BELGIUM'S GREENHOUSE GAS INVENTORY (1990-2012)

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

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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)

Belgium's quantified emission limitation is 92 per cent as included in Annex B to the Kyoto Protocol. But as Belgium is part of the European Union, whose member States will meet their reduction commitment jointly in accordance with Article 4 of the Kyoto Protocol, the actual Belgium's quantified emission limitation is 92.5 per cent. Belgium needs to achieve this reduction during the first commitment period of the Kyoto Protocol which runs from 2008 to 2012.

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 April 2014. It contains GHG emissions estimates for the period 1990 to 2012, 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 UNFCCC reporting guidelines on annual inventories contained in document FCCC/CP/2002/8 and Decision 18/CP8 of the Conference of Parties.

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 six direct greenhouse gases under the Kyoto Protocol. These are as follows:

- Carbon dioxide;
- Methane;
- Nitrous oxide;
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs) and
- Sulphur hexafluoride (SF_6).

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 8 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 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.

There are also Annexes to provide 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.

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: Emissions of GHGs in terms of carbon dioxide equivalent emissions, 1990-2012 (Gg CO_2 Equivalent).

Table ES2.1	**Gg CO_2 Equivalent**											
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
CO_2 emissions including net CO_2 from LULUCF	118 141	120 825	118 984	118 075	122 548	123 638	127 869	121 958	128 271	122 766	124 511	124 303
CO_2 emissions excluding net CO_2 from LULUCF	118 989	121 447	119 909	118 912	123 401	124 324	128 354	122 723	128 966	123 448	125 152	125 136
CH_4 emissions including CH_4 from LULUCF	9 660	9 473	9 344	9 274	9 236	9 256	9 031	8 839	8 695	8 555	8 231	7 849
CH_4 emissions excluding CH_4 from LULUCF	9 659	9 472	9 343	9 273	9 236	9 256	9 008	8 839	8 695	8 555	8 231	7 849
N_2O emissions including N_2O from LULUCF	10 913	10 807	10 462	10 743	11 292	11 749	12 300	11 738	11 839	11 683	11 078	10 820
N_2O emissions excluding N_2O from LULUCF	10 900	10 790	10 442	10 717	11 264	11 721	12 036	11 700	11 795	11 638	11 030	10 768
HFCs	NA,NO	NA,NO	440	440	448	449	534	642	776	804	933	1 062
PFCs	1 753	1 678	1 830	1 759	2 113	2 335	2 217	1 211	669	348	361	223
SF_6	1 651	1 564	1 732	1 665	2 024	2 243	2 159	564	310	155	150	145
Total (including LULUCF)	**142 118**	**144 347**	**142 791**	**141 954**	**147 661**	**149 670**	**154 110**	**144 953**	**150 560**	**144 311**	**145 264**	**144 401**
Total (excluding LULUCF)	**142 952**	**144 951**	**143 695**	**142 766**	**148 485**	**150 327**	**154 308**	**145 679**	**151 211**	**144 947**	**145 857**	**145 183**

Table ES2.1	**Gg CO_2 Equivalent**											**% Changes**
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**1990-2012**
CO_2 emissions including net CO_2 from LULUCF	124 122	125 889	126 799	123 096	120 313	115 837	118 204	105 495	112 069	102 933	99 172	-16.1
CO_2 emissions excluding net CO_2 from LULUCF	125 459	127 276	128 072	124 344	121 537	117 069	119 453	106 827	113 429	104 271	100 659	-15.4
CH_4 emissions including CH_4 from LULUCF	7 487	7 070	7 026	6 848	6 789	6 787	6 657	6 581	6 661	6 472	6 392	-33.8
CH_4 emissions excluding CH_4 from LULUCF	7 487	7 070	7 026	6 848	6 789	6 787	6 657	6 581	6 661	6 466	6 392	-33.8
N_2O emissions including N_2O from LULUCF	10 344	9 279	9 487	9 228	8 285	7 653	7 664	7 759	8 423	7 201	7 098	-35.0
N_2O emissions excluding N_2O from LULUCF	10 286	9 218	9 424	9 162	8 215	7 577	7 582	7 671	8 329	7 037	6 991	-35.9
HFCs	1 281	1 438	1 475	1 460	1 562	1 744	1 839	1 916	1 999	2 076	2 140	100.0
PFCs	82	209	308	154	159	181	202	116	86	179	220	-87.4
SF_6	121	106	94	95	80	82	91	98	107	116	117	-92.9
Total (including LULUCF)	**143 438**	**143 990**	**145 187**	**140 882**	**137 187**	**132 284**	**134 657**	**121 964**	**129 345**	**118 978**	**115 139**	**-19.0**
Total (excluding LULUCF)	**144 718**	**145 316**	**146 398**	**142 063**	**138 342**	**133 440**	**135 823**	**123 209**	**130 611**	**120 146**	**116 520**	**-18.5**

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 86.4% in 2012 (excluding LULUCF). Emissions of N_2O account for the next largest share with 6.0% and emissions of CH_4 make up a further 5.5%. Emissions of all gases have decreased since 1990, contributing to an overall decrease of 18.5%.

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)'

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

Article 3.3		2008	2009	2010	2011	2012
Net CO_2 equivalent emissions/removals	Gg CO_2 equivalent	244.35	226.51	215.12	203.33	191.50

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.

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

Table ES3.1	Gg CO_2 Equivalent											
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy	112 294	115 081	113 580	112 630	115 822	116 338	121 095	115 026	121 169	115 323	116 914	117 428
2. Industrial Processes	15 768	15 094	15 367	15 460	18 007	19 264	18 893	16 423	15 933	15 587	15 696	14 949
3. Solvent and Other Product Use	204	202	201	200	196	193	192	191	189	188	186	186
4. Agriculture	11 439	11 307	11 228	11 344	11 348	11 534	11 306	11 265	11 291	11 335	10 674	10 555
5. Land Use, Land-Use Change and Forestry	-834	-604	-904	-812	-824	-657	-198	-726	-651	-636	-593	-782
6. Waste	3 246	3 266	3 318	3 132	3 112	2 998	2 821	2 774	2 630	2 514	2 387	2 064
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	**142 118**	**144 347**	**142 791**	**141 954**	**147 661**	**149 670**	**154 110**	**144 953**	**150 560**	**144 311**	**145 264**	**144 401**

Table ES3.1	Gg CO_2 Equivalent											% Changes
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	1990-2012
1. Energy	116 667	118 542	119 041	115 061	112 223	107 819	110 533	100 597	106 866	97 287	94 400	-15.9
2. Industrial Processes	15 375	14 793	15 373	15 335	14 555	13 968	13 911	11 270	12 284	11 697	11 173	-29.1
3. Solvent and Other Product Use	185	185	184	184	184	184	184	183	183	183	183	-10.5
4. Agriculture	10 328	9 849	9 806	9 595	9 469	9 539	9 396	9 506	9 584	9 439	9 257	-19.1
5. Land Use, Land-Use Change and Forestry	-1 280	-1 326	-1 210	-1 181	-1 154	-1 156	-1 166	-1 244	-1 266	-1 168	-1 381	65.5
6. Waste	2 162	1 948	1 993	1 888	1 912	1 931	1 800	1 652	1 694	1 540	1 508	-53.5
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.0
Total (including LULUCF)	**143 438**	**143 990**	**145 187**	**140 882**	**137 187**	**132 284**	**134 657**	**121 964**	**129 345**	**118 978**	**115 139**	**-19.0**

The largest contribution to greenhouse gas emissions arises from the energy sector. In 2012 this contributed 82% to the total emissions. 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 16%.

Industrial processes make up the second largest source of greenhouse gases in Belgium, contributing 9.7% to the national total in 2012. Emissions of all six direct greenhouse gases occur from this sector and have declined by 29%.

The third largest source of greenhouse gases is agriculture with 8%. Emissions from this sector arise for both CH_4 and N_2O. Since 1990, emissions from this sector have decreased by 19%, 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 2012. Emissions from this sector occur for CO_2, CH_4 and N_2O.

The remaining sources that contribute to direct greenhouse gas totals are waste and solvent (less than 0.2%). In 2012, waste contributed around 1.3 % to the national total. Emissions arise for CO_2, CH_4 and N_2O, with emissions occurring from waste incineration, solid waste disposal on land and wastewater handling. Emissions from this sector have steadily declined and in 2012 are 54% below 1990 levels.

Total net emissions (including LULUCF) have decreased by 19.0% since 1990. A more detailed analysis of the evolution of sectors (without LULUCF) is provided in Chapter 2.3 of NIR.

ES.3.2 KP-LULUCF Activities

ES.3.2 provides the time series of the Kyoto basket of emissions of the Belgian inventory. The tables show the emissions making up the base year and subsequent years, and also estimated emissions and removals from:

- **Article 3.3**, the net emissions or removals of Afforestation, Reforestation and Deforestation (ARD);

The Base Year is 1990 for CO_2, CH_4 and N_2O and is 1995 for F-gases.

The ‘Approved Base Year Emissions’ are calculated from the Inventory submitted on 23 July 2007 which has been used to calculate the Belgian’s Assigned Amount. These emissions were approved by the UNFCCC following the initial review under the Kyoto Protocol in 2007 (Belgium submitted a revised GHG inventory on 14 March 2007 which was used as the basis for the review by ERT. Belgium submitted a corrigendum to the initial report and officially resubmitted its GHG inventory on 23 July 2007 in response to questions raised by the ERT during the course of the in-country visit). This figure will be used to assess whether Belgium is in compliance with its commitment for the first commitment period of the Kyoto Protocol.

The 'Kyoto Protocol Total' row is the sum of 'Total' row and 'Article 3.3' row.

ES.3.3 Emissions trends and KP-commitment

Emissions in 2012 (with LULUCF article 3.3) are 19.9 % under approved base year emissions. Under the Kyoto Protocol and the EU ‘burden sharing’ agreement, Belgium is committed to reduce its GHG emissions by 7.5%. Belgium complies with its commitments for the five years of the commitment period despite the rise in emissions in 2010. For the first commitment period, Belgium has reduced its emissions (expressed on an annual basis) by 13.9 %.

Table ES3.2: Kyoto basket of emissions, and emissions associated with Article 3.3, 1990-2012 (in Gg CO_2 equivalent) – UNFCCC Coverage.

Table ES3.2	**Gg CO_2 Equivalent**												
	Base Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
CO_2	118 989	118 989	121 447	119 909	118 912	123 401	124 324	128 354	122 723	128 966	123 448	125 152	125 136
CH_4	9 659	9 659	9 472	9 343	9 273	9 236	9 256	9 008	8 839	8 695	8 555	8 231	7 849
N_2O	10 900	10 900	10 790	10 442	10 717	11 264	11 721	12 036	11 700	11 795	11 638	11 030	10 768
HFCs	449	NA,NO	NA,NO	440	440	448	449	534	642	776	804	933	1 062
PFCs	2 335	1 753	1 678	1 830	1 759	2 113	2 335	2 217	1 211	669	348	361	223
SF_6	2 243	1 651	1 564	1 732	1 665	2 024	2 243	2 159	564	310	155	150	145
Total	**144 575**	**142 952**	**144 951**	**143 695**	**142 766**	**148 485**	**150 327**	**154 308**	**145 679**	**151 211**	**144 947**	**145 857**	**145 183**
Article 3.3[1]													
Approved Base Year Emissions[2]	**145 729**												

Table ES3.2	**Gg CO_2 Equivalent**											**% Changes**	
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**1990-2012**	**Base Year - 2012**
CO_2	125 459	127 276	128 072	124 344	121 537	117 069	119 453	106 827	113 429	104 271	100 659	-15.40%	-15.40%
CH_4	7 487	7 070	7 026	6 848	6 789	6 787	6 657	6 581	6 661	6 466	6 392	-33.82%	-33.82%
N_2O	10 286	9 218	9 424	9 162	8 215	7 577	7 582	7 671	8 329	7 037	6 991	-35.86%	-35.86%
HFCs	1 281	1 438	1 475	1 460	1 562	1 744	1 839	1 916	1 999	2 076	2 140	NA	376.96%
PFCs	82	209	308	154	159	181	202	116	86	179	220	-87.45%	-90.57%
SF_6	121	106	94	95	80	82	91	98	107	116	117	-92.91%	-94.78%
Total	**144 718**	**145 316**	**146 398**	**142 063**	**138 342**	**133 440**	**135 823**	**123 209**	**130 611**	**120 146**	**116 520**	**-18.49%**	**-19.40%**
Article 3.3							244.35	226.51	215.12	203.33	191.5		
Kyoto Protocol Total							**136 067.64**	**123 435.03**	**130 826.06**	**120 348.84**	**116 711.82**		
% KP Total compared to approved Base Year Emissions							**-6.63%**	**-15.30%**	**-10.23%**	**-17.42%**	**-19.91%**		

1 Emissions and removals associated with LULUCF enter the table only through the rows labelled Article 3.3

2 Base year Emissions were approved by the UNFCCC following the completion of the initial review (review in 2007 of the initial report that Belgium submitted in December 2006) and are based on emissions reported in the 1990-2004 Greenhouse Gas Inventory.

ES.4 - Other information

ES.4 lists the indirect greenhouse gases 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.

Table ES4.1: Emissions of Indirect Greenhouse Gases in Belgium, 1990-2012 (in kt).

Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
NO_x	371.33	367.39	353.96	346.86	347.29	347.32	337.34	325.97	330.31	310.51	315.51	304.30
CO	1319.15	1251.31	1202.08	1129.27	1034.48	1012.57	989.94	919.68	884.13	809.01	897.28	851.44
NMVOC	332.38	312.78	305.56	293.89	288.85	282.12	264.50	261.95	252.81	245.44	227.32	224.32
SO_2	359.02	362.06	353.41	327.76	284.78	257.65	248.34	226.82	213.44	174.37	173.79	166.87

Gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	% Changes
NO_x	293.84	291.62	297.88	288.20	275.02	264.71	234.21	208.12	216.06	201.97	193.31	-47.9
CO	841.86	819.04	793.99	754.66	660.37	661.58	666.49	438.89	530.56	422.46	390.41	-70.4
NMVOC	213.29	208.70	198.55	196.08	193.87	182.08	176.18	164.90	166.11	155.47	152.36	-54.2
SO_2	157.87	154.31	157.59	143.74	134.28	125.00	97.29	75.52	61.06	53.63	48.75	-86.4

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 80% and up to 97% for NO_x) except for NMVOC where the solvent sector is most significant (28%).

PART I: ANNUAL INVENTORY SUBMISSION

CHAPTER 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 twelfth 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 Council Decision 280/2004/EC concerning a Mechanism for Monitoring Community greenhouse gas emissions and for implementing 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, and SF_6), indirect greenhouse gases (CO, NO_x, NMVOCs) and SO_2. It covers the period 1990-2012. Inventory data for the years 1990 to 2011 have been recalculated where necessary, considering that a major update on the Belgian inventory was reported during the previous submissions.
The recalculations for the years 1990 to 2005 are mainly performed as a result of the in-country review of the initial report of Belgium and of the 2006 greenhouse gas inventory submission of Belgium, coordinated by the United Framework Convention on Climate Change (UNFCCC) secretariat in accordance with the guidelines for review under article 8 of the Kyoto Protocol (decision 22/CMP.1) and in accordance with decision 19/CP.8. This review took place from 4 to 9 June 2007 in Brussels, Belgium.
After the above mentioned UNFCCC-review some more recalculations for the complete time series took place during the next submissions mainly as a result of the UNFCCC-centralized reviews. During this 2014 submission Belgium took into account the results of the UNFCCC in-country review that took place in September 2013, although no final report was available yet.
The revision of the Belgian greenhouse gas inventory for the complete time series 1990-2011 is attached to this report together with the new estimates of greenhouse gas emissions for 2012 for Belgium.
In annex 3 of this National Inventory Report,

the Saturday Paper (September 28, 2013) of the UNFCCC in-country review of September 2013 with responses / information given by Belgium and with the conclusions of the Expert Review Team, are included.

This twelfth 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 CRF Reporter software) for the years 1990 to 2012, 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 (which is not the case for Belgium), 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 10.3 and 10.4 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 2014 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.
- some other information i.e. information on legal entities authorised to participate in mechanisms under articles 6, 12 and 17 of the Kyoto Protocol.

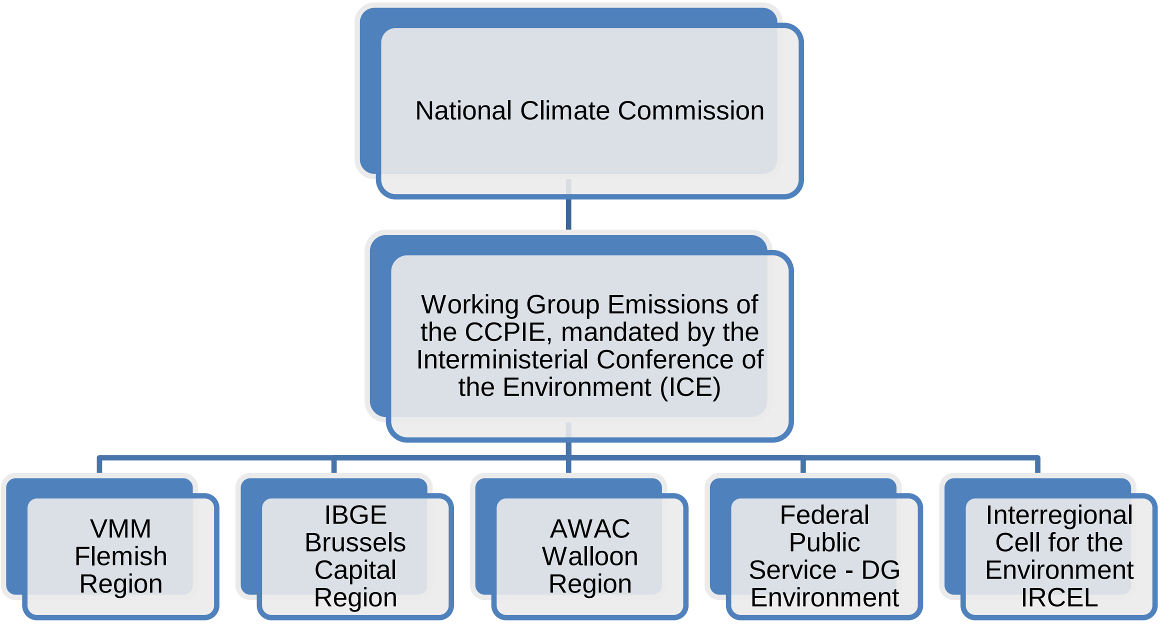
1.2. A description of the institutional arrangements for inventory preparation, including the legal and procedural arrangements for inventory planning, preparation and management

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. During the last years important efforts are 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 Council Decision 280/2004/EC concerning a Mechanism for Monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

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);
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.

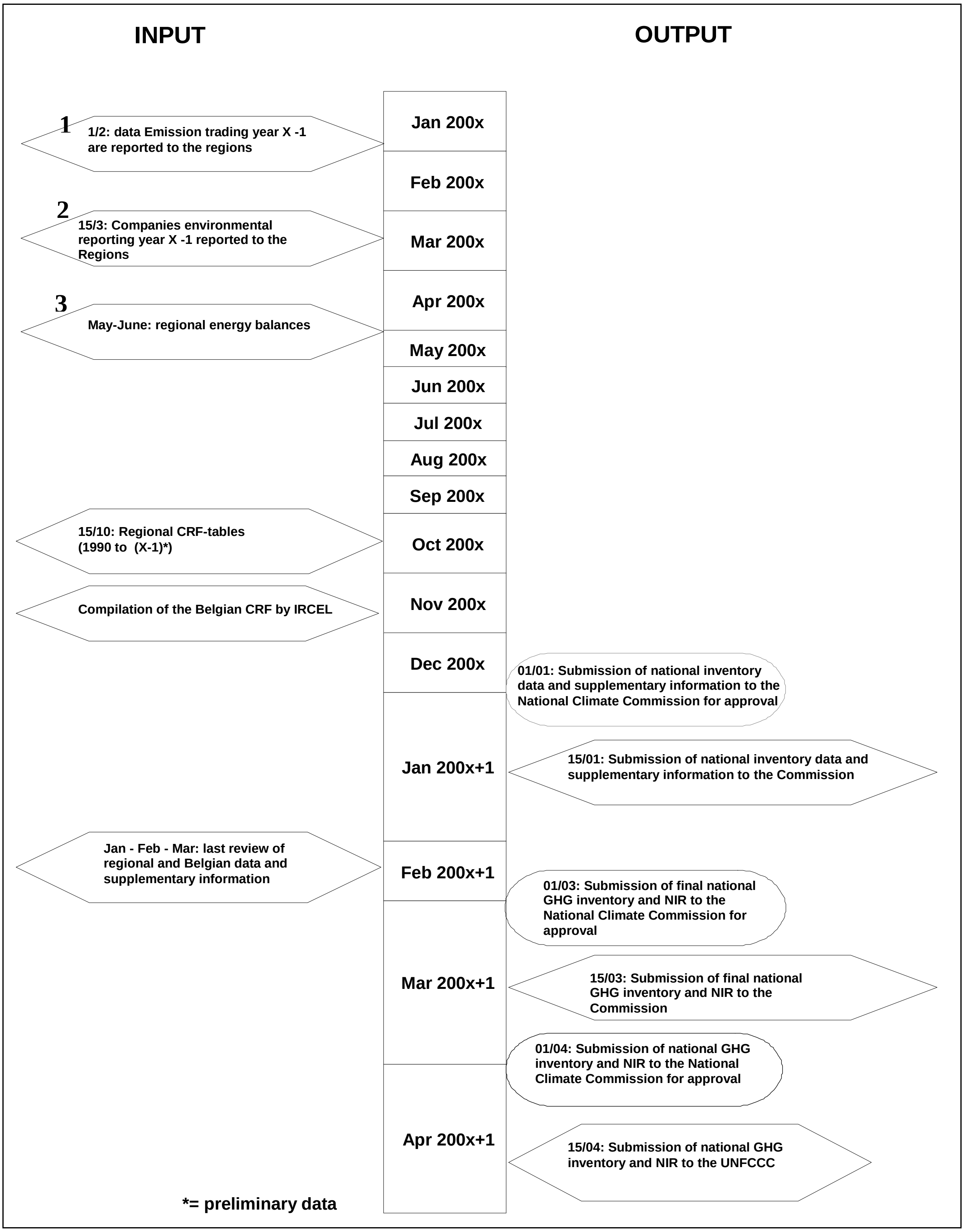
The Directorate General Energy of the Federal Public Service Economy, SMEs, Self-employed and Energy (FPS - DG Energy) is responsible for the top-down estimation of energy-related CO_2 emissions using the IPCC 'reference approach'.

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.

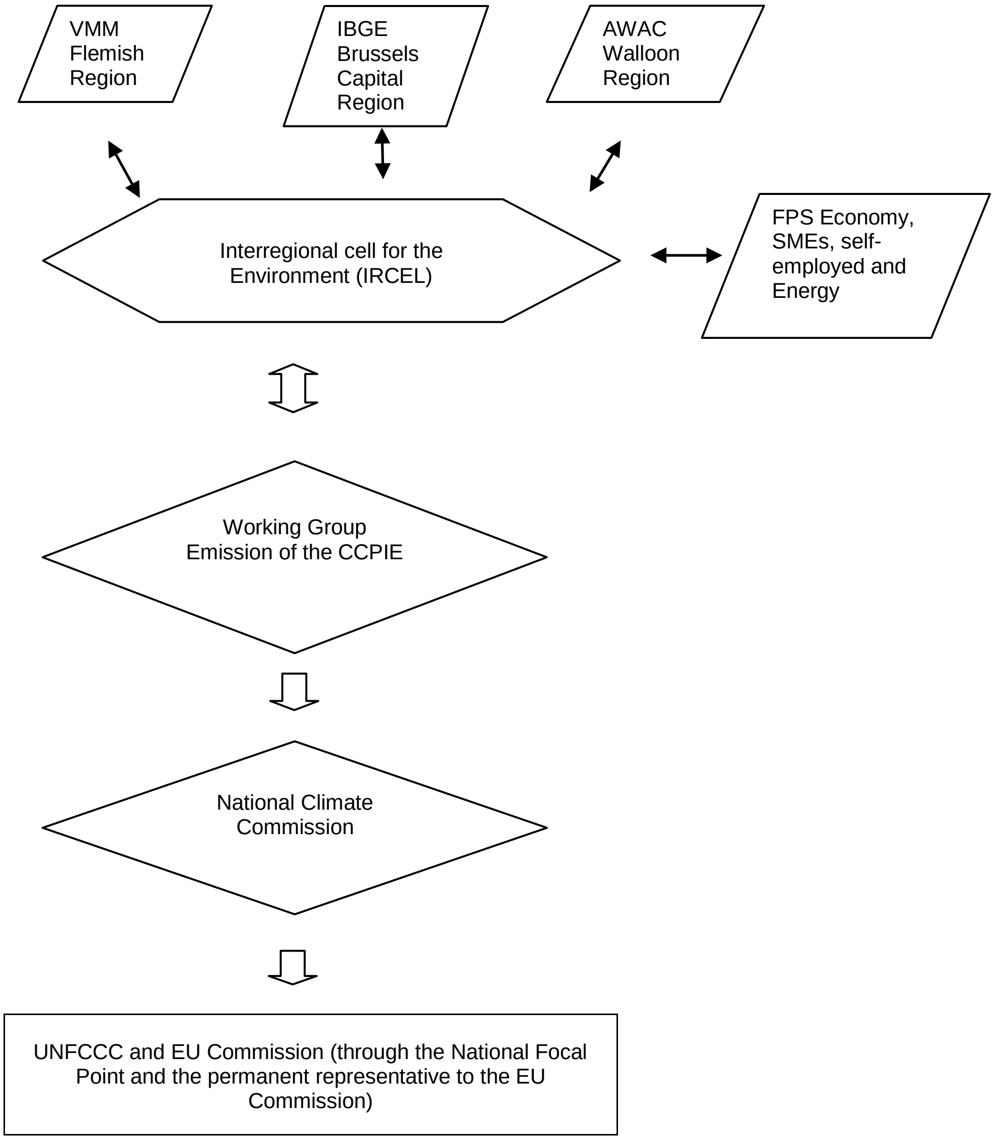
The Belgian Interregional Environment Agency (IRCEL-CELINE) is the single national entity with overall responsibility for the preparation of the Belgian GHG inventory. IRCEL-CELINE operates as national compiler of greenhouse gas emissions in Belgium.

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

1.2.2. Overview of inventory planning



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 the 31st of October 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 Directorate General Energy of the Federal Public Service Economy, SMEs, Self-employed and 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 Permanent Representation of Belgium to the European Union 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 2E and 2F) 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 2E and 2F: emissions F-gases	- full consistency between regions - study by external consultants (Econotec/Vito)
category 5: 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 8 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 8 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 4.5 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 base 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.

Another main source of data are the regional forest inventories, described in chapter 7.2. 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 emissions of CO_2 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 based on the statistics of the federal petroleum balance (fuels sold on the Belgian territory) and default emission factors (Copert 4 emission factors since the 2013 submission). This was agreed upon the UNFCCC-experts in 2003. The emissions of the other greenhouse gases originating from road transport are estimated in Belgium by taken into account the results of the regional models, based on the Copert-model and based on fuel consumption of the vehicles that travel within the region's territory and a correction factor for the differences between the fuels sold, reported in the federal petroleum balance statistics, and the fuels consumed, reported in the regional models.

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)	energy industries (1A1), Chemical industry (2B) and metal production (2C)
yearly ETS- emission reports	glass and ceramic industry (2A7) and metal production (1A2a and 2C1)
chemical federation	process emissions chemical industry (2B5) and chemical flaring (6C)
models (country/region specific)	transport (1A3), agriculture (4) and SWDS (6A)

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 350 industrial companies are registered in the industrial database in the Flemish region.
Mainly for the sectors refineries, the iron and steel sector 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.
In the Flemish region all companies under the ETS-Directive 2003/87/EC are obliged to report their emissions yearly in an emission report. A monitoring plan defines the different rules for the industrial companies to establish their emission reports. This emission report is verified by a verification office (in the Flemish region, it is called the Verification Office Benchmarking Flanders, VBBV). It is the responsibility of the VBBV to formulate an independent judgment about the emission report and the reported emissions of CO_2 (as a result of the application of the monitoring plan and the commitments recorded in this plan).
The VBBV is using judgment procedures based on their experiences over time to convince the responsible authorities about the performance of the covenant obligations of the companies involved with respect to energy efficiency and reporting of their emissions of CO_2. The activities of the VBBV are performed in a transparent way and a certified quality system, the ISO 9001:2000, is used to ensure the quality.

The Flemish region has taken into account the information from the EU-ETS data in a sense that reported sources in the EU-ETS framework are compared with the reported sources in the greenhouse gas emission inventory (integrated environmental reports, regional energy balance). When major changes are detected in the reported emissions of CO_2 and/or energy data between these two datasets, the involved industry is contacted and data are optimized if necessary. As a result more accurate emissions and/or energy data can be obtained.
Since the beginning of 2010 this work started in a more organized way in the Flemish region. A study is conducted at that time to examine the differences more in detail 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).
The 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. The study started in January 2010 and was finished in June 2010.

Since 2005 EU-ETS data are fully integrated in the Flemish greenhouse gas inventory for the sectors of glass and ceramic (category 2A7) and in the iron and steel sector (categories 1A2a and 2C). The emissions of these sectors were recalculated for the historical years by the companies involved with the same methodology as the one used for EU-ETS-purposes. Because of the small emissions of CO_2 in the sector of glass and ceramic (below the threshold of 100 kton CO_2) no other reporting obligations than the ETS-reporting for these industries exist in the Flemish region.

A comparison between data (energy consumption in TJ and emissions of CO_2 in kton) reported in the CRF-tables and reported under the ETS-Directive can be found in annex 11 of this report.

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 methodology is described in the annual reporting document ‘Energiebalans Vlaanderen: Onafhankelijke methode’ (‘Energy Balance Flanders: Independent methodology’). 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).
Last publication of this document dates from February 2014 and contains balances for the years 1990 to 2012. The energy balances of all years can be found on the website http://www.emis.vito.be/. Over the years this methodology is fine-tuned whenever necessary. Starting from this energy balance, the CO_2 emissions are calculated using CO_2 emission factors. These are mainly the default IPCC emission factors from the Revised 1996 Guidelines, except for some special products (blast furnace gas, coke oven gas, refinery gas, waste products) and sectors (refineries, electricity production) where 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 of the glass- and ceramic production, 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 1996. In some cases country specific emission factors are used.
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.
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)
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.

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)
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

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, 2011 and 2012 and trend analysis is carried out for the years 1990-2011 and 1990-2012. 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 2012 results in the identification of 50 key sources, covering 95%[3] of the total national aggregated emissions. These 50 key sources are to a large extent the same as those identified for the years 1990 and 2011 (see annex 1). Differences are summarised in the table below:

IPCC categories	GHG	1990	2011	2012
1. B. 1. a. Coal Mining and Handling	CH4	x		
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	x		
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO2		x	x
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Solid Fuels	CO2	x		
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	x		
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO2	x	x	
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	x		
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO2	x		
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	x		
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2		x	x
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2		x	x
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2	x		
2B. Chemical Industry / 5. Other / Other non-specified	CO2		x	x
2E1 By-product Emissions / Other	SF6	x		
2E1 By-product Emissions / Other	C2F6	x		
2E1 By-product Emissions / Other	CF4	x		
2F1. Refrigeration and Air Conditioning Equipment	HFC-134a		x	x
2F1. Refrigeration and Air Conditioning Equipment	HFC-143a		x	x
2F1. Refrigeration and Air Conditioning Equipment	HFC-125		x	x
5B2 Land converted to Cropland	CO2		x	x
5C2 Land converted to Grassland	CO2		x	x
5E2 Land converted to Settlements	CO2		x	x
6B2 Waste Water Handling/Domestic and Commercial Waste Water	N2O			x
6C Waste Incineration	CO2		x	x

[3] 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.

54 categories are identified as key source from the trend assessment with LULUCF 1990-2012 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 1990-2011 (53 key sources) and 1990-2012 (see annex 1) and the identified key sources overlap to a large extent.

Differences are summarised in the table below:

IPCC categories	GHG	1990 - 2011	1990 - 2012
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2		X
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	X	
4B8 Swine	CH4		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), 64 key source categories are determined (Table 1.2). The absolute change in direct greenhouse gas emissions of these key sources over the period 1990-2012 is listed in Table 1.2 and shown in Figure 1.2.

CO_2 emissions from 'public electricity and heat production (solid fuels and gaseous fuels)' and from 'road transportation' are the first key sources of greenhouse gas emissions in Belgium. They constitute the main drivers of 2012 emissions trends (annex 1). CO_2 emissions from road transport, residential space heating (liquid fuels and gaseous fuels) and electricity production (gaseous fuels and solid fuels) are pointed out by the level assessment as the five main key source categories, each contributing to 6 to 20% of the total national emissions without LULUCF (together, these five sources cover around 48% of the total emissions in 2012).

The three most important level key sources of non-CO_2 emissions in Belgium are CH_4 emissions from non-dairy cattle (1.76% in 2012), N_2O direct emissions from agricultural soils (1.69% in 2012) and CH_4 emissions from dairy cattle (1.09% in 2012).

One may finally notice that the five key source categories which displayed the most important absolute increase in their emissions over the period 1990-2012 (figure 1.2, table 1.2), are CO_2 emissions from public electricity and heat production (gaseous fuels) (category 1A1a, +5749 Gg CO_2-eq.), CO_2 from road transport (category 1A3b, +4162 Gg CO_2-eq.), CO_2 from residential space heating for gaseous fuels (category 1A4b, +2274 Gg CO_2-eq.), CO_2 from commercial & institutional (gaseous fuels) (category 1A4a, +2270 Gg CO_2-eq.) and CO_2 from chemicals in the manufacturing industries (other fuels) (category 1A2c, +1779 Gg CO_2-eq.).

On the contrary, energetic emissions of CO_2 from electricity production (solid fuels) (category 1A1a, -12018 Gg CO_2-eq.), CO_2 from the iron and steel sector (solid fuels) (category 1A2a, -7853 Gg CO_2-eq.), CO_2 from residential space heating for liquid fuels (category 1A4b, -4574 Gg CO_2-eq.), process emissions of N_2O from nitric acid production on land (category 2B2, -2881 Gg CO_2-eq.) and emissions of CH_4 from managed waste disposal on land (category 6A1, -1871 Gg CO_2-eq.) are the source categories that displayed the most important drop in GHG emissions between 1990 and 2012.

Concerning the LULUCF sector, categories 5A1 'Forest Land remaining Forest Land', 5B2 'Land converted to Cropland', 5B1 'Cropland remaining Cropland', 5E2 'Land converted to Settlements', 5C2 'Land converted into grassland' and 5C1 'Grassland remaining Grassland' are key sources in the level assessment for 2012.

Qualitative analysis shows that the sub-category 'net carbon stock change in soils' for each category listed above should be considered as key source. 'Net Carbon stock change in living biomass' is also a key source according qualitative analysis for 5A1 'Forest Land remaining Forest Land'.

5A2 'Land converted to Forest Land', 5B2 'Land converted to Cropland', 5C2 'Land converted to Grassland', 5E2 'Land converted to Settlements', 5A1 'Forest Land remaining Forest Land' and 5C1 'Grassland remaining Grassland' are key sources in the trend assessment for the years 1990 – 2012.

The qualitative level assessment shows that 'deforestation' should be considered as a key source in 2012 (496.17 Gg CO_2-eq.) as the last key source in the level assessment with LULUCF accounts for 309.26 Gg CO_2-eq.). A more detailed analysis of deforestation shows that this is the sub-sectors 5E2.1 'Forest Land converted to Settlements' and 5C2.1 'Forest Land converted to Grasslands' to be considered as key sources (respectively 35.1% and 31.0 % of deforestation in 2012). The results of the qualitative analysis of LULUCF categories are shown below in Table 1.1 below. Table 1.2. shows the results of the key source category analysis for all sectors.

IPCC categories	direct greenhouse gas	1990 estimate	2012 estimate	criteria for identification		absolute emission trend 1990-2012
		Gg CO2eq	Gg CO2eq			Gg CO2eq
supplementary key sources (according Lulucf analysis): subcategories of Lulucf items in table above						
5B2 Land converted to Cropland / Net carbon stock change in soils	CO2	75.10	878.46		L	803.35
5E2 Land converted to Settlements / Net carbon stock change in soils	CO2	51.03	478.32		L	427.30
Deforestation	CO2	416.26	496.17		L	79.92
5A1 Forest Land remaining Forest Land / Net carbon stock change in soils	CO2	-1492.89	-1449.83		L	43.07
5B1 Cropland remaining Cropland / Net carbon stock change in soils	CO2	1020.23	863.90		L	-156.33
5C1 Grassland remaining Grassland / Net carbon stock change in soils	CO2	643.08	323.69		L	-319.40
5A1 Forest Land remaining Forest Land / Net Carbon stock change in living biomass	CO2	-1666.71	-2118.00		L	-451.28
5C2 Land converted to Grassland / Net carbon stock change in soils	CO2	-48.59	-680.76		L	-632.17
5C2.1 Forest Land converted to Grassland (according qualitative analysis)	CO2	123.17	153.86		L	30.69
5E2.1 Forest Land converted to Settlements (according qualitative analysis)	CO2	205.61	174.23		L	-31.39

Table 1.1: Key source category analysis 1990-2012 for LULUCF

TABLE 1.2 Level and trend assessment 1990-2012 with Lulucf_ summary

IPCC categories	direct greenhouse gas	1990 estimate	2012 estimate	criteria for identification		absolute emission trend 1990-2012
		Gg CO2eq	Gg CO2eq			Gg CO2eq
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Gaseous Fuels	CO2	2750.94	8499.56	T	L	5748.62
1.A.3 Transport / b. Road Transportation	CO2	19487.06	23890.27	T	L	4403.21
1.A.4 Other Sectors / b. Residential / Gaseous Fuels	CO2	5824.23	8098.64	T	L	2274.41
1.A.4 Other Sectors / a. Commercial and institutional / Gaseous Fuels	CO2	1923.82	4193.94	T	L	2270.12
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Other Fuels	CO2	1833.63	3612.44	T	L	1778.81
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Other Fuels	CO2	714.27	1869.21	T	L	1154.94
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Gaseous Fuels	CO2	680.71	1763.69	T	L	1082.98
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO2	13.82	1085.97	T	L	1072.15
5B2 Land converted to Cropland	CO2	112.79	944.39	T	L	831.61
2F1. Refrigeration and Air Conditioning Equipment	HFC-134a		759.32	T	L	759.32
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2	67.04	809.21	T	L	742.17
2B. Chemical Industry / 5. Other / Other non-specified	CO2	224.19	953.13	T	L	728.93
2B. Chemical Industry / 1. Ammonia Production	CO2	422.74	1133.62	T	L	710.87
2F1. Refrigeration and Air Conditioning Equipment	HFC-143a		600.34	T	L	600.34
2F1. Refrigeration and Air Conditioning Equipment	HFC-125		577.36	T	L	577.36
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Gaseous Fuels	CO2	2519.33	2932.44	T	L	413.12
2B. Chemical Industry / 5. Other / Caprolactam	N2O	372.00	754.54	T	L	382.54
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2	186.46	554.56	T	L	368.10
5E2 Land converted to Settlements	CO2	248.03	578.80	T	L	330.77
6C Waste Incineration	CO2	287.84	517.58	T	L	229.74
1.A.2 Manufacturing Industries and Construction / f. Other / Gaseous Fuels	CO2	2555.63	2708.05	T	L	152.42
6B2 Waste Water Handling/Domestic and Commercial Waste Water	N2O	210.41	309.26		L	98.85
1.A.3 Transport / d. Navigation	CO2	398.23	462.90		L	64.68
4B8 Swine	CH4	1065.36	1080.97	T	L	15.62
4A1 Non-Dairy Cattle	CH4	2172.00	2043.99	T	L	-128.02
1. B. 2. b. Natural Gas	CH4	518.87	373.56	T	L	-145.32
2A. Mineral Products / 1. Cement Production	CO2	2823.78	2642.59	T	L	-181.20
5B1 Cropland remaining Cropland	CO2	1126.00	937.39		L	-188.61
4B Manure Management (AWMS)	N2O	961.77	765.70		L	-196.07
4D2 Pasture, Range and Paddock Manure	N2O	991.73	753.11		L	-238.62
5A2 Land converted to Forest Land	CO2	-19.70	-307.45	T		-287.75
2E2 Fugitive Emissions	C5F12	287.83	0.02	T		-287.81
1. B. 1. a. Coal Mining and Handling	CH4	298.82		T		-298.82
2E1 By-product Emissions / Other	CF4	323.69	0.60	T		-323.09
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2	428.21	101.88	T		-326.33
5C1 Grassland remaining Grassland	CO2	680.39	351.43	T	L	-328.97
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Gaseous Fuels	CO2	1485.42	1112.22		L	-373.20
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	396.70	3.31	T		-393.39
5A1 Forest Land remaining Forest Land	CO2	-3118.10	-3536.67	T	L	-418.57
4D3 Indirect Emissions	N2O	1248.42	810.74	T	L	-437.67
2A. Mineral Products / 2. Lime Production	CO2	2097.12	1611.91		L	-485.21
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	637.89	139.27	T		-498.62
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	659.33	160.26	T		-499.07
2E1 By-product Emissions / Other	C2F6	506.71		T		-506.71
4A1 Dairy Cattle	CH4	1808.17	1264.10	T	L	-544.07
4D1 Direct Soil Emissions	N2O	2567.19	1961.35		L	-605.84
5C2 Land converted to Grassland	CO2	73.73	-539.45	T	L	-613.18
1.A.4 Other Sectors / a. Commercial and institutional / Liquid Fuels	CO2	2290.06	1642.43	T	L	-647.63
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	4285.35	3528.74		L	-756.61
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	878.43	56.01	T		-822.43
1.A.2 Manufacturing Industries and Construction / f. Other / Solid Fuels	CO2	2537.32	1543.89	T	L	-993.43
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Liquid Fuels	CO2	2490.10	1290.07	T	L	-1200.03
1.A.4 Other Sectors / b. Residential / Solid Fuels	CO2	1759.18	492.36	T	L	-1266.82
1.A.2 Manufacturing Industries and Construction / f. Other / Liquid Fuels	CO2	3063.85	1642.17	T	L	-1421.68
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO2	1671.11	199.88	T		-1471.23
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO2	1835.14	277.63	T		-1557.51
2E1 By-product Emissions / Other	SF6	1559.36		T		-1559.36

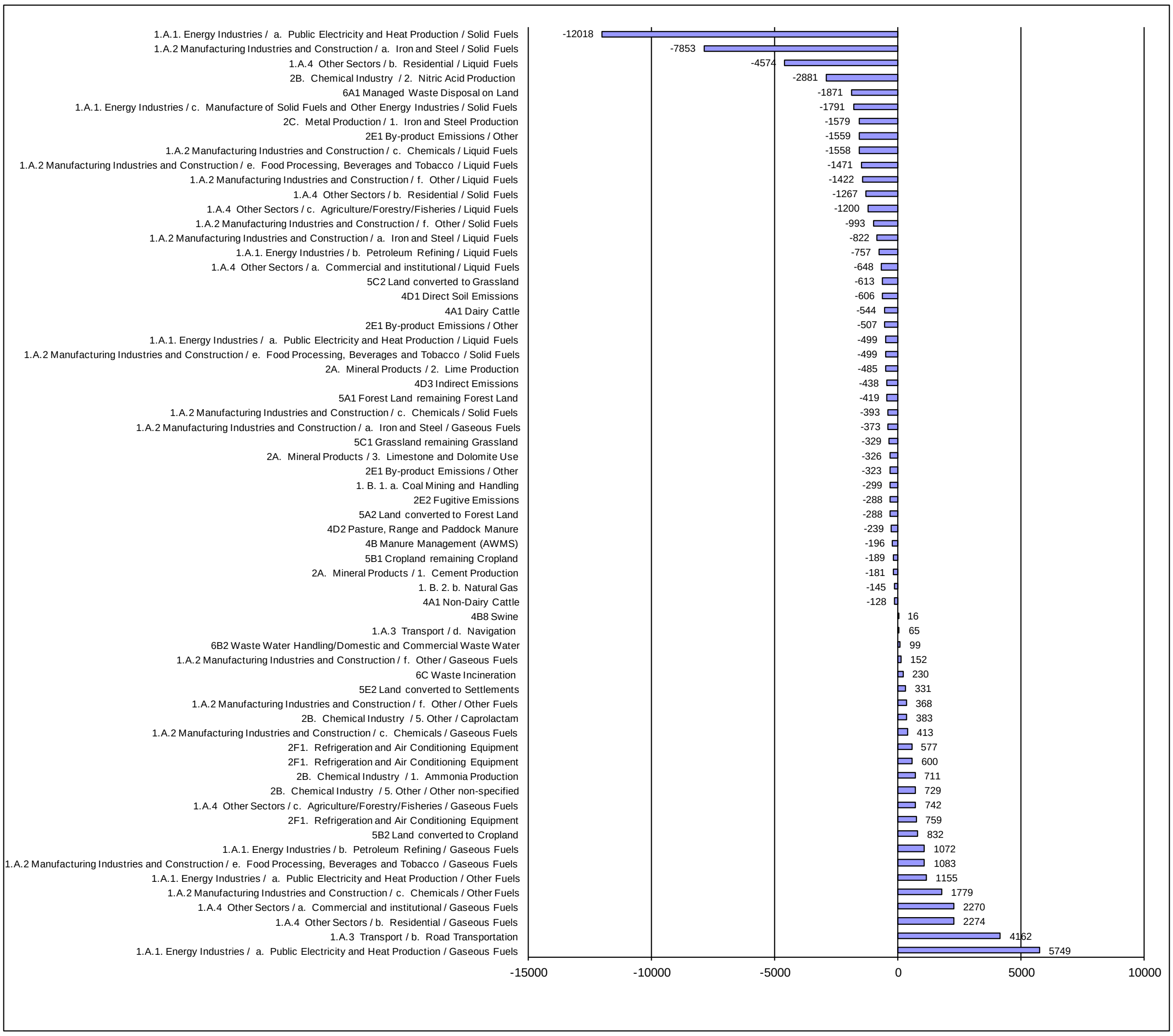


Figure 1.2: Key source category analysis: GHG Emission Trends 1990-2012 (Gg CO_2 equivalent).

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 2012, 5A1 'Forest Land remaining Forest Land', 5B1 'Cropland remaining Cropland', 5C1 'Grassland remaining Grassland', 5B2 'Land converted into cropland', 5C2 'Land converted into grassland' and 5E2 'Land converted to Settlements' are key sources in the UNFCCC inventory. 'Deforestation' is here the only activity (related to these above IPCC source/sink categories for LULUCF) which is accounted under the KP for Belgium and thus should be considered potentially as key.

'Deforestation' accounts respectively only for 9.1% in 5B2, for -18.7% in 5C2 (because 5C2 is a sink and deforestation a source) but for 30.1% in 5E2. In addition, analysis of key sources in the UNFCCC inventory has showed that 'deforestation' is a key source in 2012.

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 5E2.1 'Forest Land converted to Settlements'.

The situation is comparable for the year 2011.

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 from the 1st to the 6th of 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 bodies who take responsibility 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 bodies (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.

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.

In 2007 and 2008 a management evaluation of the quality system was performed. 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.

Internal audits took place on the 15th of June 2007, the 12th of June 2008, the 29th of June 2011 and the 1st of July 2013. Its conclusions noted the uncompleted implementation of some of the procedures (see procedures ‘not yet implemented’ above) and formulated technical recommendations concerning the use of indicators and the controls carried out in the procedure VMM/EIL/GP/5.003 of the main process. New software or upgrades of software should be clearer described and personnel files should be kept decentralized by the responsible team. 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

GHG 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 2004. At that time the certification was only valid for parts of the 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.

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

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[5]. 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, 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 is 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 July 2012.

[5] 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 responsibility of the regions in collecting primary activity data and estimating emissions at regional / sectoral level, 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 carried out by people responsible for the quality management system in the Flemish environment agency were carried out on 14/12/2005, 7/7/2006, 15/6/2007, 12/6/2008,29/06/2011 and 1/7/2013. An external audit performed by 'Det Norske Veritas' was carried out on 1/2/2006. The outputs 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 June 2014.

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 of the regional inventories (sectoral experts). 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 2012 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. The following review reports were published in the course of 2013 and the beginning of 2014:

- Status Report Belgium by the EC (received in 2013);
- QA/QC checks by the EC (received in February 2013);
- UNFCCC 2011 initial checks (received in May 2013);
- UNFCCC 2011 Synthesis & Assessment Report (received in June-August 2013);
- UNFCCC SIAR (received in May 2013);
- UNFCCC Saturday Paper 'Potential Problems and Further Questions from the ERT formulated in the course of the 2013 review of the greenhouse gas inventories of Belgium submitted in 2013' (received in September 2013) as a result of the in-country review in September 2013. No draft Annual Review Report (Report of the individual in-country review of the annual submission of Belgium submitted in 2013) was received so far (April 2014).

These reports of the Belgian greenhouse gas inventory were commented by the Belgian experts in due time.

During this 2014 submission 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 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 2012 as submitted on the 15th of April 2014 to UNFCCC and to the European Commission.
A trend uncertainty analysis is performed for the years 1990 and 2012.

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. LULUCF uncertainties are however estimated only for CO_2 emissions related to 'carbon stock changes'.

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 2012 gives an overall uncertainty of 5.53% (it was 5.64% in 2013 submission) and a trend uncertainty 1990-2012 of 2.35% (it was 2.54% in 2013 submission).

More than 86% of Belgian total emissions (CO_2 emissions compared to total) has a very small uncertainty of more or less 2%. Even with the contribution of CH_4 (CO_2 and CH_4 together represent 90% of the total emissions), the uncertainty is still very low, 2% more or less. This confirms the influence of N_2O on the inventory uncertainty even if the disaggregation of 4D sector (see above) decreased its importance.
The influence of F-gas emissions (with high uncertainty) is very low since they account for only a very limited percentage of the total emissions (2.15%).

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

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 7.2.3.

1.8. General assessment of completeness

1.8.1. GHG inventory

Sources and sinks

All sources and sinks included in the IPCC 1996 Guidelines are covered with the exception of the following (very) minor sources:

- CO_2 from asphalt roofing (2A5), due to no methodology available in the IPCC guidelines;
- CO_2 from road paving (2A6), due to no methodology available in the IPCC guidelines.

Emissions of these source categories are likely to be extremely small in relation to national emissions.

The emissions of N_2O of a new source, use as propellant in aerosol cans, are included in this 2014 submission. See section 5.1.2. for more information.

Gases

All direct and indirect greenhouse gases and SO_2 are covered 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

Belgium reported for the first time during the 2010 submission on KP-LULUCF. See chapter 10 for more information.

The KP-LULUCF part is complete in terms of geographic coverage and carbon pools. More details are given in chapter 10.3.1.2.

1.9. Assigned amount

Belgium's base year is 1990 for CO_2, CH_4 and N_2O and 1995 for HFCs, PFCs and SF_6. Belgium's quantified emission limitation is 92 per cent as included in Annex B to the Kyoto Protocol. As Belgium is part of the European Community, whose member States will meet their reduction commitment jointly in accordance with Article 4 of the Kyoto Protocol, Belgium's quantified emission limitation is 92.5 per cent. Belgium's assigned amount is calculated based on the Party's Article 4 commitment.

In response to inventory issues identified during the initial review in 2007, Belgium submitted a revised estimate of its base year inventory, which resulted in its assigned amount to be 673 995 528 tonnes CO_2 eq. Based on its calculated assigned amount, the commitment period reserve is 606 595 975 tonnes CO_2 eq.

CHAPTER 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 fifth National Communication (you can find an English version on http://unfccc.int/resource/docs/natc/bel_nc5_en_final.pdf).
A distance-to-target assessment, aiming at evaluating progress of Belgium towards fulfilling its commitment under the Kyoto Protocol and the EU 'burden sharing' agreement, is commented as well.

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

Total greenhouse gas emissions (without LULUCF) in Belgium amounted to 116.5 Mt eq. CO_2 in 2012 (Table 2.1.) and to 116.7 Mt eq. CO_2 (with LULUCF article 3.3[6]).

Emissions in 2012 (with LULUCF article 3.3) are 19.9 % under base year emissions[7] (Figure 2.1). Under the Kyoto Protocol and the EU 'burden sharing' agreement, Belgium is committed to reduce its GHG emissions by 7.5%. Because of the economic crisis experienced since 2009, Belgium complies with its commitments for the five years of the commitment period despite the rise in emissions in 2010. For the first commitment period, Belgium has reduced its emissions (expressed on an annual basis) by 13.9 %.

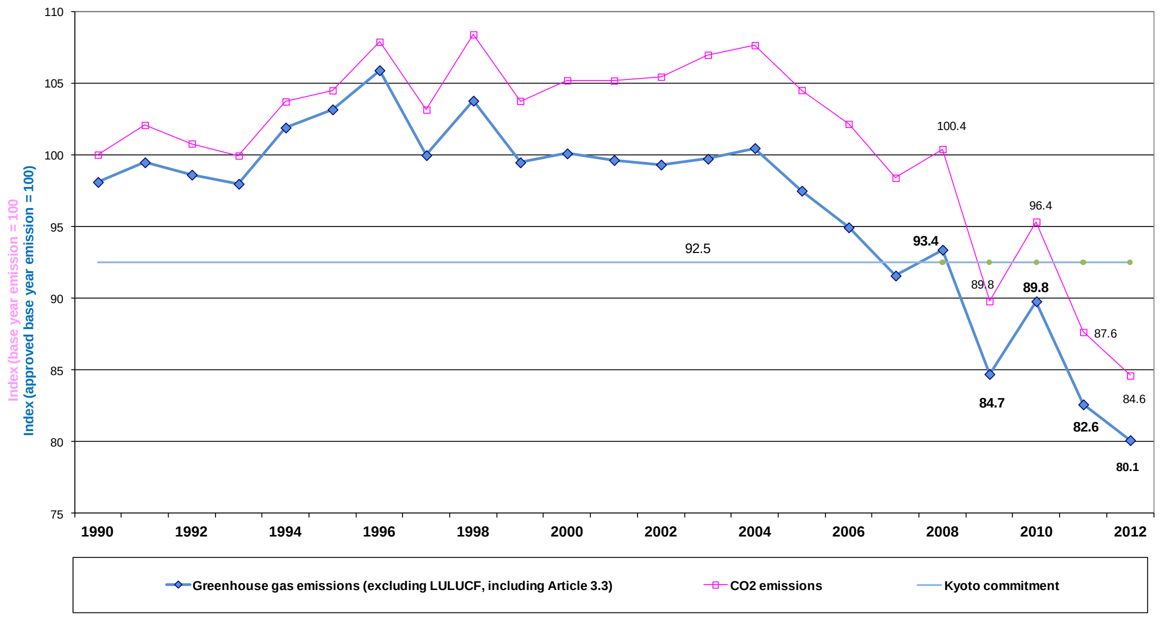


Figure 2.1.: Belgium GHG and CO_2 emissions 1990-2012 (excl. LULUCF), compared with Kyoto target. Unit: Index point (base year emissions = 100). For the fluorinated gases, the base year is 1995.

6 Belgium has not elected grassland and cropland management under Article 3.4 for inclusion in its accounting for the first commitment period.
7 Base year is 1995 for fluorinated gases and 1990 for other gases as approved by the review of the initial report of Belgium under the KP.

Table 2.1.: Overview of Belgium GHG emissions and removals from 1990 to 2012 (Gg CO_2 equivalents)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CO_2 emissions including net CO_2 from LULUCF	118 141	120 825	118 984	118 075	122 548	123 638	127 869	121 958	128 271	122 766	124 511	124 303	124 122	125 889	126 799	123 096	120 313	115 837	118 205	105 495	112 069	102 933	99 172
CO_2 emissions excluding net CO_2 from LULUCF	118 989	121 447	119 909	118 912	123 401	124 324	128 354	122 723	128 966	123 448	125 152	125 136	125 459	127 276	128 072	124 344	121 537	117 069	119 452	106 827	113 429	104 271	100 659
CH_4 emissions including CH_4 from LULUCF	9 660	9 473	9 344	9 274	9 236	9 256	9 031	8 839	8 695	8 555	8 231	7 849	7 487	7 070	7 026	6 848	6 789	6 787	6 657	6 581	6 661	6 472	6 392
CH_4 emissions excluding CH_4 from LULUCF	9 659	9 472	9 343	9 273	9 236	9 256	9 008	8 839	8 695	8 555	8 231	7 849	7 487	7 070	7 026	6 848	6 789	6 787	6 657	6 581	6 661	6 466	6 392
N_2O emissions including N_2O from LULUCF	10 913	10 807	10 462	10 743	11 292	11 749	12 300	11 738	11 839	11 683	11 078	10 820	10 344	9 279	9 487	9 228	8 285	7 653	7 664	7 759	8 423	7 201	7 098
N_2O emissions excluding N_2O from LULUCF	10 900	10 790	10 442	10 717	11 264	11 721	12 036	11 700	11 795	11 638	11 030	10 768	10 286	9 218	9 424	9 162	8 215	7 577	7 582	7 671	8 329	7 037	6 991
HFCs	NA,NO	NA,NO	440	440	448	449	534	642	776	804	933	1 062	1 281	1 438	1 475	1 460	1 562	1 744	1 839	1 916	1 999	2 076	2 140
PFCs	1 753	1 678	1 830	1 759	2 113	2 335	2 217	1 211	669	348	361	223	82	209	308	154	159	181	202	116	86	179	220
SF_6	1 651	1 564	1 732	1 665	2 024	2 243	2 159	564	310	155	150	145	121	106	94	95	80	82	91	98	107	116	117
Total (including LULUCF)	**142 118**	**144 347**	**142 791**	**141 954**	**147 661**	**149 670**	**154 110**	**144 953**	**150 560**	**144 311**	**145 264**	**144 401**	**143 438**	**143 990**	**145 187**	**140 882**	**137 187**	**132 284**	**134 658**	**121 964**	**129 345**	**118 978**	**115 139**
Total (excluding LULUCF)	**142 952**	**144 951**	**143 695**	**142 766**	**148 485**	**150 327**	**154 308**	**145 679**	**151 211**	**144 947**	**145 857**	**145 183**	**144 718**	**145 316**	**146 398**	**142 063**	**138 342**	**133 440**	**135 823**	**123 208**	**130 611**	**120 146**	**116 520**

Table 2.2.: Overview of GHG emissions and removals in the main sectors from 1990 to 2012 (Gg CO_2 equivalents)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1. Energy	112 294	115 081	113 580	112 630	115 822	116 338	121 095	115 026	121 169	115 323	116 914	117 428	116 667	118 542	119 041	115 061	112 223	107 819	110 533	100 597	106 866	97 287	94 400
2. Industrial Processes	15 768	15 094	15 367	15 460	18 007	19 264	18 893	16 423	15 933	15 587	15 696	14 949	15 375	14 793	15 373	15 335	14 555	13 968	13 911	11 270	12 284	11 697	11 173
3. Solvent and Other Product Use	204	202	201	200	196	193	192	191	189	188	186	186	185	185	184	184	184	184	184	183	183	183	183
4. Agriculture	11 439	11 307	11 228	11 344	11 348	11 534	11 306	11 265	11 291	11 335	10 674	10 555	10 328	9 849	9 806	9 595	9 469	9 539	9 396	9 506	9 584	9 439	9 257
5. Land Use, Land-Use Change and Forestry	-834	-604	-904	-812	-824	-657	-198	-726	-651	-636	-593	-782	-1 280	-1 326	-1 210	-1 181	-1 154	-1 156	-1 166	-1 244	-1 266	-1 168	-1 381
6. Waste	3 246	3 266	3 318	3 132	3 112	2 998	2 821	2 774	2 630	2 514	2 387	2 064	2 162	1 948	1 993	1 888	1 912	1 931	1 800	1 652	1 694	1 540	1 508
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (includ. LULUCF)	142 118	144 347	142 791	141 954	147 661	149 670	154 110	144 953	150 560	144 311	145 264	144 401	143 438	143 990	145 187	140 882	137 187	132 284	134 658	121 964	129 345	118 978	115 139

2.2. Description and interpretation of emission trends by gas

The major greenhouse gas in Belgium is carbon dioxide (CO_2), which accounted for 86.4% of total GHG emissions in 2012. Methane (CH_4) accounts for 5.5%, nitrous oxide (N_2O) for 6.0%, and fluorinated gases for 2.1% (Figure 2.2). Emissions of CO_2 decreased by 15.4% during 1990-2012, while CH_4, N_2O and fluorinated gas emissions have dropped with respectively 33.8%, 35.9% and 50.7%[8] during the same period.

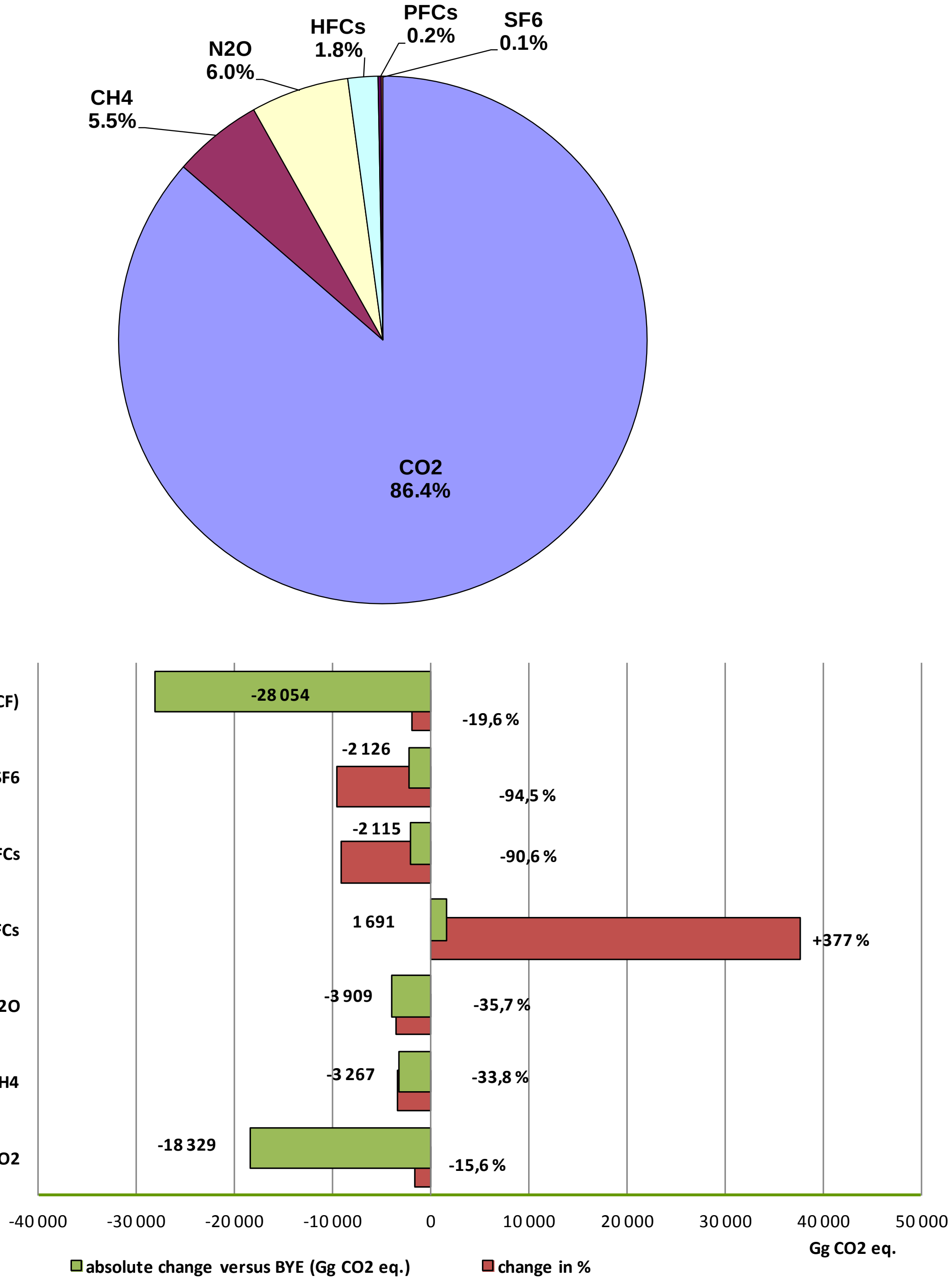
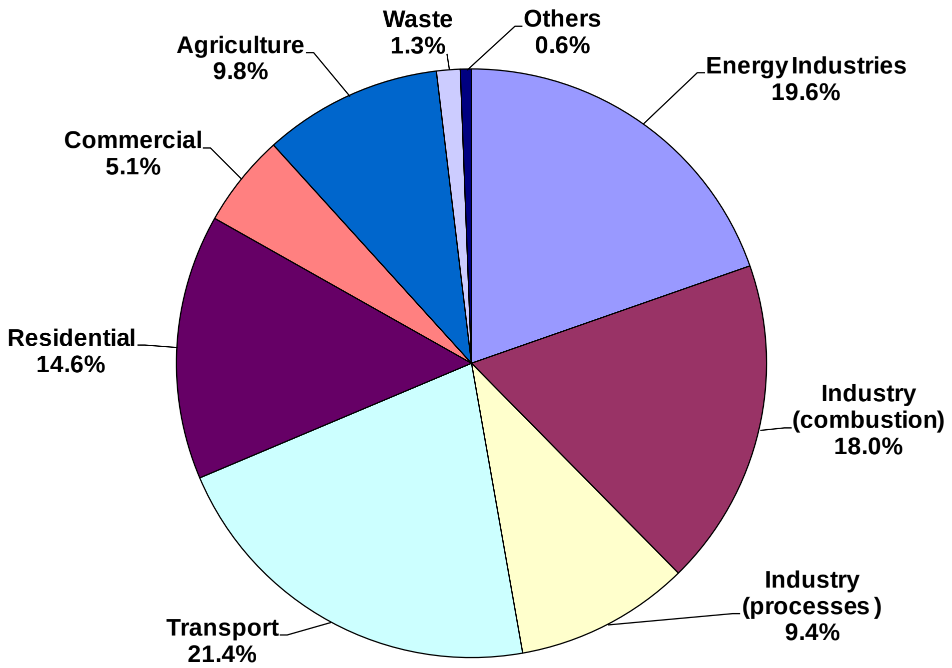


Figure 2.2: Share of greenhouse gases in Belgium (2012) and changes compared to base year (1990 for CO_2, CH_4 and N_2O; 1995 for F-gases)

[8] 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. Manufacturing industry, energy industries, transport and space heating are the most important sectors in the total GHG emissions in 2012.



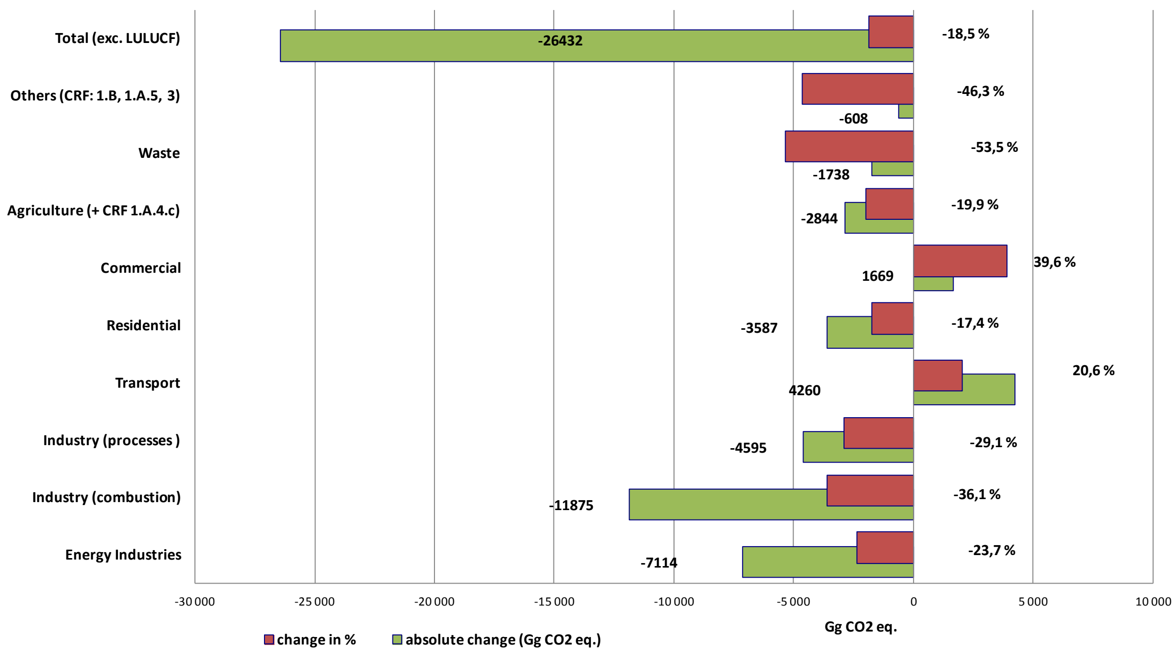


Figure 2.3: GHG emissions: share of main sectors in 2012 and changes from 1990 to 2012.

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 23.8% and have been responsible for a 4.1% increase in total emissions. In 2012, the residential sector experienced a decline (emissions from the residential sector depends more strongly on the winter weather and 2012 has been a relatively warm year).

This trend is counterbalanced by the 29.5% decrease in emissions in the other sectors, particularly industry (combustions recorded a 36.2 decrease since 1990 explaining 8.3% of decrease in total emissions), giving an overall decrease of -18.5% compared to 1990 (for all gases).

The drivers of these trends are analysed and commented, sector by sector, in the chapters 3 to 8 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 2.4 (share of sectors and changes 1990-2012). These data are commented below.
During the 2014 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 15th of February 2014.
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/envt2izjw).

2.4.1. Nitrogen oxides (NO_X)

The primary NO_x emitting source in Belgium is transport (55% in 2012), followed by manufacturing industries (21%) and energy industries (8%). Total NO_x emissions have substantially decreased (-48% in 2012 compared with 1990), mainly as a result of improved performances in the production of electricity. Emissions from transport have decreased with 43% between 1990 and 2012, thanks to the use of catalytic converters on cars (since 1993-94), as well as emissions from energy industries (-78%).

2.4.2. Carbon monoxide (CO)

CO emissions in Belgium come mainly from energy consumption in industry (33%), space heating in residential and commercial (38%) and transport (18%).
Between 1990 and 2012, national CO emissions fell by 70%, mostly as a result of the introduction in 1993 of catalytic converters.

2.4.3. NMVOC

NMVOC emissions are caused mainly by biogenic emissions from forests (32%), followed by use of solvents and other products (28%) and industry process (11%). Overall, these emissions decreased by 54% between 1990 and 2012, 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 2012, leading to a general drop of these emissions by 86%. These reductions are the result of fuel substitution and reduced sulphur content in the oil products used. The energy sector accounts for 13% of SO_2 emissions, but 'energy use in industry' is higher with 36%. Residential and commercial sector accounts for 22% and process emissions in the industry for 23%.
In the transport sector, sulphur dioxide emissions have dropped (-88% in 2012 compared with 1990), mainly due to the constant reduction in the sulphur content of fuels since 1996.

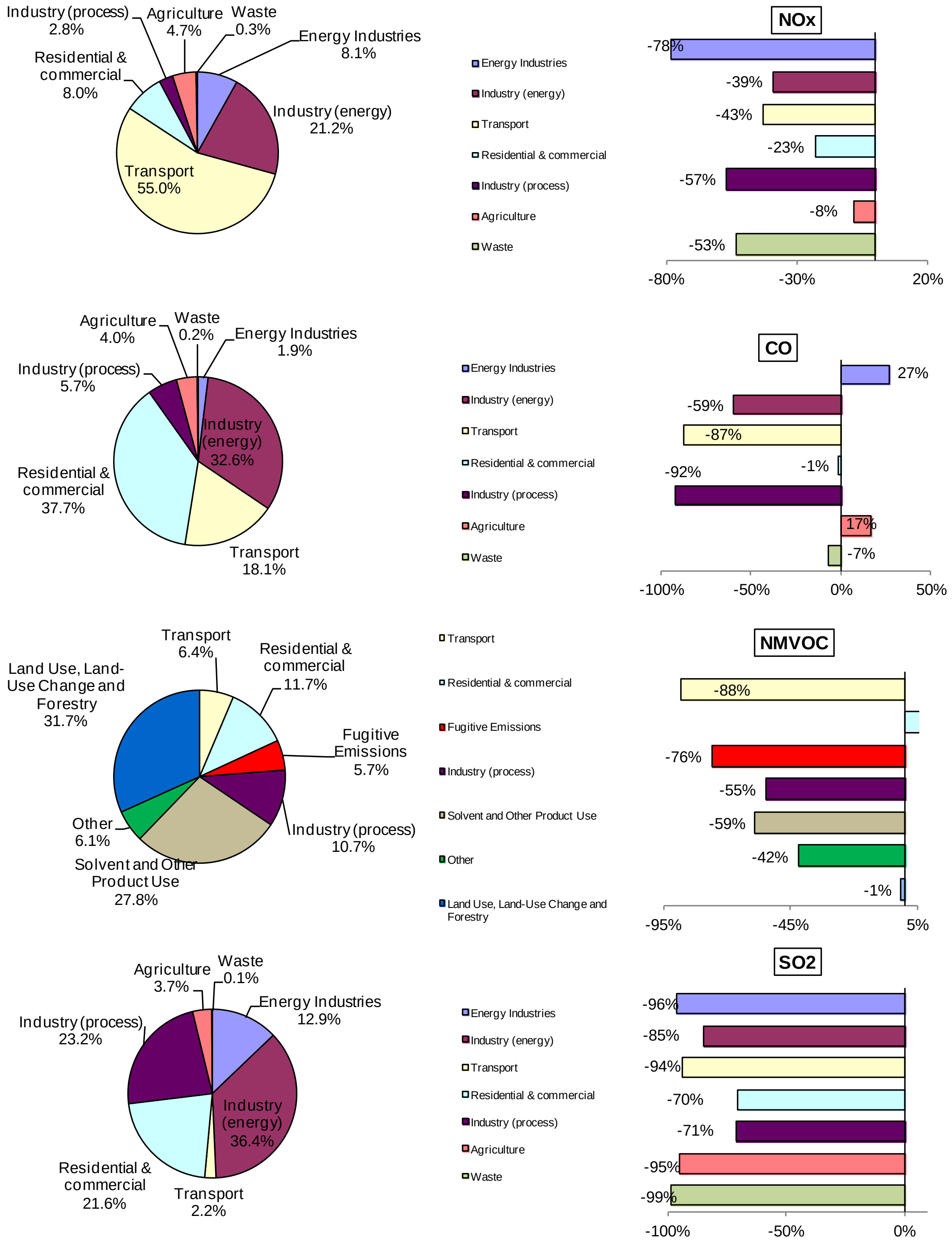


Figure 2.4: Indirect GHG emissions and SO_2: share in 2012 and changes 1990-2012.

CHAPTER 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 where the emissions are calculated based on ‘fuel sold’ (national statistics) instead of ‘fuel used’ (regional models) (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 79% of sectoral emissions in 2012. Petroleum refining (1A1b) and manufacture of solid fuels (1A1c) accounted for 20% and 1% respectively.

Emissions from the manufacturing of solid fuels have decreased by 89% since 1990 (-1806 Gg CO_2 equivalent) due to the closure of six coke plants in respectively 1993, 1995, 1997, 2000, 2005 and 2010. Emissions in 2012 from petroleum refining are 6% 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 public electricity and heat generation. While electricity and heat production have risen by 49% between 1990 and 2012, emissions have decreased (-24%) 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.

