Fugitive emissions	C6F14	288.78	191.31	0.0004	0.05	98.60
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CO2	50.62	0.00	0.0004	0.05	98.65
1.A.3.e. Other Transportation - Liquid Fuels	CO2	29.12	64.13	0.0004	0.05	98.70
2.F.2. Foam Blowing Agents	HFC-134a	0.00	39.53	0.0004	0.05	98.75
2.G.2 SF6 and PFCs from other product use	SF6	79.77	101.03	0.0004	0.04	98.79
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	7.86	42.97	0.0004	0.04	98.83
5.B. Biological treatment of solid waste	N2O	3.95	38.27	0.0004	0.04	98.88
2.C.7 Other	CO2	50.43	73.96	0.0004	0.04	98.92
2.B.9.a. By-product emissions	C5F12	41.01	0.00	0.0004	0.04	98.95
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	147.35	86.41	0.0003	0.04	98.99
1.A.3.e. Other Transportation - Gaseous Fuels	CO2	196.77	126.71	0.0003	0.04	99.03
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	124.21	70.10	0.0003	0.04	99.07
3B1 Non-Dairy Cattle	CH4	188.42	180.05	0.0003	0.03	99.10
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	37.25	4.01	0.0003	0.03	99.13

3A4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	10.65	34.08	0.0003	0.03	99.16
1.B.1.b. Solid Fuel Transformation	CH4	36.66	4.04	0.0003	0.03	99.19
5.B. Biological treatment of solid waste	CH4	2.59	25.08	0.0002	0.03	99.22
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	4.87	26.70	0.0002	0.03	99.25
1.A.4.b. Residential - Biomass	N2O	11.32	31.37	0.0002	0.03	99.27
1.A.4.a. Commercial / Institutional - Biomass	CH4	0.00	21.08	0.0002	0.03	99.30
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	CH4	0.00	21.04	0.0002	0.03	99.32
3B1 Non-Dairy Cattle	N2O	417.22	356.44	0.0002	0.02	99.35
2H. Other	CO2	0.00	20.60	0.0002	0.02	99.37
1.A.3.b. Road Transportation - LPG	CO2	169.32	116.07	0.0002	0.02	99.40
2.F.2. Foam Blowing Agents	HFC-152a	0.00	19.83	0.0002	0.02	99.42
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	54.02	24.75	0.0002	0.02	99.44
4.D.2. Land converted to Wetlands CSC	CO2	17.85	-4.24	0.0002	0.02	99.47
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	0.75	18.42	0.0002	0.02	99.49
2.D.3 Other urea	CO2	0.00	16.70	0.0002	0.02	99.51
1.A.3.b. Road Transportation - Diesel Oil	CH4	22.39	4.44	0.0001	0.02	99.52
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	281.82	240.12	0.0001	0.02	99.54
1.A.2.g. Other - Solid Fuels	CO2	33.22	13.74	0.0001	0.02	99.56
1.A.3.b. Road Transportation - Biomass	N2O	0.00	11.81	0.0001	0.0141	99.57
3B5 Indirect N2O emissions	N2O	218.32	187.18	0.0001	0.0138	99.58
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	16.96	24.70	0.0001	0.0132	99.60
2.F.3. Fire protection	HFC-227ea	0.00	10.94	0.0001	0.0131	99.61
1.A.2.d. Pulp, Paper and Print - biomass	N2O	4.66	14.60	0.0001	0.0130	99.62
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	16.82	2.91	0.0001	0.0127	99.64
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	4 285.28	3 458.27	0.0001	0.0121	99.65
2.B.10 Other	N2O	8.94	16.71	0.0001	0.0114	99.66
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	4.31	12.92	0.0001	0.0113	99.67
3A2 Sheep	CH4	38.43	21.56	0.0001	0.0112	99.68
1.A.1.a. Public Electricity and Heat Production - Biomass	CH4	0.00	9.14	0.0001	0.0109	99.69
1.A.4.b. Residential - Gaseous Fuels	CH4	13.08	19.57	0.0001	0.0108	99.70
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	3.28	11.68	0.0001	0.0108	99.71
1.A.2.f. Non-metallic minerals - biomass	N2O	0.00	8.31	0.0001	0.0099	99.72
1.A.2.c. Chemicals - Other Fuels	CO2	0.00	8.24	0.0001	0.0099	99.73
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	N2O	10.18	16.37	0.0001	0.0098	99.74
1.A.2.f. Non-metallic minerals - Other Fuels	N2O	0.28	7.74	0.0001	0.0090	99.75
1.A.4.a. Commercial / Institutional - Solid Fuels	CO2	9.01	0.00	0.0001	0.0087	99.76
1.A.2.a. Iron and Steel - Solid Fuels	N2O	8.66	0.13	0.0001	0.0082	99.77
2.G.1. Electrical equipment	SF6	7.75	12.41	0.0001	0.0074	99.78
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	10.02	2.02	0.0001	0.0072	99.78

1.A.3.c. Railways - Liquid Fuels	N2O	12.14	3.77	0.0001	0.0072	99.79
1.A.2.d. Pulp, Paper and Print - biomass	CH4	1.64	6.61	0.0001	0.0063	99.80
1.A.4.b. Residential - Solid Fuels	N2O	8.47	1.70	0.0001	0.0061	99.80
1.A.2.c. Chemicals - Biomass	N2O	0.00	4.85	0.0001	0.0058	99.81
1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	2.99	7.23	0.0001	0.0058	99.82
2.C.1. Iron and Steel Production	CH4	13.66	15.83	0.0001	0.0058	99.82
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	14.88	7.25	0.0001	0.0056	99.83
2.B.10 Other	CH4	0.00	4.56	0.0000	0.0055	99.83
1.A.2.f. Non-metallic minerals - Solid Fuels	CH4	7.77	10.77	0.0000	0.0054	99.84
3B3 Swine	N2O	91.91	78.38	0.0000	0.0053	99.84
2.D.2 Paraffin wax use	CO2	2.95	6.37	0.0000	0.0048	99.85
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	8.21	2.73	0.0000	0.0046	99.85
4.A.1 biomass burning	N2O	4.68	0.00	0.0000	0.0045	99.86
1.A.2.c. Chemicals - Other Fuels	CH4	1.39	4.78	0.0000	0.0044	99.86
3G Liming	CO2	161.57	133.40	0.0000	0.0041	99.87
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	38.43	34.31	0.0000	0.0041	99.87
2.E.1 Integrated Circuit or Semiconductor	C2F6	0.00	3.34	0.0000	0.0040	99.87
2.E.1 Integrated Circuit or Semiconductor	CF4	0.00	3.30	0.0000	0.0039	99.88
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CO2	3.98	0.00	0.0000	0.0038	99.88
1.A.4.b. Residential - Liquid Fuels	CH4	43.67	31.99	0.0000	0.0038	99.88
1.A.2.g. Other - Liquid Fuels	N2O	13.91	14.32	0.0000	0.0037	99.89
1.A.2.c. Chemicals - Liquid Fuels	N2O	4.22	0.48	0.0000	0.0035	99.89
1.B.2.a. Oil	CH4	11.38	6.24	0.0000	0.0035	99.90
1.A.2.f. Non-metallic minerals - biomass	CH4	0.00	2.74	0.0000	0.0033	99.90
4.C.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.21	2.86	0.0000	0.0032	99.90
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	127.50	99.95	0.0000	0.0032	99.91
1.A.2.a. Iron and Steel - Solid Fuels	CH4	3.22	0.05	0.0000	0.0030	99.91
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	3.13	0.08	0.0000	0.0029	99.91
1.A.2.f. Non-metallic minerals - Other Fuels	CH4	0.00	2.39	0.0000	0.0029	99.91
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	3.78	0.68	0.0000	0.0028	99.92
1.A.2.f. Non-metallic minerals - Liquid Fuels	N2O	4.55	1.32	0.0000	0.0028	99.92
2.E.1 Integrated Circuit or Semiconductor	SF6	0.00	2.31	0.0000	0.0028	99.92
1.A.4.b. Residential - Gaseous Fuels	N2O	3.12	4.66	0.0000	0.0026	99.92
2.F.1. Refrigeration and Air Conditioning Equipment	C3F8	0.00	2.13	0.0000	0.0025	99.93
1.A.4.b. Residential - Liquid Fuels	N2O	30.31	22.26	0.0000	0.0025	99.93
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	7.59	4.10	0.0000	0.0024	99.93
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	3.06	0.46	0.0000	0.0024	99.93
1.A.2.c. Chemicals - Other Fuels	N2O	0.66	2.28	0.0000	0.0021	99.94
1.A.2.b. Non-Ferrous Metals - Other fuels	CO2	0.00	1.68	0.0000	0.0020	99.94
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	1.03	2.41	0.0000	0.0019	99.94

1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH4	2.51	0.50	0.0000	0.0018	99.94
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	0.18	1.62	0.0000	0.0018	99.94
2.E.1 Integrated Circuit or Semiconductor	HFC-23	0.00	1.44	0.0000	0.0017	99.95
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	0.52	1.86	0.0000	0.0017	99.95
1.A.2.c. Chemicals - Solid Fuels	N2O	1.75	0.01	0.0000	0.0017	99.95
1.A.2.g. Other - biomass	N2O	0.01	1.33	0.0000	0.0016	99.95
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	1.67	0.06	0.0000	0.0015	99.95
1.A.3.b. Road Transportation - Gaseous fuels	CO2	0.00	1.25	0.0000	0.0015	99.95
2.E.1 Integrated Circuit or Semiconductor	NF3	0.00	1.24	0.0000	0.0015	99.96
1.A.2.c. Chemicals - Liquid Fuels	CH4	1.77	0.20	0.0000	0.0015	99.96
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	7.80	5.06	0.0000	0.0014	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	1.71	0.26	0.0000	0.0013	99.96
1.A.2.d. Pulp, Paper and Print - Other Fuels	N2O	0.00	1.12	0.0000	0.0013	99.96
1.A.3.d. Navigation - Gas/Diesel Oil	N2O	2.88	3.41	0.0000	0.0013	99.96
2.F.3. Fire protection	HFC-125	0.00	1.04	0.0000	0.0012	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0.44	1.35	0.0000	0.0012	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	1.56	0.29	0.0000	0.0012	99.97
1.A.3.b. Road Transportation - Biomass	CH4	0.00	0.96	0.0000	0.0011	99.97
1.A.2.g. Other - Liquid Fuels	CH4	4.55	2.72	0.0000	0.0011	99.97
1.A.4.a. Commercial / Institutional - Biomass	N2O	0.00	0.93	0.0000	0.0011	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	0.11	1.02	0.0000	0.0011	99.97
1.A.2.f. Non-metallic minerals - Solid Fuels	N2O	10.81	9.63	0.0000	0.0011	99.97
1.A.2.c. Chemicals - Gaseous Fuels	N2O	1.37	2.02	0.0000	0.0011	99.97
1.A.2.c. Chemicals - Biomass	CH4	0.00	0.91	0.0000	0.0011	99.97
1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	5.57	3.58	0.0000	0.0011	99.97
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.61	0.40	0.0000	0.0011	99.98
1.A.2.g. Other - biomass	CH4	0.01	0.84	0.0000	0.0010	99.98
2.F.2. Foam Blowing Agents	HFC-245fa	0.00	0.80	0.0000	0.0010	99.98
1.A.2.g. Other - Other Fuels	N2O	0.00	0.80	0.0000	0.0010	99.98
1.A.2.c. Chemicals - Solid Fuels	CH4	0.99	0.01	0.0000	0.0009	99.98
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH4	1.48	0.42	0.0000	0.0009	99.98
2.F.2. Foam Blowing Agents	HFC-365mfc	0.00	0.74	0.0000	0.0009	99.98
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	N2O	0.00	0.74	0.0000	0.0009	99.98
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CH4	0.88	0.00	0.0000	0.0008	99.98
1.A.2.d. Pulp, Paper and Print - Other Fuels	CH4	0.00	0.70	0.0000	0.0008	99.98
5.C.1 Waste incineration / Biogenic	N2O	1.40	0.49	0.0000	0.0008	99.98
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	1.00	0.17	0.0000	0.0008	99.99
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0.30	0.87	0.0000	0.0008	99.99
5.C.1 Waste incineration / Non-biogenic	N2O	1.24	0.37	0.0000	0.0007	99.99

2.F.4. Aerosols	HFC-227ea	0.00	0.56	0.0000	0.0007	99.99
1.A.3.e. Other Transportation - Liquid Fuels	N2O	0.34	0.82	0.0000	0.0007	99.99
1.A.3.b. Road Transportation - LPG	CH4	1.09	0.34	0.0000	0.0006	99.99
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	3.14	1.99	0.0000	0.0006	99.99
1.A.2.g. Other - Other Fuels	CH4	0.00	0.50	0.0000	0.0006	99.99
1.A.2.c. Chemicals - Gaseous Fuels	CH4	1.15	1.43	0.0000	0.0006	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.61	0.02	0.0000	0.0006	99.99
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.62	0.02	0.0000	0.0006	99.99
4.A.1 biomass burning	CH4	0.57	0.00	0.0000	0.0005	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.57	0.03	0.0000	0.0005	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.04	0.46	0.0000	0.0005	99.99
4.C.1. Direct N2O emissions from N mineralization/immobilisation	N2O	1.94	1.14	0.0000	0.0005	99.99
4.D.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.00	0.33	0.0000	0.0004	99.99
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.51	0.11	0.0000	0.0004	100.00
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N2O	1.14	0.62	0.0000	0.0004	100.00
3B2 Sheep	N2O	0.99	0.55	0.0000	0.0003	100.00
2.G.2 SF6 and PFCs from other product use	C6F14	0.00	0.22	0.0000	0.0003	100.00
3B2 Sheep	CH4	0.91	0.51	0.0000	0.0003	100.00
1.A.2.g. Other - Gaseous Fuels	N2O	0.64	0.72	0.0000	0.0002	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.48	0.19	0.0000	0.0002	100.00
1.A.3.b. Road Transportation - Other liquid fuels - Lubricants	CO2	0.19	0.33	0.0000	0.0002	100.00
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	0.64	0.34	0.0000	0.0002	100.00
1.A.2.g. Other - Gaseous Fuels	CH4	0.54	0.60	0.0000	0.0002	100.00
1.B.2.c Venting and Flaring	CH4	0.00	0.17	0.0000	0.0002	100.00
2.E.1 Integrated Circuit or Semiconductor	c-C4F8	0.00	0.17	0.0000	0.0002	100.00
2.F.4. Aerosols	HFC-152a	0.00	0.16	0.0000	0.0002	100.00
2.F.2. Foam Blowing Agents	HFC-227ea	0.00	0.14	0.0000	0.0002	100.00
1.A.3.c. Railways - Liquid Fuels	CH4	0.35	0.14	0.0000	0.0002	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.62	0.37	0.0000	0.0002	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.11	0.22	0.0000	0.0002	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.21	0.04	0.0000	0.0002	100.00
1.B.2.b. Natural Gas	CO2	0.73	0.48	0.0000	0.0001	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	N2O	0.00	0.10	0.0000	0.0001	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.19	0.07	0.0000	0.0001	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.34	0.20	0.0000	0.0001	100.00
1.A.2.g. Other - Solid Fuels	N2O	0.15	0.06	0.0000	0.0001	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	CH4	0.00	0.06	0.0000	0.0001	100.00
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.50	0.35	0.0000	0.0001	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.01	0.05	0.0000	0.0001	100.00

1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.14	0.16	0.0000	0.0001	100.00
1.A.3.b. Road Transportation - LPG	N2O	1.01	0.86	0.0000	0.00005	100.00
2.E.4 Heat Transfer Fluid	HFC-125	0.00	0.04	0.0000	0.00005	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.12	0.13	0.0000	0.00005	100.00
1.A.2.g. Other - Solid Fuels	CH4	0.08	0.03	0.0000	0.00004	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.07	0.09	0.0000	0.00004	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	N2O	0.04	0.00	0.0000	0.00004	100.00
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.00	0.03	0.0000	0.00003	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	N2O	0.03	0.00	0.0000	0.00003	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.03	0.00	0.0000	0.00003	100.00
4.A.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.01	0.04	0.0000	0.00003	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	CH4	0.02	0.00	0.0000	0.00002	100.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.60	0.50	0.0000	0.00002	100.00
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.05	0.03	0.0000	0.00002	100.00
1.A.2.a. Iron and Steel - Biomass	N2O	0.00	0.01	0.0000	0.00002	100.00
1.A.3.b. Road Transportation - Gaseous fuels	CH4	0.00	0.01	0.0000	0.00001	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	0.02	0.03	0.0000	0.00001	100.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.34	0.28	0.0000	0.00001	100.00
1.A.2.a. Iron and Steel - Biomass	CH4	0.000	0.008	0.0000	0.0000098	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	N2O	0.010	0.000	0.0000	0.0000092	100.00
2.E.4 Heat Transfer Fluid	HFC-32	0.000	0.007	0.0000	0.0000084	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.149	0.125	0.0000	0.0000059	100.00
2.B.1 Ammonia Production	CH4	0.015	0.017	0.0000	0.0000057	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.126	0.106	0.0000	0.0000056	100.00
1.B.2.a. Oil	CO2	0.014	0.016	0.0000	0.0000051	100.00
1.A.3.e. Other Transportation - Gaseous Fuels	CH4	0.027	0.017	0.0000	0.0000048	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	N2O	0.005	0.000	0.0000	0.0000047	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CH4	0.004	0.000	0.0000	0.0000038	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	CH4	0.003	0.000	0.0000	0.0000030	100.00
1.A.3.b. Road Transportation - Gaseous fuels	N2O	0.000	0.002	0.0000	0.0000024	100.00
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CH4	0.000	0.001	0.0000	0.0000008	100.00

Trend assessment 1990-2014 without LULUCF

IPCC categories Submission 2016	direct GHG	1990 Estimate (non-Lulucf)	2014 Estimate (non-Lulucf)	trend assessment 1990-2014	contribution to trend	cumulative total
		Gg CO_2 eq	Gg CO_2 eq		%	%
		146 021.24	**113 866.62**	**0.8614**		
1.A.3.b. Road Transportation - Diesel Oil	CO2	10 963.77	20 404.82	0.1335	15.500	15.50
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	19 434.27	6 528.04	0.0972	11.279	26.78
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	2 764.79	6 855.97	0.0529	6.145	32.92
2.C.1. Iron and Steel Production	CO2	10 277.62	3 793.75	0.0475	5.518	38.44
1.A.3.b. Road Transportation - Gasoline	CO2	8 360.02	3 750.89	0.0312	3.619	42.06
1.A.2.a. Iron and Steel - Solid Fuels	CO2	3 283.95	51.83	0.0283	3.280	45.34
2.B.8 Petrochemical and carbon black production	CO2	1 882.42	3 844.91	0.0268	3.108	48.45
1.A.4.b. Residential - Gaseous Fuels	CO2	5 874.20	6 848.94	0.0255	2.966	51.41
2.B.2 Nitric Acid Production	N2O	3 421.53	473.16	0.0247	2.870	54.28
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	1 933.79	3 585.87	0.0234	2.717	57.00
1.A.4.b. Residential - Liquid Fuels	CO2	12 800.51	8 368.83	0.0182	2.109	59.11
2.B.10 Other	CO2	285.15	1 794.65	0.0177	2.056	61.17
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	674.22	1 986.04	0.0164	1.909	63.07
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	1 969.04	182.45	0.0152	1.769	64.84
5.A. Solid Waste Disposal	CH4	3 053.39	1 064.32	0.0148	1.721	66.56
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	684.19	1 847.26	0.0148	1.718	68.28
1.A.2.c. Chemicals - Liquid Fuels	CO2	1 851.70	146.38	0.0146	1.696	69.98
2.B.9.a. By-product emissions	SF6	1 487.59	0.00000	0.0131	1.517	71.50
1.A.4.b. Residential - Solid Fuels	CO2	1 796.20	283.78	0.0126	1.460	72.96
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	1 688.70	258.97	0.0119	1.383	74.34
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	2 516.45	931.35	0.0116	1.348	75.69
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	13.89	1 020.47	0.0114	1.320	77.01
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2 532.33	2 953.19	0.0110	1.279	78.29
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	0.00	912.09	0.0103	1.192	79.48
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	0.00	866.03	0.0098	1.132	80.61
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	0.00	825.27	0.0093	1.079	81.69
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	1 508.71	379.33	0.0090	1.042	82.73
2.B.1 Ammonia Production	CO2	422.74	1 052.28	0.0081	0.945	83.68
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	67.38	763.11	0.0080	0.929	84.61
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	884.66	25.33	0.0075	0.869	85.47

1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	2 314.69	1 195.84	0.0069	0.796	86.27
2.B.9.a. By-product emissions	C2F6	671.94	0.00000	0.0059	0.685	86.96
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	662.56	44.17	0.0053	0.618	87.57
3A1 Non-Dairy Cattle	CH4	2 721.79	2 586.70	0.0052	0.607	88.18
5.D. Wastewater treatment and discharge	CH4	834.95	207.09	0.0050	0.580	88.76
2.A.1 Cement production	CO2	2 823.78	2 642.98	0.0050	0.577	89.34
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	650.58	101.91	0.0046	0.530	89.87
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	357.60	676.61	0.0045	0.520	90.39
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	4 285.28	3 711.08	0.0042	0.483	90.87
1.A.2.c. Chemicals - Solid Fuels	CO2	401.51	2.86	0.0035	0.406	91.28
1.B.1.a. Coal Mining and Handling	CH4	355.74	0.00000	0.0031	0.363	91.64
2.B.9.a. By-product emissions	CF4	368.01	9.84	0.0031	0.362	92.00
2.B.9.b Fugitive emissions	C5F12	351.53	0.02	0.0031	0.358	92.36
1.A.2.g. Other - Liquid Fuels	CO2	1 578.69	969.88	0.0029	0.341	92.70
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	186.18	383.96	0.0027	0.312	93.01
3A1 Dairy Cattle	CH4	2 304.38	1 579.48	0.0024	0.284	93.30
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	2 466.35	1 720.17	0.0023	0.266	93.56
1.A.3.b. Road Transportation - Diesel Oil	N2O	59.25	229.04	0.0021	0.239	93.80
2.B.9.a. By-product emissions	C4F10	228.60	0.00	0.0020	0.233	94.04
2.B.9.a. By-product emissions	C3F8	215.77	0.00	0.0019	0.220	94.26
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1 492.90	1 006.90	0.0018	0.206	94.46
2.B.9.b Fugitive emissions	C4F10	25.40	175.19	0.0017	0.203	94.66
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	220.47	38.48	0.0015	0.174	94.84
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	361.87	414.25	0.0015	0.173	95.01
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	212.09	36.72	0.0014	0.168	95.18
1.A.2.g. Other - Gaseous Fuels	CO2	1 203.94	1 056.04	0.0013	0.153	95.33
3B3 Swine	CH4	792.78	730.34	0.0013	0.147	95.48
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1 364.20	1 174.70	0.0012	0.145	95.62
2.B.9.b Fugitive emissions	C6F14	288.78	114.30	0.0012	0.145	95.77
1.A.2.d. Pulp, Paper and Print - Other Fuels	CO2	0.00	107.81	0.0012	0.141	95.91
2.D.1 Lubricant use	CO2	211.11	64.95	0.0011	0.130	96.04
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	234.59	85.47	0.0011	0.127	96.17
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	166.99	33.99	0.0011	0.126	96.29
3D2 Indirect N2O Emissions from managed soils	N2O	1 051.55	724.05	0.0011	0.125	96.42
1.A.3.e. Other Transportation - Gaseous Fuels	CO2	196.77	58.89	0.0011	0.124	96.54
1.A.3.b. Road Transportation - Gasoline	N2O	135.27	11.62	0.0011	0.123	96.67
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	281.82	312.14	0.0010	0.121	96.79
3B1 Dairy Cattle	CH4	296.57	320.29	0.0010	0.116	96.90
1.A.4.b. Residential - Solid Fuels	CH4	142.18	22.50	0.0010	0.116	97.02
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	0.15	87.74	0.0010	0.115	97.13

1.A.4.b. Residential - Biomass	CH4	71.24	141.25	0.0010	0.112	97.25
1.A.3.c. Railways - Liquid Fuels	CO2	222.45	88.42	0.0010	0.111	97.36
3B1 Dairy Cattle	N2O	233.60	102.65	0.0009	0.104	97.46
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	30.70	102.35	0.0009	0.103	97.56
2.F.4. Aerosols	HFC-134a	0.00	78.06	0.0009	0.102	97.66
5.D. Wastewater treatment and discharge	N2O	247.33	269.76	0.0009	0.101	97.77
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	260.84	278.45	0.0008	0.098	97.86
2.A.4 Other process uses of carbonates	CO2	135.72	173.79	0.0008	0.089	97.95
1.A.3.b. Road Transportation - Gasoline	CH4	96.77	11.65	0.0007	0.083	98.04
2G3. N2O from Product Uses	N2O	196.48	92.48	0.0007	0.079	98.12
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-32	0.00	50.26	0.0006	0.066	98.18
2.A.3 Glass production	CO2	266.17	157.33	0.0006	0.066	98.25
2.C.7 Other	CO2	50.43	88.06	0.0005	0.064	98.31
3A3 Swine	CH4	251.27	244.36	0.0005	0.063	98.37
1.A.3.e. Other Transportation - Liquid Fuels	CO2	29.12	66.50	0.0005	0.057	98.43
1.A.2.g. Other - Other Fuels	CO2	0.00	43.78	0.0005	0.057	98.49
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	147.35	73.31	0.0005	0.054	98.54
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CO2	50.62	0.00000	0.0004	0.052	98.59
2.F.2. Foam Blowing Agents	HFC-134a	0.00	38.90	0.0004	0.051	98.64
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	3.95	41.16	0.0004	0.050	98.69
1.B.2.b. Natural Gas	CH4	617.71	517.70	0.0004	0.047	98.74
5.B. Biological treatment of solid waste	N2O	3.95	37.39	0.0004	0.045	98.79
3B1 Non-Dairy Cattle	CH4	188.42	180.01	0.0004	0.043	98.83
2.B.9.a. By-product emissions	C5F12	41.01	0.00000	0.0004	0.042	98.87
1.B.2.c Venting and Flaring	CO2	83.83	97.10	0.0004	0.041	98.91
3B1 Non-Dairy Cattle	N2O	417.22	353.10	0.0003	0.036	98.95
1.B.1.b. Solid Fuel Transformation	CH4	36.66	1.49	0.0003	0.035	98.98
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	37.25	2.97	0.0003	0.034	99.02
2H. Other	CO2	0.00	25.96	0.0003	0.034	99.05
3A4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	10.65	33.51	0.0003	0.033	99.09
1.A.1.a. Public Electricity and Heat Production - Biomass	CH4	0.00	22.65	0.0003	0.030	99.12
5.B. Biological treatment of solid waste	CH4	2.59	24.51	0.0003	0.029	99.14
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	7.86	27.65	0.0002	0.028	99.17
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	CH4	0.00	21.46	0.0002	0.028	99.20
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	4.87	24.39	0.0002	0.027	99.23
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	124.21	77.25	0.0002	0.026	99.25
1.A.4.a. Commercial / Institutional - Biomass	CH4	0.00	19.41	0.0002	0.025	99.28
2.D.3 Other urea	CO2	0.00	19.09	0.0002	0.025	99.30
2.F.2. Foam Blowing Agents	HFC-152a	0.00	19.01	0.0002	0.025	99.33
2.G.2 SF6 and PFCs from other product use	SF6	79.77	80.40	0.0002	0.024	99.35

3B5 Indirect N2O emissions	N2O	218.32	187.57	0.0002	0.023	99.38
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	0.75	17.00	0.0002	0.021	99.40
1.A.3.b. Road Transportation - Biomass	N2O	0.00	14.58	0.0002	0.019	99.42
1.A.2.c. Chemicals - Other Fuels	CO2	0.00	14.42	0.0002	0.019	99.43
1.A.4.b. Residential - Biomass	N2O	11.32	22.45	0.0002	0.018	99.45
1.A.2.g. Other - Solid Fuels	CO2	33.22	12.39	0.0002	0.018	99.47
1.A.3.b. Road Transportation - Diesel Oil	CH4	22.39	4.07	0.0002	0.018	99.49
5.C.1 Waste incineration / Non-biogenic	CO2	299.50	220.30	0.0001	0.017	99.51
3D1 Direct N2O emissions from managed soils	N2O	3 356.10	2 629.63	0.0001	0.016	99.52
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	16.96	25.59	0.0001	0.016	99.54
1.A.2.d. Pulp, Paper and Print - biomass	N2O	4.66	15.14	0.0001	0.015	99.55
2.F.3. Fire protection	HFC-227ea	0.00	11.46	0.0001	0.015	99.57
2.B.10 Other	N2O	8.94	18.34	0.0001	0.015	99.58
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	54.02	31.02	0.0001	0.015	99.60
2.C.1. Iron and Steel Production	CH4	13.66	21.08	0.0001	0.014	99.61
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	16.82	2.91	0.0001	0.013	99.62
1.A.2.f. Non-metallic minerals - biomass	N2O	0.00	10.00	0.0001	0.013	99.64
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	3.28	11.72	0.0001	0.012	99.65
2.B.10 Other	CH4	0.00	8.76	0.0001	0.011	99.66
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	N2O	10.18	16.61	0.0001	0.011	99.67
1.A.2.f. Non-metallic minerals - Other Fuels	N2O	0.28	8.13	0.0001	0.010	99.68
3A2 Sheep	CH4	38.43	22.19	0.0001	0.010	99.69
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	7.59	13.32	0.0001	0.010	99.70
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	4.31	10.73	0.0001	0.010	99.71
1.A.4.a. Commercial / Institutional - Solid Fuels	CO2	9.01	0.00000	0.0001	0.009	99.72
3G Liming	CO2	161.57	132.50	0.0001	0.009	99.73
1.A.2.a. Iron and Steel - Solid Fuels	N2O	8.66	0.28	0.0001	0.008	99.74
2.A.2 Lime production	CO2	2 097.12	1 641.59	0.0001	0.008	99.75
1.A.3.c. Railways - Liquid Fuels	N2O	12.14	3.77	0.0001	0.007	99.75
1.A.2.d. Pulp, Paper and Print - biomass	CH4	1.64	6.96	0.0001	0.007	99.76
1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	2.99	7.95	0.0001	0.007	99.77
2.G.1. Electrical equipment	SF6	7.75	11.36	0.0001	0.007	99.78
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	10.02	2.51	0.0001	0.007	99.78
1.A.4.b. Residential - Liquid Fuels	CH4	43.67	28.78	0.0001	0.007	99.79
1.A.4.b. Residential - Solid Fuels	N2O	8.47	1.34	0.0001	0.007	99.80
1.A.2.f. Non-metallic minerals - Solid Fuels	CH4	7.77	0.81	0.0001	0.007	99.80
1.A.4.b. Residential - Gaseous Fuels	CH4	13.08	15.26	0.0001	0.007	99.81
1.A.3.b. Road Transportation - LPG	CO2	169.32	126.99	0.0001	0.007	99.82
1.A.2.c. Chemicals - Biomass	N2O	0.00	4.96	0.0001	0.006	99.82

1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	14.88	6.66	0.0001	0.006	99.83
1.A.3.b. Road Transportation - Gaseous fuels	CO2	0.00	4.91	0.0001	0.006	99.84
1.A.2.g. Other - Liquid Fuels	N2O	13.91	15.17	0.0000	0.006	99.84
1.A.2.a. Iron and Steel - Other fuels	CO2	0.00	4.27	0.0000	0.006	99.85
2.D.2 Paraffin wax use	CO2	2.95	6.37	0.0000	0.005	99.85
2.F.2. Foam Blowing Agents	HFC-365mfc	0.00	3.88	0.0000	0.005	99.86
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	38.43	33.77	0.0000	0.005	99.86
1.A.4.b. Residential - Liquid Fuels	N2O	30.31	20.01	0.0000	0.005	99.87
1.A.2.c. Chemicals - Other Fuels	CH4	1.39	4.65	0.0000	0.005	99.87
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	8.21	2.93	0.0000	0.005	99.88
2.E.1 Integrated Circuit or Semiconductor	SF6	0.00	3.45	0.0000	0.005	99.88
2.E.1 Integrated Circuit or Semiconductor	C2F6	0.00	3.42	0.0000	0.004	99.88
1.A.2.f. Non-metallic minerals - Solid Fuels	N2O	10.81	11.71	0.0000	0.004	99.89
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	127.50	96.21	0.0000	0.004	99.89
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CO2	3.98	0.00000	0.0000	0.004	99.90
1.A.2.c. Chemicals - Liquid Fuels	N2O	4.22	0.35	0.0000	0.004	99.90
1.A.2.a. Iron and Steel - Solid Fuels	CH4	3.22	0.05	0.0000	0.003	99.90
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	3.13	0.01	0.0000	0.003	99.91
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	3.78	0.62	0.0000	0.003	99.91
2.E.1 Integrated Circuit or Semiconductor	CF4	0.00	2.17	0.0000	0.003	99.91
1.A.2.f. Non-metallic minerals - Liquid Fuels	N2O	4.55	1.37	0.0000	0.003	99.92
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	7.80	3.98	0.0000	0.003	99.92
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	3.06	0.44	0.0000	0.003	99.92
2.F.2. Foam Blowing Agents	HFC-227ea	0.00	1.94	0.0000	0.003	99.92
2.E.1 Integrated Circuit or Semiconductor	HFC-23	0.00	1.93	0.0000	0.003	99.93
2.F.1. Refrigeration and Air Conditioning Equipment	C3F8	0.00	1.90	0.0000	0.002	99.93
1.B.2.a. Oil	CH4	11.38	7.01	0.0000	0.002	99.93
1.A.2.c. Chemicals - Other Fuels	N2O	0.66	2.22	0.0000	0.002	99.93
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	0.18	1.75	0.0000	0.002	99.94
1.A.2.b. Non-Ferrous Metals - Other fuels	CO2	0.00	1.54	0.0000	0.002	99.94
1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	5.57	2.81	0.0000	0.002	99.94
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	3.14	0.93	0.0000	0.002	99.94
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	0.52	1.86	0.0000	0.002	99.94
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH4	2.51	0.51	0.0000	0.002	99.95
1.A.2.f. Non-metallic minerals - Other Fuels	CH4	0.00	1.39	0.0000	0.002	99.95
1.A.2.c. Chemicals - Solid Fuels	N2O	1.75	0.01	0.0000	0.002	99.95
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	1.67	0.05	0.0000	0.0016	99.95
1.A.2.c. Chemicals - Liquid Fuels	CH4	1.77	0.15	0.0000	0.0016	99.95
1.A.4.b. Residential - Gaseous Fuels	N2O	3.12	3.64	0.0000	0.0016	99.95

1.A.2.g. Other - biomass	N2O	0.01	1.18	0.0000	0.0015	99.96
1.A.2.d. Pulp, Paper and Print - Other Fuels	N2O	0.00	1.16	0.0000	0.0015	99.96
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	1.03	1.90	0.0000	0.0014	99.96
1.A.2.f. Non-metallic minerals - biomass	CH4	0.00	1.10	0.0000	0.0014	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	1.71	0.25	0.0000	0.0014	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	0.11	1.13	0.0000	0.0014	99.96
1.A.3.d. Navigation - Gas/Diesel Oil	N2O	2.88	3.29	0.0000	0.0014	99.96
5.C.1 Waste incineration / Biogenic	N2O	1.40	0.05	0.0000	0.0014	99.97
2.F.3. Fire protection	HFC-125	0.00	1.03	0.0000	0.0013	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	1.56	0.26	0.0000	0.0013	99.97
1.A.2.g. Other - Liquid Fuels	CH4	4.55	2.60	0.0000	0.0012	99.97
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH4	1.48	0.22	0.0000	0.0012	99.97
1.A.2.c. Chemicals - Gaseous Fuels	N2O	1.37	2.00	0.0000	0.0012	99.97
5.C.1 Waste incineration / Non-biogenic	N2O	1.24	0.04	0.0000	0.0012	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0.44	1.27	0.0000	0.0012	99.97
1.A.2.c. Chemicals - Biomass	CH4	0.00	0.89	0.0000	0.0012	99.98
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.61	0.40	0.0000	0.0011	99.98
1.A.3.e. Other Transportation - Liquid Fuels	N2O	0.34	1.10	0.0000	0.0011	99.98
2.F.2. Foam Blowing Agents	HFC-245fa	0.00	0.83	0.0000	0.0011	99.98
1.A.2.g. Other - Other Fuels	N2O	0.00	0.82	0.0000	0.0011	99.98
1.A.3.b. Road Transportation - Biomass	CH4	0.00	0.78	0.0000	0.0010	99.98
1.A.2.c. Chemicals - Solid Fuels	CH4	0.99	0.01	0.0000	0.0010	99.98
1.A.2.g. Other - biomass	CH4	0.01	0.74	0.0000	0.0010	99.98
1.A.2.d. Pulp, Paper and Print - Other Fuels	CH4	0.00	0.73	0.0000	0.0010	99.98
2.E.1 Integrated Circuit or Semiconductor	NF3	0.00	0.69	0.0000	0.0009	99.98
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CH4	0.88	0.00000	0.0000	0.0009	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	N2O	0.00	0.66	0.0000	0.0009	99.99
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0.30	0.88	0.0000	0.0008	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	1.00	0.17	0.0000	0.0008	99.99
1.A.4.a. Commercial / Institutional - Biomass	N2O	0.00	0.60	0.0000	0.0008	99.99
2.F.4. Aerosols	HFC-227ea	0.00	0.56	0.0000	0.0007	99.99
1.A.2.g. Other - Other Fuels	CH4	0.00	0.52	0.0000	0.0007	99.99
1.A.3.b. Road Transportation - LPG	CH4	1.09	0.36	0.0000	0.0006	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.61	0.01	0.0000	0.0006	99.99
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.62	0.02	0.0000	0.0006	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.57	0.03	0.0000	0.0005	99.99
3B3 Swine	N2O	91.91	72.09	0.0000	0.0005	99.99
1.A.2.c. Chemicals - Gaseous Fuels	CH4	1.149	1.311	0.0000	0.0005	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.036	0.405	0.0000	0.0005	99.99

1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.513	0.085	0.0000	0.0004	99.99
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N2O	1.139	0.617	0.0000	0.0004	100.00
2.B.9.b Fugitive emissions	HFC-125	0.000	0.221	0.0000	0.0003	100.00
2.F.4. Aerosols	HFC-152a	0.000	0.214	0.0000	0.0003	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.479	0.162	0.0000	0.0003	100.00
3B2 Sheep	N2O	0.991	0.566	0.0000	0.0003	100.00
1.A.3.b. Road Transportation - Other liquid fuels - Lubricants	CO2	0.189	0.338	0.0000	0.0002	100.00
3B2 Sheep	CH4	0.913	0.527	0.0000	0.0002	100.00
1.B.2.c Venting and Flaring	CH4	0.000	0.181	0.0000	0.0002	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.616	0.303	0.0000	0.0002	100.00
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	0.638	0.348	0.0000	0.00020	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.215	0.036	0.0000	0.00017	100.00
1.A.3.c. Railways - Liquid Fuels	CH4	0.353	0.143	0.0000	0.00017	100.00
2.E.1 Integrated Circuit or Semiconductor	c-C4F8	0.000	0.131	0.0000	0.00017	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	N2O	0.000	0.124	0.0000	0.00016	100.00
1.A.2.g. Other - Gaseous Fuels	N2O	0.639	0.619	0.0000	0.00016	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.110	0.188	0.0000	0.00013	100.00
1.A.2.g. Other - Gaseous Fuels	CH4	0.537	0.519	0.0000	0.00013	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.344	0.170	0.0000	0.00013	100.00
1.B.2.b. Natural Gas	CO2	0.730	0.475	0.0000	0.00012	100.00
1.A.3.b. Road Transportation - LPG	N2O	1.014	0.878	0.0000	0.00011	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.189	0.062	0.0000	0.00011	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	CH4	0.000	0.078	0.0000	0.00010	100.00
1.A.2.g. Other - Solid Fuels	N2O	0.151	0.050	0.0000	0.00009	100.00
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.499	0.328	0.0000	0.00008	100.00
2.E.4 Heat Transfer Fluid	HFC-125	0.000	0.050	0.0000	0.00006	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.149	0.164	0.0000	0.00006	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.009	0.052	0.0000	0.00006	100.00
2.B.9.b Fugitive emissions	HFC-23	0.0000	0.0444	0.0000	0.00006	100.00
1.A.3.b. Road Transportation - Gaseous fuels	CH4	0.0000	0.0443	0.0000	0.00006	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.1255	0.1385	0.0000	0.00005	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.0657	0.0916	0.0000	0.00005	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.1393	0.1478	0.0000	0.00005	100.00
1.A.2.g. Other - Solid Fuels	CH4	0.0848	0.0278	0.0000	0.00005	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.1161	0.1240	0.0000	0.00004	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	N2O	0.0413	0.0000	0.0000	0.00004	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	N2O	0.0316	0.0000	0.0000	0.00003	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	CH4	0.0239	0.0000	0.0000	0.00002	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.0294	0.0050	0.0000	0.00002	100.00
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.0000	0.0140	0.0000	0.000018	100.00

1.A.3.e. Other Transportation - Gaseous Fuels	CH4	0.0266	0.0080	0.0000	0.000017	100.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.6025	0.4812	0.0000	0.000015	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	0.0211	0.0269	0.0000	0.000014	100.00
2.E.4 Heat Transfer Fluid	HFC-32	0.0000	0.0078	0.0000	0.000010	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	N2O	0.0096	0.00000	0.0000	0.000010	100.00
1.A.3.b. Road Transportation - Gaseous fuels	N2O	0.0000	0.0074	0.0000	0.000010	100.00
1.B.2.a. Oil	CO2	0.0143	0.0183	0.0000	0.000009	100.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.3370	0.2691	0.0000	0.000008	100.00
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.0511	0.0345	0.0000	0.000007	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	N2O	0.0049	0.00000	0.0000	0.000005	100.00
2.B.1 Ammonia Production	CH4	0.0151	0.0150	0.0000	0.000004	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CH4	0.0040	0.0000	0.0000	0.000004	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	CH4	0.0031	0.0000	0.0000	0.000003	100.00
2.B.9.b Fugitive emissions	HFC-134a	0.0000	0.0014	0.0000	0.000002	100.00
2.E.1 Integrated Circuit or Semiconductor	HFC-32	0.0000	0.0011	0.0000	0.000001	100.00

Trend assessment 1990-2014 with LULUCF

IPCC categories Submission 2016	direct GHG	1990 Estimate (non-Lulucf)	2014 Estimate (non-Lulucf)	trend assessment 1990-2014	contribution to trend	cumulative total
		Gg CO_2 eq	Gg CO_2 eq		%	%
		143 687.97	**110 120.31**	**0.9555**		
1.A.3.b. Road Transportation - Diesel Oil	CO2	10 963.77	20 404.82	0.1422	14.88	14.88
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	19 434.27	6 528.04	0.0991	10.38	25.26
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	2 764.79	6 855.97	0.0561	5.87	31.13
2.C.1. Iron and Steel Production	CO2	10 277.62	3 793.75	0.0484	5.06	36.20
1.A.3.b. Road Transportation - Gasoline	CO2	8 360.02	3 750.89	0.0315	3.29	39.49
1.A.2.a. Iron and Steel - Solid Fuels	CO2	3 283.95	51.83	0.0292	3.06	42.55
2.B.8 Petrochemical and carbon black production	CO2	1 882.42	3 844.91	0.0285	2.98	45.53
1.A.4.b. Residential - Gaseous Fuels	CO2	5 874.20	6 848.94	0.0278	2.91	48.44
2.B.2 Nitric Acid Production	N2O	3 421.53	473.16	0.0255	2.67	51.10
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	1 933.79	3 585.87	0.0249	2.61	53.71
2.B.10 Other	CO2	285.15	1 794.65	0.0187	1.95	55.67
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	674.22	1 986.04	0.0174	1.82	57.49
4.A.1. Forest Land remaining Forest Land CSC	CO2	-2 929.62	-3 707.01	0.0173	1.81	59.30
1.A.4.b. Residential - Liquid Fuels	CO2	12 800.51	8 368.83	0.0171	1.79	61.09
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	1 969.04	182.45	0.0157	1.65	62.73
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	684.19	1 847.26	0.0157	1.64	64.37
5.A. Solid Waste Disposal	CH4	3 053.39	1 064.32	0.0151	1.58	65.96
1.A.2.c. Chemicals - Liquid Fuels	CO2	1 851.70	146.38	0.0151	1.58	67.54
2.B.9.a. By-product emissions	SF6	1 487.59	0.00000	0.0135	1.41	68.95
1.A.4.b. Residential - Solid Fuels	CO2	1 796.20	283.78	0.0129	1.36	70.30
4.B.1. Cropland remaining Cropland CSC	CO2	238.92	-890.74	0.0127	1.33	71.64
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	1 688.70	258.97	0.0123	1.28	72.92
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2 532.33	2 953.19	0.0120	1.26	74.18
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	13.89	1 020.47	0.0120	1.25	75.43
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	2 516.45	931.35	0.0118	1.24	76.66
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	0.00	912.09	0.0108	1.13	77.80
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	0.00	866.03	0.0103	1.07	78.87
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	0.00	825.27	0.0098	1.02	79.89
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	1 508.71	379.33	0.0092	0.96	80.86
2.B.1 Ammonia Production	CO2	422.74	1 052.28	0.0086	0.90	81.76

1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	67.38	763.11	0.0084	0.88	82.64
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	884.66	25.33	0.0077	0.81	83.45
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	2 314.69	1 195.84	0.0068	0.72	84.17
2.B.9.a. By-product emissions	C2F6	671.94	0.00000	0.0061	0.64	84.81
4.B.2. Land converted to Cropland CSC	CO2	63.14	558.55	0.0060	0.63	85.44
3A1 Non-Dairy Cattle	CH4	2 721.79	2 586.70	0.0059	0.62	86.06
2.A.1 Cement production	CO2	2 823.78	2 642.98	0.0057	0.59	86.65
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	662.56	44.17	0.0055	0.57	87.23
4.E.2. Land converted to Settlements CSC	CO2	237.42	619.51	0.0052	0.54	87.77
5.D. Wastewater treatment and discharge	CH4	834.95	207.09	0.0051	0.54	88.31
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	4 285.28	3 711.08	0.0051	0.53	88.84
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	357.60	676.61	0.0048	0.50	89.34
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	650.58	101.91	0.0047	0.49	89.83
4.C.2. Land converted to Grassland CSC	CO2	84.55	-279.70	0.0041	0.43	90.26
4.G Harvest wood products	CO2	0.00	336.31	0.0040	0.42	90.67
1.A.2.c. Chemicals - Solid Fuels	CO2	401.51	2.86	0.0036	0.38	91.05
4.A.2. Land converted to Forest Land CSC	CO2	-17.43	-291.83	0.0033	0.35	91.40
1.B.1.a. Coal Mining and Handling	CH4	355.74	0.00000	0.0032	0.34	91.74
2.B.9.a. By-product emissions	CF4	368.01	9.84	0.0032	0.34	92.07
2.B.9.b Fugitive emissions	C5F12	351.53	0.02	0.0032	0.33	92.41
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	186.18	383.96	0.0029	0.30	92.71
1.A.2.g. Other - Liquid Fuels	CO2	1 578.69	969.88	0.0028	0.30	93.00
3A1 Dairy Cattle	CH4	2 304.38	1 579.48	0.0022	0.23	93.24
1.A.3.b. Road Transportation - Diesel Oil	N2O	59.25	229.04	0.0022	0.23	93.46
2.B.9.a. By-product emissions	C4F10	228.60	0.00000	0.0021	0.22	93.68
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	2 466.35	1 720.17	0.0020	0.21	93.89
2.B.9.a. By-product emissions	C3F8	215.77	0.00000	0.0020	0.21	94.10
4.C.1. Grassland remaining Grassland CSC	CO2	-43.32	-194.65	0.0019	0.20	94.30
2.B.9.b Fugitive emissions	C4F10	25.40	175.19	0.0018	0.19	94.49
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1 492.90	1 006.90	0.0016	0.17	94.66
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	361.87	414.25	0.0016	0.17	94.83
1.A.2.g. Other - Gaseous Fuels	CO2	1 203.94	1 056.04	0.0016	0.17	94.99
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	220.47	38.48	0.0015	0.16	95.16
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1 364.20	1 174.70	0.0015	0.16	95.32
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	212.09	36.72	0.0015	0.16	95.47
3B3 Swine	CH4	792.78	730.34	0.0015	0.15	95.63
1.A.2.d. Pulp, Paper and Print - Other Fuels	CO2	0.00	107.81	0.0013	0.13	95.76
2.B.9.b Fugitive emissions	C6F14	288.78	114.30	0.0013	0.13	95.89
2.D.1 Lubricant use	CO2	211.11	64.95	0.0011	0.12	96.01
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	281.82	312.14	0.0011	0.12	96.13

1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	234.59	85.47	0.0011	0.12	96.25
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	166.99	33.99	0.0011	0.12	96.36
3B1 Dairy Cattle	CH4	296.57	320.29	0.0011	0.12	96.48
1.A.3.b. Road Transportation - Gasoline	N2O	135.27	11.62	0.0011	0.11	96.59
1.A.3.e. Other Transportation - Gaseous Fuels	CO2	196.77	58.89	0.0011	0.11	96.71
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	0.15	87.74	0.0010	0.11	96.82
1.A.4.b. Residential - Biomass	CH4	71.24	141.25	0.0010	0.11	96.92
1.A.4.b. Residential - Solid Fuels	CH4	142.18	22.50	0.0010	0.11	97.03
1.A.3.c. Railways - Liquid Fuels	CO2	222.45	88.42	0.0010	0.10	97.13
3D2 Indirect N2O Emissions from managed soils	N2O	1 051.55	724.05	0.0010	0.10	97.23
5.D. Wastewater treatment and discharge	N2O	247.33	269.76	0.0010	0.10	97.33
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	30.70	102.35	0.0009	0.10	97.43
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	260.84	278.45	0.0009	0.10	97.53
2.F.4. Aerosols	HFC-134a	0.00	78.06	0.0009	0.10	97.63
3B1 Dairy Cattle	N2O	233.60	102.65	0.0009	0.09	97.72
2.A.4 Other process uses of carbonates	CO2	135.72	173.79	0.0008	0.09	97.81
1.A.3.b. Road Transportation - Gasoline	CH4	96.77	11.65	0.0007	0.08	97.88
2G3. N2O from Product Uses	N2O	196.48	92.48	0.0007	0.07	97.96
3D1 Direct N2O emissions from managed soils	N2O	3 356.10	2 629.63	0.0007	0.07	98.03
3A3 Swine	CH4	251.27	244.36	0.0006	0.06	98.09
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-32	0.00	50.26	0.0006	0.06	98.15
2.C.7 Other	CO2	50.43	88.06	0.0006	0.06	98.22
4.E.2. Direct N2O emissions from N mineralization/immobilisation	N2O	4.06	52.43	0.0006	0.06	98.28
4.B.2. Direct N2O emissions from N mineralization/immobilisation	N2O	3.73	51.22	0.0006	0.06	98.34
2.A.3 Glass production	CO2	266.17	157.33	0.0006	0.06	98.39
1.B.2.b. Natural Gas	CH4	617.71	517.70	0.0005	0.05	98.45
1.A.3.e. Other Transportation - Liquid Fuels	CO2	29.12	66.50	0.0005	0.05	98.50
1.A.2.g. Other - Other Fuels	CO2	0.00	43.78	0.0005	0.05	98.56
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	147.35	73.31	0.0005	0.05	98.61
2.F.2. Foam Blowing Agents	HFC-134a	0.00	38.90	0.0005	0.05	98.66
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CO2	50.62	0.00000	0.0005	0.05	98.70
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	3.95	41.16	0.0005	0.05	98.75
3B1 Non-Dairy Cattle	CH4	188.42	180.01	0.0004	0.04	98.80
2.A.2 Lime production	CO2	2 097.12	1 641.59	0.0004	0.04	98.84
5.B. Biological treatment of solid waste	N2O	3.95	37.39	0.0004	0.04	98.88
3B1 Non-Dairy Cattle	N2O	417.22	353.10	0.0004	0.04	98.92
1.B.2.c Venting and Flaring	CO2	83.83	97.10	0.0004	0.04	98.96
2.B.9.a. By-product emissions	C5F12	41.01	0.00000	0.0004	0.04	99.00
1.B.1.b. Solid Fuel Transformation	CH4	36.66	1.49	0.0003	0.03	99.04
2H. Other	CO2	0.00	25.96	0.0003	0.03	99.07