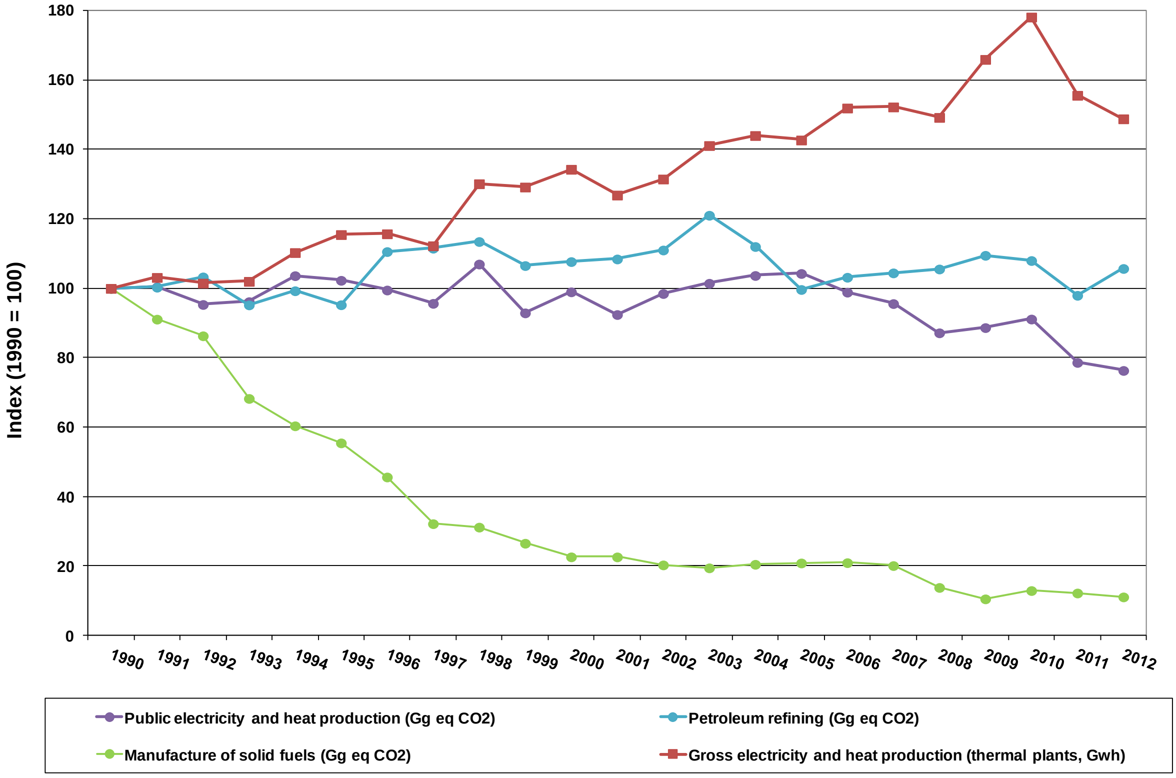


Figure 3.1: GHG emissions from public electricity and heat generation, in relation to gross electricity generation

3.1.2.2. Manufacturing industries (1A2)

In the manufacturing industries, added value[9] has increased by 19% in 2012 since 1990, while greenhouse gas emissions decreased by 36% in the same period.

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

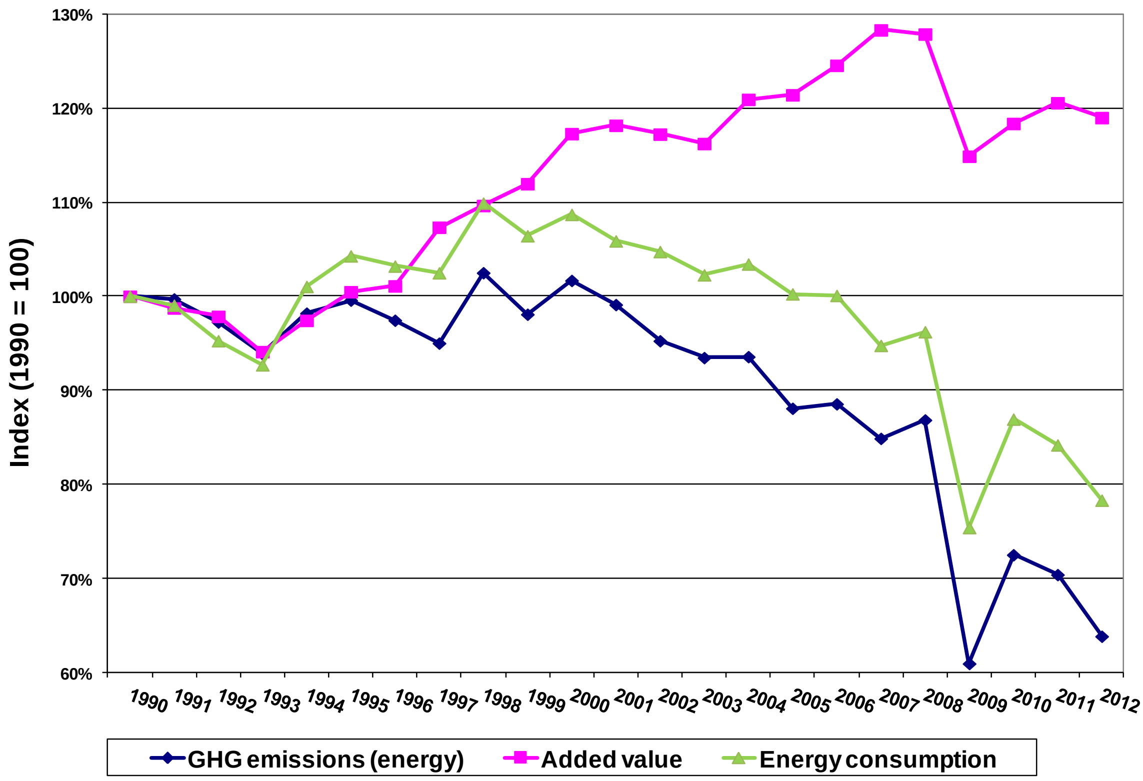


Figure 3.2: Manufacturing industries: index of GHG emissions, energy consumption and added value

As seen in Figure 3.2., fuel energy consumption decreased by 22% between 1990 and 2012 (and by 25% 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. This sector still represents 21% of the energy consumption in 2012 by the manufacturing industries and consequently has a significant impact on the global trend.

In the chemical sector, fuel consumption has increased by 47% between 1990 and 2006, compared to 65% growth in added value [1]. This relative decoupling is linked to both rational energy use and high added-value products. In 2012, this sector represents 34% of energy consumption in the manufacturing industries.

Food processing and beverages represent 7% of energy consumption in the manufacturing industries in 2006, but 13 to 14% of added value [1]. This sector shows the steepest increase in added value compared to energy consumption. 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 recently, 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 (2012) used for 71% 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 on the one hand the growing numbers of naphtha crackers and the enlargement of existing plants. On the other hand, cement plants have been using more and more substitute fuels since 1990, such as impregnated sawmills, animal waste, tyres, etc. Those fuels represented 47% of their energy consumption in 2011 and 45% in 2012, 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. Cement plants have caused a doubling of the use of biomass fuels since 1990, with a particularly steep increase since 2001, when the 'dioxin crisis' in Belgium resulted in the elimination of high levels of poultry and animal meal in cement kilns. The other 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.

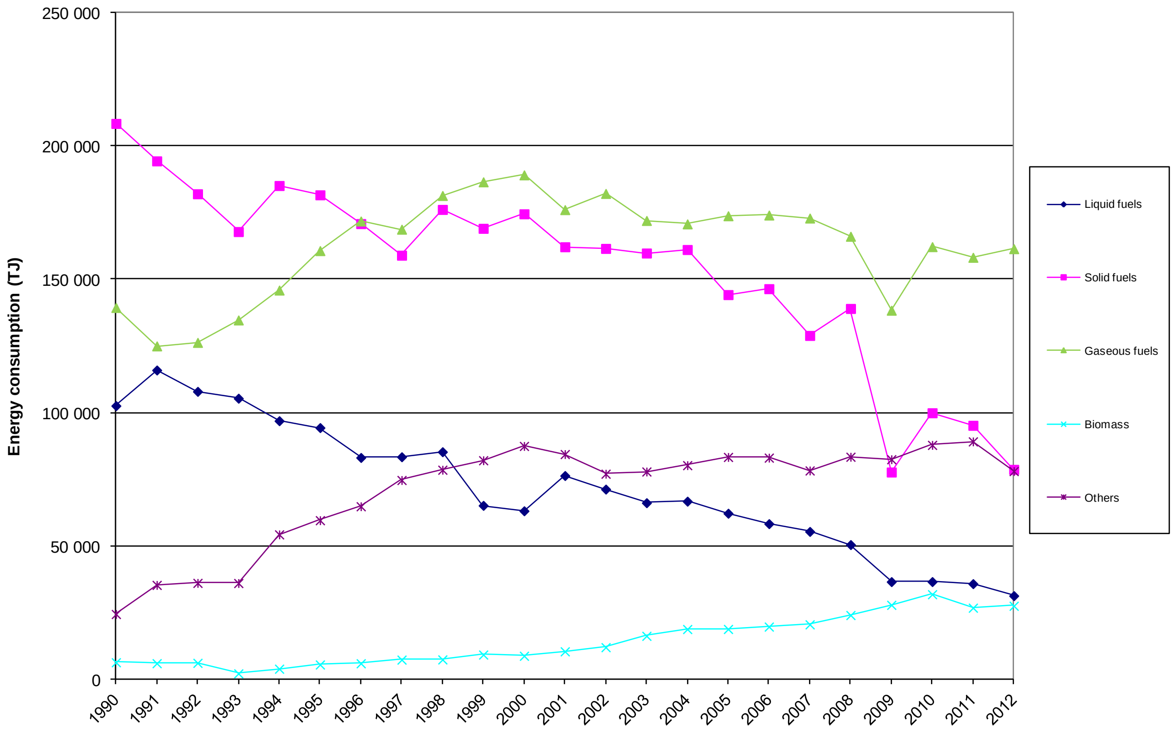


Figure 3.3: Type of fuels used in the manufacturing industries.

3.1.2.3. Transport (1A3)

Transport emissions accounted for 14.5% of total GHG emissions in 1990 and 21.4% in 2012. This increasing share is due to road transport, which represents 97.6% of total emissions by the sector in 2012 (without 1.AA.3.e sector 'other transportation').

Emissions from domestic navigation are fairly stable and represent almost 2% of transport total emissions in 2012. Emissions from railways (0.4% in 2012) 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 (2012): the number of vehicles has increased by 51% since 1990 (41% for only passengers cars) [4a], together with traffic (vehicle km) which has risen in the meantime by 40% [4b]. During the same period, the road freight traffic grew by 82% (ton-kilometer-2011) while the number of passengers carried by cars increased by only 29%.

There is a marked switch from petrol engines to diesel. The number of petrol engines (all vehicles) has dropped between 1990 and 2012 (-17%), while the number of diesel engines has almost tripled (+ 195%) for the same period. This is reflected in their respective traffic figures (- 50% for petrol engines and +300% 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 52% and is representing now in 2012 a decrease of 8% over 1990. The progress encountered during the early 2000s (thanks to subsidies and best price) have now completely disappeared. Private cars using LPG represent only 0.54% of private cars in 2012 whereas it was 1.65% in 1987.

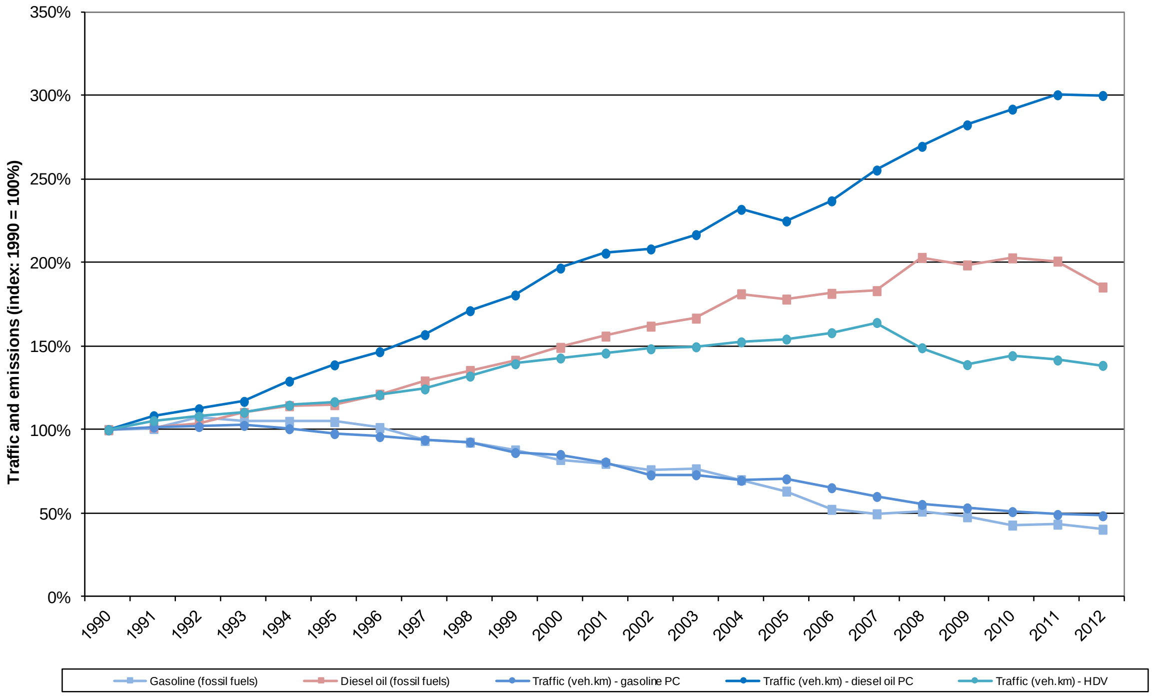


Figure 3.4: Emission trends in the transport sector (according "reference approach")

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 22% between 1990 and 2012, it constitutes one of the main drivers of emissions trends. The absolute increase in CO_2 emissions from road transport between 1990 and 2012 is the second highest among the key sources for the trend assessment (+4430 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 2012, these emissions represent 20% of national emissions, with maritime transport representing the most important source (83% of this category). Emissions from international aviation have increased by 31% since 1990, while emissions from maritime transport have risen by 47% (133 % of increase in 2008 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 (+13% between 1991 and 2001) since these two years were very similar from a climatic point of view. Annual fluctuations are of course climate-related with degree days[10], one of the key parameters used to analyse the sector energy consumption. This is particularly clear for 1996 and 2010 which were cold years with a marked peak of emissions from heating, but also for 2006 and 2007, two years with exceptionally mild winters, which caused a sharp drop in consumption. Recently, the increase in energy prices and improvement of the buildings becoming increasingly efficiency have probably also helped to reduce consumption. Since 1990, gaseous fuels consumption has increased in the residential sector from 34 to 51% of total energy consumption (without electricity and heat), together with a decrease in solid fuels and liquid fuels. Liquid fuels still account for 39 %, 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 53% since 1990 (64% if we look at 2010). 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 28% (between 1993 and 2011). In the meantime, electricity consumption has also grown by 92% (between 1990 and 2012), 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 74% 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 8.2%. In the commercial sector, a slow increase has been observed since 1998, but biomass represents only 2.2% of the sector's energy consumption. The switch from solid and liquid fuels is reflected in the decoupling of energy consumption and GHG emissions (fig 3.5).

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

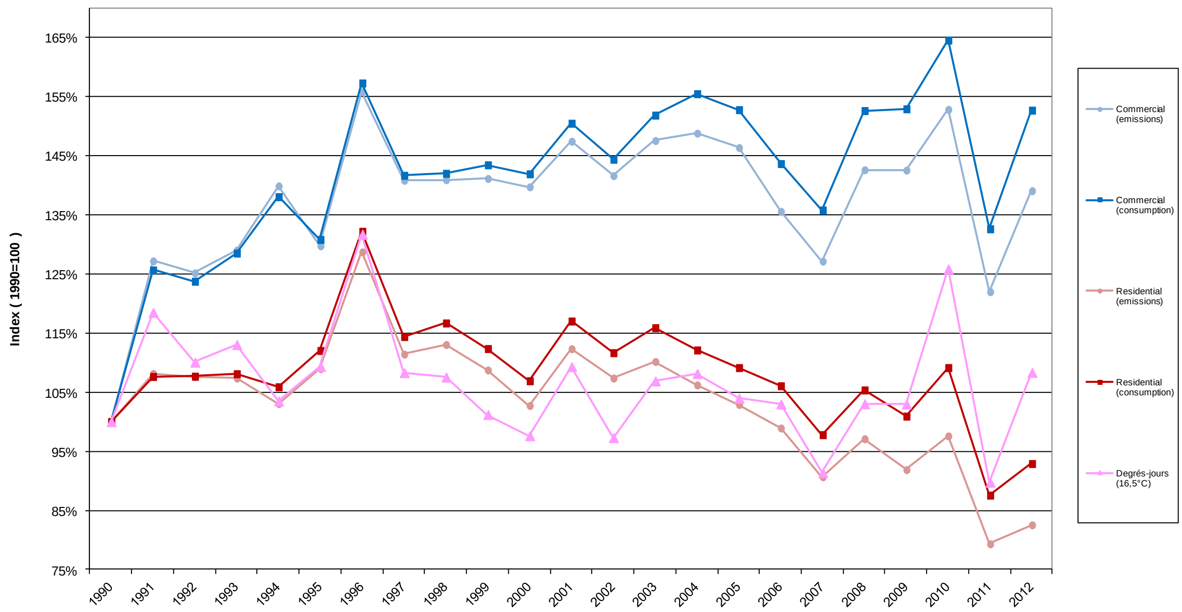


Figure 3.5 Greenhouse gas emissions and energy consumption in the residential and commercial sectors.

3.1.3 Overall recalculations in the energy sector

The tables below give the quantitative recalculations in the energy sector (category 1) compared to previous submission in November 2013. Please note that the main reason for recalculations of 2011 in the energy sector is the update of the regional energy balances.

Category 1A1 Energy industries:

Recalculations in category 1A1 mainly due to:

Flemish region: difference in 2011 mainly due to wrong allocation between solid fuel and biomass of one electric power installation and further optimization of emissions of CO_2 from 2005 on in the category 1A1a in terms of better tuning between the emissions reported through the individual Integrated Environmental Reporting by companies and the individual reporting through the ETS Directive.
Walloon region: a re-allocation of the emissions of waste incineration between 1A1a an 6C for the complete time series.
All regions: optimalization regional energy balances.

1.AA.1-Energy Industries,,All Fuels,Emissions,Aggregate GHGs (CO2, CH4, N2O,),(Gg CO2 equivalent)
Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,48	0,06	-0,67	-2,03
Flemish region	%	0,00	0,00	0,00	-0,19	1,42	0,39	0,02	0,15	0,32	5,72
Walloon region	%	0,04	0,04	0,03	-0,02	0,20	0,26	0,05	-0,13	-0,13	-0,33
Belgium	%	0,01	0,01	0,01	-0,16	1,21	0,37	0,03	0,11	0,24	4,78

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	1,40	0,19	-1,78	-5,17
Flemish region	Gg CO_2 eq.	0,00	-0,06	0,00	-46,64	327,77	92,49	5,17	32,08	70,80	1069,54
Walloon region	Gg CO_2 eq.	2,41	2,36	1,52	-0,87	9,18	9,67	1,31	-4,56	-4,85	-10,23
Belgium	Gg CO_2 eq.	2,41	2,30	1,52	-47,51	336,95	102,16	7,88	27,71	64,17	1054,15

<u>Category 1A2 Manufacturing Industry and construction</u>:

Recalculations in category 1A2 mainly due to:

Flemish region: emissions of N_2O in the category 1A2a (iron and steel) newly added for the complete time series.
All regions: optimalization regional energy balances and revision activity data off-road sector

1.AA.2-Manufacturing Industries and Construction,,All Fuels,Emissions,Aggregate GHGs (CO2, CH4, N2O),(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.01	1.05
Flemish region	%	0.38	0.36	0.43	0.42	0.43	0.43	1.01	0.24	2.08	-0.27
Walloon region	%	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.12	-1.36	-4.56
Belgium	%	0.17	0.17	0.21	0.23	0.23	0.23	0.56	0.20	0.82	-1.86

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.00	0.65
Flemish region	Gg CO_2 eq.	55.18	55.18	70.37	67.58	68.16	64.11	149.11	31.89	311.19	-39.07
Walloon region	Gg CO_2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	10.56	8.36	-117.77	-400.51
Belgium	Gg CO_2 eq.	55.18	55.18	70.37	67.58	68.16	64.11	159.66	40.25	193.42	-438.92

<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 V10.0 and new harmonized input models. Also new data on biomass content of fuels and optimalized fossil fuel data were integrated.
- Re-allocation of ‘offroad’ emissions from ports, airports and multimodal platforms following ERT recommendations from 1A4a to 1A3e.

1.AA.3-Transport,,All Fuels,Emissions,Aggregate GHGs (CO2, CH4, N2O,),(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	15,19	6,52	7,27	5,15	4,69	4,87	4,36	1,15	2,96	1,99
Flemish region	%	1,10	-1,43	-1,24	0,40	1,09	1,50	0,13	1,48	0,49	0,91
Walloon region	%	-5,59	-0,48	-0,15	-2,30	-3,24	-3,66	-1,35	-3,96	-0,80	-2,27
Belgium	%	-0,61	-0,73	-0,49	-0,40	-0,37	-0,31	-0,25	-0,56	0,12	-0,20

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	145,41	66,90	76,71	55,66	48,04	48,33	47,13	12,42	31,06	20,84
Flemish region	Gg CO_2 eq.	137,68	-196,39	-185,34	62,78	165,38	225,41	21,57	237,01	79,28	146,52
Walloon region	Gg CO_2 eq.	-410,20	-38,50	-13,41	-223,94	-309,43	-352,11	-137,60	-401,56	-78,45	-222,80
Belgium	Gg CO_2 eq.	-127,11	-167,99	-122,04	-105,50	-96,00	-78,37	-68,90	-152,13	31,90	-55,44

Category 1A4 Other sectors:

Recalculations in category 1A4 mainly due to:

- All regions : optimalization regional energy balances and re-allocation of off-road emissions from 1A4a to 1A3e and 1A5b
- Flemish region: The switch in existing houses from fuel oil to natural gas in category 1A4b was so far not taken into account, leading to an accumulated overestimation of households using fuel oil as main energy source. This correction was made during the 2014 submission for the years 2002-2012.

1.AA.4-Other Sectors,,All Fuels,Emissions,Aggregate GHGs (CO2, CH4, N2O),(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	-0,02	-0,02	-0,03	-0,04	-0,04	-0,05	-0,05	-0,04	-0,05	-6,68
Flemish region	%	-0,06	-0,06	-0,15	-5,76	-2,82	-2,26	-5,68	-7,15	-8,40	-6,15
Walloon region	%	-0,06	-0,07	-0,08	0,06	0,10	0,14	0,19	0,29	0,35	1,72
Belgium	%	-0,06	-0,06	-0,12	-3,53	-1,73	-1,41	-3,40	-4,45	-5,21	-3,95

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	-0,45	-0,62	-0,71	-1,04	-1,20	-1,12	-1,32	-1,12	-1,27	-144,28
Flemish region	Gg CO_2 eq.	-10,06	-11,36	-26,55	-1097,51	-509,50	-384,02	-1002,62	-1279,67	-1610,79	-942,82
Walloon region	Gg CO_2 eq.	-5,53	-5,85	-7,27	5,28	8,60	9,92	16,23	23,16	29,14	119,94
Belgium	Gg CO_2 eq.	-16,03	-17,83	-34,53	-1093,27	-502,09	-375,22	-987,71	-1257,63	-1582,93	-967,16

Category 1A5 Other:

Recalculations in category 1A5 mainly due to:

All regions: reallocation of military offroads consumptions following ICR 2012 from 1A4a to 1A5b.

1.AA.5-Other (Not elsewhere specified),,All Fuels,Emissions,Aggregate GHGs (CO2, CH4, N2O,),(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
Flemish region	%	239.13	165.99	1056.52	1151.31	1078.59	1260.39	1165.96	1143.44	1202.80	1324.32
Walloon region	%	1.23	2.10	2.53	2.18	2.18	2.93	3.13	3.40	3.94	-12.58
Belgium	%	2.77	4.62	5.60	4.62	4.64	6.19	6.56	7.13	8.26	-8.40

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Flemish region	Gg CO_2 eq.	2.51	2.66	2.87	2.28	2.29	2.23	2.11	2.10	2.08	2.07
Walloon region	Gg CO_2 eq.	2.00	2.17	2.37	2.03	2.03	2.00	1.93	1.91	1.89	-6.30
Belgium	Gg CO_2 eq.	4.52	4.84	5.25	4.31	4.32	4.24	4.05	4.02	3.97	-4.22

3.2. Fuel combustion (CRF 1.A)

In 2012 (Belgium's apparent gross inland consumption rose to 56329.9 ktoe (thousands tonnes oil equivalent), i.e. approximately 5.1 toe per inhabitant. This level is higher than the consumption per inhabitant in neighbouring countries and above the European average. More than 70% of Belgium's energy needs are met by the import of fossil fuels (39279 ktoe in 2011). This was made up of 2967 ktoe of coal, 21945 ktoe of oil (all petroleum products) and 14366 ktoe of gas.

In 2012, the use of nuclear fuels provided 48% 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 (3.3% of total electricity produced in 2012), 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, could contribute significantly to the production of electricity from renewable energy sources 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 1A(b), 1A(d) and 1A3b 'road transport' where the supply statistics from the national 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 federal energy administration (Energy Observatory). They are calculated on the basis of fuel delivery data, import and export, and fraction of carbon stored in products. This approach is consequently independent from the regional consumption balances.

The details of this reference approach are provided in the categories 1AB (reference approach), 1AC (comparison reference approach and sectoral approach) and 1AD (feedstocks and non-energy use) of the CRF-tables.
Default values recommended in the IPCC 1996 guidelines were adopted for carbon emission factors, fraction of carbon oxidised, and fraction of carbon stored (feed stocks), except for naphtha, where a fraction of carbon stored of 100% is taken. Reason for this 100% is that the amount of naphtha reported as feedstock in table 1.A(d) is revised, after work carried out in the Working Group on Energy Balances in Belgium (see further this section for more information). The newly 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 is considered to equal a 'net' amount of C that is stored in products. The recovered fuels of the naphtha cracking are reported in the sectoral approach as 'other fuels' in the chemical industry (category 1A2c).

For the submission 2014, all the time series has been revised according last statistics available provided to IEA and Eurostat (17/03/2014).

The comparison in Gg CO_2 with the sectoral approach (Table 1A(c)) shows differences between -8.6% (in 2002) and -0.5% (in 2010). The difference between the reference approach and the national inventory (sectoral approach) for all years is visualised in the figure 3.6 below.

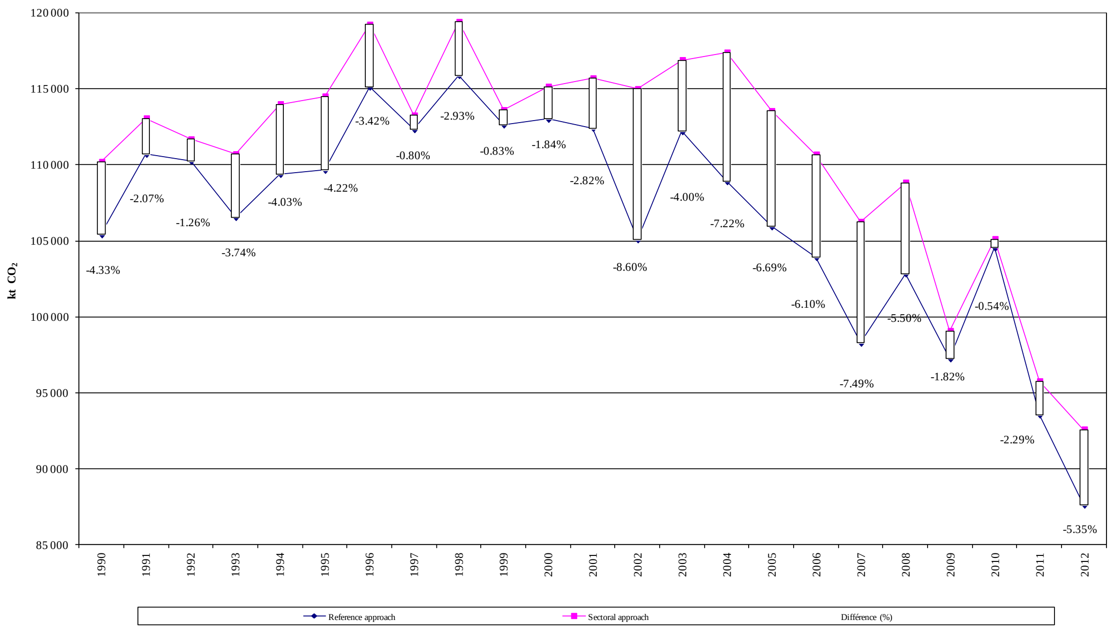


Figure 3.6.: Difference between the reference approach and the sectoral approach of the Belgian inventory (Gg CO_2).

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:

Reason number 1: 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.

Reason number 2: 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 41,87 GJ/ton in the reference approach, which is a default value. If this value is 5% less (40 GJ/ton), the reference approach would be 4500 kt CO_2 lower.

Reason number 3: except for naphtha, the % of carbon stored are default values form the IPCC 1996 guidelines. Also the amount of reported TJ of non energy use, are based on the national energy balances (except again for naphtha). This means that there is no relation between what is calculated as CO_2 emissions originating from carbon non stored reported in these tables, and what is actually calculated and reported in the sectoral approach. For the sectoral approach, emissions from processes or the use of fuels as feedstocks are calculated or collected in a bottom-up manner and not calculated using a methodology with fraction of carbons stored applied to amounts of non energy use. In section 3.2.3 is explained for the Flemish region, where the chemical industry is mostly present, how emissions are collected and where they are reported. Since there is no relation between the 'default' calculation of emissions from the non energy use of fuels in table 1AD and what is done in the sectoral approach, this also contributes to the differences in the comparison in table 1AC between reference and sectoral approach.

Reason number 4: emissions from solid fuels are partially located under 'Industrial Processs' (iron and steel sector) in the regional approaches contrary to the reference approach (where no data for carbon stored is provided). The amount of emissions reported under 'Industrial Processs' is however relatively small (only the emissions released when converting iron to steel). All the emissions related to the reducing agent introduced in the blast furnace plants and in the steel arc furnace plants are allocated in the energy sector for the sectoral approach because it is very difficult to differentiate between cokes/coal used for energy purposes and as reducing agent.

A working group of Energy Balances under the National Climate Commission (Decision made on the 30th 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 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, proposals are defined to collect the data and to split the data on a regional level. The federal responsibles will organize the surveys, consolidate the results and give this information to the regions. The surveys of the energy data will be organized via a web tool. The sectors of electricity and gas will be treated first, suppliers of petroleum products afterwards. Legislation will be newly performed to ensure reporting obligations about the allocation of delivery for the distributors of fuel oil and the suppliers to the petrol stations. It is expected that the procedures and web application will be finished for reporting the first regional data of 2014 in 2015.

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 kerosene allocated to international aviation except correction for small part kerosene allocated to domestic aviation, and emission factors IPCC 1996	Fuel supply international aviation from regional airports and emission factors IPCC 1996	NA
Marine	Total fuel supply from Belgian petroleum balance and emission factors IPCC 1996	NA	NA

No international bunker activities take place in the Brussels region in Belgium.

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) is allocated to the bunker fuels and all gasoline (supplied amounts from the regional airports) is allocated to domestic air transport (see also section 3.2.8). Default IPCC 1996 emission factors are used to calculate the CO_2 emissions (see table 3.1). Since the 29th October 2012 submission, as a result of the UNFCCC in-country review in September 2012, some missing emissions from the use of kerosene in the civil/domestic aviation were detected (based on flight movements of Belgocontrol data) and added in this category. Consequently some small emissions, from the kerosene part that were re-allocated to the civil/domestic aviation, were subtracted from the bunkers during the 2013 submission. 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 1996 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 1996 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 1A2 and 2B

The emissions of non-energy use of fuels and related emissions (emissions from recovered fuels from processes) are reported under categories 1A2c**,** 2B1 and 2B5.

Feedstocks and non-energy use of fuels	Flemish region	Walloon region	Brussels region
Category 1A2c (recovered fuels)	Applicable	NA	NA
Category 2B1 (production of NH_3)	Applicable	Applicable	NA
Category 2B5 (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 1996 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.A(d), 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 the sector 1A2c 'other fuels' 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 1A2c 'other fuels'. This is the largest source of CO_2 emissions. This includes other fuels in the chemical sector, a result of recovered fuels in the steam cracking units in 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]. The choice was made to allocate these fuels under 'other fuels' and not 'liquid fuels' or 'gaseous fuels', for transparency reasons.

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 2B5 other). These CO_2 emissions result from the same surveys in the chemical sector in Flanders as those reported under 1A2c. In the survey, more sources of emissions from chemical processes are reported than are described in the IPCC 1996 guidelines. Emissions of flaring activities in the chemical industry are re-allocated during the 2013 submission to the category 6C instead of the category 2B5 before.

3. Waste treatment of final products is 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 6C) or under the sector of energy (category 1A1a), 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 other regions.

The regional energy balances are entirely transferred to the energy sector of the regional CRF-tables (CRF-Reporter) to obtain the energy consumption data. To obtain the national energy consumption data, the regional energy consumption data are added up with the exception of road transport for which the reference approach is applied (the figures of the national oil balance are used, they correspond to fuel sales in the country).

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 are set up as qualitative as possible with the available information, some interpolation work was needed to complete these balances. As a consequence some questions raised by the ERT of UNFCCC 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, the commercial and institutional sector and the transformation sector) and by using existing statistics.

Before any legal obligations of reporting emissions existed, the Flemish region had a tradition of contacting the most important industries on a voluntary basis to estimate the emissions of air pollutants and greenhouse gases. Once the reporting obligations of greenhouse gases became valid in 2005 (first reporting year 2004), Flanders did optimize its greenhouse gas inventory.

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 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 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 come from the obliged reporting of the auto-producers to the Flemish authority.
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 autoproducer plant and consequently reported under 1A1b. A third refinery (BRC) has installed a large autoproducer 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 2012.

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 then 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].

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 Fishery 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 governement. Energyconsumption is based on type of fishery, the average of engines power, the number of vessels and the number of days at sea.

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 models other methodologies are used to estimate the energy consumptions.

<u>road transport</u>: Until the submission in 2013, the results of an environmental impact module for road transport, MIMOSA, was used to calculate the emissions and the energy consumption in this sector.

Since this submission in 2014, the Copert model (COPERT 4 v 10.0) is used to harmonize with the other regions. The energy consumption calculated by COPERT is used as amount of fuels in the regional energy balance. CO_2 emissions from road transport are not calculated on the basis of this regional energy balances but on the federal petroleum statistics of fuels sales.

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 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 difficult 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 a correction 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), Statoil 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 (2011) 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 aren't 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.

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-kilometre.
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

As in Wallonia, the Brussels energy balance is prepared by ICEDD by means of a convention with IBGE (Brussels Environment Institute).

The report of the regional energy balance is available on the Brussels Environment website (www.ibgebim.be).
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 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 1A4c 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: 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 software (harmonised approach for the 3 Regions – see 3.2.8), 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 1996 are mainly used for calculating the emissions of CO_2 from combustion processes. These emission factors are summarized below. For CO_2 the IPCC default oxidation factors are already adjusted in these figures. These oxidation factors reflect that not 100% of the carbon in the fuel is transmitted to CO_2. The oxidation factor is 0.98 for solid fuels, 0.99 for liquid and 0.995 for gaseous fuels.

Products	**emission factors (g CO_2/MJ)**		
	Flanders	Wallonia	Brussels
coal tars	92,7	-	
coking coal	92,7 (6)	92,7	92,7
Brown coal/lignite			
Butane/propane		62,75	66
coke oven coke	106	106	
crude oil	72,6	-	
Refinery gas	55,1 - 56,5 (1)	-	
LPG	62,4	62,4	
Gasoline	68,6	-	-
Kerosene	70,8	70,8	71,5
gas/diesel oil	73,3	73,3	73,3

lamp petroleum	71,1	71,1	
residual fuel oil	76,6	76,6	-
Naphta	72,6	-	
petroleum coke	99,8	99,8	
other petroleum products	72,6	-	
natural gas	55,8	55,8	55,8
coke oven gas	47,4 (till 2001) and 38-40 (from 2002) on(5)	47,4	47,4
blast furnace gas	250-265(5)	256,8-264,3 (4)	
other products	-2	-	
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)	100

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.

Energetic greenhouse gas emissions of CH_4 and N_2O

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

3.2.6 Energy industries (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

[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

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).

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 beginning of the nineties are included in this category 1A1c.
The emissions of indirect greenhouse gases from the cokes ovens are also reported in category 1A1c, fugitive emissions are reported in category 1B1b.

3.2.6.2 Methodological issues

Public electricity and heat plants (category 1A1a)

The activity data reported in this sector are the fuel consumption data as reported in the regional energy balances (see section 3.2.1.). This category contains the power installations for the production of electricity and heat and the combined heat-power installations (in joint venture with the electricity producers). These installations are 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 6C waste incineration, see chapter 8).
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 IPCC 1996 or individual plant reporting of CO_2 through ETS Directive	Individual reporting of CO_2 via ETS Directive	EPA (US Environmental Protection Agency (http://www.epa.gov/ttn/chief/ap42/ch02/final/c02s01.pdf p.22) and IPCC 1996
	CH_4 and N_2O	IPCC 2006 (agreed by electric power plants) and IPCC 1996 (combined heat-power installations)	IPCC 1996	IPCC 1996

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 (included the power plants and coke oven plants) are obliged to report their energy consumptions and CO_2 emissions via a website (Regine). These data 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.

For the smaller plants for which no emissions of CO_2 are reported directly to the responsible authorities, default 1996 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 from EPA[12] is used for waste incineration, in combination with the default 1996 IPCC CO_2 emission factor for the (small) extra natural gas supply.
For the smaller power plants, default 1996 IPCC CO_2 emission factors are used (see table 3.1).

In the CRF tables, there are some fluctuations on the time serie 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 1996 emission factors of natural gas (in gas turbines) in the industrial sector (2.5 g CH_4/GJ and 0.1 g N_2O/GJ), the IPCC 1996 emission factors for the service sector (i.e. 5 g CH_4/GJ and 0.1 g N_2O/GJ) and the IPCC 1996 emission factors for the agriculture sector (i.e. 5 g CH_4/GJ and 0.1 g N_2O/GJ for gas and 10 g CH_4/GJ and 0.6 g N_2O/GJ for fuel).

In Wallonia, emissions of CH_4 and N_2O are calculated using emission factors of the 1996 IPCC for the energy industries (included the combined heat-power installations in the service sector).

In the Brussels region, waste incineration rejects no CH_4 and the N_2O emission factor has been determined from in situ measurements. 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 1996 IPCC emission factors.
For the smaller power plants, default 1996 IPCC emission factors are used.

Fuel	**UNIT**	**CH_4**			**N_2O**		
		Fl (1)	**Wall**	**Br (2)**	**Fl (1)**	**Wall (2)**	**Br (2)**
Coal	g/GJ	3	1	/	0,5	1,40	/
Fuel	g/GJ	3	3	3	0,2	0,60	0,60
diesel oil	g/GJ	1	1,5	/	0,2	0,60	/

[12] US Environmental Protection Agency (http://www.epa.gov/ttn/chief/ap42/ch02/final/c02s01.pdf, p.22)

diesel oil (in gas turbine)	g/GJ	1			0,2		
natural gas (in gas turbine and in heat & gasturbines)	g/GJ	0,3	2,5	2,5	0,3	0,10	1,5
natural gas	g/GJ	0,3	1	2,5	0,3	0,10	1,5
Cokes gas	g/GJ	0,3	1	/	0,3	0,10	/
blast furnace-gas	g/GJ	0,3	1	/	0,3	0,10	/
H_2-gas	g/GJ	0,00	-	/	0,00	-	/
Dry sludge	g/GJ	30	-	/	4	-	/
Bisfenol-resin	g/GJ	3	-	/	0,5	-	/
Agricultural waste	g/GJ	-	30	/	-	4	/
Municipal waste		-		-	15 g/ton (3)	15 g/ton (3)	15 g/ton (3)
Coffee	g/GJ	30			4		
Olive seeds	g/GJ	30			4		
Biogas (stat. engines)	G/GJ	-	2,5 (1)		-	0,1	
Biofuel	g/GJ	1			0,2		
Wood	g/GJ	10	30		4	4	

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

(1) Source: IPCC 2006
(2) Source: IPCC 1996
(3) Source: Country-specific (measurements on 2 industrial sites)

Petroleum refining (category 1A1b)

Petroleum refining activities take only place in the Flemish region.

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 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.

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	5 coke plants in 1990 and one coke plant in 2012 (closure in 1995, 2000, 2005 and 2010)	1 coke plant until 1993
Activity data		Regional energy balances (based on individual cokes plant information and auto-producer mining industry (until 1996))	Regional energy balances (based on individual plant information)	Regional energy balances (based on individual plant information).
Emission factors	CO_2	Based on monitoring results	IPCC 1996 (until 2004) and based on monitoring results (from 2005 on)	IPCC 1996
	CH_4 and N_2O	CH_4: based on monitoring results, N_2O negligible	EMEP/EEA (CH_4) and IPCC 1996 (N_2O)	EPA (CH_4) and IPCC 1996 (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 EMEP/EEA guidebook [3] and the IPCC Guidelines [28] (table 3.1 and table 3.3). Until 2004, the CO_2 emissions were calculated with the default IPCC 1996 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, 4 of them are now closed and there is only one coke plant left since 2009 in Wallonia.

Fuel	**UNIT**	**Wallonia**	
		CH_4	**N_2O**
Diesel oil	g/GJ	1,5(2)	0,60(1)
natural gas	g/GJ	2,5(2)	0,10(1)
Coke oven gas	g/GJ	1(2)	0,10(1)
blast furnace-gas	g/GJ	0,16(2)	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
(2) Source: EMEP/EEA

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 1996 emission factors which are included 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 1996 emission factors (see table 3.5). On the other hand the emissions of CH_4 from the cokes ovens in the Flemish region are also allocated in this category 1A1c (instead of the category 1B1b before) to harmonize the allocation with the Walloon region.
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. 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).

- Further optimization of emissions of CO_2 in the category 1A1a in the Flemish region took place during the 2014 submission in terms of better tuning between the emissions reported through the individual Integrated Environmental Reporting by companies and the individual reporting through the ETS Directive. Default emissions calculated on the basis of the Flemish energy balance were in this respect further corrected and optimized for the years from 2005 on.

- Emissions of N_2O from the petroleum refining were re-allocated for the complete time-series during the 2014 submission to the gaseous fuels in the category 1A1b instead of the liquid fuels before. The notation key 'IE' is used for the liquid fuels. This is a more accurate allocation of these emissions.

- Mistake corrected in 2010 for the AD (liquid fuel) of a turbo jet (1A1a) in the Walloon region (-3,6 kt CO2).

- Mistake corrected for the AD of liquid fuels (2008 and 2009) and AD adjustement for the category "other fuels" (2008-2011) in the Brussels Region

- A re-allocation of the emissions of waste incineration between 1A1a and 6C took place in the Walloon region for the complete time series.

- Also the emissions of N2O originated from the waste incineration plants with electricity production were optimized in the Flemish region from 2008 on due to further optimization of the activity data.

3.2.6.6 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 1A1 in Belgium.

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) and other industries (1A2f).

The following industries are integrated in category 1.A.2.f (Other industries): non-metallic mineral products, (cement, lime, asphalt concrete, glass, mineral wool, bricks and tiles, fine ceramic materials), metal products, textile, leather and clothing and other industry (wood industry, rubber and synthetic material, manufacturing of furniture, recycling and construction included).

During the 2012 submission, the industrial off-road emissions are included for the first time for the 3 regions.

The industrial sector is not very developed in the Brussels region, mainly due to its urban features. The only big industry 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 1.A.2.f category (Other industries).

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 allocated to category 1A2c / other fuels.

Emissions of industrial combined heat-power installations in joint venture with the energy sector are allocated to the category 1A1a, autoproducers are allocated to the sector to which they belong.
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, the emissions of CO_2 are calculated by using the IPCC 1996 default emission factors listed in table 3.1. For some specific fuels, some industries perform analyses of these fuels and certainly

since 2004, more analyses of the fuels are 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 the case for the iron and steel sector, cement and lime sectors.
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 1996 IPCC Guidelines except for some specific fuels (see table 3.5).

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 1996	NA
	CH_4 and N_2O	(1) and for N2O: measurements from 2004 on and best estimates for the years before	EMEP/EEA (CH_4) and IPCC 1996 (N_2O) (2)	NA

(1) Emissions CH_4 of cokes plant in 1A1c and CH_4 of sinter plant in 2C1, N_2O in 1A2a
(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 are operational in 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 (a.o. based on historical background) it is not possible to harmonize completely these methodologies between the 2 regions involved (Flanders and Wallonia).

The CO_2-emissions from the iron and steel sector are partly put in category 1A2a (the energetic part) except for the emissions from the cokes ovens which are allocated in the category 1A1c and partly in category 2C1 (process part). See the respective chapters for more information.

In Wallonia, since 2004, all the IPPC companies are obliged to report their energy consumptions, their productions and the emissions of IPPC pollutants including CO_2, CH_4 and N_2O on a website (Regine). IPPC companies which are also emission trading companies are obliged to report on the same way, by sector. These plant informations 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 captured by 'pig iron' in the blast furnace which are allocated in the category 2C1. The CO_2 emissions from the blast furnace are calculated by a CO_2 balance: CO_2 from 'fuel inputs and reducing agents' – CO_2 from 'blast furnace gas used for energy purposes' – CO_2 in 'pig iron'.
All the carbon incorporated in the blast furnace is eventually considered to be emitted in CO_2 emissions. All the solid fuels used as reducing agent are included in the solid fuels of 1A2a ass all the incoming solid fuel in the blast furnace is included in the Fuel consumption in 1A2a. A result is a overestimation of the solid fuel consumption in 1A2a as a part of this solid fuel is reducing agent.

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 a large 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 1996 emission factors.
Activity data for the blast furnace gas that is sold to the electricity producers in the Flemish region is allocated to the category 1A1a and not to the category 1A2a. This explains the relatively low implied emission factor for CO_2 for solid fuels in the iron and steel sector.
The CO_2 emissions originating from the combustion of blast furnace gas are included in the category where the energy is used i.e. the category 1A1a.

Category where the Blast furnace gas (TJ) is used in 2012	1A1a Public Electricity	1A2a Iron and steel
Flemish region	17479	0

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

In the <u>Walloon region</u> 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	50 (2)	1,4 (1)
Coke oven gas	Sinter and pelletizing plants	g/GJ	257 (2)	0.1 (1)
natural gas	Blast furnace	g/GJ	2,5 (2)	0.1 (1)
Coke oven gas	Blast furnace	g/GJ	57 (2)	0.1 (1)
blast furnace-gas	Blast furnace	g/GJ	112 (2)	0.1 (1)
Coal	Electric arc furnace	g/GJ	15 (2)	1,4 (1)
Coke breeze	Electric arc furnace	g/GJ	15 (2)	1,4 (1)
Natural gas	Electric arc furnace	g/GJ	2,5 (2)	0.1 (1)

Table 3.6.: CH_4 emissions factors for the different fuels in the iron and steel plants in Wallonia.

Source (1): IPCC 1996
Source (2): EMEP/EEA

In the Walloon region, analyses of a few measurements are available (when above the detection limit). These results confirm that there is not a significant difference between the estimation of emissions based on measurements or on emission factors. Emissions of N_2O can occur and are

conservatively included in the Walloon inventory. These emissions represent only 0,08 % of the CO_2 equivalent emissions of the 1A2a category for 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 2C1 (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 timeseries.

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 1996 and based on analyses (recovered fuels, other specific fuels)	Mainly IPCC 1996 and based on analyses (lime and cement sector)	IPCC 1996
	CH_4 and N_2O	IPCC 1996 and EMEP/EEA (off road)	IPCC 1996 and EMEP/EEA (for some specific fuels, off-road and lime and cement sector)	IPCC 1996 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 1996 emission factors.

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 1996 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		95.9	92.7	92.7			
Coal 2	103.3	95.1	95.7	94.6	102.8						
Lignite		108.2				97.1	97.5	97.0	99.2	99.2	99.2
coke						106.0	106.0				
Petroleum coke	99.8	94.5	92.8	92.8	92.8	99.8	99.8	97.3			
wood								100.0			100.0
Industrial waste	81.7	73.2	92.9	97.6	97.6						100.0
Fuel						76.6	75.4	76.6	76.6	76.6	76.6
Diesel oil	73.7					73.3	73.3	73.3	73.3	73.3	73.3
Natural gas						55.8	55.8	55.8	55.8	55.8	55.8

Table 3.4.: Emissions factors of CO_2 in lime and cement by plant from 1990 to 2004 in Wallonia.

(Source: plant specific emission factors)

The emissions from the use of recovered fuels from cracking units or other processes where a fuel is used as raw material and where a part of this fuel (or transformed product) is recovered for energy purposes, are allocated under category 1A2c/other fuels (only applicable in the Flemish region).

During the 2012 submission, the industrial off-road emissions are included for the first time in the 3 regions for the complete time series. Emissions are calculated for machinery used in , defence, harbours, airports and transhipment companies (category 1A4a), in households (category 1A4b), in forestry and green area (category 1A4c) and industry (category 1A2f).
During the 2014 submission a re-allocation of these emissions took place. No emissions were no longer allocated to the category 1A4a but instead allocated to the category 1A3e (harbours, airports and transhipment companies) and 1A5b (defence). In category 1A2f off-road emission are allocated from industry (incl. construction industry, like previous submissions). Emissions from moto's and quads are allocated to the residential sector (1A4b). The allocation to the other categories remained the same as in previous submissions.

The emissions of CO_2 are calculated with the use of IPCC 1996 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.

As a result of the in-country review in June 2007, the 3 regions did perform a harmonization of the emission factors used to calculate **the emissions of CH_4 and N_2O** in the sector of manufacturing industry and construction (category 1A2).

The emission factors used to calculate the emissions of CH_4 and N_2O in the category 1A2 are for all regions based on those proposed in the Revised 1996 IPCC Guidelines except for some specific fuels (see table 3.5 below).

Emissions of CH_4 and N_2O originating from biomass in the category 1A2 are newly estimated in the Flemish region during the 2010 submission by using the IPCC default emission factors of 30 gCH_4/GJ and 4g N_2O/GJ.

		Flanders	**Wallonia**	**Brussels**	**Flanders**	**Wallonia**	**Brussels**
Fuel	**Unit**	**CH_4**			**N_2O**		
Coal	g/GJ	10	10	10	1,4	1,4	1,4
Coke oven gas	g/GJ	5	5	-	0,1	0,1	-
Coke	g/GJ	-	10	-	1,4	1,4	-
Natural gas	g/GJ	5	5	5	0,1	0,1	0,1
blast furnace-gas	g/GJ	5	5		0,1	0,1	-
Fuel	g/GJ	2	2	2	0,6	0,6	0,6
Diesel oil	g/GJ	2	2	2	0,6	0,6	0,6
Biogas	g/GJ	-	2.5(1)	-	-	0,1	-
Waste gas	g/GJ	-	2,5 (1)	-	-	0,1	-
Industrial waste	g/GJ	-	10 (1)	-	-	1.4 (1)	-

Black liquor	g/GJ	-	15 [1]	-	-	0,6	-
Wood	g/GJ	-	30	-	-	4	-
Biomass	g/GJ	30	-	-	4	-	-
LPG	g/GJ	5			0.1		

Table 3.5.: Emission factors of CH_4 and N_2O in the sector 1.A.2 Manufacturing Industries and Construction.

Source: IPCC 1996 and EMEP/EEA [1]

During the 2011 submission the emissions of CH_4 and N_2O from the cracking units (category 1A2c) are estimated for the first time (it was a 'NE' source until the 2010 submission).
Also some other previous 'NE' sources in the category 1A2 were estimated for the first time during the 2011 submission in the Flemish region. This was the case for the new estimated small emissions of CH_4 and N_2O for 'other fuels' in this category 1A2.

As indicated above, during the 2012 submission, the off-road emissions are included for the first time for the complete time series. The emissions of CH_4 and N_2O are calculated with emission factors of the EMEP/EEA guidebook.

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.

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%.

The uncertainty on emission factors is the same as for energy industries, as the same emission factors are used.

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 are 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 2011 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).

- During the 2014 submission, emissions of N_2O from the iron and steel sector were newly reported for the complete time-series in the Flemish region (category 1A2a). The emissions were calculated based on measurements performed from 2004 on and best estimates based on average concentrations and flow rates for the years before.

- During the 2014 submission the split in emissions of CO_2 between the sectors 'chemical industry' and 'other industries' was optimized for the years 2010, 2011 and 2012 for the 'other fuels' in the Flemish region. The reason for this optimization was a partly wrong allocation of emissions of 'other industries' to the chemical industry because some of these companies also are members of the chemical federation.

- In the Walloon region, there is a mistake in 1A2a in 2010 for the liquid fuels; there was a bad exportation from the software collecter. It has been corrected (- 1766 TJ – 135.3 kt CO_2).

- In the Walloon region, there is a mistake in 1A2e in 2010 for the liquid fuels; the activity data of one plant was double counted. It has been corrected. (- 13 TJ – 0.9 kt CO_2)

- In the Walloon region, there is a mistake in 1A2f in 2010 for the liquid fuels; there was a mistake in an emission factor. It has been corrected. (+ 12.31 kt CO_2)

- In the Walloon region, between 2008 and 2011, the glue is now taken into account in the manufacture of wood panels, category 1A2f (+ 8kt CO_2 in 2008, +6.7 kt CO_2 in 2009, +6.8 kt CO_2 in

2010 and +5.8 kt CO_2 in 2011) and the biomass fraction of some wastes was corrected in the cement sector, the activity data were modified but the emissions were accurate.

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). These densities of road and rail networks should be looked at 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[13]).

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 originating from the transport of natural gas through pipelines are allocated. As from the 2014 submission on offroad emissions that take place in harbours, airports and transhipment companies are newly allocated to this category 1A3e. These emissions were allocated to the category 1A4a (commercial, institutional) before.

The emissions of CO_2 are calculated with the use of IPCC 1996 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.

Since the 2014 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 10.0 - http://www.emisia.com/copert/General.html). The source of these activity data, called 'fuels sold', is the federal petroleum balance. As a result of the UNFCCC in-country review in September 2012, the emissions of CH_4 and N_2O are since the 29th October 2012 submission also calculated according the 'fuel sold' principle (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.

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

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

Road transport (1A3b)

Category 1A3b	Belgium
Activity data	Federal energy statistics (fuels sold)
Methodology emissions CO_2	Emission factors Copert 4
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 % according years) from federal energy statistics to avoid double counting. Offroad consumptions are estimated with 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 v10.0 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 v10.0. consumptions increase due to the use of air-conditioning are now included.

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 2014, regional submissions are almost fully harmonised:

- each region use directly COPERT 4 v10.0 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 use the same module for the assignment of mobility (produced by IRCEL-CELINE).

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

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 1996 EF + correction of missing kerosene for civil / domestic aviation	IPCC 1996	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 by using IPCC 1996 emission factors for the complete time series.

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 2011 (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.

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. A recalculation was performed during the 2013 submission for the years 1990-2007 by switching a part of the kerosene to the gasoline for civil aviation by using an average consumption of gasoline from the years 2008 to 2011.

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 1996	IPCC 1996	IPCC 1996
Emission factors CH_4 and N_2O	IPCC 1996	EMEP/EEA (CH_4) and IPCC (N_2O)	IPCC 1996

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 3.8.: Emissions factors per fuel in railways (EMEP/EEA)

During the 2009 submission the emissions from railways are recalculated using the EMMOSS-model in the Flemish region (http://www.tmleuven.be/project/emmoss/index.htm). The emissions of the air pollutants 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.

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 1996	IPCC 1996	IPCC 1996
Emission factors CH_4 and N_2O	IPCC 1996 (inland waterways) and EF from study Netherlands (sea navigation)	EMEP/EEA	EMEP/EEA

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 in Walloon and Brussels Region, the fuel consumption data are multiplied with IPCC 1996 default emission factors as reported in table 3.1. In the Brussels and the Walloon regions the non-CO_2 emissions are calculated by using emission factors of the EMEP/EEA handbook [3] (tableau 8-1, Bulk emission factors for 'Other Mobile Sources and Machinery', part 1: Diesel engines).

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 1996 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. 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.

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 1996	IPCC 1996	IPCC 1996
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 1996 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 seapipe 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 1B2b.

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 1996 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' 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).

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

- Recalculation of the 2011 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).

- In the category 1A3b road transport: further harmonisation of the COPERT-based models is performed between the regions during the 2014 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, modeling 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.

- As from the 2014 submission on offroad emissions that take place in harbours, airports and transhipment companies are newly allocated to this category 1A3e for the complete time-series. These emissions were allocated to the category 1A4a (commercial, institutional) before.

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 has 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) investigating the most suitable emission factors in the EMEP/EEA guidebook. In the course of 2014 a study will be conducted in the Flemish region to meet the above problem and to further optimize the emission estimates in the category A13a. Representatives of all regions will be involved in this project.

- In the category 1A3b road transport: further harmonisation in the use of COPERT 4 v10.0 is going on between the regions through some specific parameters. The activation of certain COPERT parameters (as lube-oil consumption, CO_2 monitoring and CO_2 emissions from urea consumption in SCR) should be further evaluated and possibly implemented.

- In the category 1A3d navigation, sea-navigation (Flemish Region) : an improvement of the EMMOSS-model will be finished in 2014. Where the emissions of ships for sand extraction, dredging, tug-boats and sea fishery were rudimentary calculated by multiplying an amount of fuel by an emission factor, a more detailed calculation based on movements (AIS-data) will be implemented.

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 from the off-road sector are included in the 3 regions in the categories 1A4 b and c.

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'. Autoproducer units are allocated in the sector itself.
To calculate the emissions of CO_2, all regions use the default IPCC 1996 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 (1)**
Coal	commercial	g/GJ	10
	residential	g/GJ	300
	agriculture heating	g/GJ	300
Natural gas	commercial/residential	g/GJ	5
	agriculture heating	g/GJ	5
Fuel/diesel oil	commercial/residential	g/GJ	10
	agriculture heating	g/GJ	10
	farming vehicles	g/GJ	5
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
	Farming vehicles	g/GJ	10
Lamp petroleum	commercial / residential	g/GJ	10
	agriculture heating	g/GJ	10
Bio liquid fuels	agriculture heating	g/GJ	10
Petrol	agriculture heating	g/GJ	5
Biogas	agriculture heating / commercial	g/GJ	5
wood		g/GJ	300(2)

Table 3.9.: Emission factors of CH_4 for category 1A4 Other sectors (service, residential and agriculture sector).

(1) IPCC 1996
(2) IPCC 2006

Fuel	Subsector 1A4	Unit	N_2O (1)
Coal	commercial/residential	g/Gj	1,4
	agriculture heating	g/GJ	1,4
Natural gas	commercial/residential	g/GJ	0,1
	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
Fuel	fishing activities	g/GJ	0,6
Heavy fuel	Commercial / residential	g/GJ	0,6
	agriculture heating	g/GJ	0,6
Propane/butane/LPG	agriculture heating/commercial/residential	g/GJ	0,1
Lamp petroleum	Commercial / residential	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	g/GJ	0,1
Wood	agriculture heating	g/GJ	4(2)

Table 3.10.: Emission factors of N_2O for category 1A4 Other sectors (service, residential and agriculture sector).

(1) IPCC 1996
(2) IPCC 2006

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 smissions 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,
No re-allocation took place during this submission for off-road emissions in households (category 1A4b) and in forestry and green area (category 1A4c). The emissions of CO_2 are calculated with the use of IPCC 1996 emission factors [28], emissions of CH_4 and N_2O with emission factors of the EMEP/EEA guidebook [3].
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

- Recalculation of the 2011 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).
- During the 2014 submission, Flanders has made recalculations in the category 1A4b (residential) for the use of biomass (for 1990 to 2011) and the use of fuel oil (2002 – 2011) using new data:
    - For biomass (wood consumption), 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].

- During the 2014 submission, some small corrections were made in the Flemish region in the category 1A4c for all fuels (liquid, solid and gas) for the years 2007-2009. It was not clear where these minor glitches were coming from.

- In the Walloon region, there is a mistake in 1A4a in 2006, the coal was missing and has been included (18 TJ - + 1.7 kt CO_2).

- In the Walloon region, recalculation of the biomass consumption in the residential sector (category 1A4b) took place (2002-2010) by using the Survey performed by Belgium with the financial aid of Eurostat.

- In the Walloon region, recalculation on the all time serie of the off-road emissions (liquid fuels) of the forest sector (1A4c) as the wood surface has changed slightly (-0.05 kt CO_2).

- During the 2014 submission a re-allocation of the off-road emissions took place in the category 1A4a (complete time-series): 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.

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 mobile 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 insated 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 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

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

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

No improvements are planned in the category 1A5 in the near future.

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

3.3.1. Fugitive emissions from solid fuels (CRF 1.B.1.)

3.3.1.1 Source category description

In category 1B1/solid fuels the diffuse emissions of CH_4 from mining activities (only located in the Flemish region) in the years 1990-1992 are allocated as well as the diffuse emissions from cokes production.

3.3.1.2 Methodological issues

Coal mining and handling (category 1B1a)

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.

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.

3.3.1.3 Uncertainties and time-series consistency

Fugitive emissions under category 1B1 are 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 2014 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

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 a consequence these CH_4 emissions are allocated in category 1B2a and not in category 1A1b.
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.

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 emission factors for CO_2 and CH_4 for transport of oil in pipelines. The emissions factor used for CO_2 is 4.9E-07 Gg per 103 m^3 oil transported by pipeline and for CH_4 is 5.4E-06 Gg per 103 m^3 oil transported by pipeline.

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.

Gas 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 iv/distribution) is completely harmonised for all the regions in Belgium since the submission in 2004. All information is reported by SYNERGRID, the federation of the grid operators of gas and electricity in Belgium. 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, fugitive emissions of CO_2 from the gas distribution and transmission sector are calculated and added to the inventory (natural gas contains +/- 1% of CO_2) in category 1.B.2.b iv/distribution.

Emissions of CH_4 (category 1.B.2.b.iii/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.

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).
The uncertainty on the amount of gas leaked through the distribution network is high according to page 2.92 of the IPCC Good Practice Guidance. Since the activity data (length of pipelines for the different materials of pipelines) are based on information of the gas distribution company, the uncertainty is estimated at 10%. Emission factors (= leak rates) are based on measurements carried out by this company and their uncertainty is estimated at 30%

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

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

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

No specific recalculations are performed during the 2014 submission in the category 1B2 in Belgium.

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 presented in CRF table 1s2. The emissions of CO_2 reported in this table are estimated as good as possible, depending on the information (activity data) available in the different regions in Belgium.

3.5. International bunkers and multilateral operations

During the 2014 submission the energy data (residual fuel and gasoil) of the marine bunker fuels were revised for the years 2010 and 2011.

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 11. The comparison is made for the years 2008 to 2012 for Belgium.

The sum of emissions in the GHG inventory from the relevant CRF categories is always 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.

In Wallonia, all the process emissions are coming from ETS plants.
The CO_2 emissions from coke and coal incoming in electric arc furnace are included in 1A2a and the amount of coke and coal are included in fuel consumption in 1A2a. 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). These emissions are in the process part of the ETS plant emissions.
In 2008, there were two sinter plants in Wallonia and one of these sinter plants included the coke and the coal emissions in the process part. In the CRF tables, these emissions and the amount of solid fuel were included in 1A2a. This plant closed at the end of 2008 and since 2009, there has been only one sinter plant which reported these emissions in the ETS combustion section.
In the comparison of emissions from the sinter plants, the emissions coming from the limestone and dolomite use are included in 2A3 in the ETS column as in the CRF tables.

In Flanders, the main data source for emissions for large companies are the integrated emission inventory reports in Flanders (yearly obligation for companies when fixed tresholds are exceeded). The data from ETS (CO_2 emissions) have only been used in the inventory for certain categories (mainly electricity plants, iron and steel, also glass industry, ceramic industry). For other categories, only ad hoc checks are carried out. The main reason is that in ETS data not all energy use per site for all companies is fully included in the period 2008-2012, and not all non-energy related emissions are already included. From 2013 on, because of the extention of the scope of ETS, all energy use should be included, also flaring, etc. The goal is to incorporate the data of ETS in energy statistics and CO_2 inventory more extensively from that time on.

There are some difficulties in comparing the data used in the inventory and ETS data :

- A general different approach between ETS-reporting and reporting via integrated emission inventory reports in Flanders i.e. mainly general approach of total consumption of fuels vs emission reporting per stack.

- The allocation of CHP units is not always the same: 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.
- The distinction between process and energy related emissions is different in some cases (for example: in iron and steel, in refineries), hence the allocation in CRF 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 a 'memo item' in the reports so far. Consequently not all companies report this and sometimes not for the complete time-series. Emissions 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 emissions not calculated based on energy use and EF per joule that can give somewhat different results.

The number of ETS sites in Brussels and their contribution to the regional GHG inventory are very limited

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 on energy and emissions is used. The data on the use of other fuels (including waste incineration, flare gas) from the survey are allocated in 2 categories (waste 6C and 1A2c). The typology in ETS is not always comparable to the survey, and 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. In total, survey emission are higher than ETS emissions.

kt CO2	**2008**	**2009**	**2010**	**2011**	**2012**
ETS (other fuels)	**4.175,25**	**3.897,42**	**4.306,91**	**4.213,19**	**3.889,52**
1A2c - other	*3.752,31*	*3.830,54*	*4.043,40*	*3.802,60*	*3.605,60*
waste (6)	*601,69*	*501,17*	*592,00*	*436,65*	*431,96*
total Essenscia survey	**4.353,99**	**4.331,71**	**4.635,39**	**4.239,25**	**4.037,56**
%ETS to survey	*95,9*	*90,0*	*92,9*	*99,4*	*96,3*

2. Refineries

Emissions from the refineries are taken from the integrated environmental reports in Flanders, and compared where possible with the ETS data. There are some differences: in ETS, emissions 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.

3. Iron and steel

Emissions from the companies in the iron and steel are taken from the ETS data. ETS emissions can be divided in 3 categories, see table below.

	2008	2009	2010	2011	2012
ETS total	7.991	5.986	8.203	8.185	8.452
energy	2.635	2.100	2.791	2.711	2.532
process	2.151	1.478	1.781	1.477	1.415
blast furnace gas for electricity production	3.205	2.408	3.631	3.997	4.505

In the inventory, blast furnace gas for electricity production is allocated under 1A1a and not under 1A2a. The definition of process emissions also differs in ETS and in CRF. In CRF, only emissions from the conversion from iron to steel and the use of electrodes are considered as process emissions. Also the emission from production of coke is not reported separately in the ETS data.
Furthermore, the emissions of CO_2 originating from the use of liming in the iron and steel sector is allocated to the category of process emissions 2A3 in the CRF-tables.

In the following table, the allocation of iron and steel emission is presented. In total, the emission in CRF are slightly higher than in ETS.

	2008	2009	2010	2011	2012
CRF total	8.030	6.001	8.223	8.210	8.478
1A1a - solid fuels	3.205	2.408	3.631	3.997	4.505
2B (proces)	1.044	778	709	356	375
1A1c (cokesproduction)	161	131	159	159	161
1A2a	3.514	2.618	3.619	3.590	3.354
2A3 (lime stone use in iron and steel)	105	66	105	108	82

CHAPTER 4: INDUSTRIAL PROCESSES (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 announcements of closure 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 are not related to the combustion of fossil fuels. Also the process emissions of F-gases are included in this sector.

The main process emissions of CO_2, CH_4 and N_2O are calculated in Belgium by using production figures, mainly originating directly from the industrial plant, combined with emission factors presented in reference works like IPCC 1996 Guidelines [28], EMEP/EEA handbook [3], CITEPA [2] or other specific bibliographies or calculated via monitoring results carried out by the industrial companies in Belgium.
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 2012, these emissions of greenhouse gases were mainly caused by mineral products (42% of emissions of which 38% just for cement and lime production) and the chemical industry (32% of emissions of which 16% just for nitric acid and ammonia production). Fluorinated gases accounted for 22% of total emissions in this sector while metal production only represents 4% (sharply down from 2009 due to economic crisis).

Mineral products
These emissions occur during the production of clinkers and lime (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 37% in 2012 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). However this is partly counterbalanced by an increase in CO2 emission from other products.

Metal production
In the iron and steel sector, greenhouse gas emissions decreased by 77% in 2012 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 2.1% of total greenhouse gas emissions in 2012. 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 (Figure 4.1) 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.

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.

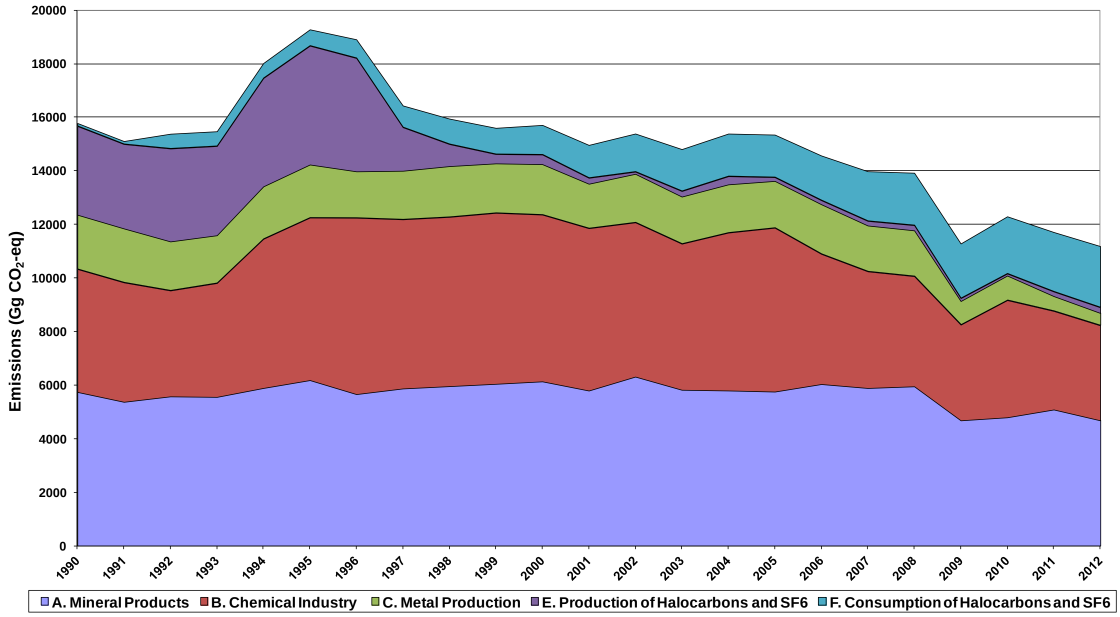


Figure 4.1: GHG emissions in sector 2 'Industrial processes': changes from 1990 to 2012 (Gg CO_2 equivalent)

4.1.3. Overall recalculations in the sector of industrial processes

The tables below give the quantitative recalculations in the sector of industrial processes (category 2) compared to previous submission in November 2013:

Recalculations in category 2A mainly due to:

- Flemish region: the missing emissions of CO_2 of one company in the category 2A7 was added for the years 1990-2004.

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

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	0,27	0,19	0,78	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	%	0,01	0,01	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	Gg CO_2 eq.	0,65	0,65	2,22	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Walloon region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	Gg CO_2 eq.	0,65	0,65	2,22	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Recalculations in category 2B mainly due to:

Flemish region: the processemissions in the chemical industry (category 2B5) were revised for the year 2011.

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	2006	2007	2008	2009	2010	2011
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11,98
Walloon region	%	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,03
Belgium	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	9,79

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Flemish region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,02	0,00	0,00	328,07
Walloon region	Gg CO_2 eq.	0,15	0,15	0,14	0,17	0,16	0,17	0,12	0,09	0,10	0,16
Belgium	Gg CO_2 eq.	0,15	0,15	0,14	0,17	0,16	0,17	0,14	0,09	0,10	328,23

No recalculations took place in the categories 2C and 2E.

Recalculations in category 2F mainly due to:

- The R134a stock of domestic refrigerators in 2011 and the corresponding fugitive emissions have been revised.
- For refrigeration "installations", the figures (existing stock, the Amount charged into new systems, Amount of systems at time of disposal and the emissions) have been revised for the complete time series.
- The end of life recovery from used cars has slightly changed for 2011.
- For 2011, the amount in systems at time of disposal for Bus & coaches has been revised.
- The HFC consumption and stock of fire extinguishers in 2011, as well as the corresponding emissions, have been corrected.
- The HFC consumption for manufacturing and the corresponding actual and potential emissions of technical aerosols have been enhanced for 2011.
- For the semiconductor industry, the potential emissions have been recalculated, on the basis of new activity data.
- Actual and potential emissions of SF6 from sport shoe soles have been included (concerns the period up to 2006).

2.F-Consumption of Halocarbons and SF6,,,Emissions,Aggregate GHGs (HFCs, PFCs, SF6),(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	8,23	3,46	0,50	0,47	0,35	0,90	1,73	2,98	3,95
Flemish region	%	5,83	2,54	0,46	0,44	0,34	0,85	1,68	2,72	3,68
Walloon region	%	6,41	2,99	0,52	0,49	0,37	0,97	1,85	3,09	3,99
Belgium	%	6,20	2,76	0,48	0,46	0,35	0,89	1,74	2,86	3,80

Relations to previous submission (Gg CO_2 eq.)

		1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	3,53	0,00	0,71	0,73	0,61	1,66	3,39	5,95	8,12
Flemish region	Gg CO_2 eq.	19,37	16,31	4,35	4,40	3,73	9,83	19,95	33,67	46,76
Walloon region	Gg CO_2 eq.	11,52	9,75	2,42	2,43	2,02	5,56	11,15	19,14	25,58
Belgium	Gg CO_2 eq.	34,41	29,06	7,49	7,57	6,36	17,06	34,49	58,76	80,47

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 (limestone and dolomite use in the iron & steel sector, in the electric power installations and in the sugar plants), category 2A4 (Soda Ash Production and Use) and category 2A7 (glass and ceramics) which are taking place in the Flemish and the Walloon region.
The activities 'other/production of glass and ceramics' are allocated to the sector 2A7 following discussions in the Working Group 1'Annual inventories' of the Climate Change Committee.

4.2.2. Methodological issues

The mineral industry is the most important sectors of industrial process emissions in Belgium and contributes now to 42% of sector emission in 2012.

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

This source is a key category for CO_2 emissions both for level and trend assesment.

The Walloon region had 5 sites producing cement clinker during 2012.

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 2 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	5752	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
Clinker production (kt)	4869
IEF clinker (kg CO_2/t)	543
CO_2 emissions (kt)	2642

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 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	760	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	1921	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	725	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	794	779	774	775
CO_2 emissions (kt)	2070	2144	2072	2228	2018	2139	2040	2054	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
Lime (kt)	1254
IEF lime (kg CO_2/t)	713
Dolomite lime (kt)	837
IEF dolomite lime (kg CO_2/t)	858
% dolomite lime prod	40
IEF global (kg CO_2/t)	772
CO_2 emissions (kt)	1612
CO_2 biomass emissions (kt)	65.85

Table 4.2: Lime and dolomite lime production in Wallonia.

The limestone and dolomite use (**category 2A3**) includes the process CO_2 emissions in the sinter plants, the flue-gas desulphurisation in electric power installations (2 in the Flemish region), in sugar plants (2 installations in the Walloon region) and in ceramic plants (4 installations in the Walloon region).

This category doesn't include the source categories in which CO_2 emissions are produced via limestone use in glass production and ceramic production (limestone fraction in the relevant raw materials). The allocation of these emissions is performed in category 2A7 to improve the harmonisation of reporting across EU Member States (discussions during the WG1 'annual inventories' of the Climate Change Committee).

The emissions reported in category 2A3 are collected directly from individual plants and are subject to independent review in the framework of the Emission Trading Scheme.

The methodology to calculate the emissions from the use of limestone in the sinter plants are described below:

Since 1990, sinter production has declined sharply in Wallonia. In 1990, there were 4 sinter plants and in 2011, the last sinter plant was closed.

Until 2002, these emissions are calculated by using an IPCC 1996 emission factor of 200 kg CO_2/ton sinter. The emissions calculated involved combustion and process emissions. As the fuel consumption was known, combustion emissions were calculated and reported in the energy sector (fuel consumption x emission factor (table 3.1) and the remaining emissions were reported in the process sector ((200 kg CO_2/ton sinter) X (production of sinter) – (combustion emissions). These process emissions are originating from additive in the furnace as limestone. From 2005 on, CO_2 emissions (process and combustion 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 the table 4.3. 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)	189	165	200	201	199	200	200	200	200	200	200
CO_2 total emissions (kt)	1602	1256	1281	1102	1062	1235	1038	1131	1244	1239	1311
CO_2 combustion emissions (kt)	1221	1129	1050	880	725	786	692	789	864	724	1010
CO_2 process emissions (kt)	381	127	231	223	337	449	345	342	380	515	301
IEF process (kg CO_2/kt)	45	17	36	41	63	73	66	61	61	83	46

	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
CO_2 total emissions (kt)	1396	1593	1582	1375	1179	1144	1071	1117	91	395	320
IEF total (kg CO_2/kt)	200	213	214	212	219	213	223	213	165	239	211
CO_2 combustion emissions (kt)	1105	907	1241	1148	919	903	852	857	72	309	241
CO_2 process emissions (kt)	291	686	341	228	260	242	219	260	18	86	79
IEF process (kg CO_2/kt)	42	92	46	35	48	45	46	50	42,4	52	52

Table 4.3: Sinter production and related emissions of CO_2 in Wallonia (1990-2011).

In the Flemish region, the process emissions originates from (1) production of fluid pig iron (category 2C1), (2) amount of lime used directly in the sinter factory to fix the alkalinity of the slags and (category 2A3) (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 (category 2A3). The emission factors used in these last 2 categories are listed below.

kg CO_2/t	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
lime in gridded mixture (sinter factory indirect)	71	70	73	69	68	65	67	64	63	61	59
lime (sinter factory direct)	416	416	416	416	416	416	416	416	416	416	416

kg CO_2/t	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Lime in gridded mixture (sinter factory indirect)	57	60	58	57	57	60	63	61	67	62	58	65
lime (sinter factory direct)	416	416	416	416	413	420	418	418	412	414	412	410

Table 4.4: Emission factors (kg CO_2/ton) in the Flemish region for the process emissions of CO_2 originating from the use of lime in the biggest steel plant in the iron and steel sector.

The CO2 emission in the category "Soda Ash production and Use (category 2A4)" are included in the sectors 2A3 (gas epuration in sugar plants), 2A7 (glass production) and 2B5.

The **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. From stochiometric considerations, the industrial process emission of CO_2 associated with the 'Solvay Process' is zero. The excess CO_2 emitted from soda ash production originated from coke oxidation is included in the combustion sector.

The **use** of Soda Ash is already included in other categories. 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, 2A7 and 2B5) is higher than the figure in the comtrade statistics report..

The emissions of CO2 from the **category 2A5** (Asphalt roofing) are not estimated as there is no methodology available in the IPCC guidelines. Emissions from this source category are likely to be extremely small in relation to national emissions.

The emissions of CO2 from the **category 2A6** (Road paving with asphalt) are not estimated, as there is no methodology available in the IPCC guidelines. Emissions from this source category are likely to be extremely small in relation to national emissions.

The CO_2 emissions in the category '**2A7 Mineral products / other**' contains the process emissions of the glass and ceramic industry in Belgium. Activity data contained in the Belgian inventory are aggregated from the data reported below.

The production of glass (category 2A7) 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.

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 the 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

	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	167	198
IEF container glass (kg CO_2/t)	102	102	105	100	97	100	101	109	99	101	103
Glass wool (kt)	148	143	164	192	90	96	97	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**	**153**	**134**	**133**	**133**	124	**125**	**122**
CO_2 emissions (kt)	198	214	215	220	235	234	226	232	173	192	198

	2012
Flat glass (kt)	1008
IEF flat glass (kg CO_2/t)	133
Container glass (kt)	158
IEF container glass (kg CO_2/t)	193
Glass wool (kt)	87
IEF glass wool (kg CO_2/t)	186
IEF global (kg CO_2/t)	54
CO_2 emissions (kt)	**136**

Table 4.5.: Glass production and related emissions of CO_2 in the Walloon region (1990-2012).

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 2A7. 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. This table is complete as far as information was available for all companies involved. Although the emissions of CO_2 are complete, some activity data are still missing for some companies and years in this sector.
The recycled glass is part of the AD of the table 4.6.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
total glas ton	431919	400752	411482	409097	433029	439198	433666	371753	388377	328441	345516
total glasfiber ton	15723	18357	20214	21389	27000	25656	27000	28350	33078	28467	38206
total enamel ton	20745	20652	20301	19046	20111	15142	18335	19191	19042	18933	21236
tkton CO_2 glass	64	54	55	56	58	59	60	51	53	45	46
kton CO_2 glasfiber	2	2	3	3	3	3	3	4	4	4	5
kton CO_2 enamel	1	1	1	1	1	1	1	1	1	1	2
total kton CO_2	67	57	59	60	63	64	65	56	59	50	52
IEF glas (kg CO_2 /ton)	148	134	134	136	135	135	138	138	137	136	133
IEF glasfiber (kg CO_2/ton)	125	125	125	125	125	125	125	125	125	125	125
IEF enamel (kg CO_2/ton)	71	71	71	71	71	71	71	71	71	71	71

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
total glas ton	365435	362734	352586	373781	377619	355885	350470	318377	278993	283490	268333	183290
total glasfiber ton	32556	39463	40680	42504	39913	47288	55269	59485	35266	53315	56993	50145
total enamel ton	21888	20863	18475	20933	18743	21143	20479	18051	16900	17375	14541	13851
tkton CO_2 glass	47	48	27	29	33	31	30	29	27	28	26	19
kton CO_2 glasfiber	4	5	5	6	6	7	8	8	6	8	9	8
kton CO_2 enamel	1	1	1	2	1	2	2	1	1	1	1	1
total kton CO_2	53	55	34	37	40	40	40	39	33	37	35	28
IEF glas (kg CO_2/ton)	129	133	78	78	88	86	86	92	95	98	95	103
IEF glasfiber (kg CO_2/ton)	125	125	125	143	143	150	148	134	159	148	151	157
IEF enamel (kg CO_2/ton)	64	69	73	76	74	79	77	83	76	73	90	81

Table 4.6: Glass (and enamel) production and related emissions of CO_2 in the Flemish region (1990-2012).

As mentioned above, the recycled glass are part of the AD presented in table 4.5 and table 4.6. These AD represent the amount of glass produced by the ovens. The calculation of CO_2 emissions doesn't taking 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 process emissions of CO_2 originating from the **ceramic sector** are also put in the category 2A7 Mineral products / other for the complete time series.

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**
ceramic production (kton)	2621	2624	2562	2613	2732	2797	2837	2598	2161	2225	2324	1987
IEF (kg CO_2/t)	67	57	60	68	71	72	71	79	80	55	61	69
CO_2 emissions (kton)	177	151	155	177	193	200	201	206	173	122	141	137

Table 4.7: Ceramic production and related emissions of CO_2 in the Flemish region (1990-2012).

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
Ceramic production (kt)	412
IEF (kg CO_2/kt)	22
CO_2 emissions (kt)	9,3

Table 4.8: Ceramic production and related emissions of CO_2 in the Walloon region (1990-2012).

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 (carbonates and / or organic carbon) in the raw materials on one hand and with the desired ceramic end-product (technical and functional requirements) on the other end. Traditionally the clay from Antwerp (Boom) is used for fast-construction and the loam/mud is used for outside front stones. These different raw materials cause differences in process emissions of CO_2. This explains mainly the differences in implied emission factors between the Flemish and the Walloon region. Even within different sub-regions big differences in emissions can occur.

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 annexe 9).

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

- During this 2014 submission, the activity data in category 2A7 (glass production) were optimized in the Flemish region for the complete timeseries. Missing activity data of 1 company was added for the entire timeseries. Besides this, the missing emissions of CO_2 of this company were added for the years 1990-2004.

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 one of the most important sectors in industrial processes in Belgium and contributes to 32% in 2012 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) and 2B5 (other). These activities take place both in the Flemish and the Walloon regions. In category 2B5 'other in the chemical industry' a.o. the production of maleic anhydride is included for the Walloon region and the production of caprolactam and other process emissions reported by the chemical industry (f.e. the production of ethylene oxide, acrylic acid, …) for the Flemish region.

4.3.2. Methodological

4.3.2.1. Ammonia production (category 2B1)

Nowadays 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 (55,8 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. A part of the process CO_2 emissions is used by two other plants. The uses of these process CO_2 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 declare 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.

As a result of the Centralized review in September 2013 (new results were submitted on 11th November 2013 to UNFCCC), A correction to the emission estimates of CO_2 was made for this category:Until the 2013 submission, Belgium was using the methodology in the Revised 1996 IPCC

Guidelines (Emission (kt) = Consumption of gas (kt) x carbon content x 44/12 to estimate CO_2 emissions from ammonia production. However, Belgium applied also an oxidation factor of 99.5 per cent. Belgium agrees with the recommendation formulated by the ERT and did recalculate the emissions of CO2 originating from the production of ammonia. This recalculation did no longer include the use of the oxidation factor of 99.5% as in previous submissions. Consequently the new methodology used is completely in line with the Revised IPCC 1996 Guidelines. 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 2011 the lowest emission factor for the complete time series of 1,17 kg N_2O/ton HNO_3 was registered in the Flemish region.

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. 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.

No emission factors and N_2O emissions are presented by region as there is only one company by region involved.

4.3.2.3. Other (category 2B5)

This source is a key category of CO_2 and N_2O emissions in terms of emissions level and trend.

In the other chemical industrial processes the following emissions are allocated:

(1) the emissions of CO_2 originate from the production of 1,2 dichloromethane and vinychloride in the Walloon region (10,22 kt in 2012). The CO_2 emissions decreases between 2008 and 2010 as the production of anhydride maleic and phtalic was stopped in 2009 in the Walloon region. The emissions are estimated by the chemical industry;

(2) the emissions of N_2O originate mainly from the production of caprolactam. 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;

(3) 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;
Since there is only one producer of carbon black 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 2B5/other;

(4) some small process emissions of N_2O (20 kton CO_2 eq in 2012) and CH_4 (4 kton CO_2 eq in 2012) 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.

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.
An exception on this rule are the emissions of CO_2 reported in the category 2B5/other in the Flemish region. So far, several contacts with the chemical federation did not give the expected result: the data and emissions reported in this section may not be released in detail and need to be treated in an aggregated way.

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

- Belgium agrees with the recommendation formulated by the ERT during the 2013 centralized review and did recalculate the emissions of CO_2 originating from the production of ammonia (category 2B1). This recalculation did no longer include the use of the oxidation factor of 99.5% as in previous submissions. Consequently the new methodology used is completely in line with the Revised IPCC 1996 Guidelines.
- during the 2014 submission, the processemissions in the chemical industry (category 2B5) were revised for the year 2011 in the Flemish region (an extra 328 kton CO_2 was added compared to previous submission).

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 production (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 regions.
Metal production, more specific the iron and steel production (category 2C) is usually the third most important sector of industrial process emissions in Belgium and contributed to about 12% in 2008 of greenhouse gas emissions in this sector of industrial processes. But because of the economic crisis in 2009, this share was reduced to 4% in 2012.

4.4.2. Methodological issues

The category 2C1 includes the emissions of CH_4 from sinter production (Flemish region) and the process emissions of CO_2 from the iron and steel sector (Flemish and Walloon regions). The emissions from the use of limestone in the sinter factory are allocated in the category 2A3.
Other emissions from the iron and steel sector are allocated to the category 1A2a (energy emissions) and category 1A1c (emissions of production of coke).
All activity data recorded in this sector (fluid steel, pig iron, sinter and cokes) originate directly from the companies involved.

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

The methodologies used to estimate the emissions of the iron and steel sector are described below for the 2 regions involved. Because different approaches approved by the different companies involved (a.o. based on historical background) it is not possible to harmonize these methodologies completely between the regions.

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 are reported in category 2A3. These changes resulted in an increase of process emissions of CO_2The process emissions originates from (1) production of fluid pig iron (the emission factors used are listed below in table 4.9.) (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, are re-allocated to the category 2A3 instead of 2C1 before.

kg CO_2/t	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
fluid pig iron	170	170	170	170	170	170	170	170	170	170	170

kg CO_2/t	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
fluid pig iron	170	170	170	170	170	170	171	171	169	170	NA	NA

Table 4.9: Emission factors used in the Flemish region to calculate the process emissions of CO_2 during the production of fluid pig iron in the biggest steel plant in the iron and steel sector.

The 2nd 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 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.

Table 4.10 gives an overview of the production figures of sinter and steel in the Flemish region.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
sinterproduction in kton	5267	5250	4461	4803	5260	5230	5160	5468	5541	5366	5601
steel production in kton	4226	4370	3654	4026	4375	4417	4513	4680	4702	4793	4686
Emissions CH_4 (ton)	0	0	0	0	0	0	0	0	0	0	0

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
sinterproduction in kton	4524	5752	5195	6300	6300	5800	6500	5336	3659	5248	5349	5044
steel production in kton	3658	4620	4676	5836	5481	5941	5306	4975	3535	5071	5084	4759
Emisisons CH_4 (ton)	24	0	0	416	1964	2699	2750	2291	842	605	479	704

Table 4.10: Iron and steel production in the Flemish region (1990-2012).

In the Walloon region, the last integrated iron and steel plant (blast furnace-oxygen furnace) was closed in 2011. Five electric arc furnaces are operational in 2012.
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 weresubsequently used as fuels for energy purposes in the integrated plant.

To estimate CO_2 emissions from the blast furnace and the basic oxygen furnace, an energy balance and a CO_2 balance were performed on the blast furnace. All the carbon in the coke and the coal brought in the blast furnace is supposed to be converted to CO_2 and in C in the pig iron. All the C in the pig iron is supposed to be emitted by the basic oxygen furnace. All the incoming solid fuel in the blast furnace are included in the Fuel consumption in 1A2a. The difference between the CO_2 emissions from the blast furnace from all the solid fuels and the CO_2 emissions emitted by the pig iron are included in 1A2a. The CO_2 emissions emitted by the pig iron (basic oxygen furnace) are included in 2C1. A result is a overestimation of the solid fuel consumption in 1a2a as a part of this solid fuel is reducing agent.
Until 2004, to estimate the amount of C in the pig iron, the plants approved an emission factor of 169 kg/t. The emission factor in the basic oxygen furnace steel plant was the following :
(Production of pig iron) X (169 kg/t pig iron) / (production of steelThese emission factors are indicated in table 4.11.

Since 2005, CO_2 emissions have been obtained directly by the obliged reporting of the plants under the emission trading scheme. As regarding the table 4.11, the CO_2 emissions calculated with the emission factor of 169 kg/t pig iron are comparable to the CO_2 emissions from the ETS monitoring plans (Comparison of the line 'CO_2 emission by calculation with the pig iron production (kt)' with the line 'CO_2 emission by the ETS plants (kt)'. The time series consistency is ensured.

Concerning the electric arc furnaces, CO_2 emissions have been obtained directly by the obliged reporting of the plants under the emission trading scheme. They take into account the carbon storage in the steel and also the emissions from burning electrodes and scrap iron. An average emission factor was estimated using the data from 2005 to 2010 and is applied for the complete time-series 1990-2004. 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 CO_2 emissions from coke and coal incoming in electric arc furnace are included in 1A2a and the amount of coke and coal are included in fuel consumption in 1A2a. 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). An example of the solid fuel consumption is presented in the table 4.11 for the year 2012. Since 2005, the plants have given the information. Therefore, the average emission factor was calculated without the CO_2 emissions from solid fuels and to be coherent on the time serie, these emissions from solid fuels are maintained in 1A2a,

The amount of CO_2 emissions coming from the solid fuel in the arc furnace includes in 1A2a is also presented in the Annex 9 : Comparison between data reported under the ETS-Directive and CRF-tables for the years 2008 to 2012.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Pig iron production (kt)	5958	5746	5719	4782	5437	5672	5084	4351	4827	5011	4835	4853	4298	4408	3908
C in pig iron (% weight)	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4,6	4.6	4.6
CO_2 emission factor (kg/t pig iron)	169	169	169	169	169	169	169	169	169	169	169	169	169	169	169
Steel production by basic oxygen furnace (kt)	6652	6518	6184	5388	5976	6133	5402	4490	5099	5076	4984	5058	4529	4576	4073
CO_2 emission factor (kg/t steel) basic oxygen furnace (obtained by calculation)	151	149	152	153	154	156	132	163	160	157	163	162	160	164	162

Steel production by electric arc furnace (kt)	691	660	602	901	1170	1143	940	1757	1733	1604	2171	2149	2406	2155	2086
CO_2 emission factor (kg/t steel) electric arc furnace	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	30	22

		2005	2006	2007	2008	2009	2010	2011
Pig iron production (kt)		3132	3197	2663	3289	336	873.9	779
CO_2 emission by calculation with the pig iron production (kt) (old methodology)	Production of pig iron) X (169 kg/t pig iron	*529*	*540*	*450*	*556*	*57*	*147*	*132*
Steel production by basic oxygen furnace (kt)		3139	3376	2885	3373	331	899.7	891
CO_2 emission factor (kg/t steel) basic oxygen furnace	CO_2 emission by the ETS plants)/(steel production)	168.3	158	156.8	156	165	162	160
CO_2 emission by the ETS plants (kt)		528	533	452	526	55	145.8	142
Steel production by electric arc furnace (kt)		1843	2584	2836	2569	1883	2162	2176
CO_2 emission factor (kg/t steel) electric arc furnace		32	31	33	33	13,7	18.93	19

	2012
Steel production by electric arc furnace (kt)	2222
CO_2 emission factor (kg/t steel) electric arc furnace	31
CO_2 emission by the ETS plants (kt) (2C1)	68,41
Solid fuel consumption (TJ) (1A2a)	636
CO_2 emission from the solid fuel by the ETS plants (kt) (1A2a)	69.3

Table 4.11: Emission factors used in the iron and steel sector in the Walloon region (Source: plant specific /Institut Wallon)

CH_4 and N_2O emissions of the iron and steel sector in the Walloon region are included in the energy sector (emission factors as recorded in table 3.6). See section 3.2.7. for more information.

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

No source-specific recalculations took place in Belgium during the 2014 submission in the category 2C (Metal production).

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. Production and consumption of halocarbons and SF_6 (CRF 2.E and 2.F)

4.5.1. Source category description

The production of halocarbons and SF_6 takes place only in the Flemish region.
The emissions are produced by a single chemical plant and are almost all fugitive emissions.

Under consumption of halocarbons and SF_6, emissions are mainly HFC emissions from refrigeration and air conditioning. Other sources are foam blowing, aerosols, fire extinguishers, as well as soundproof glazing and electrical plants.

The emissions of categories 2E and 2F (production and consumption of halocarbons and SF_6) have increased by 4.7% compared to 2011 and now contribute to 22% of total greenhouse gas emissions in the sector of industrial processes in Belgium. This share continues to grow (20% in 2011), as a result of both a slight increase of categories 2E and 2F and a slight decrease of all other categories of process emissions.

4.5.2. 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].

The present contribution of F-gases to the total GHG emissions covered by the Kyoto Protocol (2.1% in 2012) is significantly lower compared to 1995 (3.3%), mainly thanks to abatement measures in the chemical industry in the late nineties. Since 1999, the total F-gas emissions have been progressively increasing every year (except in 2005, which can entirely be explained by the reduction of PFCs in the chemical industry and in 2009, where they remained practically stable), as a result of the current regulations relating to the substitution of ozone depleting substances.

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 2012 can be considered as time consistent for the complete time series.

4.5.2.1. Production of halocarbons (2E)

This source is a key category of SF_6, CF_4, C_2F_6 and C_5F_{12} emissions in terms of emissions trend.
The emissions of category 2E (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 and mainly in the electronic industry. The emissions of this key 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 2012 at about 212 kt CO_2 equivalents (for the gases covered by the Kyoto Protocol), down from 4.4 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).

4.5.2.2. Consumption of halocarbons (2F)

This source is a key category of HFC-134a, HFC143a and HFC-125 emissions both in terms of level and trend assesment for 2F1 "Refrigeration and Air Conditioning Equipment".
Emissions of fluorinated greenhouse gases 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. These emissions are allocated to category 2F.

As explained in [45], the potential emissions of each substance for each application are calculated as production plus consumption minus the amount recovered, the stock variation being neglected.

The actual emissions of HFCs come from the following categories: refrigeration (industrial & commercial and household refrigerators) and air conditioning equipment (in stationary applications and in vehicles), foams (closed cell foams, polyurethane cans and foams in refrigerators/freezers), Metered Dose Inhalers (MDI), aerosols other than MDIs and fire extinguishing (fixed installations).

For the refrigeration sector, emissions have been estimated separately for the following source categories: industrial and commercial installations, household refrigerators, air conditioning of private cars, air conditioning of buses and coaches, and refrigerated transport. 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. These data are used for calculating the ‘product’ potential emissions as well as the assembly emissions.

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. The consumption and emission of refrigerants are modelled on the basis of an annual inquiry among refrigerant suppliers on their national supply by refrigerant mixture, as well as on assumptions on average loss rates, from which the estimated supply for refilling vehicles is subtracted. 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

$$E_{end-of-life,t} = M_{t-d} \bullet \frac{p}{100} \bullet \left(1 - \frac{\eta_{rec,d}}{100}\right)$$

where:

$E_{end\text{-}of\text{-}life,\,t}$ = amount of HFC emitted at system disposal in year t, kg
$M_{t\text{-}d}$ = 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' together (industrial and commercial refrigeration plants and large stationary air conditioning plants that are filled on site). The lifetime is assumed to be 15 years, which is an average. Disposal emissions of HFC 125 and HFC 143a only appear for the year 2010, as they have only started to be used in 1995.

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 (cars, buses and coaches).

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.

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 are obtained from Federplast.be (Belgian Association of Plastics and Rubber Converters). They are collected separately for the manufacture of polyurethane foam (PUR), One-Component-Foam (OCF) and extruded polystyrene (XPS).

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.

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, except for 2011 and 2012, where 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 the literature. Assuming a 20 years lifetime, disposal emissions will appear for the first time in 2013.

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.

The former CFC aerosol market has practically completely moved to alternative propellants, 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.

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.

SF_6 emissions from the electricity sector are small (11,3 kt CO2-eq in 2012). 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. Emissions from stock are based on figures on the stock of SF6 and on emission factors provided by the production sector (source: FEBEG), the transport sector (ELIA) and the distribution sector (source: SYNERGRID). For 2012, the corresponding emission factors are 0.12%, 0.84% and 0.03% respectively. As the equipment lifetime is assumed to be 40 years [78] disposal emissions are not expecte before 2015, except for those of one significant plant in the transport sector that has been dismantled in 2011.

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 of glazing 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.
Category 2F9 'Other non-specified' 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%).

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%).

In total, the 'Kyoto' HFC gas emissions expressed in tonnes CO_2-equivalents, have gradually increased (+377% between 1995 and 2012), as a result of the current regulations related to CFC and HCFC substitution. The refrigeration sector is by far the main emission source.

4.5.3. Uncertainties and time-series consistency

4.5.3.1. Production of halocarbons (2E)

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).

4.5.3.2. Consumption of halocarbons (2F)

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.

4.5.4. Source-specific QA/QC and verification, if applicable

Standard QA/QC and verification activities take place in the sectors 2E and 2F.

4.5.5. 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 1995-2011 are the following:

- The R134a stock of domestic refrigerators in 2011and the corresponding fugitive emissions have been revised.
- For refrigeration “installations”, the figures (existing stock, the Amount charged into new systems, Amount of systems at time of disposal and the emissions) have been revised for the whole period, for several reasons:
    - A revision of the assumptions on the refrigerant mix in systems at time of disposal.
    - Disposal emissions of room air conditioning appliances have been included. The stock data of these appliances have also been adapted, by taking into account the consumption of earlier years than 2005.
    - The emissions of Transport refrigeration, which used to be included in this category, are now taken up in CRF Reporter as a separate category.
- The end of life recovery from used cars has slightly changed for 2011.
- For 2011, the amount in systems at time of disposal for Bus & coaches has been revised.
- The HFC consumption and stock of fire extinguishers in 2011, as well as the corresponding emissions, have been corrected.
- The HFC consumption for manufacturing and the corresponding actual and potential emissions of technical aerosols have been enhanced for 2011.
- For the semiconductor industry, the potential emissions have been recalculated, on the basis of new activity data.
- Actual and potential emissions of SF_6 from sport shoe soles have been included (concerns the period up to 2006).

4.5.6. 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.

4.6. Other (CRF 2.G)

4.6.1. Source category description

In this category 2G the process emissions of indirect greenhouse gases and SO_2 are reported.

4.6.2. Methodological issues

As a result of the in-country review performed by the expert review team of UNFCCC in June 2007, the emissions reported in category 2G during the previous submissions were no longer included in the Belgian emission inventory since the 2008 submission. In this category 2G the emissions from the non-energy use of fuel were reported, estimated by using the IPCC default emission factors of carbon stored during the use of lubricants and solvents.

Following the advice of the expert review team, these emissions of CO_2 from the use of solvents and lubricants only arise when they are burned or destroyed. As a consequence these emissions are excluded out of the Belgian emission inventory during the 2008 submission and the emissions of CO_2 in the base year decreased with 415,544 kton CO_2.
The emissions reported in this category are some minor process emissions of indirect greenhouse gases and SO_2 from industries which could not be allocated to other CRF categories (automobile industry, fine mechanical & optical industry, textile industry, plastic industry, …)

4.6.3. Uncertainties and time-series consistency

Not applicable.

4.6.4. Source-specific QA/QC and verification, if applicable

Not applicable.

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

Not applicable.

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

Not applicable.

CHAPTER 5: SOLVENT AND OTHER PRODUCTS USE (CRF SECTOR 3)

5.1 Overview of sector (e.g., quantitative overview and description)

5.1.1. Source category description

In Belgium the emissions of NMVOC in the source category 'Solvent and other product 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 CO_2 equivalent emissions of the solvent consumption is carried out in Belgium.

The greenhouse gas emissions in this category 3 are related in Belgium to the use of N_2O as anaesthetics and in aerosol cans.

5.1.2. Methodological issues

The regions in Belgium are using comparable methodologies to estimate the emissions of solvent and other product use in their region.
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. 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 1996 IPCC Guidelines.

The emission calculation for the emission of N_2O from anaesthesia (3D1) is based on the number of hospital beds in Belgium and the average consumption of anaesthetics per bed. The emission factor is 10,3 kg N_2O/bed/year. This factor was determined by inquiries carried out in 1995 by the independent consultant agency Econotec [39].
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 DGASS (General Directorate for Health and Social Action) and from the Health Public Federal Service.

The entire time series has been actualized in March 2014 for Wallonia to take into account the new activity data obtained from the Health Public Federal Service. Recalculation is included in 15th April submission. Concerning activity data, the number of beds are provided below.

	Wallonia	Brussels	Flanders	Belgium
1990	19 161	9 524	32 963	61 648
1991	19 102	9 269	32 672	61 043
1992	19 078	9 014	32 611	60 703
1993	18 957	8 759	32 528	60 244
1994	18 133	8 504	32 481	59 118
1995	17 917	8 249	31 755	57 921
1996	17 817	8 197	31 727	57 741
1997	17 657	8 146	31 596	57 399
1998	17 506	8 094	31 303	56 903
1999	17 511	8 043	30 970	56 524
2000	17 112	7 991	30 802	55 905
2001	17 041	8 037	30 705	55 783
2002	16 852	8 083	30 509	55 444
2003	16 867	8 128	30 416	55 411
2004	16 756	8 174	30 362	55 292
2005	16 754	8 161	30 267	55 182
2006	16 703	8 073	30 231	55 007
2007	16 672	8 178	30 174	55 024
2008	16 692	8 178	30 139	55 009
2009	16 717	8 089	30 096	54 902
2010	16 707	7 977	30 088	54 772
2011	16 707	7 974	30 068	54 749
2012	16 677	7 944	30 028	54 649

The N_2O emissions from fire extinguishers (3D2) are not estimated because of a lack of activity data.

The N_2O emissions from aerosol cans (3D3) are newly 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 over time. 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.

5.1.3. Uncertainties and time-series consistency

3D1 N_2O from anaesthesia

The activity data is the number of hospital beds, which is well known. As no default emission factor is available by EMEP/EEA nor by the IPCC Guidelines [10], a national specific emission factor has been estimated through surveys in hospitals. The uncertainty on this emission factor is considered high.

3D3 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 but this sector was included in 3D.

5.1.4. 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.

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

The following recalculations have been performed during the 2014 submission in the category 3 in Belgium:

- In the Flemish region the emissions of NMVOC of polyurethane processing and polystyrene foam processing were recalculated based on more detailed information from the industrial companies.
- In the Walloon region, several recalculations were made in order to ensure the consistency of the time series (see IIR for the detailed description of the recalculations of the Solvent and Other Product Use Sector). Among them, the emissions of the wood preservation sector have been estimated for the years 1990 to 1999.
- The N_2O emissions from aerosol cans (category 3D3) are newly estimated for the complete timeseries in Belgium (following EU-QAQC).
- New activity data (number of beds obtained from the Health Public Federal Service) has been taken into account in the Walloon region for the complete timeseries to estimate the emissions of N_2O from anesthesia.

The table below give the quantitative recalculations of the emissions of N_2O in the sector 'Solvent and other product use' (category 3) compared to previous submission in November 2013.

3-Solvent and Other Product Use,,,Emissions,N2O,,(Gg)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	2,41	2,74	2,86	2,93	3,00	3,00	3,05	3,14	3,25	3,34
Flemish region	%	4,14	4,39	4,59	4,75	4,78	4,82	4,86	4,91	4,94	4,99
Walloon region	%	-18,14	-17,56	-36,23	-37,46	-37,62	-37,72	-37,63	-37,52	-37,54	-37,52
Belgium	%	-4,22	-3,77	-12,76	-13,29	-13,37	-13,38	-13,33	-13,29	-13,30	-13,26

Relations to previous submission ($Gg\ CO_2$ eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	0,73	0,72	0,73	0,76	0,77	0,78	0,80	0,81	0,83	0,85
Flemish region	Gg CO_2 eq.	4,36	4,45	4,51	4,59	4,62	4,65	4,68	4,72	4,75	4,79
Walloon region	Gg CO_2 eq.	-14,11	-12,72	-32,48	-33,58	-33,73	-33,82	-33,74	-33,64	-33,66	-33,64
Belgium	Gg CO_2 eq.	-9,02	-7,54	-27,24	-28,23	-28,34	-28,39	-28,26	-28,11	-28,08	-28,00

5.1.6. 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 ‘Solvent and other product use’ in the near future.

CHAPTER 6: AGRICULTURE (CRF SECTOR 4)

6.1. Overview of the sector

6.1.1. Description of the sector

The evolution (1990-2012) in Belgium of the main categories of livestock and cultivation business and their numbers are represented in the tables 6.1 and 6.2. Those data are available on a yearly basis and are used as one of the activity data for the agricultural sector. Table 6.1 gives an overview of the main types of cultivation in Belgium. These data originate from ‘Statistics Belgium’. Table 6.2 gives the evolution of the livestock.

The land used for agriculture in 2012 extends to 1 333 913 hectares (Table 6.1) or 44% of Belgium. In 2012, the number of agricultural and horticultural businesses amounted to 38 559. This number had dropped by 38% since 2000. The disappearing of small businesses being 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 2012 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 54 ha per farm in the Walloon region. 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 4.5% of the total area in 2012 (7.6 % in Wallonia, 0.8 % 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
Number of businesses	86962	72660	61705	51540	42854	39528	38559
Usable agricultural area (ha)	1357366	1368135	1394083	1385582	1358019	1337303	1333913
Cropland	760559	851770	864076	842999	834388	824783	802772
Grains (ha) (without maize)	327226	282427	277702	267975	276571	255654	274605
Wheat (ha)	205050	196828	204022	204209	209532	190875	206639
Sugarbeet (ha)	107837	98810	90858	85527	59303	62199	61165
Potatoes (ha)	49255	57417	65845	64952	81760	82341	66975
Maize (ha)	140066	183274	202120	218081	238844	245565	237688
Permanent Grassland (ha)	578626	495253	506946	519096	499687	488924	507237

Table 6.1.: Main types of cultivation in Belgium in 1990-2012.

	1990	1995	2000	2005	2010	2011	2012
Cattle	3248780	3286233	2993819	2664101	2627441	2569688	2501737
Dairy cattle	838697	684464	581462	494743	464311	455454	455345
Non-dairy cattle	2410083	2601769	2412358	2169358	2163130	2114234	2046392
Sheep	192133	157570	123943	118644	104560	98388	106264
Goats	8700	8872	13226	24021	30880	32668	34797
Horses	21141	23944	41440	43668	52538	50597	53555
Mules and asses	189	259	4878	6539	8770	8706	8892
Swine	6700422	7268492	6895306	6161195	6624836	6591315	6655857
Poultry (total)	27166776	33381390	36860444	32036898	32558931	32330971	33825782
other	23745	31293	76187	54884	64500	61189	63775

Table 6.2.: Number of heads in the main livestock categories in Belgium in 1990-2012.

Climate:
With an average temperature of 10.6°C in 2012 (http://www.meteo.be/meteo/view/nl/10275209-2012.html), Belgium as a whole has a 'cool' climate.

6.1.2. Allocation of emissions

Three source categories occur in the agricultural sector:

- Category 4.A enteric fermentation: CH_4 emissions;
- Category 4.B manure management: CH_4 and N_2O emissions;
- Category 4.D Agricultural soils: N_2O emissions.

Some agricultural sectors such as rice cultivation, prescribed burning of savannahs (categories 4.C and 4.E) and field burning of agricultural residues (category 4.F) are not occurring (NO) in Belgium.

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 0.14 % of the national figure. Keeping in mind the large uncertainty on Belgian agricultural emissions, and according to the recommendations of the UNFCCC in-country review of September 2012, the emissions in the Brussels region are estimated with IPCC default equations (Tier 1 approach) and some mean emission factors based on the other regions.

6.1.3. Trend assessment

GHG emissions from agriculture (without fuels used) account in 2012 for 8.0% of the total emissions in Belgium. Overall (including emissions from energy sector 1A4c), they have decreased by 19.9 % between 1990 and 2012.

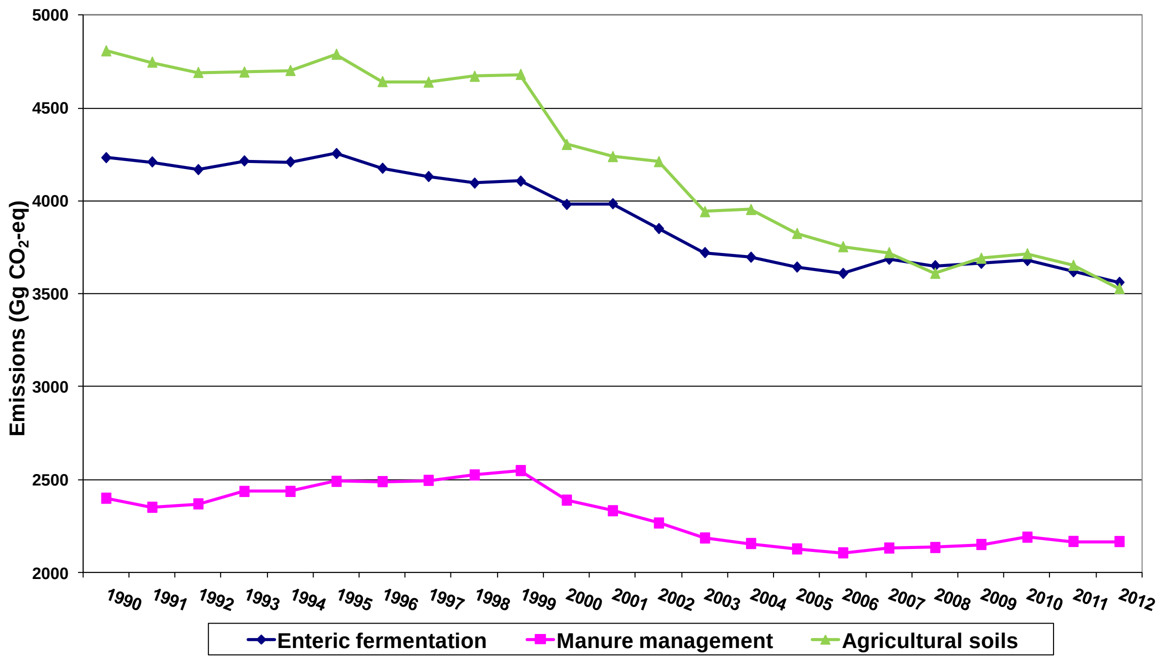


Figure 6.1 Emission trends in agriculture

38.5% of these emissions (without fuel used) are CH_4 emissions from enteric fermentation (category 4A) in 2012, cattle are for 93% responsible for these emissions. As can be seen in figure 6.1 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.

23.4% of the emissions are CH_4 emissions from manure management in 2012 of which swine accounts for the biggest part (77%). 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.

38.1% of the emissions in the agriculture are originating from N_2O emissions from soils. Those have decreased by 23%, due to the smaller quantities of nitrogen from mineral fertiliser applied on the one hand and to the livestock reduction (nitrogen excreted on pasture) on the other hand. Both reductions have also an impact on indirect emissions.

6.1.4. Data sources

The main activity data are the livestock figures, agricultural land area and edible crop production of N-fixing and non-N-fixing crops. '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.

Edible crop production of N-fixing and non-N-fixing crops:
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 6.3 gives an overview of the production data of the main types of crops in Belgium from 1990-2012. 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
	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
Barley	5752	6639	6864	7548	8333	7695	8060
Maize	39950	35785	38723	38425	37362	35749	33804
Potatoes	34492	37502	44376	42813	42267	50142	41979
Sugar beet	59520	61540	67710	69957	75288	86962	78974
Fodder beet	90560	93650	99840	99118	95797	106376	89544
chicory	39540	38884	45494	45039	48366	54581	47687

Table 6.3. Production data of the main types of cultivation in Belgium in 1990-2012.

Livestock numbers:
The livestock numbers are the primary activity data used in the calculation of CH_4 and N_2O emissions. The numbers originate from the agricultural census which is available on: http://statbel.fgov.be/nl/modules/publications/statistiques/economie/downloads/landbouw_-_landbouwgegevens_van_2012.jsp. These data are available for and used by the three regions (see annex 9, table 9.1(a-c)). Table 6.4 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

Table 6.4. Origin of the livestock numbers in the three regions.

In Flanders, however, 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 6.5 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, after the year 2007, no further comparison has been made.

	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 6.5 Consistency check of CH_4 emission with STATBEL and VLM animal numbers in Flanders.

6.1.5. Overall recalculations in the agricultural sector

The tables below give the quantitative recalculations in the agricultural sector and subsectors compared to previous submission in November 2013.

<u>Category 4A Enteric fermentation</u>:

Recalculations in emissions of CH_4 in category 4A due to:

Flemish region: revision of livestock from 2007 on.
Brussels region: revision of livestock values for 2011.

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,87
Flemish region	%	0,00	0,00	0,00	0,00	0,00	-0,23	-0,09	0,45	0,50	0,63
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	%	0,00	0,00	0,00	0,00	0,00	-0,12	-0,04	0,23	0,26	0,32

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02
Flemish region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	-4,34	-1,60	8,28	9,46	11,59
Walloon region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Belgium	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	-4,34	-1,60	8,28	9,46	11,61

<u>Category 4B Manure management</u>:

Recalculations in emissions of CH_4 and N_2O in category 4B due to:

Flemish region: revision of livestock from 2007 on.
Brussels region: revision of livestock values for 2011.

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	6,75
Flemish region	%	0,00	0,00	0,00	0,00	0,00	-0,07	-0,02	0,05	0,09	0,23
Walloon region	%	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,20
Belgium	%	0,00	0,00	0,00	0,00	0,00	-0,05	-0,01	0,04	0,07	0,22

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
Flemish region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	-1,06	-0,32	0,83	1,51	3,75
Walloon region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,07
Belgium	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	-1,06	-0,32	0,83	1,51	4,83

<u>Category 4D Sludge spreading</u>:

Recalculations in emissions N_2O in category 4D (sludge spreading) due to:

Walloon region: update activity data sludgespreading complete timeseries.

For the other minor recalculations in category 4D: see section 6.4.5.

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Walloon region	%	-100	414,31	411,07	338,98	286,63	314,30	549,74	466,84	588,84	668,19
Belgium	%	-100	414,31	411,07	338,98	286,63	314,30	549,74	466,84	588,84	668,19

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Flemish region	Gg CO_2 eq.	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Walloon region	Gg CO_2 eq.	-0,458	1,889	1,894	1,560	1,321	1,431	2,510	2,117	2,657	2,940
Belgium	Gg CO_2 eq.	-0,458	1,889	1,894	1,560	1,321	1,431	2,510	2,117	2,657	2,940

Category 4 Total Agriculture:

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	-2,72	-2,32	-1,05	-0,45	-1,02	-0,56	-0,15	0,00	-0,20	-29,13
Flemish region	%	0,00	0,00	0,00	0,00	0,00	0,05	-0,04	0,16	0,21	-1,07
Walloon region	%	-0,01	0,05	0,04	0,19	0,15	0,04	0,08	0,07	0,30	-0,01
Belgium	%	-0,01	0,02	0,02	0,09	0,07	0,05	0,01	0,12	0,25	-0,61

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	-0,06	-0,05	-0,02	-0,01	-0,01	-0,01	0,00	0,00	0,00	-0,43
Flemish region	Gg CO_2 eq.	0,00	0,00	0,00	0,00	0,00	2,67	-2,00	8,39	11,36	-57,31
Walloon region	Gg CO_2 eq.	-0,70	2,50	1,84	8,22	6,56	1,87	3,34	2,81	12,43	-0,45
Belgium	Gg CO_2 eq.	-0,76	2,45	1,83	8,22	6,55	4,53	1,34	11,20	23,79	-58,18

The recalculations for Brussels Region are due to :

- a recalculation of the cultivated agricultural area (2011)
- a revision of average annual biomass yields for some crops (all years)

6.2. Enteric fermentation (CRF 4.A)

6.2.1. Source category description

Because in Flanders and Wallonia, CH_4 emissions from enteric fermentation are a key source category for cattle, a Tier 2 approach is required in both regions. The Tier 2 methodology is used for cattle since the 2008 submission. This methodology is based on the IPCC 1996 Guidelines (IPCC 1996 GL) and harmonized between the two regions. Seen the few amount of cattle in Brussels, the Brussels Region uses a Tier 1 methodology as described in the IPCC 1996 GL.

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 1996 GL [28]. Enteric fermentation emissions from poultry are not estimated. The IPCC Guidelines do not provide an emission factor for poultry. This is due to the negligible amount 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 6.6 gives an overview of the methodologies used in the three regions.

Used methodology	Flanders	Wallonia	Brussels
Key sub-source category (4.A.1)	IPCC 1996 GL (Tier 2)	IPCC 1996 GL (Tier 2)	IPCC 1996 GL (Tier 1)
Non key sub-source categories (4.A.3, 4.A.4, 4.A.6, 4.A.7, 4.A.8, 4.A.10)	IPCC 1996 GL (Tier 1)	IPCC 1996 GL (Tier 1)	IPCC 1996 GL (Tier 1)

Table 6.6. Overview of the methodologies used in the three regions

6.2.2. 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 1996 GL is used. The region of Brussels has used the Tier 1 methodology and emission factors as described in the IPCC 1996 GL (table 4-3) in order to estimate these emissions.

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) = $\sum EF(\text{kg } CH_4/\text{animal}_{\text{category } x}) * \text{animal number}_{\text{category } x}$

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 * 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, feeding (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 and Wallonia can be found. The different steps and the formulas used are hereunder discussed in detail.

Animal population
The cattle population is divided into slightly different groups in Flanders and Wallonia as can be seen in table 6.7.

Net energy for Maintenance
The average animal weight and weight gain used for the estimation of the net energy for maintenance (NE_m) originate in Flanders from the *Department Agriculture and Fishery* and in Wallonia from average weights published by the federal finance department.

Subcategories	Average weight (kg)	Weight gain (kg/day)	Coefficient C
Flanders			

Slaughter calves	162	1.100	1.2
Bovine under 1 year	184	0.750	1
Bovine between 1 and 2 years	427	0.700	1
Bovine more than 2 years	660	0.250	1
Dairy cows	600	0.650	0.8
Brood cows	600	0.650	0.8
Wallonia			
Bovines under 6 months	164	0.700	1.2
Bovines between 6 months and 1 year: male	184	0.700	1.2
Bovines between 6 months and 1 year: female	184	0.650	0.8
Bovines more than 1 year for fattening: male	427	0.700	1
Bovines more than 1 year for reproduction: male	617	0.700	1.2
Bovines more than 1 year: female	501	0.650	0.8
Dairy cows	600	0.650	0.8
Brood cows	600	0.650	0.8

Table 6.7. Average weight, weight gain & coefficient C (for Net Energy for growth calculation) for the different cattle categories in Flanders and Wallonia.

Net energy for Feeding

For the calculation of the net energy for feeding (NE_{feed}) in Wallonia a coefficient 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 of 0% is used, considering the animals are kept inside their entire lifetime. Dairy cows and brood cows spend 42% of the year on pasture and the other bovine 40%. Resulting in a coefficient respectively of 7.14% and 6.8%.

Net Energy for growth

The formula used for the calculation of the net energy for growth originates from the IPCC Good Practice Guidance, equation 4.3a. The coefficient C in the equation 4.3a is detailed by category and by region in the Table 6.7. 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 en 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 6.10). The milk production by brood cows is taken 4.66kg milk/day.head in both regions. Equation 4.5a from the IPCC Good Practice Guidance 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 both regions, for dairy and brood cows, a coefficient of 0.8 is applied. Assuming that only 80% of this subcategory is actually pregnant each year. This is the default assumption provided on page 4.18 of the IPCC Good Practice Guidance.

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 6.8 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 6.8. 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 23.05 kg milk/day/cow in 2012 (see also table 6.10.). For non-dairy cows 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 Flanders and Wallonia a methane conversion rate (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 emission factors for all categories with exception for dairy and brood cows stay constant over the entire time series (table 6.9). For dairy cows the emission factor increases with increasing milk production, from 102.66 kg CH_4/head in 1990 to 132.20 kg CH_4/head in 2012. The implied emission factor for non-dairy cattle increases from 42.91 kg CH_4/head in 1990 to 47.56 kg CH_4/head in 2012.

Table 6.9 shows the emission factors used in the three regions for the different cattle types in 2012. Table 6.10 gives the evolution of the milk production and IEF for dairy cattle in Flanders and Wallonia.

Subcategories	Emission factor (kg CH_4 / head)
Flanders	
Slaughter calves	2.74
Bovine under 1 year	25.80
Bovine between 1 and 2 years	47.16
Bovine more than 2 years	50.45
Brood cows	82.27
Dairy cattle	140.06
Wallonia	
Bovine under 6 months	20.2

Bovine between 6 months and 1 year: male	24.8
Bovine between 6 months and 1 year: female	26.9
Bovine more than 1 year for fattening: male	48.7
Bovine more than 1 year for reproduction: male	61.3
Bovine more than 1 year: female	57
Brood cows	82.4
Dairy cattle	122.7
Brussels	
Dairy cattle	100
Non-dairy cattle	48

Table 6.9. Emission factor for each animal category (2012).

Dairy cattle	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**
Flanders							
Milk production in Flanders	10.99	12.81	15.99	19.00	22.93	23.26	23.05
IEF for methane in Flanders	101.57	107.57	117.93	127.78	139.79	140.69	140.06
Wallonia							
Milk production in Wallonia	11.35	12.59	13.93	15.26	17.41	18.18	17.55
IEF for methane in Wallonia	100.79	104.54	108.59	112.60	119.10	121.41	122.7

Table 6.10. Milk production (kg milk/cow/day) and IEF (kg CH_4/cow/yr) for dairy cattle in Flanders and Wallonia (1990-2012).

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 1996 emission factors in table 4-3 of the Guidelines are used for all non-key sub-source animal categories. The classification of the animal categories occurs according to the IPCC 1996 methodology.

Table 6.11 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 6.11. The emission factors (kg CH_4/head) for the different non key sub-source categories.

6.2.3. 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.

6.2.4. 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.

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

- As a result of the centralized UNFCCC review of September 2013, the ERT recommended Flanders and Wallonia to calculate the net energy for pregnancy of dairy cows (and not only for brood cows). Therefore, for the 2014 submission, the net energy for pregnancy of dairy cows is taken into account. The method, parameters and equation 4.8 as described in the IPCC Good Practice Guidance is used. In both regions, the assumption is made that 80% of the mature females give birth in a year. This recalculation results in Flanders in an increase of the methane emission from enteric fermentation of maximum 1.406 Gg CH_4 and in Wallonia in an increase of maximum 1.22 Gg CH_4.
- Also as a result of the centralized UNFCCC review of September 2013, in Wallonia the net energy of lactation of non-dairy cows is taken into account. Following the methods, parameters and equation 4.5a from the IPCC Good Practice Guidance, this results in an increase of maximum 4.7 Gg CH_4.
- In Flanders, from 2007, animal numbers have slightly changed. This results is a small decrease of the methane emission from enteric fermentation of max 0.203Gg in 2007 to a small increase of the methane emission from 0.084Gg in 2010.
- In Brussels, livestock values for 2011 were revised.

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

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

6.3. Manure management (CRF 4.B)

6.3.1. 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 6.12 gives an overview of the methodologies used in the three regions.

Used methodology	**Flanders**	**Wallonia**	**Brussels**
CH_4 manure management 4.B(a)			
- key sub-source categories 4.B.1 and 4.B.8	IPCC 1996 GL (Tier 2)	IPCC 1996 GL (Tier 2)	IPCC 1996 GL (Tier 1)
- non key sub-source categories 4.B.3, B.4.4, 4.B.6, 4.B.7, 4.B.9	Region specific	Region specific	IPCC 1996 GL (Tier 1)
N_2O manure management 4.B(b)			
- all source categories	IPCC GPG 2000	IPCC GPG 2000	IPCC GPG 2000

Table 6.12. 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 1996 Guidelines (IPCC 1996 GL) and is harmonized between the two regions, Flanders and Wallonia. Although sheep, goats, poultry, horses, mules and asses are no key sub-source categories, however a region specific approach is used.
Considering the urban character of the Brussels region and the very limited contribution of the agricultural sector to the total regional greenhouse gas emissions, a Tier 1 approach has been implemented (IPCC 1996 GL) for all animal categories.
Camels, llamas and buffalo do not occur in Belgium. Therefore 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 Good Practice Guidance 2000 (IPCC GPG 2000).
N_2O-emissions from manure produced by grazing animals are not taken into account in the source category 4.B, but are included in the source category Agricultural Soils (4.D). This as described in the IPCC 1996 Guidelines.

6.3.2. Methodological issues

6.3.2.1 Methane

<u>Key sub-source categories</u>
Because CH_4 emissions from manure management are a key source category for swine and previously for cattle, a Tier 2 approach is required and used in the Flemish and Walloon Region. As explained above, the Brussels Region uses the Tier 1 methodology as described in the IPCC 1996 GL.

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 16 of the IPCC 1996 GL 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 15 of the IPCC 1996 Guidelines.

VS (kg dm/day) = GE_{intake} (MJ/day) * (1kg /18,45MJ) * (1-DE%/100) * (1-ASH%/100)
where:
GE_{intake} = Daily average feed intake (MJ/day);
DE% = Digestibility of the feed (%)
ASH% = Ash content of the manure (%).

Table 6.13 gives an overview of the factors and IEF used in Flanders and Wallonia, in 2012. 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 1996 GL.

Volatile solids excreted by swine are not derived as described in the IPCC 1996 Guidelines (equation 4.15), 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. DE% is taken 75%, ash content of the manure and Bo are defaults (IPCC 1996 GL). For the Walloon region, these data are downloadable at: http://www.nitrawal.be/upload_files/3.1.1%20PGDA/AGW%20PGDA%2031%2003%2011.pdf.
For Flanders these data originate from the www.varkensloket.be. This portal is the information centre for Flanders' pig farmers.

As can be seen in table 6.13, the IEF for dairy cattle in Flanders (21.03 kg CH_4/head) is considerably higher than in Wallonia (12.73 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 Region 24% is liquid storage and 32% solid. In the Flemish Region this is 39% liquid and 19% 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 2012 this is 23.05 kg milk/cow/day. In Wallonia this is 17.55 kg milk/cow/day. This has an important effect on the gross energy (GE) intake, which is 356 MJ/day in Flanders and 289 MJ/day in Wallonia. This GE is one of the region specific factors used to calculate the CH_4 IEF from manure management.

Subcategories	GE (MJ/day)	ASH (%)	VS (kg dm/day)	Bo (m^3/kg of VS)	Implied Emission Factor (kg CH_4/head)
Flanders					
Slaughter calves	50	8	0.25	0.17	1.96
Bovines under 1 year	66	8	0.82	0.17	1.93
Bovines between 1 and 2 years	120	8	1.49	0.17	3.53
Bovines more than 2 years	128	8	1.60	0.17	3.77
Dairy cattle	356	8	4.36	0.24	21.03
Brood cattle	209	8	2.61	0.17	8.90
Piglets from 7 to 20kg	NE	NE	0.16	0.45	3.17
Fattening pigs from 20 to 110kg	NE	NE	0.48	0.45	9.54
Fattening pigs from more than 110kg	NE	NE	0.63	0.45	12.73
Boars	NE	NE	0.63	0.45	12.73
Sows including piglets less than 7kg	NE	NE	0.61	0.45	9.97
Wallonia					
Bovines under 6 months	51	8	0.26	0.17	0.23
Bovines between 6 months and 1 year: male	63	8	0.77	0.17	0.61
Bovines between 6 months and 1 year: female	68	8	0.85	0.17	0.76
Bovines more than 1 year for fattening: male	124	8	1.54	0.17	1.37
Bovines more than 1 year for reproduction: male	156	8	1.94	0.17	2.45
Bovines more than 1 year: female	145	8	1.81	0.17	2.28
Dairy cattle	287	8	3.58	0.24	11.41
Brood cattle	174	8	2.31	0.17	1.77
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 6.13.Overview of the factors used in 2012 to calculate the CH_4 emission from manure management for cattle and swine in Flanders and Wallonia.

The methane conversion factors for each manure management system (Table 6.14) are harmonized between the two regions and originate from the IPCC GPG 2000 (Table 4.10) or the IPCC 2006 Guidelines [54] (table 10.17). The IPCC 2006 Guidelines are used for the MCF of liquid and solid storage because this reflects better the actual situation. For liquid storage the MCF 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 solid storage*	2%
MCF poultry manure	1.5
MCF pasture, range and paddock	1%

*: IPCC 2006 Guidelines

Table 6.14.: 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 originate in Flanders from the Manure Bank of the Flemish land Agency (VLM). In Wallonia, 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 6.17a-b under nitrous oxide emissions.

Non key sub-source categories

Sheep, goats, poultry, horses, mules and asses are no key source categories. The methodology used is region specific and different for the three regions. Therefore they will be discussed separately.

Flanders

CH_4 emissions from manure management for the non-key source categories in Flanders are estimated using a region specific methodology.
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.
In the box below the formula used for the estimation of CH_4 emissions from manure management can be found as well as the source of the different factors used.

CH_4 emission (m³) = number of animals * average weight(1) (kg) * integrator(2) * manure production(2&3) (kg/day/1000kg) * 365/1000 * volatile solid(3) (%) * emission potential(3) (m³/kg VS) * MCF(4) (%)

[[(1) Source: Department Agriculture and Fishery; (2) Source: Flemish Land Agency; (3) Source: Casada & Safley [53], (4) see table 6.10].

CH_4 emission (ton) = CH_4 emission (m³) * 0.662 kg/m³

For poultry the slaughter weight and an integrator (value less than 1) are used (see table 6.15) taking into account that the weight of the poultry over the whole lifetime is not the same as the slaughter weight. The integrator integrates therefore between the weight at birth and the slaughter weight.
For the other animal types, the average weight is known, and therefore the integrator is 1. The MCF values are weighted averages depending on the different manure management systems for one category (see table 6.14 and table 6.17a).

Category	Slaughter weight	Integrator	Manure production (kg/d/1000kg)	VS	Emission Potential	MCF (%)
	(kg)			(%)	(m^3/ kg VS)	
Sheep	50	1	40	23	0,19	4.42
Goats	50	1	41	26.6	0,17	4.42
Horses	500	1	51	19.6	0,33	1
Mules	200	1	51	19.6	0,33	1
Poultry						
Broilers (for breeding)	2	1	85	19.4	0,32	2
Broilers (for fattening)	1,3	0,52	85	19.4	0,32	2
Laying hens	2	1	85	19.4	0,32	1.78
Young laying hens	1,3	0,52	85	19.4	0,32	1.78
Ducks	2,5	0,54	85	19.4	0,32	1.5
Goose	7,5	0,65	47	19.4	0,3	1.5
Turkeys	7	0,49	47	19.4	0,3	2
Guinia fowl	1,2	0,55	85	19.4	0,32	2

Table 6.15.: Calculation factors used for the CH_4 emissions from manure management in the Flemish region (Source: Department Agriculture and Fishery, Flemish Land Agency, Casada & Safley [53]).

Wallonia

Emission factors for other non-key sub-source animal categories in the Walloon region have been developed by Siterem [30]. Those factors take into account the type and volume of manure produced during the time spent in stables, its density and carbon content, and its carbon volatilisation ratio. The parameters come from studies conducted in Wallonia or France. Those emission factors are multiplied by the number of animals to estimate the total emissions from manure management.

The resulting implied emission factors (table 6.16 hereunder) are comparable to the default EF as given in the IPCC 1996 GL.

The change between 1990 and 2005 is linked to the changes in AWMS between 1990 and 1996 (see table 6.17b presented under nitrous oxide emissions).

Brussels

The region of Brussels has used the Tier 1 methodology as described in the IPCC 1996 GL to calculate the methane emissions from the non-key sub-sources categories.

<u>Trend in implied emission factor</u>

The table below gives a summary of the evolution of the IEF's of the main animal categories in the 3 regions.

The IEF for manure management of dairy cattle increased significantly between 1990 and 2012. 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.

Flanders	1990	1995	2000	2005	2010	2011	2012
IEF (kg CH_4/head.yr)							
Cattle							
Dairy cattle	15.25	16.15	17.71	19.19	20.99	21.12	21.03
Non-dairy cattle	3.34	3.59	3.71	3.78	3.77	3.77	3.76
Swine	7.67	7.51	8.04	7.97	7.94	7.94	7.93
Sheep	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Goats	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Horses	4.03	4.03	4.03	4.03	4.03	4.03	4.03
Mules	2.02	2.02	1.61	1.61	1.61	1.61	1.61
Poultry	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Wallonia							
Cattle							
Dairy cattle	9.8	10.15	11.94	12.37	13.06	13.31	13.11
Non-dairy cattle	1.54	1.59	1.71	1.79	1.81	1.81	1.84
Swine	5.56	5.59	5.22	4.94	4.73	4.71	4.70
Sheep	0.25	0.25	0.26	0.25	0.26	0.26	0.24
Goats	0.25	0.25	0.25	0.26	0.26	0.25	0.25
Horses	2.03	2.03	2.03	2.03	2.03	2.03	2.03
Mules	IE	IE	IE	IE	IE	IE	IE
Poultry	0.11	0.08	0.07	0.08	0.08	0.08	0.08
Brussels							
Cattle							
Dairy cattle	14	14	14	14	14	14	14
Non-dairy cattle	6	6	6	6	6	6	6
Swine	3	3	3	3	3	3	3
Sheep	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Goats	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Horses	1.39	1.39	1.39	1.39	1.39	1.39	1.39
Mules	NO	NO	NO	NO	NO	NO	NO
Poultry	0.078	0.078	0.078	0.078	0.078	0.078	0.078

Table 6.16.: Methane implied emission factor (kg CH_4/head/yr) for manure management for the main animal categories (1990-2012) in the three regions.

6.3.2.2. Nitrous oxide

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 liquid, solid, daily spread, pit storage below animal confinements and other systems (poultry manure without bedding) are IPCC defaults from table 4.12 and 4.13 from the IPCC GPG 2000 (respectively 0,001; 0,02; 0; 0,001; 0.005 kg N_2O-N/kg N excreted).

The method used in the three regions is fully in compliance with the IPCC GPG 2000. N_2O emissions from manure produced by grazing animals are not taken into account into category 4.B but are included in the category 4.D, agricultural soils, as described in the IPCC 1996 Guidelines.

The model used for the calculation of the emissions has been developed in a simple excel format. A copy of the excel file regions can be found in annex 3 of this report and is similar and given for the three regions. The model integrates the three N_2O sources: emissions from manure management, discussed here, indirect and direct emissions discussed below in 6.4.2.

N-excretion factors:
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 the ratio of liquid systems, solid storage, daily spread and other.
In Belgium, the local excretion factors are more or less comparable to the IPCC 1996 default value, especially if the principle of table 4.14 of the IPCC GPG 2000 is taken into account. The adjustment factors from the revised IPCC 1996 GL: reference manual table 4-20, are given according to the age range. The three regions use different N-excretion factors. Therefore tables 6.17a-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 2012 are described in the manure decree of December 2006 (or MAP3):
http://www.vlm.be/SiteCollectionDocuments/Publicaties/mestbank/bemestingsnormen_2013.pdf.
Unfortunately no translation in English is available.
For dairy cows, in MAP3, these N-excretion factors depend on the average milk production per cow.
Till 2006 the N-excretion factors of the manure action plan (MAP2bis) are used.

Wallonia
In Wallonia N-excretion factors were first determined 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
The Brussels region uses the default values for N-excretion as described in the IPCC 1996 GL table 4-6.

Animal waste management system (AWMS):
The animal waste management systems used in Belgium differ slightly between the three regions. In all three regions swine and poultry stay 100% of their lifetime in house. Cattle (with exception of slaughter calves) spend more or less 50% of their lifetime on pasture.
The differences between the regions and the origin of the data are given in the tables 6.17a-c hereunder.

Flanders
In Flanders the allocation of animals to AWMS originate form the Manure Bank (VLM). Table 6.17a 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% liquid storage
Other bovine under 1 year		
for replacement	33	24% liquid storage 36% solid storage 40% pasture ditto
other bovine	22.3	ditto
Bovine from 1 to 2 year		
for replacement	58	ditto
other	58	ditto
Bovine more than 2 years	77	ditto
Dairy cows	116	39% liquid storage 19% solid storage 42% pasture
Brood cows	65	39% liquid storage 19% solid storage 42% pasture
Sheep & goats		
Sheep & goats under 1 year	4,36	19% liquid storage 81% pasture
Sheep & goats more than 1 year	10,5	ditto
Swine		
Piglet from 7 to 20 kg	2.29	96% liquid storage 4% daily spreading
Fattening pigs from 20 to 110 kg: 2 phase feeding	11.14	ditto
Fattening pigs from 20 to 110 kg: 3 phase feeding	11.14	ditto
Fattening pigs more than 110 kg	21.49	ditto
Boars	21.36	ditto
Sows including piglets less than 7 kg	21.50	76% liquid storage 24% solid storage
Horses		
Horses and pony less than 200 kg	35	96% pasture 4% other
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)	0.44	85% solid storage 15% other
Broilers (parental animals)	1.13	ditto
Broilers (for fattening)	0.53	ditto
Laying hens (for breeding)	0.33	44% storage within housing 23% solid storage 33% other
laying hens	0.80	ditto
Turkeys (for fattening)	1.70	100% solid storage
Turkeys (parental animals)	2.00	ditto
Ostriches (between 0-3 months)	3.5	ditto
Ostriches (for fattening)	8.6	ditto
Ostriches (for breeding)	18	ditto
Other poultry	0.24	ditto

Table 6.17a: Nitrogen excretion factors and allocation of animals to AWMS for each category in Flanders (2012).

Wallonia

In Wallonia, 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 6.17b. 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 a s dairy cows. An update of the 1996 data would likely be useful in the near future. So far we have no information about the STATBEL planning an update.

The last column of the table gives the ratio per animal category of in housing system versus pasture.

Animal category	Nex (kg N/animal/yr)	1992	1992	1996	1996	1992 & 1996
		Solid manure	Liquid manure	Solid manure	Liquid manure	stable vs pasture
		(%)	(%)	(%)	(%)	(%)
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
Dairy cows	120,5	63	37	56	44	56
Brood cows	97,8	93	7	91	9	50
				0		
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
				0		
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
		0		0		
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
				0		
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 6.17b: Nitrogen excretion factors and allocation of animals to AWMS for each category in Wallonia . Evolution between 1992 and 1996 data from STATBEL.

Brussels
The animal waste management systems in the Brussels region are based on the data of the Walloon region (see table 6.17b), with that difference that de values for 1992 are considered as constant on the whole time series.

Animal category	Nex (kg N/animal/yr)
Dairy cattle	100
Non-dairy cattle	70
Sheep	20
Goats	25
Swine	20
Horses	25
Poultry	0.6

Table 6.17c. Nitrogen excretion factors for each main category in Brussels.

6.3.3. 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.

6.3.4. 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.

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

- As a result of the centralized UNFCCC review of September 2013, the ERT recommended Flanders and Wallonia to calculate the net energy for pregnancy of dairy cows (and not only for brood cows). Therefore, for the 2014 submission, the net energy for pregnancy of dairy cows is taken into account. The method, parameters and equation 4.8 as described in the IPCC Good Practice Guidance is used. In both regions, the assumption is made that 80% of the mature females give birth in a year. This recalculation results in Flanders in an increase of the methane emission from manure management of maximum 0.211 Gg CH_4 and in Wallonia in an increase of maximum 0.115 Gg CH_4.
- Also as a result of the centralized UNFCCC review of September 2013, in Wallonia the net energy of lactation of non-dairy cows is taken into account. Following the methods, parameters and equation 4.5a from the IPCC Good Practice Guidance, this results in an increase of maximum 0.152 Gg CH_4.

- In Flanders, from 2007, animal numbers have slightly changed. This results in a small decrease of the methane emission from manure management of max 0.132Gg in 2007 and a small increase of the methane emission of 0.020Gg in 2010. For N_2O this results in an increase of 0.006Gg of the N_2O emission from manure management in 2007 to a small decrease of 0.001Gg in 2009.
- In Brussels, livestock values for 2011 were revised

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

In the near future no source-specific improvements are planned.

6.4. Agricultural soils (CRF 4.D)

6.4.1. Source category description

As described in the IPCC 1996 Guidelines, the N_2O emission estimation from agricultural soils can be divided into:

- Direct soil emissions from the application of synthetic fertilizers and animal manure, N-fixing crops, crop residues and the cultivation of histosols (4.D.1);
- Emissions from animal production by grazing animals (4.D.2);
- Indirect emissions from N-leaching and run-off and from atmospheric N deposition (4.D.3);
- Other emissions from sludge spreading (4.D.4).

Table 6.18 gives an overview of the methodologies used in the three regions.

Used methodology	**Flanders**	**Wallonia**	**Brussels**
Direct soil emissions 4.D.1	IPCC GPG 2000 (Tier 1a)	IPCC GPG 2000 (Tier 1a)	IPCC GPG 2000 (Tier 1a)
Emissions from grazing 4.D.2	IPCC GPG 2000	IPCC GPG 2000	IPCC GPG 2000
Indirect emissions 4.D.3	IPCC GPG 2000	IPCC GPG 2000	IPCC GPG 2000
Emissions from Sludge spreading 4.D.4	Not occurring	IPCC GPG 2000	Not occurring

Table 6.18: Overview of the methodologies used in the three regions.

6.4.2. Methodological issues

Direct soil emissions: 4.D.1

The direct N_2O emissions are calculated according to the Tier 1a methodology as described in the IPCC GPG 2000 using country or region specific data when available. The same methodology is used in all 3 regions, using the equation 4.20. In Wallonia and Brussels however no cultivated organic soils are present, therefore the last part of the equation is not taken into account in the Walloon and Brussels region. In annex 3 of this report a copy of the excel file can be found for the 3 regions.

$$N_2O_{direct}\text{-}N = [(F_{SN} + F_{AM} + F_{BN} + F_{CR}) * EF_1] + [F_{OS} * EF_2]$$

where:
N_2Odirect = the direct emissions of N_2O;
F_{SN} = amount of synthetic fertilizer nitrogen applied to soils, adjusted for the amount that volatilizes as NH_3 and NO_X;
F_{AM} = amount of animal manure nitrogen applied directly to soils, adjusted for the amount that volatilizes as NH_3 and NO_X;
F_{BN} = amount of nitrogen fixed by nitrogen-fixing crops;
F_{CR} = amount of nitrogen in crop residues returned to soils;
F_{OS} = the area of cultivation of organic soils;
EF_1 = N_2O emission factor for emissions from direct nitrogen inputs (kg N_2O-N/kg N);
EF_2 = N_2O emission factor for emissions from cultivation of organic soils (kg N_2O-N/kg N).

Application of Synthetic fertilizer: F_{SN} (4.D.1.1)
Equation 4.22 of the IPCC GPG 2000 is used for the calculation of the N_2O emission from the application of mineral fertilizer.

$FSN = N_{fert} * (1-Frac_{GASF})$

where
N_{fert} = total amount of synthetic fertilizer nitrogen applied to soils (kg N);
$Frac_{GASF}$ = fraction of synthetic fertilizer nitrogen that volatilizes as NH_3 and $NO_{x.}$

The amount of synthetic fertilizer use can be found in table 6.20. The amount used, as well as the data sources, is different in the three regions as can be seen in the table 6.19 below. Therefore the 3 regions are discussed separately.
The N_2O emissions from mineral fertilisers account for the nitrogen volatilised as NH_3 and NO. The model uses a volatilisation rate ($Frac_{GASF}$) from mineral nitrogen to NH_3 and NO.

Table 6.19 gives an overview of the origin of the activity data (AD), the implied emission factor (IEF) and the fractions used.

AD & IEF & fraction used	**Flanders**	**Wallonia**	**Brussels**
N_{fert}	Region specific: Departement Agriculture and Fishery	Region specific: Ministry of environment and agriculture	100 kg N/ha/yr (average value for Belgium in the 2011 inventory)
$Frac_{GASF}$	Region specific	Default IIASA	IPCC 1996 GL (table 4.19)
IEF	Default IPCC 1996 GL	Default IPCC 1996 GL	Default IPCC 1996 GL

Table 6.19: Overview of the origin of AD, IEF and fractions used in the 3 regions.

Flanders
In Flanders the *Department Agriculture and Fishery* 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 6.20).

The N volatilised as NH_3 from fertiliser use is derived from the model used to calculate the respective NH_3 emissions [51]. In 2009 a new model (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 factors used in this model are updated yearly if necessary. The average rate for NH_3 volatilisation in 2012 is 3.8% (1.7% in 1990). The rate for NO volatilisation is 1.5% and stays constant over the entire time series.

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). The average rate of NH_3 volatilisation in 2012 is 2.3 %. This factor is based on the default values recommended by IIASA for different types of fertilisers. The factor of 2.3% is based on the values proposed by Asman for Europe on page B1010-9 of the EMEP/corinair guidebook 1999 (http://www.eea.europa.eu/publications/EMEPCORINAIR/page019.html), which are used to calculate a weighted average taking into account the type of fertiliser actually applied in Belgium. The use of fertiliser is detailed on Appendix IV of the working paper of IIASA (available on : http://webarchive.iiasa.ac.at/Admin/PUB/Documents/WP-90-068.pdf). Given that calcium ammonium nitrate is the most used fertilizer, the final EF of 2.3% is rather close to the 2% of this fertilizer. Furthermore the EF was developed by EMEP (see table 4.1), which is a Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe. The EMEP guidebook is published by the European Environment Agency for the purpose of developing the emission inventories within Europe. Finally, as pointed out by Misselbrook et al, 2000 (http://mie.esab.upc.es/ms/informacio/residus_ramaders/Ammonia%20emisions%20factors%20UK.pdf) EMEP/CORINAIR uses largely Dutch and UK data, with default values being agreed by a panel of experts representing 17 European countries.
In this regard the default emission factors are applicable to Belgium. As explained above, the final EF recommended by IIASA and applied in the inventory also takes into account country specific data on fertilizer use.

Brussels

In Brussels the default factor for $Frac_{GASF}$ from the IPCC 1996 Guidelines, table 4-17 is used: 0.1 kg (NH_3-N + NO_x-N) / kg of synthetic fertiliser nitrogen applied.

	Synthetic fertilizer use (kg N /ha)
Wallonia	105
Flanders	
Dunes	139
Kempen area	98
Sandy area	107
Sand Loam area	105
Loamy area	105
Polders	139
Luikse Meadow area	98
Brussels	100

Table 6.20.: The amount (kg N) of synthetic fertilizer use (per ha) (2012) in each Region.

Application of animal manure: F_{AM} (4.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 formula (equation 4.23 of the IPCC GPG 2000).

$$F_{AM} = N_{ex} * (1 - Frac_{GASM}) * (1-(Frac_{FUEL} + Frac_{GRAZ}))$$

where

N_{ex} = total amount of animal manure nitrogen excreted by livestock (kg N);

$Frac_{GASM}$ = fraction of animal manure nitrogen that volatilizes as NH_3 and NO_x ;
$Frac_{FUEL}$ = fraction of livestock nitrogen excretion contained in excrements burned for fuel = 0 ;
$Frac_{GRAZ}$ = fraction of N_{ex} that is excreted by livestock during grazing.

The total nitrogen excreted per animal category is described above in 6.3.2.2 (nitrous oxide emission from manure management).
The amount of animal manure nitrogen applied to land is again adjusted for volatilisation of NH_3 and NO_x ($Frac_{GASM}$) and for the fraction N that is excreted by grazing animals ($Frac_{GRAZ}$). In Belgium no animal manure is burned. This is indicated with the notation key 'NO' and $Frac_{FUEL}$=0

Table 6.21 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**	**Brussels**
N_{ex}	Region specific: Manure Bank	Region specific: http://www.nitrawal.be/upload_files/3.1.1%20PGDA/AGW%20PGDA%2031%2003%2011.pdf	IPCC 1996 GL (table 4-20)
$Frac_{GASM}$	Region specific	IPCC 1996 GL (table 4-19)	IPCC 1996 GL (table 4-19)
$Frac_{FUEL}$	NO	NO	NO
$Frac_{GRAZ}$	Region specific	Region specific	zero (Nex is calculated excluding pasture range and paddock)
IEF	Default IPCC 1996 GL	Default IPCC 1996 GL	Default IPCC 1996 GL

Table 6.21: Overview of the origin of AD, IEF and fractions used in the 3 regions.

Flanders
In Flanders, N_{ex} in the equation above is calculated taking into account the manure produced (including the imported manure), but minus exported manure. 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. 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 N_2O 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/Algemeen%20(General)/Emissierapportages%20(Emission%20reports)/NIR%20Greenhouse%20Gas%20Emissions%20in%20the%20Netherlands/NIR2013_def(HR).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 2012.
The fraction volatilised as NH_3 and NO in Flanders ($Frac_{GASM}$) varies from 0.34 kg(NH_3-N+NO-N)/kg Nex in 1990 to 0.19 kg(NH_3-N+NO-N)/kg Nex in 2012. 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. The reason for this strong reduction of NH_3 emission can be found in 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 $Frac_{GRAZ}$ varies between 0.23 in 1990 to 0.21 in 2012.
The rate for NO volatilisation is 1.5% and stays constant over the entire time series.

Wallonia
In Wallonia, the IPCC default value of 0,2 for $Frac_{GASM}$ is used (IPCC 1996 GL table 4-19) for the entire time series.

Brussels
In Brussels, also the IPCC default value of 0,2 for $Frac_{GASM}$ is used (IPCC 1996 GL table 4-17) for the entire time series. $Frac_{GRAZ}$ is taken zero (N_{ex} in the Brussels region is calculated excluding pasture, range and paddock).

N fixed by crops: F_{BN} (4.D.1.3) and N in crop residues returned to soils: F_{CR} (4.D.1.4)
The methodology used for estimating the amount of nitrogen fixed by N-fixing crops (F_{BN}) is based on equation 4.25 from the IPCC GPG 2000.

$$F_{BN} = 2 * Crop_{BF} * Frac_{NCRBF}$$

where
$Crop_{BF}$ = production of pulses (kg dry biomass/yr);
$Frac_{NCRFB}$ = fraction of N in N-fixing crops (kg N / kg dry biomass).