1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	37.25	2.97	0.0003	0.03	99.10
3A4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	10.65	33.51	0.0003	0.03	99.13
1.A.1.a. Public Electricity and Heat Production - Biomass	CH4	0.00	22.65	0.0003	0.03	99.16
5.B. Biological treatment of solid waste	CH4	2.59	24.51	0.0003	0.03	99.19
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	7.86	27.65	0.0003	0.03	99.21
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	CH4	0.00	21.46	0.0003	0.03	99.24
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	4.87	24.39	0.0002	0.03	99.27
3B5 Indirect N2O emissions	N2O	218.32	187.57	0.0002	0.025	99.29
1.A.4.a. Commercial / Institutional - Biomass	CH4	0.00	19.41	0.0002	0.024	99.31
2.G.2 SF6 and PFCs from other product use	SF6	79.77	80.40	0.0002	0.024	99.34
2.D.3 Other urea	CO2	0.00	19.09	0.0002	0.024	99.36
2.F.2. Foam Blowing Agents	HFC-152a	0.00	19.01	0.0002	0.024	99.39
4.D.2. Land converted to Wetlands CSC	CO2	17.85	-4.65	0.0002	0.023	99.41
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	124.21	77.25	0.0002	0.022	99.43
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	0.75	17.00	0.0002	0.020	99.45
1.A.3.b. Road Transportation - Biomass	N2O	0.00	14.58	0.0002	0.018	99.47
1.A.2.c. Chemicals - Other Fuels	CO2	0.00	14.42	0.0002	0.018	99.49
1.A.4.b. Residential - Biomass	N2O	11.32	22.45	0.0002	0.017	99.50
1.A.3.b. Road Transportation - Diesel Oil	CH4	22.39	4.07	0.0002	0.016	99.52
1.A.2.g. Other - Solid Fuels	CO2	33.22	12.39	0.0002	0.016	99.54
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	16.96	25.59	0.0001	0.016	99.55
1.A.2.d. Pulp, Paper and Print - biomass	N2O	4.66	15.14	0.0001	0.014	99.57
2.B.10 Other	N2O	8.94	18.34	0.0001	0.014	99.58
2.F.3. Fire protection	HFC-227ea	0.00	11.46	0.0001	0.014	99.60
2.C.1. Iron and Steel Production	CH4	13.66	21.08	0.0001	0.013	99.61
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	54.02	31.02	0.0001	0.013	99.62
1.A.2.f. Non-metallic minerals - biomass	N2O	0.00	10.00	0.0001	0.012	99.63
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	16.82	2.91	0.0001	0.012	99.65
5.C.1 Waste incineration / Non-biogenic	CO2	299.50	220.30	0.0001	0.011	99.66
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	3.28	11.72	0.0001	0.011	99.67
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	N2O	10.18	16.61	0.0001	0.011	99.68
2.B.10 Other	CH4	0.00	8.76	0.0001	0.011	99.69
3G Liming	CO2	161.57	132.50	0.0001	0.011	99.70
1.A.2.f. Non-metallic minerals - Other Fuels	N2O	0.28	8.13	0.0001	0.010	99.71
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	7.59	13.32	0.0001	0.009	99.72
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	4.31	10.73	0.0001	0.009	99.73
3A2 Sheep	CH4	38.43	22.19	0.0001	0.009	99.74
1.A.4.a. Commercial / Institutional - Solid Fuels	CO2	9.01	0.00000	0.0001	0.009	99.75
1.A.2.a. Iron and Steel - Solid Fuels	N2O	8.66	0.28	0.0001	0.008	99.76
1.A.2.d. Pulp, Paper and Print - biomass	CH4	1.64	6.96	0.0001	0.007	99.76

1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	2.99	7.95	0.0001	0.007	99.77
1.A.3.c. Railways - Liquid Fuels	N2O	12.14	3.77	0.0001	0.007	99.78
2.G.1. Electrical equipment	SF6	7.75	11.36	0.0001	0.007	99.78
1.A.4.b. Residential - Gaseous Fuels	CH4	13.08	15.26	0.0001	0.006	99.79
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	10.02	2.51	0.0001	0.006	99.80
1.A.4.b. Residential - Solid Fuels	N2O	8.47	1.34	0.0001	0.006	99.80
1.A.2.f. Non-metallic minerals - Solid Fuels	CH4	7.77	0.81	0.0001	0.006	99.81
1.A.2.c. Chemicals - Biomass	N2O	0.00	4.96	0.0001	0.006	99.81
1.A.3.b. Road Transportation - Gaseous fuels	CO2	0.00	4.91	0.0001	0.006	99.82
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	14.88	6.66	0.0001	0.006	99.83
1.A.4.b. Residential - Liquid Fuels	CH4	43.67	28.78	0.0001	0.006	99.83
1.A.2.g. Other - Liquid Fuels	N2O	13.91	15.17	0.0001	0.006	99.84
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	38.43	33.77	0.0001	0.005	99.84
1.A.2.a. Iron and Steel - Other fuels	CO2	0.00	4.27	0.0001	0.005	99.85
2.D.2 Paraffin wax use	CO2	2.95	6.37	0.0000	0.005	99.85
2.F.2. Foam Blowing Agents	HFC-365mfc	0.00	3.88	0.0000	0.005	99.86
4.A.1 biomass burning	N2O	4.68	0.00000	0.0000	0.004	99.86
1.A.2.c. Chemicals - Other Fuels	CH4	1.39	4.65	0.0000	0.004	99.87
2.E.1 Integrated Circuit or Semiconductor	SF6	0.00	3.45	0.0000	0.004	99.87
1.A.2.f. Non-metallic minerals - Solid Fuels	N2O	10.81	11.71	0.0000	0.004	99.88
2.E.1 Integrated Circuit or Semiconductor	C2F6	0.00	3.42	0.0000	0.004	99.88
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	8.21	2.93	0.0000	0.004	99.88
1.A.4.b. Residential - Liquid Fuels	N2O	30.31	20.01	0.0000	0.004	99.89
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CO2	3.98	0.00000	0.0000	0.004	99.89
1.A.2.c. Chemicals - Liquid Fuels	N2O	4.22	0.35	0.0000	0.004	99.90
1.A.3.b. Road Transportation - LPG	CO2	169.32	126.99	0.0000	0.003	99.90
4.C.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.21	2.78	0.0000	0.003	99.90
1.A.2.a. Iron and Steel - Solid Fuels	CH4	3.22	0.05	0.0000	0.003	99.91
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	3.13	0.01	0.0000	0.003	99.91
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	3.78	0.62	0.0000	0.003	99.91
2.E.1 Integrated Circuit or Semiconductor	CF4	0.00	2.17	0.0000	0.003	99.91
1.A.2.f. Non-metallic minerals - Liquid Fuels	N2O	4.55	1.37	0.0000	0.003	99.92
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	7.80	3.98	0.0000	0.002	99.92
2.F.2. Foam Blowing Agents	HFC-227ea	0.00	1.94	0.0000	0.002	99.92
2.E.1 Integrated Circuit or Semiconductor	HFC-23	0.00	1.93	0.0000	0.002	99.92
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	3.06	0.44	0.0000	0.002	99.93
2.F.1. Refrigeration and Air Conditioning Equipment	C3F8	0.00	1.90	0.0000	0.002	99.93
1.A.2.c. Chemicals - Other Fuels	N2O	0.66	2.22	0.0000	0.002	99.93
1.B.2.a. Oil	CH4	11.38	7.01	0.0000	0.002	99.93

3B3 Swine	N2O	91.91	72.09	0.0000	0.002	99.93
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	0.18	1.75	0.0000	0.002	99.94
1.A.2.b. Non-Ferrous Metals - Other fuels	CO2	0.00	1.54	0.0000	0.002	99.94
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	127.50	96.21	0.0000	0.002	99.94
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	3.14	0.93	0.0000	0.002	99.94
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	0.52	1.86	0.0000	0.002	99.94
1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	5.57	2.81	0.0000	0.002	99.95
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH4	2.51	0.51	0.0000	0.002	99.95
1.A.2.f. Non-metallic minerals - Other Fuels	CH4	0.00	1.39	0.0000	0.002	99.95
1.A.2.c. Chemicals - Solid Fuels	N2O	1.75	0.01	0.0000	0.002	99.95
1.A.4.b. Residential - Gaseous Fuels	N2O	3.12	3.64	0.0000	0.002	99.95
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	1.67	0.05	0.0000	0.002	99.95
1.A.2.c. Chemicals - Liquid Fuels	CH4	1.77	0.15	0.0000	0.002	99.96
1.A.2.g. Other - biomass	N2O	0.01	1.18	0.0000	0.0015	99.96
1.A.2.d. Pulp, Paper and Print - Other Fuels	N2O	0.00	1.16	0.0000	0.0014	99.96
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	1.03	1.90	0.0000	0.0014	99.96
1.A.2.f. Non-metallic minerals - biomass	CH4	0.00	1.10	0.0000	0.0014	99.96
1.A.3.d. Navigation - Gas/Diesel Oil	N2O	2.88	3.29	0.0000	0.0013	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	1.71	0.25	0.0000	0.0013	99.96
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	0.11	1.13	0.0000	0.0013	99.97
2.F.3. Fire protection	HFC-125	0.00	1.03	0.0000	0.0013	99.97
5.C.1 Waste incineration / Biogenic	N2O	1.40	0.05	0.0000	0.0013	99.97
1.A.2.c. Chemicals - Gaseous Fuels	N2O	1.37	2.00	0.0000	0.0012	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	1.56	0.26	0.0000	0.0012	99.97
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0.44	1.27	0.0000	0.0012	99.97
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH4	1.48	0.22	0.0000	0.0011	99.97
5.C.1 Waste incineration / Non-biogenic	N2O	1.24	0.04	0.0000	0.0011	99.97
1.A.2.c. Chemicals - Biomass	CH4	0.00	0.89	0.0000	0.0011	99.97
1.A.2.g. Other - Liquid Fuels	CH4	4.55	2.60	0.0000	0.0011	99.98
1.A.3.e. Other Transportation - Liquid Fuels	N2O	0.340	1.102	0.0000	0.0010	99.98
2.F.2. Foam Blowing Agents	HFC-245fa	0.000	0.831	0.0000	0.0010	99.98
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.610	0.404	0.0000	0.0010	99.98
1.A.2.g. Other - Other Fuels	N2O	0.000	0.820	0.0000	0.0010	99.98
1.A.3.b. Road Transportation - Biomass	CH4	0.000	0.783	0.0000	0.0010	99.98
1.A.2.c. Chemicals - Solid Fuels	CH4	0.986	0.008	0.0000	0.0009	99.98
1.A.2.g. Other - biomass	CH4	0.006	0.741	0.0000	0.0009	99.98
1.A.2.d. Pulp, Paper and Print - Other Fuels	CH4	0.000	0.730	0.0000	0.0009	99.98
2.E.1 Integrated Circuit or Semiconductor	NF3	0.000	0.690	0.0000	0.0009	99.98
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CH4	0.878	0.00000	0.0000	0.0008	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	N2O	0.000	0.660	0.0000	0.0008	99.99

1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0.305	0.882	0.0000	0.0008	99.99
1.A.4.a. Commercial / Institutional - Biomass	N2O	0.000	0.604	0.0000	0.0007	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	1.002	0.174	0.0000	0.0007	99.99
2.F.4. Aerosols	HFC-227ea	0.000	0.557	0.0000	0.0007	99.99
1.A.2.g. Other - Other Fuels	CH4	0.000	0.515	0.0000	0.0006	99.99
1.A.3.b. Road Transportation - LPG	CH4	1.091	0.361	0.0000	0.0006	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.613	0.013	0.0000	0.0006	99.99
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.616	0.020	0.0000	0.0006	99.99
4.A.1 biomass burning	CH4	0.571	0.00000	0.0000	0.0005	99.99
1.A.2.c. Chemicals - Gaseous Fuels	CH4	1.149	1.311	0.0000	0.0005	99.99
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.573	0.027	0.0000	0.0005	99.99
4.C.1. Direct N2O emissions from N mineralization/immobilisation	N2O	1.937	1.105	0.0000	0.0005	99.99
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.036	0.405	0.0000	0.0005	99.99
4.D.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.005	0.340	0.0000	0.0004	99.99
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.513	0.085	0.0000	0.0004	100.00
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N2O	1.139	0.617	0.0000	0.0003	100.00
2.B.9.b Fugitive emissions	HFC-125	0.000	0.221	0.0000	0.0003	100.00
2.F.4. Aerosols	HFC-152a	0.000	0.214	0.0000	0.0003	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.479	0.162	0.0000	0.0003	100.00
3B2 Sheep	N2O	0.991	0.566	0.0000	0.0002	100.00
1.A.3.b. Road Transportation - Other liquid fuels - Lubricants	CO2	0.189	0.338	0.0000	0.0002	100.00
1.B.2.c Venting and Flaring	CH4	0.000	0.181	0.0000	0.0002	100.00
3B2 Sheep	CH4	0.913	0.527	0.0000	0.0002	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.616	0.303	0.0000	0.0002	100.00
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	0.638	0.348	0.0000	0.0002	100.00
2.E.1 Integrated Circuit or Semiconductor	c-C4F8	0.000	0.131	0.0000	0.0002	100.00
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.215	0.036	0.0000	0.0002	100.00
1.A.2.g. Other - Gaseous Fuels	N2O	0.639	0.619	0.0000	0.0002	100.00
1.A.3.c. Railways - Liquid Fuels	CH4	0.353	0.143	0.0000	0.0002	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	N2O	0.000	0.124	0.0000	0.0002	100.00
1.A.2.g. Other - Gaseous Fuels	CH4	0.537	0.519	0.0000	0.0001	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.110	0.188	0.0000	0.0001	100.00
1.A.3.b. Road Transportation - LPG	N2O	1.014	0.878	0.0000	0.0001	100.00
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.344	0.170	0.0000	0.0001	100.00
1.B.2.b. Natural Gas	CO2	0.730	0.475	0.0000	0.0001	100.00
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.189	0.062	0.0000	0.0001	100.00
1.A.2.b. Non-Ferrous Metals - Other fuels	CH4	0.000	0.078	0.0000	0.0001	100.00
1.A.2.g. Other - Solid Fuels	N2O	0.151	0.050	0.0000	0.0001	100.00
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.499	0.328	0.0000	0.0001	100.00
2.E.4 Heat Transfer Fluid	HFC-125	0.000	0.050	0.0000	0.0001	100.00

1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.149	0.164	0.0000	0.0001	100.00
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.009	0.052	0.0000	0.00006	100.00
2.B.9.b Fugitive emissions	HFC-23	0.000	0.044	0.0000	0.00006	100.00
1.A.3.b. Road Transportation - Gaseous fuels	CH4	0.000	0.044	0.0000	0.00005	100.00
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.126	0.138	0.0000	0.00005	100.00
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.066	0.092	0.0000	0.00005	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.1393	0.1478	0.0000	0.00005	100.00
1.A.2.g. Other - Solid Fuels	CH4	0.0848	0.0278	0.0000	0.00005	100.00
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.1161	0.1240	0.0000	0.00004	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	N2O	0.0413	0.0000	0.0000	0.00004	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	N2O	0.0316	0.0000	0.0000	0.00003	100.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.6025	0.4812	0.0000	0.00002	100.00
4.A.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.0149	0.0299	0.0000	0.00002	100.00
1.A.4.a. Commercial / Institutional - Solid Fuels	CH4	0.0239	0.00000	0.0000	0.00002	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.0294	0.0050	0.0000	0.00002	100.00
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.0000	0.0140	0.0000	0.00002	100.00
1.A.3.e. Other Transportation - Gaseous Fuels	CH4	0.0266	0.0080	0.0000	0.00002	100.00
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.3370	0.2691	0.0000	0.00001	100.00
1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	0.0211	0.0269	0.0000	0.00001	100.00
2.E.4 Heat Transfer Fluid	HFC-32	0.0000	0.0078	0.0000	0.00001	100.00
1.B.2.a. Oil	CO2	0.0143	0.0183	0.0000	0.00001	100.00
1.A.3.b. Road Transportation - Gaseous fuels	N2O	0.0000	0.0074	0.0000	0.00001	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	N2O	0.0096	0.00000	0.0000	0.00001	100.00
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.0511	0.0345	0.0000	0.00001	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	N2O	0.0049	0.00000	0.0000	0.000005	100.00
2.B.1 Ammonia Production	CH4	0.0151	0.0150	0.0000	0.000004	100.00
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CH4	0.0040	0.0000	0.0000	0.000004	100.00
1.A.2.b. Non-Ferrous Metals - Biomass	CH4	0.0031	0.0000	0.0000	0.000003	100.00
2.B.9.b Fugitive emissions	HFC-134a	0.0000	0.0014	0.0000	0.000002	100.00
2.E.1 Integrated Circuit or Semiconductor	HFC-32	0.0000	0.0011	0.0000	0.000001	100.00

Annex 2: Uncertainty analysis – 2014

IPCC source category	Gas	Base year emissions or removals (1990) Sub 2016	2014 emissions or removals	Activity data uncertainty (%)	Emission factor uncertainty (%)	Combined uncertainty	Contribution to Variance by Category in 2014	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 - Gaseous Fuels	CO2	2764.79	6855.97	1	1	1.41	0.00775	0.03296	0.04771	0.03296	0.06748	0.00564
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	0.75	17.00	1	100	100.00	0.00024	0.00011	0.00012	0.01143	0.00017	0.00013
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	7.86	27.65	1	500	500.00	0.01576	0.00015	0.00019	0.07526	0.00027	0.00566
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	662.56	44.17	1	2	2.24	0.00000	0.00323	0.00031	0.00645	0.00043	0.00004
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.61	0.01	1	100	100.00	0.00000	0.00000	0.00000	0.00032	0.00000	0.00000
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.57	0.03	1	500	500.00	0.00000	0.00000	0.00000	0.00143	0.00000	0.00000
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	674.22	1986.04	5	10	11.18	0.04066	0.01023	0.01382	0.10225	0.09774	0.02001
1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	2.99	7.95	5	500	500.02	0.00130	0.00004	0.00006	0.01968	0.00039	0.00039
1.A.1.a. Public Electricity and Heat Production - Biomass	CH4	0.00	22.65	20	75	77.62	0.00025	0.00016	0.00016	0.01182	0.00446	0.00016
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	3.95	41.16	20	500	500.40	0.03499	0.00027	0.00029	0.13270	0.00810	0.01767
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	19434.27	6528.04	1	5	5.10	0.09137	0.05815	0.04543	0.29073	0.06425	0.08865
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	10.02	2.51	1	100	100.00	0.00001	0.00004	0.00002	0.00360	0.00002	0.00001
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	37.25	2.97	1	500	500.00	0.00018	0.00018	0.00002	0.08899	0.00003	0.00792
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	13.89	1020.47	1	1	1.41	0.00017	0.00703	0.00710	0.00703	0.01004	0.00015
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	4285.28	3711.08	5	2	5.39	0.03294	0.00297	0.02583	0.00594	0.18263	0.03339
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	124.21	77.25	5	50	50.25	0.00124	0.00012	0.00054	0.00624	0.00380	0.00005
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CO2	50.62	0.00	1	1	1.41	0.00000	0.00027	0.00000	0.00027	0.00000	0.00000
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CH4	0.88	0.00	1	100	100.00	0.00000	0.00000	0.00000	0.00047	0.00000	0.00000
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	N2O	0.03	0.00	1	500	500.00	0.00000	0.00000	0.00000	0.00008	0.00000	0.00000
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CO2	3.98	0.00	5	2	5.39	0.00000	0.00002	0.00000	0.00004	0.00000	0.00000
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CH4	0.00	0.00	5	75	75.17	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	N2O	0.01	0.00	5	500	500.02	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000

1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	1969.04	182.45	1	2	2.24	0.00001	0.00923	0.00127	0.01846	0.00180	0.00034
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	7.59	13.32	1	50	50.01	0.00004	0.00005	0.00009	0.00261	0.00013	0.00001
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	3.13	0.01	1	500	500.00	0.00000	0.00002	0.00000	0.00830	0.00000	0.00007
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1492.90	1006.90	2	1	2.24	0.00042	0.00095	0.00701	0.00095	0.01982	0.00039
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	0.64	0.35	2	75	75.03	0.00000	0.00000	0.00000	0.00007	0.00001	0.00000
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	54.02	31.02	2	500	500.00	0.01984	0.00007	0.00022	0.03610	0.00061	0.00130
1.A.2.a. Iron and Steel - Liquid Fuels	CO2	884.66	25.33	2	2	2.83	0.00000	0.00454	0.00018	0.00908	0.00050	0.00008
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.62	0.02	2	75	75.03	0.00000	0.00000	0.00000	0.00024	0.00000	0.00000
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	1.67	0.05	2	500	500.00	0.00000	0.00001	0.00000	0.00429	0.00000	0.00002
1.A.2.a. Iron and Steel - Solid Fuels	CO2	3283.95	51.83	2	5	5.39	0.00001	0.01715	0.00036	0.08575	0.00102	0.00735
1.A.2.a. Iron and Steel - Solid Fuels	CH4	3.22	0.05	2	75	75.03	0.00000	0.00002	0.00000	0.00126	0.00000	0.00000
1.A.2.a. Iron and Steel - Solid Fuels	N2O	8.66	0.28	2	500	500.00	0.00000	0.00004	0.00000	0.02212	0.00001	0.00049
1.A.2.a. Iron and Steel - Other fuels	CO2	0.00	4.27	5	10	11.18	0.00000	0.00003	0.00003	0.00030	0.00021	0.00000
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	260.84	278.45	2	1	2.24	0.00003	0.00055	0.00194	0.00055	0.00548	0.00003
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.12	0.12	2	75	75.03	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.14	0.15	2	500	500.00	0.00000	0.00000	0.00000	0.00014	0.00000	0.00000
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	220.47	38.48	2	2	2.83	0.00000	0.00091	0.00027	0.00182	0.00076	0.00000
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.21	0.04	2	75	75.03	0.00000	0.00000	0.00000	0.00007	0.00000	0.00000
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.51	0.08	2	500	500.00	0.00000	0.00000	0.00000	0.00107	0.00000	0.00000
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	147.35	73.31	5	5	7.07	0.00002	0.00028	0.00051	0.00138	0.00361	0.00001
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.34	0.17	5	75	75.17	0.00000	0.00000	0.00000	0.00005	0.00001	0.00000
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.62	0.30	5	500	500.02	0.00000	0.00000	0.00000	0.00059	0.00001	0.00000
1.A.2.b. Non-Ferrous Metals - Other fuels	CO2	0.00	1.54	5	10	11.18	0.00000	0.00001	0.00001	0.00011	0.00008	0.00000
1.A.2.b. Non-Ferrous Metals - Other fuels	CH4	0.00	0.08	5	75	75.17	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000
1.A.2.b. Non-Ferrous Metals - Other fuels	N2O	0.00	0.12	5	500	500.02	0.00000	0.00000	0.00000	0.00043	0.00001	0.00000
1.A.2.b. Non-Ferrous Metals - Biomass	CH4	0.00	0.00	20	75	77.62	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.2.b. Non-Ferrous Metals - Biomass	N2O	0.00	0.00	20	500	500.40	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2532.33	2953.19	2	1	2.24	0.00360	0.00704	0.02055	0.00704	0.05813	0.00343
1.A.2.c. Chemicals - Gaseous Fuels	CH4	1.15	1.31	2	75	75.03	0.00000	0.00000	0.00001	0.00022	0.00003	0.00000
1.A.2.c. Chemicals - Gaseous Fuels	N2O	1.37	2.00	2	500	500.00	0.00008	0.00001	0.00001	0.00331	0.00004	0.00001
1.A.2.c. Chemicals - Liquid Fuels	CO2	1851.70	146.38	2	2	2.83	0.00001	0.00886	0.00102	0.01771	0.00288	0.00032
1.A.2.c. Chemicals - Liquid Fuels	CH4	1.77	0.15	2	75	75.03	0.00000	0.00001	0.00000	0.00063	0.00000	0.00000
1.A.2.c. Chemicals - Liquid Fuels	N2O	4.22	0.35	2	500	500.00	0.00000	0.00002	0.00000	0.01004	0.00001	0.00010
1.A.2.c. Chemicals - Other Fuels	CO2	0.00	14.42	20	20	28.28	0.00001	0.00010	0.00010	0.00201	0.00284	0.00001
1.A.2.c. Chemicals - Other Fuels	CH4	1.39	4.65	20	75	77.62	0.00001	0.00002	0.00003	0.00187	0.00092	0.00000
1.A.2.c. Chemicals - Other Fuels	N2O	0.66	2.22	20	500	500.40	0.00010	0.00001	0.00002	0.00596	0.00044	0.00004
1.A.2.c. Chemicals - Solid Fuels	CO2	401.51	2.86	5	5	7.07	0.00000	0.00212	0.00002	0.01061	0.00014	0.00011
1.A.2.c. Chemicals - Solid Fuels	CH4	0.99	0.01	5	75	75.17	0.00000	0.00001	0.00000	0.00039	0.00000	0.00000

1.A.2.c. Chemicals - Solid Fuels	N2O	1.75	0.01	5	500	500.02	0.00000	0.00001	0.00000	0.00461	0.00000	0.00002
1.A.2.c. Chemicals - Biomass	CH4	0.00	0.89	20	75	77.62	0.00000	0.00001	0.00001	0.00047	0.00018	0.00000
1.A.2.c. Chemicals - Biomass	N2O	0.00	4.96	20	500	500.40	0.00051	0.00003	0.00003	0.01727	0.00098	0.00030
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	281.82	312.14	2	1	2.24	0.00004	0.00067	0.00217	0.00067	0.00614	0.00004
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.13	0.14	2	75	75.03	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.15	0.16	2	500	500.00	0.00000	0.00000	0.00000	0.00017	0.00000	0.00000
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	234.59	85.47	5	2	5.39	0.00002	0.00066	0.00059	0.00131	0.00421	0.00002
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.19	0.06	5	75	75.17	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.48	0.16	5	500	500.02	0.00000	0.00000	0.00000	0.00071	0.00001	0.00000
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	127.50	96.21	5	5	7.07	0.00004	0.00001	0.00067	0.00005	0.00473	0.00002
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.34	0.27	5	75	75.17	0.00000	0.00000	0.00000	0.00001	0.00001	0.00000
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.60	0.48	5	500	500.02	0.00000	0.00000	0.00000	0.00007	0.00002	0.00000
1.A.2.d. Pulp, Paper and Print - Other Fuels	CO2	0.00	107.81	5	10	11.18	0.00012	0.00075	0.00075	0.00750	0.00531	0.00008
1.A.2.d. Pulp, Paper and Print - Other Fuels	CH4	0.00	0.73	5	75	75.17	0.00000	0.00001	0.00001	0.00038	0.00004	0.00000
1.A.2.d. Pulp, Paper and Print - Other Fuels	N2O	0.00	1.16	5	500	500.02	0.00003	0.00001	0.00001	0.00404	0.00006	0.00002
1.A.2.d. Pulp, Paper and Print - biomass	CH4	1.64	6.96	20	75	77.62	0.00002	0.00004	0.00005	0.00298	0.00137	0.00001
1.A.2.d. Pulp, Paper and Print - biomass	N2O	4.66	15.14	20	500	500.40	0.00474	0.00008	0.00011	0.04027	0.00298	0.00163
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	684.19	1847.26	2	1	2.24	0.00141	0.00921	0.01286	0.00921	0.03636	0.00141
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0.30	0.88	2	75	75.03	0.00000	0.00000	0.00001	0.00034	0.00002	0.00000
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0.44	1.27	2	500	500.00	0.00003	0.00001	0.00001	0.00325	0.00002	0.00001
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	1688.70	258.97	6	2	6.32	0.00022	0.00720	0.00180	0.01441	0.01529	0.00044
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	1.56	0.26	6	75	75.24	0.00000	0.00001	0.00000	0.00049	0.00002	0.00000
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	3.78	0.62	6	500	500.04	0.00001	0.00002	0.00000	0.00792	0.00004	0.00006
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	650.58	101.91	5	5	7.07	0.00004	0.00276	0.00071	0.01380	0.00502	0.00022
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	1.71	0.25	5	75	75.17	0.00000	0.00001	0.00000	0.00056	0.00001	0.00000
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	3.06	0.44	5	500	500.02	0.00000	0.00001	0.00000	0.00663	0.00002	0.00004
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	0.11	1.13	20	75	77.62	0.00000	0.00001	0.00001	0.00055	0.00022	0.00000
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	0.18	1.75	20	500	500.40	0.00006	0.00001	0.00001	0.00564	0.00035	0.00003
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CO2	1364.20	1174.70	2	1	2.24	0.00057	0.00090	0.00818	0.00090	0.02312	0.00054
1.A.2.f. Non-metallic minerals - Gaseous Fuels	CH4	2.51	0.51	2	75	75.03	0.00000	0.00001	0.00000	0.00074	0.00001	0.00000
1.A.2.f. Non-metallic minerals - Gaseous Fuels	N2O	1.14	0.62	2	500	500.00	0.00001	0.00000	0.00000	0.00089	0.00001	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	CO2	1508.71	379.33	8	2	8.25	0.00081	0.00541	0.00264	0.01081	0.02987	0.00101
1.A.2.f. Non-metallic minerals - Liquid Fuels	CH4	1.48	0.22	8	75	75.43	0.00000	0.00001	0.00000	0.00048	0.00002	0.00000
1.A.2.f. Non-metallic minerals - Liquid Fuels	N2O	4.55	1.37	8	500	500.06	0.00004	0.00001	0.00001	0.00736	0.00011	0.00005
1.A.2.f. Non-metallic minerals - Solid Fuels	CO2	2466.35	1720.17	5	5	7.07	0.01220	0.00118	0.01197	0.00591	0.08465	0.00720
1.A.2.f. Non-metallic minerals - Solid Fuels	CH4	7.77	0.81	5	75	75.17	0.00000	0.00004	0.00001	0.00269	0.00004	0.00001
1.A.2.f. Non-metallic minerals - Solid Fuels	N2O	10.81	11.71	5	500	500.02	0.00283	0.00002	0.00008	0.01191	0.00058	0.00014
1.A.2.f. Non-metallic minerals - Other Fuels	CO2	186.18	383.96	5	5	7.07	0.00061	0.00168	0.00267	0.00840	0.01890	0.00043

1.A.2.f. Non-metallic minerals - Other Fuels	CH4	0.00	1.39	5	5	7.07	0.00000	0.00001	0.00001	0.00005	0.00007	0.00000
1.A.2.f. Non-metallic minerals - Other Fuels	N2O	0.28	8.13	5	500	500.02	0.00136	0.00006	0.00006	0.02753	0.00040	0.00076
1.A.2.f. Non-metallic minerals - biomass	CH4	0.00	1.10	20	75	77.62	0.00000	0.00001	0.00001	0.00057	0.00022	0.00000
1.A.2.f. Non-metallic minerals - biomass	N2O	0.00	10.00	20	500	500.40	0.00207	0.00007	0.00007	0.03481	0.00197	0.00122
1.A.2.g. Other - Gaseous Fuels	CO2	1203.94	1056.04	2	1	2.24	0.00046	0.00093	0.00735	0.00093	0.02079	0.00043
1.A.2.g. Other - Gaseous Fuels	CH4	0.54	0.52	2	75	75.03	0.00000	0.00000	0.00000	0.00006	0.00001	0.00000
1.A.2.g. Other - Gaseous Fuels	N2O	0.64	0.62	2	500	500.00	0.00001	0.00000	0.00000	0.00045	0.00001	0.00000
1.A.2.g. Other - Liquid Fuels	CO2	1578.69	969.88	8	2	8.25	0.00527	0.00167	0.00675	0.00334	0.07637	0.00584
1.A.2.g. Other - Liquid Fuels	CH4	4.55	2.60	8	75	75.43	0.00000	0.00001	0.00002	0.00046	0.00021	0.00000
1.A.2.g. Other - Liquid Fuels	N2O	13.91	15.17	8	500	500.06	0.00475	0.00003	0.00011	0.01570	0.00119	0.00025
1.A.2.g. Other - Solid Fuels	CO2	33.22	12.39	5	5	7.07	0.00000	0.00009	0.00009	0.00045	0.00061	0.00000
1.A.2.g. Other - Solid Fuels	CH4	0.08	0.03	5	75	75.17	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.2.g. Other - Solid Fuels	N2O	0.15	0.05	5	500	500.02	0.00000	0.00000	0.00000	0.00023	0.00000	0.00000
1.A.2.g. Other - Other Fuels	CO2	0.00	43.78	5	5	7.07	0.00001	0.00030	0.00030	0.00152	0.00215	0.00001
1.A.2.g. Other - Other Fuels	CH4	0.00	0.52	5	5	7.07	0.00000	0.00000	0.00000	0.00002	0.00003	0.00000
1.A.2.g. Other - Other Fuels	N2O	0.00	0.82	5	500	500.02	0.00001	0.00001	0.00001	0.00285	0.00004	0.00001
1.A.2.g. Other - biomass	CH4	0.01	0.74	20	75	77.62	0.00000	0.00001	0.00001	0.00038	0.00015	0.00000
1.A.2.g. Other - biomass	N2O	0.01	1.18	20	500	500.40	0.00003	0.00001	0.00001	0.00407	0.00023	0.00002
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	8.21	2.93	7.5	5	9.01	0.00000	0.00002	0.00002	0.00012	0.00022	0.00000
1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.03	0.01	7.5	140	140.20	0.00000	0.00000	0.00000	0.00002	0.00000	0.00000
1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	0.02	0.03	7.5	500	500.06	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	4.87	24.39	7.5	5	9.01	0.00000	0.00014	0.00017	0.00072	0.00180	0.00000
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.01	0.05	7.5	140	140.20	0.00000	0.00000	0.00000	0.00004	0.00000	0.00000
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.11	0.19	7.5	500	500.06	0.00000	0.00000	0.00000	0.00036	0.00001	0.00000
1.A.3.b. Road Transportation - Diesel Oil	CO2	10963.77	20404.82	5	2	5.39	0.99570	0.08347	0.14201	0.16693	1.00415	1.03618
1.A.3.b. Road Transportation - Diesel Oil	CH4	22.39	4.07	5	40	40.31	0.00000	0.00009	0.00003	0.00365	0.00020	0.00001
1.A.3.b. Road Transportation - Diesel Oil	N2O	59.25	229.04	5	100	100.12	0.04337	0.00128	0.00159	0.12779	0.01127	0.01646
1.A.3.b. Road Transportation - Gasoline	CO2	8360.02	3750.89	5	2	5.39	0.03365	0.01847	0.02610	0.03695	0.18459	0.03544
1.A.3.b. Road Transportation - Gasoline	CH4	96.77	11.65	5	40	40.31	0.00002	0.00044	0.00008	0.01740	0.00057	0.00030
1.A.3.b. Road Transportation - Gasoline	N2O	135.27	11.62	5	100	100.12	0.00011	0.00064	0.00008	0.06406	0.00057	0.00410
1.A.3.b. Road Transportation - LPG	CO2	169.32	126.99	5	2	5.39	0.00004	0.00002	0.00088	0.00004	0.00625	0.00004
1.A.3.b. Road Transportation - LPG	CH4	1.09	0.36	5	40	40.31	0.00000	0.00000	0.00000	0.00013	0.00002	0.00000
1.A.3.b. Road Transportation - LPG	N2O	1.01	0.88	5	100	100.12	0.00000	0.00000	0.00001	0.00007	0.00004	0.00000
1.A.3.b. Road Transportation - Other liquid fuels - Lubricants	CO2	0.19	0.34	5	2	5.39	0.00000	0.00000	0.00000	0.00000	0.00002	0.00000
1.A.3.b. Road Transportation - Gaseous fuels	CO2	0.00	4.91	5	2	5.39	0.00000	0.00003	0.00003	0.00007	0.00024	0.00000
1.A.3.b. Road Transportation - Gaseous fuels	CH4	0.00	0.04	5	40	40.31	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.b. Road Transportation - Gaseous fuels	N2O	0.00	0.01	5	100	100.12	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.b. Road Transportation - Biomass	CH4	0.00	0.78	5	40	40.31	0.00000	0.00001	0.00001	0.00022	0.00004	0.00000

1.A.3.b. Road Transportation - Biomass	N2O	0.00	14.58	5	100	100.12	0.00018	0.00010	0.00010	0.01014	0.00072	0.00010
1.A.3.c. Railways - Liquid Fuels	CO2	222.45	88.42	6	2	6.32	0.00003	0.00057	0.00062	0.00114	0.00522	0.00003
1.A.3.c. Railways - Liquid Fuels	CH4	0.35	0.14	6	100	100.18	0.00000	0.00000	0.00000	0.00009	0.00001	0.00000
1.A.3.c. Railways - Liquid Fuels	N2O	12.14	3.77	6	125	125.14	0.00002	0.00004	0.00003	0.00481	0.00022	0.00002
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	361.87	414.25	10	2	10.20	0.00147	0.00095	0.00288	0.00191	0.04077	0.00167
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.50	0.33	10	75	75.66	0.00000	0.00000	0.00000	0.00003	0.00003	0.00000
1.A.3.d. Navigation - Gas/Diesel Oil	N2O	2.88	3.29	10	125	125.40	0.00001	0.00001	0.00002	0.00094	0.00032	0.00000
1.A.3.e. Other Transportation - Gaseous Fuels	CO2	196.77	58.89	5	1	5.10	0.00001	0.00064	0.00041	0.00064	0.00290	0.00001
1.A.3.e. Other Transportation - Gaseous Fuels	CH4	0.03	0.01	5	75	75.17	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	3.14	0.93	5	500	500.02	0.00002	0.00001	0.00001	0.00512	0.00005	0.00003
1.A.3.e. Other Transportation - Liquid Fuels	CO2	29.12	66.50	10	2	10.20	0.00004	0.00031	0.00046	0.00061	0.00655	0.00004
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.05	0.03	10	75	75.66	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.A.3.e. Other Transportation - Liquid Fuels	N2O	0.34	1.10	10	125	125.40	0.00000	0.00001	0.00001	0.00073	0.00011	0.00000
1.A.4.a. Commercial / Institutional - Biomass	CH4	0.00	19.41	20	75	77.62	0.00019	0.00014	0.00014	0.01013	0.00382	0.00012
1.A.4.a. Commercial / Institutional - Biomass	N2O	0.00	0.60	20	500	500.40	0.00001	0.00000	0.00000	0.00210	0.00012	0.00000
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	1933.79	3585.87	4	1	4.12	0.01803	0.01464	0.02496	0.01464	0.14117	0.02014
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	4.31	10.73	4	75	75.11	0.00005	0.00005	0.00007	0.00388	0.00042	0.00002
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	1.03	1.90	4	500	500.02	0.00007	0.00001	0.00001	0.00389	0.00007	0.00002
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	2314.69	1195.84	10	2	10.20	0.01226	0.00402	0.00832	0.00805	0.11770	0.01392
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	7.80	3.98	10	75	75.66	0.00001	0.00001	0.00003	0.00104	0.00039	0.00000
1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	5.57	2.81	10	500	500.10	0.00016	0.00001	0.00002	0.00508	0.00028	0.00003
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	30.70	102.35	20	20	28.28	0.00069	0.00055	0.00071	0.01097	0.02015	0.00053
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	3.28	11.72	20	75	77.62	0.00007	0.00006	0.00008	0.00480	0.00231	0.00003
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	0.52	1.86	20	500	500.40	0.00007	0.00001	0.00001	0.00509	0.00037	0.00003
1.A.4.a. Commercial / Institutional - Solid Fuels	CO2	9.01	0.00	15	5	15.81	0.00000	0.00005	0.00000	0.00024	0.00000	0.00000
1.A.4.a. Commercial / Institutional - Solid Fuels	CH4	0.02	0.00	15	75	76.49	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
1.A.4.a. Commercial / Institutional - Solid Fuels	N2O	0.04	0.00	15	500	500.22	0.00000	0.00000	0.00000	0.00011	0.00000	0.00000
1.A.4.b. Residential - Biomass	CH4	71.24	141.25	65	75	99.25	0.01621	0.00060	0.00098	0.04523	0.09037	0.01021
1.A.4.b. Residential - Biomass	N2O	11.32	22.45	65	500	504.21	0.01057	0.00010	0.00016	0.04793	0.01436	0.00250
1.A.4.b. Residential - Gaseous Fuels	CO2	5874.20	6848.94	4	1	4.12	0.06576	0.01633	0.04767	0.01633	0.26964	0.07297
1.A.4.b. Residential - Gaseous Fuels	CH4	13.08	15.26	4	75	75.11	0.00011	0.00004	0.00011	0.00273	0.00060	0.00001
1.A.4.b. Residential - Gaseous Fuels	N2O	3.12	3.64	4	500	500.02	0.00027	0.00001	0.00003	0.00434	0.00014	0.00002
1.A.4.b. Residential - Liquid Fuels	CO2	12800.51	8368.83	10	2	10.20	0.60066	0.01002	0.05824	0.02004	0.82368	0.67885
1.A.4.b. Residential - Liquid Fuels	CH4	43.67	28.78	10	75	75.66	0.00039	0.00003	0.00020	0.00245	0.00283	0.00001
1.A.4.b. Residential - Liquid Fuels	N2O	30.31	20.01	10	500	500.10	0.00826	0.00002	0.00014	0.01121	0.00197	0.00013
1.A.4.b. Residential - Solid Fuels	CO2	1796.20	283.78	15	5	15.81	0.00166	0.00760	0.00197	0.03802	0.04190	0.00320
1.A.4.b. Residential - Solid Fuels	CH4	142.18	22.50	15	75	76.49	0.00024	0.00060	0.00016	0.04513	0.00332	0.00205
1.A.4.b. Residential - Solid Fuels	N2O	8.47	1.34	15	500	500.22	0.00004	0.00004	0.00001	0.01794	0.00020	0.00032

1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	CH4	0.00	21.46	20	75	77.62	0.00023	0.00015	0.00015	0.01120	0.00422	0.00014
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	N2O	0.00	0.66	20	500	500.40	0.00001	0.00000	0.00000	0.00230	0.00013	0.00001
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	67.38	763.11	4	1	4.12	0.00082	0.00495	0.00531	0.00495	0.03004	0.00093
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	0.15	87.74	4	75	75.11	0.00358	0.00061	0.00061	0.04574	0.00345	0.00210
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.04	0.41	4	500	500.02	0.00000	0.00000	0.00000	0.00132	0.00002	0.00000
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	2516.45	931.35	10	2	10.20	0.00744	0.00694	0.00648	0.01388	0.09167	0.00860
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	14.88	6.66	10	75	75.66	0.00002	0.00003	0.00005	0.00248	0.00066	0.00001
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	38.43	33.77	10	500	500.10	0.02353	0.00003	0.00024	0.01504	0.00332	0.00024
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	212.09	36.72	15	5	15.81	0.00003	0.00088	0.00026	0.00438	0.00542	0.00005
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	16.82	2.91	15	75	76.49	0.00000	0.00007	0.00002	0.00521	0.00043	0.00003
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	1.00	0.17	15	500	500.22	0.00000	0.00000	0.00000	0.00207	0.00003	0.00000
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	166.99	33.99	20	2	20.10	0.00004	0.00065	0.00024	0.00131	0.00669	0.00005
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.07	0.09	20	75	77.62	0.00000	0.00000	0.00000	0.00002	0.00002	0.00000
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	1.61	0.40	20	100	101.98	0.00000	0.00001	0.00000	0.00058	0.00008	0.00000
1.B.1.a. Coal Mining and Handling	CH4	355.74	0.00	5	60	60.21	0.00000	0.00190	0.00000	0.11384	0.00000	0.01296
1.B.1.b. Solid Fuel Transformation	CH4	36.66	1.49	5	60	60.21	0.00000	0.00019	0.00001	0.01111	0.00007	0.00012
1.B.2.a. Oil	CO2	0.01	0.02	10	30	31.62	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1.B.2.a. Oil	CH4	11.38	7.01	5	50	50.25	0.00001	0.00001	0.00005	0.00060	0.00035	0.00000
1.B.2.b. Natural Gas	CH4	617.71	517.70	10	30	31.62	0.02210	0.00031	0.00360	0.00925	0.05095	0.00268
1.B.2.b. Natural Gas	CO2	0.73	0.47	10	30	31.62	0.00000	0.00000	0.00000	0.00002	0.00005	0.00000
1.B.2.c Venting and Flaring	CO2	83.83	97.10	1	10	10.05	0.00008	0.00023	0.00068	0.00229	0.00096	0.00001
1.B.2.c Venting and Flaring	CH4	0.00	0.18	5	50	50.25	0.00000	0.00000	0.00000	0.00006	0.00001	0.00000
2.A.1 Cement production	CO2	2823.78	2642.98	5	5	7.07	0.02880	0.00333	0.01839	0.01666	0.13006	0.01719
2.A.2 Lime production	CO2	2097.12	1641.59	5	2	5.39	0.00644	0.00024	0.01142	0.00048	0.08078	0.00653
2.A.3 Glass production	CO2	266.17	157.33	5	5	7.07	0.00010	0.00032	0.00109	0.00162	0.00774	0.00006
2.A.4 Other process uses of carbonates	CO2	135.72	173.79	5	5	7.07	0.00012	0.00049	0.00121	0.00243	0.00855	0.00008
2.B.1 Ammonia Production	CO2	422.74	1052.28	1.5	1.5	2.12	0.00041	0.00507	0.00732	0.00760	0.01554	0.00030
2.B.1 Ammonia Production	CH4	0.02	0.02	2	5	5.39	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.B.2 Nitric Acid Production	N2O	3421.53	473.16	2	30	30.07	0.01669	0.01495	0.00329	0.44858	0.00931	0.20131
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N2O	357.60	676.61	2	30	30.07	0.03413	0.00280	0.00471	0.08404	0.01332	0.00724
2.B.8 Petrochemical and carbon black production	CO2	1882.42	3844.91	20	5	20.62	0.51812	0.01672	0.02676	0.08358	0.75685	0.57981
2.B.10 Other	CO2	285.15	1794.65	20	5	20.62	0.11288	0.01097	0.01249	0.05484	0.35327	0.12781
2.B.10 Other	CH4	0.00	8.76	20	75	77.62	0.00004	0.00006	0.00006	0.00457	0.00172	0.00002
2.B.10 Other	N2O	8.94	18.34	20	100	101.98	0.00029	0.00008	0.00013	0.00799	0.00361	0.00008
2.C.1. Iron and Steel Production	CO2	10277.62	3793.75	2	5	5.39	0.03442	0.02839	0.02640	0.14197	0.07468	0.02573
2.C.1. Iron and Steel Production	CH4	13.66	21.08	2	5	5.39	0.00000	0.00007	0.00015	0.00037	0.00041	0.00000
2.C.7 Other	CO2	50.43	88.06	20	5	20.62	0.00027	0.00034	0.00061	0.00172	0.01733	0.00030
2.D.1 Lubricant use	CO2	211.11	64.95	5	5	7.07	0.00002	0.00067	0.00045	0.00337	0.00320	0.00002

2.D.2 Paraffin wax use	CO2	2.95	6.37	5	5	7.07	0.00000	0.00003	0.00004	0.00014	0.00031	0.00000
2.D.3 Other urea	CO2	0.00	19.09	5	5	7.07	0.00000	0.00013	0.00013	0.00066	0.00094	0.00000
2.B.9.a. By-product emissions	CF4	368.01	9.84	90		90.00	0.00006	0.00189	0.00007	0.00000	0.00871	0.00008
2.B.9.a. By-product emissions	C2F6	671.94	0.00	26		26.00	0.00000	0.00358	0.00000	0.00000	0.00000	0.00000
2.B.9.a. By-product emissions	C3F8	215.77	0.00	26		26.00	0.00000	0.00115	0.00000	0.00000	0.00000	0.00000
2.B.9.a. By-product emissions	C4F10	228.60	0.00	26		26.00	0.00000	0.00122	0.00000	0.00000	0.00000	0.00000
2.B.9.a. By-product emissions	C5F12	41.01	0.00	26		26.00	0.00000	0.00022	0.00000	0.00000	0.00000	0.00000
2.B.9.a. By-product emissions	SF6	1487.59	0.00	26		26.00	0.00000	0.00793	0.00000	0.00000	0.00000	0.00000
2.B.9.b Fugitive emissions	C4F10	25.40	175.19	26		26.00	0.00171	0.00108	0.00122	0.00000	0.04483	0.00201
2.B.9.b Fugitive emissions	C5F12	351.53	0.02	26		26.00	0.00000	0.00187	0.00000	0.00000	0.00000	0.00000
2.B.9.b Fugitive emissions	C6F14	288.78	114.30	26		26.00	0.00073	0.00074	0.00080	0.00000	0.02925	0.00086
2.B.9.b Fugitive emissions	HFC-23	0.00	0.04	26		26.00	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000
2.B.9.b Fugitive emissions	HFC-125	0.00	0.22	26		26.00	0.00000	0.00000	0.00000	0.00000	0.00006	0.00000
2.B.9.b Fugitive emissions	HFC-134a	0.00	0.00	26		26.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-32	0.00	50.26	0.94	74.24	74.25	0.00115	0.00035	0.00035	0.02597	0.00047	0.00067
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	0.00	866.03	1.90	73.56	73.59	0.33496	0.00603	0.00603	0.44338	0.01620	0.19685
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	0.00	912.09	64.72	41.41	78.05	0.41796	0.00635	0.00635	0.26287	0.58099	0.40664
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.00	0.01		75	75.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	0.00	825.27	2.56	73.09	73.14	0.30046	0.00574	0.00574	0.41979	0.02080	0.17666
2.F.1. Refrigeration and Air Conditioning Equipment	C3F8	0.00	1.90		75	75.00	0.00000	0.00001	0.00001	0.00099	0.00000	0.00000
2.F.2. Foam Blowing Agents	HFC-134a	0.00	38.90	15	5	15.82	0.00003	0.00027	0.00027	0.00135	0.00574	0.00003
2.F.2. Foam Blowing Agents	HFC-152a	0.00	19.01	15	5	15.82	0.00001	0.00013	0.00013	0.00066	0.00281	0.00001
2.F.2. Foam Blowing Agents	HFC-245fa	0.00	0.83	15	5	15.82	0.00000	0.00001	0.00001	0.00003	0.00012	0.00000
2.F.2. Foam Blowing Agents	HFC-227ea	0.00	1.94	15	5	15.82	0.00000	0.00001	0.00001	0.00007	0.00029	0.00000
2.F.2. Foam Blowing Agents	HFC-365mfc	0.00	3.88	15	5	15.82	0.00000	0.00003	0.00003	0.00014	0.00057	0.00000
2.F.3. Fire protection	HFC-125	0.00	1.03	10	50	51.05	0.00000	0.00001	0.00001	0.00036	0.00010	0.00000
2.F.3. Fire protection	HFC-227ea	0.00	11.46	10	50	51.05	0.00003	0.00008	0.00008	0.00399	0.00113	0.00002
2.F.4. Aerosols	HFC-134a	0.00	78.06	15.38	82.89	84.56	0.00359	0.00054	0.00054	0.04503	0.01181	0.00217
2.F.4. Aerosols	HFC-152a	0.00	0.21		200	200.00	0.00000	0.00000	0.00000	0.00030	0.00000	0.00000
2.F.4. Aerosols	HFC-227ea	0.00	0.56	25	50	56.27	0.00000	0.00000	0.00000	0.00019	0.00014	0.00000
2.E.1 Integrated Circuit or Semiconductor	HFC-23	0.00	1.93		100	100.00	0.00000	0.00001	0.00001	0.00135	0.00000	0.00000
2.E.1 Integrated Circuit or Semiconductor	HFC-32	0.00	0.00		100	100.00	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
2.E.1 Integrated Circuit or Semiconductor	CF4	0.00	2.17		100	100.00	0.00000	0.00002	0.00002	0.00151	0.00000	0.00000
2.E.1 Integrated Circuit or Semiconductor	C2F6	0.00	3.42		100	100.00	0.00001	0.00002	0.00002	0.00238	0.00000	0.00001
2.E.1 Integrated Circuit or Semiconductor	SF6	0.00	3.45		100	100.00	0.00001	0.00002	0.00002	0.00240	0.00000	0.00001
2.E.1 Integrated Circuit or Semiconductor	NF3	0.00	0.69		100	100.00	0.00000	0.00000	0.00000	0.00048	0.00000	0.00000
2.E.1 Integrated Circuit or Semiconductor	c-C4F8	0.00	0.13		100	100.00	0.00000	0.00000	0.00000	0.00009	0.00000	0.00000
2.E.4 Heat Transfer Fluid	HFC-32	0.00	0.01		100	100.00	0.00000	0.00000	0.00000	0.00001	0.00000	0.00000