The methodology used for estimating the amount of nitrogen returned to soils through incorporation of crop residues (F_{CR}) is based on equation 4.28 from the IPCC GPG 2000.

$$F_{CR} = 2 * (crop_0 * Frac_{NCR0} + Crop_{BF} * Frac_{NCRBF}) * (1-Frac_R) * (1-Frac_{BURN})$$

where
$Crop_{BF}$ = production of pulses (kg dry biomass/yr);
$Crop_0$ = production of all other crops (kg dry biomass/yr);
$Frac_{NCR0}$ = fraction of N in non N-fixing crops (kg N / kg dry biomass);
$Frac_{NCRBF}$ = fraction of N in N-fixing crops (kg N / kg dry biomass);
$Frac_R$ = fraction of crop removed from the field as product (kg N / kg crop N);
$Frac_{BURN}$ = fraction of crop burned = 0.

Table 6.22 gives an overview of the origin of the activity data (AD), implied emission factor (IEF) and the fractions used.

AD & EF & fraction used	Flanders/Wallonia/Brussels
Crop production	Statistics Belgium
Cultivated crop area	Statistics Belgium

Dry matter content	Region specific
$Frac_{NCRBF}$	IPCC GPG 2000 (table 4.16) or IPCC 1996 GL (table 4-17)
$Frac_{NCR0}$	IPCC GPG 2000 (table 4.16) or IPCC 1996 GL (table 4-17)
$Frac_{R}$	IPCC GPG 2000 (footnote 14)
$Frac_{BURN}$	NO
IEF	Default IPCC 1996 GL

Table 6.22: 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 (1990-2012) of the crop production for each crop is given for the three regions.
The nitrogen content of the N-fixing and non N-fixing crops is estimated by multiplying, for each culture, the cultivated area by the edible dry matter crop production and the $Frac_{NCRBF}$ or $Frac_{NCR0.}$ The dry matter content of the crops is region specific. The fractions $Frac_{NCR0}$ and $Frac_{NCRBF}$ are those, when available, from table 4.16 from the IPCC GPG 2000. If not available, the default values of 0.015 kg N/kg dry biomass ($Frac_{NCR0}$) and 0.03 kg N/kg dry biomass ($Frac_{NCRBF}$) are used (IPCC 1996 GL).
The fraction of crop removed from the field as product is taken 0.5 kg N/kg crop N (footnote 14 of IPCC GPG 2000).
In Belgium, no crops or residues are burned. Therefore $Frac_{BURN}$ is taken zero.

Table 6.23 gives an overview of the dry matter fraction of the crops (%), $Frac_{NCRBF}$ and $FRAC_{NCR0}$ used in the entire time series for the three regions.

	Dry matter content (%) used in Flanders and Brussels	**Dry matter content (%) used in Wallonia**	**$Frac_{NCRBF}$**	**$Frac_{NCR0}$**
Clover	85	85	0.03	
Alfalfa	85	85	0.03	
Dry beans	88	88	0.03	
Horse beans	85	88	0.03	
Green beans	18	88	0.03	
Dry peas	88	88	0.0142	
Green peas	18	88	0.0142	
rape	6	6		0.015
Winter wheat	85	85		0.0028
Spring wheat	85	85		0.0028
Rye	85	85		0.0048
Spelt	85	85		0.015
Brewing barley	85	85		0.0043
Winter barley	85	85		0.0043
Spring barley	85	85		0.0043
Oats	85	85		0.007
Triticale	85	85		0.015
Chicory	6	6		0.015
Flax	85	85		0.015
Winter rape	85	85		0.015

	Dry matter content (%) used in Flanders and Brussels	Dry matter content (%) used in Wallonia	$Frac_{NCRBF}$	$Frac_{NCR0}$
Tobacco	85	85		0.015
Hop	85	85		0.015
Grain maize	30	78		0.0081
Green maize (entire plant)	30	78		0.0081
Green maize (only cob)	30			0.0081
Sugar beet	26	26		0.015
Fodder beet	15	26		0.015
Seed potatoes	23	23		0.011
Early potatoes	23	23		0.011
Bintje (specific type potato)	23	23		0.011
Other potatoes	23	23		0.011
Colza	85	85		0.015

Table 6.23: Dry matter fraction, $Frac_{NCRBF}$ and $Frac_{NCR0}$ used in Belgium

Implied emission factor: EF_1
The default IPCC emission factor (IPCC 1996 GL) of 0.0125 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.

Cultivation of organic soils: F_{OS} (4.D.1.5)
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 histosols is 8 kg N_2O-N / kg N as described in the IPCC GPG 2000 (table 4.17)
No histosol cultivation occurs in Wallonia and Brussels, where the only recorded organic soils are part of a nature reserve.

Table 6.24 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 GPG 2000 (table 4.17)	NO	NO

Table 6.24: Overview of the origin of AD and IEF used.

Pasture, range and paddock manure: 4.D.2

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 6.15). The IPCC default emission factor of 0.02 kg N_2O-N / kg N excreted (IPCC GPG 2000 table 4.12) is then used to estimate the N_2O emissions.

Table 6.25 gives an overview of the origin of the activity data (AD) and implied emission factor (IEF) used.

AD & EF used	Flanders	Wallonia	Brussels
Nex grazing	Region specific: Manure Bank	Region specific http://www.nitrawal.be/upload_files/3.1.1%20PGDA/AGW%20PGDA%2031%2003%2011.pdf	As calculated in 4.B
IEF	IPCC GPG 2000 (table 4.12)	IPCC GPG 2000 (table 4.12)	IPCC GPG 2000 (table 4.12)

Table 6.25: Overview of the origin of AD and IEF used.

Indirect soil emissions: 4.D.3

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 1a methodology as described in the IPCC GPG 2000 using country or region specific data when available. The same methodology is used in all regions, using the equation 4.30 of the IPCC GPG 2000. In annex 3 of this report a copy of the excel file can be found. N_2O emissions from human sewage are calculated here, but reported under category 6.B and described in this NIR under chapter 8.

$$N_2O_{indirect}\text{-}N = N_2O_{(G)} + N_2O_{(L)} + N_2O_{(s)}$$

where
$N_2O_{(G)}$ = N_2O emission due to atmospheric nitrogen deposition;
$N_2O_{(L)}$ = N_2O emission due to nitrogen leaching;
$N_2O_{(S)}$ = N_2O emission due to discharge of human sewage N (included elsewhere: 6B).

<u>Atmospheric deposition of NO_x and NH_4: $N_2O_{(G)}$ (4.D.3.1)</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 4.31 from the IPCC GPG 2000 is used.

$$N_2O_{(G)}\text{-}N = (N_{FERT} * Frac_{GASF}) + (N_{ex} * Frac_{GASM}) * EF_4$$

where
N_{fert} = total amount of synthetic fertilizer nitrogen applied to soils (kg N);
$Frac_{GASF}$ = fraction of synthetic fertilizer nitrogen that volatilizes as NH_3 and $NO_{x;}$
N_{ex} = total amount of animal manure nitrogen excreted by livestock (kg N);
$Frac_{GASM}$ = fraction of animal manure nitrogen that volatilizes as NH_3 and NO_x;
EF_4 = kg N_2O-N / kg NH_4-N & NO_x-N deposited.

The fractions used, N_{fert} and N_{ex} are described above (F_{AM} and F_{SN}). The emission factor, $EF_{4,}$ used is the IPCC default of 0.01 kg N_2O-N/kg NH_4-N &NO_x-N deposited (table 4.18 of the IPCC GPG 2000).

Table 6.26 gives an overview of the origin of the activity data (AD), implied emission factor (IEF) and the fractions used.

AD & EF & fraction used	**Flanders**	**Wallonia**	**Brussels**
N_{fert}	Region specific: Department Agriculture and Fishery	Region specific: Agriculture administration	As calculated in 4.D.1.1
$Frac_{GASF}$	Region specific	Default IIASA	IPCC 1996 GL (table 4.19)
N_{ex}	Region specific: Manure Bank	Region specific: http://www.nitrawal.be/upload_files/3.1.1%20PGDA/AGW%20PGDA%2031%2003%2011.pdf	As calculated in 4.B
$Frac_{GASM}$	Region specific	IPCC 1996 GL (table 4-17)	IPCC 1996 GL (table 4-17)
EF_4	IPCC GPG 2000 (table 4.18)	IPCC GPG 2000 (table 4.18)	IPCC GPG 2000 (table 4.18)

Table 6.26: Overview of the origin of AD, IEF and fractions used.

Leaching/runoff of applied or deposited nitrogen: $N_2O_{(L)}$ (4.D.3.2)
Indirect N_2O emissions resulting from leaching and runoff N-emissions are estimated using equation 4.36 from the IPCC GPG 2000.

$$N_2O_{(L)}\text{-}N = (N_{fert} + N_{ex} + N_{SEWSLUDGE}) * Frac_{LEACH} * EF_5$$

where
N_{fert} = total amount of synthetic fertilizer nitrogen applied to soils (kg N);
N_{ex} = total amount of animal manure nitrogen excreted by livestock (kg N);
$N_{SEWSLUDGE}$ = total amount of sewage sludge nitrogen (kg N);
$Frac_{LEACH}$ = fraction N lost through leaching and runoff;
EF_5 = kg N_2O-N / kg N leached & runoff.

The calculation of N_{fert} and N_{ex} is described above (F_{AM} and F_{SN}). $N_{SEWSLUDGE}$ is only calculated in Wallonia. In Flanders no sewage sludge spreading is allowed and in Brussels it does not take place. The emission factor, EF_5, used is the IPCC default of 0.025 kg N_2O-N/kg N leached & runoff (table 4.18 of the IPCC GPG 2000).

Only Brussels uses the IPCC default $Frac_{LEACH}$ factor of 0.3 kg N/kg fertiliser or manure N (table 4.24 of the IPCC 1996 Guidelines). The Walloon and Flemish region use a region specific factor as described hereunder.

Table 6.27 gives an overview of the origin of the activity data (AD), implied emission factor (IEF) and the fractions used.

AD & EF & fraction used	Flanders	Wallonia	Brussels
N_{fert}	Region specific: Department Agriculture and Fishery	Region specific: Agriculture administration	As calculated in 4.D.1.1
N_{ex}	Region specific: Manure Bank	Region specific: http://www.nitrawal.be/upload_files/3.1.1%20PGDA/AGW%20PGDA%2031%2003%2011.pdf	As calculated in 4.B
$N_{SEWSLUDGE}$	NO	Region specific	NO
$Frac_{LEACH}$	Region specific: SENTWA model	Region specific: SITEREM	IPCC 1996 GL (table 4.19)
EF_5	IPCC GPG 2000 (table 4.18)	IPCC GPG 2000 (table 4.18)	IPCC GPG 2000 (table 4.18)

Table 6.27: Overview of the origin of AD, IEF and fractions used.

Flanders
In Flanders, the nitrogen leaching is based on the SENTWA model (System for the Evaluation of Nutrient Transport to Water) [50] which is updated yearly. This model calculates empirically the discharge of nutrient streams caused by agriculture to the surface water. This because one of the polluting sources of the watercourses is the diffuse discharge coming from agriculture (from animal manure, fertiliser and silage). The SENTWA model is based on a split of the nutrient stream in seven sub-streams or sources of loss. A summary in English of the methodology can be found in annex 3. The N losses calculated by the SENTWA model are in agreement to what is measured in the surface waters.
FracLeach in 2012 is 0.08 kg N_2O-N/kg N leached & runoff.

Wallonia
In Wallonia the region specific $FRAC_{leach}$ of 0.18 kg N / kg N is used. This factor comes from a study conducted by SITEREM in 2001 (reference [30] in the NIR 2011, p 195). See chapter 2, page 18 for the 0.18 factor for leaching ('ruissellement'). Note that the other results of this study are no longer used as such, as IPCC Tier 2 methodology is now applied.

Brussels
Brussels uses the IPCC default $Frac_{LEACH}$ factor of 0.3 kg N/kg fertiliser or manure N (table 4.19 of the IPCC 1996 Guidelines)

other soil emissions: 4.D.4

The category 'other' consists of N_2O emission from sludge spreading on agricultural soils and is only calculated by the Walloon region. In Flanders, the use of sewage sludge on agricultural soils is forbidden.This is described in the manure decree (article 13, paragraph 8: http://navigator.emis.vito.be/milnav-consult/plainWettekstServlet?wettekstId=17942&lang=nl). Unfortunately no translation in English is available. In Brussels sludge spreading does not take place. In Wallonia, the data on sludge spreading on agricultural soils are available on the website of DGARNE (http://www.environnement.wallonie.be/). It is considered a fixed contribution of 0.1kg N/ha.yr and an emission factor equal to 0.0125 kg N_2O-N/kg N from sludge is used.

6.4.3. 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.

6.4.4. 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.

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

- In Flanders, from 2007, animal numbers have slightly changed. This results in a small increase of the direct N_2O emission of max 0.026Gg in 2007 and a small decrease of the direct N_2O emission of max 0.002Gg in 2009. For the indirect N_2O emission this results in an increase of max 0.03% in 2007 to a small decrease of max 0.005% in 2009.
- In Brussels, the annual yields values of several N-fixing and non N-fixing crops were revised and matched with those used in Flanders. The area of arable crops for 2011 was also revised.
- In Wallonia, sewage sludge has been taken into account to estimate the indirect N_2O emissions. However it was included only under N from leaching and runoff (equations 4.34 and 4.36), and not in equation 4.32 for atmospheric deposition. From this submission, it is included for the whole time series. The impact is not significant (for example in 2011, the revised estimate of emissions is 70.4 tons CO_2-eq. higher than in previous submission). Furthermore, the activity data has also been improved: in the past the quantity of sludge was estimated as a percentage of the usable agricultural area. Now, we use the data coming from the Walloon Waste Office. They have the annual amount of sludge spread in agriculture since 1994. This modification of the activity data results in higher emissions (in 2011, it represents an additionnal emission of 0.026 Gg N_2O (a little bit less than 8000 tons CO_2-eq)).

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

No further improvements are planned for the next submissions in the agricultural sector in Belgium.

CHAPTER 7: LULUCF (CRF SECTOR 5)

7.1. 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 2010 Forest Resource Assessment.
The distribution of forests in Belgium is shown in table 7.1.

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 7.1: Forest cover in Belgium (source: National Institute of Statistics and regional forest inventories)

7.1.1. 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 is 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 7.1). 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. Estimates for the last years were delivered in December 2011.

Emissions were calculated for the first time during the 2011 submission for the Brussels-Capital Region with a view to ensure complete geographical coverage in this sector.

Further details on the methodology are presented in chapter 10.2

		1990						**Total 2012**	
		F	**C**	**G**	**W**	**S**	**O**	**Area (kha)**	**%**
2012	**F**	**691,1**	3,2	17,9	1,0	0,9	1,4	**715,4**	**23,4%**
	C	2,4	**822,2**	132,4	0,6	2,8	2,0	**962,4**	**31,5%**
	G	7,1	98,5	**548,4**	2,7	4,4	3,2	**664,3**	**21,8%**
	W	0,9	1,9	1,3	**47,0**	0,2	0,6	**51,9**	**1,7%**
	S	10,2	43,7	52,3	0,9	**527,4**	5,3	**639,7**	**21,0%**
	O	1,9	7,8	3,0	0,4	0,9	**5,0**	**19,0**	**0,6%**
Total 1990	**Area (kha)**	**713,5**	**977,4**	**755,2**	**52,5**	**536,6**	**17,5**	**3053**	
	%	**23,4%**	**32,0%**	**24,7%**	**1,7%**	**17,6%**	**0,6%**		

Table 7.2: Land Use Change matrix in Belgium (1990 and 2012) [55].

7.1.2. Trend assessment

As seen in Figure 7.1 in Belgium forests are a major sink of carbon rather stable over time while all other sectors are sources (except in recent years with regard to grassland and wetlands).

Croplands continually increase their carbon emissions (59% since 1990) mainly due to the conversion of other land to this sector. In contrast, grasslands decreased continuously their emissions to such an extent that they have become a slight carbon sink since 2008. This is also the conversion of other lands that explain this. The area of settlements increased steadily since 1990 (19% growth between 1990 and 2012). This is of course only increased urbanized areas that explained this growth. Other lands has seen continued growth in emissions, but remains at a low level (+107 Gg eq. CO_2 in 2012) while wetlands reduces its emissions to become a very small carbon sink since 2007.

The result of these evolutions generates negative net emissions fairly stable for the whole LULUCF in Belgium, in the range of -1000 Gg eq. CO_2 (-1402 Gg eq. CO_2 in 2012).

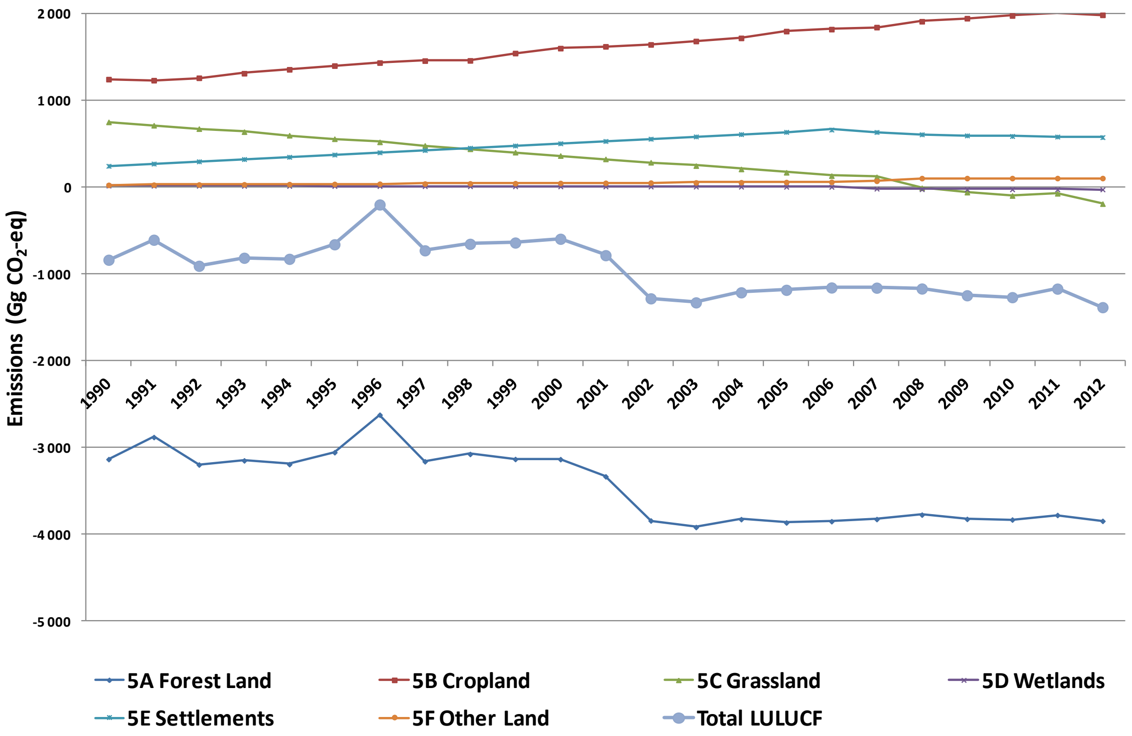


Figure 7.1: Emission and removal trends in LULUCF sector

Emissions of N_2O and CH_4 (only sources) represent only 2-3% of total sector sources (except in 1996 with 11.8% and 2011 with 6.5% due to large forest fires).
N_2O emissions '5(III)' from disturbance associated with land-use conversion to cropland represent 10.1% of total emissions in the subsector in 2012 (5B2) and increase slowly.
CO_2 emissions '5(IV)' from agricultural lime application (cropland and grassland) represent 2.8% of total emissions associated with cropland and grassland (when a source).

If we look at the compartments rather than sub-sectors (see Figure 7.2), we find there is an accumulation of carbon in living biomass relatively stable and linked to the forest. This sink is partially offset by emissions from soil carbon mainly related to land conversions to settlements and croplands. Emissions from biomass burning '5(V)' have been significant only in 1996 (+504 Gg eq. CO_2) and 2011 (+138 Gg eq. CO_2)

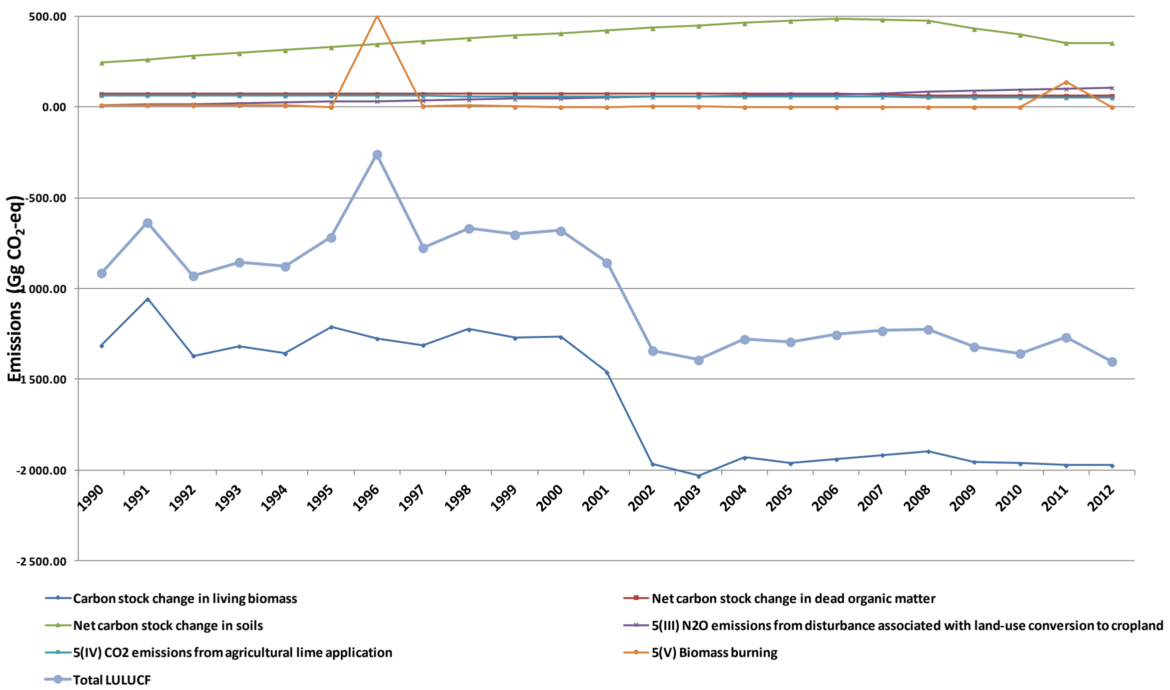


Figure 7.2: Emission and removal trends in LULUCF compartments

7.1.3. Overall recalculations in the LULUCF-sector

The tables below give the quantitative recalculations in the LULUCF sector (category 5) compared to previous submission in November 2013.

5-LULUCF,Emissions,Aggregate GHGs (CO2, CH4, N2O,),(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussel region	%	0,00	-1,65	0,00	0,00	42,92	-70,01	0,00	0,00	0,06	-0,05
Flemish region	%	6,77	4,58	6,45	8,28	7,14	5,22	3,94	5,50	6,92	7,41
Walloon region	%	-0,18	-0,12	-0,33	-0,12	-0,18	-0,13	-0,10	-0,12	-0,02	-0,05
Belgium	%	-8,68	-8,53	-13,06	-8,68	-8,02	-6,20	-4,76	-5,82	-6,72	-7,94

Relations to previous submission ($Gg\ CO_2$ eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussel region	Gg CO_2 eq.	0,00	0,08	0,00	0,00	-0,40	0,40	0,00	0,00	0,00	0,00
Flemish region	Gg CO_2 eq.	75,61	58,76	82,64	109,21	96,42	72,65	55,68	73,74	90,81	99,55
Walloon region	Gg CO_2 eq.	3,69	2,41	6,39	3,12	4,65	3,38	2,65	3,08	0,47	1,21
Belgium	Gg CO_2 eq.	79,31	61,24	89,03	112,33	100,67	76,42	58,33	76,82	91,27	100,76

Recalculations in category 5A in Belgium due to:

- New estimations of the losses of carbon stocks from orchards converted to forest land following the 2013 review recommendation.
- Update of areas in Flanders following last data available (2008-2011).

Recalculations in category 5B and 5C in Belgium due to:

- Carbon stock change in living biomass in cropland (orchards) are newly estimated and reported in the 2014 submission.
- Carbon emissions from organic soils in cropland and grassland are newly estimated and reported in the 2014 submission.
- Emissions originating from liming are included.

7.2. Forest land (CRF 5.A)

7.2.1. Source category description

This category includes all land with woody vegetation consistent with thresholds used to define forest land as described in paragraph 7.1 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 2009 and first results were made available by the end of 2011 (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). Data analysis should be possible by the end of 2014.

In the Brussels region, a continuous forest inventory has been implemented from 2008 on. 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).

7.2.2. Methodological issues

7.2.2.1. 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 7.2.1), the total solid wood volumes (TSW) of each species, spread over three age classes, were calculated for Flanders and Wallonia, as given in table 7.3. Values for Belgium were calculated by summing up the Flemish and Walloon forest areas and wood volumes.

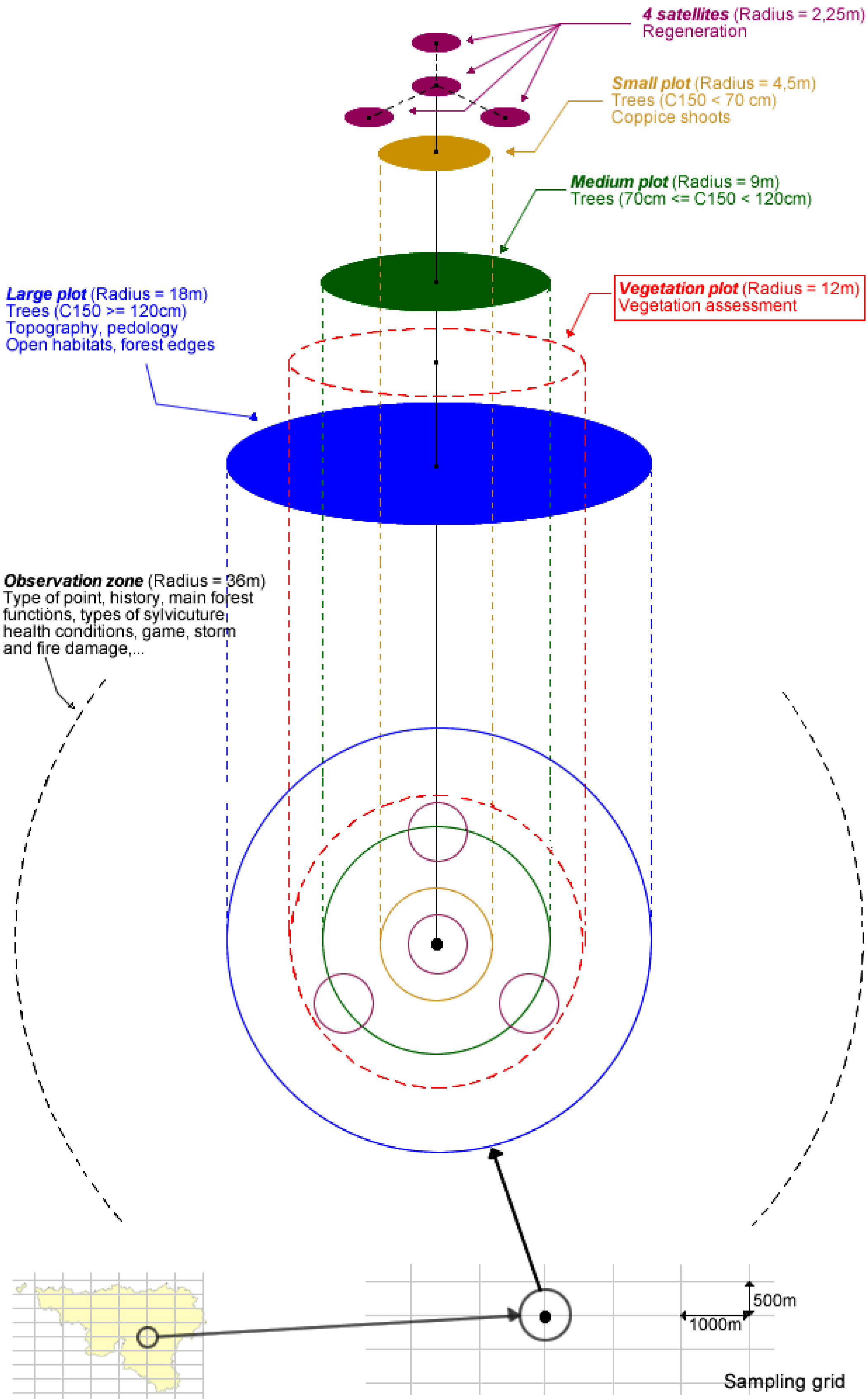


Figure 7.1.: schema of a sampling unit and data collected (Rondeux *et al*, 2005)

Species	Wallonia 2001	Wallonia 2010	Flanders 2000
Picea abies (Norway Spruce)	53,9	48,3	0,5
Quercus petraea et Q. robur (Oaks)	26,2	28,9	3,6
Fagus silvatica (Beech)	16,9	20,9	2,4
Pinus silvestris (Scots Pine)	2,9	2,8	8,6
Populus sp (Poplars)	2,5	3,2	5,1
Betula sp (Birch)	3,5	3,8	1,4
Pinus laricio (Corsican Pine)	0,4	0,5	3,9
Fraxinus excelsior (Ash)	3,5	4,0	0,4
Larix sp (Larch)	2,6	2,8	0,8
Pseudotsuga menziesii (Douglas fir)	4,8	6,4	0,4
Other species	9,9	12,5	4,5
Total	**127,1**	**134,1**	**31,7**

Table 7.3: 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 7.4: 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 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. Since the 2013 submission, results of the first 3 years of the 3rd cycle are also used. Central years for the 3 cycles are 1981, 2001 and 2010 (see 7.2.1). See Tables 7.3 and 7.4 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 7.3 (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 3.2.3. from the IPCC GPG on LULUCF, with t1 and t2 being repectively 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 7.2.1.

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). Data analysis based on these results should be possible by the end of 2014.

In Brussels-Capital region, only one forest inventory is available. The emissions and removals were therefore 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 7.5 and 7.6. 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)	11,9
Quercus petraea et Q. robur (Oaks)	3,2
Fagus silvatica (Beech)	5,9
Pinus silvestris (Scots Pine)	4,3
Populus sp (Poplars)	8,1
Betula sp (Birch)	4,3
Pinus laricio (Corsican Pine)	12,2
Fraxinus excelsior (Ash)	5,4
Larix sp (Larch)	10
Pseudotsuga menziesii (Douglas fir)	13,3
Carpinus betulus (hornbeam)	5,4
Other deciduous	5,6
Other coniferous	13,2
3728860	7,9
Average coniferous	11,3
Average deciduous	4,7

Table 7.5: Annual increment for different tree species (based on Walloon Forest Inventories)

Harvest (roundwood overbark, 1000 m³)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average 1998-2002	Average 2003-2007
Belgium	3227	3232	2782	3157	4889	4579	4426	4121	3663	3731	3457	4104

Table 7.6: Historical harvest rate as reported in the Belgian Forest Resources Assessment Report 2010 (http://www.fao.org/docrep/013/al456f/al456f.pdf).

The table 7.7 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 7.7. 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 (Caverage) 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 111 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 0,61t C /ha.yr in Wallonia (Gembloux Agro Bio Tech, in [55]) 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 7.3.

The average carbon stocks in 2000 are given in table 7.8

Carbon stocks in soil (t C/ha)	Wallonia	Flanders
A. Forest Land	111	89,5
B. Cropland	44	52
C. Grassland	87	86
D. Wetland	100	100
E. Settlements	48	48
F. Other land	48	48

Table 7.8.: Average carbon stocks in soils (t C/ha, 0-30 cm) in 2000.

D. N_2O emissions from fertilization and drainage (Categories 5(I) and 5(II))

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. Emissions from wildfires (Category 5(III))

Emissions from fires are calculated using the current available data, which cover the period 1990-2012.

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, 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).

7.2.2.2 Land converted to forest land

The areas of land converted to forest land are estimated by the study described in chapter 7.1.1.

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 were 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.

7.2.3. 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.

7.2.4. 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].

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

- The losses of carbon stocks from orchards converted to forest land were calculated following the 2013 review recommendation (section 7.2.2).

Carbon stock losses (Gg)	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Belgium	0.078	0.096	0.109	0.113	0.112	0.110	0.000	0.000	0.000	0.000	0.000
Brussels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Wallonia	0.002	0.002	0.002	0.003	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Flanders	0.076	0.094	0.106	0.110	0.109	0.110	0.000	0.000	0.000	0.000	0.000

- Update of areas in Flanders following last data available (2008-2011).

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

- In Wallonia, results of the 3rd forest inventory cycle may be updated during the next submission if data from the last sampling years are available.

- 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 data analysis should be possible by the end of 2014.

- Uncertainty on CH4 and N2O emissions are now calculated and reported in Annex 2 .

7.3. Cropland and grassland (CRF 5.B and 5.C)

7.3.1. 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.

7.3.2. Methodological issues

7.3.2.1. 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 7.2), this subcategory is a net sink over time.

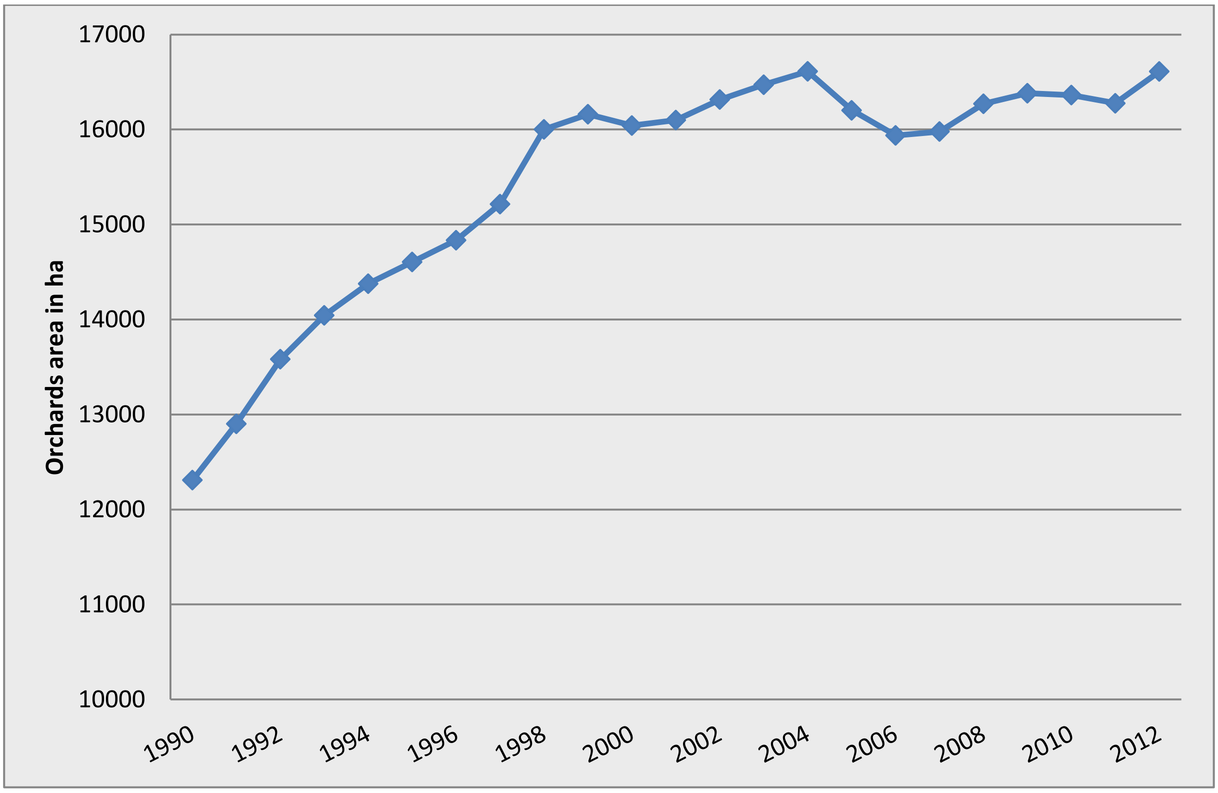


Figure 7.2: Orchard area in Belgium, according to the agricultural census (1990-2012).

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 7.8 (section 7.2.2.1)
.
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.

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]

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 determined by the study by Gembloux. Given the very limited share of crop- and grasslands in Brussels-Capital region compared to Wallonia and Flanders, this estimate is deemed reasonable in first approach, although region-specific methodology is foreseen in the future if the necessary data become available.

Organic soils

Emisisons 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 average temperature in Belgium is 10.7°C for the reference peridoe 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 5(III))

Emissions from fires are calculated using the current available data, which cover the period 1990-2012.

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. Emissions from agricultural lime application (Category 5(IV))

Liming is a common practice on cropland and grassland to maintain soil pH. Country-specific data are not available. Consequently the amount of limestone and dolomite applied were estimated according to expert judgement, based on the amounts observed in neighbouring countries, namely 60 kg/ha.yr for limestone and 25 kg/ha.yr for dolomite, using data from the Netherlands According to expert judgement from the agriculture services, these data seem to be in line with the agricultural practices in Belgium.

Decarbonation of these components leads to CO_2 emissions, estimated with the default factor defined by IPCC (0.12 t C/ t product) and equation 3.3.6 of the IPCC GPG on LULUCF.

7.3.2.2. 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,

N_2O 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 3.3.14 et 3.3.15 from IPCC Guidelines: FE1 = 0,0125 kg N_2O -N/kg N and C/N ratio of the converted land. Emissions are caused by the nitrogen cycle, intimately linked to carbon cycle. 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.

N_2O 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.

7.3.3. Uncertainties and time-series consistency

See paragraph 7.2.3.

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 liming, an uncertainty of 100% is considered for liming emissions, as no country-specific value is available for the time being. For the emission factor, an uncertainty of 50% is applied, as in Denmark and Austria.

For N2O emissions due to the conversion to cropland, an uncertainty of 18% on the Area converted is used, and an uncertainty of 150% on the N2O emission factor. Results are reported in Annex 2.

7.3.4. Source-specific QA/QC and verification, if applicable

Source-specific QA/QC and verification is planned for the next submission.

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

Carbon stock change in living biomass in cropland (orchards) are estimated and reported in the 2014 submission.

Carbon emissions from organic soils in cropland and grassland are estimated and reported in the 2014 submission.

Uncertainty is now calculated for all subcatgories and gases.

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

In Wallonia, some region-specific information on liming practices should be available by the course of 2014. It will be included in the next submission .

7.4. Wetland, settlement and other lands (CRF 5.D, 5.E and 5.F)

7.4.1. 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 includes 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 includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available.

7.4.2. 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 $SOC_{Non\ Wetland}$ 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'.

7.4.3. Uncertainties and time-series consistency

See paragraph 7.2.3.

7.4.4. Source-specific QA/QC and verification, if applicable

Source-specific QA/QC and verification is planned for the next submission.

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

See 7.2.5. for changes in the reporting of areas (consistency with decision 15/CMP1 and 16/CMP1)

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

See 7.2.6.

CHAPTER 8: WASTE (CRF SECTOR 6)

8.1. Overview of sector

8.1.1. Description of the sector

The largest sources of waste in Belgium are manufacturing industry (34.3 million tons or 55% of all waste produced in 2010) and the construction sector (18.2 million tons or 29% in 2010)[14].

Regarding municipal waste, the total volume collected amounted to 5.07 million tons in 2012, which corresponds to 459 kg per inhabitant. The recycling rate was in 2012 36% and the incineration rate was 42%, in most cases with energy recovery[15]. 21% of the collected municipal waste is 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.

The *Waste Prevention and Management Plan in Brussels-Capital Region* also subscribes to this double strategy of waste prevention and recovery. The current Plan, launched in 2009, is evaluated every 2 years[16].

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.

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[17].

[14] http://statbel.fgov.be/fr/statistiques/chiffres/environnement/dechets/production/
[15] http://statbel.fgov.be/fr/statistiques/chiffres/environnement/dechets/municipaux/
[16] http://www.bruxellesenvironnement.be/Templates/Particuliers/informer.aspx?id=3964&langtype=2060
[17] http://statbel.fgov.be/fr/statistiques/chiffres/environnement/eau/pollu/

8.1.2. Allocation of emissions

The emissions from the waste sector are allocated in 4 source categories :

- 6A: solid waste disposal on land
- 6B: wastewater handling
- 6C: waste incineration
- 6D: other (composting)

No solid waste disposal sites (SWDS) are located in the Brussels region.

Regarding waste incineration, the emissions from municipal waste incineration plants working with energy recovery are allocated under category 1A1.

8.1.3. Trend assessment

GHG emissions from waste (excluding waste incineration with energy recovery) accounted for 1.29% of total national emissions in 2012, compared to 2.27% in 1990. This decrease is mainly due to CH_4 emissions from solid waste disposal on land, which represents 38% of total emissions from the waste sector in 2012. 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 76% in 2012 since 1990.

The remaining 62% 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 up to about only 10 Gg CO_2 equivalent these last years. Hospital waste are 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 8.1 to give a complete overview of the greenhouse gas emissions of the waste sector (kton CO_2 eq).

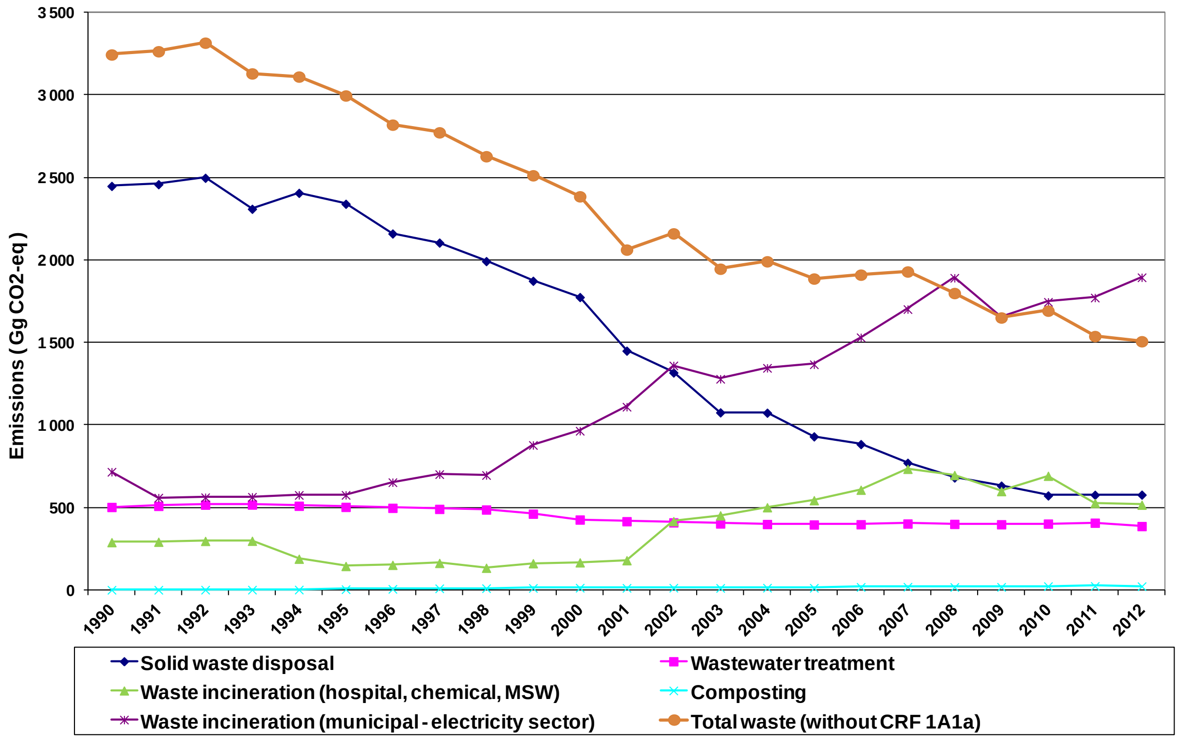


Figure 8.1: Emission trends (1990-2012) in the waste sector (CRF 6), and non-biogenic GHG emissions from MSW incineration (CRF 1A1)

8.1.4. Overall recalculations in the waste sector

The tables below give the quantitative recalculations in the waste sector (category 6) compared to previous submission in November 2013.

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	0,00	0,00	0,21	0,31	0,51	4,00	4,11	1,95	1,95	1,95
Flemish region	%	-3,10	-2,25	-8,22	-8,92	-4,35	-2,78	-2,81	-4,21	-3,93	-4,50
Walloon region	%	-8,65	-8,27	-8,14	-6,21	-6,99	-5,96	-5,81	-5,51	-5,23	-5,03
Belgium	%	-4,88	-4,29	-8,11	-7,94	-5,11	-3,65	-3,62	-4,53	-4,23	-4,56

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	0,00	0,00	0,05	0,09	0,14	1,14	1,19	0,58	0,59	0,61
Flemish region	Gg CO_2 eq.	-70,27	-45,63	-142,59	-122,75	-59,09	-37,85	-35,59	-47,85	-46,89	-46,74
Walloon region	Gg CO_2 eq.	-96,31	-88,70	-68,07	-40,17	-44,01	-36,44	-33,29	-31,10	-28,55	-27,37
Belgium	Gg CO_2 eq.	-166,58	-134,32	-210,61	-162,83	-102,95	-73,16	-67,69	-78,37	-74,85	-73,51

Recalculation in emissions of CH_4 in the category 6A1 due to:
Walloon region: correction with oxidation factor (10%) for the complete timeseries
Flemish region: optimization activity data (waste disposed) for the complete timeseries

Recalculation in emissions of N_2O in the category 6B due to:
Belgium: correction of protein consumption due to an update of the FAO statistics, from 2000 onwards.

Recalculation in the category 6C1 due to:
Walloon region: re-allocation of the emissions of waste incineration between 1A1a and 6C1
Flemish region: optimization activity data for the year 2005 (inconsistency with Flemish energy balance was corrected).

8.2. Solid waste disposal on land (CRF 6.A)

8.2.1. Source category description

Category 6A1 contains the emissions of CH_4 originating from solid waste disposal on land in Belgium. No such waste disposal site is located in the Brussels region.

8.2.2. Methodological issues and data sources

Flanders
The emissions of CH_4 from solid waste disposal sites (SWDS) in Flanders are calculated for all so-called Category II SWDS (Flemish environmental legislation [63]): solid waste disposal sites for non-hazardous municipal wastes and similar commercial, industrial and institutional wastes (including separately collected fractions). Those are the landfill sites where biodegradable waste is disposed.

Two separate models are used for the calculations:

- First Order Model: calculates the CH_4 emissions from ‘older’ SWDS;
- Multi-phase model: calculates CH_4 emissions from ‘recent’ SWDS.

The total CH_4 emission is the sum of the emissions by ‘older’ SWDS and ‘recent’ SWDS. Both models were developed by VITO, the Flemish Institute for Technological Research [64, 65] and are based on the IPCC First Order decay model (Tier-2) as described in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories [28] and the IPCC 2000 Good Practice Guidance [10]. The basic data (amount of waste, waste composition) are obtained from OVAM (Flemish Waste Agency).

SWDS in Flanders must meet several conditions to prevent the contamination of soil, groundwater or surface water. In addition, since 1995, the landfill gas produced must be recovered for flaring or energetic utilization. This obligation applies to 16 SWDS, which are referred to as the ‘recent’ SWDS. By the end of 2004, 15 of the 16 SWDS had a flare and electricity was produced at 12 SWDS. At one SWDS, the landfill gas generation was insufficient for active recovery. This site is currently investigating the potential for energetic valorisation of the landfill gas in the near future. The legal obligation of landfill gas recovery does not apply to the ‘older’ SWDS in Flanders.

The Flemish waste policy takes into account the European waste hierarchy, with prevention as the most favoured option and disposal (landfilling) as the least favoured option (cfr. Ladder of Lansinck). A high percentage of waste in Flanders is collected selectively for re-use, recycling and composting. For municipal waste, this percentage increased from 34% in 1995 to 66% in 2000 and ranging between 70 and 72% from 2002 onward [64]. The incineration of waste has also gained importance compared to landfilling. Since 2006, there has been an absolute ban on the disposal of combustible household waste (i.e. waste that can be incinerated instead). In 2011, less than 4 % of municipal waste was landfilled, this is primarily construction and demolition waste [65].

SWDS which are no longer actively exploited are finished off according to the legal regulations, followed by a period of after-care of 30 years in general. During this period, the operator remains responsible for maintenance, monitoring and control of the SWDS. Of the 16 ‘recent’ SWDS in Flanders, 4 sites remain licensed for active exploitation in 2011 [66].

Estimation of CH_4 emissions from 'older' SWDS: First Order model

The First Order model calculates the landfill gas generation (volume, m^3) from older Category II SWDS for the period 1970-2025. The model is based on the IPCC First Order decay model - Tier-2 methodology [28, 64]. It takes into account the amount of waste disposed, its biodegradable fraction, time factors of the degradation process as well as methane recovery and oxidation. The main input for this model is the total amount of waste disposed at older Category II SWDS in Flanders. These data are available from OVAM from the year 1981 onwards. For the period 1970-1980, the amounts of waste have been estimated by VITO [1] based on the 1981 data.

Step 1: Calculation of landfill gas generation

The Flanders First Order model calculates the generation of landfill gas (volume, m^3) using the equation:

$$S_t = a * Qi * B_0 * k * \exp -k(t-x)$$

where:

- S_t = generation of landfill gas at time t after disposal (in m^3)
- a = conversion factor: 1 kg of organic waste releases 1 m^3 of landfill gas (stoichiometric ratio)
- Qi = the amount of waste disposed (= IPCC Guidelines: MSW_T * MSW_F)
- B_0 = biodegradable fraction, assumed 0.18 (= the initial concentration of biodegradable material in the waste disposed, in kg ton^{-1}) ; this value is based on a study conducted in the Netherlands [67]
- k = first-order degradation rate constant, assumed 0.1; this value is based on another study conducted in the Netherlands, that measured the CH_4 emissions at three SWDS and calculated an average degradation coefficient of 0.1 year-1 [68]

An active lifetime of 25 years is assumed for the older Flemish SWDS, including an aerobic period of 1 year (no CH_4 emissions) and an anaerobic period of 24 years.

The total amount of landfill gas generated in year T (S_T) (volume, m^3) is calculated as the sum of the landfill gas generated from waste disposed in all previous years, from the starting year till year T:

$$S_T = \sum S_{t,x} \text{ for x = starting year till year T } (t_{total} = 25 \text{ years})$$

Step 2: Calculation of CH_4 emission

The landfill gas generated by the solid waste at 'older' sites (S_t, see above) is assumed to be composed of 55% CH_4 and 45% CO_2, in accordance with the stoichiometry of the decomposition of organic waste:

$C_6H_{10}O_4 + 1.5\ H_2O = 2.75\ CO_2 + 3.25\ CH_4$ [69]

Thus, the fraction of methane in landfill gas is assumed to be 55 % (F = assumed 0.55). The volume of CH_4 generated is then:

$$\text{volume } CH_4 \text{ generated (Q, } m^3) = \text{volume landfill gas generated (} S_t, m^3) * 0{,}55$$

The emission of CH_4 is calculated in accordance with the IPCC Guidelines: first, the volume of CH_4 recovered for flaring or energetic valorisation (R) is subtracted from the volume of CH_4 generated, after which an oxidation factor (OX) is applied. For the older Flemish SWDS, R = 0 since there are no facilities for recovery of the landfill gas at these sites. The oxidation of methane is assumed to be 10% (OX = 0.1).

The volume of CH_4 emitted is then:

CH_4 emission (m^3) = (Q – R) * (1 – OX) = (Q – 0) * (1 – 0.1) = Q * 0.9

Estimation of CH_4 emissions from 'recent' SWDS: Multi-phase model

Introduction

The multi-phase model calculates the landfill gas generation (volume, m^3) of recent Category II SWDS in Flanders, sixteen sites in total. The model is based on the IPCC First Order decay model – Tier-2 methodology [28,10]. It takes into account the amount of waste disposed, its composition and organic carbon content, time factors of the degradation process, methane recovery and oxidation as well as a methane correction factor. The model is called 'multi-phase' because it considers three 'phases' of degradation: for slowly, moderately and rapidly degrading waste.
The generation of landfill gas is calculated for each SWDS individually in separate worksheets. The time series is different for the individual landfills, depending on the period of active exploitation.
The main input for this model is the amount of waste disposed at recent Category II SWDS in Flanders. The multi-phase model distinguishes between three categories of waste: 1) household waste, 2) bulky waste and waste from municipalities and 3) industrial waste (definitions: see below). These data are available from OVAM. The SWDS operators report these data to OVAM annually by means of a survey.

Note:
Two recent SWDS, the sites 'Vanheede Landfill Solutions' (previously: 'Depovan') and 'Hooge Maey' have developed their own model to calculate CH_4 emissions. These models are comparable to the multi-phase model for recent SWDS. They can, however, be considered more detailed, both in terms of formulae used and as regards the input for certain parameters which is based on site-specific measures (e.g. detailed characterization of waste, CH_4 content of landfill gas).

Step 1: Calculation of landfill gas generation

The Flanders multi-phase model calculates the generation of landfill gas (volume, m^3) using the equation:

$$Q_g = \zeta\, a \left[\sum_{j=0}^{m}\sum_{i=1}^{n} A_j k_i C_{o,i,j} e^{-k_i(t-j)}\right]_{household\ waste}$$

$$+ \quad \zeta\, a \left[\sum_{j=0}^{m}\sum_{i=1}^{n} A_j k_i C_{o,i,j} e^{-k_i(t-j)}\right]_{bulky\ and\ municipality\ waste}$$

$$+ \quad \zeta\, a \left[\sum_{j=0}^{m}\sum_{i=1}^{n} A_j k_i C_{o,i,j} e^{-k_i(t-j)}\right]_{industrial\ waste}$$

where:

- Q_g = landfill gas generation (volume, m^3)
- ζ = landfill gas generation factor, assumed 1.0 (= IPCC: methane correction factor, MCF) (*this value has been adjusted following the in-country review of September 2012*)
- a = landfill gas generation constant (conversion factor), assumption: 1,87 m^3 landfill gas/kg C
- j = year
- m = period of disposal
- i = phase (rapidly degradable = 1, moderately degradable = 2, slowly degradable = 3)
- A_j = amount of waste disposed in year j (in tons/year)
- k_i = biodegradation rate constant in each phase i (rapidly, moderately, slowly degradable)
- $C_{o,i,j}$ = amount of organic carbon (C_o) in each phase i in year j (in kg C/ton)

The Flanders multi-phase model assumes that landfill gas generation starts one year after disposal, reaching a maximum immediately.

The model considers three phases of degradation. For each degradation rate k, half-life values ($t_{1/2}$) are estimated. These values are based on practical experience. The following values for k and $t_{1/2}$ have been defined, using the equation $k = \ln(2)/ t_{1/2}$:

rapidly degradable:	$k_1 = 0{,}173$, $t_{1/2}$ = 4 years
moderately degradable:	$k_2 = 0{,}069$, $t_{1/2}$ = 10 years
slowly degradable:	$k_3 = 0{,}023$, $t_{1/2}$ = 30 years

The amount of organic carbon in each phase in year j ($C_{o,i,j}$) (kg C/ton) is calculated based on the composition of waste, using the equation:

$$C_{o,i,j} = (w_i * d_i * o_i * c_i) * 1000$$

With, for each degradation rate phase i (slowly, moderately, rapidly degradable):

- w = the fraction (%) in the total amount of waste disposed with a specific biodegradation rate (e.g. fraction of slowly degradable waste = % textiles + % carpets etc.)
- d = the fraction (%) of dry material
- o = the fraction (%) of organic material in the dry material
- c = the organic carbon content of the organic dry material

Different values have been calculated for the three waste categories (household waste; bulky waste & waste from municipalities; industrial waste), because of their different compositions.

- Household waste refers to all waste generated by the normal operation of a private household, excluding bulky waste.
- 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.
- 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.
- Industrial waste refers to all waste arising from a commercial, industrial or institutional activity, similar to non-hazardous municipal wastes. Therefore, this category includes waste from the industry sector as well as the trade & services sector.

Table 8.1 show the values for the amount of organic carbon ($C_{o,i,j}$) used in the multi-phase model.

degradation phase (i)	household waste, before 1991	household waste, from 1991	bulky & municipality waste	industrial waste
rapidly degradable	44,4	49,5	0,0	49,0
moderately degradable	64,3	45,5	34,8	8,0
slowly degradable	22,8	25,3	65,8	18,0

Table 8.1: Values for amount of organic carbon in each phase in year j ($C_{o,i,j}$) (kg C/ton) used in the multi-phase model.

These values represent the amount of organic carbon which is actually degraded. Thus, $C_{o,i,j}$ corresponds with DOC * DOC_f (degradable organic carbon really degraded) in the IPCC Guidelines.

The same values are used for all years, except for household waste, where the model distinguishes between two periods: before 1991 and from 1991 onwards (taking into account the selective collection of household waste).

For more details on the calculation of $C_{o,i,j}$, we refer to Annex 10.

Step 2: Calculation of CH_4 emission

For the recent SWDS, the fraction of methane in landfill gas generated is assumed to be 50% (F = assumed 0.50). The volume of CH_4 generated is then:

volume CH_4 generated (Q, m^3) = volume landfill gas generated (Q_g, m^3) * 0,50

The emission of CH_4 is calculated in accordance with the IPCC Guidelines:
CH_4 emission = (Q – R) * (1 – OX).

An oxidation factor of 10% is assumed at each SWDS for the entire time series (OX = assumed 0.1).

Recovery (flaring and energetic valorisation) of landfill gas

Recovery (R) has been considered separately for flaring and valorisation, in accordance with the IPCC guidelines.
Most 'recent' landfill sites in Flanders have facilities for the energetic valorisation of landfill gas. Data on the amount of landfill gas captured at landfill sites and used for energetic valorisation (expressed in GJ) are annually compiled by VITO in the 'Flanders Energy Balance'. These data 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. CH_4 recovery started in the 1990s. Data from the Flanders Energy Balance are available from 2001 onwards.

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 for energetic valorisation (m^3) = landfill gas (GJ) * 1000 / Low Calorific Value LCV (MJ/m^3) with the assumption: LCV = 20MJ per m^3 landfill gas

The landfill gas used for energetic valorisation is assumed to have an average methane content of 50%. 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.

For flaring, the IPCC-default value (zero) has been applied, due to the lack of data based on measurements.

Evolution of CH_4 generation, recovery and emissions in the Flemish Region (1990-2012)

Figure 8.2 shows the evolution of the CH_4 generation, recovery and net emissions in the Flemish Region in the period 1990-2012.
The CH_4 generation in Flanders is calculated as the sum of CH_4 generated from older SWDS (using the First Order model) and from recent SWDS (using the multi-phase model). An oxidation factor of 10% is assumed.

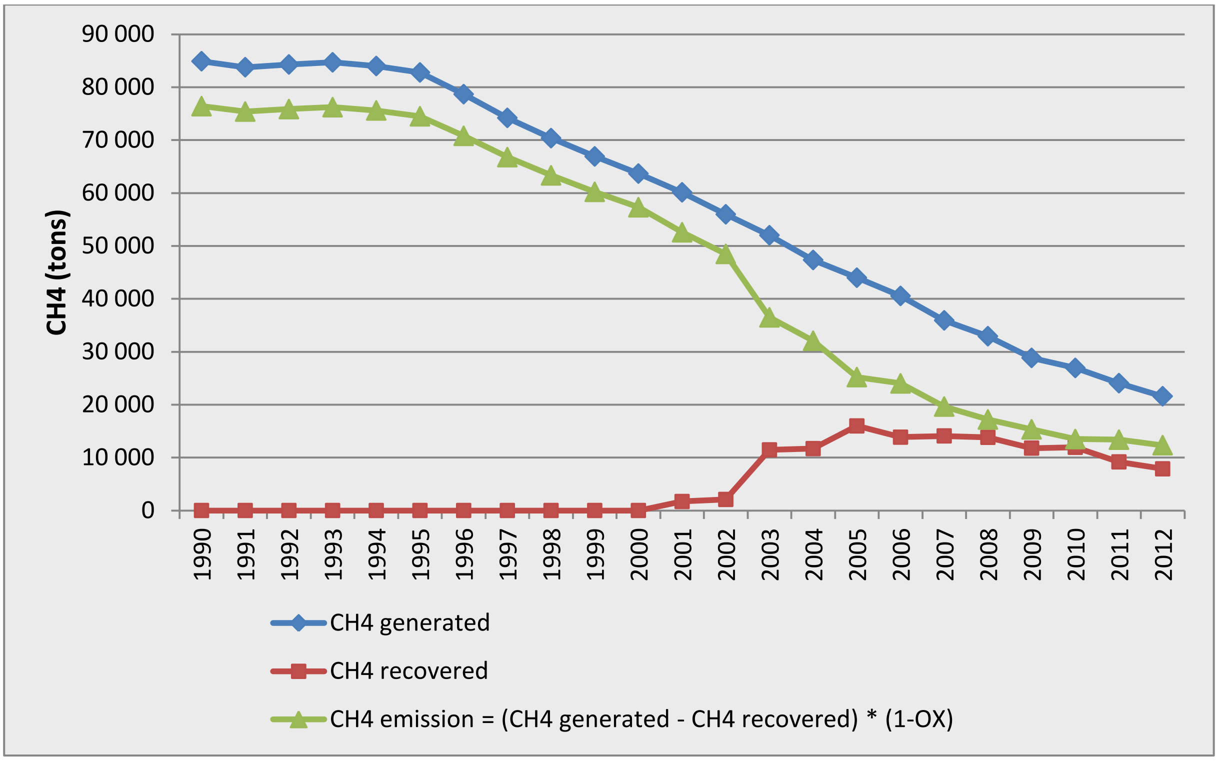


Figure 8.2.: Evolution of CH_4 generation, recovery for energetic valorisation, and net emissions (in ton) in the Flemish Region (1990-2012).

The amounts of waste disposed in the Flemish waste disposal sites since 1990 are presented in table 8.2.

	total waste (ton)
1990	2 345 052
1991	2 090 332
1992	2 428 617
1993	2 391 366
1994	2 361 972
1995	2 243 143
1996	1 982 214
1997	1 661 619
1998	1 431 194
1999	1 439 152
2000	1 354 366
2001	1 162 885
2002	840 680
2003	879 209
2004	761 011
2005	834 615
2006	782 816
2007	572 070
2008	451 261
2009	289 603
2010	271 023
2011	287 965
2012	275 527

Table 8.2: Quantity of waste disposed in SWDS in the Flemish region (ton) since 1990. Data for 2012 are provisional.

Wallonia

The model used in Wallonia is the first order decay model described in the 2000 IPCC Good Practices Guidance and the methodology follows the Tier 2 IPCC methodology (equations 5.1 and 5.2, IPCC Good Practice Guidance [10]).

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. 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) (IPCC Good Practice Guidance [10] equation 5.4, page 5.9), which are used as an input in the 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. 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. Between 2008 and 2004, municipal waste disposed has decreased by about 65% in Wallonia [59]. This trend is going on. Table 8.3. shows that the amount of waste has decreased by nearly a half between 2008 and 2010). This has an important effect on Implied Emission Factor evolution because waste deposed in SWD is emitting biogas during several decades. So, we have on the one hand a large quantity of emissions `stable` and on the other hand a quantity of waste which decreases very quickly. Consequently, for emissions of the SWD sector, IEF evolution is not so relevant than in other sectors.

	Industrial waste	*Municipal waste*	Total
1990	*1.370.343*	*1.217.000*	2.587.343
1991	*1.384.343*	*1.248.000*	2.632.343
1992	*1.392.343*	*1.264.000*	2.656.343
1993	*1.333.343*	*1.275.000*	2.608.343
1994	*1.428.429*	*1.314.331*	2.742.760
1995	*1.345.025*	*1.303.378*	2.648.403
1996	*1.134.879*	*1.274.302*	2.409.181
1997	*1.254.012*	*1.078.782*	2.332.794
1998	*1.187.062*	*969.358*	2.156.420
1999	*1.237.725*	*906.820*	2.144.545
2000	*1.068.091*	*873.031*	1.941.123
2001	*1.075.147*	*797.496*	1.872.643
2002	*1.197.336*	*687.077*	1.884.413
2003	*1.054.761*	*628.394*	1.683.155
2004	*850.471*	*740.556*	1.591.027
2005	*822.937*	*659.000*	1.481.937
2006	*742.293*	*616.173*	1.358.466
2007	*768.125*	*565.423*	1.333.548
2008	-	-	1.077.790
2009	-	-	901.808
2010	-	-	510.479
2011	-	-	617.615
2012	-	-	719.515

Table 8.3.: Quantity of waste disposed in SWDS in Wallonia (ton) since 1990

The DOC values for municipal and industrial waste were calculated using the detailed waste types from OWD and the IPCC Good Practice Guidance methodology (equation 5.4). Evolution of the annual mean DOC (*sum of the municipal and industrial waste*) is given in figure 8.3.

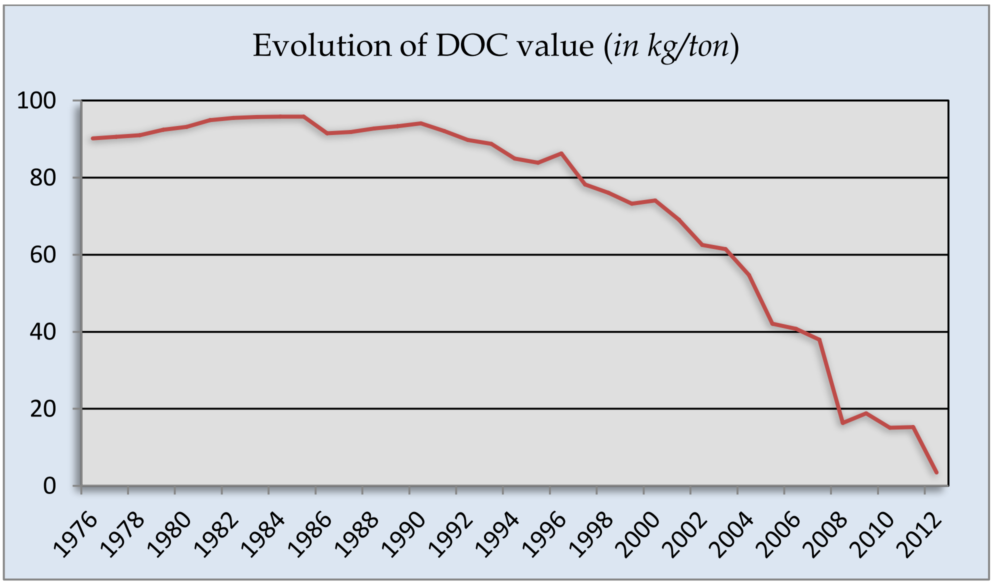


Figure 8.3.: Evolution of annual DOC values (in kg/ton) in Wallonia from 1976 to 2012

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[18]. The drop in 2012 is linked to a decrease in the amount of sludge disposed.

The biodegradation rate constant (*k*) and the rate of DOC really degraded (DOC_f) also come from the IPCC Good Practice Guidance [10]. The default value of 0.5 for DOC_f, proposed in the IPCC Good Practice Guidance if lignin is included in the DOC value, has been used in the model. The *k* default value of IPCC has also been chosen ($k=0.05$ which means that $t_{1/2}=14$ *years*).
All the SWDS in Wallonia are managed and consequently, the Methane Correction Factor (MCF) value is 1 over the whole time series.
The *F* value (fraction of methane in biogas) has been calculated from the data provided by the different SWDS and is closed to the IPCC value of 0.5.
The Table 8.4. resumes the values of the different parameters used in Wallonia.

The annual emissions are the results of the sum of $3*t_{1/2}$ (i.e. 42 years) of annual generation of emissions as suggested in the IPCC Good Practice Guidance [10].

	Years	Municipal waste	Industrial waste
DOC	1970-1985	180	27
	1986-1990	170	27
(in kg.ton^{-1})	1995	143	27

[18] **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**

	2000	106	49
	2002	93	45
	2003	99	39
	2005	54	33
	2007	63	19
	2008	16	
	2009	19	
	2010	15	
	2011	15	
	2012	3.5	
k	All years	0.05	
MCF	All years	1	
F	All years	0.49	
DOC_f	All years	0.5	

Table 8.4.: Parameters values used in the first order decay model in Wallonia

The model provides, for each year, estimation for the range of CH_4 and CO_2 production. The biogas CO_2 emissions are not reported in the CRF tables 6.A as it is from biogenic source.

The CH_4 recovered is subtracted from total emissions following the equation 5.2 of the IPCC Good Practice Guidance. This CH_4 is assumed to be completely converted into CO_2 through the combustion process.

CH_4 recovery started in 1993 and largely increased since that year, by gradually equipping more and more disposal sites. It is the main driver of the reduction of the net emissions in this sector.
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 ('torchères' in French) and the fraction of CH_4 and CO_2. 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[19].

Figure 8.4. shows the evolutions of CH_4 production, recovery and net emission.

[19] http://environnement.wallonie.be/data/dechets/cet/

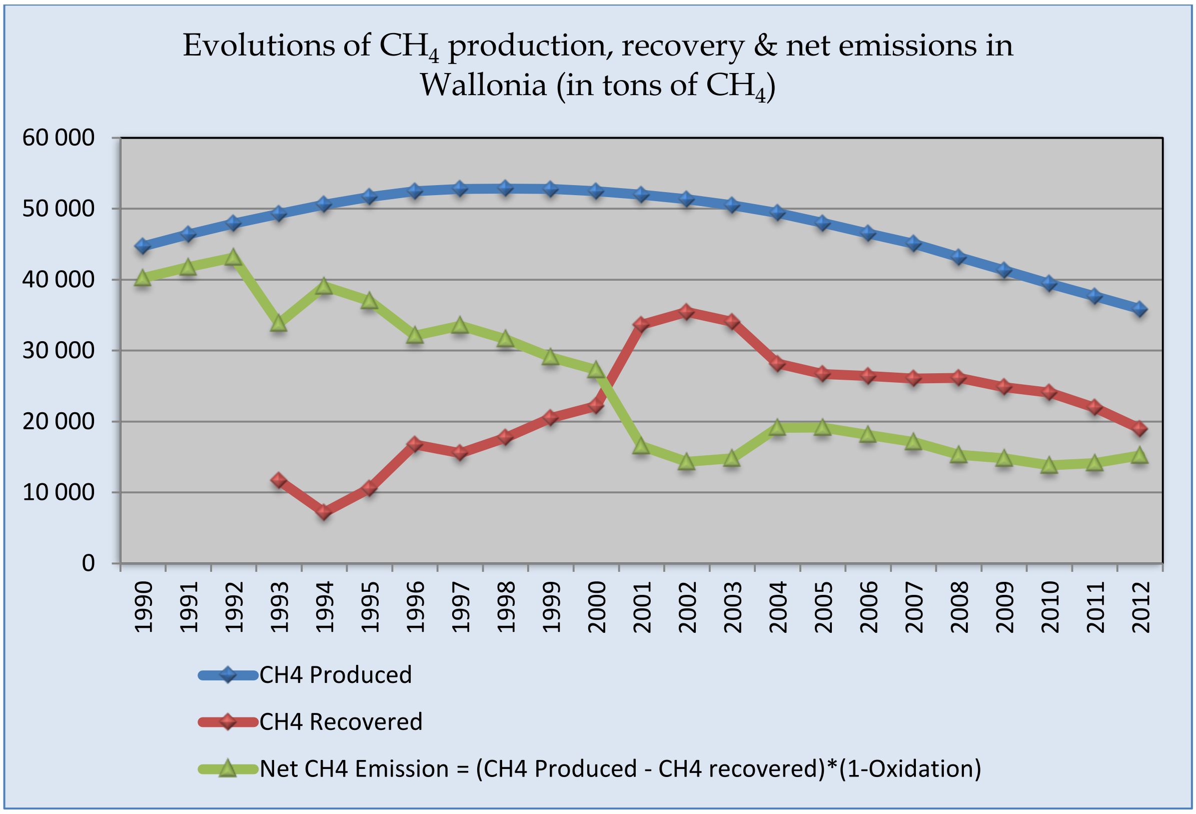


Figure 8.4.: Evolutions of CH_4 production, recovery and net emissions in Wallonia

Comparison of parameters used in the region-specific models

CH_4 emissions from solid waste disposal sites in Belgium are estimated using different approaches. The Flemish region uses a first order model to calculate emissions from older landfills and a multi-phase model to calculate emissions from 16 recent landfills. Both models are based on the guidelines in the IPCC 2000 Good Practice Guidance (First Order decay model, Tier 2 methodology) and take into account the amount of waste disposed, its composition, time factors of the degradation process as well as methane recovery and oxidation. The reason for using two separate models for the Flemish region is the availability of more detailed information from the Flemish Waste Agency (OVAM) concerning the recent landfills (16 solid waste disposal sites). This allowed the development of a more advanced model using more detailed parameters, which is believed to lead to a more accurate estimation of the emissions. Hence, the multi-phase model contains detailed formulae for calculating the composition and organic carbon content of waste, distinguishing between three categories of waste (1- household waste, 2- bulky waste and waste from municipalities and 3- industrial waste) and three phases of degradation (slowly, moderately and rapidly degrading waste). The multi-phase model also uses a specific value for k for slowly, moderately and rapidly degrading waste.

The Walloon region uses the first order decay model described in the 2000 IPCC Good Practices Guidance and the methodology follows the Tier 2 IPCC methodology.

There are no landfills in the Brussels-Capital region.

The table below gives an overview of region-specific parameters used in the different models, using the same terminology.

IPCC parameter		Flanders First Order model (older SWDS)	Flanders multi-phase model (recent SWDS)	Wallonia IPCC First Order model
MSW_T * MSW_F	amount of waste disposed (ton)	= parameter Q_i	= parameter A_j	cf. IPCC-equations
k	first order degradation rate constant	0.1	0.173 (rapidly degradable waste); 0.069 (moderately degradable waste); 0.023 (slowly degradable waste)	0.05 (IPCC default value).
MCF	methane correction factor	1.0	1.0	1.0
F	fraction of methane in landfill gas (%)	0.55	0.5	0.49
R	recovery	0	flaring = 0; energetic valorisation = based on measurements	flaring and valorisation = based on measurements
OX	oxidation factor	0.1	0.1	0.1
DOC, DOC_f	composition of waste / amount of organic carbon	Parameter B_0 = biodegradable fraction of waste = 18% (0.18) = initial concentration of biodegradable material ton^{-1}. Parameter a = conversion factor: assumes 1 kg of organic waste releases 1 m^3 of landfill gas.	Parameter $C_{0,i,j}$ represents amount of carbon in each phase i (rapidly, moderately, slowly degradable waste) in year j (in kg C / ton). See table 8.1 for the values of $C_{o,i,j}$ for household waste, bulky & municipality waste and industrial waste. Annex 10 provides detailed information on the calculations. Parameter a = conversion factor: assumes 1.87 m^3 landfill gas is generated per kg C.	See NIR table 8.4: DOC values for municipal and industrial waste are calculated using the detailed waste types from the Walloon waste office (OWD) and IPCC Good Practice Guidance equation 5.4. DOC_f = 0.5 (IPCC default value).

Table 8.5.: overview of Region-specific parameters used in the models

8.2.3. Uncertainties and time-series consistency

In the Flemish region input data of waste disposal sites are available since 1990.

In Wallonia, complete statistics on the amount of waste input in solid waste disposal sites are delivered on a yearly basis since 1994. For the previous years, the amounts have been estimated using available data and expert judgement from the waste offices. Hence, the uncertainty on activity data is lower since 1994. However, given that in the model the activity data of a single year is used over a 42 years degradation time, the same uncertainty of 30 % (1990 estimate) has been applied on the whole time series. For the same reasons, the activity data are assumed to be correlated for the calculation of the uncertainty in trend.

The global uncertainty on emission factors reported in other member states goes from 30 % (Netherlands, Finland, Norway) to 50 % (Ireland, France). A provisional value of 40 % is accordingly adopted for this calculation for Belgium.

8.2.4. Source-specific QA/QC and verification

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.

For the CH_4 emissions of the 6.A.1 category, QA/QC procedure is a continue improving process and consists in:

- The activity data, emission factors and parameters valeurs are always compared to the values of the previous submission and the general trend is analysed to detect potential peaks. If a peak appears (hard drop or increase), the reason is documented directly in the file.
- Sensitivity analyses are conducted for some parameters in order to evaluate their possible modification.
- Every year the methodology is read in order to improve the transparency and to add complementary information (e.g. answers provided during the review).
- Calculation files are sometimes improved when there is a lack of information or clarity.
- The documentation tends to be more detailed over the years.