2.E.4 Heat Transfer Fluid	HFC-125	0.00	0.05		100	100.00	0.00000	0.00000	0.00000	0.00003	0.00000	0.00000
2.G.1. Electrical equipment	SF6	7.75	11.36		50	50.00	0.00003	0.00004	0.00008	0.00189	0.00000	0.00000
2.G.2 SF6 and PFCs from other product use	SF6	79.77	80.40		100	100.00	0.00533	0.00013	0.00056	0.01341	0.00000	0.00018
2G3. N2O from Product Uses	N2O	196.48	92.48	3	100	100.04	0.00706	0.00040	0.00064	0.04044	0.00273	0.00164
2H. Other	CO2	0.00	25.96	20	5	20.62	0.00002	0.00018	0.00018	0.00090	0.00511	0.00003
3A1 Dairy Cattle	CH4	2304.38	1579.48	5	20	20.62	0.08743	0.00130	0.01099	0.02596	0.07773	0.00672
3A1 Non-Dairy Cattle	CH4	2721.79	2586.70	5	20	20.62	0.23450	0.00348	0.01800	0.06969	0.12729	0.02106
3A2 Sheep	CH4	38.43	22.19	5	20	20.62	0.00002	0.00005	0.00015	0.00101	0.00109	0.00000
3A4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	10.65	33.51	5	20	20.62	0.00004	0.00018	0.00023	0.00353	0.00165	0.00002
3A3 Swine	CH4	251.27	244.36	5	20	20.62	0.00209	0.00036	0.00170	0.00721	0.01203	0.00020
3B1 Dairy Cattle	CH4	296.57	320.29	10	40	41.23	0.01438	0.00065	0.00223	0.02589	0.03152	0.00166
3B1 Non-Dairy Cattle	CH4	188.42	180.01	10	40	41.23	0.00454	0.00025	0.00125	0.00991	0.01772	0.00041
3B2 Sheep	CH4	0.91	0.53	10	40	41.23	0.00000	0.00000	0.00000	0.00005	0.00005	0.00000
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	CH4	16.96	25.59	10	40	41.23	0.00009	0.00009	0.00018	0.00351	0.00252	0.00002
3B3 Swine	CH4	792.78	730.34	10	40	41.23	0.07478	0.00085	0.00508	0.03417	0.07188	0.00633
3B1 Dairy Cattle	N2O	233.60	102.65	10	90	90.55	0.00712	0.00053	0.00071	0.04784	0.01010	0.00239
3B5 Indirect N2O emissions	N2O	218.32	187.57	30	250	251.79	0.18395	0.00014	0.00131	0.03524	0.05538	0.00431
3B1 Non-Dairy Cattle	N2O	417.22	353.10	10	90	90.55	0.08431	0.00023	0.00246	0.02089	0.03475	0.00164
3B2 Sheep	N2O	0.99	0.57	10	90	90.55	0.00000	0.00000	0.00000	0.00012	0.00006	0.00000
3B4 (rabbit, fur-bearing animals, goats, horses, mules and asses, poultry)	N2O	10.18	16.61	10	90	90.55	0.00019	0.00006	0.00012	0.00552	0.00163	0.00003
3B3 Swine	N2O	91.91	72.09	10	90	90.55	0.00351	0.00001	0.00050	0.00103	0.00709	0.00005
3D1 Direct N2O emissions from managed soils	N2O	3356.10	2629.63	15.61	130.06	130.99	9.78418	0.00040	0.01830	0.05209	0.40393	0.16587
3D2 Indirect N2O Emissions from managed soils	N2O	1051.55	724.05	23.52	195.98	197.39	1.68445	0.00057	0.00504	0.11162	0.16760	0.04055
3G Liming	CO2	161.57	132.50	100	50	111.80	0.01810	0.00006	0.00092	0.00302	0.13041	0.01702
4.A.1. Forest Land remaining Forest Land CSC (biomass burning incl.)	CO2	-2933.67	-3701.11		21.6	21.60	0.52965	0.01015	0.02576	0.21926	0.00000	0.04808
4.A.1 biomass burning	CH4	0.57	0.00	30	70	76.16	0.00000	0.00000	0.00000	0.00021	0.00000	0.00000
4.A.1 biomass burning	N2O	4.68	0.00	30	70	76.16	0.00000	0.00002	0.00000	0.00174	0.00000	0.00000
4.A.2. Land converted to Forest Land CSC	CO2	-10.01	-504.66		59.3	59.30	0.07422	0.00346	0.00351	0.20512	0.00000	0.04208
4.A.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.01	0.03	30	250	251.79	0.00000	0.00000	0.00000	0.00005	0.00001	0.00000
4.B.1. Cropland remaining Cropland CSC	CO2	239.01	-839.67		20.6	20.60	0.02480	0.00712	0.00584	0.14658	0.00000	0.02149
4.B.2. Land converted to Cropland CSC	CO2	53.97	657.63		28.5	28.50	0.02911	0.00429	0.00458	0.12226	0.00000	0.01495
4.B.2. Direct N2O emissions from N mineralization/immobilisation	N2O	2.56	63.59	18	150	151.08	0.00765	0.00043	0.00044	0.06435	0.01127	0.00427
4.C.1. Grassland remaining Grassland CSC	CO2	-43.19	-181.51		23.4	23.40	0.00149	0.00103	0.00126	0.02418	0.00000	0.00058
4.C.1 biomass burning	CH4	0.00	0.00	30	100	104.40	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4.C.1 biomass burning	N2O	0.00	0.00	30	100	104.40	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4.C.1. Direct N2O emissions from N mineralization/immobilisation	N2O	1.92	1.17	30	250	251.79	0.00001	0.00000	0.00001	0.00053	0.00034	0.00000
4.C.2. Land converted to Grassland CSC	CO2	88.95	-442.61		57.9	57.90	0.05443	0.00355	0.00308	0.20577	0.00000	0.04234
4.C.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.13	3.97	30	250	251.79	0.00008	0.00003	0.00003	0.00674	0.00117	0.00005

4.D.2. Land converted to Wetlands CSC	CO2	19.10	-13.92		45.9	45.90	0.00003	0.00020	0.00010	0.00911	0.00000	0.00008
4.D.2. Direct N2O emissions from N mineralization/immobilisation	N2O	0.01	0.09	30	250	251.79	0.00000	0.00000	0.00000	0.00014	0.00003	0.00000
4.E.2. Land converted to Settlements CSC	CO2	231.07	542.78		40.6	40.60	0.04024	0.00255	0.00378	0.10345	0.00000	0.01070
4.E.2. Direct N2O emissions from N mineralization/immobilisation	N2O	2.98	59.60	30	250	251.79	0.01866	0.00040	0.00041	0.09974	0.01760	0.01026
4.G Harvest wood products	CO2	0.00	336.31	50	50	70.71	0.04664	0.00234	0.00234	0.11703	0.16550	0.04109
5.A. Solid Waste Disposal	CH4	3053.39	1064.32	30	40	50.00	0.23354	0.00888	0.00741	0.35507	0.26630	0.19699
5.D. Wastewater treatment and discharge	CH4	834.95	207.09	20	70	72.80	0.01874	0.00301	0.00144	0.21084	0.04076	0.04611
5.D. Wastewater treatment and discharge	N2O	247.33	269.76	20	110	111.80	0.07501	0.00056	0.00188	0.06140	0.05310	0.00659
5.C.1 Waste incineration / Biogenic	N2O	1.40	0.05	20	500	500.40	0.00000	0.00001	0.00000	0.00355	0.00001	0.00001
5.C.1 Waste incineration / Non-biogenic	CO2	299.50	220.30	19.24	19.25	27.21	0.00296	0.00006	0.00153	0.00124	0.04171	0.00174
5.C.1 Waste incineration / Non-biogenic	N2O	1.24	0.04	5	100	100.12	0.00000	0.00001	0.00000	0.00064	0.00000	0.00000
5.B. Biological treatment of solid waste	CH4	2.59	24.51	30	200	202.24	0.00203	0.00016	0.00017	0.03135	0.00724	0.00104
5.B. Biological treatment of solid waste	N2O	3.95	37.39	30	250	251.79	0.00731	0.00024	0.00026	0.05980	0.01104	0.00370
TOTAL		**143 679.33**	**109 848.31**				17.41596					4.65510
				percentage uncertainty in total inventory (%):			**4.173**			**Trend uncertainty (%)**		**2.158**

Annex 3: Supplementary documents attached to the Belgian National Inventory Report

- National CRF tables (CRF Reporter) for the years 1990-2014.

- 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 (“QMS Flanders”).

- A list of the parameters used in the preparation of the Belgian inventory for agriculture at the regional level (“List of parameters for Agriculture in Belgian Inventory_060416.xlsx”).

- Information related to the calculation of the Manure Balance in Flanders (“Manure Balance data_Flanders_2013”).

- Information related to the transactions of Kyoto-units in Belgium: “CONFIDENTIAL_Annexes_BE_NIR_2016.zip” and “ITL_BE_2015_2_1.zip”.

- Information related to the changes in National Registry: (“AnnexH test results EU - 07March2016.docx”)

- National Inventory System of April 2010: (“NIS Belgium 15042014.doc).

- Belgian QA/QC-plan of April 2010: (“QAQC_Belgium 15042014.doc).

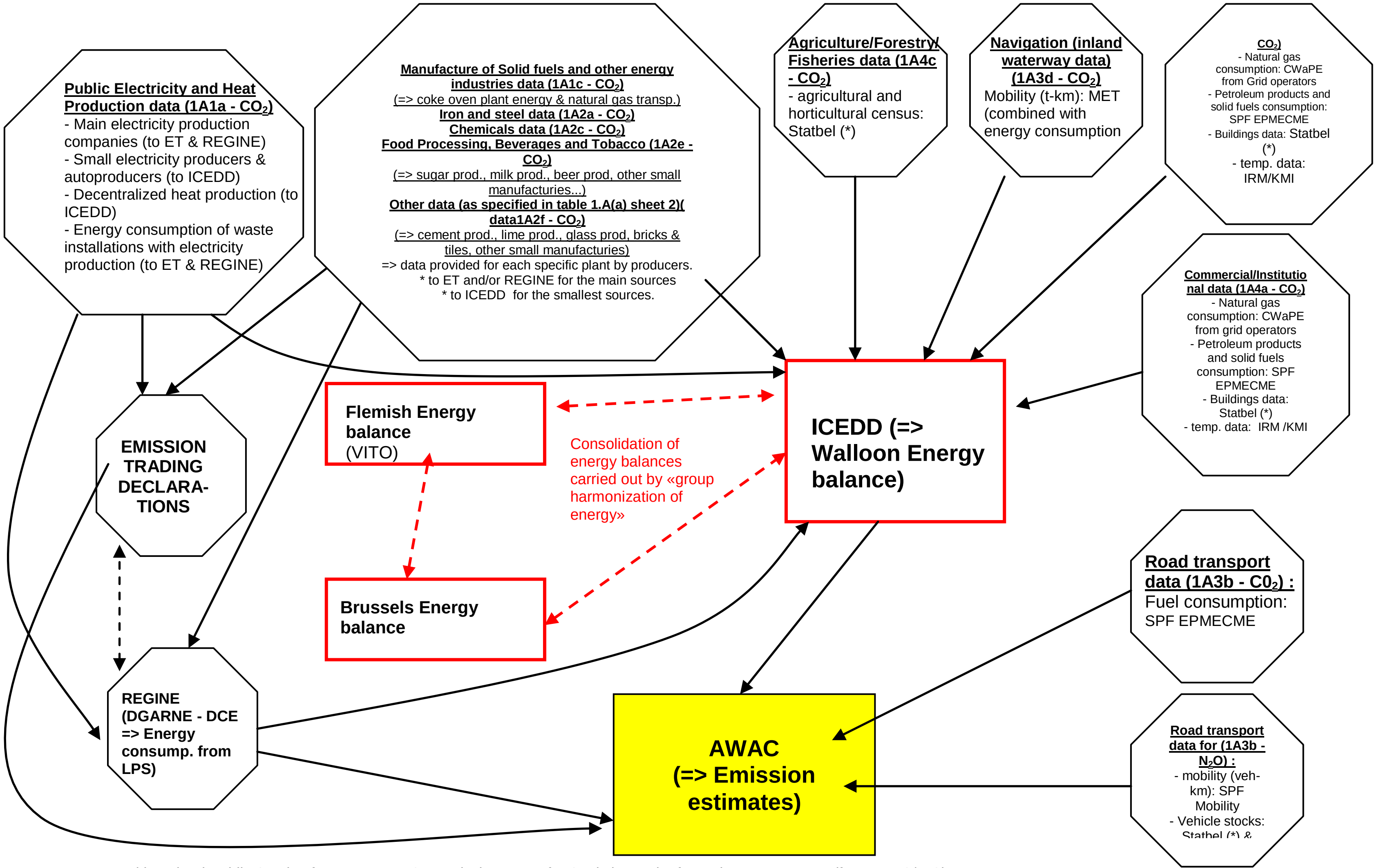
- Belgian energy balance as provided by Eurostat: (“Annual Balance Belgium 2014.xls”).

Annex 4: Net calorific value of the main products

Products	Net calorific value(TJ/kton)
Hard coal	34,9
coking coal	29,3
Butane	45,73
Propane	46,14
coke oven coke	29,3
LPG	45,95
LPG (road transport)	46,556
Bioethanol	28,8
Biodiesel	37,3
gas/diesel oil	42,697 (mainly for road traffic)
gasoil	42,279
lamp petroleum	43,12
residual fuel oil	40,604
petroleum coke	31,4
gasoline	43,774
jet fuel	41,87
kerosene	43,116
Coke gas	plant specific
Blast furnace gas	plant specific
Natural gas	plant specific (ETS 2012 Wallonia : 0,0323 to 0,038 GJ/Nm3)

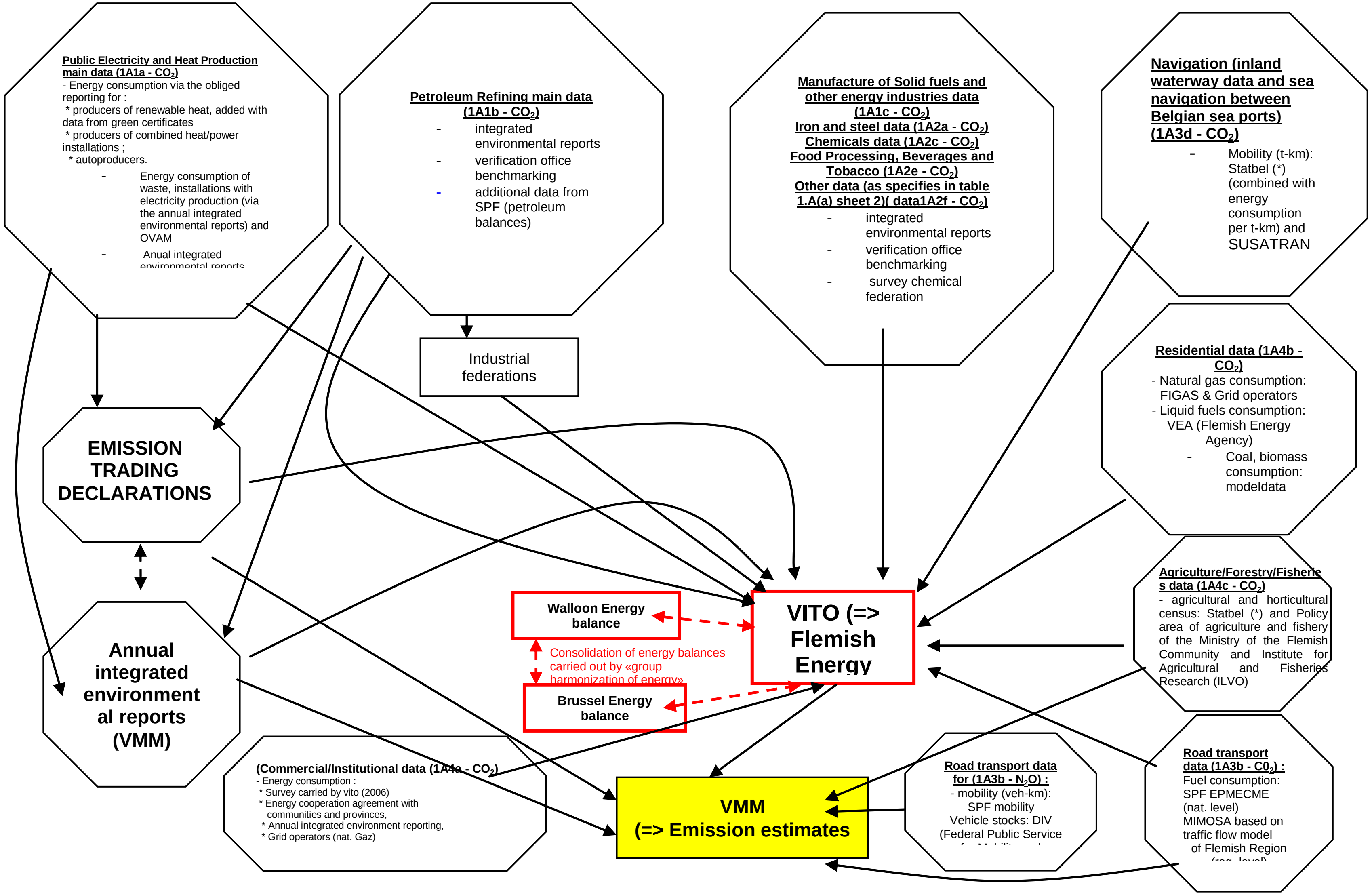
Annex 5: Key sources: flows of activity data

ENERGY- Key Sources - flow of activity data Wallonia

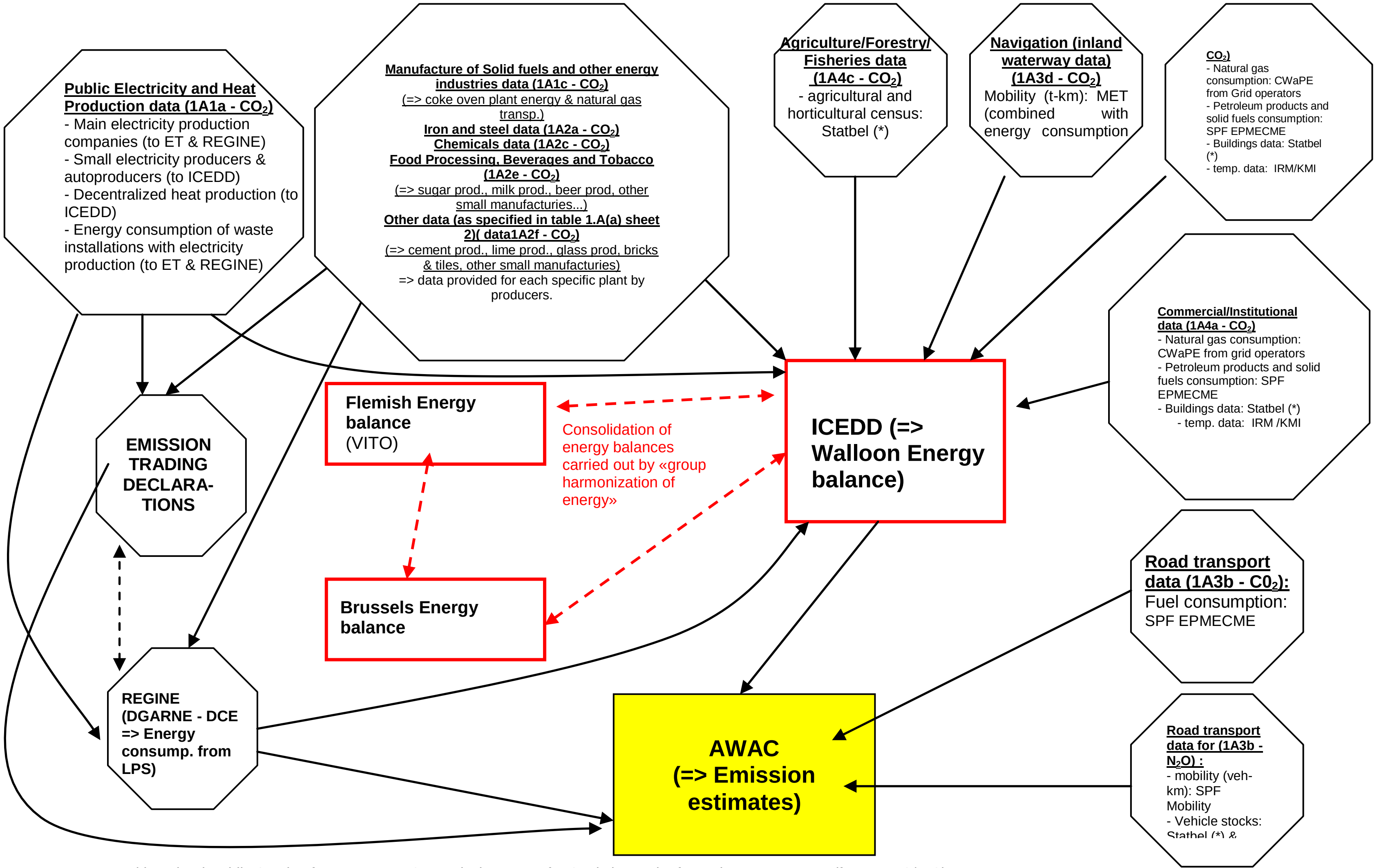


(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

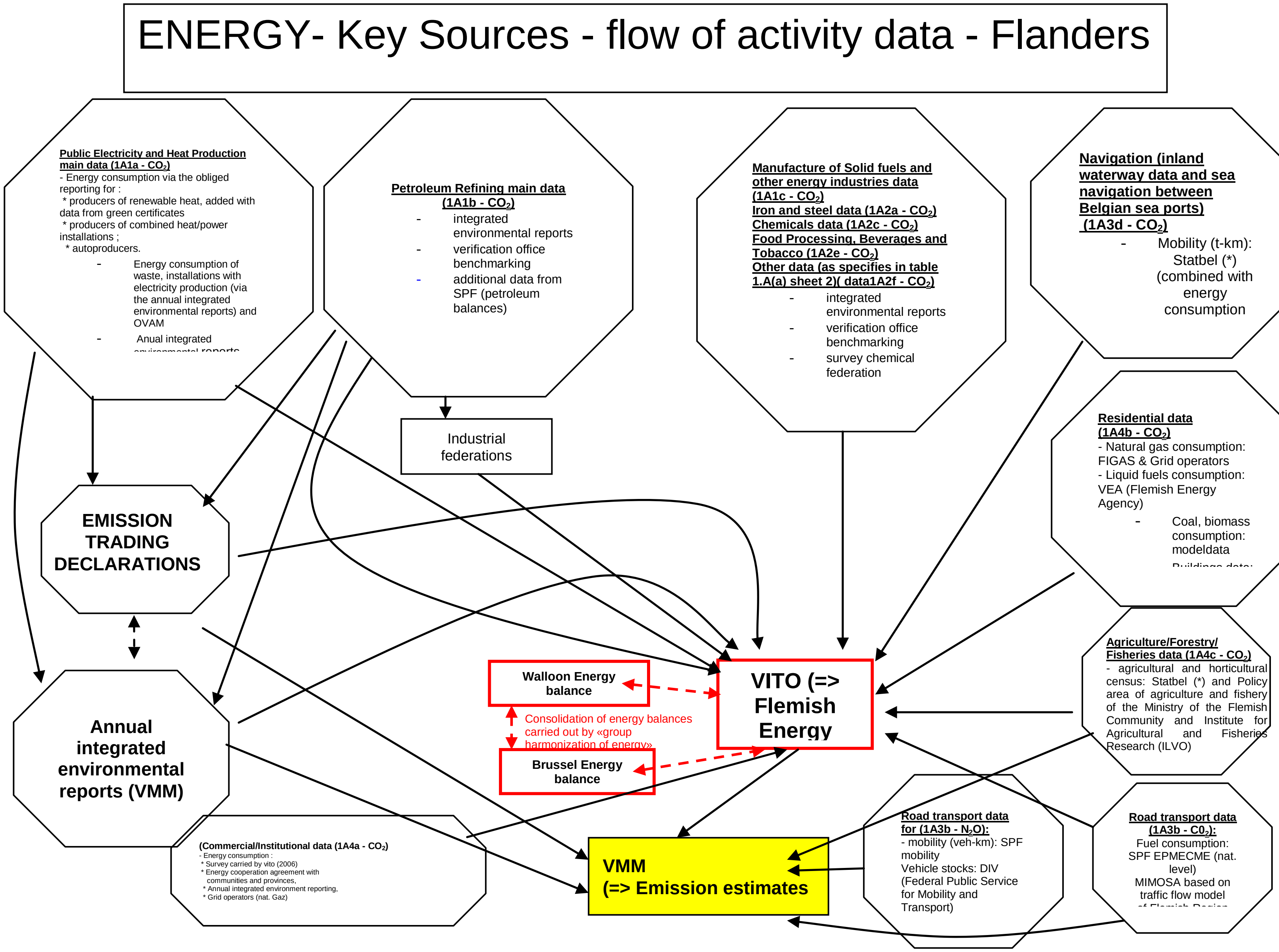
ENERGY- Key Sources - flow of activity data - Flanders



ENERGY- Key Sources - flow of activity data Wallonia

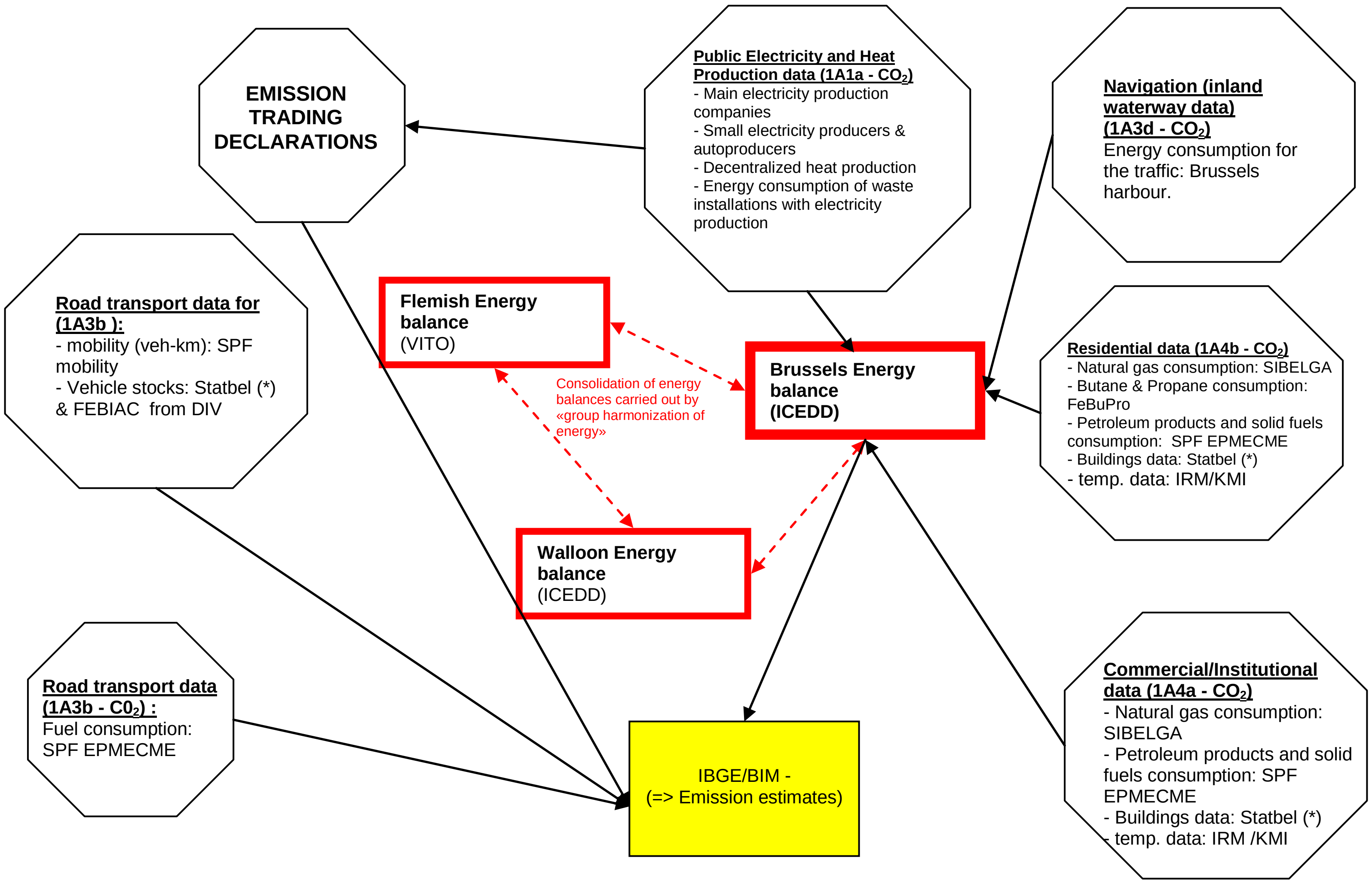


(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)