Since the 2012 submission, the check list tier 1 QC is completed.

8.2.5. Source-specific recalculations

Flanders

As a result of the UNFCCC in-country review in September 2012, several corrections were made to the emission estimates of Flemish solid waste disposal sites during the 2013 submission. Details of these recalculations are described in the 2013 NIR (section 8.2.5).

During the 2014 submission the amounts of waste were further optimised. Following consultation with waste experts (from the Flemish Waste Agency OVAM and others), the entire time series of waste disposed at ‘older’ and ‘recent’ SWDS was reviewed and emissions estimates were corrected.

The main correction concerned the amount of waste disposed at 1 of the 16 ‘recent’ SWDS. Previously, the amounts of waste disposed at this site between 1970 and 2000 (around 9 million tonnes in total) had been (wrongly) assigned to the older SWDS and estimated using the first older model, leading to a significant overestimation of the emissions by older Flemish SWDS. At the same time, the emissions of the 16 ‘recent’ Flemish SWDS were significantly underestimated, as for this SWDS, only the waste amounts from 2000 onwards were used as input for the multi-phase model. In the 2014 submission, this error was corrected. The amount of waste disposed at this SWDS was completed for the entire time series 1970-2012 and used entirely as input for the multi-phase model (thus resulting in higher emissions from recent SWDS). On the other hand, this waste was subtracted from the amounts of waste used as input for the first order model (thus resulting in lower emissions from older SWDS).

A further correction was the elimination of a double counting of waste amounts in 2001 and 2002. Around 2 million tonnes of waste in total had been wrongly assigned to the older SWDS and used as input for the first older model, leading to an overestimate of the emissions from older SWDS.

The table 8.6 below shows the result of these corrections for the Flemish region. For the year 2011, this resulted in a higher estimate of the CH_4 emissions from recent Flemish SWDS (+7,1 kton) and a lower estimate for older SWDS (-9.5 ton), leading to an overall estimate of 13.4 kton CH_4 emissions from Flemish SWDS (compared to 15.8 kton in the 2013 submission).

	submission April 2013			submission March 2014		
	16 recent SWDS	older SWDS	total	16 recent SWDS	older SWDS	total
1990	20,6	59,2	79,8	26,7	49,7	76,4
1991	22,0	55,5	77,5	29,2	46,1	75,4
1992	23,8	52,9	76,7	33,0	42,9	75,9
1993	25,1	51,8	76,9	36,4	39,8	76,2
1994	26,4	50,6	77,0	39,6	36,0	75,6
1995	27,6	49,1	76,7	41,9	32,6	74,5
1996	27,9	46,2	74,1	42,2	28,6	70,8
1997	27,7	44,1	71,7	41,8	24,9	66,8
1998	27,5	41,2	68,7	41,7	21,7	63,3
1999	26,8	39,7	66,5	41,5	18,7	60,2
2000	25,4	38,7	64,1	41,3	16,0	57,3
2001	22,7	40,2	62,9	39,0	13,6	52,6
2002	21,2	35,5	56,7	37,1	11,4	48,5
2003	11,4	31,2	42,6	27,1	9,4	36,5
2004	9,6	27,4	36,9	24,4	7,6	32,1
2005	5,2	23,9	29,1	19,1	6,1	25,2
2006	6,1	20,8	26,9	19,4	4,7	24,0
2007	3,8	18,0	21,8	16,3	3,4	19,6
2008	3,7	15,5	19,2	14,9	2,3	17,2
2009	4,1	13,6	17,7	13,7	1,7	15,3
2010	4,0	11,9	15,9	12,2	1,3	13,5
2011	5,4	10,4	15,8	12,5	0,9	13,4
2012				11,7	0,7	12,3

Table 8.6 : Estimate of CH_4-emissions (kton) from recent and older Flemish SWDS: comparison of 2013 and 2014 submissions.

Wallonia
The QA-QC realised in end of 2013 detected an error in a calcul sheet: the net emissions of CH_4 were overestimated because the 0.1 oxidation factor was not applied in the column of the final net emission of CH_4.Thus, the correction has been applied and resulted in lower net emissions in the whole time serie (63 kt CH_4 on all the period 1990-2011 or less than 6.5 kt CH_4 between 2008 & 2011).

Years	**CH_4 Produced (tons)**	**CH_4 Recovered (tons)**	**Net CH_4 Emission (tons)**
1990	44 716		40 244
1991	46 399		41 760
1992	47 937		43 143
1993	49 291	11 698	33 834
1994	50 603	7 203	39 060
1995	51 677	10 564	37 002
1996	52 469	16 781	32 119
1997	52 818	15 568	33 525
1998	52 856	17 713	31 628
1999	52 782	20 491	29 061

2000	52 501	22 189	27 281
2001	52 003	33 636	16 531
2002	51 346	35 444	14 312
2003	50 490	34 044	14 802
2004	49 416	28 172	19 120
2005	48 000	26 714	19 158
2006	46 541	26 408	18 120
2007	45 078	26 070	17 106
2008	43 160	26 156	15 303
2009	41 326	24 858	14 821
2010	39 433	24 088	13 811
2011	37 661	21 962	14 129
2012	35 865	18 965	15 210

Table 8.7.: Annual CH_4 production, recovery and net emission in tons of CH_4.
*(Net emissions = Production – Recovery * 0.9)*

8.2.6. Source-specific planned improvements

In the course of 2014, the Flemish and Walloon region will investigate the possible implementation of the IPCC 2006 Guidelines to replace the current methods for estimation of CH_4 emissions from SWDS.

8.3. Wastewater handling (CRF 6.B)

8.3.1. Source category description

The category 6B1 (industrial waste water handling) is briefly discussed in this chapter.

The emissions from the treatment of domestic and commercial wastewater are allocated to the category 6B2.

8.3.2. Methodological issues

6B1. Industrial wastewater handling and treatment

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).

6B2. Domestic and commercial wastewater handling and treatment

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.

CH_4 emissions

The methodology for the septic tanks is based on an article (Vasel, 1992) [32] which describes the characteristics and parameters of individual septic tanks. The IPCC default value of 0.6 kg CH_4/kg BOD is used. Each habitant produces 0.060kg BOD/day, whose 60 % eventually settles (IPCC fraction that readily settles). It is considered that only 25 % of the BOD loading is anaerobically degraded (0,060*0,6*0,25), because the septic tanks are regularly emptied and consequently the sludge is then treated aerobically (Vasel, 1992) [32]. The annual emission factor becomes 1,971 kg CH_4/inhab*year (0,6*0,060*60%*25%*365 kgCH_4/kg BOD). The CH_4 emissions are estimated by multiplying these emission factors by the number of inhabitants not connected with a municipal wastewater treatment plant (in Wallonia, this number is estimated at 11-12% of the Walloon population).

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 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 1996 Guidelines by multiplying the protein consumption per capita with the population, the N fraction in the protein and the default EF. The default values for N fraction in protein (kg N / kg protein) and N_2O emission factor are 16 % and 0.01 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 8.8 gives an overview of the AD and factors used for 2012.

	Belgium
Protein consumption (kg/capita/yr)	35.95
Population	11035948
N fraction in protein (kgN/kg protein)	0.16
EF (kg N_2O-N/kg sewage-N)	0.01

Table 8.8: factors used in Belgium to calculate the N_2O-human sewage in 2012.

8.3.3. Uncertainties and time-series consistency

IPCC recommends an activity data uncertainty of 5% for population and 30 % for BOD/person. An overall uncertainty of 20 % is considered for activity data. The same uncertainty is used for N_2O calculation, assuming that the uncertainty on the annual per capita protein intake and the fraction of nitrogen in these proteins lies in the same range.

The uncertainty on CH_4 emission factor reported by other parties goes from 48 % (UK, 2000) to 104 % (Finland), mainly depending on the uncertainty on the Methane Conversion Factor (fraction treated anaerobically). A default value is used for the time being and further expert judgement is needed on this estimate. Thus, an average uncertainty of 70 % is used for the time being.

For N_2O the default IPCC emission factor of 0.01 kg N_2O/kg N is used. This emission factor originates from table 4.18 of the IPCC 1996 Guidelines with a given range of 0.0025 to 0.0225. This range represents an uncertainty of –75% to +125%. An uncertainty of 110 % is used in this calculation.

8.3.4. 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.

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

- Due to an update of the FAO statistics, from 2000 onwards, the protein consumption has been corrected during this 2014 submission in Belgium. As a result emissions in the category 6B2 ‘domestic and commercial waste water’ did change slightly compared to previous submission.

8.3.6. Source-specific planned improvements, if applicable

No specific improvements are planned in the near future in the category of waste water handling (category 6B).

8.4. Waste incineration (CRF 6.C)

8.4.1. Source category description

The waste incineration category (category 6C) includes incineration of municipal and industrial waste, incineration of hospital waste and incineration of corpses (crematoriums). 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 6C (Flemish and Walloon regions). The emissions of the waste incineration plants with energy recovery are allocated to the category 1A1a.

Only one incineration plant with energy recovery is located in the Brussels region. Its emissions are allocated to the category 1A1a.

8.4.2. Methodological issues

<u>Waste incineration</u>

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 5.23 'Emissions of CH_4 are not likely to be significant because of the combustion conditions in incinerators (e.g. high temperatures and long residence time)'.

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 6C.

The activity data (total amount of waste incinerated) in the Flemish region for the complete time series is shown in the table 8.9. 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	8,52	0	58,32	65,5
2012	9,36	0	58,32	65,5

Table 8.9.: Amounts of waste incinerated (PJ) in the Flemish region (1990-2012).

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.

To allocate the emissions in the energy sector, category 1A1a, the activity data must be converted to TJ/year. The conversion of incinerated waste with energy recovery from ton/year to TJ/year is 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.

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	199249	68	157614	68	356 863	68
1991	210740	68	161864	68	372 604	68
1992	201748	68	167660	68	369 408	68
1993	195009	68	174391	68	369 400	68
1994	215945	68	184552	68	400 497	68
1995	210217	68	181914	68	392 131	68
1996	238143	68	193000	68	431 143	68
1997	238354	68	166399	68	404 753	68
1998	266525	68	125669	68	392 194	68
1999	256471	68	122975	68	379 446	68
2000	242817	68	82042	68	324 859	68
2001	269808	21	71501	38	341 309	24
2002	408493	27	46555	35	455 048	28
2003	461164	33	58899	35	520 062	33
2004	512311	32	44301	35	556 612	33
2005	476685	30	21716	41	498 401	31
2006	553663	31	17000	41	570 663	31
2007	579360	33	17000	41	596 360	33
2008	623185	38	11665	41	634 850	38
2009	587198	47	36064	41	623 262	47
2010	859075	50	17231	41	876 306	50

2011	893029	50	13426	41	906455	50
2012	919463	50	12600	41	932063	50

Table 8.10.: Amounts of waste incinerated (ton) and organic content (%) in the Walloon region (1990-2012).

Brussels region

The emissions from the waste incineration plant with energy recovery are allocated to the sector 1A1a.

The evolution of the corresponding amount of waste incinerated and of its organic content are presented in Table 8.11.

	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

Table 8.11.: 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 8.12. No energy recovery occurs in these 3 plants.

	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 8.12.: Amounts of municipal and hospital waste (tons) incinerated in the Brussels Region without energy recovery (category 6C)

The evolution of the number of corpses incinerated at the Uccle crematorium is presented in Table 8.13.

	Corpses incinerated (Uccle crematorium)
1990	7217
1991	7104
1992	6990
1993	5802
1994	5443
1995	5477
1996	5043
1997	5175
1998	5267
1999	5322
2000	5463
2001	5429
2002	5619
2003	6154
2004	6205
2005	6026
2006	6116
2007	6007
2008	6356
2009	6348
2010	6121
2011	6049
2012	5651

Table 8.13.: Number of corpses incinerated at the Uccle crematorium

Flaring in the chemical industry

No flaring activities in the chemical industry take place in the Brussels region.

The emissions of CO_2 from the flaring in the chemical industry are reported in category 6C 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.

8.4.3. 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 %.

8.4.4. 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 CO2 emissions of the 6.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 CO2 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.

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

- The activity data in the category 6C (waste incineration) were optimized during the 2014 submission in the Flemish region for the year 2005. An inconsistency with the Flemish energy balance was corrected. As a result the emissions in this category did change with -41,523 Gg CO2 eq total difference.

8.4.6. Source-specific planned improvements, if applicable

No improvements are planned in the future in the category 6C in the Belgian greenhouse gas inventory.

8.5. Other (CRF 6.D)

8.5.1. Source category description

Emissions of CH_4 from the composting of organic waste are put under category 6D.

8.5.2. Methodological issues

CH_4 emissions from composting of organic waste are estimated using regional activity data combined with a default emission factor of 0.75 kg CH_4/ton waste entering in the compost centres. The emission factor of 0.75 kg CH_4/ton waste composted is used after consultation with colleagues in the Netherlands who use this factor as a result of measurements carried out since 2009. This monitoring program was carried out in the Netherlands and the Ministry as well as the waste sector were involved. The monitoring was not a random indication of emissions but was carried out over a longer period which increases the reliability of this emission factor used.

In Wallonia, new figures are available for the activity data of 2010. 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. This methodology is deemed more adequate and more reliable for the calculation of the CH_4 emissions coming from composting. Data are better 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	714 897	785 515	18 869

Table 8.14.: Amounts of ton waste composted in Belgium (1990-2012) (figures for 2012 are provisional).

8.5.3. Uncertainties and time-series consistency

The uncertainties both on activity data and emission factors for CH_4 are based on expert judgment and results in an uncertainty of 30% on the activity data and 200% on the emission factor.

8.5.4. 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.

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

- The activity data reported in the category 6D (composting) are optimized during the 2014 submission in the Flemish region from 2008 on. As a result the emissions did change slightly.

8.5.6. Source-specific planned improvements, if applicable

No improvements are planned in the future in the category 6D in the Belgian greenhouse gas inventory.

CHAPTER 9: RECALCULATIONS AND IMPROVEMENTS

9.1. Recalculations, including in response to the review process and for KP-LULUCF inventory

9.1.1 GHG inventory

The specific recalculations and methodological improvements achieved since the last 2013 submission are presented in the respective chapters of all sectors in this National Inventory Report.

A summary of these recalculations is provided below and in the CRF table 8b (please note that only the changes compared to the 2013 submission of November 2013 are encoded in the CRF table 8b and table 8a).

A constant actualization of all sectors of the inventory is performed (mostly in most recent years) from the moment more accurate data become available. This applies especially to the energy sector due to the process of finalizing the regional energy balances.

Important recalculations (with a major impact on the total emissions) on the Belgian inventory were carried out during the 2006 submission at the moment the assigned amounts were set down.
In all regions, the emissions were completely updated during that submission for the entire time series.

In addition to the November 2013 submission, following the recommendations as provided in the 'Saturday Paper', Belgium took into account as far as possible during this 2014 submission (no draft annual review report of the centralized review was received so far but only a not official preliminary draft annual review report) supplementary recommendations as occuring during the review process.

Saturday Paper ‘Potential Problems and Further Questions from the ERT formulated in the course of the 2013 review of the greenhouse gas inventories of Belgium submitted in 2013’ of September 28, 2013 with the responses of Belgium to the Saturday Paper and the official approval from the ERT on December 13, 2013 is attached in annex 3 of this national inventory report.

On the technical side, all the national sectoral tables have been fulfilled in this submission.

Recalculations performed during the 2014 submission:

General

The indirect greenhouse gas emissions (NO_x, SO_2, NMVOC and CO) have been actualized, to fully harmonize the Belgian inventory presented in this National Inventory Report with the reporting of Belgian’s emissions performed under the Convention of EMEP/LRTAP. All the years have been revised

Overall recalculations in figures

GHG Totals, Total with LULUCF (6 gases / actual emissions only)(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	3.55	1.57	1.80	1.24	1.10	1.24	1.16	0.39	0.80	-3.12
Flemish region	%	0.22	-0.12	-0.20	-1.13	0.12	0.05	-0.93	-1.12	-1.22	0.78
Walloon region	%	-0.96	-0.23	-0.19	-0.59	-0.77	-0.90	-0.36	-1.13	-0.50	-1.49
Belgium	%	-0.12	-0.11	-0.13	-0.87	-0.15	-0.22	-0.67	-1.07	-0.93	-0.05

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	144.9	70.6	0.0	56.2	48.1	50.1	50.9	16.3	35.4	-118.8
Flemish region	Gg CO_2 eq.	188.3	-112.4	-175.5	-1016.1	100.4	46.0	-792.0	-917.6	-1053.7	611.4
Walloon region	Gg CO_2 eq.	-506.1	-124.7	-99.2	-277.3	-353.6	-393.3	-162.9	-420.3	-200.1	-554.4
Belgium	Gg CO_2 eq.	-173.0	-166.5	-195.0	-1237.2	-205.0	-297.1	-904.1	-1321.7	-1218.5	-61.8

GHG Totals, Total without LULUCF (6 gases / actual emissions only)(Gg CO2 equivalent)

Relations to previous submission as in CRF table 8a

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	%	3.54	1.56	1.80	1.23	1.11	1.23	1.16	0.39	0.80	-3.11
Flemish region	%	0.13	-0.19	-0.29	-1.27	0.00	-0.03	-1.01	-1.23	-1.35	0.67
Walloon region	%	-0.93	-0.23	-0.20	-0.56	-0.73	-0.86	-0.34	-1.06	-0.47	-1.39
Belgium	%	-0.18	-0.15	-0.19	-0.94	-0.22	-0.28	-0.70	-1.12	-0.99	-0.14

Relations to previous submission (Gg CO_2 eq.)

		1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Brussels region	Gg CO_2 eq.	144.9	70.5	0.0	56.2	48.5	49.7	50.9	16.3	35.4	-118.8
Flemish region	Gg CO_2 eq.	112.6	-171.1	-258.2	-1125.3	4.0	-26.6	-847.7	-991.4	-1144.5	511.8
Walloon region	Gg CO_2 eq.	-509.8	-127.1	-105.6	-280.4	-358.2	-396.7	-165.6	-423.4	-200.6	-555.6
Belgium	Gg CO_2 eq.	-252.3	-227.7	-284.0	-1349.6	-305.7	-373.6	-962.4	-1398.5	-1309.7	-162.6

In the energy sector:

- Further optimization of emissions of CO_2 in the category 1A1a in the Flemish region took place during the 2014 submission in terms of better tuning between the emissions reported through the individual Integrated Environmental Reporting by companies and the individual reporting through the ETS Directive. Default emissions calculated on the basis of the Flemish energy balance were in this respect further corrected and optimized for the years from 2005 on.

- Also the emissions of N_2O originated from the waste incineration plants with electricity production (category 1A1a) were optimized in the Flemish region from 2008 on due to further optimization of the activity data.
- Mistake corrected in 2010 for the AD (liquid fuel) of a turbo jet (1A1a) in the Walloon region (-3,6 kt CO_2).
- Mistake corrected in 2008 and 2009 for the AD (liquid fuel) of a turbojet and AD adjustement for the category “other fuels” (2008-2011) in the Brussels Region (1A1a)
- A re-allocation of the emissions of waste incineration between 1A1a an 6C took place in the Walloon regin for the complete time series.
- Emissions of N_2O from the petroleum refining in the Flemish region were re-allocated during the 2014 submission to the gaseous fuels in the category 1A1b instead of the liquid fuels before. The notation key ‘IE’ is used for the liquid fuels. This is a more accurate allocation of these emissions.
- During the 2014 submission, emissions of N_2O from the iron and steel sector were newly reported in the Flemish region (category 1A2a). The emissions were calculated based on measurements performed from 2004 on and best estimates based on average concentrations and flow rates for the years before.
- During the 2014 submission the split in emissions of CO_2 between the sectors ‘chemical industry’ and ‘other industries’ (category 1A2c and 1A2f) was optimized for the years 2010, 2011 and 2012 for the ‘other fuels’ in the Flemish region. The reason for this optimization was a partly wrong allocation of emissions of ‘other industries’ to the ‘chemical industry’ because some of these companies also are members of the chemical federation.
- In the Walloon region, some mistakes were corrected in 2010 in the sector 1A2a, 1A2e and 1A2f.
- In the Walloon region, between 2008 and 2011, the glue is now taken into account in the manufacture of wood panels (+ 8kt CO_2 in 2008, +6,7 kt CO_2 in 2009, +6,8 kt CO_2 in 2010 and +5,8 kt CO_2 in 2011) and the biomass fraction of some wastes was corrected in the cement sector, the activity data were modified but the emissions were accurate.
- In the category 1A3b road transport: further harmonisation of the COPERT-based models is performed between the regions during the 2014 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, modeling 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.
- As from the 2014 submission on offroad emissions that take place in harbours, airports and transhipment companies are newly allocated to the category 1A3e ‘other transportation’ for all regions in Belgium. These emissions were allocated to the category 1A4a (commercial, institutional) before.
- During the 2014 submission, Flanders has made recalculations in the category 1A4b (residential) for the use of biomass (for 1990 to 2011) and the use of fuel oil (2002 – 2011) using new data: (1) For biomass (wood consumption), 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. (2) 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].

- During the 2014 submission, some small corrections were made in the Flemish region in the category 1A4c for all fuels (liquid, solid and gas) for the years 2007-2009. It was not clear where these minor glitches were coming from.
- In the Walloon region, there was a mistake in 1A4a in 2006, the coal was missing and has been included (18 TJ, - /+ 1,7 kt CO_2).
- In the Walloon region, recalculation of the biomass consumption in the residential sector (category 1A4b) in the Walloon sector (2002-2010) by using the Survey performed by Belgium with the financial aid of Euostat.
- In the Walloon region, recalculation on the all time serie of the off-road emissions of the forest sector (category 1A4c) as the wood surface has changed slightly (-0,05 kt CO_2).
- During the 2014 submission a re-allocation of the off-road emissions took place in the category 1A4 in Belgium: 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 2014 submission off-road emissions of defence are newly allocated in Belgium for the complete time-series in the category 1A5b instead of category 1A4a before.
-

In the sector of industrial processes:

As a result of the UNFCCC centralized review in September 2013 (new results were submitted on November 11, 2013 to UNFCCC):

2.B.1 Ammonia production (CO2): Belgium agrees with the recommendation formulated by the ERT and did recalculate the emissions of CO2 originating from the production of ammonia. This recalculation did no longer include the use of the oxidation factor of 99.5% as in previous submissions. Consequently the new methodology used is completely in line with the Revised IPCC 1996 Guidelines. The result of the recalculation is an increase of the CO2 emissions with 5.54 kt in 2011.

2.F. Consumption of Halocarbons and SF6, 2.F.1 Refrigeration and air-conditioning equipment Commercial refrigeration (HFCs, PFCs): Belgium did not follow the first recommendation of the ERT: 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 since 2002 is 79 tonnes, while the total “amount in systems at time of disposal” up to now is 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.

Further more:

- During this 2014 submission, the activity data in category 2A7 (glass production) were optimized in the Flemish region for the complete timeseries. Missing activity data of 1 company was added for the entire timeseries. Besides this, the missing emissions of CO_2 of this company were added for the years 1990-2004.

- During the 2014 submission, the processemissions in the chemical industry (category 2B5) were revised for the year 2011 in the Flemish region (an extra 328 kton CO_2 was added compared to previous submission).
- The main changes made in categories 2E and 2F for the period 1995-2011 are the following:
  - The R134a stock of domestic refrigerators in 2011and the corresponding fugitive emissions have been revised.
  - For refrigeration “installations”, the figures (existing stock, the Amount charged into new systems, Amount of systems at time of disposal and the emissions) have been revised for the whole period, for several reasons:
    - A revision of the assumptions on the refrigerant mix in systems at time of disposal.
    - Disposal emissions of room air conditioning appliances have been included. The stock data of these appliances have also been adapted, by taking into account the consumption of earlier years than 2005.
    - The emissions of Transport refrigeration, which used to be included in this category, are now taken up in CRF Reporter as a separate category.
  - The end of life recovery from used cars has slightly changed for 2011.
  - For 2011, the amount in systems at time of disposal for Bus & coaches has been revised.
  - The HFC consumption and stock of fire extinguishers in 2011, as well as the corresponding emissions, have been corrected.
  - The HFC consumption for manufacturing and the corresponding actual and potential emissions of technical aerosols have been enhanced for 2011.
  - For the semiconductor industry, the potential emissions have been recalculated, on the basis of new activity data.
  - Actual and potential emissions of SF6 from sport shoe soles have been included (concerns the period up to 2006).

In the sector of solvent and other product use:

- The N_2O emissions from aerosol cans (category 3D3) are newly estimated for the complete timeseries in Belgium (section 5.1.2.)
- New activity data (number of beds obtained from the Health Public Federal Service) has been taken into account in the Walloon region for the complete timeseries to estimate the emissions of N_2O from anesthesia (category 3D2).

In the sector of agriculture:

As a result of the UNFCCC centralized review in September 2013 (new results were submitted on November 11, 2013 to UNFCCC):

- In the category 4A the net energy for pregnancy of dairy cows has been taken into account for the calculation of the CH_4 emission from enteric fermentation during the 2014 submission for the complete time-series (Flemish and Walloon regions). Before this was only done for brood cows. The method, parameters and equation 4.8 as described in the IPCC Good Practice Guidance are used. In both regions, the assumption is made that 80% of the mature females give birth in a year. This recalculation results in Flanders in an increase of the methane emission from enteric fermentation of maximum 1.406 Gg CH4 and in Wallonia in an increase of maximum 1.22 Gg CH_4.
- Also in the category 4A, in Wallonia, the net energy of lactation of non-dairy cows is taken into account for the calculation of the CH_4 emission form enteric fermentation for the complete time-series. Following the methods, parameters and equation 4.5a from the IPCC Good Practice Guidance, this results in an increase of maximum 4.7 Gg CH_4.
- In the category 4B, the net energy for pregnancy of dairy cows (and not only for brood cows) has been taken into account for the calculation of the CH_4 emission from manure management. These corrections are performed in the Flemish and Walloon regions for the complete time-series. The method, parameters and equation 4.8 as described in the IPCC Good Practice Guidance are used. In both regions, the assumption is made that 80% of the mature females give birth in a year. This recalculation results in Flanders in an increase of the

methane emission from manure management of maximum 0.211 Gg CH4 and in Wallonia in an increase of maximum 0.152 Gg CH_4.

- Also in the category 4B, in Wallonia the net energy of lactation of non-dairy cows is taken into account for the calculation of the CH_4 emission from manure management for the complete time-series. Following the methods, parameters and equation 4.5a from the IPCC Good Practice Guidance, this results in an increase of maximum 0.152 Gg CH_4.
- In the Walloon Region, in the category 4D3, sewage sludge has been taken into account to estimate the indirect N_2O emissions from atmospheric deposition. And this for the entire time series. The impact is not significant (for example in 2011, the revised estimate of emissions is 70.4 tons CO_2-eq. higher than in previous submission).

Further more:

In the Flemish region:

- In Flanders, from 2007 on, animal numbers have slightly changed during the 2014 submission. This results is a small decrease of the methane emission from enteric fermentation (category 4A) of max 0.23% (or 203 ton CH_4) in 2007 to a small increase of the methane emission from 0.09% (or 84 ton CH_4) in 2010.
- For the category 4B the change in above mentioned animal number results in a small decrease of the methane emission from manure management of max 0.23% (or 132 ton CH_4) in 2007 and a small increase of the methane emission of 0.03% (20 ton CH_4) in 2010. For N_2O this results in an increase of 0.47% (or 6 ton N_2O) of the N_2O emission from manure management in 2007 to a small decrease of 0.10% (or 1.2 ton N_2O) in 2009.
- For the category 4D the change in above mentioned animal number results in a small increase of the direct N_2O emission (category 4D1) of max 0.54% (or 26 ton N_2O) in 2007 and a small decrease of the direct N_2O emission of max 0.05% (or 2 ton N_2O) in 2009. For the indirect N_2O emission this results in an increase of max 0.03% (or 0.4 ton N_2O) in 2007 to a small decrease of max 0.005% (or 0.06 ton N_2O) in 2009.

In the Walloon region:

- In category 4D3, the activity data of sewage sludge has also been improved: in the past the quantity of sludge was estimated as a percentage of the usable agricultural area. Now, the data coming from the Walloon Waste Office are used. This modification of the activity data results in higher emissions (in 2011, it represents an additionnal emission of 0.026 Gg N_2O (a little bit less than 8000 tons CO_2-eq)).

In Brussels region:

- Livestock values for 2011 were revised (category 4).
- the annual yields values of several N-fixing and non N-fixing crops were revised (category 4D) and matched with those used in Flanders. The area of arable crops for 2011 was also revised.

In the LULUCF-sector:

- The losses of carbon stocks from orchards (living biomass in cropland) converted to forest land were calculated for the first time for the complete timeseries following the 2013 UNFCCC review recommendation (section 7.2.2).

- Carbon emissions from organic soils in cropland and grassland were estimated and reported for the first time for the complete timeseries in the 2014 submission.

- Emissions and removals from liming in land deforested and converted to cropland or grassland (deforestation) were recalculated. Asa result a complete harmonization between LULUCF and KP-LULUCF is achieved.

- Update of areas (5A1) in Flanders following last data available (2008-2011).

In the waste sector:

- As a result of the UNFCCC in-country review in September 2012, several corrections were made to the emission estimates of Flemish solid waste disposal sites during the 2013 submission. Details of these recalculations are described in the 2013 NIR (section 8.2.5, p. 191). During the 2014 submission the amounts of waste were further optimised for the complete time-series in the Flemish region. Following consultation with waste experts (from the Flemish Waste Agency OVAM and others), the entire time series of waste disposed at ‘older’ and ‘recent’ SWDS was reviewed and emissions estimates were corrected. See section 8.2.5 for more information.
- In Wallonia, the QA-QC realised at the end of 2013 detected an error in a calculation sheet: the net emissions of CH_4 were overestimated because the 10% oxidation factor was not applied in the column of the final net emission of CH_4. Consequently, the correction has been applied and resulted in lower net emissions for the complete time series.
- Due to an update of the FAO statistics, from 2000 onwards, the protein consumption has been corrected during this 2014 submission in Belgium. As a result emissions in the category 6B2 ‘domestic and commercial waste water’ did change slightly compared to previous submission.
- The activity data reported in the category 6D (composting) are optimized during the 2014 submission in the Flemish region from 2008 on. As a result the emissions did change slightly. During the QA-QC realised in end of 2013, the Walloon region detected an error in a calculation sheet in the category 6A (solid waste disposal sites): the net emissions of CH_4 were overestimated because the 0.1 oxidation factor was not applied in the column of the final net emission of CH_4.Consequently, the correction has been applied and resulted in lower net emissions for the complete timeseries (63 kt CH_4 on all the period 1990-2011 or less than 6.5 kt CH_4 between 2008 & 2011).
- The activity data in the category 6C (waste incineration) were optimized during the 2014 submission in the Flemish region for the year 2005. An inconsistency with the Flemish energy balance was corrected. As a result the emissions in this category did change with -41,523 Gg CO2 eq total difference.

9.1.2. Overview of the Belgian responses to the UNFCCC centralized review of September 2013

An overview of the responses of the Belgian experts to the Saturday Paper (September 28, 2013) can be found in annex 3 of this NIR.

The ERT has assessed the information provided by Belgium in response to the 'Potential Problems and Further Questions from the ERT formulated in the course of the 2013 review of the greenhouse gas inventories submitted in 2013' and concluded that Belgium has resolved all the potential problems appropriately.

All potential problems were official approved by the UNFCCC-secretariat on December 13, 2013.

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 relative 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.
In chapter 9.2, 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.
Although the results of the UNFCCC centralized review carried out by UNFCCC in September 2013 are not yet available in March 2014 (no draft Annual Review Report received so far), Belgium gives an overview of planned improvements below.

9.2.1 GHG inventory

In general:

From the next submission on (in 2015 for the emissions 1990-2013) the greenhouse gas inventory will be revised with the application of the obliged IPCC 2006 guidelines.

In the energy sector:

- In the category 1A3a civil aviation, Belgium recognizes that further harmonization between the regions has 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) investigating the most suitable emission factors in the EMEP/EEA guidebook. In the course of 2014 a study will be conducted in the Flemish region to meet the above problem and to further optimize the emission estimates in the category A13a. Representatives of all regions will be involved in this project.

- In the category 1A3b road transport: further harmonisation in the use of COPERT 4 v10.0 is going on between the regions through some specific parameters. The activation of certain COPERT parameters (as lube-oil consumption, CO2 monitoring and CO2 emissions from urea consumption in SCR) should be further evaluated and possibly implemented.

- In the category 1A3d navigation, sea-navigation (Flemish Region) : an improvement of the EMMOSS-model to calculate the off-road emissions will be finalized in 2014. Where the emissions of ships for sand extraction, dredging, tug-boats and sea fishery were rudimentary calculated by multiplying an amount of fuel by an emission factor, a more detailed calculation based on movements (AIS-data) will be implemented.

In the LULUCF-sector (incl. KP LULUCF):

- Changes in Carbon stock in living biomass (forest land): the Flemish region will investigate in the near future 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 data analysis should be possible by the end of 2014.
- In Wallonia, results of the 3rd forest inventory cycle may be updated during the next submission if data from the last sampling years become available.
- Cropland and grassland: in Wallonia, some region-specific information on liming practices might be available in the near future. Current calculations are based on information from the neighbouring countries.

In the waste sector:

- In the course of 2014, the Flemish and Walloon region will investigate the possible implementation of the IPCC 2006 Guidelines to replace the current methods for estimation of CH_4 emissions from SWDS.

9.3 Documentation of major changes in methodological descriptions compared to previous NIR

Besides a yearly actualization of most of the chapters in the NIR, the table below summarizes the other major changes in methodological descriptions.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please tick where the latest NIR includes major changes in methododological descriptions compared to the previous year NIR	Please tick where this is also reflected in recalculations compared to the previous year CRF	If ticked please provide some more detailed information for example related to sub-category, gas, reference to pages in the NIR, etc
Total (Net Emissions)			
1. Energy			
A. Fuel Combustion (Sectoral Approach)			
1. Energy Industries		v	Flemish region (see 3.2.6.5) : 1A1a further optimization of emissions of CO2 (a.o. tuning with ETS-data) (2005-2011) and 1A1b re-allocation emissions of N2O (complete time-series) Walloon region: correction AD 1A1a/liquid fuels for 2010 and re-allocation between 1A1a and 6C complete timeseries. See 3.2.6.5. Brussels region : correction AD 1A1a/liquid fuels for 2008 and 2009 and 1A1a/other fuels for 2008-2011
2. Manufacturing Industries and Construction		v	Flemish region (see 3.2.7.2 (category 1A2a) and 3.2.7.5): new emission estimates of N2O (complete timeseries) in the iron&steel sector (1A2a) and re-allocation emissions of CO2/other fuels between chemical industry and 'other industries' (2010-2011) Walloon region: optimization emissions CO2 for liquid fuels in 2010 in the categories 1A2a, 1A2e and 1A2f and optimization AD and emissions of CO2 for the years 2008-2011 in 1A2f. See 3.2.7.5

3. Transport	v	v	All regions: (1) As from the 2014 submission on offroad emissions that take place in harbours, airports and transhipment companies are newly allocated to the category 1A3e 'other transportation' for all regions in Belgium (complete time-series). These emissions were allocated to the category 1A4a (commercial, institutional) before. See 3.2.8.2. / 1A3e in NIR. (2) In the category 1A3b road transport: further harmonisation of the COPERT-based models is performed between the regions during the 2014 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, modeling 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. See 3.2.8. Transport (CRF 1.A.3)
4. Other Sectors	v	v	Flemish region: (1) category 1A4b (residential): new methodology for biomass (1990-2011) and for gasoil (2002-2011): see 3.2.5.1 (Flemish Energy Balance) and 3.2.9.5 and (2) minor corrections of emissions in 1A4c (all fuels) for the years 2007-2009 All regions: re-allocation off-road emissions (complete time-series) from 1A4a to 1A3e (harbours, airports and transhipment companies) and to 1A5b (defence). Walloon region: In 1A4a, missing coal was added for 2006. In 1A4b: optimization of consumption of biomass for the years 2002-2010 and in 1A4c: optimization of off-road emissions for the complete timeseries.

5. Other	v	v	All regions: re-allocation off-road emissions of defence for the complete time-series to category 1A5b instaed of category 1A4a before.
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas			
2. Industrial Processes			
A. Mineral Products		v	Flemish region: activity data in category 2A7 were optimized for the complete time series and emissions of CO_2 were optimized for the years 1990-2004. See 4.2.5.
B. Chemical Industry		v	Flemish region : optimization emission CO2 in 2011 in category 2B5 (missing emission of 1 company added). See 4.3.5.
C. Metal Production			
D. Other Production			
E. Production of Halocarbons and SF_6			
F. Consumption of Halocarbons and SF_6		v	Optimization of the activity data in the involved sectors
G. Other			
3. Solvent and Other Product Use			All regions: emissions of N_2O are newly estimated in category 3D3 (aerosol cans). See section 5.1.2. for more information.
4. Agriculture			
A. Enteric Fermentation	v	v	Flemish and Walloon region: A description of the method used for the calculation of the Net energy for growth (methane) is added. This has no influence on the emission. A small paragraph on net energy for pregnancy (methane) is added. This has a small effect on the methane emission, for the entire time series. See 6.2.2. Walloon region : Inclusion net energy of lactation of non-dairy cows. See 6.2.5 Brussels region : recalculation of AD (livestocks) for 2011

B. Manure Management			Flemish and Walloon region: A description of the method used for the calculation of the Net energy for growth (methane) is added. This has no influence on the emission. A small paragraph on net energy for pregnancy (methane) is added. This has a small effect on the methane emission, for the entire time series. See 6.2.2. Walloon region : Inclusion net energy of lactation of non-dairy cows. See 6.3.5 Brussels region : recalculation of AD (livestocks) for 2011
C. Rice Cultivation			
D. Agricultural Soils	v	v	Walloon region : Inclusion sewage sludge in the calculations. See 6.4.5 Brussels region : recalculation of AD (arable crops area) for 2011, and correction of yields values for several crops on the whole time series
E. Prescribed Burning of Savannas			
F. Field Burning of Agricultural Residues			
G. Other			
5. Land Use, Land-Use Change and Forestry			
A. Forest Land	v	v	- Emissions and removals from liming in forest land converted to cropland or grassland (deforestation) were recalculated for the complete timeseries in Belgium.
B. Cropland	v	v	- Carbon emissions from organic soils in cropland were estimated and reported in the 2014 submission for the complete timeseries. - The losses of carbon stocks from orchards converted to forest land were calculated for the complete timeseries.
C. Grassland	v	v	- Carbon emissions from organic soils in grassland were estimated and reported in the 2014 submission for the complete timeseries.
D. Wetlands			
E. Settlements			
F. Other Land			
G. Other			

6. Waste			
A. Solid Waste Disposal on Land	v	v	Flemish region: optimization amounts of waste disposed for the entire time-series (see section 8.2.5) Wallonia: the QA-QC realised at the end of 2013 detected an error in a calculation sheet: the net emissions of CH_4 were overestimated because the 10% oxidation factor was not applied in the column of the final net emission of CH_4.Consequently, the correction has been applied and resulted in lower net emissions for the complete time series (see section 8.2.5).
B. Waste-water Handling		v	Belgium: revision protein consumption data from 2000 on (revision FAO statistics), see NIR 8.3.5
C. Waste Incineration		v	Flemish region : optimization activity data from 2008 on (see NIR 8.4.5) Walloon region: re-allocation between 1A1a and 6C complete timeseries
D. Other		v	Flemish region : optimization activity data (composting) from 2008 on (see NIR 8.5.5)
7. Other (as specified in Summary 1.A)			
Memo Items:			
International Bunkers			
Aviation			
Marine			
Multilateral Operations			
CO_2 Emissions from Biomass			
NIR Chapter	**DESCRIPTION**		**REFERENCE**
	Please tick where the latest NIR includes major changes in descriptions compared to the previous year NIR		**If ticked please provide some more detailed information for example reference to pages in the NIR**

Chapter 1.2 Institutional arrangements			
Chapter 1.6 QA/QC plan			

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

CHAPTER 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.

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 7.1.1.

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.

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).

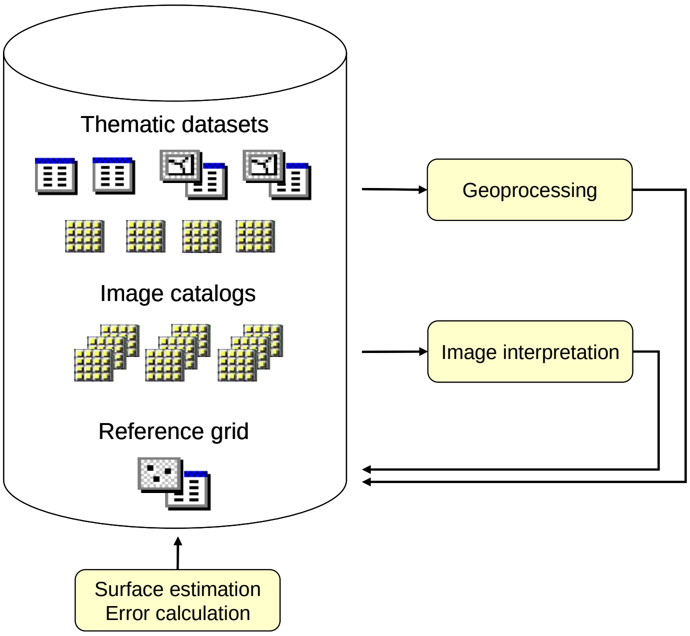


Figure 10.1: Main steps of the spatial assessment [55]

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 géotraitement, 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 10.2).

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).

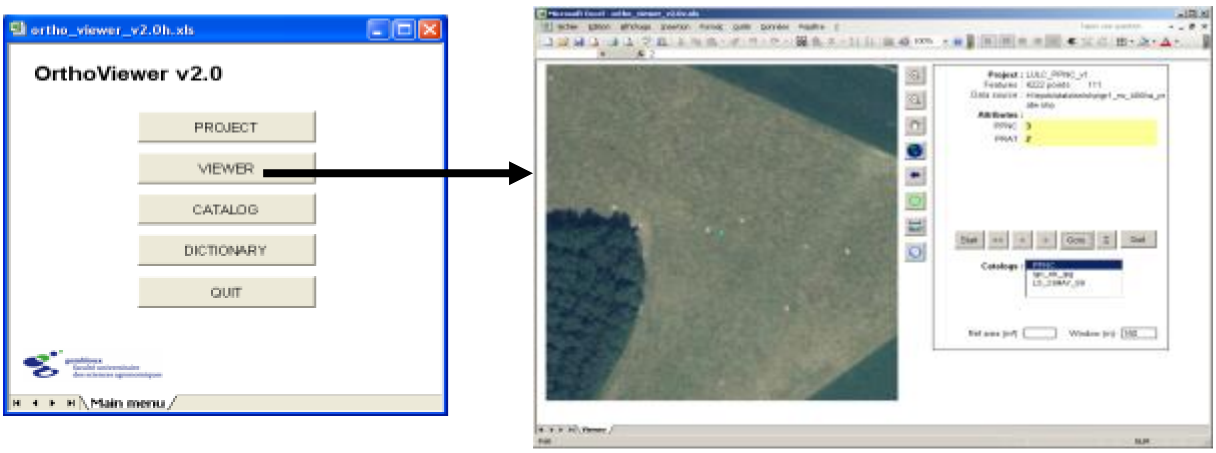


Figure 10.2: Ortho-viewer functionalities facilitating the work of image-interpretation

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, in fact 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

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 :

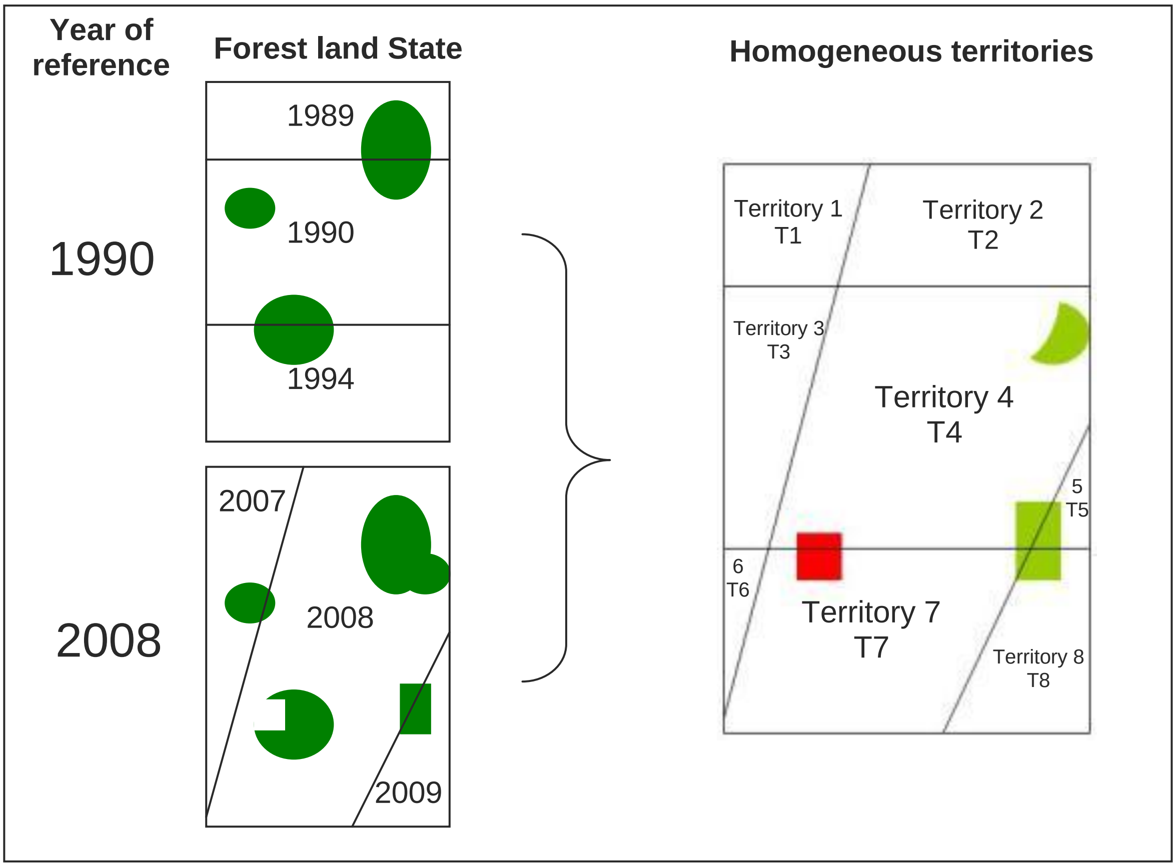


Figure 10.3: Theoretical territory with its forest land in 1990 and 2008 (on the left). The layers that were used to draw up 1990 land inventory are from 1989, 1990 and 1994. Whereas, the 2008 land inventory are from 2007, 2008 and 2009. On the right hand side, the superposition of the 1990 and 2008 land use state makes 8 portions of homogenous territory with land use change occurring in between these two years.

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 10.1 and 10.2 present the batches of data used for the inventory of 1990, table 10.3 indicates the data employed for 2008, and table 10.4 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 flamande		

10.2.4. Areas under ARD

The resulting general LUC matrix was presented in table 7.2 (chapter 7).

Regarding Afforestation, Reforestation and Deforestation, the annual rates are presented in table 10.4. The cumulated areas under ARD in the commitment period are presented in table 10.5.

There is an overall balance between afforested and deforested areas, as confirmed by the stable forest area observed in forest inventories. Indeed, the confidence intervals of the forest surfaces of Belgium of 1990 and 2008 overlap (698.000 ha to 756.000 ha in 1990 and 678.000 ha to 735.000 ha in 2008). From a statistical point of view, it is thus not possible to conclude about a significant reduction from the forest between 1990 and 2008. However, due to accounting rules (instantaneous oxidation in the case of deforestation), this results in net CO_2 emissions under Art 3.3.

Region	Afforestation/reforestation (ha year^{-1})							
	1990-2008				2008-2012			
	n	Mean	SE	CI (%)	n	Mean	SE	CI (%)
Brussels	0	0	0	0	0	0	0	0
Flanders	127	698	60	17	6	597	243	105
Wallonia	45	396	59	30	8	533	176	78
Belgium	172	1094	84	15	14	1130	419	80

Region	Deforestation (ha year^{-1})							
	1990-2008				2008-2012			
	n	Mean	SE	CI (%)	n	Mean	SE	CI (%)
Brussels	2	13	9	893	0	0	0	0
Flanders	94	522	51	20	4	398	199	159
Wallonia	62	524	67	25	7	500	191	94
Belgium	158	1058	85	16	11	898	390	86

Table 10.4: Annual rate surfaces of afforestation/reforestation/deforestation in Belgium between the periods of 1990 to 2008 and between 2008 and 2012, including areas (mean) and number of points identified (n). The percentage confidence interval (CI) is expressed as the ratio between the half confidence interval (with a confidence level of 95% $t_{0.95}$ x SE) and the mean estimated area.

	2008	2009	2010	2011	2012
Deforestation					
FC	1,94	2,10	2,27	2,44	2,60
FG	6,50	6,80	7,10	7,40	7,70
FW	1,03	1,03	1,03	1,03	1,03
FS	10,17	10,44	10,70	10,97	11,23
FO	1,35	1,52	1,68	1,85	2,02
Afforestation/reforestation					
CF	3,57	3,57	3,57	3,57	3,57
GF	15,69	16,62	17,55	18,48	19,41
WF	0,86	0,92	0,99	1,06	1,12
SF	1,01	1,01	1,01	1,01	1,01
OF	0,92	1,06	1,19	1,32	1,46

Table 10.5: Cumulated areas under ARD by land categories (FC= Forest converted to cropland, CF= Cropland Converted to Forest Land,...)

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 7) and from KP-LULUCF under the Kyoto Protocol (present section 10), so the methods are those described in chapter 7.2. and chapter 7.3., 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	1.60	85.2

Table 10.6 : 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 7.2.2.2 and 7.3.2.1/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 $SOC_{\text{Non Forest Land}}$ 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 7.8.

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 N_2O -N/kg N and C/N ratio of the converted land. Emissions are caused by the nitrogen cycle, intimately linked to carbon cycle. 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 7.3.2.1/A . This is aplied to the whole time series, but in practice, no such conversion occurred between 2008 and 2012, so no such emissions are reported under the KP, although they are reported under UNFCCC for the years 1990-2007.

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 7.2.5 for recalculations in the LULUCF sectors, which include land reported under the KP.

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

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 7.2.3.

10.3.1.6. Information on other methodological issues

An increased sampling rate of 1 pt/100 ha was used since the 2012 submission, in order to improve the accuracy of the areas of land subject to ARD.

10.3.1.7. 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 between the 1990 and 2008 data, 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

Not applicable for Belgium.

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

CHAPTER 11: INFORMATION ON ACCOUNTING OF KYOTO UNITS

Information about the transactions of the Kyoto-units is attached in annex to this document.

11.1. Background information

11.2. Summary of information reported in the SEF tables

The secured SEF (standard electronic format) report is attached to this report.

11.3. Discrepancies and notifications

(not applicable; empty lists)

11.4. Publicly accessible information

The public reports can be consulted at:
http://www.climateregistry.be/EN/INF/reports.htm

However, the main information is as well provided by the European Commission via the website of the EUTL (http://ec.europa.eu/environment/ets/welcome.do). Therefore reference is made at the public reports page to the website of the EUTL.

11.5. Calculation of the commitment period reserve (CPR)

Status of the Commitment Period Reserve (CPR) at 31/12/2013: 644.817.368, which is 38.221.393 units above the threshold for CP 1 (2008-2012).

For Belgium, this CPR threshold is 606.595.975 units (90 per cent of the assigned amount).

11.6. KP-LULUCF accounting

(not applicable; empty lists)

11.7. 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 2013.

15. No non-replacements occurred in 2013.

16. No invalid units to list for 2013.

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.

19. (no requests received from expert review teams)

20. *(not applicable)*

CHAPTER 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.

CHAPTER 13: INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of Belgium have occurred in 2013.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	*(no changes)*
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	An updated diagram of the database structure is attached as Annex A. Iteration 5 of the national registry released in January 2013 and Iteration 6 of the national registry released in June 2013 introduces changes in the structure of the database. Changes introduced in release 5 and 6 of the national registry 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. 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 in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. However, 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 was carried out in February 2014 and the successful test report has been attached. 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	The public reports can be consulted at: http://www.climateregistry.be/EN/INF/reports.htm
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 in release 5 and 6 of the national registry were limited and only affected EU ETS functionality. 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 2014 and the successful test report has been attached.
The previous Annual Review recommendations	See below

In response to the previous Annual Review recommendations, the following document had already been submitted as a second addendum to Chapter 13: 'Information on changes in national registry' of the Annual Inventory Submission for the reporting year 2012.

Reference	Recommendation description	Response
2.3.3	The assessor recommends that following major changes, the party provide a data model which contains all DES required entities complete with descriptions in its annual NIR.	The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. Since the successful certification of the registry on 1 June 2012, Iteration 4 of the registry, introduced in October 2012, added a limited number of new entities, none of them relating to DES entities. A data model was attached which more clearly shows the relevant entities "RECONCILIATIONS", "NOTIFICATIONS", "RESPONSES"," INTERNAL AUDIT LOG" and "MESSAGE LOG." As specified in the DES (Section VII. Data Logging Specifications/E. Message Archive), a copy of messages sent and received is stored in standalone files in one of two managed servers in the hosting environment. For that reason, the Message Archive is not shown in the model. The "MESSAGE LOG" object holds the location of the entire message, for each Message_ID. Since the successful certification of the registry on 1 June 2012, there has been no change in the capacity of the registry or change of its infrastructure.
2.3.10	The assessor strongly recommends that	The consolidated EU system of registries successfully completed a full certification

	the Party test each release thoroughly against the DES as part of each major release cycle and provide the results of such tests in its annual NIR.	procedure in June 2012. Notably, this procedure includes connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). This included a full Annex H test. All tests were executed successfully and led to successful certification on 1 June2012 The October 2012 release (version 4.0) was only a minor iteration and changes were limited to EU ETS functionality and had no impact on Kyoto Protocol functions in the registry. The test script previously provided reflects this. However, each major release of the registry is subject to both regression testing and tests related to new functionality. These tests include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production.

CHAPTER 14: INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

Preliminary remark: the text presented below is almost identical to the text presented in previous reports. The only changes that were made relate to the updating of the table of CDM projects contracted on the primary market. It concerns the deletion of some projects for which the ERPAs were terminated due to various reasons. Moreover, a new paragraph was inserted to present Belgium's support for the development of a Programme of Activities (PoA) in Rwanda and the first steps taken to support the development of Nationally Appropriate Mitigation Actions (NAMAs) in Rwanda and Mozambique.

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.

Belgium also takes advantage of flexibility mechanisms, particularly in its participation to clean development mechanisms (CDM) projects. Those are typically designed with the aim of improving capacity building and implementing technology transfer in developing countries through mitigation and adaptation projects. Actions in that domain are direct funding of projects or participation to carbon credit funds. The selection of CDM projects applies sustainability criteria based on the internationally recognized so-called 'Gold Standards' checklist, addressing environmental aspects (including bio-

diversity), social sustainability and development, quality of life and labour, and techno-economic aspects including employment and technological autonomy.
The table hereunder presents a list of projects with which the Belgian federal and/or regional governments signed an ERPA. This list does not include the projects delivering carbon credits via secondary markets and/or carbon funds (CDCF World Bank, Multilateral Carbon Credit Fund (European Bank for Reconstruction and Development (EBRD) and European Investment Bank (EIB), First Tranche of Carbon Fund for Europe (World Bank, EIB), Asia Pacific Carbon Fund (Asian Development Bank).

Finally, the Belgian Federal government is supporting the development and validation of a Renewable Energy CDM Programme of Activities in Rwanda (UNFCCC 9847) and is supporting the identification of opportunities for sustainable charcoal production in Rwanda and Mozambique and for the treatment of municipal waste in Mozambique to benefit from climate financing (most probably under the NAMA framework). Under each initiative, workshops for informing and consulting local stakeholders are organised and their comments are taken into account in the further development of these initiatives.

Project Name	Type	Country	UNFCCC reference number
Berlin Binary Cycle Power Plant	CDM	El Salvador	1218
Biomass based Cogeneration Power Project in Uttar Pradesh	CDM	India	827
Palmas del Espino – Biogas recovery and heat generation from Palm Oil Mill Effluent (POME) ponds	CDM	Perú	1249
Substitution of coal with jute biomass residue (caddies) in the steam generating boiler for use onsite	CDM	India	1059
Rice Husk based cogeneration power plant-II at SBPML	CDM	India	802
EECOPALSA SA – Biomass Project	CDM	Honduras	1877
Viyyat Power – Small Hydro	CDM	India	1514
Hubei Yihua Fertilizers Company Waste Heat Recovery and Utilization Project	CDM	China	2416
Generation of electricity from 6.25 MW capacity wind mills by Sun-n-Sand Hotels Pvt. Ltd at Soda Mada Rajasthan	CDM	India	447
Optimal Utilization of Clinker project at Shree Cement Limited (SCL), Beawar, Rajasthan	CDM	India	183
INOLASA Biomass Fuel Switch Project	CDM	Costa Rica	1314
Shalivahana 10MW Biomass Power Generation Project	CDM	India	1473
Shalivahana Non-Conventional Renewable Sources Biomass Power Project	CDM	India	591
Torrent Natural Gas Power Plant	CDM	India	1116
Electric Power Co-generation by LDG Recovery – CST - Brasil	CDM	Brazil	184
Comodoro Energy Efficiency Project	CDM	Argentina	1482
Nahar Industrial Enterprise Ltd – Rice-husk based cogeneration project	CDM	India	1130
Eco-Friendly electricity export to grid	CDM	India	1236
Santa Cruz I & II hydroelectric power plant	CDM	Perú	2405 and 3337
Simbhaoli biomass power project	CDM	India	1112
Qiangling CFL distribution project	CDM	China	3659
Camil Itaqui biomass electricity generation project	CDM	Brazil	0231
Landfill gas recovery and energy generation project	CDM	Tanzania	0908
Dak Pone hydropower project	CDM	Vietnam	4550
Hubei Chibi Lushuihe Jiedi Small Hydropower Project	CDM	China	7345
Hunan Chenzhou Xiangdian Luhejin 48MW Wind Power Project	CDM	China	6681
Hunan Gaojiaba Hydropower Project	CDM	China	7148

Jiangxi Le’an County Dong’an Small Hydropower Project	CDM	China	7344
Yunan Fumin Baihuashan Wind Power Project	CDM	China	7202
Copiulemu landfill gas project (Center for the Storage and Transfer, Recovery and Control of Waste, Treatment and Disposal of Industrial and Household Waste) and Cosmito landfill gas project (Improvement of Gas Extraction System in Old Cosmito Dump)'	CDM	Chile	0096 and 0097

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ANNEXES

Annex 1: Key sources analysis

LEVEL ASSESSMENT 1990 with and without LULUCF

IPCC categories	Direct greenhouse gas	Base Year Estimate (non-Lulucf) Gg CO2eq	Base Year Estimate (Lulucf) Gg CO2eq	Base Year Estimate (Absolute value) Gg CO2eq	Level assessment without Lulucf %	Cumulative total without Lulucf %	level assessment 1990 %	Cumulative total %
		142 952	-834.4	148 393				
1.A.3 Transport / b. Road Transportation	CO2	19 487.1		19 487.1	13.63	13.63	13.13	13.13
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Solid Fuels	CO2	19 344.9		19 344.9	13.53	27.16	13.04	26.17
1.A.4 Other Sectors / b. Residential / Liquid Fuels	CO2	12 664.5		12 664.5	8.86	36.02	8.53	34.70
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Solid Fuels	CO2	11 062.1		11 062.1	7.74	43.76	7.45	42.16
1.A.4 Other Sectors / b. Residential / Gaseous Fuels	CO2	5 824.2		5 824.2	4.07	47.84	3.92	46.08
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	4 285.35		4 285.35	3.00	50.83	2.89	48.97
2B. Chemical Industry / 2. Nitric Acid Production	N2O	3 561.90		3 561.90	2.49	53.33	2.40	51.37
5A1 Forest Land remaining Forest Land	CO2		-3 118.1	3 118.10		53.33	2.10	53.47
1.A.2 Manufacturing Industries and Construction / f. Other / Liquid Fuels	CO2	3 063.85		3 063.85	2.14	55.47	2.06	55.54
2A. Mineral Products / 1. Cement Production	CO2	2 823.78		2 823.78	1.98	57.44	1.90	57.44
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Gaseous Fuels	CO2	2 750.94		2 750.94	1.92	59.37	1.85	59.29
4D1 Direct Soil Emissions	N2O	2 567.19		2 567.19	1.80	61.16	1.73	61.02
1.A.2 Manufacturing Industries and Construction / f. Other / Gaseous Fuels	CO2	2 555.63		2 555.63	1.79	62.95	1.72	62.75
1.A.2 Manufacturing Industries and Construction / f. Other / Solid Fuels	CO2	2 537.32		2 537.32	1.77	64.73	1.71	64.45
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Gaseous Fuels	CO2	2 519.33		2 519.33	1.76	66.49	1.70	66.15
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Liquid Fuels	CO2	2 490.10		2 490.10	1.74	68.23	1.68	67.83
6A1 Managed Waste Disposal on Land	CH4	2 449.68		2 449.68	1.71	69.94	1.65	69.48

1.A.4 Other Sectors / a. Commercial and institutional / Liquid Fuels	CO2	2 290.06		2 290.06	1.60	71.55	1.54	71.02
4A1 Non-Dairy Cattle	CH4	2 172.00		2 172.00	1.52	73.07	1.46	72.49
2A. Mineral Products / 2. Lime Production	CO2	2 097.12		2 097.12	1.47	74.53	1.41	73.90
2C. Metal Production / 1. Iron and Steel Production	CO2	2 022.38		2 022.38	1.41	75.95	1.36	75.26
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Solid Fuels	CO2	2 015.94		2 015.94	1.41	77.36	1.36	76.62
1.A.4 Other Sectors / a. Commercial and institutional / Gaseous Fuels	CO2	1 923.82		1 923.82	1.35	78.70	1.30	77.92
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO2	1 835.14		1 835.14	1.28	79.99	1.24	79.16
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Other Fuels	CO2	1 833.63		1 833.63	1.28	81.27	1.24	80.39
4A1 Dairy Cattle	CH4	1 808.17		1 808.17	1.26	82.54	1.22	81.61
1.A.4 Other Sectors / b. Residential / Solid Fuels	CO2	1 759.18		1 759.18	1.23	83.77	1.19	82.80
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO2	1 671.11		1 671.11	1.17	84.93	1.13	83.92
2E1 By-product Emissions / Other	SF6	1 559.36		1 559.36	1.09	86.03	1.05	84.97
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Gaseous Fuels	CO2	1 485.42		1 485.42	1.04	87.06	1.00	85.97
4D3 Indirect Emissions	N2O	1 248.42		1 248.42	0.87	87.94	0.84	86.81
5B1 Cropland remaining Cropland	CO2		1 126.00	1 126.00		87.94	0.76	87.57
4B8 Swine	CH4	1 065.36		1 065.36	0.75	88.68	0.72	88.29
4D2 Pasture, Range and Paddock Manure	N2O	991.73		991.73	0.69	89.38	0.67	88.96
4B Manure Management (AWMS)	N2O	961.77		961.77	0.67	90.05	0.65	89.61
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	878.43		878.43	0.61	90.66	0.59	90.20
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Other Fuels	CO2	714.27		714.27	0.50	91.16	0.48	90.68
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Gaseous Fuels	CO2	680.71		680.71	0.48	91.64	0.46	91.14
5C1 Grassland remaining Grassland	CO2		680.39	680.39		91.64	0.46	91.60
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	659.33		659.33	0.46	92.10	0.44	92.04
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	637.89		637.89	0.45	92.55	0.43	92.47
1. B. 2. b. Natural Gas	CH4	518.87		518.87	0.36	92.91	0.35	92.82
2E1 By-product Emissions / Other	C2F6	506.71		506.71	0.35	93.27	0.34	93.16
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2	428.21		428.21	0.30	93.56	0.29	93.45
2B. Chemical Industry / 1. Ammonia Production	CO2	422.74		422.74	0.30	93.86	0.28	93.74
1.A.3 Transport / d. Navigation	CO2	398.23		398.23	0.28	94.14	0.27	94.01

1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	396.70		396.70	0.28	94.42	0.27	94.27
2B. Chemical Industry / 5. Other / Caprolactam	N2O	372.00		372.00	0.26	94.68	0.25	94.52
2E1 By-product Emissions / Other	CF4	323.69		323.69	0.23	94.90	0.22	94.74
1. B. 1. a. Coal Mining and Handling	CH4	298.82		298.82	0.21	95.11	0.20	94.94
6B2 Waste Water Handling/Domestic and Commercial Waste Water	N2O	293.49		293.49	0.21	95.32	0.20	95.14
6C Waste Incineration	CO2	287.84		287.84	0.20	95.52	0.19	95.34
2E2 Fugitive Emissions	C5F12	287.83		287.83	0.20	95.72	0.19	95.53
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Gaseous Fuels	CO2	280.38		280.38	0.20	95.92	0.19	95.72
2A. Mineral Products / 7. Other / Glass Production	CO2	266.16		266.16	0.19	96.10	0.18	95.90
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Gaseous Fuels	CO2	259.52		259.52	0.18	96.28	0.17	96.07
5E2 Land converted to Settlements	CO2		248.03	248.03		96.28	0.17	96.24
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Liquid Fuels	CO2	232.15		232.15	0.16	96.45	0.16	96.40
2E2 Fugitive Emissions	C6F14	229.78		229.78	0.16	96.61	0.15	96.55
1.A.4 Other Sectors / b. Residential	CH4	226.93		226.93	0.16	96.77	0.15	96.70
1.A.3 Transport / e. Other Transportation (please specify)(5)	CO2	225.33		225.33	0.16	96.92	0.15	96.86
4B1 Dairy Cattle	CH4	224.44		224.44	0.16	97.08	0.15	97.01
2B. Chemical Industry / 5. Other / Other non-specified	CO2	224.19		224.19	0.16	97.24	0.15	97.16
1.A.3 Transport / c. Railways	CO2	224.06		224.06	0.16	97.39	0.15	97.31
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Liquid Fuels	CO2	218.17		218.17	0.15	97.55	0.15	97.46
4A8 Swine	CH4	211.06		211.06	0.15	97.69	0.14	97.60
6B2 Waste Water Handling/Domestic and Commercial Waste Water	CH4	210.41		210.41	0.15	97.84	0.14	97.74
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Solid Fuels	CO2	207.85		207.85	0.15	97.99	0.14	97.88
3D Other / use of N2O	N2O	204.40		204.40	0.14	98.13	0.14	98.02
1.A.3 Transport / b. Road Transportation	N2O	203.60		203.60	0.14	98.27	0.14	98.15
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2	186.46		186.46	0.13	98.40	0.13	98.28
2E1 By-product Emissions / Other	C4F10	180.61		180.61	0.13	98.53	0.12	98.40
2E1 By-product Emissions / Other	C3F8	171.05		171.05	0.12	98.65	0.12	98.52
1.A.5 Other / b. Mobile / Military use	CO2	165.30		165.30	0.12	98.76	0.11	98.63
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Solid Fuels	CO2	145.98		145.98	0.10	98.87	0.10	98.73
2A. Mineral Products / 7. Other / Ceramics	CO2	135.72		135.72	0.09	98.96	0.09	98.82

1.A.1. Energy Industries / b. Petroleum Refining	N2O	129.21		129.21	0.09	99.05	0.09	98.91
4B1 Non-Dairy Cattle	CH4	125.60		125.60	0.09	99.14	0.08	98.99
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Solid Fuels	CO2	124.95		124.95	0.09	99.23	0.08	99.07
5B2 Land converted to Cropland	CO2		112.79	112.79		99.23	0.08	99.15
1.A.3 Transport / b. Road Transportation	CH4	101.09		101.09	0.07	99.30	0.07	99.22
1. B. 2. c. 2. Flaring	CO2	83.83		83.83	0.06	99.36	0.06	99.28
2F9. Other	SF6	83.62		83.62	0.06	99.42	0.06	99.33
1.A.2 Manufacturing Industries and Construction / f. Other	N2O	75.53		75.53	0.05	99.47	0.05	99.38
5C2 Land converted to Grassland	CO2		73.73	73.73		99.47	0.05	99.43
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2	67.04		67.04	0.05	99.51	0.05	99.48
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	N2O	63.43		63.43	0.04	99.56	0.04	99.52
1.A.4 Other Sectors / b. Residential	N2O	54.78		54.78	0.04	99.60	0.04	99.56
1.A.1. Energy Industries / a. Public Electricity and Heat Production	N2O	51.31		51.31	0.04	99.63	0.03	99.59
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	CH4	50.61		50.61	0.04	99.67	0.03	99.63
4A (sheep, goats, horses, mules and asses)	CH4	41.22		41.22	0.03	99.70	0.03	99.65
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	N2O	40.23		40.23	0.03	99.73	0.03	99.68
2E1 By-product Emissions / Other	C5F12	33.58		33.58	0.02	99.75	0.02	99.70
1. B. 1. b. Solid Fuel Transformation	CH4	30.79		30.79	0.02	99.77	0.02	99.72
1.A.4 Other Sectors / a. Commercial and institutional / Other Fuels	CO2	30.70		30.70	0.02	99.79	0.02	99.74
5F2 Land converted to Other Land	CO2		28.23	28.23		99.79	0.02	99.76
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	CH4	26.42		26.42	0.02	99.81	0.02	99.78
4B (sheep, goats, horses, poultry, mules and asses)	CH4	22.49		22.49	0.02	99.83	0.02	99.80
1.A.4 Other Sectors / b. Residential / Other Fuels	CO2	20.69		20.69	0.01	99.84	0.01	99.81
5D2 Land converted to Wetlands	CO2		20.55	20.55		99.84	0.01	99.82
2E2 Fugitive Emissions	C4F10	20.07		20.07	0.01	99.86	0.01	99.84
5A2 Land converted to Forest Land	CO2		-19.70	19.70		99.86	0.01	99.85
1.A.2 Manufacturing Industries and Construction / f. Other	CH4	16.98		16.98	0.01	99.87	0.01	99.86
1.A.3 Transport / d. Navigation	N2O	15.40		15.40	0.01	99.88	0.01	99.87
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO2	13.82		13.82	0.01	99.89	0.01	99.88
1.A.4 Other Sectors / a. Commercial and institutional	CH4	12.95		12.95	0.01	99.90	0.01	99.89

1.A.3 Transport / a. Civil Aviation	CO2	12.88		12.88	0.01	99.91	0.01	99.90
1.A.3 Transport / c. Railways	N2O	12.87		12.87	0.01	99.91	0.01	99.91
1.A.1. Energy Industries / a. Public Electricity and Heat Production	CH4	10.45		10.45	0.01	99.92	0.01	99.92
1. B. 2. a. Oil	CH4	9.56		9.56	0.01	99.93	0.01	99.92
2B. Chemical Industry / 5. Other / Other non-specified	N2O	9.30		9.30	0.01	99.93	0.01	99.93
1.A.4 Other Sectors / a. Commercial and institutional / Solid Fuels	CO2	8.83		8.83	0.01	99.94	0.01	99.93
5B2 Land converted to Cropland	N2O		8.33	8.33		99.94	0.01	99.94
1.A.2 Manufacturing Industries and Construction / c. Chemicals	N2O	8.18		8.18	0.01	99.95	0.01	99.95
1.A.2 Manufacturing Industries and Construction / c. Chemicals	CH4	7.81		7.81	0.01	99.95	0.01	99.95
2F8. Electrical Equipment	SF6	7.75		7.75	0.01	99.96	0.01	99.96
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	N2O	7.60		7.60	0.01	99.96	0.01	99.96
1.A.4 Other Sectors / a. Commercial and institutional	N2O	7.45		7.45	0.01	99.97	0.01	99.97
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	CH4	7.08		7.08	0.00	99.97	0.00	99.97
1.A.3 Transport / e. Other Transportation (please specify)(5)	N2O	6.71		6.71	0.00	99.98	0.00	99.98
5A1 Forest Land remaining Forest Land	N2O		4.87	4.87		99.98	0.00	99.98
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Liquid Fuels	CO2	4.42		4.42	0.00	99.98	0.00	99.98
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	N2O	4.29		4.29	0.00	99.98	0.00	99.98
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	CH4	3.73		3.73	0.00	99.99	0.00	99.99
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	N2O	3.10		3.10	0.00	99.99	0.00	99.99
6C Waste Incineration	N2O	2.75		2.75	0.00	99.99	0.00	99.99
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	CH4	2.64		2.64	0.00	99.99	0.00	99.99
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Gaseous Fuels	CO2	2.59		2.59	0.00	99.99	0.00	99.99
6D Other (compost production)	CH4	2.17		2.17	0.00	100.00	0.00	100.00
1.A.5 Other / b. Mobile / Military use	N2O	2.12		2.12	0.00	100.00	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	N2O	1.28		1.28	0.00	100.00	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	CH4	0.90		0.90	0.00	100.00	0.00	100.00
1. B. 2. b. Natural Gas	CO2	0.61		0.61	0.00	100.00	0.00	100.00
5A1 Forest Land remaining Forest Land	CH4		0.48	0.48		100.00	0.00	100.00
1.A.3 Transport / d. Navigation	CH4	0.37		0.37	0.00	100.00	0.00	100.00
1.A.3 Transport / c. Railways	CH4	0.30		0.30	0.00	100.00	0.00	100.00

1.A.3 Transport / a. Civil Aviation	N2O	0.14	0.14	0.00	100.00	0.00	100.00
1.A.3 Transport / e. Other Transportation (please specify)(5)	CH4	0.07	0.07	0.00	100.00	0.00	100.00
1.A.5 Other / b. Mobile / Military use	CH4	0.06	0.06	0.00	100.00	0.00	100.00
1.A.3 Transport / a. Civil Aviation	CH4	0.03	0.03	0.00	100.00	0.00	100.00
1. B. 2. a. Oil	CO2	0.01	0.01	0.00	100.00	0.00	100.00
2B. Chemical Industry / 1. Ammonia Production	CH4	0.01	0.01	0.00	100.00	0.00	100.00
Supplementary key sources (according Lulucf analysis)							
5A1 Forest Land remaining Forest Land / Net Carbon stock change in living biomass	CO2	-1666.71					
5A1 Forest Land remaining Forest Land / Net carbon stock change in soils	CO2	-1492.89					
5B1 Cropland remaining Cropland / Net carbon stock change in soils / Mineral Soils	CO2	1020.23					
5C1 Grassland remaining Grassland / Net carbon stock change in soils / Mineral Soils	CO2	643.08					
Deforestation	CO2	416.26					
5E2.1 Forest Land converted to Settlements	CO2	205.61					
Not a key source according level assessment without LuLucf							