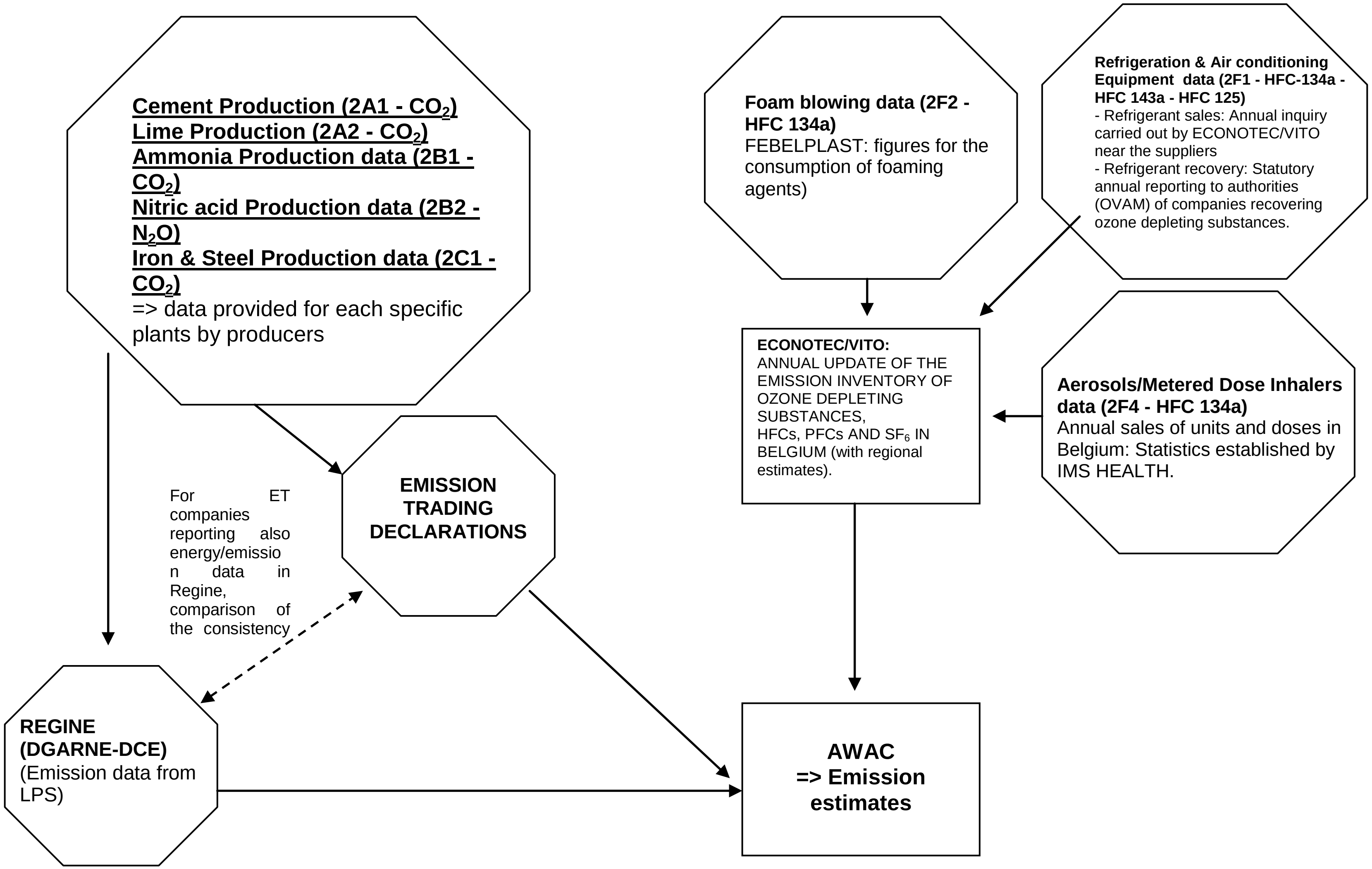
ENERGY- Key Sources - flow of activity data - Flanders
Public Electricity and Heat Production main data (1A1a - CO2)
- Energy consumption via the obliged reporting for :
* producers of renewable heat, added with data from green certificates
* producers of combined heat/power installations ;
* autoproducers.
- Energy consumption of waste, installations with electricity production (via the annual integrated environmental reports) and OVAM
- Anual integrated
Petroleum Refining main data (1A1b - CO2)
- integrated environmental reports
- verification office benchmarking
- additional data from SPF (petroleum balances)
Manufacture of Solid fuels and other energy industries data (1A1c - CO2)
Iron and steel data (1A2a - CO2)
Chemicals data (1A2c - CO2)
Food Processing, Beverages and Tobacco (1A2e - CO2)
Other data (as specifies in table 1.A(a) sheet 2)(data1A2f - CO2)
- integrated environmental reports
- verification office benchmarking
- survey chemical federation
Navigation (inland waterway data and sea navigation between Belgian sea ports) (1A3d - CO2)
- Mobility (t-km): Statbel (*) (combined with energy consumption
Industrial federations
Residential data (1A4b - CO2)
- Natural gas consumption: FIGAS & Grid operators
- Liquid fuels consumption: VEA (Flemish Energy Agency)
- Coal, biomass consumption: modeldata
EMISSION TRADING DECLARATIONS
Agriculture/Forestry/ Fisheries data (1A4c - CO2)
- agricultural and horticultural census: Statbel (*) and Policy area of agriculture and fishery of the Ministry of the Flemish Community and Institute for Agricultural and Fisheries Research (ILVO)
Walloon Energy balance
VITO (=> Flemish Energy
Consolidation of energy balances carried out by «group harmonization of energy»
Brussel Energy balance
Annual integrated environmental reports (VMM)
VMM (=> Emission estimates
(Commercial/Institutional data (1A4a - CO2)
- Energy consumption :
* Survey carried by vito (2006)
* Energy cooperation agreement with communities and provinces,
* Annual integrated environment reporting,
* Grid operators (nat. Gaz)
Road transport data for (1A3b - N2O):
- mobility (veh-km): SPF mobility
Vehicle stocks: DIV (Federal Public Service for Mobility and Transport)
Road transport data (1A3b - C02):
Fuel consumption: SPF EPMECME (nat. level)
MIMOSA based on traffic flow model

ENERGY- Key Sources - flow of activity data - Brussels

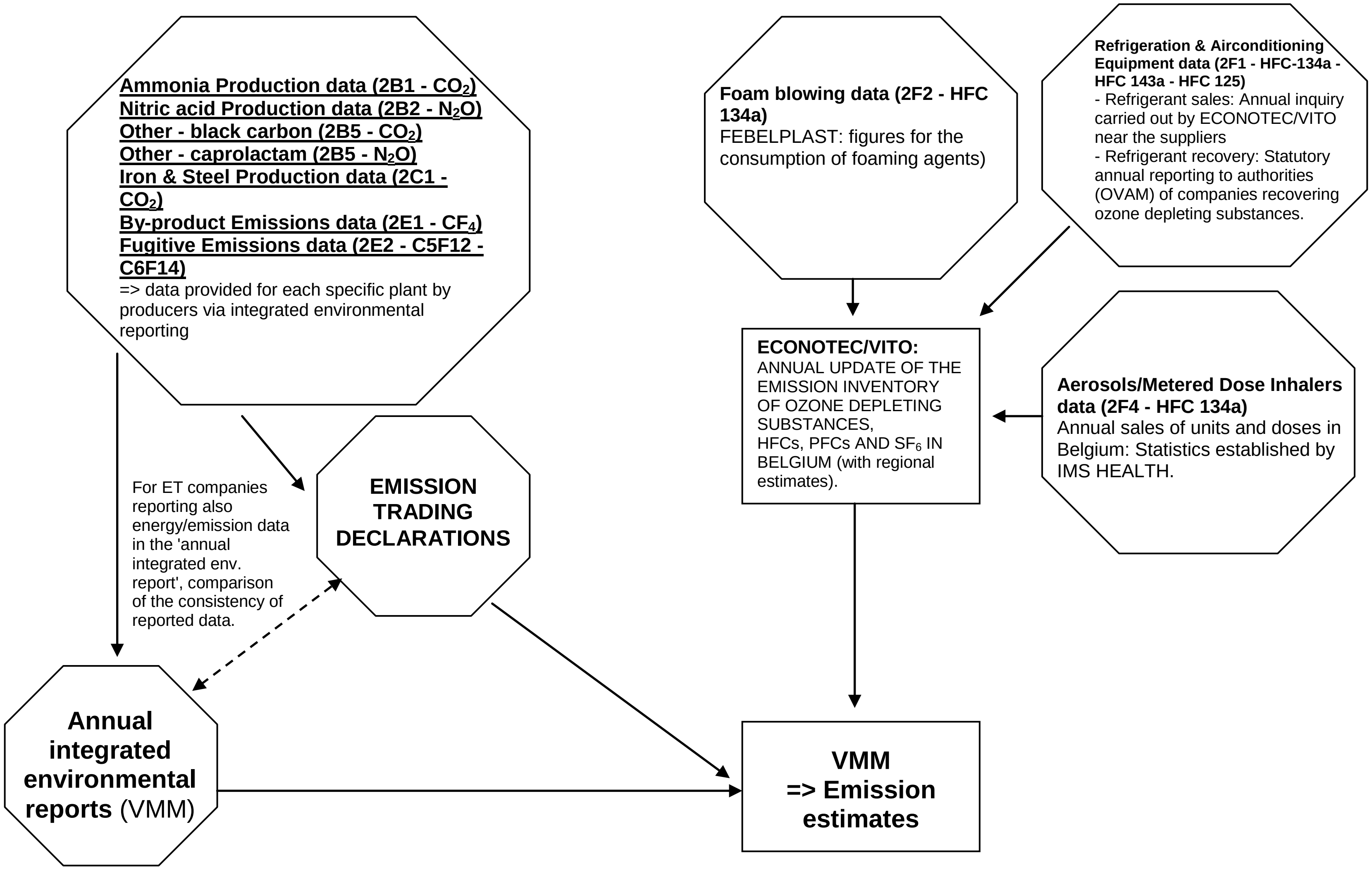


(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

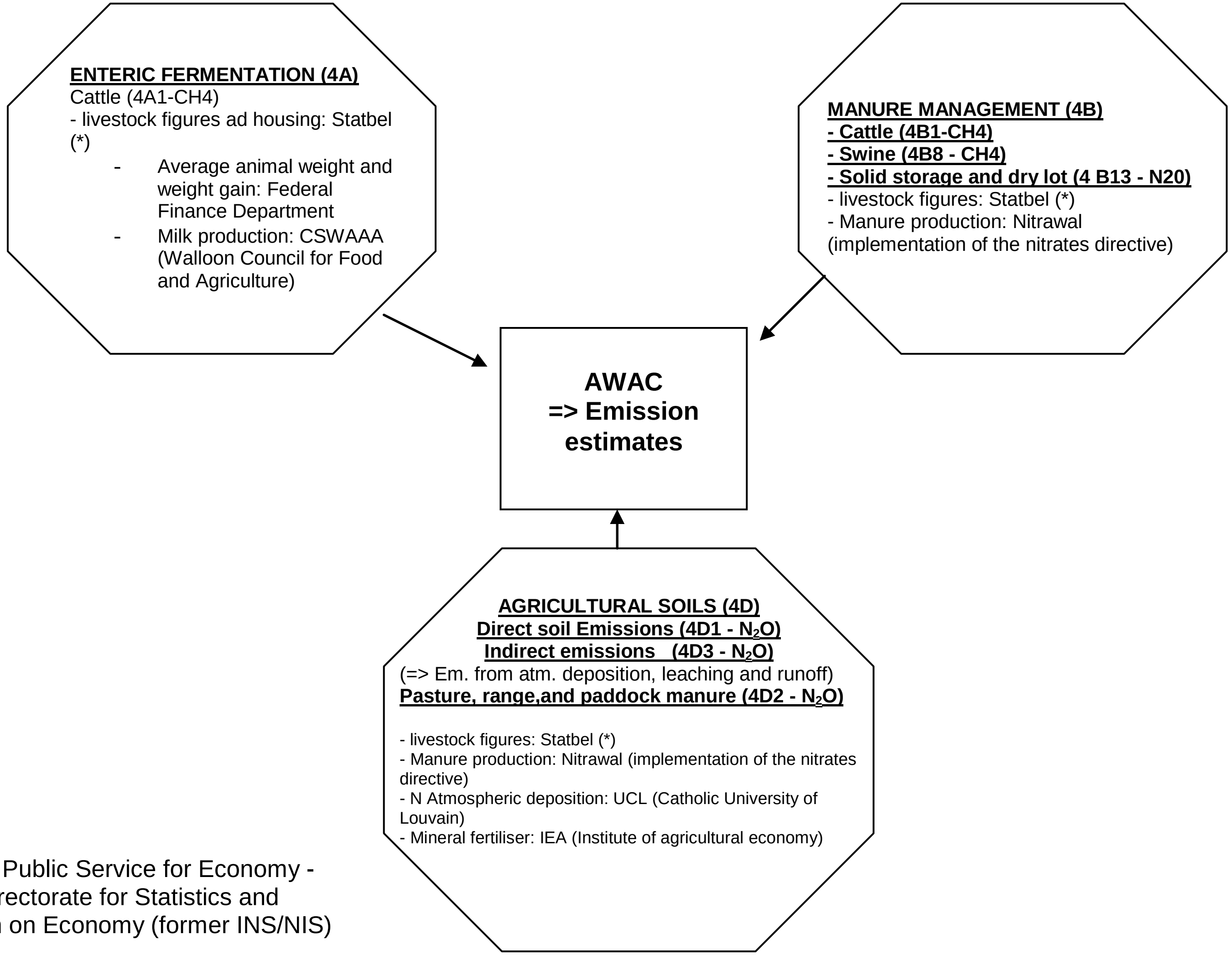
INDUSTRY - Key Sources - Flow of activity data - Wallonia



INDUSTRY - Key Sources - Flow of activity data - Flanders

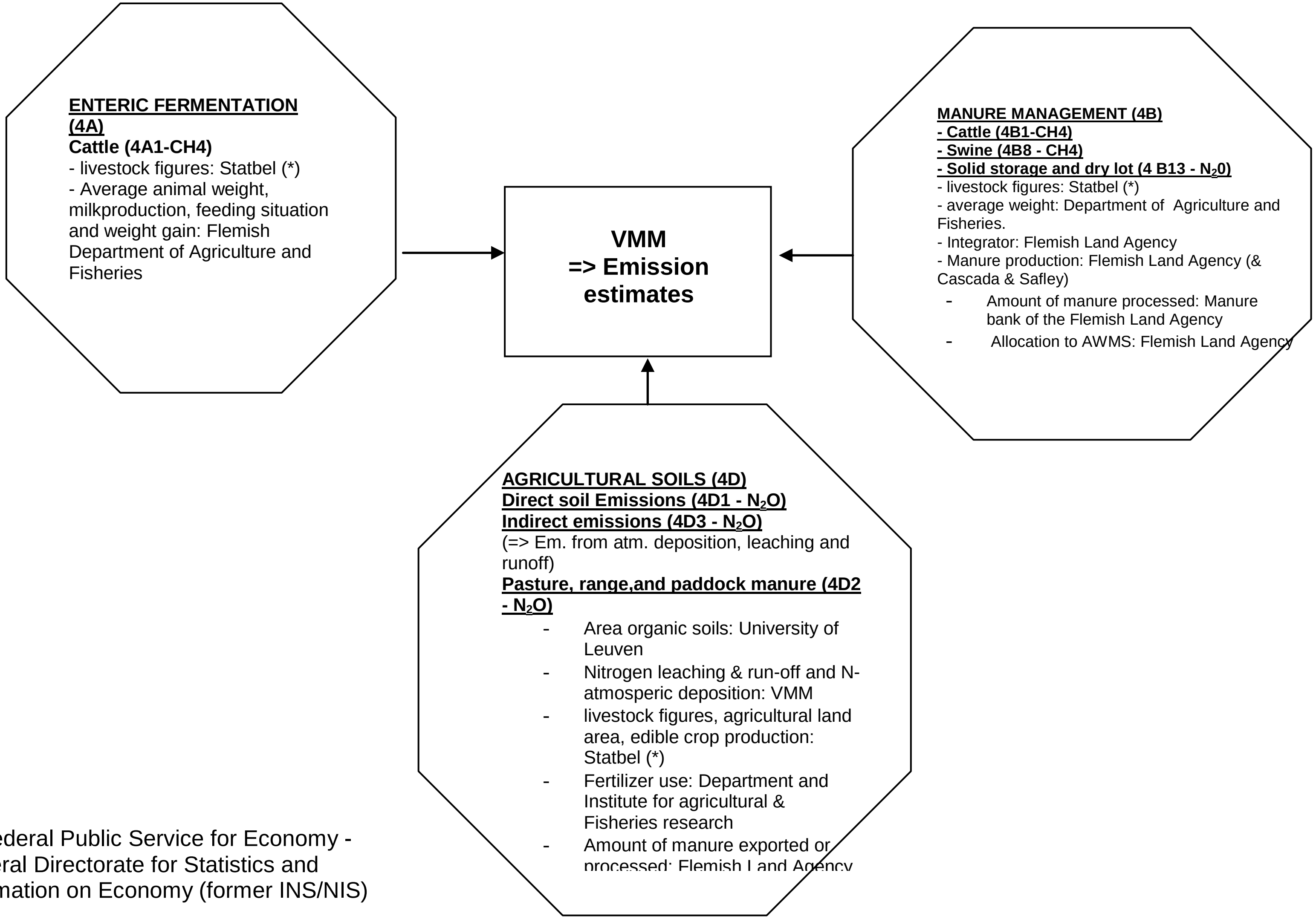


AGRICULTURE - Key Sources - Flow of activity data - Wallonia



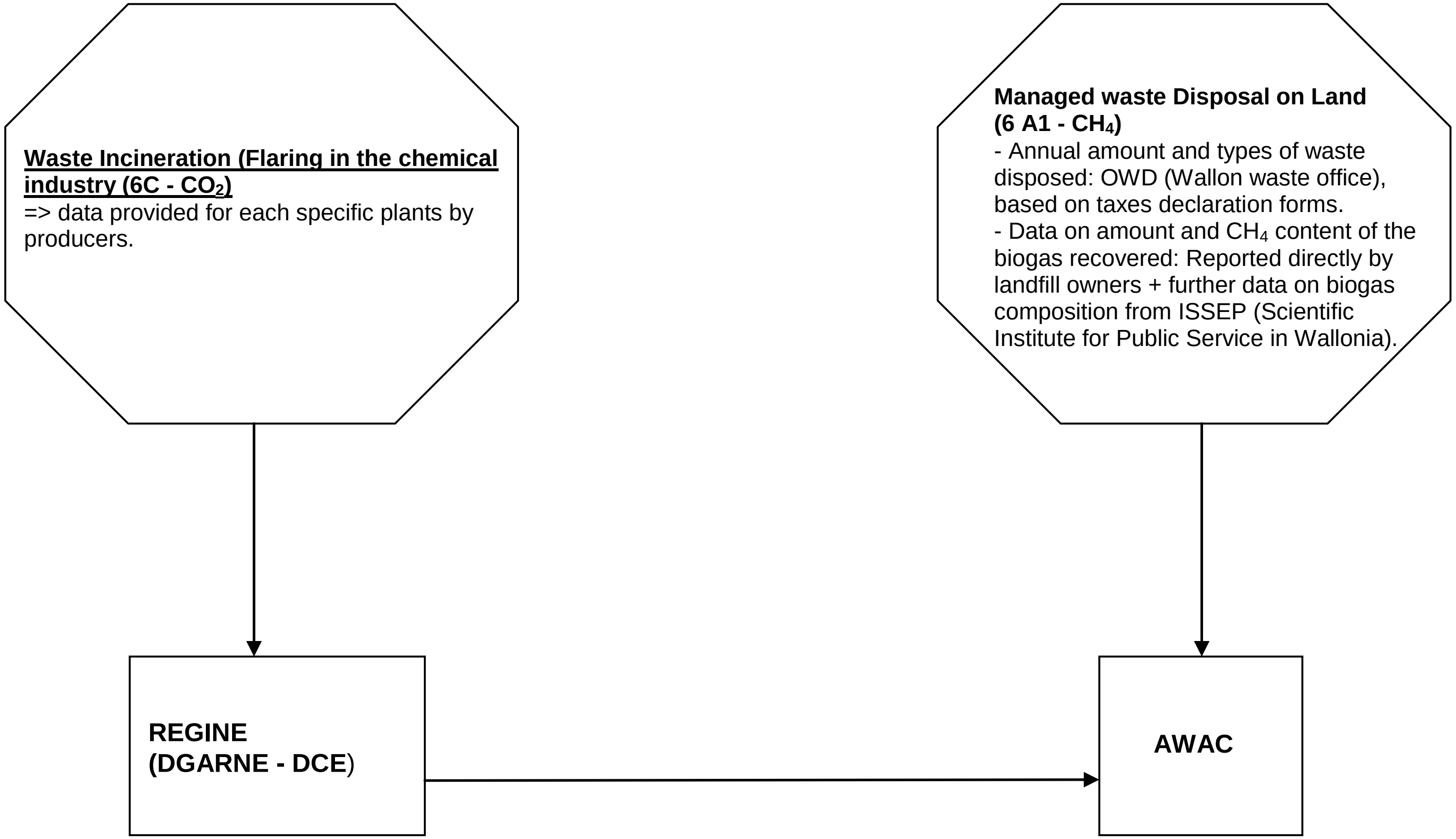
(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

AGRICULTURE - Key Sources - Flow of activity data - Flanders

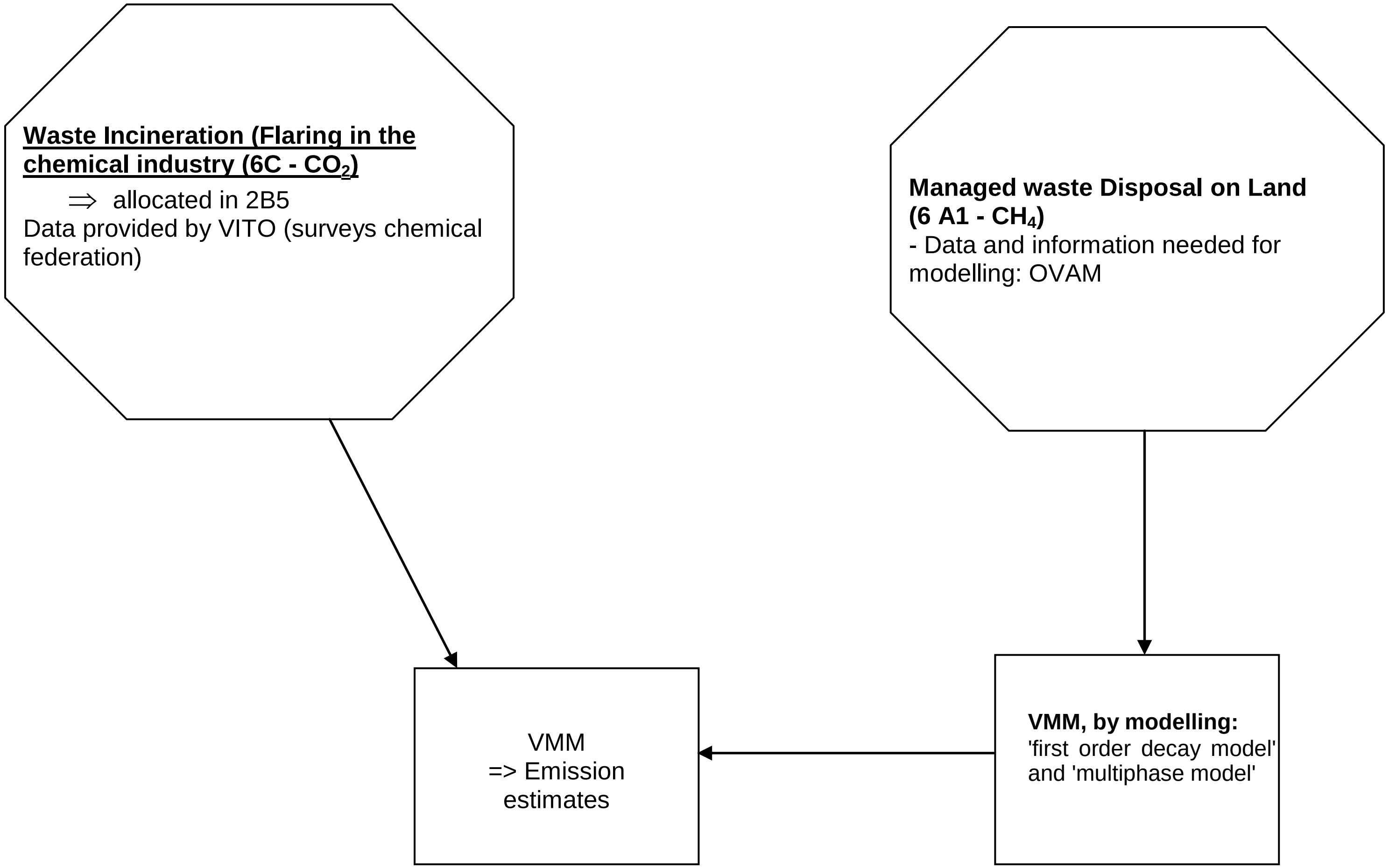


(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

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
CRF	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 TJ	Diesel TJ	LPG TJ	Gas TJ	Biomass TJ	Total TJ	Gasoline kt CO2	Diesel kt CO2	LPG kt CO2	Gas kt CO2	Biomass kt CO2	Total CO2 (excluding biomass)
1990	117841	148540	2608			268989	8360	10964	169			19493
1991	118341	150954	2189			271484	8396	11142	142			19680
1992	125549	154125	2095			281770	8907	11376	136			20419
1993	122751	163863	1863			288477	8708	12095	121			20924
1994	122808	169869	2421			295099	8712	12538	157			21408
1995	122530	170795	2794			296119	8693	12606	181			21480
1996	118408	180126	2980			301513	8400	13295	194			21889
1997	109492	191851	3399			304742	7768	14161	221			22149
1998	108468	201181	4377			314026	7695	14849	284			22828
1999	103288	210251	4470			318010	7328	15519	290			23137
2000	96752	221686	4144			322582	6864	16363	269			23496
2001	94167	231662	4750			330578	6680	17099	308			24088
2002	89824	240469	4330			334624	6372	17749	281			24403
2003	90618	247590	3865			342073	6429	18275	251			24954
2004	83054	269211	3725			355991	5892	19871	242			26005
2005	75584	264508	3539			343631	5362	19523	230			25115
2006	62572	269590	3399	0,08		335561	4439	19898	221	0,004		24558
2007	59447	271657	2934	0,40	3693	337731	4217	20051	190	0,023	277	24459
2008	61420	301240	2701	2,67	4202	369565	4357	22235	175	0,153	311	26767
2009	57413	294329	2468	4,28	11849	366063	4073	21724	160	0,246	871	25958
2010	51504	300518	2235	6,29	15039	369302	3654	22181	145	0,362	1108	25981
2011	52173	297478	2049	8,67	14407	366115	3701	21957	133	0,499	1063	25792
2012	48578	274364	1909	13,99	14760	339624	3446	20251	124	0,805	1089	23822
2013	48755	271550	1787	21,65	14016	336131	3459	20043	116	1,245	1033	23619
2014	52872	276450	1956	85,43	16402	347765	3751	20405	127	4,913	1217	24288

Annex 8: Regional energy balance and Belgian energy balance

Belgium

Enery balance 2014 as provided by Eurostat http://ec.europa.eu/eurostat/web/energy/data/database - please see Annex 3 for the file

(TJ)

INDIC_NRG/PRODUCT	All products	Solid fuels	Patent Fuels	Anthracite	Coking Coal	Other Bituminous Coal	Sub-bituminous Coal	Coke Oven Coke	Gas Coke	Coal Tar	Lignite/Brown Coal	BKB (brown coal briquettes)	Peat	Peat products	Oil shale and oil sands	Total petroleum products	Crude oil (without NGL)	Natural gas liquids (NGL)	Refinery feedstocks	Additives/Oxygenates	Other hydrocarbons	Refinery gas	Ethane	Liquified petroleum gas (LPG)	Gasoline (without bio components)	Aviation gasoline	Other kerosene	Gasoline type jet fuel	Kerosene type jet fuel (without bio components)	Naphtha	Gas/diesel oil (without bio components)	Total fuel oil	White Spirit and SBP	Lubricants	Bitumen	Petroleum coke	Paraffin Waxes	Other Oil Products	Gas	Natural gas	Coke Oven Gas	Blast Furnace Gas	Gas Works Gas	Other recovered gases	Nuclear heat	Derived heat	Renewable energies	Hydro power	Wind power	Solar thermal	Solar photovoltaic	Tide, Wave and Ocean	Solid biofuels (excluding charcoal)	Biogas	Municipal waste	Municipal waste (renewable)	Municipal waste (non-renewable)	Charcoal	Biogasoline	Biodiesels	Other liquid biofuels	Bio jet kerosene	Geothermal Energy	Electrical energy	Industrial wastes	Waste (non-renewable)
Gross electricity generation Main activity electricity only - Solar Thermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Main activity CHP plants - Solar Thermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Autoproducer electricity only - Solar Thermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Autoproducer CHP plants - Solar Thermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross heat production Main activity CHP plants - Solar Thermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Gross heat production Main activity heat only plants - Solar Thermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Gross heat production Autoproducer CHP plants - Solar Thermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Gross heat production Autoproducer heat only plants - Solar Thermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Gross electricity generation Main activity electricity only - Nuclear	121 331	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	121 331	:	:
Gross electricity generation Main activity CHP plants - Nuclear	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Autoproducer electricity only - Nuclear	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Autoproducer CHP plants - Nuclear	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Main activity electricity only - Pumped Hydro	4 439	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	4 439	:	:
Gross electricity generation Autoproducer electricity only - Pumped Hydro	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Main activity electricity only - Geothermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Main activity CHP plants - Geothermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Autoproducer electricity only - Geothermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:
Gross electricity generation Autoproducer CHP plants - Geothermal	0	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0	:	:

Walloon Region
Enery balance 2014 (provisional values)
(GWh PCI)

Bilan global provisoire 2014
en GWh PCI

	Charbon et aggloméré s de houille	Coke	Lignite	Goudron ,benzol	Fioul léger et pétr.lamp ant	Fioul lourd	Coke de pétrole	Essence kérosène	Butane, propane, GPL	Autres prod. pétroliers	Gaz naturel	Gaz de cokerie	Bois, sciure de bois écorces	Liqueur noire	Biogaz	Biodiesel	Bioéthanol	Autre biocarburant	Déchets solides renouvelabl es	Autre biomasse	Autres combustibles
Consom.intér.brute	**4 596**	**-1 127**	**2 315**	**-51**	**40 989**	**461**	**548**	**8 742**	**784**	**1 774**	**39 493**	**--**	**6 333**	**2 407**	**547**	**1 144**	**200**	**1**	**2 242**	**27**	**3 112**
Entrées en transform.	**1 781**	**--**	**--**	**--**	**42**	**299**	**--**	**--**	**12**	**--**	**13 269**	**222**	**3 758**	**2 407**	**489**	**--**	**--**	**1**	**779**	**27**	**1 766**
Centrales électriques	**--**	**--**	**--**	**--**	**42**	**299**	**--**	**--**	**12**	**--**	**13 269**	**222**	**3 758**	**2 407**	**489**	**--**	**--**	**1**	**779**	**27**	**1 766**
Nucléaire	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thermique classique	--	--	--	--	0	--	--	--	--	--	23	--	338	--	--	--	--	--	--	--	--
TGV TAG	--	--	--	--	2	--	--	--	--	--	8 885	--	--	--	--	--	--	--	--	--	--
Turbojets	--	--	--	--	18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Incinérateurs	--	--	--	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	779	--	1 617
Autr.centr.(cog.et autop.)	--	--	--	--	15	299	--	--	12	--	4 361	222	3 420	2 407	489	--	--	1	--	27	149
Cokeries	1 781	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hauts-fourneaux	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sorties de transform.	**--**	**1 252**	**--**	**51**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**318**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Centrales électriques	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Cokeries	--	1 252	--	51	--	--	--	--	--	--	--	318	--	--	--	--	--	--	--	--	--
Echange entre produits	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Cons. branche énergie	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**22**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Cokeries	--	--	--	--	--	--	--	--	--	--	--	22	--	--	--	--	--	--	--	--	--
Pertes de distribution	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**92**	**74**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Consommation finale	**2 815**	**125**	**2 315**	**--**	**40 948**	**163**	**548**	**8 742**	**772**	**1 774**	**26 132**	**--**	**2 575**	**--**	**59**	**1 144**	**200**	**--**	**1 463**	**--**	**1 346**
Cons.finale énergét.	**2 807**	**125**	**2 315**	**--**	**40 948**	**163**	**548**	**8 742**	**765**	**--**	**24 378**	**--**	**2 575**	**--**	**59**	**1 144**	**200**	**--**	**1 463**	**--**	**1 346**
Industrie	**2 517**	**125**	**2 315**	**--**	**982**	**163**	**548**	**44**	**105**	**--**	**12 323**	**--**	**395**	**--**	**53**	**--**	**--**	**--**	**1 463**	**--**	**1 346**
Sidérurgie	58	57	--	--	38	27	4	--	2	--	2 717	--	--	--	--	--	--	--	--	--	--
Chimie	--	0	--	--	77	13	--	--	3	--	3 206	--	44	--	--	--	--	--	--	--	100
Minéraux non métalliques	2 454	0	2 315	--	435	73	544	--	27	--	3 244	--	--	--	--	--	--	--	1 463	--	1 246
Autres	6	67	--	--	432	49	--	44	73	--	3 156	--	351	--	53	--	--	--	--	--	--
Transport	**--**	**--**	**--**	**--**	**26 061**	**--**	**--**	**8 698**	**71**	**--**	**--**	**--**	**--**	**--**	**--**	**1 144**	**200**	**--**	**--**	**--**	**--**
Ferroviaire	--	--	--	--	108	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Routier	--	--	--	--	25 771	--	--	4 807	71	--	--	--	--	--	--	1 144	200	--	--	--	--
Aérien	--	--	--	--	--	--	--	3 891	--	--	--	--	--	--	--	--	--	--	--	--	--
Navigation intérieure	--	--	--	--	183	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Domestique & équival.	**290**	**--**	**--**	**--**	**13 905**	**--**	**--**	**--**	**589**	**--**	**12 055**	**--**	**2 179**	**--**	**5**	**--**	**--**	**--**	**--**	**--**	**--**
Agriculture	--	--	--	--	1 025	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Logement	290	--	--	--	10 597	--	--	--	529	--	7 968	--	2 117	--	--	--	--	--	--	--	--
Tertiaire	--	--	--	--	2 283	--	--	--	60	--	4 087	--	63	--	5	--	--	--	--	--	--
Cons.fin.non-énergét.	**8**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**7**	**1 774**	**1 754**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
Chimie	8	--	--	--	--	--	--	--	--	11	1 754	--	--	--	--	--	--	--	--	--	--
Autres secteurs	--	--	--	--	--	--	--	--	7	1 762	--	--	--	--	--	--	--	--	--	--	--

Brussels Region
Enery balance 2014 (provisional values)
(GWh PCI)

2014 (GWh PCI)	Production primaire Récupération d'énergie	Consommation intérieure brute	Entrée en transformation	Sortie de transformation	Auto-consommation	Pertes de distribution	Consommation finale (énergétique)	CF industrie	CF tertiaire	CF logement	CF transport
CHARBON ET DERIVES: charbon, coke, gaz de cokerie		43,24					43,24			43,24	
DECHETS MENAGERS (fraction non organique)	535,56	535,56	535,56								
BITUME: bitume, asphalte et goudron		195,71									
PARAFINES											
FIOUL LOURD		3,05					3,05	3,05			
FIOUL LEGER: Mazout de chauffage, pétrol lampant		2051,15	0,46				2050,69	15,61	601,96	1433,11	
LUBRIFIANTS		49,85					0,03				0,03
GASOIL (transport)		3097,68					3097,68				3097,68
ESSENCE		550,39					550,39				550,39
WHITE-SPIRIT											
AUTRES CARBURANTS LIQUIDES: LPG, CNG, H2,etc		8,68					8,68				8,68
GAZ NATUREL		7779,03	264,21			17,02	7531,84	294,60	2779,86	4457,38	
BUTANE, PROPANE		23,11					23,11	0,04	0,36	22,71	
AUTRES SOURCES FOSSILES											
BOIS	6,47	64,71					64,71			64,71	
DECHETS MENAGERS (fraction organique)	543,33	543,33	543,33								
BIODIESEL		153,15					153,15				153,15
BIOETHANOL		35,82					35,82				35,82
AUTRES BIOCARBURANTS LIQUIDES: Huile de colza, etc		6,11	6,11								
BIOGAZ	22,12	22,12	22,12								
AUTRES SOURCES RENOUVELABLES											
ELECTRICITE	3,00	5195,00		186,83	42,02	149,00	5314,68	300,00	3388,00	1323,00	303,68
ELECTRICITE (photovoltaïque)	38,00										
ELECTRICITE (autres sources renouvelables)				127,08	3,21						
VAPEUR, CHALEUR	14,83	-66,21	598,97	684,61			25,56	0,01	20,83	4,72	
SOLAIRE THERMIQUE	7,22										
Pompes à chaleur (PAC)							0,11	0,11			
VAPEUR, CHALEUR (autres sources renouvelables)			217,48	223,72							
TOTAL	1170,53	20291,47	2188,25	1222,25	45,23	166,02	18902,73	613,42	6791,01	7348,87	4149,43

Flemish region
Energy Balance 2014 (provisional values)
PJ

	Koolteer	Kolen	Cokes	Totaal kolen	Aardolie en interm. prod.	Raff. gas	LPG	Benzine	Kerosine	Gas-en dieselolie	Lamppetro- leum	Zware stookolie	Nafta	Petroleum- cokes	Andere petro. prod.	Totaal petro. producten	Aard- en mijngas	Cokes- ovengas	Hoog- ovengas	Totaal gas	Totaal fossiele brandstoffen	Andere brandst.	Biomassa	Elek- triciteit	Warmte	Nucleaire warmte	Totaal
	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]	[PJ]
Primaire produktie				**0,0**												**0,0**				**0,0**	**0,0**	89,9	42,6	11,4	10,6		**154,5**
Netto invoer	7,2	105,9	4,2	**117,2**	1.508,6	0,5	12,1	-170,8	-29,2	-275,7	-0,9	-12,0	50,3	3,3	-212,8	**873,3**	357,9	-0,3	0,0	**357,6**	**1.348,2**		20,1	67,2		161,6	**1.597,1**
Primair verbruik	**7,2**	**105,9**	**4,2**	**117,2**	**1.508,6**	**0,5**	**12,1**	**-170,8**	**-29,2**	**-275,7**	**-0,9**	**-12,0**	**50,3**	**3,3**	**-212,8**	**873,3**	**357,9**	**-0,3**	**0,0**	**357,6**	**1.348,2**	**89,9**	**62,7**	**78,5**	**10,6**	**161,6**	**1.751,6**
Internationale bunkers	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**42,5**	**25,7**	**0,0**	**204,3**	**0,0**	**0,0**	**0,0**	**272,6**					**272,6**						**272,6**
scheepvaart				**0,0**						25,7		204,3				**230,0**				**0,0**	**230,0**						**230,0**
luchtvaart				**0,0**					42,5							**42,5**				**0,0**	**42,5**						**42,5**
Bruto consumptie	**7,2**	**105,9**	**4,2**	**117,2**	**1.508,6**	**0,5**	**12,1**	**-170,8**	**-71,7**	**-301,4**	**-0,9**	**-216,3**	**50,3**	**3,3**	**-212,8**	**600,8**	**357,9**	**-0,3**	**0,0**	**357,6**	**1.075,7**	**89,9**	**62,7**	**78,5**	**10,6**	**161,6**	**1.479,1**
Transformatie input	**0,0**	**66,0**	**0,0**	**66,0**	**1.508,6**	**0,5**	**0,0**	**0,0**	**0,0**	**0,1**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**1.509,2**	**78,4**	**0,0**	**18,4**	**96,8**	**1.672,0**	**11,0**	**23,8**	**0,0**	**0,0**	**161,6**	**1.868,4**
Elektriciteit en warmte	0,0	19,8	0,0	**19,8**	0,0	0,5	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	**0,6**	78,4	0,0	18,4	**96,8**	**117,2**	11,0	23,8	0,0		161,6	**313,7**
* Elektriciteit	0,0	19,8	0,0	**19,8**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	**0,1**	31,6	0,0	18,4	**50,1**	**69,9**	9,4	22,3	0,0	0,0	161,6	**263,3**
Thermische centrales	0,0	19,8	0,0	**19,8**	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	**0,1**	31,6	0,0	18,4	**50,1**	**69,9**	9,4	22,3				**101,6**
Kerncentrales				**0,0**																**0,0**	**0,0**					161,6	**161,6**
* WKK		0,0		**0,0**	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,5**	46,6			**46,6**	**47,2**	1,4	1,3				**49,9**
* 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**	0,2		0,0	**0,2**	**0,2**	0,2	0,2				**0,5**
Raffinaderijen				**0,0**	1.508,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**1.508,6**				**0,0**	**1.508,6**						**1.508,6**
Andere transformatie	0,0	46,2	0,0	**46,2**	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**	**46,2**	0,0		0,0	0,0	0,0	**46,2**
Cokesfabrieken		46,2		**46,2**												**0,0**					**46,2**						**46,2**
Andere				**0,0**												**0,0**					**0,0**						**0,0**
Transformatie output	**1,8**	**0,0**	**34,1**	**35,9**	**0,0**	**40,9**	**32,4**	**200,2**	**71,7**	**571,1**	**0,9**	**221,4**	**112,9**	**10,3**	**229,3**	**1.491,3**	**0,0**	**10,3**	**0,0**	**10,3**	**1.537,4**	**0,0**	**0,0**	**112,3**	**23,6**	**0,0**	**1.673,4**
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		112,3	23,6		**135,9**
* 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		93,0	2,3		**95,2**
Thermische centrales				**0,0**												**0,0**				**0,0**	**0,0**			39,6	2,3		**41,9**
Kerncentrales				**0,0**												**0,0**				**0,0**	**0,0**			53,3			**53,3**
* WKK				**0,0**												**0,0**				**0,0**	**0,0**			19,4	20,9		**40,3**
* Warmte				**0,0**												**0,0**				**0,0**	**0,0**				0,4		**0,4**
Raffinaderijen				**0,0**	0,0	40,9	32,4	200,2	71,7	571,1	0,9	221,4	112,9	10,3	229,3	**1.491,3**				**0,0**	**1.491,3**						**1.491,3**
Andere transformatie	1,8	0,0	34,1	**35,9**	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	10,3	0,0	**10,3**	**46,2**						**46,2**
Cokesfabrieken	1,8		34,1	**35,9**												**0,0**		10,3		**10,3**	**46,2**						**46,2**
Andere				**0,0**												**0,0**				**0,0**	**0,0**						**0,0**
																											0,0
Eigenverbruik transformatiesector	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**40,9**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**1,6**	**0,0**	**12,8**	**0,0**	**55,3**	**18,2**	**4,0**	**0,0**	**22,2**	**77,5**	**0,4**	**0,0**	**6,1**	**4,2**	**0,0**	**88,3**
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	4,9	0,0		**4,9**
* Elektriciteit	0,0	0,0	0,0	**0,0**												**0,0**				**0,0**	**0,0**	0,0	0,0	4,4	0,0		**4,4**
Thermische centrales				**0,0**												**0,0**				**0,0**	**0,0**			1,2			**1,2**
Kerncentrales				**0,0**												**0,0**				**0,0**	**0,0**			3,2			**3,2**
* WKK				**0,0**												**0,0**				**0,0**	**0,0**			0,4	0,0		**0,5**
* Warmte				**0,0**												**0,0**				**0,0**	**0,0**						**0,0**
Raffinaderijen				**0,0**	0,0	40,9	0,0	0,0	0,0	0,0	0,0	1,6	0,0	12,8	0,0	**55,3**	18,2	0,0	0,0	**18,2**	**73,5**	0,4	0,0	1,0	4,2		**79,2**
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**		4,0		**4,0**	**4,0**			0,2			**4,2**
Andere				**0,0**												**0,0**				**0,0**	**0,0**						**0,0**
																											0,0
Verliezen elektriciteitsnet				**0,0**												**0,0**				**0,0**	**0,0**			9,2			**9,2**
																0,0											

Beschikbaar voor finale consumptie	9,0	39,9	38,3	87,2	0,0	0,0	44,5	29,4	0,0	269,6	0,0	3,5	163,2	0,8	16,5	527,6	261,3	6,0	-18,4	248,9	863,6	78,5	38,9	175,6	30,0	0,0	1.186,6
Statistisch verschil in Joule	0,0	0,0	0,0	-14,2	0,0	0,0	0,0	7,1	0,0	0,0	0,0	4,0	0,0	-0,4	3,6	-113,7	0,0	0,0	0,0	0,0	-113,7	14,2	0,0	0,0	0,0	0,0	0,0
Finaal verbruik	9,0	39,9	38,3	87,2	0,0	0,0	44,5	29,4	0,0	269,6	0,0	3,5	163,2	0,8	16,5	527,6	261,3	6,0	-18,4	248,9	863,6	78,5	38,9	175,6	30,0	0,0	1.186,6
Niet energetisch finaal verbruik	9,0	0,0	0,0	9,0	0,0	0,0	39,6	0,0	0,0	0,0	0,0	0,5	163,2	0,8	16,5	220,6	30,0	0,0	0,0	30,0	259,6	0,0	0,0	0,0	0,0	0,0	259,6
* Chemie	9,0	0,0	0,0	9,0	0,0	0,0	39,6	0,0	0,0	0,0	0,0	0,5	163,2	0,8	0,0	204,2	30,0			30,0	243,2						243,2
* 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	16,4	16,4	0,0			0,0	16,4						16,4
Energetisch finaal verbruik	0,0	39,9	38,3	78,2	0,0	0,0	5,0	29,4	0,0	269,6	0,0	3,0	0,0	0,0	0,0	306,9	231,3	6,0	-18,4	218,9	604,0	78,5	38,9	175,6	30,0	0,0	926,9
*** Industrie**	0,0	37,7	38,3	76,0	0,0	0,0	2,5	0,2	0,0	11,0	0,0	2,3	0,0	0,0	0,0	16,0	99,3	6,0	-18,4	86,9	179,0	76,9	9,7	92,2	24,3		382,1
IJzer en staal	0,0	35,2	37,5	72,7	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,1	7,0	6,0	-18,4	-5,4	67,4	0,1	0,0	8,0	0,0		75,4
Non-ferro	0,0	0,0	0,7	0,7	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,3	0,0	0,0	0,0	0,5	4,6	0,0	0,0	4,6	5,7	0,1	0,0	6,3	0,0		12,2
Chemie	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,2	0,0	0,9	0,0	0,0	0,0	1,2	37,9	0,0	0,0	37,9	39,1	74,3	0,2	33,4	0,0		147,0
Voeding, dranken en tabak	0,0	1,0	0,0	1,0	0,0	0,0	0,0	0,0	0,0	2,7	0,0	0,1	0,0	0,0	0,0	2,8	22,3	0,0	0,0	22,3	26,1	0,0	0,8	14,3	0,0		41,1
Papier en uitgeverijen	0,0	1,1	0,0	1,1	0,0	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,3	3,3	0,0	0,0	3,3	4,6	1,0	6,0	4,6	0,0		16,2
Minerale niet-metaalprodukten	0,0	0,5	0,0	0,5	0,0	0,0	0,1	0,0	0,0	0,4	0,0	0,7	0,0	0,0	0,0	1,2	9,2	0,0	0,0	9,2	10,8	0,8	0,0	3,9	0,0		15,6
Metaalverwerkende nijverheid	0,0	0,0	0,1	0,1	0,0	0,0	0,1	0,0	0,0	0,8	0,0	0,0	0,0	0,0	0,0	0,9	4,9	0,0	0,0	4,9	5,9	0,0	0,1	7,5	0,0		13,5
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	0,1	0,0	0,0	0,0	0,2	3,3	0,0	0,0	3,3	3,4	0,0	0,0	3,5	0,0		7,0
Andere industrieën	0,0	0,0	0,0	0,0	0,0	0,0	2,3	0,2	0,0	6,3	0,0	0,2	0,0	0,0	0,0	9,0	6,9	0,0	0,0	6,9	15,9	0,7	2,7	10,7	0,0		30,0
Waarvan zelfproducenten industrie	0,0	2,1	0,0	2,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	17,1	0,0	0,0	17,1	19,1	1,8	6,2		9,3	0,0	36,4
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	0,0	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	1,0			1,0	1,0	0,0	0,0		1,3		2,2
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	9,1			9,1	9,1	0,7	0,0		8,0		17,9
Voeding, drank en tabak		1,0		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	5,1			5,1	6,1	0,0	0,3		0,0		6,4
Papier en uitgeverijen		1,1		1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,5			1,5	2,6	1,1	5,9		0,0		9,5
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	0,1			0,1	0,1	0,0	0,0		0,0		0,1
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	0,1			0,1	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	0,1			0,1	0,1	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	0,2			0,2	0,2	0,0	0,0		0,0		0,2
***Residentiële en gelijkgestelde sectoren**	0,0	2,2	0,0	2,2	0,0	0,0	1,9	0,7	0,0	79,9	0,0	0,6	0,0	0,0	0,0	83,1	130,1	0,0	0,0	130,1	215,4	1,6	19,4	80,9	5,7	0,0	322,9
Huishoudelijke sector, handel, administratie, …	0,0	1,8	0,0	1,8		0,0	1,8	0,6	0,0	71,8	0,0	0,3	0,0	0,0	0,0	74,6	116,5	0,0	0,0	116,5	192,9	1,6	16,1	82,5		0,0	293,1
Tertiaire sector, handel en administratie				0,0			0,4	0,0		6,0		0,3				6,7	39,2			39,2	45,9	1,6	5,1	42,7			95,3
waarvan zelfproducenten	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	0,4			0,4	0,5	1,6	5,0				7,0
Huishoudens		1,8		1,8			1,5	0,6		65,8						67,9	77,3			77,3	147,0		11,0	39,8			197,8
Land- en tuinbouw, zeevisserij, bosbouw, groenvoorziening		0,4		0,4			0,0	0,1		8,1		0,3				8,5	13,6			13,6	22,5		3,3	-1,7			24,2
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	13,6			13,6	13,6	0,0	3,1				16,7
*** Transport**	0,0	0,0	0,0	0,0	0,0	0,0	0,6	28,5	0,0	178,6	0,0	0,1	0,0	0,0	0,0	207,7	1,9	0,0	0,0	1,9	209,7	0,0	9,8	2,6	0,0	0,0	222,0
Wegvervoer							0,6	28,5		172,7	0,0	0,0	0,0	0,0		201,8	0,0			0,0	201,8		9,8	0,0			211,6
Spoorvervoer										0,8						0,8				0,0	0,8			2,4			3,2
Luchtvaart								0,0								0,0				0,0	0,0						0,0
Scheepvaart										5,1		0,1				5,1				0,0	5,1						5,1
Transport door pijpleidingen																0,0	0,9			1,9	1,9			0,1			2,0

Annex 9: Activity data on livestock numbers and crop production in Belgium

Tables 9.1a-c give the evolution (1990-2014) of the livestock number in the three regions.