LEVEL ASSESSMENT 2011 with and without LULUCF

IPCC categories	Direct greenhouse gas	Base Year Estimate (non-Lulucf) Gg CO2eq	Base Year Estimate (Lulucf) Gg CO2eq	Base Year Estimate (Absolute value) Gg CO2eq	Level assessment without Lulucf %	Cumulative total without Lulucf %	level assessment 2011 %	Cumulative total %
Sum		120 146	-1 167.6	127 647				
1.A.3 Transport / b. Road Transportation	CO2	25 839.9		25 839.9	21.51	21.51	20.24	20.24
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Gaseous Fuels	CO2	9 692.52		9 692.52	8.07	29.57	7.59	27.84
1.A.4 Other Sectors / b. Residential / Liquid Fuels	CO2	8 421.68		8 421.68	7.01	36.58	6.60	34.43
1.A.4 Other Sectors / b. Residential / Gaseous Fuels	CO2	7 275.51		7 275.51	6.06	42.64	5.70	40.13
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Solid Fuels	CO2	6 875.04		6 875.04	5.72	48.36	5.39	45.52
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Solid Fuels	CO2	4 795.83		4 795.83	3.99	52.35	3.76	49.28
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Other Fuels	CO2	3 808.46		3 808.46	3.17	55.52	2.98	52.26
1.A.4 Other Sectors / a. Commercial and institutional / Gaseous Fuels	CO2	3 660.31		3 660.31	3.05	58.57	2.87	55.13
5A1 Forest Land remaining Forest Land	CO2		-3 511.1	3 511.07		58.57	2.75	57.88
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	3 271.95		3 271.95	2.72	61.29	2.56	60.44
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Gaseous Fuels	CO2	2 863.18		2 863.18	2.38	63.68	2.24	62.69
2A. Mineral Products / 1. Cement Production	CO2	2 761.55		2 761.55	2.30	65.97	2.16	64.85
1.A.2 Manufacturing Industries and Construction / f. Other / Gaseous Fuels	CO2	2 630.81		2 630.81	2.19	68.16	2.06	66.91
4A1 Non-Dairy Cattle	CH4	2 095.18		2 095.18	1.74	69.91	1.64	68.55
4D1 Direct Soil Emissions	N2O	2 062.79		2 062.79	1.72	71.63	1.62	70.17
1.A.2 Manufacturing Industries and Construction / f. Other / Liquid Fuels	CO2	1 872.62		1 872.62	1.56	73.18	1.47	71.63
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Other Fuels	CO2	1 749.06		1 749.06	1.46	74.64	1.37	73.00
2A. Mineral Products / 2. Lime Production	CO2	1 741.47		1 741.47	1.45	76.09	1.36	74.37
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Gaseous Fuels	CO2	1 673.65		1 673.65	1.39	77.48	1.31	75.68
1.A.2 Manufacturing Industries and Construction / f. Other / Solid Fuels	CO2	1 624.08		1 624.08	1.35	78.83	1.27	76.95

1.A.4 Other Sectors / a. Commercial and institutional / Liquid Fuels	CO2	1 452.39		1 452.39	1.21	80.04	1.14	78.09
4A1 Dairy Cattle	CH4	1 274.87		1 274.87	1.06	81.10	1.00	79.09
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Liquid Fuels	CO2	1 200.18		1 200.18	1.00	82.10	0.94	80.03
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Gaseous Fuels	CO2	1 181.43		1 181.43	0.98	83.09	0.93	80.95
2B. Chemical Industry / 5. Other / Other non-specified	CO2	1 169.06		1 169.06	0.97	84.06	0.92	81.87
2B. Chemical Industry / 1. Ammonia Production	CO2	1 108.93		1 108.93	0.92	84.98	0.87	82.74
4B8 Swine	CH4	1 074.16		1 074.16	0.89	85.88	0.84	83.58
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO2	995.33		995.33	0.83	86.70	0.78	84.36
5B1 Cropland remaining Cropland	CO2		985.61	985.61		86.70	0.77	85.13
5B2 Land converted to Cropland	CO2		922.15	922.15		86.70	0.72	85.85
4D3 Indirect Emissions	N2O	825.48		825.48	0.69	87.39	0.65	86.50
4B Manure Management (AWMS)	N2O	770.78		770.78	0.64	88.03	0.60	87.11
4D2 Pasture, Range and Paddock Manure	N2O	761.46		761.46	0.63	88.67	0.60	87.70
2B. Chemical Industry / 5. Other / Caprolactam	N2O	751.75		751.75	0.63	89.29	0.59	88.29
2F1. Refrigeration and Air Conditioning Equipment	HFC-134a	736.60		736.60	0.61	89.91	0.58	88.87
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2	732.46		732.46	0.61	90.52	0.57	89.44
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2	632.96		632.96	0.53	91.04	0.50	89.94
2B. Chemical Industry / 2. Nitric Acid Production	N2O	624.68		624.68	0.52	91.56	0.49	90.43
2F1. Refrigeration and Air Conditioning Equipment	HFC-143a	588.66		588.66	0.49	92.05	0.46	90.89
5E2 Land converted to Settlements	CO2		585.43	585.43		92.05	0.46	91.35
6A1 Managed Waste Disposal on Land	CH4	577.85		577.85	0.48	92.53	0.45	91.80
2F1. Refrigeration and Air Conditioning Equipment	HFC-125	541.70		541.70	0.45	92.98	0.42	92.22
2C. Metal Production / 1. Iron and Steel Production	CO2	539.79		539.79	0.45	93.43	0.42	92.65
6C Waste Incineration	CO2	528.08		528.08	0.44	93.87	0.41	93.06
5C2 Land converted to Grassland	CO2		-504.97	504.97		93.87	0.40	93.46
1.A.3 Transport / d. Navigation	CO2	474.20		474.20	0.39	94.27	0.37	93.83
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO2	398.69		398.69	0.33	94.60	0.31	94.14
5C1 Grassland remaining Grassland	CO2		396.66	396.66		94.60	0.31	94.45
1. B. 2. b. Natural Gas	CH4	395.10		395.10	0.33	94.93	0.31	94.76
1.A.4 Other Sectors / b. Residential / Solid Fuels	CO2	368.52		368.52	0.31	95.24	0.29	95.05

6B2 Waste Water Handling/Domestic and Commercial Waste Water	N2O	306.89		306.89	0.26	95.49	0.24	95.29
5A2 Land converted to Forest Land	CO2		-295.86	295.86		95.49	0.23	95.52
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Gaseous Fuels	CO2	286.24		286.24	0.24	95.73	0.22	95.75
1.A.3 Transport / b. Road Transportation	N2O	255.95		255.95	0.21	95.94	0.20	95.95
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO2	247.20		247.20	0.21	96.15	0.19	96.14
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Solid Fuels	CO2	243.23		243.23	0.20	96.35	0.19	96.33
1.A.3 Transport / e. Other Transportation (please specify)(5)	CO2	238.68		238.68	0.20	96.55	0.19	96.52
2A. Mineral Products / 7. Other / Glass Production	CO2	233.22		233.22	0.19	96.74	0.18	96.70
4A8 Swine	CH4	207.63		207.63	0.17	96.92	0.16	96.86
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2	206.09		206.09	0.17	97.09	0.16	97.02
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Gaseous Fuels	CO2	196.81		196.81	0.16	97.25	0.15	97.18
3D Other / use of N2O	N2O	183.13		183.13	0.15	97.40	0.14	97.32
1.A.4 Other Sectors / b. Residential	CH4	181.32		181.32	0.15	97.55	0.14	97.46
4B1 Dairy Cattle	CH4	167.75		167.75	0.14	97.69	0.13	97.59
2A. Mineral Products / 7. Other / Ceramics	CO2	153.63		153.63	0.13	97.82	0.12	97.72
2E2 Fugitive Emissions	C4F10	137.46		137.46	0.11	97.94	0.11	97.82
1.A.2 Manufacturing Industries and Construction / f. Other	N2O	131.20		131.20	0.11	98.05	0.10	97.93
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	127.48		127.48	0.11	98.15	0.10	98.03
4B1 Non-Dairy Cattle	CH4	124.30		124.30	0.10	98.25	0.10	98.12
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Other Fuels	CO2	120.56		120.56	0.10	98.36	0.09	98.22
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Liquid Fuels	CO2	116.22		116.22	0.10	98.45	0.09	98.31
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Solid Fuels	CO2	110.76		110.76	0.09	98.54	0.09	98.40
5F2 Land converted to Other Land	CO2		106.70	106.70		98.54	0.08	98.48
1.A.3 Transport / c. Railways	CO2	101.81		101.81	0.08	98.63	0.08	98.56
6B2 Waste Water Handling/Domestic and Commercial Waste Water	CH4	101.66		101.66	0.08	98.71	0.08	98.64
5B2 Land converted to Cropland	N2O		100.35	100.35		98.71	0.08	98.72
2F9. Other	SF6	97.16		97.16	0.08	98.79	0.08	98.79
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Solid Fuels	CO2	94.45		94.45	0.08	98.87	0.07	98.87
1. B. 2. c. 2. Flaring	CO2	92.66		92.66	0.08	98.95	0.07	98.94

1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	89.84		89.84	0.07	99.02	0.07	99.01
1.A.1. Energy Industries / a. Public Electricity and Heat Production	N2O	75.75		75.75	0.06	99.09	0.06	99.07
1.A.4 Other Sectors / a. Commercial and institutional / Other Fuels	CO2	73.93		73.93	0.06	99.15	0.06	99.13
1.A.1. Energy Industries / b. Petroleum Refining	N2O	72.47		72.47	0.06	99.21	0.06	99.18
2F4. Aerosols/Metered Dose Inhalers	HFC-134a	66.01		66.01	0.05	99.26	0.05	99.24
2F2. Foam Blowing	HFC-134a	52.60		52.60	0.04	99.31	0.04	99.28
1.A.4 Other Sectors / b. Residential	N2O	50.04		50.04	0.04	99.35	0.04	99.32
1.A.5 Other / b. Mobile / Military use	CO2	45.21		45.21	0.04	99.39	0.04	99.35
2F2. Foam Blowing	HFC-152a	43.88		43.88	0.04	99.42	0.03	99.39
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	N2O	42.96		42.96	0.04	99.46	0.03	99.42
4A (sheep, goats, horses, mules and asses)	CH4	40.91		40.91	0.03	99.49	0.03	99.45
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Liquid Fuels	CO2	39.91		39.91	0.03	99.53	0.03	99.48
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	39.62		39.62	0.03	99.56	0.03	99.51
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	N2O	38.43		38.43	0.03	99.59	0.03	99.54
1.A.3 Transport / a. Civil Aviation	CO2	37.19		37.19	0.03	99.62	0.03	99.57
5C1 Grassland remaining Grassland	N2O		35.96	35.96		99.62	0.03	99.60
2F1. Refrigeration and Air Conditioning Equipment	HFC-32	34.28		34.28	0.03	99.65	0.03	99.63
1.A.1. Energy Industries / a. Public Electricity and Heat Production	CH4	31.48		31.48	0.03	99.68	0.02	99.65
4B (sheep, goats, horses, poultry, mules and asses)	CH4	30.05		30.05	0.03	99.70	0.02	99.68
2E2 Fugitive Emissions	C6F14	29.14		29.14	0.02	99.73	0.02	99.70
5A1 Forest Land remaining Forest Land	N2O		27.60	27.60		99.73	0.02	99.72
1.A.2 Manufacturing Industries and Construction / f. Other	CH4	27.56		27.56	0.02	99.75	0.02	99.74
6D Other (compost production)	CH4	25.13		25.13	0.02	99.77	0.02	99.76
2B. Chemical Industry / 5. Other / Other non-specified	N2O	23.44		23.44	0.02	99.79	0.02	99.78
5D2 Land converted to Wetlands	CO2		-22.43	22.43		99.79	0.02	99.80
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Solid Fuels	CO2	19.37		19.37	0.02	99.81	0.02	99.81
1.A.4 Other Sectors / a. Commercial and institutional	CH4	19.23		19.23	0.02	99.82	0.02	99.83
1.A.3 Transport / b. Road Transportation	CH4	17.08		17.08	0.01	99.84	0.01	99.84
2F8. Electrical Equipment	SF6	15.09		15.09	0.01	99.85	0.01	99.85
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	N2O	13.02		13.02	0.01	99.86	0.01	99.86

1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	CH4	12.07		12.07	0.01	99.87	0.01	99.87
1.A.3 Transport / e. Other Transportation (please specify)(5)	N2O	11.20		11.20	0.01	99.88	0.01	99.88
1.A.3 Transport / d. Navigation	N2O	10.41		10.41	0.01	99.89	0.01	99.89
2C. Metal Production / 1. Iron and Steel Production	CH4	10.06		10.06	0.01	99.90	0.01	99.90
PFC, HFC, SF6 Emissions from Semiconductor Manufacturing	PFC, HFC, SF6	10.05		10.05	0.01	99.91	0.01	99.91
1.A.2 Manufacturing Industries and Construction / c. Chemicals	CH4	9.94		9.94	0.01	99.91	0.01	99.91
2F3. Fire Extinguishers	HFC-227ea	9.49		9.49	0.01	99.92	0.01	99.92
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	CH4	9.04		9.04	0.01	99.93	0.01	99.93
1.A.4 Other Sectors / a. Commercial and institutional	N2O	7.23		7.23	0.01	99.93	0.01	99.93
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	CH4	7.12		7.12	0.01	99.94	0.01	99.94
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Other Fuels	CO2	6.77		6.77	0.01	99.95	0.01	99.94
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	CH4	6.68		6.68	0.01	99.95	0.01	99.95
1.A.4 Other Sectors / b. Residential / Other Fuels	CO2	5.95		5.95	0.00	99.96	0.00	99.95
1. B. 1. b. Solid Fuel Transformation	CH4	5.82		5.82	0.00	99.96	0.00	99.96
1. B. 2. a. Oil	CH4	5.65		5.65	0.00	99.97	0.00	99.96
2E1 By-product Emissions / Other	CF4	5.31		5.31	0.00	99.97	0.00	99.97
1.A.2 Manufacturing Industries and Construction / c. Chemicals	N2O	5.29		5.29	0.00	99.98	0.00	99.97
1.A.3 Transport / c. Railways	N2O	4.51		4.51	0.00	99.98	0.00	99.98
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	CH4	3.89		3.89	0.00	99.98	0.00	99.98
5C1 Grassland remaining Grassland	CH4		3.54	3.54		99.98	0.00	99.98
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	3.48		3.48	0.00	99.99	0.00	99.98
4D4 Other/sludge spreading	N2O	3.38		3.38	0.00	99.99	0.00	99.99
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	N2O	3.20		3.20	0.00	99.99	0.00	99.99
5A1 Forest Land remaining Forest Land	CH4		2.72	2.72		99.99	0.00	99.99
2F1. Refrigeration and Air Conditioning Equipment	C3F8	2.23		2.23	0.00	99.99	0.00	99.99
2B. Chemical Industry / 5. Other / Other non-specified	CH4	1.78		1.78	0.00	99.99	0.00	99.99
1. B. 2. c. 1. Venting	CH4	1.12		1.12	0.00	99.99	0.00	100.00
2F3. Fire Extinguishers	HFC-125	0.86		0.86	0.00	100.00	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	CH4	0.79		0.79	0.00	100.00	0.00	100.00
1.A.5 Other / b. Mobile / Military use	N2O	0.73		0.73	0.00	100.00	0.00	100.00

1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	N2O	0.73		0.73	0.00	100.00	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-227ea	0.46		0.46	0.00	100.00	0.00	100.00
1. B. 2. b. Natural Gas	CO2	0.46		0.46	0.00	100.00	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-152a	0.39		0.39	0.00	100.00	0.00	100.00
2F9. Other	C6F14	0.38		0.38	0.00	100.00	0.00	100.00
1.A.3 Transport / d. Navigation	CH4	0.28		0.28	0.00	100.00	0.00	100.00
1.A.4 Other Sectors / a. Commercial and institutional / Solid Fuels	CO2	0.20		0.20	0.00	100.00	0.00	100.00
1.A.3 Transport / a. Civil Aviation	N2O	0.15		0.15	0.00	100.00	0.00	100.00
1.A.3 Transport / c. Railways	CH4	0.14		0.14	0.00	100.00	0.00	100.00
1.A.5 Other / b. Mobile / Military use	CH4	0.09		0.09	0.00	100.00	0.00	100.00
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	N2O	0.07		0.07	0.00	100.00	0.00	100.00
6C Waste Incineration	N2O	0.07		0.07	0.00	100.00	0.00	100.00
1.A.3 Transport / a. Civil Aviation	CH4	0.05		0.05	0.00	100.00	0.00	100.00
2F1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.05		0.05	0.00	100.00	0.00	100.00
1.A.3 Transport / e. Other Transportation (please specify)(5)	CH4	0.05		0.05	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
2B. Chemical Industry / 1. Ammonia Production	CH4	0.01		0.01	0.00	100.00	0.00	100.00
2E2 Fugitive Emissions	C5F12	0.01		0.01	0.00	100.00	0.00	100.00
Supplementary key sources (according Lulucf analysis)								
5A1 Forest Land remaining Forest Land / Net Carbon stock change in living biomass	CO2		-2120.32					
5A1 Forest Land remaining Forest Land / Net carbon stock change in soils	CO2		-1451.57					
5B1 Cropland remaining Cropland / Net carbon stock change in soils / Mineral Soils	CO2		878.32					
5B2 Land converted to Cropland / Net carbon stock change in soils	CO2		856.21					
5C2 Land converted to Grassland / Net carbon stock change in soils	CO2		-646.28					
5E2 Land converted to Settlements / Net carbon stock change in soils	CO2		484.96					
5C1 Grassland remaining Grassland / Net carbon stock change in soils / Mineral Soils	CO2		329.83					
Deforestation	CO2		496.60					
5E2.1 Forest Land converted to Settlements	CO2		176.48					

LEVEL ASSESSMENT 2012 with and without LULUCF

IPCC categories	Direct greenhouse gas	Base Year Estimate (non-Lulucf) Gg CO2eq	Base Year Estimate (Lulucf) Gg CO2eq	Base Year Estimate (Absolute value) Gg CO2eq	Level assessment without Lulucf %	Cumulative total without Lulucf %	level assessment 2012 %	Cumulative total %
Sum		116 520	-1 381.3	123 952				
1.A.3 Transport / b. Road Transportation	CO2	23 890.3		23 890.3	20.50	20.50	19.27	19.27
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Gaseous Fuels	CO2	8 499.56		8 499.56	7.29	27.80	6.86	26.13
1.A.4 Other Sectors / b. Residential / Gaseous Fuels	CO2	8 098.64		8 098.64	6.95	34.75	6.53	32.66
1.A.4 Other Sectors / b. Residential / Liquid Fuels	CO2	8 090.54		8 090.54	6.94	41.69	6.53	39.19
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Solid Fuels	CO2	7 326.79		7 326.79	6.29	47.98	5.91	45.10
1.A.4 Other Sectors / a. Commercial and institutional / Gaseous Fuels	CO2	4 193.94		4 193.94	3.60	51.58	3.38	48.49
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Other Fuels	CO2	3 612.44		3 612.44	3.10	54.68	2.91	51.40
5A1 Forest Land remaining Forest Land	CO2		-3 536.7	3 536.67		54.68	2.85	54.25
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	3 528.74		3 528.74	3.03	57.71	2.85	57.10
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Solid Fuels	CO2	3 209.41		3 209.41	2.75	60.46	2.59	59.69
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Gaseous Fuels	CO2	2 932.44		2 932.44	2.52	62.98	2.37	62.06
1.A.2 Manufacturing Industries and Construction / f. Other / Gaseous Fuels	CO2	2 708.05		2 708.05	2.32	65.30	2.18	64.24
2A. Mineral Products / 1. Cement Production	CO2	2 642.59		2 642.59	2.27	67.57	2.13	66.37
4A1 Non-Dairy Cattle	CH4	2 043.99		2 043.99	1.75	69.32	1.65	68.02
4D1 Direct Soil Emissions	N2O	1 961.35		1 961.35	1.68	71.01	1.58	69.60
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Other Fuels	CO2	1 869.21		1 869.21	1.60	72.61	1.51	71.11
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Gaseous Fuels	CO2	1 763.69		1 763.69	1.51	74.13	1.42	72.53
1.A.4 Other Sectors / a. Commercial and institutional / Liquid Fuels	CO2	1 642.43		1 642.43	1.41	75.54	1.33	73.86
1.A.2 Manufacturing Industries and Construction / f. Other / Liquid Fuels	CO2	1 642.17		1 642.17	1.41	76.94	1.32	75.18
2A. Mineral Products / 2. Lime Production	CO2	1 611.91		1 611.91	1.38	78.33	1.30	76.48
1.A.2 Manufacturing Industries and Construction / f. Other / Solid Fuels	CO2	1 543.89		1 543.89	1.32	79.65	1.25	77.73
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Liquid Fuels	CO2	1 290.07		1 290.07	1.11	80.76	1.04	78.77

4A1 Dairy Cattle	CH4	1 264.10		1 264.10	1.08	81.85	1.02	79.79
2B. Chemical Industry / 1. Ammonia Production	CO2	1 133.62		1 133.62	0.97	82.82	0.91	80.71
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Gaseous Fuels	CO2	1 112.22		1 112.22	0.95	83.77	0.90	81.60
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO2	1 085.97		1 085.97	0.93	84.70	0.88	82.48
4B8 Swine	CH4	1 080.97		1 080.97	0.93	85.63	0.87	83.35
2B. Chemical Industry / 5. Other / Other non-specified	CO2	953.13		953.13	0.82	86.45	0.77	84.12
5B2 Land converted to Cropland	CO2		944.39	944.39		86.45	0.76	84.88
5B1 Cropland remaining Cropland	CO2		937.39	937.39		86.45	0.76	85.64
4D3 Indirect Emissions	N2O	810.74		810.74	0.70	87.15	0.65	86.29
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2	809.21		809.21	0.69	87.84	0.65	86.95
4B Manure Management (AWMS)	N2O	765.70		765.70	0.66	88.50	0.62	87.56
2F1. Refrigeration and Air Conditioning Equipment	HFC-134a	759.32		759.32	0.65	89.15	0.61	88.18
2B. Chemical Industry / 5. Other / Caprolactam	N2O	754.54		754.54	0.65	89.80	0.61	88.78
4D2 Pasture, Range and Paddock Manure	N2O	753.11		753.11	0.65	90.44	0.61	89.39
2B. Chemical Industry / 2. Nitric Acid Production	N2O	680.67		680.67	0.58	91.03	0.55	89.94
2F1. Refrigeration and Air Conditioning Equipment	HFC-143a	600.34		600.34	0.52	91.54	0.48	90.43
5E2 Land converted to Settlements	CO2		578.80	578.80		91.54	0.47	90.89
6A1 Managed Waste Disposal on Land	CH4	578.60		578.60	0.50	92.04	0.47	91.36
2F1. Refrigeration and Air Conditioning Equipment	HFC-125	577.36		577.36	0.50	92.53	0.47	91.82
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2	554.56		554.56	0.48	93.01	0.45	92.27
5C2 Land converted to Grassland	CO2		-539.45	539.45		93.01	0.44	92.71
6C Waste Incineration	CO2	517.58		517.58	0.44	93.45	0.42	93.13
1.A.4 Other Sectors / b. Residential / Solid Fuels	CO2	492.36		492.36	0.42	93.88	0.40	93.52
1.A.3 Transport / d. Navigation	CO2	462.90		462.90	0.40	94.27	0.37	93.90
2C. Metal Production / 1. Iron and Steel Production	CO2	443.82		443.82	0.38	94.66	0.36	94.25
1. B. 2. b. Natural Gas	CH4	373.56		373.56	0.32	94.98	0.30	94.56
5C1 Grassland remaining Grassland	CO2		351.43	351.43		94.98	0.28	94.84
6B2 Waste Water Handling/Domestic and Commercial Waste Water	N2O	309.26		309.26	0.27	95.24	0.25	95.09
5A2 Land converted to Forest Land	CO2		-307.45	307.45		95.24	0.25	95.34
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Gaseous Fuels	CO2	296.10		296.10	0.25	95.50	0.24	95.58

1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO2	277.63		277.63	0.24	95.73	0.22	95.80
1.A.3 Transport / b. Road Transportation	N2O	250.22		250.22	0.21	95.95	0.20	96.00
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Solid Fuels	CO2	224.90		224.90	0.19	96.14	0.18	96.18
1.A.4 Other Sectors / b. Residential	CH4	220.27		220.27	0.19	96.33	0.18	96.36
4A8 Swine	CH4	209.66		209.66	0.18	96.51	0.17	96.53
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO2	199.88		199.88	0.17	96.68	0.16	96.69
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Gaseous Fuels	CO2	199.28		199.28	0.17	96.85	0.16	96.85
2A. Mineral Products / 7. Other / Glass Production	CO2	188.37		188.37	0.16	97.01	0.15	97.00
1.A.3 Transport / e. Other Transportation (please specify)(5)	CO2	185.14		185.14	0.16	97.17	0.15	97.15
3D Other / use of N2O	N2O	182.88		182.88	0.16	97.33	0.15	97.30
4B1 Dairy Cattle	CH4	166.84		166.84	0.14	97.47	0.13	97.43
2E2 Fugitive Emissions	C4F10	161.97		161.97	0.14	97.61	0.13	97.57
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	160.26		160.26	0.14	97.75	0.13	97.69
2A. Mineral Products / 7. Other / Ceramics	CO2	146.37		146.37	0.13	97.88	0.12	97.81
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	139.27		139.27	0.12	98.00	0.11	97.93
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Liquid Fuels	CO2	121.27		121.27	0.10	98.10	0.10	98.02
4B1 Non-Dairy Cattle	CH4	120.93		120.93	0.10	98.20	0.10	98.12
1.A.2 Manufacturing Industries and Construction / f. Other	N2O	111.25		111.25	0.10	98.30	0.09	98.21
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Solid Fuels	CO2	109.96		109.96	0.09	98.39	0.09	98.30
5F2 Land converted to Other Land	CO2		106.81	106.81		98.39	0.09	98.39
5B2 Land converted to Cropland	N2O		106.50	106.50		98.39	0.09	98.47
2F9. Other	SF6	103.97		103.97	0.09	98.48	0.08	98.55
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2	101.88		101.88	0.09	98.57	0.08	98.64
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Other Fuels	CO2	95.22		95.22	0.08	98.65	0.08	98.71
1.A.3 Transport / c. Railways	CO2	92.66		92.66	0.08	98.73	0.07	98.79
1. B. 2. c. 2. Flaring	CO2	92.02		92.02	0.08	98.81	0.07	98.86
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	N2O	89.63		89.63	0.08	98.89	0.07	98.94
1.A.1. Energy Industries / a. Public Electricity and Heat Production	N2O	80.79		80.79	0.07	98.96	0.07	99.00
6B2 Waste Water Handling/Domestic and Commercial Waste Water	CH4	78.87		78.87	0.07	99.02	0.06	99.06

1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Solid Fuels	CO2	77.70		77.70	0.07	99.09	0.06	99.13
1.A.4 Other Sectors / a. Commercial and institutional / Other Fuels	CO2	73.82		73.82	0.06	99.15	0.06	99.19
1.A.1. Energy Industries / b. Petroleum Refining	N2O	67.10		67.10	0.06	99.21	0.05	99.24
2F4. Aerosols/Metered Dose Inhalers	HFC-134a	66.01		66.01	0.06	99.27	0.05	99.29
1.A.4 Other Sectors / b. Residential	N2O	56.09		56.09	0.05	99.32	0.05	99.34
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	56.01		56.01	0.05	99.36	0.05	99.38
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Liquid Fuels	CO2	49.69		49.69	0.04	99.41	0.04	99.42
2E2 Fugitive Emissions	C6F14	49.43		49.43	0.04	99.45	0.04	99.46
2F2. Foam Blowing	HFC-134a	48.72		48.72	0.04	99.49	0.04	99.50
1.A.5 Other / b. Mobile / Military use	CO2	45.28		45.28	0.04	99.53	0.04	99.54
4A (sheep, goats, horses, mules and asses)	CH4	43.62		43.62	0.04	99.57	0.04	99.58
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	N2O	38.79		38.79	0.03	99.60	0.03	99.61
2F1. Refrigeration and Air Conditioning Equipment	HFC-32	38.11		38.11	0.03	99.63	0.03	99.64
2F2. Foam Blowing	HFC-152a	36.95		36.95	0.03	99.67	0.03	99.67
1.A.1. Energy Industries / a. Public Electricity and Heat Production	CH4	33.38		33.38	0.03	99.69	0.03	99.69
4B (sheep, goats, horses, poultry, mules and asses)	CH4	32.12		32.12	0.03	99.72	0.03	99.72
1.A.3 Transport / a. Civil Aviation	CO2	26.87		26.87	0.02	99.74	0.02	99.74
6D Other (compost production)	CH4	23.93		23.93	0.02	99.77	0.02	99.76
1.A.4 Other Sectors / a. Commercial and institutional	CH4	23.09		23.09	0.02	99.79	0.02	99.78
5D2 Land converted to Wetlands	CO2		-23.00	23.00		99.79	0.02	99.80
2B. Chemical Industry / 5. Other / Other non-specified	N2O	19.58		19.58	0.02	99.80	0.02	99.81
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Solid Fuels	CO2	19.37		19.37	0.02	99.82	0.02	99.83
1.A.3 Transport / b. Road Transportation	CH4	14.90		14.90	0.01	99.83	0.01	99.84
2C. Metal Production / 1. Iron and Steel Production	CH4	14.78		14.78	0.01	99.84	0.01	99.85
1.A.2 Manufacturing Industries and Construction / f. Other	CH4	14.10		14.10	0.01	99.86	0.01	99.86
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	N2O	13.47		13.47	0.01	99.87	0.01	99.88
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	CH4	12.93		12.93	0.01	99.88	0.01	99.89
2F8. Electrical Equipment	SF6	11.02		11.02	0.01	99.89	0.01	99.89
PFC, HFC, SF6 Emissions from Semiconductor Manufacturing	PFC, HFC, SF6	10.21		10.21	0.01	99.90	0.01	99.90
1.A.3 Transport / e. Other Transportation (please specify)(5)	N2O	10.12		10.12	0.01	99.91	0.01	99.91

1.A.3 Transport / d. Navigation	N2O	10.06	10.06	0.01	99.91	0.01	99.92
1.A.2 Manufacturing Industries and Construction / c. Chemicals	CH4	9.47	9.47	0.01	99.92	0.01	99.93
2F3. Fire Extinguishers	HFC-227ea	9.44	9.44	0.01	99.93	0.01	99.93
1.A.4 Other Sectors / a. Commercial and institutional	N2O	8.51	8.51	0.01	99.94	0.01	99.94
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Other Fuels	CO2	7.69	7.69	0.01	99.94	0.01	99.95
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	CH4	7.28	7.28	0.01	99.95	0.01	99.95
1. B. 2. a. Oil	CH4	5.75	5.75	0.00	99.96	0.00	99.96
1.A.4 Other Sectors / b. Residential / Other Fuels	CO2	5.67	5.67	0.00	99.96	0.00	99.96
1. B. 1. b. Solid Fuel Transformation	CH4	4.84	4.84	0.00	99.96	0.00	99.97
1.A.2 Manufacturing Industries and Construction / c. Chemicals	N2O	4.67	4.67	0.00	99.97	0.00	99.97
2B. Chemical Industry / 5. Other / Other non-specified	CH4	4.27	4.27	0.00	99.97	0.00	99.97
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	CH4	4.21	4.21	0.00	99.98	0.00	99.98
1.A.3 Transport / c. Railways	N2O	4.12	4.12	0.00	99.98	0.00	99.98
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	N2O	3.44	3.44	0.00	99.98	0.00	99.98
4D4 Other/sludge spreading	N2O	3.38	3.38	0.00	99.99	0.00	99.99
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	3.31	3.31	0.00	99.99	0.00	99.99
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	CH4	2.20	2.20	0.00	99.99	0.00	99.99
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	CH4	2.06	2.06	0.00	99.99	0.00	99.99
2F1. Refrigeration and Air Conditioning Equipment	C3F8	1.94	1.94	0.00	99.99	0.00	99.99
1.A.4 Other Sectors / a. Commercial and institutional / Solid Fuels	CO2	1.17	1.17	0.00	99.99	0.00	99.99
1.A.5 Other / b. Mobile / Military use	N2O	0.91	0.91	0.00	100.00	0.00	100.00
2F3. Fire Extinguishers	HFC-125	0.85	0.85	0.00	100.00	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	CH4	0.79	0.79	0.00	100.00	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	N2O	0.70	0.70	0.00	100.00	0.00	100.00
2E1 By-product Emissions / Other	CF4	0.60	0.60	0.00	100.00	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-227ea	0.46	0.46	0.00	100.00	0.00	100.00
1. B. 2. b. Natural Gas	CO2	0.45	0.45	0.00	100.00	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-152a	0.39	0.39	0.00	100.00	0.00	100.00
1.A.3 Transport / d. Navigation	CH4	0.27	0.27	0.00	100.00	0.00	100.00
1. B. 2. c. 1. Venting	CH4	0.21	0.21	0.00	100.00	0.00	100.00

2F9. Other	C6F14	0.18	0.18	0.00	100.00	0.00	100.00
1.A.3 Transport / c. Railways	CH4	0.13	0.13	0.00	100.00	0.00	100.00
1.A.3 Transport / a. Civil Aviation	N2O	0.12	0.12	0.00	100.00	0.00	100.00
1.A.5 Other / b. Mobile / Military use	CH4	0.09	0.09	0.00	100.00	0.00	100.00
6C Waste Incineration	N2O	0.06	0.06	0.00	100.00	0.00	100.00
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	N2O	0.06	0.06	0.00	100.00	0.00	100.00
1.A.3 Transport / a. Civil Aviation	CH4	0.04	0.04	0.00	100.00	0.00	100.00
1.A.3 Transport / e. Other Transportation (please specify)(5)	CH4	0.038654	0.04	0.00	100.00	0.00	100.00
2F1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.03	0.03	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
2E2 Fugitive Emissions	C5F12	0.02	0.02	0.00	100.00	0.00	100.00
2B. Chemical Industry / 1. Ammonia Production	CH4	0.01	0.01	0.00	100.00	0.00	100.00
Supplementary key sources (according Lulucf analysis)							
5A1 Forest Land remaining Forest Land / Net Carbon stock change in living biomass	CO2	-2118.00					
5A1 Forest Land remaining Forest Land / Net carbon stock change in soils	CO2	-1449.83					
5B1 Cropland remaining Cropland / Net carbon stock change in soils / Mineral Soils	CO2	863.90					
5B2 Land converted to Cropland / Net carbon stock change in soils	CO2	878.46					
5C2 Land converted to Grassland / Net carbon stock change in soils	CO2	-680.76					
5E2 Land converted to Settlements / Net carbon stock change in soils	CO2	478.32					
5C1 Grassland remaining Grassland / Net carbon stock change in soils / Mineral Soils	CO2	323.69					
Deforestation	CO2	496.17					
5E2.1 Forest Land converted to Settlements	CO2	174.23					
5C2.1 Forest Land converted to Grassland	CO2	153.86					

Trend assessment 1990-2011 without LULUCF

IPCC categories	direct greenhouse gas	1990 estimate Gg CO2eq	2011 estimate Gg CO2eq	trend assessment 1990-2011	contribution to trend %	cumulative total %
Sum		**142 952**	**120 146**	**0.71**		
1.A.3 Transport / b. Road Transportation	CO2	19 487.1	25 839.9	0.0937	13.26	13.26
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Solid Fuels	CO2	19 344.9	6 875.0	0.0929	13.15	26.41
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Gaseous Fuels	CO2	2 750.9	9 692.5	0.0731	10.34	36.75
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Solid Fuels	CO2	11 062.1	4 795.8	0.0446	6.31	43.06
1.A.4 Other Sectors / b. Residential / Gaseous Fuels	CO2	5 824.2	7 275.5	0.0236	3.34	46.39
2B. Chemical Industry / 2. Nitric Acid Production	N2O	3 561.9	624.7	0.0235	3.32	49.71
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Other Fuels	CO2	1 833.6	3 808.5	0.0225	3.18	52.89
1.A.4 Other Sectors / b. Residential / Liquid Fuels	CO2	12 664.5	8 421.7	0.0220	3.11	56.00
1.A.4 Other Sectors / a. Commercial and institutional / Gaseous Fuels	CO2	1 923.8	3 660.3	0.0202	2.86	58.87
6A1 Managed Waste Disposal on Land	CH4	2 449.7	577.8	0.0147	2.08	60.94
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Solid Fuels	CO2	2 015.9	243.2	0.0144	2.03	62.98
2E1 By-product Emissions / Other	SF6	1 559.4		0.0130	1.84	64.81
2C. Metal Production / 1. Iron and Steel Production	CO2	2 022.4	539.8	0.0115	1.63	66.44
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO2	1 671.1	247.2	0.0115	1.62	68.06
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Other Fuels	CO2	714.3	1 749.1	0.0114	1.61	69.67
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO2	1 835.1	398.7	0.0113	1.60	71.27
1.A.4 Other Sectors / b. Residential / Solid Fuels	CO2	1 759.2	368.5	0.0110	1.56	72.83
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Gaseous Fuels	CO2	680.7	1 673.6	0.0109	1.54	74.37
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO2	13.8	995.3	0.0097	1.38	75.75
2B. Chemical Industry / 5. Other / Other non-specified	CO2	224.2	1 169.1	0.0097	1.37	77.12
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Liquid Fuels	CO2	2 490.1	1 200.2	0.0088	1.25	78.37
2B. Chemical Industry / 1. Ammonia Production	CO2	422.7	1 108.9	0.0075	1.06	79.43
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Gaseous Fuels	CO2	2 519.3	2 863.2	0.0074	1.05	80.48

2F1. Refrigeration and Air Conditioning Equipment	HFC-134a		736.6	0.0073	1.03	81.51
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	878.4	39.6	0.0069	0.98	82.49
1.A.2 Manufacturing Industries and Construction / f. Other / Liquid Fuels	CO2	3 063.8	1 872.6	0.0070	0.98	83.47
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2	67.0	732.5	0.0067	0.95	84.42
2F1. Refrigeration and Air Conditioning Equipment	HFC-143a		588.7	0.0058	0.82	85.24
2F1. Refrigeration and Air Conditioning Equipment	HFC-125		541.7	0.0054	0.76	86.00
1.A.2 Manufacturing Industries and Construction / f. Other / Solid Fuels	CO2	2 537.3	1 624.1	0.0050	0.71	86.72
1.A.2 Manufacturing Industries and Construction / f. Other / Gaseous Fuels	CO2	2 555.6	2 630.8	0.0048	0.68	87.39
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2	186.5	633.0	0.0047	0.67	88.06
1.A.4 Other Sectors / a. Commercial and institutional / Liquid Fuels	CO2	2 290.1	1 452.4	0.0047	0.66	88.72
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	659.3	89.8	0.0046	0.65	89.37
2B. Chemical Industry / 5. Other / Caprolactam	N2O	372.0	751.8	0.0043	0.62	89.99
2E1 By-product Emissions / Other	C2F6	506.7		0.0042	0.60	90.58
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	637.9	127.5	0.0040	0.57	91.16
2A. Mineral Products / 1. Cement Production	CO2	2 823.8	2 761.6	0.0038	0.54	91.70
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	396.7	3.5	0.0033	0.46	92.16
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	4 285.3	3 271.9	0.0033	0.46	92.62
6C Waste Incineration	CO2	287.8	528.1	0.0028	0.40	93.03
4A1 Non-Dairy Cattle	CH4	2 172.0	2 095.2	0.0027	0.38	93.40
2E1 By-product Emissions / Other	CF4	323.7	5.3	0.0026	0.37	93.78
1. B. 1. a. Coal Mining and Handling	CH4	298.8		0.0025	0.35	94.13
2E2 Fugitive Emissions	C5F12	287.8	0.007	0.0024	0.34	94.47
4A1 Dairy Cattle	CH4	1 808.2	1 274.9	0.0024	0.34	94.81
4D3 Indirect Emissions	N2O	1 248.4	825.5	0.0022	0.31	95.12
4B8 Swine	CH4	1 065.36	1 074.16	0.0018	0.25	95.38
2E2 Fugitive Emissions	C6F14	229.78	29.14	0.0016	0.23	95.61
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Solid Fuels	CO2	207.85	19.37	0.0015	0.22	95.82
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2	428.21	206.09	0.0015	0.22	96.04
2E1 By-product Emissions / Other	C4F10	180.61		0.0015	0.21	96.25

2E1 By-product Emissions / Other	C3F8	171.05		0.0014	0.20	96.45
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Liquid Fuels	CO2	218.17	39.91	0.0014	0.20	96.65
1.A.3 Transport / d. Navigation	CO2	398.23	474.20	0.0014	0.20	96.85
2E2 Fugitive Emissions	C4F10	20.07	137.46	0.0012	0.17	97.02
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Other Fuels	CO2		120.56	0.0012	0.17	97.19
4D1 Direct Soil Emissions	N2O	2 567.19	2 062.79	0.0009	0.13	97.32
1.A.5 Other / b. Mobile / Military use	CO2	165.30	45.21	0.0009	0.13	97.45
1.A.3 Transport / c. Railways	CO2	224.06	101.81	0.0009	0.12	97.57
1.A.3 Transport / b. Road Transportation	N2O	203.60	255.95	0.0008	0.12	97.69
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Liquid Fuels	CO2	232.15	116.22	0.0008	0.11	97.80
6B2 Waste Water Handling/Domestic and Commercial Waste Water	CH4	210.41	101.66	0.0007	0.11	97.91
4D2 Pasture, Range and Paddock Manure	N2O	991.73	761.46	0.0007	0.10	98.01
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Gaseous Fuels	CO2	259.52	286.24	0.0007	0.10	98.10
1.A.3 Transport / b. Road Transportation	CH4	101.09	17.08	0.0007	0.10	98.20
1.A.2 Manufacturing Industries and Construction / f. Other	N2O	75.53	131.20	0.0007	0.09	98.29
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Gaseous Fuels	CO2	1 485.42	1 181.43	0.0007	0.09	98.39
2F4. Aerosols/Metered Dose Inhalers	HFC-134a		66.01	0.0007	0.09	98.48
6B2 Waste Water Handling/Domestic and Commercial Waste Water	N2O	293.49	306.89	0.0006	0.08	98.56
2F2. Foam Blowing	HFC-134a		52.60	0.0005	0.07	98.64
1.A.3 Transport / e. Other Transportation (please specify)(5)	CO2	225.33	238.68	0.0005	0.07	98.71
1.A.4 Other Sectors / a. Commercial and institutional / Other Fuels	CO2	30.70	73.93	0.0005	0.07	98.77
2F2. Foam Blowing	HFC-152a		43.88	0.0004	0.06	98.84
1. B. 2. b. Natural Gas	CH4	518.87	395.10	0.0004	0.06	98.89
2A. Mineral Products / 7. Other / Ceramics	CO2	135.72	153.63	0.0004	0.06	98.95
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Gaseous Fuels	CO2	280.38	196.81	0.0004	0.05	99.00
4B Manure Management (AWMS)	N2O	961.77	770.78	0.0004	0.05	99.06
1.A.1. Energy Industries / b. Petroleum Refining	N2O	129.21	72.47	0.0004	0.05	99.11
2F1. Refrigeration and Air Conditioning Equipment	HFC-32		34.28	0.0003	0.05	99.15
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	CH4	50.61	9.04	0.0003	0.05	99.20

1.A.1. Energy Industries / a. Public Electricity and Heat Production	N2O	51.31	75.75	0.0003	0.05	99.25
4A8 Swine	CH4	211.06	207.63	0.0003	0.04	99.29
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Solid Fuels	CO2	145.98	94.45	0.0003	0.04	99.33
2E1 By-product Emissions / Other	C5F12	33.58		0.0003	0.04	99.37
2F9. Other	SF6	83.62	97.16	0.0003	0.04	99.41
1.A.3 Transport / a. Civil Aviation	CO2	12.88	37.19	0.0003	0.04	99.44
6D Other (compost production)	CH4	2.17	25.13	0.0002	0.03	99.48
1.A.1. Energy Industries / a. Public Electricity and Heat Production	CH4	10.45	31.48	0.0002	0.03	99.51
1. B. 2. c. 2. Flaring	CO2	83.83	92.66	0.0002	0.03	99.54
2A. Mineral Products / 2. Lime Production	CO2	2 097.12	1 741.47	0.0002	0.03	99.57
4B1 Dairy Cattle	CH4	224.44	167.75	0.0002	0.03	99.60
1. B. 1. b. Solid Fuel Transformation	CH4	30.79	5.82	0.0002	0.03	99.63
4B1 Non-Dairy Cattle	CH4	125.60	124.30	0.0002	0.03	99.65
2B. Chemical Industry / 5. Other / Other non-specified	N2O	9.30	23.44	0.0002	0.02	99.67
1.A.2 Manufacturing Industries and Construction / f. Other	CH4	16.98	27.56	0.0001	0.02	99.69
1.A.4 Other Sectors / b. Residential / Other Fuels	CO2	20.69	5.95	0.0001	0.02	99.71
3D Other / use of N2O	N2O	204.40	183.13	0.0001	0.02	99.72
4B (sheep, goats, horses, poultry, mules and asses)	CH4	22.49	30.05	0.0001	0.02	99.74
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	N2O	63.43	42.96	0.0001	0.01	99.75
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	CH4	26.42	12.07	0.0001	0.01	99.77
2C. Metal Production / 1. Iron and Steel Production	CH4		10.06	0.0001	0.01	99.78
PFC, HFC, SF6 Emissions from Semiconductor Manufacturing	PFC, HFC, SF6		10.05	0.0001	0.01	99.80
2A. Mineral Products / 7. Other / Glass Production	CO2	266.16	233.22	0.0001	0.01	99.81
2F3. Fire Extinguishers	HFC-227ea		9.49	0.0001	0.01	99.82
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	N2O	4.29	13.02	0.0001	0.01	99.84
1.A.4 Other Sectors / b. Residential	CH4	226.93	181.32	0.0001	0.01	99.85
2F8. Electrical Equipment	SF6	7.75	15.09	0.0001	0.01	99.86
1.A.4 Other Sectors / a. Commercial and institutional	CH4	12.95	19.23	0.0001	0.01	99.87

1.A.4 Other Sectors / a. Commercial and institutional / Solid Fuels	CO_2	8.83	0.20	0.0001	0.01	99.88
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Other Fuels	CO_2		6.77	0.0001	0.01	99.89
1.A.3 Transport / c. Railways	N_2O	12.87	4.51	0.0001	0.01	99.90
4A (sheep, goats, horses, mules and asses)	CH_4	41.22	40.91	0.0001	0.01	99.91
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Solid Fuels	CO_2	124.95	110.76	0.0001	0.01	99.92
1.A.3 Transport / e. Other Transportation (please specify)(5)	N_2O	6.71	11.20	0.0001	0.01	99.93
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	CH_4	2.64	7.12	0.0000	0.01	99.93
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	N_2O	40.23	38.43	0.0000	0.01	99.94
1.A.4 Other Sectors / b. Residential	N_2O	54.78	50.04	0.0000	0.01	99.95
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Liquid Fuels	CO_2	4.42		0.0000	0.01	99.95
4D4 Other/sludge spreading	N_2O		3.38	0.0000	0.00	99.96
1.A.2 Manufacturing Industries and Construction / c. Chemicals	CH_4	7.81	9.94	0.0000	0.00	99.96
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	N_2O	7.60	3.20	0.0000	0.00	99.97
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	N_2O	3.10	0.07	0.0000	0.00	99.97
1.A.3 Transport / d. Navigation	N_2O	15.40	10.41	0.0000	0.00	99.97
1. B. 2. a. Oil	CH_4	9.56	5.65	0.0000	0.00	99.98
6C Waste Incineration	N_2O	2.75	0.07	0.0000	0.00	99.98
2F1. Refrigeration and Air Conditioning Equipment	C_3F_8		2.23	0.0000	0.00	99.98
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Gaseous Fuels	CO_2	2.59		0.0000	0.00	99.98
2B. Chemical Industry / 5. Other / Other non-specified	CH_4		1.78	0.0000	0.00	99.99
1.A.2 Manufacturing Industries and Construction / c. Chemicals	N_2O	8.18	5.29	0.0000	0.00	99.99
1. B. 2. c. 1. Venting	CH_4		1.12	0.0000	0.00	99.99
1.A.5 Other / b. Mobile / Military use	N_2O	2.12	0.73	0.0000	0.00	99.99
1.A.4 Other Sectors / a. Commercial and institutional	N_2O	7.45	7.23	0.0000	0.00	99.99
2F3. Fire Extinguishers	HFC-125		0.86	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	CH_4	3.73	3.89	0.0000	0.00	100.00
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	CH_4	7.08	6.68	0.0000	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-227ea		0.46	0.0000	0.00	100.00

2F4. Aerosols/Metered Dose Inhalers	HFC-152a		0.39	0.0000	0.00	100.00
2F9. Other	C6F14		0.38	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	N2O	1.28	0.73	0.0000	0.00	100.00
1.A.3 Transport / c. Railways	CH4	0.30	0.14	0.0000	0.00	100.00
2F1. Refrigeration and Air Conditioning Equipment	HFC-152a		0.05	0.0000	0.00	100.00
1. B. 2. b. Natural Gas	CO2	0.61	0.46	0.0000	0.00	100.00
1.A.5 Other / b. Mobile / Military use	CH4	0.06	0.09	0.0000	0.00	100.00
1.A.3 Transport / a. Civil Aviation	N2O	0.14	0.15	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	CH4	0.90	0.79	0.0000	0.00	100.00
1.A.3 Transport / d. Navigation	CH4	0.37	0.28	0.0000	0.00	100.00
1.A.3 Transport / a. Civil Aviation	CH4	0.03	0.05	0.0000	0.00	100.00
1.A.3 Transport / e. Other Transportation (please specify)(5)	CH4	0.07	0.05	0.0000	0.00	100.00
1. B. 2. a. Oil	CO2	0.01	0.02	0.0000	0.00	100.00
2B. Chemical Industry / 1. Ammonia Production	CH4	0.01	0.01	0.0000	0.00	100.00
Key source according "trend analysis without Lulucf"						

Trend assessment 1990-2011 with LULUCF

IPCC categories	direct greenhouse gas	1990 estimate Gg CO2eq	2011 estimate Gg CO2eq	trend assessment 1990-2011	contribution to trend %	cumulative total %
Sum		**142 118**	**118 978**	**0.75**		
1.A.3 Transport / b. Road Transportation	CO2	19 487.1	25 839.9	0.0956	12.76	12.76
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Solid Fuels	CO2	19 344.9	6 875.0	0.0936	12.48	25.24
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Gaseous Fuels	CO2	2 750.9	9 692.5	0.0742	9.90	35.14
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Solid Fuels	CO2	11 062.1	4 795.8	0.0448	5.98	41.12
1.A.4 Other Sectors / b. Residential / Gaseous Fuels	CO2	5 824.2	7 275.5	0.0241	3.21	44.33
2B. Chemical Industry / 2. Nitric Acid Production	N2O	3 561.9	624.7	0.0237	3.16	47.49
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Other Fuels	CO2	1 833.6	3 808.5	0.0228	3.04	50.53
1.A.4 Other Sectors / b. Residential / Liquid Fuels	CO2	12 664.5	8 421.7	0.0219	2.92	53.45
1.A.4 Other Sectors / a. Commercial and institutional / Gaseous Fuels	CO2	1 923.8	3 660.3	0.0206	2.75	56.20
6A1 Managed Waste Disposal on Land	CH4	2 449.7	577.8	0.0148	1.97	58.17
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Solid Fuels	CO2	2 015.9	243.2	0.0145	1.93	60.11
2E1 By-product Emissions / Other	SF6	1 559.4		0.0131	1.75	61.85
2C. Metal Production / 1. Iron and Steel Production	CO2	2 022.4	539.8	0.0116	1.54	63.40
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO2	1 671.1	247.2	0.0116	1.54	64.94
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Other Fuels	CO2	714.3	1 749.1	0.0116	1.54	66.48
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO2	1 835.1	398.7	0.0114	1.52	68.01
1.A.4 Other Sectors / b. Residential / Solid Fuels	CO2	1 759.2	368.5	0.0111	1.48	69.49
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Gaseous Fuels	CO2	680.7	1 673.6	0.0111	1.48	70.96
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO2	13.8	995.3	0.0099	1.32	72.28
2B. Chemical Industry / 5. Other / Other non-specified	CO2	224.2	1 169.1	0.0099	1.31	73.60
5A1 Forest Land remaining Forest Land	CO2	-3 118.1	-3 511.1	0.0090	1.21	74.80
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Liquid Fuels	CO2	2 490.1	1 200.2	0.0089	1.18	75.99
5B2 Land converted to Cropland	CO2	112.8	922.1	0.0083	1.11	77.10
2B. Chemical Industry / 1. Ammonia Production	CO2	422.7	1 108.9	0.0076	1.01	78.11

1.A.2 Manufacturing Industries and Construction / c. Chemicals / Gaseous Fuels	CO2	2 519.3	2 863.2	0.0076	1.01	79.12
2F1. Refrigeration and Air Conditioning Equipment	HFC-134a		736.6	0.0074	0.99	80.10
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	878.4	39.6	0.0070	0.93	81.04
1.A.2 Manufacturing Industries and Construction / f. Other / Liquid Fuels	CO2	3 063.8	1 872.6	0.0070	0.93	81.96
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2	67.0	732.5	0.0068	0.91	82.87
2F1. Refrigeration and Air Conditioning Equipment	HFC-143a		588.7	0.0059	0.79	83.66
5C2 Land converted to Grassland	CO2	73.7	-505.0	0.0057	0.76	84.42
2F1. Refrigeration and Air Conditioning Equipment	HFC-125		541.7	0.0054	0.73	85.14
1.A.2 Manufacturing Industries and Construction / f. Other / Solid Fuels	CO2	2 537.3	1 624.1	0.0050	0.67	85.81
1.A.2 Manufacturing Industries and Construction / f. Other / Gaseous Fuels	CO2	2 555.6	2 630.8	0.0049	0.66	86.47
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2	186.5	633.0	0.0048	0.64	87.11
1.A.4 Other Sectors / a. Commercial and institutional / Liquid Fuels	CO2	2 290.1	1 452.4	0.0047	0.62	87.73
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	659.3	89.8	0.0046	0.62	88.35
2B. Chemical Industry / 5. Other / Caprolactam	N2O	372.0	751.8	0.0044	0.59	88.94
2E1 By-product Emissions / Other	C2F6	506.7		0.0043	0.57	89.51
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	637.9	127.5	0.0041	0.54	90.05
2A. Mineral Products / 1. Cement Production	CO2	2 823.8	2 761.6	0.0040	0.53	90.58
5E2 Land converted to Settlements	CO2	248.0	585.4	0.0038	0.51	91.09
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	396.7	3.5	0.0033	0.44	91.53
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	4 285.3	3 271.9	0.0032	0.42	91.95
6C Waste Incineration	CO2	287.8	528.1	0.0029	0.38	92.34
5A2 Land converted to Forest Land	CO2	-19.7	-295.9	0.0028	0.37	92.71
4A1 Non-Dairy Cattle	CH4	2 172.0	2 095.2	0.0028	0.37	93.08
2E1 By-product Emissions / Other	CF4	323.7	5.3	0.0027	0.36	93.44
1. B. 1. a. Coal Mining and Handling	CH4	298.8		0.0025	0.34	93.77
2E2 Fugitive Emissions	C5F12	287.8	0.0068	0.0024	0.32	94.10
4A1 Dairy Cattle	CH4	1 808.2	1 274.9	0.0024	0.32	94.42
4D3 Indirect Emissions	N2O	1 248.4	825.5	0.0022	0.29	94.71
4B8 Swine	CH4	1 065.4	1 074.2	0.0018	0.24	94.95
5C1 Grassland remaining Grassland	CO2	680.39	396.66	0.0017	0.23	95.19

2E2 Fugitive Emissions	C6F14	229.78	29.14	0.0016	0.22	95.40
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Solid Fuels	CO2	207.85	19.37	0.0016	0.21	95.61
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2	428.21	206.09	0.0015	0.20	95.82
2E1 By-product Emissions / Other	C4F10	180.61		0.0015	0.20	96.02
2E1 By-product Emissions / Other	C3F8	171.05		0.0014	0.19	96.21
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Liquid Fuels	CO2	218.17	39.91	0.0014	0.19	96.40
1.A.3 Transport / d. Navigation	CO2	398.23	474.20	0.0014	0.19	96.59
2E2 Fugitive Emissions	C4F10	20.07	137.46	0.0012	0.16	96.75
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Other Fuels	CO2		120.56	0.0012	0.16	96.91
5B2 Land converted to Cropland	N2O	8.33	100.35	0.0009	0.13	97.04
1.A.5 Other / b. Mobile / Military use	CO2	165.30	45.21	0.0009	0.12	97.16
4D1 Direct Soil Emissions	N2O	2 567.19	2 062.79	0.0009	0.12	97.28
1.A.3 Transport / c. Railways	CO2	224.06	101.81	0.0009	0.11	97.39
1.A.3 Transport / b. Road Transportation	N2O	203.60	255.95	0.0009	0.11	97.51
5F2 Land converted to Other Land	CO2	28.23	106.70	0.0008	0.11	97.62
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Liquid Fuels	CO2	232.15	116.22	0.0008	0.10	97.72
6B2 Waste Water Handling/Domestic and Commercial Waste Water	CH4	210.41	101.66	0.0007	0.10	97.82
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Gaseous Fuels	CO2	259.52	286.24	0.0007	0.09	97.92
4D2 Pasture, Range and Paddock Manure	N2O	991.73	761.46	0.0007	0.09	98.01
1.A.2 Manufacturing Industries and Construction / f. Other	N2O	75.53	131.20	0.0007	0.09	98.10
1.A.3 Transport / b. Road Transportation	CH4	101.09	17.08	0.0007	0.09	98.19
2F4. Aerosols/Metered Dose Inhalers	HFC-134a		66.01	0.0007	0.09	98.28
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Gaseous Fuels	CO2	1 485.42	1 181.43	0.0006	0.08	98.36
6B2 Waste Water Handling/Domestic and Commercial Waste Water	N2O	293.49	306.89	0.0006	0.08	98.44
2F2. Foam Blowing	HFC-134a		52.60	0.0005	0.07	98.51
1.A.3 Transport / e. Other Transportation (please specify)(5)	CO2	225.33	238.68	0.0005	0.07	98.58
1.A.4 Other Sectors / a. Commercial and institutional / Other Fuels	CO2	30.70	73.93	0.0005	0.06	98.65
2F2. Foam Blowing	HFC-152a		43.88	0.0004	0.06	98.70
5B1 Cropland remaining Cropland	CO2	1 126.00	985.61	0.0004	0.06	98.76
2A. Mineral Products / 7. Other / Ceramics	CO2	135.72	153.63	0.0004	0.05	98.82

5D2 Land converted to Wetlands	CO2	20.55	-22.43	0.0004	0.05	98.87
1. B. 2. b. Natural Gas	CH4	518.87	395.10	0.0004	0.05	98.92
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Gaseous Fuels	CO2	280.38	196.81	0.0004	0.05	98.97
5C1 Grassland remaining Grassland	N2O		35.96	0.0004	0.05	99.02
1.A.1. Energy Industries / b. Petroleum Refining	N2O	129.21	72.47	0.0004	0.05	99.07
4B Manure Management (AWMS)	N2O	961.77	770.78	0.0003	0.05	99.11
2F1. Refrigeration and Air Conditioning Equipment	HFC-32		34.28	0.0003	0.05	99.16
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	CH4	50.61	9.04	0.0003	0.04	99.20
1.A.1. Energy Industries / a. Public Electricity and Heat Production	N2O	51.31	75.75	0.0003	0.04	99.25
4A8 Swine	CH4	211.06	207.63	0.0003	0.04	99.29
2E1 By-product Emissions / Other	C5F12	33.58		0.0003	0.04	99.33
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Solid Fuels	CO2	145.98	94.45	0.0003	0.04	99.36
2F9. Other	SF6	83.62	97.16	0.0003	0.04	99.40
1.A.3 Transport / a. Civil Aviation	CO2	12.88	37.19	0.0003	0.04	99.44
5A1 Forest Land remaining Forest Land	N2O	4.87	27.60	0.0002	0.03	99.47
6D Other (compost production)	CH4	2.17	25.13	0.0002	0.03	99.50
1.A.1. Energy Industries / a. Public Electricity and Heat Production	CH4	10.45	31.48	0.0002	0.03	99.53
1. B. 2. c. 2. Flaring	CO2	83.83	92.66	0.0002	0.03	99.56
4B1 Dairy Cattle	CH4	224.44	167.75	0.0002	0.03	99.59
1. B. 1. b. Solid Fuel Transformation	CH4	30.79	5.82	0.0002	0.03	99.61
4B1 Non-Dairy Cattle	CH4	125.60	124.30	0.0002	0.03	99.64
2B. Chemical Industry / 5. Other / Other non-specified	N2O	9.30	23.44	0.0002	0.02	99.66
2A. Mineral Products / 2. Lime Production	CO2	2 097.12	1 741.47	0.0001	0.02	99.68
1.A.2 Manufacturing Industries and Construction / f. Other	CH4	16.98	27.56	0.0001	0.02	99.70
3D Other / use of N2O	N2O	204.40	183.13	0.0001	0.02	99.71
1.A.4 Other Sectors / b. Residential / Other Fuels	CO2	20.69	5.95	0.0001	0.02	99.73
4B (sheep, goats, horses, poultry, mules and asses)	CH4	22.49	30.05	0.0001	0.02	99.74
2A. Mineral Products / 7. Other / Glass Production	CO2	266.16	233.22	0.0001	0.01	99.76
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	N2O	63.43	42.96	0.0001	0.01	99.77
2C. Metal Production / 1. Iron and Steel Production	CH4		10.06	0.0001	0.01	99.78

1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	CH4	26.42	12.07	0.0001	0.01	99.80
PFC, HFC, SF6 Emissions from Semiconductor Manufacturing	PFC, HFC, SF6		10.05	0.0001	0.01	99.81
2F3. Fire Extinguishers	HFC-227ea		9.49	0.0001	0.01	99.82
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	N2O	4.29	13.02	0.0001	0.01	99.84
1.A.4 Other Sectors / b. Residential	CH4	226.93	181.32	0.0001	0.01	99.85
2F8. Electrical Equipment	SF6	7.75	15.09	0.0001	0.01	99.86
1.A.4 Other Sectors / a. Commercial and institutional	CH4	12.95	19.23	0.0001	0.01	99.87
1.A.4 Other Sectors / a. Commercial and institutional / Solid Fuels	CO2	8.83	0.20	0.0001	0.01	99.88
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Other Fuels	CO2		6.77	0.0001	0.01	99.89
4A (sheep, goats, horses, mules and asses)	CH4	41.22	40.91	0.0001	0.01	99.90
1.A.3 Transport / c. Railways	N2O	12.87	4.51	0.0001	0.01	99.91
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Solid Fuels	CO2	124.95	110.76	0.0001	0.01	99.91
1.A.3 Transport / e. Other Transportation (please specify)(5)	N2O	6.71	11.20	0.0001	0.01	99.92
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	CH4	2.64	7.12	0.0000	0.01	99.93
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	N2O	40.23	38.43	0.0000	0.01	99.93
1.A.4 Other Sectors / b. Residential	N2O	54.78	50.04	0.0000	0.01	99.94
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Liquid Fuels	CO2	4.42		0.0000	0.00	99.95
5C1 Grassland remaining Grassland	CH4		3.54	0.0000	0.00	99.95
1.A.2 Manufacturing Industries and Construction / c. Chemicals	CH4	7.81	9.94	0.0000	0.00	99.95
4D4 Other/sludge spreading	N2O		3.38	0.0000	0.00	99.96
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	N2O	7.60	3.20	0.0000	0.00	99.96
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	N2O	3.10	0.07	0.0000	0.00	99.97
1.A.3 Transport / d. Navigation	N2O	15.40	10.41	0.0000	0.00	99.97
1. B. 2. a. Oil	CH4	9.56	5.65	0.0000	0.00	99.97
5A1 Forest Land remaining Forest Land	CH4	0.48	2.72	0.0000	0.00	99.98
2F1. Refrigeration and Air Conditioning Equipment	C3F8		2.23	0.0000	0.00	99.98
6C Waste Incineration	N2O	2.75	0.07	0.0000	0.00	99.98
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Gaseous Fuels	CO2	2.59		0.0000	0.00	99.99
2B. Chemical Industry / 5. Other / Other non-specified	CH4		1.78	0.0000	0.00	99.99
1.A.2 Manufacturing Industries and Construction / c. Chemicals	N2O	8.18	5.29	0.0000	0.00	99.99

1. B. 2. c. 1. Venting	CH4		1.12	0.0000	0.00	99.99
1.A.5 Other / b. Mobile / Military use	N2O	2.12	0.73	0.0000	0.00	99.99
1.A.4 Other Sectors / a. Commercial and institutional	N2O	7.45	7.23	0.0000	0.00	99.99
2F3. Fire Extinguishers	HFC-125		0.86	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	CH4	3.73	3.89	0.0000	0.00	100.00
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	CH4	7.08	6.68	0.0000	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-227ea		0.46	0.0000	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-152a		0.39	0.0000	0.00	100.00
2F9. Other	C6F14		0.38	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	N2O	1.28	0.73	0.0000	0.00	100.00
1.A.3 Transport / c. Railways	CH4	0.30	0.14	0.0000	0.00	100.00
2F1. Refrigeration and Air Conditioning Equipment	HFC-152a		0.05	0.0000	0.00	100.00
1. B. 2. b. Natural Gas	CO2	0.61	0.46	0.0000	0.00	100.00
1.A.5 Other / b. Mobile / Military use	CH4	0.06	0.09	0.0000	0.00	100.00
1.A.3 Transport / a. Civil Aviation	N2O	0.14	0.15	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	CH4	0.90	0.79	0.0000	0.00	100.00
1.A.3 Transport / d. Navigation	CH4	0.37	0.28	0.0000	0.00	100.00
1.A.3 Transport / a. Civil Aviation	CH4	0.03	0.05	0.0000	0.00	100.00
1.A.3 Transport / e. Other Transportation (please specify)(5)	CH4	0.07	0.05	0.0000	0.00	100.00
1. B. 2. a. Oil	CO2	0.01	0.02	0.0000	0.00	100.00
2B. Chemical Industry / 1. Ammonia Production	CH4	0.01	0.01	0.0000	0.00	100.00
Key source according "trend analysis with Lulucf"						
Not a key source according "trend analyse without Lulucf"						

Trend assessment 1990-2012 without LULUCF

IPCC categories	direct greenhouse gas	1990 estimate Gg CO2eq	2012 estimate Gg CO2eq	trend assessment 1990-2012	contribution to trend %	cumulative total %
Sum		**142 952**	**116 520**	**0.74**		
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Solid Fuels	CO2	19 344.9	7 326.8	0.0889	12.03	12.03
1.A.3 Transport / b. Road Transportation	CO2	19 487.1	23 890.3	0.0843	11.41	23.43
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Gaseous Fuels	CO2	2 750.9	8 499.6	0.0659	8.91	32.35
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Solid Fuels	CO2	11 062.1	3 209.4	0.0611	8.27	40.62
1.A.4 Other Sectors / b. Residential / Gaseous Fuels	CO2	5 824.2	8 098.6	0.0353	4.77	45.40
1.A.4 Other Sectors / a. Commercial and institutional / Gaseous Fuels	CO2	1 923.8	4 193.9	0.0276	3.74	49.14
2B. Chemical Industry / 2. Nitric Acid Production	N2O	3 561.9	680.7	0.0234	3.17	52.30
1.A.4 Other Sectors / b. Residential / Liquid Fuels	CO2	12 664.5	8 090.5	0.0235	3.18	55.49
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Other Fuels	CO2	1 833.6	3 612.4	0.0223	3.02	58.50
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Solid Fuels	CO2	2 015.9	224.9	0.0149	2.02	60.52
6A1 Managed Waste Disposal on Land	CH4	2 449.7	578.6	0.0149	2.02	62.54
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Other Fuels	CO2	714.3	1 869.2	0.0136	1.83	64.38
2E1 By-product Emissions / Other	SF6	1 559.4		0.0134	1.81	66.19
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Gaseous Fuels	CO2	680.7	1 763.7	0.0127	1.72	67.91
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO2	1 835.1	277.6	0.0128	1.74	69.65
2C. Metal Production / 1. Iron and Steel Production	CO2	2 022.4	443.8	0.0127	1.72	71.36
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO2	1 671.1	199.9	0.0122	1.66	73.02
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO2	13.8	1 086.0	0.0113	1.53	74.55
1.A.4 Other Sectors / b. Residential / Solid Fuels	CO2	1 759.2	492.4	0.0099	1.34	75.89
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Gaseous Fuels	CO2	2 519.3	2 932.4	0.0093	1.25	77.14
1.A.2 Manufacturing Industries and Construction / f. Other / Liquid Fuels	CO2	3 063.8	1 642.2	0.0090	1.22	78.36
2B. Chemical Industry / 1. Ammonia Production	CO2	422.7	1 133.6	0.0083	1.12	79.49

2B. Chemical Industry / 5. Other / Other non-specified	CO2	224.2	953.1	0.0081	1.10	80.58
2F1. Refrigeration and Air Conditioning Equipment	HFC-134a		759.3	0.0080	1.08	81.67
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2	67.0	809.2	0.0079	1.08	82.74
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Liquid Fuels	CO2	2 490.1	1 290.1	0.0078	1.05	83.79
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	878.4	56.0	0.0069	0.94	84.73
1.A.2 Manufacturing Industries and Construction / f. Other / Gaseous Fuels	CO2	2 555.6	2 708.1	0.0066	0.89	85.63
2F1. Refrigeration and Air Conditioning Equipment	HFC-143a		600.3	0.0063	0.86	86.48
2F1. Refrigeration and Air Conditioning Equipment	HFC-125		577.4	0.0061	0.82	87.30
1.A.2 Manufacturing Industries and Construction / f. Other / Solid Fuels	CO2	2 537.3	1 543.9	0.0055	0.75	88.05
2B. Chemical Industry / 5. Other / Caprolactam	N2O	372.0	754.5	0.0048	0.64	88.69
2E1 By-product Emissions / Other	C2F6	506.7		0.0043	0.59	89.28
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2	186.5	554.6	0.0042	0.57	89.85
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	637.9	139.3	0.0040	0.54	90.40
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	659.3	160.3	0.0040	0.54	90.93
2A. Mineral Products / 1. Cement Production	CO2	2 823.8	2 642.6	0.0036	0.49	91.42
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	396.7	3.308	0.0034	0.46	91.88
4A1 Non-Dairy Cattle	CH4	2 172.0	2 044.0	0.0029	0.39	92.27
6C Waste Incineration	CO2	287.8	517.6	0.0030	0.40	92.67
2E1 By-product Emissions / Other	CF4	323.7	0.605	0.0028	0.38	93.04
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2	428.2	101.9	0.0026	0.35	93.40
1. B. 1. a. Coal Mining and Handling	CH4	298.8		0.0026	0.35	93.74
2E2 Fugitive Emissions	C5F12	287.8	0.0156	0.0025	0.33	94.08
4B8 Swine	CH4	1 065.4	1 081.0	0.0022	0.30	94.38
1.A.4 Other Sectors / a. Commercial and institutional / Liquid Fuels	CO2	2 290.1	1 642.4	0.0024	0.32	94.70
4D3 Indirect Emissions	N2O	1 248.4	810.7	0.0022	0.29	94.99
4A1 Dairy Cattle	CH4	1 808.2	1 264.1	0.0022	0.30	95.29
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Solid Fuels	CO2	207.85	19.37	0.0016	0.21	95.51
2E1 By-product Emissions / Other	C4F10	180.61		0.0016	0.21	95.72

2E2 Fugitive Emissions	C4F10	20.07	161.97	0.0015	0.21	95.92
2E1 By-product Emissions / Other	C3F8	171.05		0.0015	0.20	96.12
1.A.3 Transport / d. Navigation	CO2	398.23	462.90	0.0015	0.20	96.32
2E2 Fugitive Emissions	C6F14	229.78	49.43	0.0015	0.20	96.52
4D1 Direct Soil Emissions	N2O	2 567.19	1 961.35	0.0014	0.19	96.70
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Liquid Fuels	CO2	218.17	49.69	0.0013	0.18	96.89
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Gaseous Fuels	CO2	1 485.42	1 112.22	0.0010	0.14	97.03
2A. Mineral Products / 2. Lime Production	CO2	2 097.12	1 611.91	0.0010	0.14	97.17
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Other Fuels	CO2		95.22	0.0010	0.14	97.30
6B2 Waste Water Handling/Domestic and Commercial Waste Water	CH4	210.41	78.87	0.0010	0.13	97.43
1.A.3 Transport / c. Railways	CO2	224.06	92.66	0.0009	0.13	97.56
1.A.5 Other / b. Mobile / Military use	CO2	165.30	45.28	0.0009	0.13	97.69
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Gaseous Fuels	CO2	259.52	296.10	0.0009	0.12	97.81
1.A.3 Transport / b. Road Transportation	N2O	203.60	250.22	0.0009	0.12	97.93
6B2 Waste Water Handling/Domestic and Commercial Waste Water	N2O	293.49	309.26	0.0007	0.10	98.03
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Liquid Fuels	CO2	232.15	121.27	0.0007	0.10	98.13
1.A.3 Transport / b. Road Transportation	CH4	101.09	14.90	0.0007	0.10	98.22
2F4. Aerosols/Metered Dose Inhalers	HFC-134a		66.01	0.0007	0.09	98.32
4D2 Pasture, Range and Paddock Manure	N2O	991.73	753.11	0.0006	0.08	98.39
1.A.2 Manufacturing Industries and Construction / f. Other	N2O	75.53	111.25	0.0005	0.07	98.47
1. B. 2. b. Natural Gas	CH4	518.87	373.56	0.0005	0.07	98.54
1.A.4 Other Sectors / a. Commercial and institutional / Other Fuels	CO2	30.70	73.82	0.0005	0.07	98.61
2F2. Foam Blowing	HFC-134a		48.72	0.0005	0.07	98.67
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Solid Fuels	CO2	145.98	77.70	0.0004	0.06	98.73
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	CH4	50.61	2.06	0.0004	0.06	98.79
1.A.1. Energy Industries / a. Public Electricity and Heat Production	N2O	51.31	80.79	0.0004	0.06	98.84
1.A.1. Energy Industries / b. Petroleum Refining	N2O	129.21	67.10	0.0004	0.05	98.90
2F1. Refrigeration and Air Conditioning Equipment	HFC-32		38.11	0.0004	0.05	98.95

1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	N2O	63.43	89.63	0.0004	0.05	99.01
4A8 Swine	CH4	211.06	209.66	0.0004	0.05	99.06
2F2. Foam Blowing	HFC-152a		36.95	0.0004	0.05	99.11
2F9. Other	SF6	83.62	103.97	0.0004	0.05	99.17
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	4 285.35	3 528.74	0.0004	0.05	99.22
2A. Mineral Products / 7. Other / Ceramics	CO2	135.72	146.37	0.0004	0.05	99.27
1.A.4 Other Sectors / b. Residential	CH4	226.93	220.27	0.0004	0.05	99.32
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Gaseous Fuels	CO2	280.38	199.28	0.0003	0.04	99.36
2A. Mineral Products / 7. Other / Glass Production	CO2	266.16	188.37	0.0003	0.04	99.40
2E1 By-product Emissions / Other	C5F12	33.58		0.0003	0.04	99.44
1.A.1. Energy Industries / a. Public Electricity and Heat Production	CH4	10.45	33.38	0.0003	0.04	99.47
1. B. 2. c. 2. Flaring	CO2	83.83	92.02	0.0002	0.03	99.51
6D Other (compost production)	CH4	2.17	23.93	0.0002	0.03	99.54
1. B. 1. b. Solid Fuel Transformation	CH4	30.79	4.84	0.0002	0.03	99.57
4B1 Non-Dairy Cattle	CH4	125.60	120.93	0.0002	0.03	99.59
4B Manure Management (AWMS)	N2O	961.77	765.70	0.0002	0.03	99.62
1.A.3 Transport / a. Civil Aviation	CO2	12.88	26.87	0.0002	0.02	99.64
3D Other / use of N2O	N2O	204.40	182.88	0.0002	0.02	99.67
4B1 Dairy Cattle	CH4	224.44	166.84	0.0002	0.02	99.69
2C. Metal Production / 1. Iron and Steel Production	CH4		14.78	0.0002	0.02	99.71
4B (sheep, goats, horses, poultry, mules and asses)	CH4	22.49	32.12	0.0001	0.02	99.73
1.A.4 Other Sectors / a. Commercial and institutional	CH4	12.95	23.09	0.0001	0.02	99.75
2B. Chemical Industry / 5. Other / Other non-specified	N2O	9.30	19.58	0.0001	0.02	99.77
1.A.4 Other Sectors / b. Residential	N2O	54.78	56.09	0.0001	0.02	99.78
1.A.4 Other Sectors / b. Residential / Other Fuels	CO2	20.69	5.67	0.0001	0.02	99.80
PFC, HFC, SF6 Emissions from Semiconductor Manufacturing	PFC, HFC, SF6		10.21	0.0001	0.01	99.81
4A (sheep, goats, horses, mules and asses)	CH4	41.22	43.62	0.0001	0.01	99.83
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	N2O	4.29	13.47	0.0001	0.01	99.84