Livestock number Flanders	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Cattle													
- slaughter calves	134863	168430	171502	164827	169463	165955	170912	168931	175951	172769	164730	162298	161654
- bovine < 1yr	424150	420511	342388	284837	276823	273276	269656	275816	274949	271535	270055	274312	273715
- bovine between 1 and 2 yr	372193	381427	353903	278343	271863	258381	262270	257185	264993	260882	257873	259519	261442
- bovine > 2yr	220321	198081	141328	148253	150456	190774	195935	201295	199894	191094	183025	182826	176463
- Brood cows	111451	182065	186468	175192	175413	186613	174190	174526	173167	170576	163607	158132	159979
- Dairy cows	452794	380599	314740	264304	255260	254743	252093	249683	249681	247208	250570	261748	267056
Swine	6395797	6990977	6577861	5795500	5831684	5954633	5997807	6064480	6234198	6231735	6269146	6305798	6101207
- piglet < 20kg	1767168	1977494	1637064	1498616	1511821	1542435	1549599	1578502	1629182	1631599	1653082	1657787	1624594
- fattening pigs > 20kg	3900149	4273720	4355490	3810790	3842016	3942952	3996538	4037426	4160040	4167003	4190962	4232708	4076958
- breeding males	20079	17621	10867	7670	7233	6951	6486	6407	6071	5863	5760	5626	5007
- sows	708401	722142	574440	478424	470614	462295	445184	442145	438905	427270	419342	409677	394648
Poultry	25998165	31773947	32886836	26871980	25578569	25172565	24679359	25688551	27344835	27601433	28486060	29773783	30862883
- laying hens	9394876	11850384	12407523	10039716	9521798	9081696	8733706	8901947	9024029	8661047	8948209	9245975	9575273
- broilers	16047766	19523418	20205510	16667926	15875486	15913206	15756975	16600216	18131863	18716884	19308780	20271663	21039240
- other	555523	486447	400145	164338	181285	177663	188678	186388	188943	223502	229071	256145	248370
Sheep	122649	100102	66096	62236	62851	61464	61138	59976	57096	55471	57021	58068	60142
Goats	4981	4291	5529	13796	15661	15988	19108	21895	20978	22737	25013	28397	30606
Horses	13816	15209	30960	31948	32715	34242	36100	37816	38215	38071	39715	40859	39084
Mules and asses	189	259	4878	6539	6815	7200	7594	8210	8778	8792	8921	8966	8645
Other (rabbits, furred animals)	23745	31293	76187	54884	51002	51668	62975	70033	64500	61189	63799	66091	72200

Table 9.1a: Evolution of the livestock numbers in Flanders (1990-2014).

Livestock number Wallonia	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Cattle													
Bovine under 6 months	278.816	288.631	264.798	212.796	206.422	204.586	188.283	195.810	196.679	190.650	175.574	170.305	171.977
Male bovine between 6 months and 1 year	56.609	59.162	51.859	46.937	45.730	47.056	46.715	46.589	43.553	42.937	39.008	47.369	46.258
Female bovine between 6 months and 1 year	105.092	105.913	106.243	91.963	92.397	92.530	94.715	95.000	91.075	89.524	80.575	98.297	97.800
Fattening male bovine more than 1 year	91.097	92.425	83.186	64.872	60.733	62.458	62.015	58.114	58.936	57.647	56.230	55.494	56.666
Reproductive male bovine more than 1 year	28.980	29.682	24.161	18.465	17.421	17.962	18.083	17.991	17.218	17.492	19.151	17.382	17.326
Young female bovine more than 1 year	383.455	378.790	360.276	353.360	351.653	352.121	352.882	342.541	342.343	333.045	319.211	330.408	328.338
Dairy cattle	385.775	303.780	266.657	230.374	223.538	219.218	217.948	218.619	214.695	208.859	205.757	183.002	184.867
Brood cow	202.670	296.142	325.880	329.265	331.920	334.521	329.196	329.061	324.029	317.664	318.806	309.466	311.937
Swine													
Piglet under 20 kg	89.065	72.884	59.965	54.022	54.043	52.196	57.335	52.610	49.539	43.306	62.210	46.524	45.185
Piglet between 20 and 50 kg	74.878	68.301	94.768	87.948	102.382	93.836	85.428	100.769	97.914	86.844	89.472	0	0
Fattening pigs more than 50 kg	98.922	97.884	131.769	198.880	190.051	190.715	214.166	214.020	226.749	223.780	236.775	359.272	354.291
Swine	28.302	23.982	23.723	19.116	18.989	15.866	16.150	15.595	13.972	12.857	14.030	110	0
Fully grown male and female pigs	13.444	14.463	7.208	5.727	5.264	4.966	4.460	4.636	4.254	3.484	3.597	16.221	15.652
Others													
Lambs	9.125	8.121	10.721	8.307	8.205	7.749	6.759	6.441	7.449	6.391	6.800	7.331	7.493
Sheep under 1 year	19.106	14.284	12.078	16.373	16.213	16.144	13.268	14.516	12.637	11.419	15.356	13.952	14.261
Sheep more than 1 year	41.171	35.029	34.749	31.712	32.189	32.233	29.085	28.656	27.508	25.306	27.170	28.416	29.045
Goat under 1 year	1.010	1.479	2.462	2.720	3.777	3.350	2.617	2.484	2.616	3.051	2.770	3.009	3.076
Goat more than 1 year	2.705	3.102	5.233	7.495	7.622	8.222	8.127	7.853	7.271	6.882	7.035	7.534	7.701
Horses	7.307	8.719	10.456	11.659	12.780	13.086	13.487	13.756	14.335	12.892	14.473	19.031	19.031
Poultry													
Broilers	609.870	964.198	2.864.647	3.439.718	3.114.146	3.567.309	3.596.008	3.678.693	3.588.891	3.357.731	3.724.845	4.437.376	4.596.185
Laying hens	390.171	310.565	778.920	1.444.120	1.367.768	1.431.226	1.491.276	1.400.751	1.425.057	1.234.154	1.365.733	2.101.691	2.386.901
Other poultry	168.043	332.583	329.714	280.304	239.136	221.639	211.698	218.361	234.959	221.995	376.654	58.084	21.446

Table 9.1b: Evolution of the livestock numbers in Wallonia (1990-2014).

Livestock number Brussels	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Cattle	514	595	430	313	339	286	246	218	238	266	266	266	266
Swine	14	1	12	2	2	0	3	2	5	3	3	3	3
Poultry	527	97	327	776	780	736	681	695	366	652	652	652	652
Sheep	82	34	299	16	10	38	25	35	15	25	25	25	25
Goats	4	0	2	10	20	18	23	12	15	18	18	18	18
Horses	18	16	24	61	73	69	32	26	29	46	46	46	46

Table 9.1c: Evolution of the livestock numbers in Brussels (1990-2014).

Tables 9.2a-c give the evolution (1990-2014) of the crop production in the three regions.

Crop production Flanders	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton	Ton
Clover	568	371	513	2424	3324	4371	4291	3398	2646	2408	27	21	
Alfalfa	2463	4219	1323	8346	11446	15050	14781	11726	9110	8291	93	71	
Dry beans	1246	704	572	400	400	258	244	384	591	789	1039	IE	3
Horse beans	277	101	232	227	170	368	221	175	322	276	361	1118	1269
Peas	18.681	19119	24109	19613	21417	17937	17796	17465	14861	15863	14710	18513	22551
Green beans	8266	15196	30737	42732	44534	41465	35878	32012	40643	36197	9731	13982	12795
Rape	6909	6909	3150	552	394	435	543	515	720	697	697	IE	IE
Winter wheat	399574	465780	510293	548112	530236	496449	576499	596047	603211	425680	561267	470794	510417
Spring wheat	5836	9978	11241	7842	8770	5215	6503	9363	7189	28308	2930	25786	10925
Rye	10241	6417	3741	1598	1910	1272	1130	1102	931	1024	1093	1512	820
Spelt	251	344	817	1491	1810	2096	2905	2338	2780	2404	3480	3367	4587
Brewing barley	778	469	985	748	881	830	1034	1172	1511	546	223	581	202
Winter barley	145203	63453	63969	63547	79393	81256	84182	91115	84524	74454	87758	92680	90030
Spring barley	8041	61036	8803	7749	7296	5650	7162	8151	4290	8780	2678	8610	8495
Oat	11701	7184	7379	5722	4599	3788	4757	4815	4404	3491	3220	3409	2616
Chicory	21194	77907	141951	117107	64622	61695	75318	87431	69325	62162	45719	50956	54181
Flax	27029	27346	34229	33459	33383	25204	20287	24838	18924	31032	49588	51166	42186
Winter rape	154	853	334	471	2943	3141	1435	1699	2394	2004	2563	IE	2221
Grain mais	41557	155578	329249	523830	473363	571667	704217	669233	605825	670729	577409	655883	574888
Silage mais	2866381	3408346	4141483	4531040	3934497	4582095	4953102	4948405	4803379	4619367	4052362	4945088	5189972
Other mais	91752	93240	73176	58246	46803	48907	54321	56942	60600	60413	59019	IE	IE
Sugarbeet	593687	522087	586210	579648	545099	551274	402635	431526	402625	473373	410114	430041	435735
Fodderbeet	125824	78516	80833	44779	39879	39971	48009	47390	43617	70169	32328	40577	41406
Seed potatoes	3235	3179	3763	6354	7401	7803	6973	8428	10274	9299	7789	8921	9192
Early potatoes	47469	70039	91715	75542	77360	102612	85437	95064	91650	112959	65922	70574	76365
Bintje (variety of potato)	192442	219328	250851	213788	190654	222646	192611	191838	193495	230841	IE	IE	IE
Other potatoes	32171	34307	73335	79762	83324	102356	99834	122291	134721	170736	268698	353922	416594

Table 9.2a: Evolution of the crop production (ton of dry matter, harvested products) in Flanders (1990-2014).

Crop production in Wallonia (ton dm)	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Grains	86 710	129 761	106 749	118 632	109 209	113 794	114 998	102 478	89 338	88 305	104 231	117 941	131 798
Beans & pulses	0	0	5 419	4 895	3 890	3 490	83 123	90 523	84 006	96 905	10 458	11 617	13 074
Tubers	103 884	164 118	222 839	236 276	211 641	266 351	262 770	308 254	326 285	375 167	274 829	319 037	391 592
Root crops, other	3 943 080	3 787 327	4 458 833	4 385 406	3 786 960	3 877 864	3 254 256	3 581 845	3 050 777	3 630 601	3 230 784	3 172 077	3 660 658
N-fixing forages	28 047	37 387	28 939	34 587	39 372	45 467	25 558	34 371	38 965	40 611	63 112	70 454	72 751
Non-N-fixing forages	1 793 855	1 995 024	2 130 694	2 255 392	1 847 099	2 310 802	2 588 211	2 642 767	2 547 029	2 512 376	2 285 382	2 145 618	2 519 439
Perennial grasses	0	0	0	0	0	0	191 946	179 092	159 289	173 088	237 864	253 837	249 677
Maize	6 153	30 898	16 674	26 308	27 366	37 638	55 706	52 964	53 492	73 788	60 183	71 631	52 933
Wheat	711 895	800 680	915 732	973 971	927 315	892 223	1 066 470	1 101 432	1 063 139	982 832	1 000 595	1 067 458	1 085 303
Barley	319 974	222 189	222 670	196 205	239 296	245 398	286 441	301 836	242 585	214 432	231 883	244 884	256 768

Table 9.2b: Evolution of the crop production (ton of dry matter, harvested products) in Wallonia (1990-2014).

Crop production Brussels	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton
Grains	33.5	10.0	181.6	147.2	42.2	74.6	65.3	59.8	60.0	60.0	64.4	62.7	62.7
Tubers	80.2	8.2	16.4	45.1	53.6	49.0	56.0	63.9	43.0	46.7	42.8	44.4	44.4
Root crops, other	2625.5	2442.5	2318.9	1095.3	1599.9	1833.3	144.2	160.7	148.0	171.7	158.5	157.2	157.2
N-fixing forages	0.0	25.7	0.0	2.5	6.7	1.0	3.2	3.9	3.8	3.9	5.2	5.3	5.3
Non-N-fixing forages	704.0	877.5	1087.8	691.2	431.1	523.5	601.4	603.0	396.7	399.6	375.8	357.9	357.9
Perennial grasses	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Maize	18.7	154.8	78.6	161.3	119.3	184.3	313.1	95.4	179.1	179.2	165.5	157.8	157.8
Wheat	1729.2	1163.8	1426.9	656.7	690.6	745.0	822.1	763.3	786.4	756.7	754.0	808.7	808.7
Barley	508.1	176.2	377.6	75.0	99.6	66.9	66.7	78.6	70.7	65.7	68.5	70.4	70.4

Table 9.2c: Evolution of the crop production (ton of dry matter, harvested products) in Brussels (1990-2014).

Tables 9.3a-c give the evolution (1990-2014) of GE(only for cattle), VS, IEF for cattle and swine in the three regions. These factors are used to calculate the CH_4 emission from manure management.

	1990	1995	2000	2005	2010	2011	2012	2013	2014
Slaughter calves									
GE	70	70	70	70	72	72	72	72	72
VS	0.49	0.49	0.49	0.49	0.50	0.50	0.50	0.50	0.50
IEF	4.07	4.07	4.07	4.07	4.22	4.22	4.22	4.22	4.22
Bovine under 1 yr									
GE	80	80	80	80	80	80	80	80	80
VS	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
IEF	3.93	3.93	3.29	2.74	2.01	1.37	1.37	1.37	1.37
Bovine between 1 and 2 yr									
GE	120	120	120	120	120	120	120	120	120
VS	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
IEF	4.96	4.96	6.34	7.29	8.39	9.36	9.36	9.36	9.36
Bovine more than 2 yr									
GE	121	121	121	121	121	121	121	121	121
VS	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
IEF	3.52	3.52	3.64	3.77	3.90	3.90	3.90	3.90	3.90
Dairy cattle									
GE	277	292	314	338	366	369	368	367	368
VS	3.95	4.17	4.47	4.82	5.22	5.26	5.24	5.23	5.24
IEF	15.87	16.72	21.25	26.46	32.53	36.71	36.59	36.52	36.59
Brood cattle									
GE	233	233	234	234	234	234	234	234	233
VS	3.37	3.38	3.38	3.38	3.38	3.38	3.38	3.38	3.38
IEF	1.56	1.56	1.83	2.10	3.93	2.63	2.63	2.63	2.63
Piglets from 7 to 20kg									
VS	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
IEF	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61
Fattening pigs from 20 to 50kg									
VS	0.16	0.16	IE	IE	IE	IE	IE	IE	IE
IEF	3.22	3.22	IE	IE	IE	IE	IE	IE	IE
Fattening pigs from 50 to 80kg									
VS	0.23	0.23	IE	IE	IE	IE	IE	IE	IE
IEF	4.82	4.82	IE	IE	IE	IE	IE	IE	IE
Fattening pigs from 80 to 110kg									
VS	0.31	0.31	IE	IE	IE	IE	IE	IE	IE
IEF	6.43	6.43	IE	IE	IE	IE	IE	IE	IE
Fattening pigs from 20 to 110kg									
VS	IE	IE	0.23	0.23	0.23	0.23	0.23	0.23	0.23
IEF	IE	IE	4.82	4.82	4.82	4.82	4.82	4.82	4.82
Fattening pigs more than 110kg									

VS	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
IEF	6.43	6.43	6.43	6.43	6.43	6.37	6.37	6.37	6.37
Boars									
VS	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
IEF	5.01	5.01	5.01	5.01	5.01	4.64	4.64	4.64	4.64
Sows including piglets less than 110kg									
VS	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
IEF	12.46	12.46	12.46	12.46	12.46	12.34	12.34	12.34	12.34

Table 9.3a: Evolution of the GE, VS and IEF for cattle and swine in Flanders (1990-2014).

	1990	1995	2000	2005	2010	2011	2012	2013	2014
Bovines under 6 months									
GE	51	51	51	51	51	51	51	51	51
VS	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
IEF	0.87	0.87	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Bovines between 6 months and 1 year: male									
GE	69	69	69	69	69	69	69	69	69
VS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
IEF	0.87	0.87	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Bovines between 6 months and 1 year: female									
GE	68	68	68	68	68	68	68	68	68
VS	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
IEF	1.09	1.09	1.12	1.12	1.12	1.12	1.12	1.12	1.12
Bovines more than 1 year for fattening: male									
GE	136	136	136	136	136	136	136	136	136
VS	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
IEF	2.16	2.16	2.22	2.22	2.22	2.22	2.22	2.22	2.22
Bovines more than 1 year for reproduction: male									
GE	172	172	172	172	172	172	172	172	172
VS	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48	2.48
IEF	3.66	3.66	3.74	3.74	3.74	3.74	3.74	3.74	3.74
Bovines more than 1 year: female									
GE	145	145	145	145	145	145	145	145	145
VS	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
IEF	3.08	3.08	3.15	3.15	3.15	3.15	3.15	3.15	3.15
Brood cows									
GE	232	232	232	232	232	232	232	232	232
VS	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35
IEF	3.11	3.11	3.39	3.39	3.39	3.39	3.39	3.39	3.39
Dairy cows									
GE	282	291	298	316	328	334	329	328	337
VS	4.07	4.21	4.32	4.57	4.75	4.83	4.76	4.74	4.87
IEF	12.12	12.53	14.56	15.43	16.01	16.29	16.06	15.98	16.44
Piglet under 20 kg									
VS	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
IEF	4.51	4.51	4.29	4.29	4.29	4.29	4.29	4.29	4.29
Piglet between 20 and 50 kg									
VS	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
IEF	4.51	4.51	4.29	4.29	4.29	4.29	4.29	4.29	4.29
Fattening pigs more than 50 kg									
VS	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
IEF	4.51	4.51	4.29	4.29	4.29	4.29	4.29	4.29	4.29
Swine									
VS	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
IEF	11.45	11.45	13.67	13.67	13.67	13.67	13.67	13.67	13.67
Fully grown male and female pigs									
VS	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
IEF	13.72	13.72	14.16	14.16	14.16	14.16	14.16	14.16	14.16

Table 9.3b & 9.3c: Evolution of the GE, VS and IEF for cattle and swine in Wallonia and Brussels (1990-2014).

Annex 10: Comparison between data reported under the ETS-Directive and CRF-tables (see also BE_Annex V_MMR-IRArticle10_Template_v4_EEA final.xlsx) for 2014

Implementing Regulation Article 10: Reporting on consistency of reported emissions with data from the emissions trading system
1.Member States shall report the information referred to in Article 7(1)(k) of Regulation (EU) No 525/2013 in accordance with the tabular format set out in Annex V to this Regulation.
2.Member States shall report textual information on the results of the checks performed pursuant to Article 7(1)(l) of Regulation (EU) No 525/2013.

Allocation of verified emissions reported by installations and operators under Directive 2003/87/EC to source categories of the national greenhouse gas inventory	
Member State:	BELGIUM
Reporting year:	2016
Basis for data: verified ETS emissions and greenhouse gas emissions as reported in inventory submission for the year X-2	

Total emissions (CO2 -eq)

Category[1]	Gas	Greenhouse gas inventory emissions [kt CO2eq][3]	Verified emissions under Directive 2003/87/EC [kt CO2eq][3]	Ratio in % (Verified emissions/ inventory emissions)[3]	Comment [2]
Greenhouse gas emissions (total emissions without LULUCF for GHG inventory and without emissions from 1A3a Civil aviation, total emissions from installations under Article 3h of Directive 2003/87/EC)	Total GHG	113.839,0	43.853,1	38,5	
CO2 emissions (total CO2 emissions without LULUCF for GHG inventory and without emissions from 1A3a Civil aviation, total emissions from installations under Article 3h of Directive 2003/87/EC)	Total GHG	96.298,1	43.395,8	45,1	

CO2 emissions

Category[1]		Greenhouse gas inventory emissions [kt CO2eq][3]	Verified emissions under Directive 2003/87/EC [kt CO2eq][3]	Ratio in % (Verified emissions/ inventory emissions)[3]	Comment [2]
1.A Fuel combustion activities, total	CO2	80.569,3	NA	NA	
1.A Fuel combustion activities, stationary combustion [4]	CO2	54.959,7	28.765,4	52,3	
1.A.1 Energy industries	CO2	20.328,2	18.317,1	90,1	
1.A.1.a Public electricity and heat production	CO2	15.414,2	13.327,2	86,5	
1.A.1.b Petroleum refining	CO2	4.731,5	4.828,7	102,1	ETS: total emissions refineries including flaring which is included in CRF

					1B2
1.A.1.c Manufacture of solid fuels and other energy industries	CO2	182,4	161,2	88,4	Walloina: the emissions from the consumption of coke gas are in 1A2a for ETS
Iron and steel total (1.A.2, 1.B, 2.C.1) [5]	CO2	5.064,5	5.001,4	98,8	
1.A.2. Manufacturing industries and construction	CO2	13.147,0	10.334,3	78,6	
1.A.2.a Iron and steel	CO2	1.088,3	1.844,0	169,4	See NIR and "Iron and steel total"
1.A.2.b Non-ferrous metals	CO2	391,8	319,4	81,5	
1.A.2.c Chemicals	CO2	3.116,9	2.520,7	80,9	
1.A.2.d Pulp, paper and print	CO2	601,6	478,3	79,5	Wallonia: The CO_2 emissions from the production of lime in a paper pulp plant are allocated in CRF 1A2f
1.A.2.e Food processing, beverages and tobacco	CO2	2.208,1	1.318,4	59,7	
1.A.2.f Non-metallic minerals	CO2	3.658,2	3.425,4	93,6	
1.A.2.g Other	CO2	2.082,1	428,1	20,6	
1.A.3. Transport	CO2	24.943,3			
1.A.3.e Other transportation (pipeline transport)	CO2	125,4	44,2	35,3	
1.A.4 Other sectors	CO2	22.116,8	69,8	0,3	
1.A.4.a Commercial / Institutional	CO2	4.884,1	60,0	1,2	
1.A.4.c Agriculture/ Forestry / Fisheries	CO2	1.731,2	9,8	0,6	
1.B Fugitive emissions from Fuels	CO2	97,6	NO		
1.C CO2 Transport and storage	CO2	NO	NO		
1.C.1 Transport of CO2	CO2	NO	NO		
1.C.2 Injection and storage	CO2	NO	NO		
1.C:3 Other 2.A Mineral products	CO2	NO	NO		
2.A Mineral products	CO2	4.615,7	4.604,9	99,8	
2.A.1 Cement Production	CO2	2.643,0	2.643,0	100,0	
2.A.2. Lime production	CO2	1.641,6	1.641,6	100,0	
2.A.3. Glass production	CO2	157,3	146,6	93,2	
2.A.4. Other process uses of carbonates	CO2	173,8	173,8	100,0	
2.B Chemical industry	CO2	6.691,8	6.690,8	100,0	
2.B.1. Ammonia production	CO2	1.052,3	1.052,3	100,0	
2.B.3. Adipic acid production (CO2)	CO2	NO	NO		
2.B.4. Caprolactam, glyoxal and glyoxylic acid production	CO2	NA,NO	NO		
2.B.5. Carbide production	CO2	NO	NO		
2.B.6 Titanium dioxide production	CO2	NO	NO		
2.B.7 Soda ash production	CO2	IE (2B10 other)			
2.B.8 Petrochemical and carbon black production	CO2	3.844,9	3.834,9	99,7	

2.B.10 Other	CO_2	1.794,6	1.803,7	100,5	Flanders: difference in emissions (9,042 kton CO_2) is from the glassoven which is allocated to 2A3
2.C Metal production	CO_2	3.881,8	3.084,2	79,5	
2.C.1. Iron and steel production	CO_2	3.793,7	2.996,2	79,0	
2.C.2 Ferroalloys production	CO_2	NO	NO		
2.C.3 Aluminium production	CO_2	NO	NO		
2.C.4 Magnesium production	CO_2	NO	NO		
2.C.5 Lead production	CO_2	IE (2C7)			
2.C.6 Zinc production	CO_2	IE (2C7)			
2.C.7 Other metal production	CO_2	88,1	88,1	100,0	
2.H Other	CO_2	26,0	26,0	100,0	
5C. waste incineration (chemical industry)	CO_2	211,9	224,5	105,9	Wallonia: a part of the off gas (other fuels) is burnt in boilers (1A2c)

N_2O emissions

Category[1]	Gas	Greenhouse gas inventory emissions [kt CO_2eq][3]	Verified emissions under Directive 2003/87/EC [kt CO_2eq][3]	Ratio in % (Verified emissions/ inventory emissions)[3]	Comment [2]
2.B.2. Nitric acid production	N_2O	473,2	457,366	96,7	
2.B.3. Adipic acid production	N_2O	NO	NO		
2.B.4. Caprolactam, glyoxal and glyoxylic acid production	N_2O	676,6	NO		

PFC emissions

Category[1]	Gas	Greenhouse gas inventory emissions [kt CO_2eq][3]	Verified emissions under Directive 2003/87/EC [kt CO_2eq][3]	Ratio in % (Verified emissions/ inventory emissions)[3]	Comment [2]
2.C.3 Aluminium production	PFC	NO	NO		

[1] The allocation of verified emissions to disaggregated inventory categories at four digit level must be reported where such allocation of verified emissions is possible and emissions occur. The following notation keys should be used: NO = not occurring IE = included elsewhere C = confidential negligible = small amount of verified emissions may occur in respective CRF category, but amount is < 5% of the category

[2] The column comment should be used to give a brief summary of the checks performed and if a Member State wants to provide additional explanations with regard to the allocation reported. Member States should add a short explanation when using IE or other notation keys to ensure transparency.

[3] Data to be reported up to one decimal point for kt and % values

[4] 1.A Fuel combustion, stationary combustion should include the sum total of the relevant rows below for 1.A (without double counting) plus the addition of other stationary combustion emissions not explicitly included in any of the rows below.

[5] To be filled on the basis of combined CRF categories pertaining to 'Iron and Steel' , to be determined individually by each Member State; e.g. (1.A.2.a+ 2.C.1 + 1.A.1.c and other relevant CRF categories that include emissions from iron and steel (e.g. 1A1a, 1B1))