2F3. Fire Extinguishers	HFC-227ea		9.44	0.0001	0.01	99.85
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	CH4	26.42	12.93	0.0001	0.01	99.87
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Solid Fuels	CO2	124.95	109.96	0.0001	0.01	99.88
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Other Fuels	CO2		7.69	0.0001	0.01	99.89
1.A.3 Transport / c. Railways	N2O	12.87	4.12	0.0001	0.01	99.90
1.A.4 Other Sectors / a. Commercial and institutional / Solid Fuels	CO2	8.83	1.17	0.0001	0.01	99.91
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	N2O	40.23	38.79	0.0001	0.01	99.92
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	CH4	2.64	7.28	0.0001	0.01	99.92
2F8. Electrical Equipment	SF6	7.75	11.02	0.0000	0.01	99.93
1.A.3 Transport / e. Other Transportation (please specify)(5)	N2O	6.71	10.12	0.0000	0.01	99.94
2B. Chemical Industry / 5. Other / Other non-specified	CH4		4.27	0.0000	0.01	99.94
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Liquid Fuels	CO2	4.42		0.0000	0.01	99.95
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	CH4	7.08	2.20	0.0000	0.01	99.95
4D4 Other/sludge spreading	N2O		3.38	0.0000	0.00	99.96
1.A.2 Manufacturing Industries and Construction / c. Chemicals	CH4	7.81	9.47	0.0000	0.00	99.96
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	N2O	7.60	3.44	0.0000	0.00	99.97
1.A.3 Transport / d. Navigation	N2O	15.40	10.06	0.0000	0.00	99.97
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	N2O	3.10	0.06	0.0000	0.00	99.97
1.A.4 Other Sectors / a. Commercial and institutional	N2O	7.45	8.51	0.0000	0.00	99.98
6C Waste Incineration	N2O	2.75	0.06	0.0000	0.00	99.98
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Gaseous Fuels	CO2	2.59		0.0000	0.00	99.98
1. B. 2. a. Oil	CH4	9.56	5.75	0.0000	0.00	99.99
1.A.2 Manufacturing Industries and Construction / c. Chemicals	N2O	8.18	4.67	0.0000	0.00	99.99
2F1. Refrigeration and Air Conditioning Equipment	C3F8		1.94	0.0000	0.00	99.99
1.A.3 Transport / e. Other Transportation (please specify)(5)	CO2	225.33	185.14	0.0000	0.00	99.99
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	CH4	3.73	4.21	0.0000	0.00	99.99
2F3. Fire Extinguishers	HFC-125		0.85	0.0000	0.00	100.00
1.A.5 Other / b. Mobile / Military use	N2O	2.12	0.91	0.0000	0.00	100.00

2F4. Aerosols/Metered Dose Inhalers	HFC-227ea		0.46	0.0000	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-152a		0.39	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	N2O	1.28	0.70	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / f. Other	CH4	16.98	14.10	0.0000	0.00	100.00
1. B. 2. c. 1. Venting	CH4		0.21	0.0000	0.00	100.00
2F9. Other	C6F14		0.18	0.0000	0.00	100.00
1.A.3 Transport / c. Railways	CH4	0.30	0.13	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	CH4	0.90	0.79	0.0000	0.00	100.00
1.A.5 Other / b. Mobile / Military use	CH4	0.06	0.09	0.0000	0.00	100.00
1. B. 2. b. Natural Gas	CO2	0.61	0.45	0.0000	0.00	100.00
1.A.3 Transport / d. Navigation	CH4	0.37	0.27	0.0000	0.00	100.00
2F1. Refrigeration and Air Conditioning Equipment	HFC-152a		0.03	0.0000	0.00	100.00
1.A.3 Transport / a. Civil Aviation	CH4	0.03	0.04	0.0000	0.00	100.00
1.A.3 Transport / e. Other Transportation (please specify)(5)	CH4	0.07	0.04	0.0000	0.00	100.00
1. B. 2. a. Oil	CO2	0.01	0.02	0.0000	0.00	100.00
1.A.3 Transport / a. Civil Aviation	N2O	0.14	0.12	0.0000	0.00	100.00
2B. Chemical Industry / 1. Ammonia Production	CH4	0.01	0.01	0.0000	0.00	100.00
Key source according "trend analysis without Lulucf"						

Trend assessment 1990-2012 with LULUCF

IPCC categories	direct greenhouse gas	1990 estimate Gg CO2eq	2012 estimate Gg CO2eq	trend assessment 1990-2012	contribution to trend %	cumulative total %
Sum		**142 118**	**115 139**	**0.79**		
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Solid Fuels	CO2	19 344.9	7 326.8	0.0895	11.34	11.34
1.A.3 Transport / b. Road Transportation	CO2	19 487.1	23 890.3	0.0869	11.01	22.35
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Gaseous Fuels	CO2	2 750.9	8 499.6	0.0672	8.52	30.87
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Solid Fuels	CO2	11 062.1	3 209.4	0.0617	7.82	38.69
1.A.4 Other Sectors / b. Residential / Gaseous Fuels	CO2	5 824.2	8 098.6	0.0362	4.59	43.28
1.A.4 Other Sectors / a. Commercial and institutional / Gaseous Fuels	CO2	1 923.8	4 193.9	0.0283	3.58	46.86
2B. Chemical Industry / 2. Nitric Acid Production	N2O	3 561.9	680.7	0.0236	3.00	49.86
1.A.4 Other Sectors / b. Residential / Liquid Fuels	CO2	12 664.5	8 090.5	0.0233	2.95	52.81
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Other Fuels	CO2	1 833.6	3 612.4	0.0228	2.89	55.70
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Solid Fuels	CO2	2 015.9	224.9	0.0151	1.91	57.61
6A1 Managed Waste Disposal on Land	CH4	2 449.7	578.6	0.0151	1.91	59.52
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Other Fuels	CO2	714.3	1 869.2	0.0138	1.75	61.27
2E1 By-product Emissions / Other	SF6	1 559.4		0.0135	1.72	62.99
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Gaseous Fuels	CO2	680.7	1 763.7	0.0130	1.65	64.64
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Liquid Fuels	CO2	1 835.1	277.6	0.0130	1.64	66.28
2C. Metal Production / 1. Iron and Steel Production	CO2	2 022.4	443.8	0.0128	1.62	67.90
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Liquid Fuels	CO2	1 671.1	199.9	0.0124	1.57	69.47
1.A.1. Energy Industries / b. Petroleum Refining / Gaseous Fuels	CO2	13.8	1 086.0	0.0115	1.46	70.93
5A1 Forest Land remaining Forest Land	CO2	-3 118.1	-3 536.7	0.0108	1.37	72.31
1.A.4 Other Sectors / b. Residential / Solid Fuels	CO2	1 759.2	492.4	0.0100	1.27	73.57
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Gaseous Fuels	CO2	2 519.3	2 932.4	0.0096	1.21	74.78
5B2 Land converted to Cropland	CO2	112.8	944.4	0.0091	1.16	75.94
1.A.2 Manufacturing Industries and Construction / f. Other / Liquid Fuels	CO2	3 063.8	1 642.2	0.0090	1.14	77.09

2B. Chemical Industry / 1. Ammonia Production	CO2	422.7	1 133.6	0.0085	1.07	78.16
2B. Chemical Industry / 5. Other / Other non-specified	CO2	224.2	953.1	0.0083	1.05	79.21
2F1. Refrigeration and Air Conditioning Equipment	HFC-134a		759.3	0.0081	1.03	80.24
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Gaseous Fuels	CO2	67.0	809.2	0.0081	1.03	81.27
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Liquid Fuels	CO2	2 490.1	1 290.1	0.0078	0.99	82.25
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Liquid Fuels	CO2	878.4	56.0	0.0070	0.89	83.15
1.A.2 Manufacturing Industries and Construction / f. Other / Gaseous Fuels	CO2	2 555.6	2 708.1	0.0068	0.87	84.01
2F1. Refrigeration and Air Conditioning Equipment	HFC-143a		600.3	0.0064	0.82	84.83
5C2 Land converted to Grassland	CO2	73.7	-539.4	0.0064	0.81	85.64
2F1. Refrigeration and Air Conditioning Equipment	HFC-125		577.4	0.0062	0.78	86.43
1.A.2 Manufacturing Industries and Construction / f. Other / Solid Fuels	CO2	2 537.3	1 543.9	0.0055	0.70	87.12
2B. Chemical Industry / 5. Other / Caprolactam	N2O	372.0	754.5	0.0049	0.62	87.74
2E1 By-product Emissions / Other	C2F6	506.7		0.0044	0.56	88.30
1.A.2 Manufacturing Industries and Construction / f. Other / Other Fuels	CO2	186.5	554.6	0.0043	0.55	88.84
5E2 Land converted to Settlements	CO2	248.0	578.8	0.0041	0.51	89.36
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco / Solid Fuels	CO2	637.9	139.3	0.0040	0.51	89.87
1.A.1. Energy Industries / a. Public Electricity and Heat Production / Liquid Fuels	CO2	659.3	160.3	0.0040	0.51	90.38
2A. Mineral Products / 1. Cement Production	CO2	2 823.8	2 642.6	0.0038	0.48	90.86
1.A.2 Manufacturing Industries and Construction / c. Chemicals / Solid Fuels	CO2	396.7	3.308	0.0034	0.43	91.29
5A2 Land converted to Forest Land	CO2	-19.7	-307.4	0.0031	0.40	91.69
4A1 Non-Dairy Cattle	CH4	2 172.0	2 044.0	0.0030	0.39	92.07
6C Waste Incineration	CO2	287.8	517.6	0.0030	0.39	92.46
2E1 By-product Emissions / Other	CF4	323.7	0.605	0.0028	0.36	92.82
2A. Mineral Products / 3. Limestone and Dolomite Use	CO2	428.2	101.9	0.0026	0.33	93.15
1. B. 1. a. Coal Mining and Handling	CH4	298.8		0.0026	0.33	93.48
2E2 Fugitive Emissions	C5F12	287.8	0.0156	0.0025	0.32	93.80
4B8 Swine	CH4	1 065.4	1 081.0	0.0023	0.30	94.09
1.A.4 Other Sectors / a. Commercial and institutional / Liquid Fuels	CO2	2 290.1	1 642.4	0.0023	0.29	94.38
4A1 Dairy Cattle	CH4	1 808.2	1 264.1	0.0022	0.27	94.65
4D3 Indirect Emissions	N2O	1 248.4	810.7	0.0022	0.27	94.93

5C1 Grassland remaining Grassland	CO2	680.39	351.43	0.0021	0.27	95.20
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries / Solid Fuels	CO2	207.85	19.37	0.0016	0.20	95.40
2E1 By-product Emissions / Other	C4F10	180.61		0.0016	0.20	95.60
2E2 Fugitive Emissions	C4F10	20.07	161.97	0.0016	0.20	95.80
1.A.3 Transport / d. Navigation	CO2	398.23	462.90	0.0015	0.19	95.99
2E1 By-product Emissions / Other	C3F8	171.05		0.0015	0.19	96.18
2E2 Fugitive Emissions	C6F14	229.78	49.43	0.0015	0.19	96.36
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Liquid Fuels	CO2	218.17	49.69	0.0014	0.17	96.53
4D1 Direct Soil Emissions	N2O	2 567.19	1 961.35	0.0013	0.16	96.70
5B2 Land converted to Cropland	N2O	8.33	106.50	0.0011	0.14	96.83
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Other Fuels	CO2		95.22	0.0010	0.13	96.96
6B2 Waste Water Handling/Domestic and Commercial Waste Water	CH4	210.41	78.87	0.0010	0.12	97.09
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel / Gaseous Fuels	CO2	1 485.42	1 112.22	0.0010	0.12	97.21
1.A.3 Transport / c. Railways	CO2	224.06	92.66	0.0010	0.12	97.33
1.A.5 Other / b. Mobile / Military use	CO2	165.30	45.28	0.0010	0.12	97.45
2A. Mineral Products / 2. Lime Production	CO2	2 097.12	1 611.91	0.0009	0.12	97.57
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Gaseous Fuels	CO2	259.52	296.10	0.0009	0.12	97.69
1.A.3 Transport / b. Road Transportation	N2O	203.60	250.22	0.0009	0.12	97.80
5F2 Land converted to Other Land	CO2	28.23	106.81	0.0009	0.11	97.92
6B2 Waste Water Handling/Domestic and Commercial Waste Water	N2O	293.49	309.26	0.0008	0.10	98.01
1.A.3 Transport / b. Road Transportation	CH4	101.09	14.90	0.0007	0.09	98.10
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Liquid Fuels	CO2	232.15	121.27	0.0007	0.09	98.19
2F4. Aerosols/Metered Dose Inhalers	HFC-134a		66.01	0.0007	0.09	98.28
1.A.1. Energy Industries / b. Petroleum Refining / Liquid Fuels	CO2	4 285.35	3 528.74	0.0006	0.08	98.36
4D2 Pasture, Range and Paddock Manure	N2O	991.73	753.11	0.0005	0.07	98.43
1.A.2 Manufacturing Industries and Construction / f. Other	N2O	75.53	111.25	0.0005	0.07	98.50
1.A.4 Other Sectors / a. Commercial and institutional / Other Fuels	CO2	30.70	73.82	0.0005	0.07	98.56
2F2. Foam Blowing	HFC-134a		48.72	0.0005	0.07	98.63
1. B. 2. b. Natural Gas	CH4	518.87	373.56	0.0005	0.06	98.69
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Solid Fuels	CO2	145.98	77.70	0.0004	0.06	98.75

5D2 Land converted to Wetlands	CO2	20.55	-23.00	0.0004	0.05	98.80
1.A.1. Energy Industries / a. Public Electricity and Heat Production	N2O	51.31	80.79	0.0004	0.05	98.86
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	CH4	50.61	2.06	0.0004	0.05	98.91
4A8 Swine	CH4	211.06	209.66	0.0004	0.05	98.96
1.A.2 Manufacturing Industries and Construction / a. Iron and Steel	N2O	63.43	89.63	0.0004	0.05	99.01
2F1. Refrigeration and Air Conditioning Equipment	HFC-32		38.11	0.0004	0.05	99.07
1.A.1. Energy Industries / b. Petroleum Refining	N2O	129.21	67.10	0.0004	0.05	99.12
2F2. Foam Blowing	HFC-152a		36.95	0.0004	0.05	99.17
1.A.4 Other Sectors / b. Residential	CH4	226.93	220.27	0.0004	0.05	99.22
2A. Mineral Products / 7. Other / Ceramics	CO2	135.72	146.37	0.0004	0.05	99.27
2F9. Other	SF6	83.62	103.97	0.0004	0.05	99.31
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Gaseous Fuels	CO2	280.38	199.28	0.0003	0.04	99.35
2A. Mineral Products / 7. Other / Glass Production	CO2	266.16	188.37	0.0003	0.04	99.39
2E1 By-product Emissions / Other	C5F12	33.58		0.0003	0.04	99.43
5B1 Cropland remaining Cropland	CO2	1 126.00	937.39	0.0003	0.03	99.46
1.A.1. Energy Industries / a. Public Electricity and Heat Production	CH4	10.45	33.38	0.0003	0.03	99.49
1. B. 2. c. 2. Flaring	CO2	83.83	92.02	0.0003	0.03	99.53
6D Other (compost production)	CH4	2.17	23.93	0.0002	0.03	99.56
1. B. 1. b. Solid Fuel Transformation	CH4	30.79	4.84	0.0002	0.03	99.58
4B1 Non-Dairy Cattle	CH4	125.60	120.93	0.0002	0.03	99.61
3D Other / use of N2O	N2O	204.40	182.88	0.0002	0.02	99.63
1.A.3 Transport / a. Civil Aviation	CO2	12.88	26.87	0.0002	0.02	99.66
4B1 Dairy Cattle	CH4	224.44	166.84	0.0002	0.02	99.68
2C. Metal Production / 1. Iron and Steel Production	CH4		14.78	0.0002	0.02	99.70
4B (sheep, goats, horses, poultry, mules and asses)	CH4	22.49	32.12	0.0001	0.02	99.72
4B Manure Management (AWMS)	N2O	961.77	765.70	0.0001	0.02	99.73
1.A.4 Other Sectors / a. Commercial and institutional	CH4	12.95	23.09	0.0001	0.02	99.75
2B. Chemical Industry / 5. Other / Other non-specified	N2O	9.30	19.58	0.0001	0.02	99.77
1.A.4 Other Sectors / b. Residential	N2O	54.78	56.09	0.0001	0.02	99.78
1.A.4 Other Sectors / b. Residential / Other Fuels	CO2	20.69	5.67	0.0001	0.02	99.80

4A (sheep, goats, horses, mules and asses)	CH4	41.22	43.62	0.0001	0.01	99.81
PFC, HFC, SF6 Emissions from Semiconductor Manufacturing	PFC, HFC, SF6		10.21	0.0001	0.01	99.83
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	N2O	4.29	13.47	0.0001	0.01	99.84
2F3. Fire Extinguishers	HFC-227ea		9.44	0.0001	0.01	99.85
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print / Solid Fuels	CO2	124.95	109.96	0.0001	0.01	99.86
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	CH4	26.42	12.93	0.0001	0.01	99.88
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals / Other Fuels	CO2		7.69	0.0001	0.01	99.89
1.A.3 Transport / c. Railways	N2O	12.87	4.12	0.0001	0.01	99.90
1.A.4 Other Sectors / c. Agriculture/Forestry/Fisheries	N2O	40.23	38.79	0.0001	0.01	99.90
1.A.4 Other Sectors / a. Commercial and institutional / Solid Fuels	CO2	8.83	1.17	0.0001	0.01	99.91
1.A.2 Manufacturing Industries and Construction / d. Pulp, Paper and Print	CH4	2.64	7.28	0.0001	0.01	99.92
2F8. Electrical Equipment	SF6	7.75	11.02	0.0001	0.01	99.93
1.A.3 Transport / e. Other Transportation (please specify)(5)	N2O	6.71	10.12	0.0001	0.01	99.93
2B. Chemical Industry / 5. Other / Other non-specified	CH4		4.27	0.0000	0.01	99.94
5A1 Forest Land remaining Forest Land	N2O	4.87		0.0000	0.01	99.94
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Liquid Fuels	CO2	4.42		0.0000	0.00	99.95
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	CH4	7.08	2.20	0.0000	0.00	99.95
4D4 Other/sludge spreading	N2O		3.38	0.0000	0.00	99.96
1.A.2 Manufacturing Industries and Construction / c. Chemicals	CH4	7.81	9.47	0.0000	0.00	99.96
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	N2O	7.60	3.44	0.0000	0.00	99.97
1.A.3 Transport / e. Other Transportation (please specify)(5)	CO2	225.33	185.14	0.0000	0.00	99.97
1.A.4 Other Sectors / a. Commercial and institutional	N2O	7.45	8.51	0.0000	0.00	99.97
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries	N2O	3.10	0.06	0.0000	0.00	99.98
1.A.3 Transport / d. Navigation	N2O	15.40	10.06	0.0000	0.00	99.98
6C Waste Incineration	N2O	2.75	0.06	0.0000	0.00	99.98
1.A.1. Energy Industries / c. Manufacture of Solid Fuels and Other Energy Industries / Gaseous Fuels	CO2	2.59		0.0000	0.00	99.98
1. B. 2. a. Oil	CH4	9.56	5.75	0.0000	0.00	99.99
1.A.2 Manufacturing Industries and Construction / c. Chemicals	N2O	8.18	4.67	0.0000	0.00	99.99
2F1. Refrigeration and Air Conditioning Equipment	C3F8		1.94	0.0000	0.00	99.99
1.A.2 Manufacturing Industries and Construction / e. Food Processing, Beverages and Tobacco	CH4	3.73	4.21	0.0000	0.00	99.99

2F3. Fire Extinguishers	HFC-125		0.85	0.0000	0.00	100.00
1.A.5 Other / b. Mobile / Military use	N2O	2.12	0.91	0.0000	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-227ea		0.46	0.0000	0.00	100.00
2F4. Aerosols/Metered Dose Inhalers	HFC-152a		0.39	0.0000	0.00	100.00
5A1 Forest Land remaining Forest Land	CH4	0.48		0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / f. Other	CH4	16.98	14.10	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	N2O	1.28	0.70	0.0000	0.00	100.00
1. B. 2. c. 1. Venting	CH4		0.21	0.0000	0.00	100.00
2F9. Other	C6F14		0.18	0.0000	0.00	100.00
1.A.3 Transport / c. Railways	CH4	0.30	0.13	0.0000	0.00	100.00
1.A.2 Manufacturing Industries and Construction / b. Non-Ferrous Metals	CH4	0.90	0.79	0.0000	0.00	100.00
1.A.5 Other / b. Mobile / Military use	CH4	0.06	0.09	0.0000	0.00	100.00
1. B. 2. b. Natural Gas	CO2	0.61	0.45	0.0000	0.00	100.00
2F1. Refrigeration and Air Conditioning Equipment	HFC-152a		0.03	0.0000	0.00	100.00
1.A.3 Transport / d. Navigation	CH4	0.37	0.27	0.0000	0.00	100.00
1.A.3 Transport / a. Civil Aviation	CH4	0.03	0.04	0.0000	0.00	100.00
1.A.3 Transport / e. Other Transportation (please specify)(5)	CH4	0.07	0.04	0.0000	0.00	100.00
1. B. 2. a. Oil	CO2	0.01	0.02	0.0000	0.00	100.00
1.A.3 Transport / a. Civil Aviation	N2O	0.14	0.12	0.0000	0.00	100.00
2B. Chemical Industry / 1. Ammonia Production	CH4	0.01	0.01	0.0000	0.00	100.00

Key source according "trend analysis with Lulucf"

Annex 2: Uncertainty analysis - 2012

IPCC source category	Gas	Base year emissions (1990) Sub 2014 Gg CO2 eq	Year t emissions : 2012 Gg CO2 eq	Activity data uncertainty (%)	Emission factor uncertainty (%)	Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Combined uncertainty squared	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emision factor uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions	Uncertainty introduced into the trend in total national emissions Squared
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CO2	2 750.936	8 499.555	1	1	1.414213562	0.104397125	0.01089876	0.04411571	0.05980644	0.04411571	0.084579079	0.095392958	0.009099816
1.A.1.a. Public Electricity and Heat Production - Biomass	CH4	0.888	10.186	20	75	77.62087348	0.006867197	4.71584E-05	6.66122E-05	7.16763E-05	0.004995917	0.002027311	0.005391584	2.90692E-05
1.A.1.a. Public Electricity and Heat Production - Biomass	N2O	9.356	49.415	20	500	500.3998401	0.214758253	0.046121107	0.000294364	0.000347702	0.147181868	0.009834496	0.147510066	0.02175922
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	CH4	0.590	4.775	1	100	100.0049999	0.004147777	1.72041E-05	3.02367E-05	3.36022E-05	0.003023672	4.75207E-05	0.003024046	9.14485E-06
1.A.1.a. Public Electricity and Heat Production - Gaseous Fuels	N2O	5.054	16.080	1	500	500.001	0.069829922	0.004876218	8.43369E-05	0.000113148	0.042168463	0.000160015	0.042168767	0.001778205
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CO2	659.330	160.263	1	2	2.236067977	0.003112392	9.68698E-06	-0.002630826	0.001127674	-0.005261652	0.001594772	0.005498025	3.02283E-05
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	CH4	0.553	0.035	1	100	100.0049999	3.02117E-05	9.12745E-10	-2.90647E-06	2.44753E-07	-0.000290647	3.46133E-07	0.000290648	8.4476E-08
1.A.1.a. Public Electricity and Heat Production - Liquid Fuels	N2O	0.682	0.061	1	500	500.001	0.000263944	6.96666E-08	-3.4626E-06	4.27677E-07	-0.001731298	6.04826E-07	0.001731298	2.99739E-06
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CO2	714.274	1 869.215	5	10	11.18033989	0.181506209	0.032944504	0.009080276	0.013152578	0.090802763	0.093002772	0.12997945	0.016894657
1.A.1.a. Public Electricity and Heat Production - Other Fuels	CH4	0.00000000	16.448	5	75	75.16648189	0.010737604	0.000115296	0.000115733	0.000115733	0.008679982	0.000818357	0.008718475	7.60118E-05
1.A.1.a. Public Electricity and Heat Production - Other Fuels	N2O	3.108	10.483	5	500	500.0249994	0.04552707	0.002072714	5.6049E-05	7.37653E-05	0.0280245	0.0005216	0.028029354	0.000785645
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CO2	19 344.871	7 326.785	1	5	5.099019514	0.324472184	0.105282198	-0.05864463	0.051554338	-0.293223148	0.072908843	0.302151476	0.091295514
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	CH4	8.418	1.933	1	100	100.0049999	0.00167859	2.81766E-06	-3.43874E-05	1.35987E-05	-0.003438736	1.92315E-05	0.00343879	1.18253E-05
1.A.1.a. Public Electricity and Heat Production - Solid Fuels	N2O	33.112	4.755	1	500	500.001	0.020648329	0.000426353	-0.000155301	3.34571E-05	-0.077650351	4.73155E-05	0.077650365	0.006029579
1.A.1.b. Petroleum Refining - Gaseous Fuels	CO2	13.823	1 085.972	1	1	1.414213562	0.013338623	0.000177919	0.00756255	0.007641356	0.00756255	0.010806509	0.013189875	0.000173973
1.A.1.b. Petroleum Refining - Gaseous Fuels	N2O	129.213	67.104	5	50	50.24937811	0.02928562	0.000857648	-0.000264426	0.00047217	-0.013221323	0.003338744	0.01363637	0.000185951
1.A.1.b. Petroleum Refining - Liquid Fuels	CO2	4 285.347	3 528.741	5	2	5.385164807	0.165042614	0.027239065	0.000400215	0.024829702	0.000800431	0.175572507	0.175574331	0.030826346
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CO2	2.592	0.00000000	1	1	1.414213562	0	0	-1.47768E-05	0	-1.47768E-05	0	1.47768E-05	2.18353E-10
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	CH4	0.005	0.00000000	1	100	100.0049999	0	0	-2.7796E-08	0	-2.7796E-06	0	2.7796E-06	7.72619E-12
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Gaseous Fuels	N2O	0.001	0.00000000	1	500	500.001	0	0	-8.20645E-09	0	-4.10322E-06	0	4.10322E-06	1.68364E-11
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CO2	4.423	0.00000000	5	2	5.385164807	0	0	-2.52162E-05	0	-5.04324E-05	0	5.04324E-05	2.54342E-09
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	CH4	0.002	0.00000000	5	75	75.16648189	0	0	-1.30856E-08	0	-9.81418E-07	0	9.81418E-07	9.63181E-13
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Liquid Fuels	N2O	0.011	0.00000000	5	500	500.0249994	0	0	-6.39453E-08	0	-3.19727E-05	0	3.19727E-05	1.02225E-09
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CO2	2 015.938	224.900	1	2	2.236067977	0.004367695	1.90768E-05	-0.009908308	0.001582493	-0.019816616	0.002237983	0.019942588	0.000397707
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	CH4	7.074	2.199	1	50	50.009999	0.000955248	9.12499E-07	-2.48487E-05	1.54751E-05	-0.001242436	2.18851E-05	0.001242629	1.54413E-06
1.A.1.c. Manuf.of Solid Fuels and Other Energ.Ind. - Solid Fuels	N2O	3.090	0.059	1	500	500.001	0.000255778	6.54225E-08	-1.72009E-05	4.14445E-07	-0.008600425	5.86114E-07	0.008600425	7.39673E-05
1.A.2.a. Iron and Steel - Gaseous Fuels	CO2	1 485.424	1 112.220	2	1	2.236067977	0.02159996	0.000466558	-0.000641806	0.007826045	-0.000641806	0.022135399	0.022144701	0.000490388
1.A.2.a. Iron and Steel - Gaseous Fuels	CH4	1.609	1.218	2	75	75.02666193	0.000793944	6.30347E-07	-5.99183E-07	8.57331E-06	-4.49387E-05	2.4249E-05	5.10637E-05	2.6075E-09
1.A.2.a. Iron and Steel - Gaseous Fuels	N2O	0.508	0.419	2	500	500.004	0.001817382	3.30288E-06	4.65194E-08	2.94474E-06	2.32597E-05	8.32899E-06	2.4706E-05	6.10385E-10

1.A.2.a. Iron and Steel - Liquid Fuels	CO2	878.434	56.006	2	2	2.828427125	0.001375813	1.89286E-06	-0.004613298	0.000394084	-0.009226595	0.001114638	0.00929368	8.63725E-05
1.A.2.a. Iron and Steel - Liquid Fuels	CH4	0.420	0.027	2	75	75.02666193	1.73509E-05	3.01053E-10	-2.20812E-06	1.87361E-07	-0.000165609	5.29938E-07	0.00016561	2.74266E-08
1.A.2.a. Iron and Steel - Liquid Fuels	N2O	1.860	0.118	2	500	500.004	0.000512086	2.62232E-07	-9.77351E-06	8.29743E-07	-0.004886754	2.34687E-06	0.004886755	2.38804E-05
1.A.2.a. Iron and Steel - Solid Fuels	CO2	11 062.073	3 209.407	2	5	5.385164807	0.150107069	0.022532132	-0.040447045	0.022582736	-0.202235224	0.063873623	0.212082355	0.044978925
1.A.2.a. Iron and Steel - Solid Fuels	CH4	48.577	0.811	2	75	75.02666193	0.000528201	2.78997E-07	-0.000271219	5.70372E-06	-0.020341447	1.61326E-05	0.020341454	0.000413775
1.A.2.a. Iron and Steel - Solid Fuels	N2O	61.064	89.079	2	500	500.004	0.386833171	0.149639902	0.000278688	0.000626794	0.139343875	0.00177284	0.139355153	0.019419859
1.A.2.a. Iron and Steel - Biomass	CH4	0.000	0.007	20	75	77.62087348	4.77039E-06	2.27566E-11	4.97908E-08	4.97908E-08	3.73431E-06	1.4083E-06	3.99104E-06	1.59284E-11
1.A.2.a. Iron and Steel - Biomass	N2O	0.000	0.014	20	500	500.3998401	6.04926E-05	3.65936E-09	9.79399E-08	9.79399E-08	4.897E-05	2.77016E-06	4.90483E-05	2.40573E-09
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CO2	259.517	296.100	2	1	2.236067977	0.005750436	3.30675E-05	0.000604052	0.002083484	0.000604052	0.005892983	0.005923861	3.50921E-05
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	CH4	0.488	0.557	2	75	75.02666193	0.000362904	1.31699E-07	1.13597E-06	3.91877E-06	8.5198E-05	1.1084E-05	8.5916E-05	7.38155E-09
1.A.2.b. Non-Ferrous Metals - Gaseous Fuels	N2O	0.145	0.165	2	500	500.004	0.000717539	5.14862E-07	3.36459E-07	1.16264E-06	0.00016823	3.28845E-06	0.000168262	2.8312E-08
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CO2	218.168	49.691	2	2	2.828427125	0.001220667	1.49003E-06	-0.000894044	0.000349644	-0.001788088	0.000988944	0.002043347	4.17527E-06
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	CH4	0.121	0.027	2	75	75.02666193	1.78323E-05	3.17992E-10	-4.95024E-07	1.9256E-07	-3.71268E-05	5.44643E-07	3.71308E-05	1.37869E-09
1.A.2.b. Non-Ferrous Metals - Liquid Fuels	N2O	0.530	0.119	2	500	500.004	0.00051851	2.68852E-07	-2.18387E-06	8.40152E-07	-0.001091936	2.37631E-06	0.001091938	1.19233E-06
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CO2	145.977	77.705	5	5	7.071067812	0.004772095	2.27729E-05	-0.000285403	0.000546762	-0.001427015	0.003866193	0.004121143	1.69838E-05
1.A.2.b. Non-Ferrous Metals - Solid Fuels	CH4	0.289	0.154	5	75	75.16648189	0.000100496	1.00994E-08	-5.65409E-07	1.08317E-06	-4.24057E-05	7.6592E-06	4.30918E-05	1.85691E-09
1.A.2.b. Non-Ferrous Metals - Solid Fuels	N2O	0.598	0.318	5	500	500.0249994	0.001381612	1.90885E-06	-1.16851E-06	2.23856E-06	-0.000584256	1.5829E-05	0.000584471	3.41606E-07
1.A.2.b. Non-Ferrous Metals - Other fuels	CO2	0.00000000	7.685	5	10	11.18033989	0.000746236	5.56868E-07	5.40749E-05	5.40749E-05	0.000540749	0.000382367	0.000662279	4.38614E-07
1.A.2.b. Non-Ferrous Metals - Other fuels	CH4	0.00000000	0.048	5	75	75.16648189	3.16072E-05	9.99015E-10	3.40672E-07	3.40672E-07	2.55504E-05	2.40891E-06	2.56637E-05	6.58625E-10
1.A.2.b. Non-Ferrous Metals - Other fuels	N2O	0.00000000	0.095	5	500	500.0249994	0.000413842	1.71265E-07	6.70529E-07	6.70529E-07	0.000335264	4.74135E-06	0.000335298	1.12425E-07
1.A.2.b. Non-Ferrous Metals - Biomass	CH4	0.003	0.001	20	75	77.62087348	5.91202E-07	3.49519E-13	-8.56376E-09	6.17066E-09	-6.42282E-07	1.74533E-07	6.65573E-07	4.42988E-13
1.A.2.b. Non-Ferrous Metals - Biomass	N2O	0.005	0.002	20	500	500.3998401	7.50163E-06	5.62744E-11	-1.68556E-08	1.21454E-08	-8.42782E-06	3.43524E-07	8.43481E-06	7.11461E-11
1.A.2.c. Chemicals - Gaseous Fuels	CO2	2 519.326	2 932.444	2	1	2.236067977	0.056949783	0.003243278	0.00627094	0.020633908	0.00627094	0.058361505	0.058697444	0.00344539
1.A.2.c. Chemicals - Gaseous Fuels	CH4	4.824	5.517	2	75	75.02666193	0.003594776	1.29224E-05	1.13172E-05	3.88178E-05	0.000848789	0.000109793	0.000855861	7.32498E-07
1.A.2.c. Chemicals - Gaseous Fuels	N2O	1.424	1.628	2	500	500.004	0.007069744	4.99813E-05	3.33992E-06	1.14553E-05	0.00166996	3.24003E-05	0.001670274	2.78982E-06
1.A.2.c. Chemicals - Liquid Fuels	CO2	1 835.135	277.629	2	2	2.828427125	0.006820035	4.65129E-05	-0.008506896	0.001953512	-0.017013791	0.005525365	0.017888509	0.000319999
1.A.2.c. Chemicals - Liquid Fuels	CH4	1.014	0.164	2	75	75.02666193	0.000106925	1.14329E-08	-4.62398E-06	1.15462E-06	-0.000346799	3.26575E-06	0.000346814	1.2028E-07
1.A.2.c. Chemicals - Liquid Fuels	N2O	4.395	0.678	2	500	500.004	0.002946074	8.67935E-06	-2.02785E-05	4.77358E-06	-0.010139266	1.35017E-05	0.010139275	0.000102805
1.A.2.c. Chemicals - Other Fuels	CO2	1 833.634	3 612.442	20	20	28.28427125	0.887407787	0.787492581	0.014963784	0.02541866	0.299275672	0.718948278	0.778750637	0.606452554
1.A.2.c. Chemicals - Other Fuels	CH4	1.165	3.688	20	75	77.62087348	0.002486412	6.18224E-06	1.93085E-05	2.59519E-05	0.001448134	0.00073403	0.001623543	2.63589E-06
1.A.2.c. Chemicals - Other Fuels	N2O	0.688	2.178	20	500	500.3998401	0.00946432	8.95733E-05	1.14003E-05	1.53231E-05	0.005700154	0.000433403	0.005716607	3.26796E-05
1.A.2.c. Chemicals - Solid Fuels	CO2	396.702	3.308	5	5	7.071067812	0.000203166	4.12765E-08	-0.002238129	2.32777E-05	-0.011190643	0.000164599	0.011191853	0.000125258
1.A.2.c. Chemicals - Solid Fuels	CH4	0.811	0.008	5	75	75.16648189	4.93541E-06	2.43583E-11	-4.57027E-06	5.31953E-08	-0.00034277	3.76148E-07	0.000342771	1.17492E-07
1.A.2.c. Chemicals - Solid Fuels	N2O	1.677	0.016	5	500	500.0249994	6.73133E-05	4.53108E-09	-9.45211E-06	1.09065E-07	-0.004726054	7.71203E-07	0.004726054	2.23356E-05
1.A.2.c. Chemicals - Biomass	CH4	0.00000000	0.091	20	75	77.62087348	6.13199E-05	3.76013E-09	6.40026E-07	6.40026E-07	4.80019E-05	1.81027E-05	5.1302E-05	2.63189E-09
1.A.2.c. Chemicals - Biomass	N2O	0.00000000	0.166	20	500	500.3998401	0.000719693	5.17958E-07	1.16521E-06	1.16521E-06	0.000582605	3.29571E-05	0.000583537	3.40515E-07
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CO2	280.375	199.276	2	1	2.236067977	0.003870062	1.49774E-05	-0.000196131	0.001402191	-0.000196131	0.003965996	0.003970843	1.57676E-05
1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	CH4	0.528	0.375	2	75	75.02666193	0.000244325	5.96946E-08	-3.68979E-07	2.63831E-06	-2.76734E-05	7.46228E-06	2.86619E-05	8.21502E-10

1.A.2.d. Pulp, Paper and Print - Gaseous Fuels	N2O	0.155	0.111	2	500	500.004	0.000481803	2.32134E-07	-1.04717E-07	7.80675E-07	-5.23587E-05	2.20808E-06	5.24052E-05	2.74631E-09
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CO2	232.155	121.268	5	2	5.385164807	0.005671815	3.21695E-05	-0.000470139	0.000853292	-0.000940277	0.006033683	0.006106509	3.72894E-05
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	CH4	0.143	0.093	5	75	75.16648189	6.08349E-05	3.70088E-09	-1.57348E-07	6.55697E-07	-1.18011E-05	4.63647E-06	1.26792E-05	1.60763E-10
1.A.2.d. Pulp, Paper and Print - Liquid Fuels	N2O	0.567	0.292	5	500	500.0249994	0.001269001	1.61036E-06	-1.17518E-06	2.0561E-06	-0.000587589	1.45388E-05	0.000587768	3.45472E-07
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CO2	124.952	109.958	5	5	7.071067812	0.00675287	4.56013E-05	6.13991E-05	0.000773709	0.000306996	0.005470951	0.005479557	3.00256E-05
1.A.2.d. Pulp, Paper and Print - Solid Fuels	CH4	0.283	0.249	5	75	75.16648189	0.000162603	2.64399E-08	1.39081E-07	1.75259E-06	1.04311E-05	1.23927E-05	1.61983E-05	2.62386E-10
1.A.2.d. Pulp, Paper and Print - Solid Fuels	N2O	0.585	0.515	5	500	500.0249994	0.002235464	4.9973E-06	2.87434E-07	3.62202E-06	0.000143717	2.56115E-05	0.000145981	2.13106E-08
1.A.2.d. Pulp, Paper and Print - Other Fuels	CO2	0.00000000	95.219	5	10	11.18033989	0.009246063	8.54897E-05	0.000670002	0.000670002	0.006700023	0.004737631	0.008205818	6.73355E-05
1.A.2.d. Pulp, Paper and Print - Other Fuels	CH4	0.00000000	0.600	5	75	75.16648189	0.000391622	1.53367E-07	4.22101E-06	4.22101E-06	0.000316576	2.98471E-05	0.00031798	1.01111E-07
1.A.2.d. Pulp, Paper and Print - Other Fuels	N2O	0.00000000	1.181	5	500	500.0249994	0.005127613	2.62924E-05	8.30803E-06	8.30803E-06	0.004154014	5.87466E-05	0.004154429	1.72593E-05
1.A.2.d. Pulp, Paper and Print - biomass	CH4	1.687	5.964	20	75	77.62087348	0.004020925	1.61678E-05	3.23505E-05	4.19684E-05	0.002426288	0.001187044	0.002701102	7.29595E-06
1.A.2.d. Pulp, Paper and Print - biomass	N2O	2.982	11.374	20	500	500.3998401	0.049429945	0.002443319	6.30284E-05	8.0029E-05	0.031514218	0.002263562	0.031595405	0.00099827
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	680.706	1 763.688	2	1	2.236067977	0.03425186	0.00117319	0.008529159	0.012410051	0.008529159	0.035100925	0.036122313	0.001304822
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	1.281	3.079	2	75	75.02666193	0.002006263	4.02509E-06	1.43641E-05	2.16644E-05	0.00107731	6.12762E-05	0.001079051	1.16435E-06
1.A.2.e. Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0.379	0.978	2	500	500.004	0.004247129	1.80381E-05	4.71968E-06	6.88171E-06	0.002359839	1.94644E-05	0.00235992	5.56922E-06
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	1 671.114	199.881	6	2	6.32455532	0.010979432	0.000120548	-0.008119069	0.00140645	-0.016238139	0.011934124	0.020151934	0.0004061
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	0.919	0.123	6	75	75.23961722	8.01234E-05	6.41976E-09	-4.37384E-06	8.62754E-07	-0.000328038	7.32071E-06	0.00032812	1.07663E-07
1.A.2.e. Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	4.067	0.484	6	500	500.0359987	0.002101953	4.41821E-06	-1.97775E-05	3.40562E-06	-0.009888733	2.88976E-05	0.009888775	9.77879E-05
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CO2	637.890	139.272	5	5	7.071067812	0.008553152	7.31564E-05	-0.002656308	0.000979976	-0.013281538	0.00692948	0.014980552	0.000224417
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	CH4	1.436	0.315	5	75	75.16648189	0.000205743	4.23301E-08	-5.97094E-06	2.21756E-06	-0.00044782	1.56805E-05	0.000448095	2.00789E-07
1.A.2.e. Food Processing, Beverages and Tobacco - Solid Fuels	N2O	2.969	0.651	5	500	500.0249994	0.002828542	8.00065E-06	-1.23399E-05	4.58295E-06	-0.006169968	3.24064E-05	0.006170053	3.80696E-05
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	CH4	0.093	0.698	20	75	77.62087348	0.000470678	2.21538E-07	4.38494E-06	4.9127E-06	0.00032887	0.000138952	0.00035702	1.27463E-07
1.A.2.e. Food Processing, Beverages and Tobacco - Biomass	N2O	0.182	1.326	20	500	500.3998401	0.005764849	3.32335E-05	8.29475E-06	9.33351E-06	0.004147374	0.000263992	0.004155767	1.72704E-05
1.A.2.f. Other manufact. Industr. and Constr. - Gaseous Fuels	CO2	2 555.634	2 708.052	2	1	2.236067977	0.052591953	0.002765914	0.004485348	0.019054989	0.004485348	0.053895649	0.054081968	0.002924859
1.A.2.f. Other manufact. Industr. and Constr. - Gaseous Fuels	CH4	5.606	4.738	2	75	75.02666193	0.003087619	9.53339E-06	1.3857E-06	3.33413E-05	0.000103927	9.43034E-05	0.000140335	1.9694E-08
1.A.2.f. Other manufact. Industr. and Constr. - Gaseous Fuels	N2O	1.419	1.504	2	500	500.004	0.006531507	4.26606E-05	2.49187E-06	1.05831E-05	0.001245934	2.99336E-05	0.001246294	1.55325E-06
1.A.2.f. Other manufact. Industr. and Constr. - Liquid Fuels	CO2	3 063.849	1 642.168	8	2	8.246211251	0.117611361	0.013832432	-0.005909745	0.011554981	-0.011819491	0.130729686	0.131262908	0.017229951
1.A.2.f. Other manufact. Industr. and Constr. - Liquid Fuels	CH4	4.807	2.915	8	75	75.42545989	0.00190942	3.64588E-06	-6.8917E-06	2.05096E-05	-0.000516878	0.00023204	0.000566573	3.21005E-07
1.A.2.f. Other manufact. Industr. and Constr. - Liquid Fuels	N2O	61.585	73.284	8	500	500.0639959	0.318282542	0.101303776	0.00016458	0.000515658	0.08229025	0.005834003	0.082496792	0.006805721
1.A.2.f. Other manufact. Industr. and Constr. - Solid Fuels	CO2	2 537.316	1 543.886	5	5	7.071067812	0.094815117	0.008989906	-0.003600336	0.010863431	-0.018001678	0.076816054	0.07889719	0.006224767
1.A.2.f. Other manufact. Industr. and Constr. - Solid Fuels	CH4	6.565	1.795	5	75	75.16648189	0.001171671	1.37281E-06	-2.4795E-05	1.26286E-05	-0.001859622	8.92978E-05	0.001861765	3.46617E-06
1.A.2.f. Other manufact. Industr. and Constr. - Solid Fuels	N2O	12.513	9.537	5	500	500.0249994	0.041417866	0.00171544	-4.22618E-06	6.71074E-05	-0.002113089	0.000474521	0.002165714	4.69031E-06
1.A.2.f. Other manufact. Industr. and Constr. - Other Fuels	CO2	186.456	554.558	5	5	7.071067812	0.034057207	0.001159893	0.002839137	0.0039021	0.014195684	0.027592017	0.031029612	0.000962837
1.A.2.f. Other manufact. Industr. and Constr. - Other Fuels	CH4	0.00043953	1.639	5	5	7.071067812	0.000100658	1.0132E-08	1.15304E-05	1.15329E-05	5.76519E-05	8.15498E-05	9.98705E-05	9.97411E-09
1.A.2.f. Other manufact. Industr. and Constr. - Other Fuels	N2O	0.00012977	11.286	5	500	500.0249994	0.049012648	0.00240224	7.94121E-05	7.94129E-05	0.039706062	0.000561534	0.039710033	0.001576887
1.A.2.f. Other manufact. Industr. and Constr. - biomass	CH4	0.005	3.010	20	75	77.62087348	0.002029489	4.11883E-06	2.11527E-05	2.11828E-05	0.001586452	0.000599139	0.001695818	2.8758E-06
1.A.2.f. Other manufact. Industr. and Constr. - biomass	N2O	0.010	15.639	20	500	500.3998401	0.067966345	0.004619424	0.000109981	0.00011004	0.054990483	0.003112405	0.055078493	0.00303364
1.A.3.a. Civil Aviation - Aviation Gasoline	CO2	8.054	2.143	7.5	5	9.013878189	0.000167798	2.81562E-08	-3.08321E-05	1.50817E-05	-0.000154161	0.000159965	0.000222158	4.93544E-08

1.A.3.a. Civil Aviation - Aviation Gasoline	CH4	0.027	0.039	7.5	140	140.2007489	4.79858E-05	2.30263E-09	1.2456E-07	2.77292E-07	1.74384E-05	2.94112E-06	1.76847E-05	3.12749E-10
1.A.3.a. Civil Aviation - Aviation Gasoline	N2O	0.022	0.016	7.5	500	500.0562468	6.92768E-05	4.79928E-09	-1.21539E-08	1.12239E-07	-6.07696E-06	1.19047E-06	6.19247E-06	3.83467E-11
1.A.3.a. Civil Aviation - Jet Kerosene	CO2	4.825	24.727	7.5	5	9.013878189	0.001935777	3.74723E-06	0.000146481	0.000173987	0.000732403	0.001845416	0.00198544	3.94197E-06
1.A.3.a. Civil Aviation - Jet Kerosene	CH4	0.005	0.005	7.5	140	140.2007489	5.88132E-06	3.45899E-11	3.05813E-09	3.39859E-08	4.28138E-07	3.60475E-07	5.59682E-07	3.13244E-13
1.A.3.a. Civil Aviation - Jet Kerosene	N2O	0.114	0.099	7.5	500	500.0562468	0.000430832	1.85616E-07	4.88626E-08	6.98013E-07	2.44313E-05	7.40354E-06	2.55284E-05	6.517E-10
1.A.3.b. Road Transportation - Diesel Oil	CO2	10 963.771	20 250.834	5	2	5.385164807	0.947151047	0.897095106	0.079930827	0.14249337	0.159861655	1.00758028	1.020183204	1.04077377
1.A.3.b. Road Transportation - Diesel Oil	CH4	18.811	3.914	5	40	40.31128874	0.001370429	1.87808E-06	-7.96951E-05	2.75426E-05	-0.003187803	0.000194755	0.003193747	1.02E-05
1.A.3.b. Road Transportation - Diesel Oil	N2O	61.655	222.172	5	100	100.124922	0.193200646	0.03732649	0.001211817	0.001563294	0.121181667	0.011054161	0.121684802	0.014807191
1.A.3.b. Road Transportation - Gasoline	CO2	8 360.613	3 446.341	5	2	5.385164807	0.161188695	0.025981795	-0.023397455	0.024249902	-0.046794909	0.171472704	0.177743218	0.031592652
1.A.3.b. Road Transportation - Gasoline	CH4	81.441	9.746	5	40	40.31128874	0.003412272	1.16436E-05	-0.000395688	6.8579E-05	-0.015827502	0.000484927	0.015834929	0.000250745
1.A.3.b. Road Transportation - Gasoline	N2O	140.983	14.115	5	100	100.124922	0.01227468	0.000150668	-0.000704367	9.93213E-05	-0.07043669	0.000702308	0.070440191	0.004961821
1.A.3.b. Road Transportation - LPG	CO2	162.675	192.290	5	2	5.385164807	0.008993589	8.08846E-05	0.000425674	0.001353033	0.000851347	0.009567389	0.009605193	9.22597E-05
1.A.3.b. Road Transportation - LPG	CH4	0.838	0.381	5	40	40.31128874	0.00013342	1.78009E-08	-2.09491E-06	2.68144E-06	-8.37964E-05	1.89607E-05	8.59147E-05	7.38134E-09
1.A.3.b. Road Transportation - LPG	N2O	0.964	1.266	5	100	100.124922	0.001100844	1.21186E-06	3.41294E-06	8.90755E-06	0.000341294	6.29859E-05	0.000347057	1.20449E-07
1.A.3.b. Road Transportation - Gaseous fuels	CO2	0.00000000	0.802	5	2	5.385164807	3.75099E-05	1.40699E-09	5.64315E-06	5.64315E-06	1.12863E-05	3.99031E-05	4.14685E-05	1.71964E-09
1.A.3.b. Road Transportation - Gaseous fuels	CH4	0.00000000	0.006	5	40	40.31128874	2.14918E-06	4.61899E-12	4.31938E-08	4.31938E-08	1.72775E-06	3.05426E-07	1.75454E-06	3.07841E-12
1.A.3.b. Road Transportation - Gaseous fuels	N2O	0.00000000	0.002	5	100	100.124922	1.71945E-06	2.95649E-12	1.3913E-08	1.3913E-08	1.3913E-06	9.83798E-08	1.39477E-06	1.94539E-12
1.A.3.b. Road Transportation - Biomass	CH4	0.00000000	0.849	5	40	40.31128874	0.000297353	8.84189E-08	5.97613E-06	5.97613E-06	0.000239045	4.22576E-05	0.000242752	5.89284E-08
1.A.3.b. Road Transportation - Biomass	N2O	0.00000000	12.662	5	100	100.124922	0.01101064	0.000121234	8.90932E-05	8.90932E-05	0.008909325	0.000629984	0.00893157	7.97729E-05
1.A.3.c. Railways - Liquid Fuels	CO2	224.059	92.663	6	2	6.32455532	0.005089931	2.59074E-05	-0.000625266	0.000652013	-0.001250532	0.005532515	0.005672085	3.21725E-05
1.A.3.c. Railways - Liquid Fuels	CH4	0.299	0.126	6	100	100.1798383	0.000109437	1.19765E-08	-8.19298E-07	8.85032E-07	-8.19298E-05	7.50974E-06	8.22733E-05	6.76889E-09
1.A.3.c. Railways - Liquid Fuels	N2O	12.867	4.119	6	125	125.1439172	0.004476912	2.00427E-05	-4.43671E-05	2.8983E-05	-0.005545883	0.000245929	0.005551333	3.08173E-05
1.A.3.d. Navigation - Gas/Diesel Oil	CO2	398.229	462.904	10	2	10.19803903	0.041000129	0.001681011	0.000986988	0.003257189	0.001973976	0.046063609	0.046105885	0.002125753
1.A.3.d. Navigation - Gas/Diesel Oil	CH4	0.373	0.270	10	75	75.66372975	0.000177599	3.15414E-08	-2.26154E-07	1.90163E-06	-1.69616E-05	2.68932E-05	3.17953E-05	1.01094E-09
1.A.3.d. Navigation - Gas/Diesel Oil	N2O	15.401	10.061	10	125	125.399362	0.010957688	0.000120071	-1.70011E-05	7.07943E-05	-0.002125141	0.001001182	0.002349168	5.51859E-06
1.A.3.e. Other Transportation - Gaseous Fuels	CO2	196.510	120.651	5	1	5.099019514	0.005343118	2.85489E-05	-0.000271285	0.000848951	-0.000271285	0.006002988	0.006009115	3.61095E-05
1.A.3.e. Other Transportation - Gaseous Fuels	CH4	0.022	0.013	5	75	75.16648189	8.49957E-06	7.22426E-11	-3.48374E-08	9.16108E-08	-2.61281E-06	6.47787E-07	2.69191E-06	7.24638E-12
1.A.3.e. Other Transportation - Gaseous Fuels	N2O	3.274	1.922	5	500	500.0249994	0.008346542	6.96648E-05	-5.14226E-06	1.35235E-05	-0.00257113	9.56256E-05	0.002572908	6.61985E-06
1.A.3.e. Other Transportation - Liquid Fuels	CO2	28.819	64.485	10	2	10.19803903	0.005711509	3.26213E-05	0.000289455	0.000453742	0.000578911	0.006416876	0.006442936	4.15114E-05
1.A.3.e. Other Transportation - Liquid Fuels	CH4	0.043	0.026	10	75	75.66372975	1.6846E-05	2.83789E-10	-6.43147E-08	1.80378E-07	-4.8236E-06	2.55093E-06	5.45659E-06	2.97744E-11
1.A.3.e. Other Transportation - Liquid Fuels	N2O	3.440	8.197	10	125	125.399362	0.008926912	7.96898E-05	3.80665E-05	5.7674E-05	0.004758307	0.000815634	0.004827706	2.33067E-05
1.A.4.a. Commercial / Institutional - Biomass	CH4	0.00000000	3.539	20	75	77.62087348	0.002385804	5.69206E-06	2.49018E-05	2.49018E-05	0.001867635	0.000704329	0.001996031	3.98414E-06
1.A.4.a. Commercial / Institutional - Biomass	N2O	0.00000000	0.852	20	500	500.3998401	0.003703501	1.37159E-05	5.99611E-06	5.99611E-06	0.002998056	0.000169596	0.003002849	9.0171E-06
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CO2	1 923.817	4 193.936	4	1	4.123105626	0.15018398	0.022555228	0.018540733	0.029510296	0.018540733	0.166935442	0.167961902	0.0282112
1.A.4.a. Commercial / Institutional - Gaseous Fuels	CH4	3.619	7.890	4	75	75.10659092	0.005146864	2.64902E-05	3.48856E-05	5.55187E-05	0.002616422	0.000314061	0.002635203	6.9443E-06
1.A.4.a. Commercial / Institutional - Gaseous Fuels	N2O	1.069	2.330	4	500	500.0159997	0.010118974	0.000102394	1.03004E-05	1.63956E-05	0.005150197	9.27474E-05	0.005151032	2.65331E-05
1.A.4.a. Commercial / Institutional - Liquid Fuels	CO2	2 290.059	1 642.434	10	2	10.19803903	0.14547281	0.021162338	-0.001497786	0.011556853	-0.002995573	0.163438576	0.163466025	0.026721141
1.A.4.a. Commercial / Institutional - Liquid Fuels	CH4	6.549	4.564	10	75	75.66372975	0.002998958	8.99375E-06	-5.22192E-06	3.21112E-05	-0.000391644	0.000454121	0.000599676	3.59611E-07

1.A.4.a. Commercial / Institutional - Liquid Fuels	N2O	5.793	3.927	10	500	500.09999	0.017055804	0.0002909	-5.39213E-06	2.76306E-05	-0.002696067	0.000390755	0.002724237	7.42147E-06
1.A.4.a. Commercial / Institutional - Other Fuels	CO2	30.702	73.822	20	20	28.28427125	0.018134509	0.00032886	0.000344416	0.00051944	0.006888328	0.014691976	0.016226621	0.000263303
1.A.4.a. Commercial / Institutional - Other Fuels	CH4	2.759	7.099	20	75	77.62087348	0.004785985	2.29057E-05	3.42239E-05	4.99537E-05	0.002566789	0.001412903	0.002929966	8.5847E-06
1.A.4.a. Commercial / Institutional - Other Fuels	N2O	0.543	1.397	20	500	500.3998401	0.006072838	3.68794E-05	6.73614E-06	9.83216E-06	0.003368069	0.000278095	0.00337953	1.14212E-05
1.A.4.a. Commercial / Institutional - Solid Fuels	CO2	8.833	1.171	15	5	15.8113883	0.000160856	2.58747E-08	-4.21121E-05	8.24218E-06	-0.000210561	0.000174843	0.000273689	7.49059E-08
1.A.4.a. Commercial / Institutional - Solid Fuels	CH4	0.020	0.003	15	75	76.4852927	1.76328E-06	3.10916E-12	-9.56419E-08	1.86775E-08	-7.17314E-06	3.96209E-07	7.18408E-06	5.1611E-11
1.A.4.a. Commercial / Institutional - Solid Fuels	N2O	0.042	0.005	15	500	500.2249494	2.38255E-05	5.67654E-10	-2.00853E-07	3.85879E-08	-0.000100427	8.18573E-07	0.00010043	1.00862E-08
1.A.4.b. Residential - Biomass	CH4	59.840	148.014	65	75	99.24716621	0.127585008	0.016277934	0.000700362	0.001041492	0.052527131	0.095737988	0.109201015	0.011924862
1.A.4.b. Residential - Biomass	N2O	11.777	29.135	65	500	504.2072986	0.127584247	0.01627774	0.000137867	0.000205004	0.06893363	0.018844764	0.07146307	0.00510697
1.A.4.b. Residential - Gaseous Fuels	CO2	5 824.228	8 098.638	4	1	4.123105626	0.290010556	0.084106122	0.023773654	0.05698542	0.023773654	0.322358218	0.323233673	0.104480007
1.A.4.b. Residential - Gaseous Fuels	CH4	10.957	15.236	4	75	75.10659092	0.009938598	9.87757E-05	4.47419E-05	0.000107207	0.003355645	0.000606452	0.003410006	1.16281E-05
1.A.4.b. Residential - Gaseous Fuels	N2O	3.235	4.498	4	500	500.0159997	0.019534548	0.000381599	1.32074E-05	3.16515E-05	0.006603706	0.000179048	0.006606133	4.3641E-05
1.A.4.b. Residential - Liquid Fuels	CO2	12 664.509	8 090.540	10	2	10.19803903	0.716591295	0.513503084	-0.015254195	0.056928438	-0.03050839	0.805089696	0.805667538	0.649100181
1.A.4.b. Residential - Liquid Fuels	CH4	36.671	23.553	10	75	75.66372975	0.015477995	0.000239568	-4.33183E-05	0.00016573	-0.003248875	0.002343777	0.004006056	1.60485E-05
1.A.4.b. Residential - Liquid Fuels	N2O	31.527	20.147	10	500	500.09999	0.087506772	0.007657435	-3.79642E-05	0.000141762	-0.018982117	0.002004815	0.019087693	0.00036434
1.A.4.b. Residential - Other Fuels	CO2	20.688	5.673	10	2	10.19803903	0.000502506	2.52512E-07	-7.80121E-05	3.99208E-05	-0.000156024	0.000564565	0.000585728	3.43077E-07
1.A.4.b. Residential - Other Fuels	CH4	0.033	0.009	10	75	75.66372975	5.9314E-06	3.51816E-11	-1.2411E-07	6.35103E-08	-9.30827E-06	8.98171E-07	9.3515E-06	8.74506E-11
1.A.4.b. Residential - Other Fuels	N2O	0.010	0.003	10	500	500.09999	1.15744E-05	1.33967E-10	-3.66421E-08	1.87507E-08	-1.8321E-05	2.65174E-07	1.8323E-05	3.35731E-10
1.A.4.b. Residential - Solid Fuels	CO2	1 759.177	492.362	15	5	15.8113883	0.067613213	0.004571547	-0.006563219	0.003464463	-0.032816093	0.073492368	0.080486173	0.006478024
1.A.4.b. Residential - Solid Fuels	CH4	119.430	33.459	15	75	76.4852927	0.022226601	0.000494022	-0.000445393	0.000235434	-0.033404506	0.004994313	0.033775793	0.001140804
1.A.4.b. Residential - Solid Fuels	N2O	8.228	2.305	15	500	500.2249494	0.01001579	0.000100316	-3.06861E-05	1.62216E-05	-0.015343048	0.000344113	0.015346907	0.000235528
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	CH4	0.00000000	3.412	20	75	77.62087348	0.002300157	5.29072E-06	2.40079E-05	2.40079E-05	0.001800589	0.000679045	0.001924376	3.70322E-06
1.A.4.c. Agriculture / Forestry / Fisheries - Biomass	N2O	0.00000000	0.715	20	500	500.3998401	0.003109242	9.66739E-06	5.03398E-06	5.03398E-06	0.002516992	0.000142383	0.002521016	6.35552E-06
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CO2	67.039	809.206	4	1	4.123105626	0.028977512	0.000839696	0.005311722	0.005693916	0.005311722	0.032209652	0.032644694	0.001065676
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	CH4	0.126	1.522	4	75	75.10659092	0.000992929	9.85907E-07	9.99173E-06	1.07106E-05	0.00074938	6.05884E-05	0.000751825	5.65241E-07
1.A.4.c. Agriculture / Forestry / Fisheries - Gaseous Fuels	N2O	0.037	0.449	4	500	500.0159997	0.001951625	3.80884E-06	2.94994E-06	3.16218E-06	0.00147497	1.7888E-05	0.001475078	2.17586E-06
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CO2	2 490.102	1 290.075	10	2	10.19803903	0.114263875	0.013056233	-0.005116853	0.009077509	-0.010233706	0.128375364	0.128782619	0.016584963
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	CH4	12.172	6.679	10	75	75.66372975	0.004388813	1.92617E-05	-2.23948E-05	4.69931E-05	-0.001679609	0.000664582	0.00180631	3.26276E-06
1.A.4.c. Agriculture / Forestry / Fisheries - Liquid Fuels	N2O	39.225	37.537	10	500	500.09999	0.163038657	0.026581604	4.05179E-05	0.000264124	0.02025897	0.00373528	0.020600441	0.000424378
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CO2	207.851	19.365	15	5	15.8113883	0.00265931	7.07193E-06	-0.001048616	0.000136262	-0.005243078	0.002890545	0.005987079	3.58451E-05
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	CH4	14.125	1.316	15	75	76.4852927	0.000874179	7.64189E-07	-7.126E-05	9.2597E-06	-0.005344497	0.000196428	0.005348106	2.86022E-05
1.A.4.c. Agriculture / Forestry / Fisheries - Solid Fuels	N2O	0.973	0.091	15	500	500.2249494	0.000393855	1.55122E-07	-4.90902E-06	6.3789E-07	-0.002454512	1.35317E-05	0.002454549	6.02481E-06
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CO2	165.299	45.278	20	2	20.09975124	0.0079041	6.24748E-05	-0.000623717	0.000318593	-0.001247434	0.00901117	0.009097103	8.27573E-05
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	CH4	0.055	0.087	20	75	77.62087348	5.84029E-05	3.4109E-09	2.95596E-07	6.09579E-07	2.21697E-05	1.72415E-05	2.80849E-05	7.88764E-10
1.A.5. Other (Not elsewhere specified) - Liquid Fuels	N2O	2.121	0.913	20	100	101.9803903	0.000808856	6.54249E-07	-5.6649E-06	6.42583E-06	-0.00056649	0.00018175	0.000594932	3.53944E-07
1. B. 1. a. Coal Mining and Handling	CH4	298.819	0.000	5	60	60.20797289	0	0	-0.001703432	0	-0.102205906	0	0.102205906	0.010446047
1.B.1.b. Fugitive Emissions - Solid Fuel Transformation	CH4	30.793	4.836	5	60	60.20797289	0.002528865	6.39516E-06	-0.000141513	3.40288E-05	-0.008490754	0.00024062	0.008494163	7.21508E-05
1.B.2.a. Fugitve Emissions - Oil	CO2	0.014	0.018	10	30	31.6227766	4.96921E-06	2.4693E-11	4.58127E-08	1.2731E-07	1.37438E-06	1.80043E-06	2.26505E-06	5.13047E-12

1.B.2.a. Fugitve Emissions - Oil	CH4	9.562	5.746	5	50	50.24937811	0.002507562	6.28787E-06	-1.40823E-05	4.04292E-05	-0.000704113	0.000285878	0.000759935	5.77501E-07
1.B.2.b. Fugitive Emissions - Natural Gas - Distribution-transmission	CH4	518.873	373.555	10	30	31.6227766	0.102596473	0.010526036	-0.000329418	0.002628493	-0.009882553	0.037172506	0.03846375	0.00147946
1.B.2.b. Fugitive Emissions - Natural Gas - Distribution-transmission	CO2	0.606	0.453	10	30	31.6227766	0.000124454	1.54889E-08	-2.66091E-07	3.18848E-06	-7.98272E-06	4.5092E-05	4.57931E-05	2.09701E-09
1.B.2.c Fugitive Emissions - Flaring	CO2	83.830	92.020	1	10	10.04987562	0.008031962	6.45124E-05	0.000169605	0.000647493	0.00169605	0.000915694	0.001927455	3.71508E-06
1.B.2.c Fugitive Emissions - Venting	CH4	0.00000000	0.207	5	50	50.24937811	9.01825E-05	8.13289E-09	1.45401E-06	1.45401E-06	7.27003E-05	1.02814E-05	7.34237E-05	5.39104E-09
2.A.1 Mineral products-cement	CO2	2 823.783	2 642.587	5	5	7.071067812	0.162289973	0.026338035	0.002496394	0.018594354	0.012481971	0.131481939	0.132073085	0.0174433
2.A.2 Mineral products-lime	CO2	2 097.116	1 611.910	5	2	5.385164807	0.075390587	0.005683741	-0.000612805	0.011342076	-0.00122561	0.080200585	0.08020995	0.006433636
2.A.3 Mineral Products-limestone and dolomite use	CO2	428.208	101.881	5	5	7.071067812	0.006256847	3.91481E-05	-0.001724143	0.000716877	-0.008620714	0.005069089	0.010000619	0.000100012
2.A.7 Mineral products-other	CO2	401.878	334.736	5	5	7.071067812	0.020557238	0.0004226	6.43636E-05	0.002355343	0.000321818	0.01665479	0.016657899	0.000277486
2.B.1. Chemical Industry - Ammonia Production	CO2	422.741	1 133.616	1.5	1.5	2.121320344	0.020885716	0.000436213	0.005566523	0.007976595	0.008349784	0.016920913	0.018868921	0.000356036
2.B.1. Chemical Industry - Ammonia Production	CH4	0.013	0.013	2	5	5.385164807	5.89314E-07	3.47291E-13	1.56333E-08	8.86589E-08	7.81664E-08	2.50765E-07	2.62666E-07	6.89932E-14
2.B.2. Chemical Industry - Nitric Acid Production	N2O	3 561.905	680.666	2	30	30.06659276	0.177744206	0.031593003	-0.015511919	0.00478945	-0.465357568	0.013546611	0.465554698	0.216741177
2.B.5. Chemical Industry - Production of caprolactam	N2O	372.000	754.540	2	30	30.06659276	0.197035199	0.03882287	0.003188526	0.00530926	0.095655789	0.015016856	0.096827351	0.009375536
2.B.5. Chemical Industry - others / other non specified	CO2	224.193	953.127	20	5	20.61552813	0.170656397	0.029123606	0.005428463	0.006706602	0.027142314	0.189691343	0.191623357	0.036719511
2.B.5. Chemical Industry - others / other non specified	CH4	0.00000000	4.269	20	75	77.62087348	0.002877691	8.28111E-06	3.00359E-05	3.00359E-05	0.002252689	0.000849542	0.002407557	5.79633E-06
2.B.5. Chemical Industry - others / other non specified	N2O	9.300	19.585	20	100	101.9803903	0.017346339	0.000300895	8.47889E-05	0.000137805	0.008478887	0.003897719	0.009331867	8.70837E-05
2.C.1. Iron and Steel Production	CO2	2 022.377	443.817	2	5	5.385164807	0.020757758	0.000430885	-0.008404833	0.003122884	-0.042024164	0.00883285	0.042942399	0.00184405
2.C.1. Iron and Steel Production	CH4	0.000	14.780	2	5	5.385164807	0.000691285	4.77875E-07	0.000104	0.000104	0.000519999	0.000294156	0.000597434	3.56927E-07
2.E.1. By-product emissions - Other	CF4	323.694	0.605	90	0	90	0.000472516	2.23271E-07	-0.001840975	4.25352E-06	0	0.000541384	0.000541384	2.93097E-07
2.E.1. By-product emissions - Other	C2F6	506.708	0.000	26	0	26	0	0	-0.002888476	0	0	0	0	0
2.E.1. By-product emissions - Other	C3F8	171.052	0.000	26	0	26	0	0	-0.0009751	0	0	0	0	0
2.E.1. By-product emissions - Other	C4F10	180.607	0.000	26	0	26	0	0	-0.001029568	0	0	0	0	0
2.E.1. By-product emissions - Other	C5F12	33.578	0.000	26	0	26	0	0	-0.000191414	0	0	0	0	0
2.E.1. By-product emissions - Other	SF6	1 559.356	0.000	26	0	26	0	0	-0.008888401	0	0	0	0	0
2.E.2. Fugitive emissions	C4F10	20.069	161.974	26	0	26	0.036575898	0.001337796	0.001025306	0.001139714	0	0.041906791	0.041906791	0.001756179
2.E.2. Fugitive emissions	C5F12	287.828	0.016	26	0	26	3.5227E-06	1.24094E-11	-0.001640668	1.09768E-07	0	4.03613E-06	4.03613E-06	1.62903E-11
2.E.2. Fugitive emissions	C6F14	229.785	49.432	26	0	26	0.011162433	0.0001246	-0.000962088	0.000347824	0	0.012789344	0.012789344	0.000163567
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-32	0.00000000	38.114		75	75	0.024827043	0.000616382	0.000268187	0.000268187	0.020114045	0	0.020114045	0.000404575
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-125	0.00000000	577.359		75	75	0.376083996	0.141439172	0.004062543	0.004062543	0.304690747	0	0.304690747	0.092836451
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-134a	0.00000000	759.316	100	117	154.1103501	1.016322963	1.032912365	0.005342867	0.005342867	0.626506661	0.755595463	0.981547299	0.9634351
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-152a	0.00000000	0.033		75	75	2.17239E-05	4.71927E-10	2.34666E-07	2.34666E-07	1.76E-05	0	1.76E-05	3.09759E-10
2.F.1. Refrigeration and Air Conditioning Equipment	HFC-143a	0.00000000	600.340		106	106.0660172	0.553032387	0.305844821	0.004224241	0.004224241	0.448048448	0	0.448048448	0.200747412
2.F.1. Refrigeration and Air Conditioning Equipment	C3F8	0.00000000	1.938		75	75	0.001262123	1.59296E-06	1.36337E-05	1.36337E-05	0.00102253	0	0.00102253	1.04557E-06
2.F.2. Foam blowing	HFC-134a	0.00000000	48.720	34	143	146.7140075	0.062080864	0.003854034	0.000342816	0.000342816	0.048963863	0.016261172	0.051593464	0.002661886
2.F.2. Foam blowing	HFC-152a	0.00000000	36.946	15	17	22.49444376	0.007218052	5.21003E-05	0.000259968	0.000259968	0.004357851	0.005514745	0.007028746	4.94033E-05
2.F.3. Fire extinguishers	HFC-125	0.00000000	0.846	10	50	50.99019514	0.000374825	1.40494E-07	5.95547E-06	5.95547E-06	0.000297773	8.4223E-05	0.000309455	9.57625E-08
2.F.3. Fire extinguishers	HFC-227ea	0.00000000	9.437	10	50	50.99019514	0.004179201	1.74657E-05	6.6402E-05	6.6402E-05	0.003320098	0.000939066	0.003450347	1.19049E-05
2.F.4. Aerosols/Metered Dose Inhalers	HFC-134a	0.00000000	66.009	25	206	207.6655966	0.119055144	0.014174127	0.00046447	0.00046447	0.095753022	0.016421508	0.09715095	0.009438307

2.F.4. Aerosols/Metered Dose Inhalers	HFC-152ea	0.00000000	0.393	25	50	55.90169944	0.00019058	3.63206E-08	2.76202E-06	2.76202E-06	0.000138101	9.7652E-05	0.000169138	2.86077E-08
2.F.4. Aerosols/Metered Dose Inhalers	HFC-227ea	0.00000000	0.464	25	50	55.90169944	0.000225279	5.07505E-08	3.2649E-06	3.2649E-06	0.000163245	0.000115432	0.000199933	3.99734E-08
2.F.7. Semiconductor Manufacture	HFC-23		2.216		100	100	0.001924612	3.70413E-06	1.55926E-05	1.55926E-05	0.001559257	0	0.001559257	2.43128E-06
2.F.7. Semiconductor Manufacture	HFC-32		0.000		100	100	0	0	0	0	0	0	0	0
2.F.7. Semiconductor Manufacture	CF4		3.598		100	100	0.003125264	9.76728E-06	2.53199E-05	2.53199E-05	0.002531985	0	0.002531985	6.41095E-06
2.F.7. Semiconductor Manufacture	C2F6		2.385		100	100	0.002071096	4.28944E-06	1.67793E-05	1.67793E-05	0.001677933	0	0.001677933	2.81546E-06
2.F.7. Semiconductor Manufacture	SF6		2.008		100	100	0.001743631	3.04025E-06	1.41263E-05	1.41263E-05	0.001412632	0	0.001412632	1.99553E-06
2.F.8. Electrical equipment	SF6	7.748	11.025		100	100	0.009575271	9.16858E-05	3.34081E-05	7.75757E-05	0.003340807	0	0.003340807	1.1161E-05
2.F.9. Other (Double glaze windows)	SF6	83.616	103.969	100.50	53.85	114.0175425	0.102956771	0.010600097	0.000254904	0.000731573	0.01372698	0.103976055	0.104878263	0.01099945
2.F.9. Other (other non specified)	C6F14		0.178	100.00	50.00	111.8033989	0.000172455	2.97407E-08	1.24967E-06	1.24967E-06	6.24834E-05	0.00017673	0.00018745	3.51376E-08
3.D. Use of N2O	N2O	204.397	182.875	3	100	100.0449899	0.158901197	0.02524959	0.000121584	0.001286786	0.012158431	0.005459369	0.013327871	0.000177632
4A1 Dairy Cattle	CH4	1 808.168	1 264.102	5	20	20.61552813	0.22633618	0.051228066	-0.00141284	0.008894754	-0.028256807	0.062895407	0.068951282	0.004754279
4A1 Non-Dairy Cattle	CH4	2 172.002	2 043.986	5	20	20.61552813	0.365973518	0.133936616	0.002000165	0.014382342	0.040003301	0.101698515	0.109283357	0.011942852
4A (sheep, goats, horses, mules and asses)	CH4	41.223	43.617	5	20	20.61552813	0.007809605	6.09899E-05	7.19105E-05	0.000306909	0.001438209	0.002170171	0.002603476	6.77809E-06
4A8 Swine	CH4	211.063	209.659	5	20	20.61552813	0.037539314	0.0014092	0.000272045	0.001475252	0.005440906	0.010431609	0.011765284	0.000138422
4B1 Dairy Cattle	CH4	224.441	166.840	10	40	41.23105626	0.059745004	0.003569465	-0.000105508	0.001173955	-0.004220306	0.016602234	0.017130241	0.000293445
4B1 Non-Dairy Cattle	CH4	125.604	120.934	10	40	41.23105626	0.043306159	0.001875423	0.000134915	0.000850941	0.005396618	0.012034128	0.013188772	0.000173944
4B (sheep, goats, horses, poultry, mules and asses)	CH4	22.490	32.125	10	40	41.23105626	0.011503845	0.000132338	9.78337E-05	0.000226044	0.003913349	0.003196745	0.005053066	2.55335E-05
4B8 Swine	CH4	1 065.355	1 080.974	10	40	41.23105626	0.387094473	0.149842131	0.001532829	0.007606186	0.061313164	0.107567709	0.123814846	0.015330116
4B Manure Management (AWMS)	N2O	961.771	765.705	10	90	90.55385138	0.602206902	0.362653153	-9.49114E-05	0.005387822	-0.008542023	0.076195305	0.07667262	0.005878691
4D1 Direct Soil Emissions	N2O	2 567.194	1 961.352	30	250	251.7935662	4.289211557	18.39733578	-0.000833687	0.013800895	-0.208421755	0.585522386	0.621511136	0.386276092
4D2 Pasture, Range and Paddock Manure	N2O	991.728	753.109	30	250	251.7935662	1.646947496	2.712436056	-0.000354303	0.005299191	-0.088575662	0.224825615	0.241644791	0.058392205
4D3 Indirect Emissions	N2O	1 248.416	810.744	30	250	251.7935662	1.772988715	3.143488984	-0.001411947	0.005704739	-0.35298679	0.242031564	0.427994103	0.183178952
4D4 Other/sludge spreading	N2O	0.000	3.380	30	250	251.7935662	0.007392433	5.46481E-05	2.37858E-05	2.37858E-05	0.005946442	0.001009145	0.006031463	3.63785E-05
5.A.1. Forest Land remaining Forest Land	CO2	-3 123.339	-3 536.673		21.6	21.6	-0.663477236	0.440202043	-0.007081939	-0.024885518	-0.152969889	0	0.152969889	0.023399787
5.A.1 biomass burning	CO2	5.24	0	30.00	50	58	0	0	-2.98595E-05	0	-0.001492975	0	0.001492975	2.22897E-06
5.A.1 biomass burning	CH4	0.48	0	30	70	76	0	0	-2.73622E-06	0	-0.000191535	0	0.000191535	3.66857E-08
5.A.1 biomass burning	N2O	4.87	0	30	70	76	0	0	-2.77693E-05	0	-0.001943853	0	0.001943853	3.77857E-06
5.A.2. Land converted to Forest Land	CO2	-19.698	-307.447		59.3	59.3	-0.158344264	0.025072906	-0.002051038	-0.002163326	-0.121626564	0	0.121626564	0.014793021
5.B.1. Cropland remaining Cropland	CO2	1 089.857	907.050		20.6	20.6	0.162284004	0.026336098	0.000169451	0.006382384	0.003490683	0	0.003490683	1.21849E-05
5.B.1 liming	CO2	36.14	30.34	100	50	112	0.029460137	0.0008679	7.44994E-06	0.000213479	0.000372497	0.030190421	0.030192719	0.0009116
5.B.2. Land converted to Cropland	CO2	112.786	944.394		28.5	28.5	0.23376276	0.054645028	0.006002146	0.006645151	0.171061164	0	0.171061164	0.029261922
5.B.2 N2O from conversion to cropland	N2O	8.33	106.50	18	150	151	0.139736599	0.019526317	0.000701893	0.000749357	0.105283978	0.019075512	0.106998089	0.011448591
5.C.1. Grassland remaining Grassland	CO2	652.443	331.215		23.4	23.4	0.067313619	0.004531123	-0.001388735	0.002330566	-0.03249641	0	0.03249641	0.001056017
5.C.1 biomass burning	CO2	0	0	30	100	104	0	0	0	0	0	0	0	0
5.C.1 biomass burning	CH4	0	0	30	100	104	0	0	0	0	0	0	0	0
5.C.1 biomass burning	N2O	0	0	30	100	104	0	0	0	0	0	0	0	0
5.C.1 liming	CO2	27.95	20.21	100	50	112	0.019626093	0.000385184	-1.7107E-05	0.000142218	-0.000855349	0.020112602	0.020130782	0.000405248

5.C.2. Land converted to Grassland	CO2	73.733	-539.445		57.9	57.9	-0.271271017	0.073587965	-0.00421607	-0.003795764	-0.244110455	0	0.244110455	0.059589914
5.D.1. Wetlands remaining Wetlands	CO2						0	0	0	0	0	0	0	0
5.D.2. Land converted to Wetlands	CO2	20.549	-23.003		45.9	45.9	-0.009170277	8.4094E-05	-0.000279007	-0.000161862	-0.012806406	0	0.012806406	0.000164004
5.E.1. Settlements remaining settlements	CO2						0	0	0	0	0	0	0	0
5.E.2. Land converted to Settlements	CO2	248.027	578.797		40.6	40.6	0.204093745	0.041654257	0.002658692	0.004072659	0.107942895	0	0.107942895	0.011651669
5.F.1. Other land remaining Other Land	CO2						0	0	0	0	0	0	0	0
5.F.2. Land converted to Other Land	CO2	28.235	106.807		70.7	70.7	0.065583765	0.00430123	0.000590581	0.000751539	0.041754063	0	0.041754063	0.001743402
6.A.1. Solid Waste Disposal on Land - Managed Waste Disposal	CH4	2 449.681	578.604	30	40	50	0.251263304	0.063133248	-0.009891825	0.004071303	-0.395672981	-0.296754736	0.494591227	0.244620481
6.B.2. Wastewater Handling - Domestic and Commercial Wastew.	CH4	210.407	78.870	20	70	72.80109889	0.049868506	0.002486868	-0.000644488	0.000554961	-0.045114162	0.015696681	0.047766865	0.002281673
6.B.2. Wastewater Handling - Domestic and Commercial Wastew.	N2O	293.494	309.258	20	110	111.8033989	0.300298693	0.090179305	0.000502945	0.00217607	0.055323921	0.061548552	0.082758447	0.006848961
6.C.1 Waste incineration / Biogenic	CH4	0.000	0.000	20	75	77.62087348	0	0	0	0	0	0	0	0
6.C.1 Waste incineration / Biogenic	N2O	1.456	0.027	20	500	500.3998401	0.000119247	1.42197E-08	-8.10499E-06	1.93065E-07	-0.004052495	5.4607E-06	0.004052499	1.64227E-05
6.C.2 Waste incineration / Other	CO2	271.245	7.172	7.071067812	24.04163056	25.05992817	0.001560974	2.43664E-06	-0.001495783	5.0465E-05	-0.035961058	0.00050465	0.035964599	0.001293452
6.C.2 Waste incineration / Other	N2O	1.289	0.035	7.071067812	141.4213562	141.5980226	4.25119E-05	1.80726E-09	-7.1074E-06	2.43236E-07	-0.001005138	2.43236E-06	0.001005141	1.01031E-06
6.C.2 Flaring in the chemical industry	CO2	16.599	510.409	20	20	28.28427125	0.125383576	0.015721041	0.003496822	0.003591452	0.069936437	0.101581603	0.123328534	0.015209927
6.D. Composting	CH4	2.174	23.929	30	200	202.2374842	0.042029845	0.001766508	0.000155982	0.000168372	0.031196341	0.00714343	0.032003754	0.00102424
Emissions totales	**(kt eq-CO2)**	142 117.727	115 139.056											
Incertitudes totales				Overall uncertainty in the year (%)				5.525400519			Trend uncertainty (%)			2.349688207

Annex 3: Supplementary documents attached to the Belgian National Inventory Report

- National CRF tables (CRF Reporter) for the years 1990-2012 and KP tables for the years 2008-2012.

- Saturday Paper 'Potential Problems and Further Questions from the ERT formulated in the course of the 2013 review of the greenhouse gas inventories of Belgium submitted in 2013' of September 28, 2013 with the responses of Belgium to the Saturday Paper.
- 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 copy of the model used to calculate the CH_4 emissions from enteric fermentation en manure management (category 4A en 4B(a)) in Flanders (CH4model_2012_Flanders.xls), Wallonia (N2O and CH4 emissions Belgium-Wallonia submission 2014.xlsx) and Brussels (agri_RBC_database_140115final.xls)).

- A copy of the model used to calculate the direct and indirect N_2O emissions (category 4D) and the N_2O emissions from manure management (category 4B(b)) in Flanders (N2Omodel_2012_Flanders.xls), Wallonia (N2O and CH4 emissions Belgium-Wallonia submission 2014.xlsx) and Brussels (agri_RBC_database_140115final.xls).

- Information related to the calculation of the Manure Balance in Flanders (Manure Balance data_Flanders_2011.doc).

- Information related to SENTWA model (SENTWA.doc) used in Flanders.

- Information related to the transactions of Kyoto-units in Belgium: the secured SEF (standard electronic format) in attached file "SEF_BE_2014_2_14-18-55 10-1-2014.xls".

- National Inventory System of April 2010.

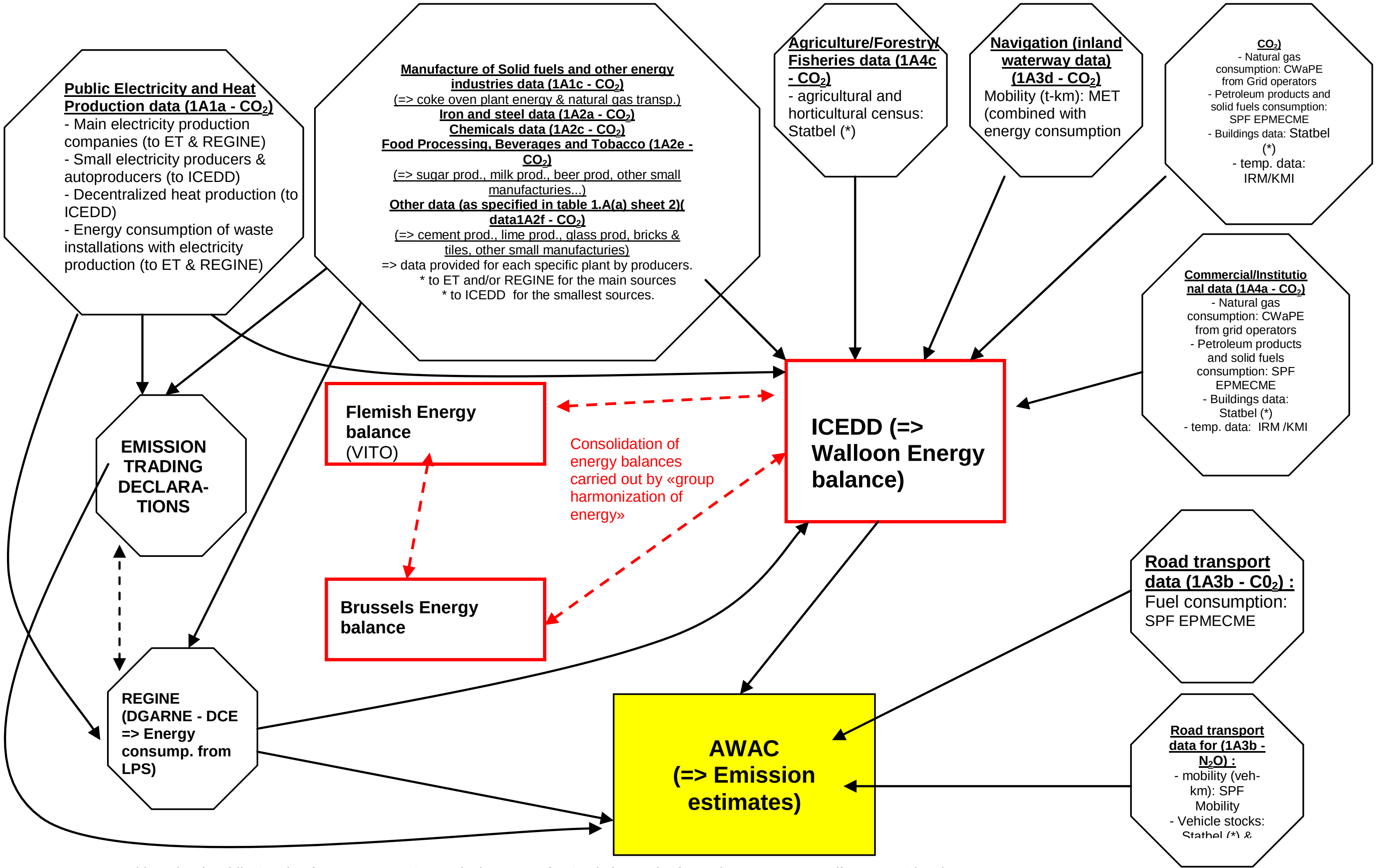
- Belgian QA/QC-plan of April 2010.

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	42,7
lamp petroleum	43,12
residual fuel oil	40,6
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)

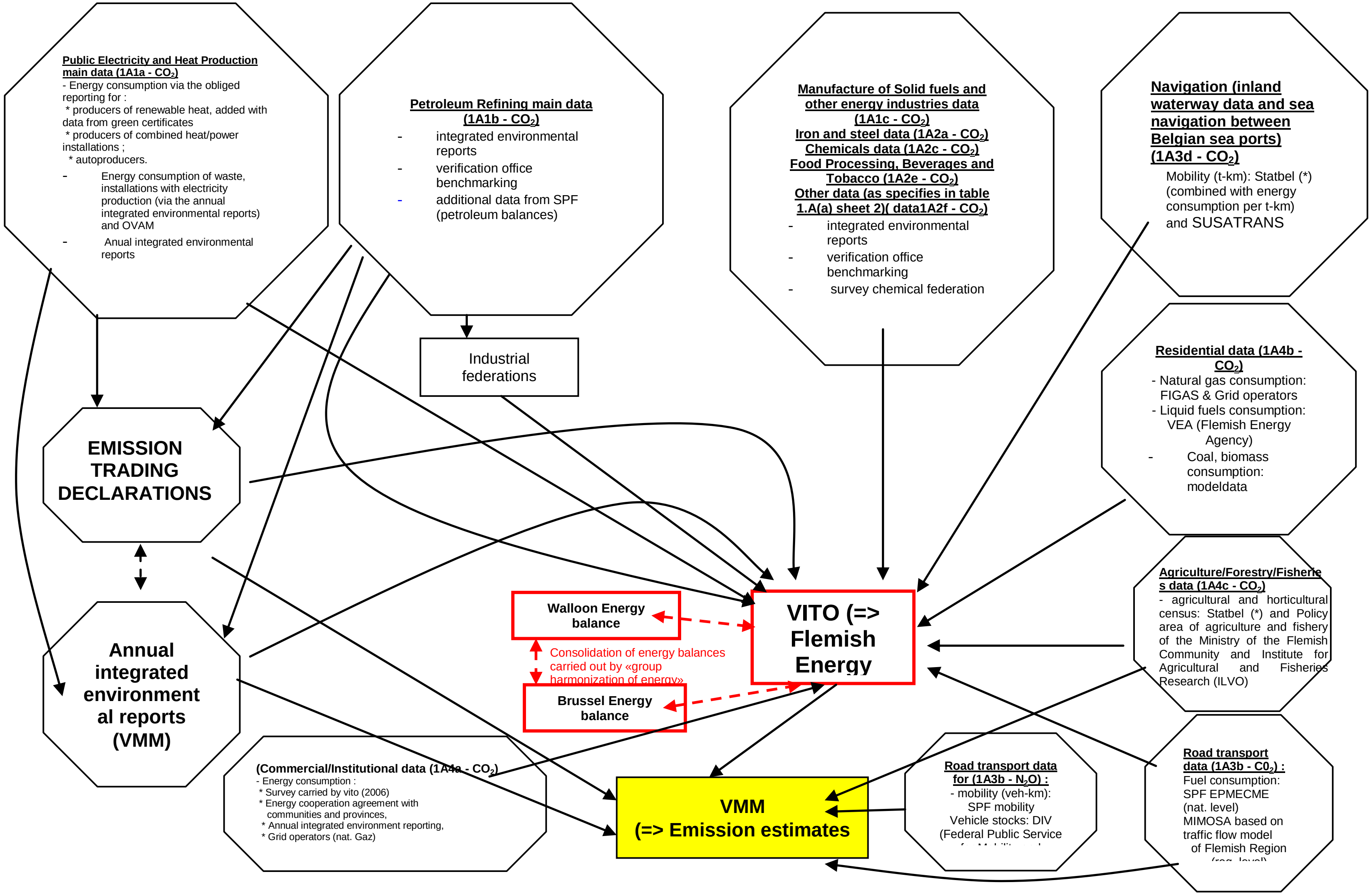
Annex 5: Key sources: flows of activity data

ENERGY- Key Sources - flow of activity data Wallonia

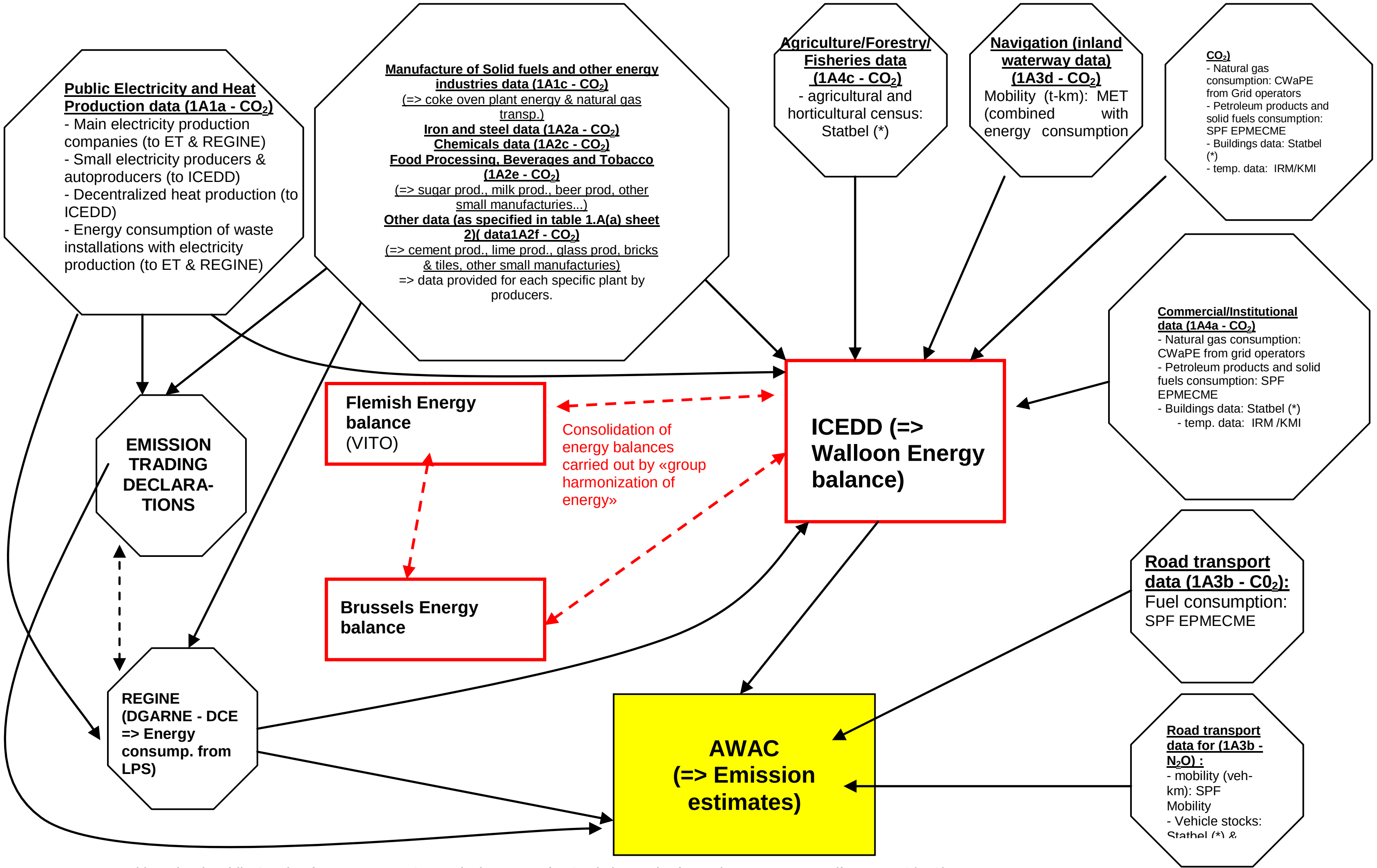


(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

ENERGY- Key Sources - flow of activity data - Flanders

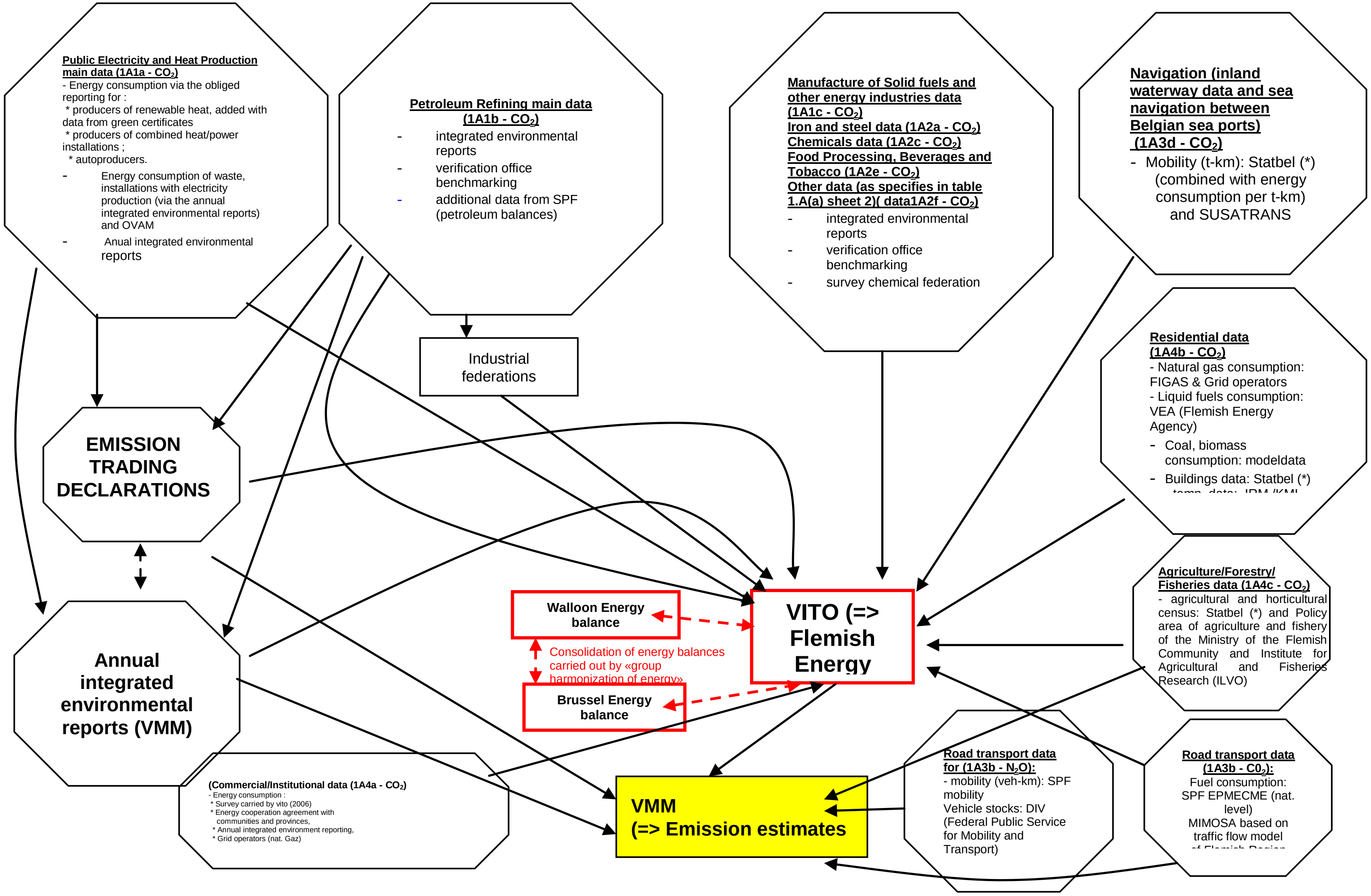


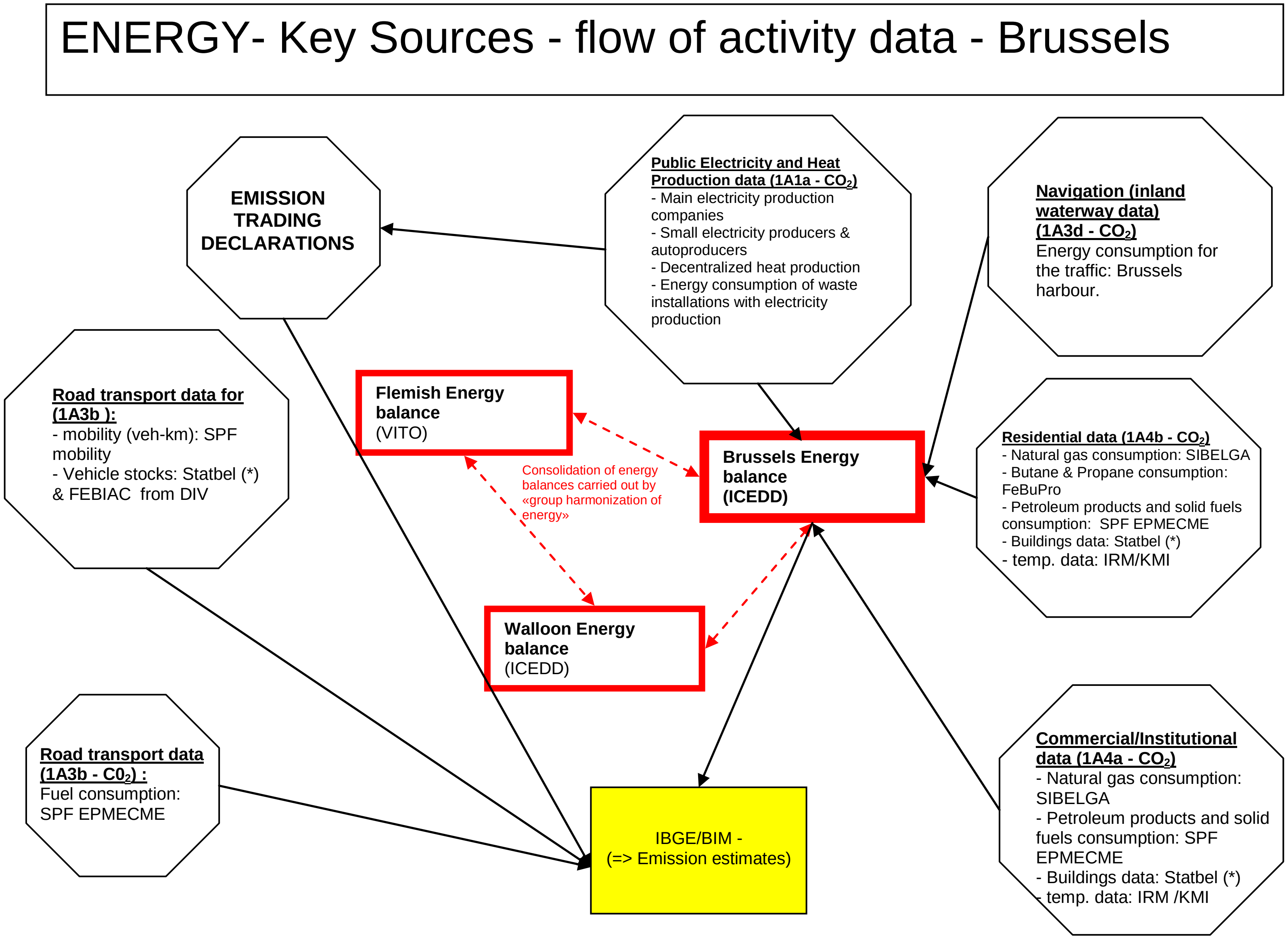
ENERGY- Key Sources - flow of activity data Wallonia



(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

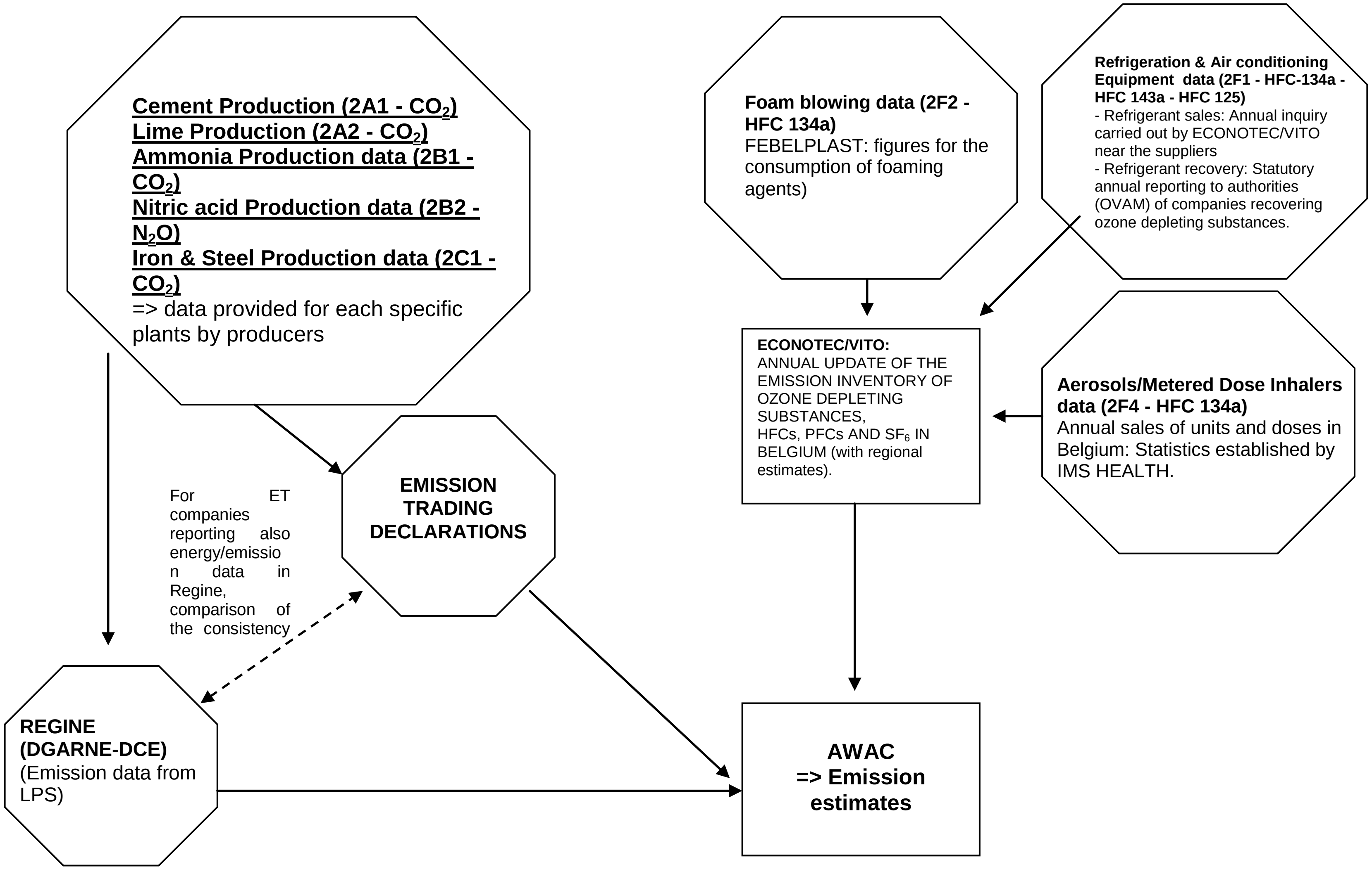
ENERGY- Key Sources - flow of activity data - Flanders



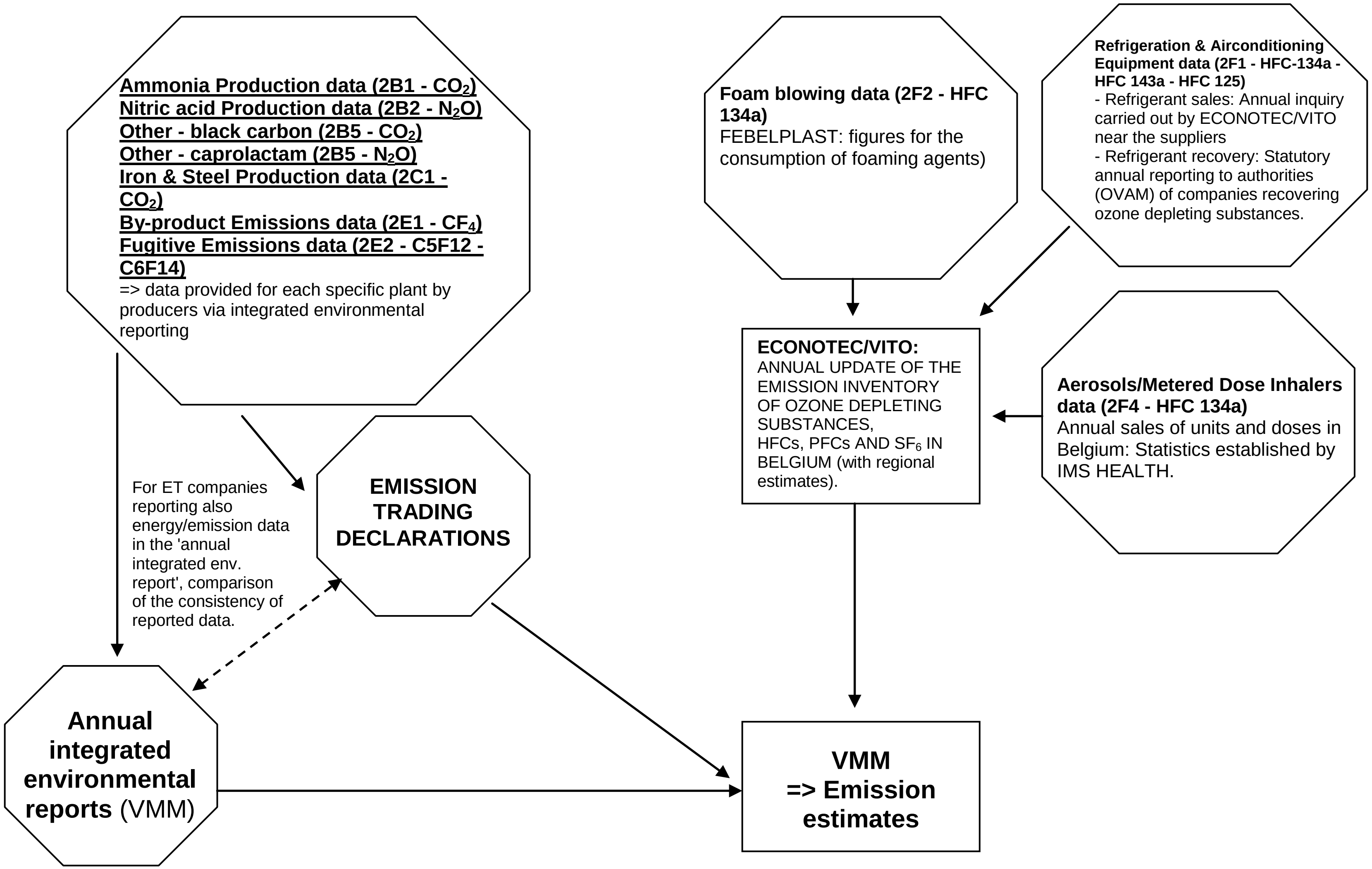


(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

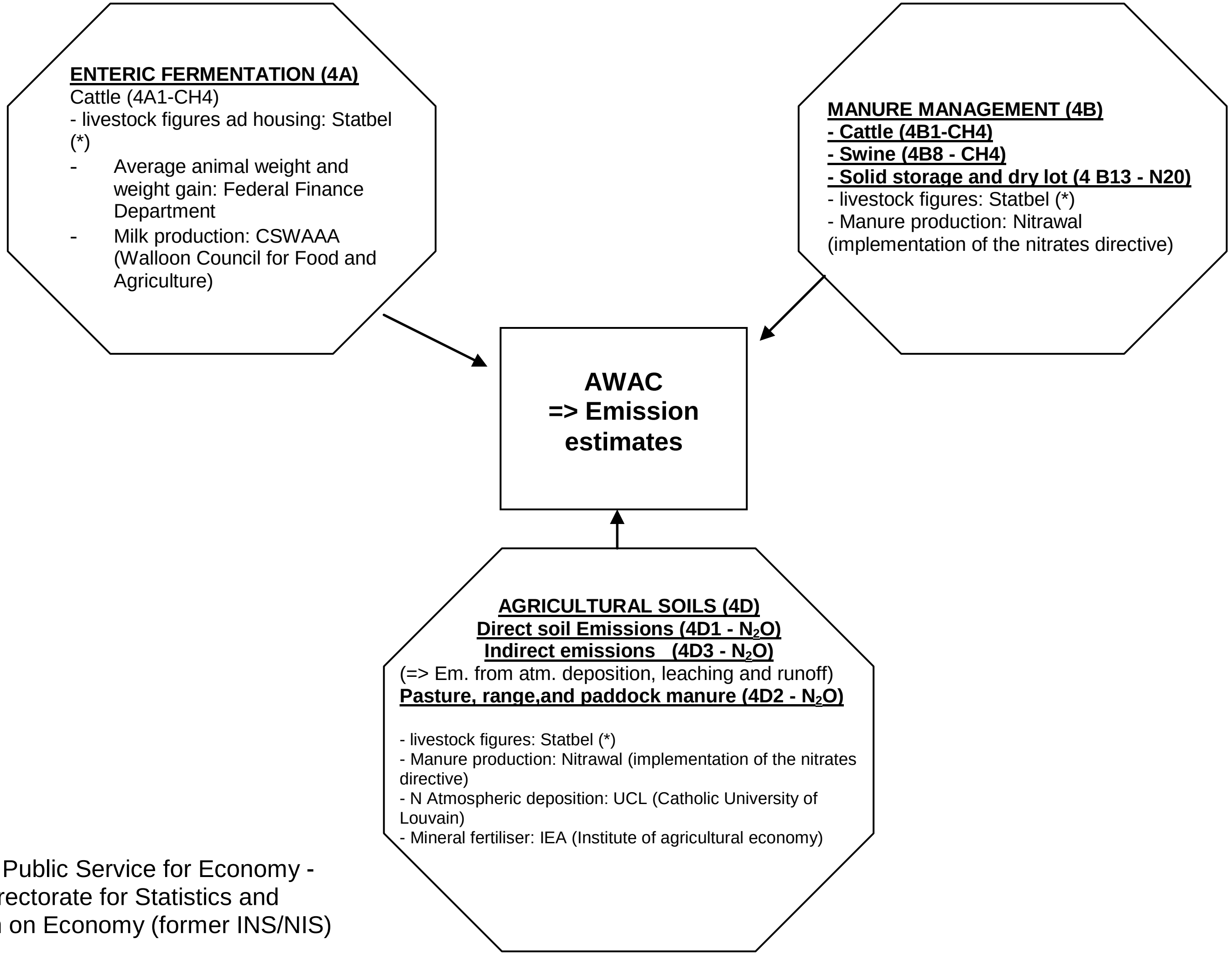
INDUSTRY - Key Sources - Flow of activity data - Wallonia



INDUSTRY - Key Sources - Flow of activity data - Flanders

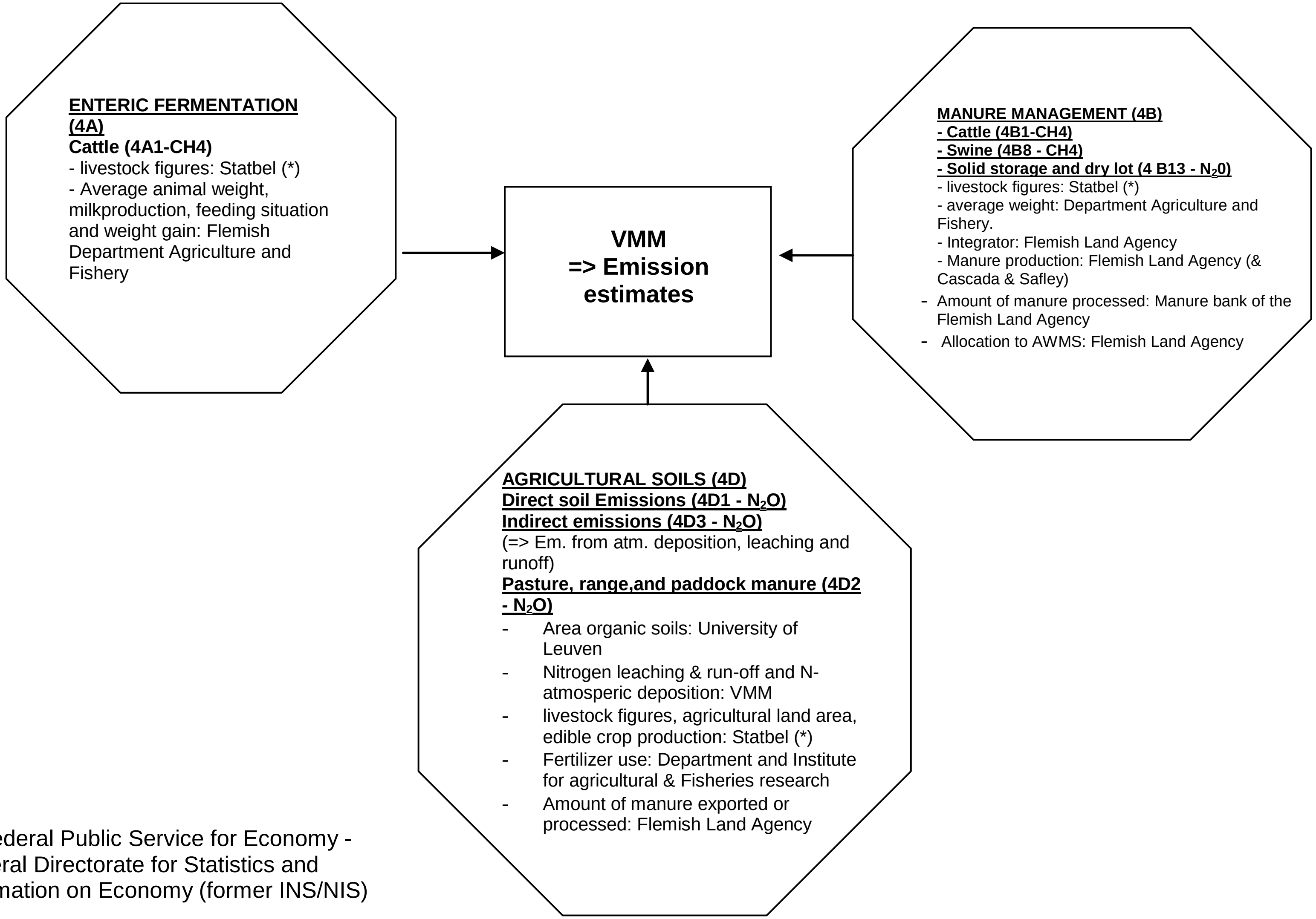


AGRICULTURE - Key Sources - Flow of activity data - Wallonia



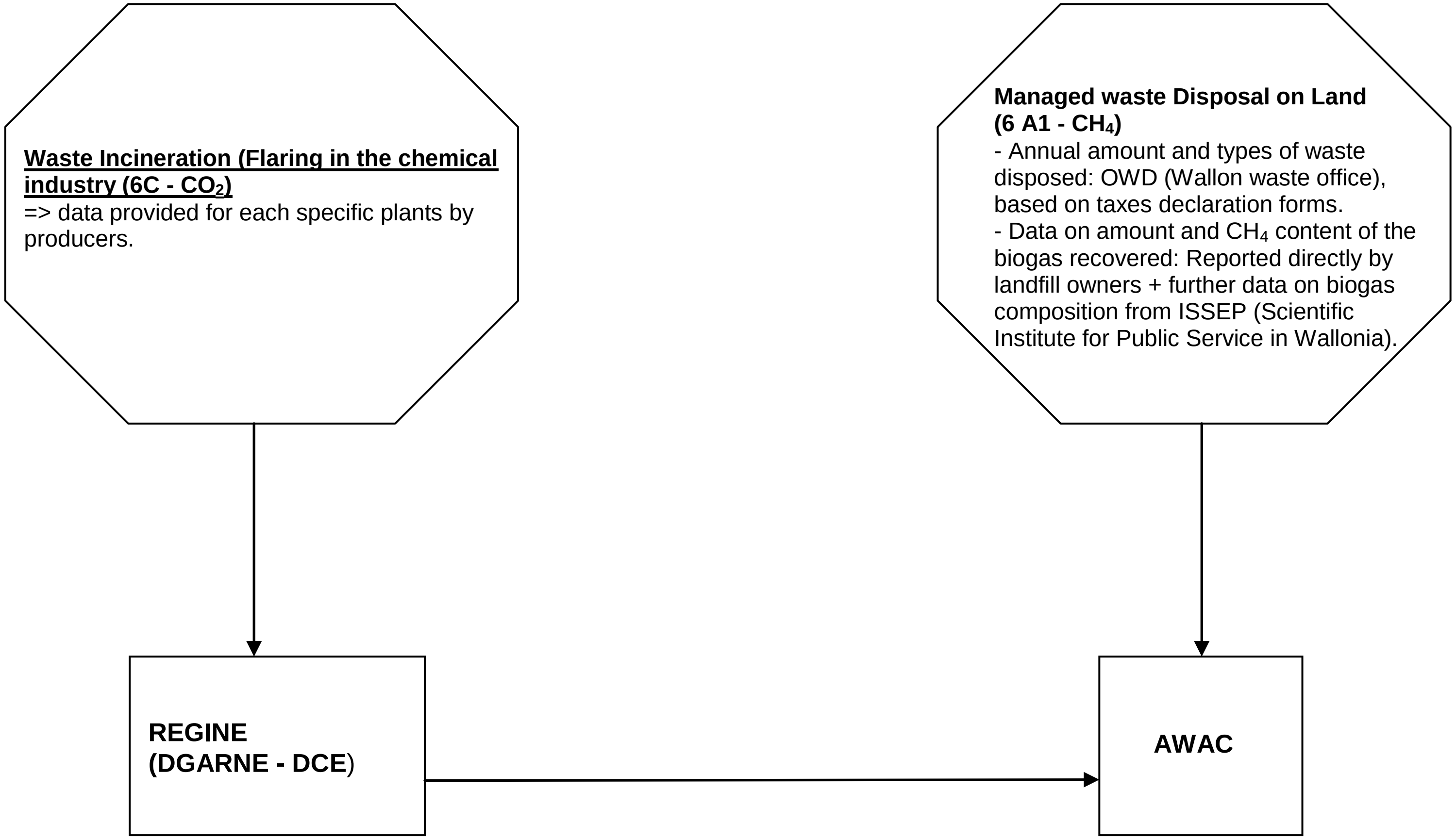
(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

AGRICULTURE - Key Sources - Flow of activity data - Flanders

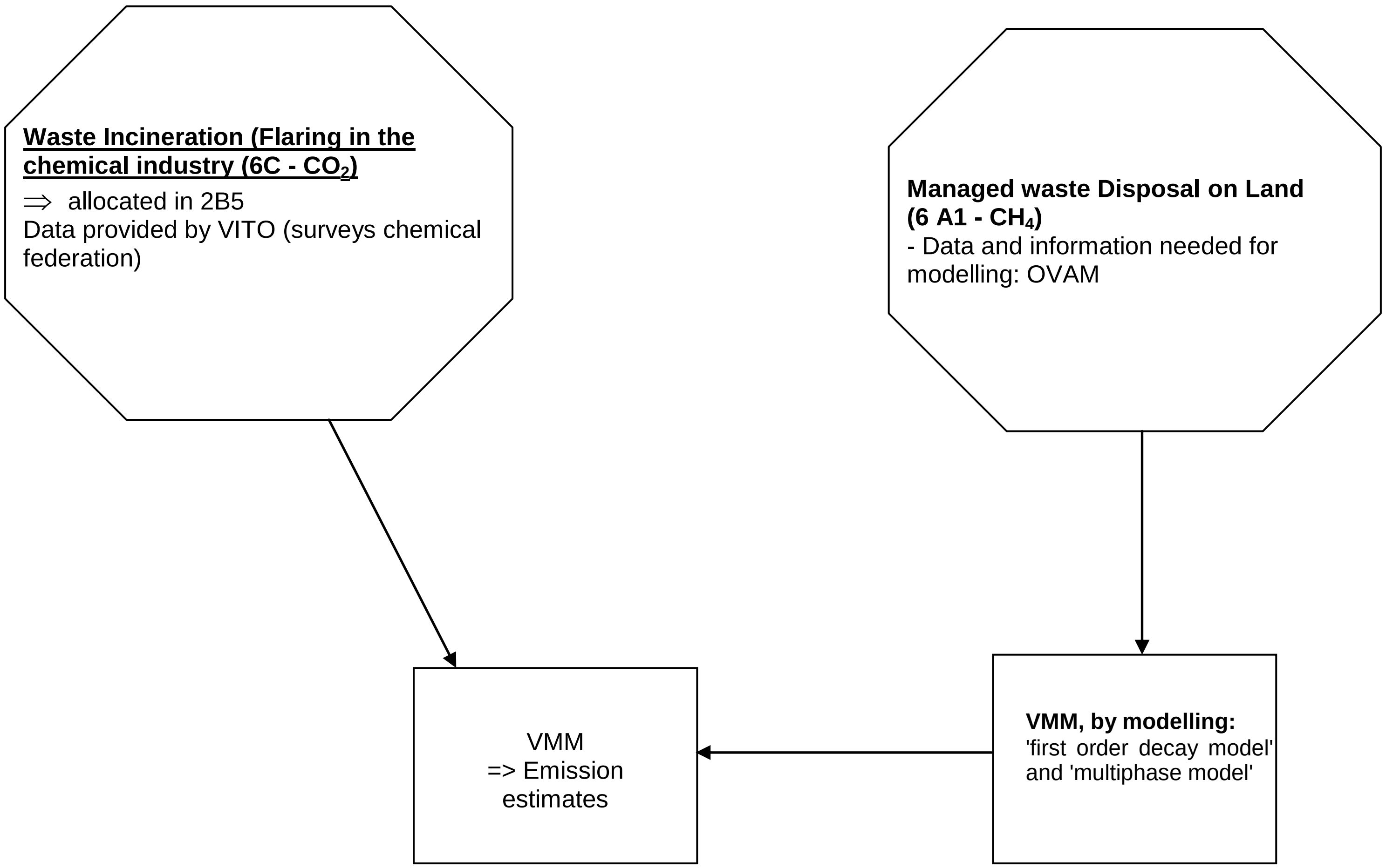


(*) Federal Public Service for Economy - General Directorate for Statistics and Information on Economy (former INS/NIS)

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 CO_2	Diesel kt CO_2	LPG kt CO_2	Gas kt CO_2	Biomass kt CO_2	Total CO_2 (excluding biomass)
1990	117 850	148 540	2 505			268 895	8 361	10 964	163			19 487
1991	118 347	150 954	2 101			271 401	8 396	11 142	136			19 674
1992	125 555	154 125	2 007			281 687	8 907	11 376	130			20 414
1993	122 756	163 863	1 758			288 377	8 709	12 095	114			20 918
1994	122 813	169 869	2 330			295 012	8 713	12 538	151			21 402
1995	122 535	170 795	2 664			295 994	8 693	12 606	173			21 472
1996	118 413	180 126	2 906			301 445	8 401	13 295	189			21 884
1997	109 497	191 851	3 294			304 643	7 768	14 161	214			22 143
1998	108 474	201 181	4 310			313 965	7 695	14 849	280			22 825
1999	103 293	210 251	4 676			318 220	7 328	15 519	304			23 150
2000	96 758	221 686	4 812			323 255	6 864	16 363	312			23 539
2001	94 172	231 662	6 241			332 075	6 681	17 099	405			24 185
2002	89 830	240 469	5 734			336 033	6 373	17 749	372			24 494
2003	90 623	247 590	5 034			343 247	6 429	18 275	327			25 031
2004	83 060	269 211	3 745			356 016	5 893	19 871	243			26 006
2005	75 590	264 508	3 551			343 650	5 363	19 523	231			25 117
2006	62 578	269 590	4 128	0.08		336 296	4 439	19 898	268	0.004		24 606
2007	59 453	271 842	2 927	0.40	3 532	337 755	4 218	20 065	190	0.023	265	24 473
2008	61 426	301 092	2 865	2.67	4 332	369 716	4 358	22 224	186	0.153	320	26 768
2009	57 414	294 329	2 923	4.28	11 852	366 522	4 073	21 724	190	0.246	871	25 988
2010	51 502	300 518	2 524	6.29	15 044	369 593	3 654	22 181	164	0.362	1 108	25 999
2011	52 172	297 478	2 792	8.67	1 4 410	366 861	3 701	21 957	181	0.499	1 063	25 840
2012	48 579	274 364	2 961	13.94	14 764	340 682	3 446	20 251	192	0.802	1 089	23 890

Annex 8: Regional energy balance

Walloon region
Energy Balance 2012 (provisional values)
(GWh PCI)

	Charbon et agglomérés de houille	Coke	Lignite	Goudron,benzol	Fioul léger et pétr.lampant	Fioul lourd	Coke de pétrole	Essence kérosène	Butane, propane, GPL	Autres prod. pétroliers	Gaz naturel	Gaz de cokerie	Gaz de haut-fourneau	Bois, sciure de bois écorces et liqueur noire	Biogaz	Autre biomasse	Autres combustibles
Consom.intér.brute	8 598	-3 662	2 037	-166	42 778	1 462	773	9 586	983	1 830	42 506	0	0	9 345	456	3 471	2 899
Entrées en transform.	5 747	0	0	0	54	458	0	0	3	0	12 258	641	0	6 180	456	832	1 557
Centrales électriques	0	0	0	0	54	458	0	0	3	0	12 258	641	0	6 180	456	832	1 557
Thermique classique	0	0	0	0	0	0	0	0	0	0	167	0	0	1 273	0	0	0
TGV TAG	0	0	0	0	5	0	0	0	0	0	8 101	0	0	0	0	0	0
Turbojets	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0
Incinérateurs	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	764	1 521
Autr.centr.(cog.et autop.)	0	0	0	0	22	458	0	0	3	0	3 990	641	0	4 907	456	68	36
Fabriques d'agglomérés	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cokeries	5 747	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hauts-fourneaux	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorties de transform.	0	3 817	0	166	0	0	0	0	0	0	0	1 494	0	0	0	0	0
Cokeries	0	3 817	0	166	0	0	0	0	0	0	0	1 494	0	0	0	0	0
Echange entre produits	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cons. branche énergie	0	0	0	0	0	0	0	0	0	0	0	702	0	0	0	0	0
Cokeries	0	0	0	0	0	0	0	0	0	0	0	702	0	0	0	0	0
Pertes de distribution	0	0	0	0	0	0	0	0	0	0	100	151	0	0	0	0	0
Consommation finale	2 852	155	2 037	0	42 724	1 004	773	9 586	980	1 830	30 149	0	0	3 165	0	2 639	1 342
Cons.finale énergét.	2 842	155	2 037	0	42 724	1 004	773	9 586	973	0	28 116	0	0	3 165	0	2 639	1 342
Industrie	2 452	155	2 037	0	1 266	1 004	773	12	105	0	13 677	0	0	450	0	1 300	1 342
Sidérurgie	53	79	0	0	28	58	3	0	1	0	3 390	0	0	0	0	0	0
Chimie	9	0	0	0	234	55	0	0	3	0	3 687	0	0	9	0	0	104
Minéraux non métalliques	2 382	8	2 037	0	412	776	770	0	31	0	3 321	0	0	22	0	1 300	1 239
Autres	7	68	0	0	593	115	0	12	70	0	3 278	0	0	418	0	0	0
Transport	0	0	0	0	26 163	0	0	9 574	85	0	0	0	0	0	0	1 339	0
Ferroviaire	0	0	0	0	118	0	0	0	0	0	0	0	0	0	0	0	0
Routier	0	0	0	0	25 850	0	0	4 571	85	0	0	0	0	0	0	1 339	0
Aérien	0	0	0	0	0	0	0	5 003	0	0	0	0	0	0	0	0	0
Navigation intérieure	0	0	0	0	194	0	0	0	0	0	0	0	0	0	0	0	0
Domestique & équival.	390	0	0	0	15 295	0	0	0	783	0	14 439	0	0	2 716	0	0	0
Agriculture	0	0	0	0	1 075	0	0	0	0	0	0	0	0	0	0	0	0
Logement	387	0	0	0	11 679	0	0	0	583	0	9 250	0	0	2 687	0	0	0
Tertiaire	4	0	0	0	2 541	0	0	0	200	0	5 189	0	0	29	0	0	0
Cons.fin.non-énergét.	10	0	0	0	0	0	0	0	7	1 830	2 033	0	0	0	0	0	0
Chimie	10	0	0	0	0	0	0	0	0	15	2 033	0	0	0	0	0	0
Autres secteurs	0	0	0	0	0	0	0	0	7	1 815	0	0	0	0	0	0	0

Brussels Region
Enery balance 2012 (provisional values)
(GWh PCI)

	CHARBON	FIOUL LEGER, DIESEL, PETROLE LAMPANT	ESSENCE	BUTANE PROPANE ET AUTRES PROD PETR.	GAZ NATUREL	DECHETS MENAGERS NON ORGANIQUES	DECHETS MENAGERS ORGANIQUES	BOIS	BIODIESEL	BIOETHANOL	AUTRE BIO CARBURANT LIQUIDE	BIOGAZ	POMPES A CHALEUR	SOLAIRE THERMIQUE	SOLAIRE PHOTO-VOLTAIQUE	VAPEUR CHALEUR	ELECTRICITE	TOTAL
PROD. PRIMAIRE RECUPERATION	--	--	--	--	--	838,2	310,2	5,8	--	--	--	17,2	12,5	6,4	13,4	--	2,5	1.206,2
SOLDE DES ECHANGES	37,1	5.255,2	1.168,5	307,4	9.320,9	--	--	52,2	148,7	48,1	3,4	--	--	--	--	8,7	5.470,4	21.820,6
CONSOMMATION INTER.BRUTE	37,1	5.255,2	1.168,5	307,4	9.320,9	838,2	310,2	58,0	148,7	48,1	3,4	17,2	12,5	6,4	13,4	8,7	5.472,9	23.026,8
ENTREE EN TRANSFORMATION	--	4,4	--	--	310,5	838,2	310,2	--	--	--	3,4	17,2	--	--	--	838,7	--	2.322,7
SORTIE DE TRANSFORMATION	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	955,2	370,7	1.325,9
AUTOCONSOMMATION	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	42,9	42,9
PERTES DE DISTRIBUTION	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	170,7	170,7
CONSOMMATION FINALE	37,1	5.250,8	1.168,5	307,4	9.010,4	--	--	58,0	148,7	48,1	--	--	12,5	6,4	13,4	125,3	5.630,0	21.816,4
C.F. ENERGETIQUE	37,1	5.250,8	1.168,5	117,9	9.010,4	--	--	58,0	148,7	48,1	--	--	12,5	6,4	13,4	125,3	5.630,0	21.627,0
INDUSTRIE	--	15,7	--	0,1	285,5	--	--	--	--	--	--	--	0,1	--	--	0,0	328,6	630,1
TERTIAIRE	--	568,9	--	0,0	3.214,4	--	--	--	--	--	--	--	4,5	0,6	7,6	116,0	3.620,2	7.532,3
LOGEMENT	37,1	1.314,7	--	23,9	5.510,5	--	--	58,0	--	--	--	--	7,9	5,8	5,8	9,3	1.401,3	8.374,1
TRANSPORT	--	3.351,4	1.168,5	93,9	--	--	--	--	148,7	48,1	--	--	--	--	--	--	279,9	5.090,5
Ferroviaire	--	3,1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	279,9	283,0
dont STIB	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	146,6	146,6
Routier	--	3.341,8	1.168,5	93,9	--	--	--	--	148,7	48,1	--	--	--	--	--	--	--	4.801,0
Fluvial	--	6,5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6,5
C.F. NON ENERGETIQUE	--	--	--	189,5	--	--	--	--	--	--	--	--	--	--	--	--	--	189,5

Flemish region
Energy Balance 2012 (provisional values)
PJ

	Koolteer [PJ]	Kolen [PJ]	Cokes [PJ]	Totaal kolen [PJ]	Aardolie en interm. prod. [PJ]	Raff. gas [PJ]	LPG [PJ]	Benzine [PJ]	Kerosine [PJ]	Gas-en dieselolie [PJ]	Lamppetro-leum [PJ]	Zware stookolie [PJ]	Nafta [PJ]	Petroleum-cokes [PJ]	Andere petro. prod. [PJ]	Totaal petro. producten [PJ]	Aard- en mijngas [PJ]	Cokes-ovengas [PJ]	Hoog-ovengas [PJ]	Totaal gas [PJ]	Totaal fossiele brandstoffen [PJ]	Andere brandst. [PJ]	Biomassa [PJ]	Elek-triciteit [PJ]	Warmte [PJ]	Nucleaire warmte [PJ]	Totaal [PJ]
Primaire produktie																						88,3	47,2	8,6	5,8		**149,9**
Netto invoer	6,9	116,9	0,8	**124,6**	1.355,6	0,9	26,4	-93,1	-35,5	-266,8	-1,5	25,8	102,4	2,5	-209,5	**907,2**	421,2	-0,1		**421,1**	**1.452,8**		22,3	35,4		195,3	**1.705,9**
Primair verbruik	**6,9**	**116,9**	**0,8**	**124,6**	**1.355,6**	**0,9**	**26,4**	**-93,1**	**-35,5**	**-266,8**	**-1,5**	**25,8**	**102,4**	**2,5**	**-209,5**	**907,2**	**421,2**	**-0,1**		**421,1**	**1.452,8**	**88,3**	**69,5**	**44,0**	**5,8**	**195,3**	**1.855,8**
Internationale bunkers									**42,8**	**21,3**		**235,5**				**299,7**					**299,7**						**299,7**
scheepvaart										21,3		235,5				**256,9**					**256,9**						**256,9**
luchtvaart									42,8							**42,8**					**42,8**						**42,8**
Bruto consumptie	**6,9**	**116,9**	**0,8**	**124,6**	**1.355,6**	**0,9**	**26,4**	**-93,1**	**-78,4**	**-288,1**	**-1,5**	**-209,7**	**102,4**	**2,5**	**-209,5**	**607,5**	**421,2**	**-0,1**		**421,1**	**1.153,1**	**88,3**	**69,5**	**44,0**	**5,8**	**195,3**	**1.556,048**
Transformatie input		**80,0**		**80,0**	**1.355,6**	**0,9**			**0,1**	**0,1**	**0,0**	**0,4**			**0,6**	**1.357,6**	**113,8**		**17,5**	**131,3**	**1.568,9**	**11,5**	**####**			**195,3**	**1.808,6**
Elektriciteit en warmte		30,9		**30,9**		0,9			0,1	0,1	0,0	0,4			0,6	**2,1**	113,801		17,5	**131,3**	**164,3**	11,5	32,9			195,3	**404,0**
* Elektriciteit		30,9		**30,9**					0,1	0,0	0,0	0,4			0,6	**1,2**	45,6		17,5	**63,1**	**95,2**	9,9	30,5			195,3	**330,9**
Thermische centrales		30,9		**30,9**					0,1	0,0	0,0	0,4			0,6	**1,2**	45,6		17,5	**63,1**	**95,2**	9,9	30,5				**135,6**
Kerncentrales																										195,3	**195,3**
* WKK						0,9				0,0						**0,9**	68,0			**68,0**	**68,9**	1,7	2,2				**72,8**
*																											
Warmte																	0,1			**0,1**	**0,1**		0,2				**0,3**
Raffinaderijen					1.355,6											**1.355,6**					**1.355,6**						**1.355,6**
Andere transformatie		49,1		**49,1**																	**49,1**						**49,1**
Cokesfabrieken		49,1		**49,1**																	**49,1**						**49,1**
Andere																											
Transformatie output	**1,7**		**36,9**	**38,6**		**39,1**	**22,1**	**120,3**	**78,4**	**536,4**	**1,5**	**216,9**	**63,1**	**10,4**	**239,2**	**1.327,6**		**10,4**		**10,4**	**1.376,6**			**152,7**	**28,1**		**1.557,5**
Elektriciteit en warmte																								152,7	28,1		**180,8**
* Elektriciteit																								122,9	1,6		**124,6**
Thermische centrales																								53,7	1,6		**55,4**
Kerncentrales																								69,2			**69,2**
* WKK																								29,8	26,4		**56,2**
*																											
Warmte																									0,1		**0,1**
Raffinaderijen						39,1	22,1	120,3	78,4	536,4	1,5	216,9	63,1	10,4	239,2	**1.327,6**					**1.327,6**						**1.327,6**
Andere transformatie	1,7		36,9	**38,6**														10,4		**10,4**	**49,1**						**49,1**
Cokesfabrieken	1,7		36,9	**38,6**														10,4		**10,4**	**49,1**						**49,1**
Andere																											
Eigenverbruik transformatiesector						**39,1**				**0,1**		**1,2**		**12,8**		**53,2**	**19,5**	**4,1**		**23,5**	**76,7**	**2,8**		**8,5**	**6,6**		**94,7**
Elektriciteit en warmte																								7,3	0,7		**8,0**
* Elektriciteit																								6,6			**6,6**
Thermische centrales																								2,6			**2,6**
Kerncentrales																								4,0			**4,0**
* WKK																								0,7	0,7		**1,4**
*																											
Warmte																											
Raffinaderijen						39,1				0,1		1,2		12,8		**53,2**	19,5			**19,5**	**72,7**	2,8		1,0	5,9		**82,4**
Andere transformatie																		4,1		**4,1**	**4,1**			0,2			**4,3**
Cokesfabrieken																		4,1		**4,1**	**4,1**			0,2			**4,279**
Andere																											
Verliezen elektriciteitsnet																								9,9			**9,9**
Beschikbaar voor finale consumptie	8,7	36,9	37,7	**83,2**			48,5	27,2		248,2		5,6	165,5	0,1	29,2	**524,2**	287,9	6,2	-17,5	**276,7**	**884,1**	73,9	36,6	178,4	27,2		**1.200,3**
Statistisch verschil in Joule		-7,1						7,1		56,8		15,1		1,0	10,7	227,4		0,9		-56,8	113,7		7,1		-3,6		227,4
Finaal verbruik	**8,7**	**36,9**	**37,7**	**83,2**			**48,5**	**27,2**		**248,2**		**5,6**	**165,5**	**0,1**	**29,2**	**524,2**	**287,9**	**6,2**	**-17,5**	**276,7**	**884,1**	**73,9**	**36,6**	**178,4**	**27,2**		**1.200,3**
Niet energetisch finaal verbruik	**8,7**			**8,7**			**40,9**			**0,0**		**0,4**	**165,5**		**29,2**	**236,0**	**30,2**			**30,2**	**274,9**						**274,9**
* Chemie	8,7			**8,7**			40,9			0,0		0,4	165,5		0,0	**206,8**	30,2			**30,2**	**245,7**						**245,7**
* Andere															29,2	**29,2**					**29,2**						**29,2**
Energetisch finaal verbruik		**36,9**	**37,7**	**74,6**			**7,6**	**27,2**		**248,2**		**5,2**		**0,1**		**288,2**	**257,7**	**6,2**	**-17,5**	**246,4**	**609,2**	**73,9**	**36,6**	**178,4**	**27,2**		**925,4**
*** Industrie**		**32,9**	**37,7**	**70,6**			**2,7**	**0,2**		**9,394**		**3,6**		**0,1**		**15,8**	**104,4**	**6,2**	**-17,5**	**93,2**	**179,6**	**72,8**	**8,9109**	**92,0**	**24,1**		**377,4**

IJzer en staal		29,8	36,8	**66,6**			0,0			0,1		0,0				**0,1**	6,5	6,2	-17,5	**-4,8**	**61,9**		0,0	7,6		**69,5**
Non-ferro			0,7	**0,7**			0,0			0,2		0,2		0,1		**0,5**	4,7			**4,7**	**6,0**	0,1	0,0	6,1		**12,1**
Chemie							0,1			0,3		1,8				**2,3**	37,9			**37,9**	**40,2**	70,1	0,1	34,5		**144,9**
Voeding, dranken en tabak		1,5	0,0	**1,5**			0,1			1,0		0,6				**1,7**	21,7			**21,7**	**25,0**		0,5	13,4		**38,9**
Papier en uitgeverijen		1,2		**1,2**			0,1			0,3						**0,4**	1,5			**1,5**	**3,0**	1,0	5,4	6,6		**16,0**
Minerale niet-metaalprodukten		0,4	0,0	**0,4**			0,0			0,6		0,6				**1,2**	8,8			**8,8**	**10,5**	0,9		3,5		**14,9**
Metaalverwerkende nijverheid			0,1	**0,1**			0,0			0,7		0,0				**0,8**	8,6			**8,6**	**9,4**		0,084	6,4		**16,0**
Textiel, leder en kleding							0,0			0,1		0,0				**0,1**	4,8			**4,8**	**4,9**		0,0	3,1		**8,0**
Andere industrieën		0,0		**0,0**			2,2	0,2		6,1		0,2				**8,8**	10,0			**10,0**	**18,7**	0,7	2,8	10,7		**33,0**
Waarvan zelfproducenten industrie		2,6		**2,6**						**0,0**						**0,0**	**13,2**			**13,2**	**15,8**	**3,6**	**5,544**		**4,8**	**29,9**
IJzer en staal																										
Non-ferro																	1,1			**1,1**	**1,1**				1,1	**2,2**
Chemie										0,0						**0,0**	6,9			**6,9**	**6,9**	2,7	0,0008		3,8	**13,3**
Voeding, drank en tabak		1,5		**1,5**													4,9			**4,9**	**6,4**		0,1687			**6,5**
Papier en uitgeverijen		1,1		**1,1**													0,1			**0,1**	**1,2**	1,0	5,374165			**7,5**
Minerale niet-metaalprodukten																	0,1			**0,1**	**0,1**					**0,1**
Metaalverwerkende nijverheid																	0,0			**0,0**	**0,0**		0,0003			**0,0**
Textiel, leder en kleding										0,0						**0,0**	0,1			**0,1**	**0,1**					**0,1**
Andere industrie																	0,1			**0,1**	**0,1**					**0,1**
***Residentiële en gelijkgestelde sectoren**		**4,0**		**4,0**			**3,9**	**0,7**		**80,6**		**1,6**				**86,8**	**151,4**			**151,4**	**242,2**	**1,1**	**19,1**	**84,0**	**3,2**	**349,5**
Huishoudelijke sector, handel, administratie, …		3,8		**3,8**			3,8	0,6		68,5		0,5				**73,5**	136,9			**136,9**	**214,1**	1,1	16,5	85,2		**316,9**
Tertiaire sector, handel en administratie							1,1	0,114		9,9		0,5				**11,7**	44,9			**44,9**	**56,6**	1,1	2,9	43,6		**104,168**
waarvan zelfproducenten																	0,4			0,4	**0,4**	1,1	2,4			**3,9**
Huishoudens		3,8		**3,8**			2,7	0,5		58,6						**61,8**	92,0			**92,0**	**157,5**		13,61	41,6		**212,7**
Land- en tuinbouw, zeevisserij, bosbouw, groenvoorziening		0,2		**0,2**			0,0	0,1		12,1		1,1				**13,358**	14,5			**14,5**	**28,1**		2,6	-1,2		**29,437**
waarvan zelfproducenten										0,0						**0,0**	14,5			**14,5**	**14,5**		2,3			**16,756**
*** Transport**							**1,1**	**26,3**		**158,1**		**0,1**				**185,6**	**1,9**			**1,9**	**187,5**		**8,6**	**2,4**		**198,6**
Wegvervoer							1,062	26,292		151,782						**179,1**	0,012			**0,0**	**179,1**		8,6	0,000		**187,787**
Spoorvervoer										0,8						**0,8**					**0,8**			2,3		**3,1**
Luchtvaart								0,022								**0,0**					**0,0**					**0,0**
Scheepvaart										5,5		0,1				**5,6**					**5,6**					**5,6**
Transport door pijpleidingen																	1,893			**1,9**	**1,9**			0,147		**2,0**
koolstof-emissiefactor (kton/PJ)	25,8	25,8	29,5		20,0	20,0	17,2	18,9	19,5	20,2	19,6	21,1	20,0	27,5	20,0		15,3	13,0	66,0							
reële emissiefactor CO2 (kton/PJ)	92,7	92,7	106,0		72,6	72,6	62,4	68,6	70,8	73,3	71,1	76,593	72,6	99,8	72,6		55,8195	47,4	240,8							

Annex 9: Activity data on livestock numbers and crop production in Belgium

Tables 9.1a-c give the evolution (1990-2012) of the livestock number in the three regions.

Livestock number Flanders	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Cattle											
- slaughter calves	134863	168430	171502	164827	169463	165954	170912	168928	175947	172761	164085
- bovine < 1yr	424150	420511	342388	284837	276823	273183	269597	275746	275007	271040	269682
- bovine between 1 and 2 yr	372193	381427	353903	278343	271863	258318	262238	166028	265045	260355	257470
- bovine > 2yr	220321	198081	141328	148253	150456	190700	195865	201246	199836	190170	182094
- Brood cows	111451	182065	186468	175192	175413	186663	174282	174626	173296	170750	164307
- Dairy cows	452794	380599	314740	264304	255260	254607	251911	249402	249544	246528	249521
Swine	6395797	6990977	6577861	5795500	5831684	5954854	5997965	6065417	6232403	6221040	6249769
- piglet < 20kg	1767168	1977494	1637064	1498616	1511821	1541865	1549352	1578742	1629492	1628726	1645891
- fattening pigs > 20kg	3900149	4273720	4355490	3810790	3842016	3944022	3997195	4038207	4157991	4160285	4180260
- breeding males	20079	17621	10867	7670	7233	6950	6485	6406	6071	5862	6036
- sows	708401	722142	574440	478424	470614	462017	444933	442062	438849	426167	417582
Poultry	25998165	31773947	32886836	26871980	25578569	25172565	24679359	25688551	27309658	27516439	28357898
- laying hens	9394876	11850384	12407523	10039716	9521798	9081696	8733706	8901947	9005678	8622797	8950323
- broilers	16047766	19523418	20205510	16667926	15875486	15913206	15756975	16600216	18115037	18670140	19178504
- other	555523	486447	400145	164338	181285	177663	188678	186388	188943	223502	229071
Sheep	122649	100102	66096	62236	62851	61464	61138	59878	56951	55247	56913
Goats	4981	4291	5529	13796	15661	15977	19108	21895	20978	22717	24974
Horses	13816	15209	30960	31948	32715	34241	36097	37812	38174	37659	39036
Mules and asses	189	259	4878	6539	6815	7200	7591	8207	8770	8706	8892
Other (rabbits, furred animals)	23745	31293	76187	54884	51002	51668	62975	70033	64500	61189	63775

Table 9.1a: Evolution of the livestock numbers in Flanders (1990-2012).

Livestock number Wallonia	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
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
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
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
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
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
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
Dairy cattle	385.775	303.780	266.657	230.374	223.538	219.218	217.948	218.619	214.695	208.859	205.757
Brood cow	202.670	296.142	325.880	329.265	331.920	334.521	329.196	329.061	324.029	317.664	318.806
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
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
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
Swine	28.302	23.982	23.723	19.116	18.989	15.866	16.150	15.595	13.972	12.857	14.030
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
Others											
Lambs	9.125	8.121	10.721	8.307	8.205	7.749	6.759	6.441	7.449	6.391	6.800
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
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
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
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
Horses	7.307	8.719	10.456	11.659	12.780	13.086	13.487	13.756	14.335	12.892	14.473
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
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
Other poultry	168.043	332.583	329.714	280.304	239.136	221.639	211.698	218.361	234.959	221.995	376.654

Table 9.1b: Evolution of the livestock numbers in Wallonia (1990-2012).

Livestock number Brussels	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Cattle	514	595	430	313	339	286	246	218	238	266	266
Swine	14	1	12	2	2	0	3	2	5	4	4
Poultry	527	97	327	776	780	736	681	695	366	652	652
Sheep	82	34	299	16	10	38	25	35	15	25	25
Goats	4	0	2	10	20	18	23	12	15	18	18
Horses	18	16	24	61	73	69	32	26	29	46	46

Table 9.1c: Evolution of the livestock numbers in Brussels (1990-2012).

Tables 9.2a-c give the evolution (1990-2012) of the crop production in the three regions.

Crop production Flanders	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
	ton	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**
N-fixing crops											
Clover	631	413	570	2693	3694	4235	4196	3735	3295	3144	334
Alfalfa	2737	4688	1470	9273	12718	14583	14452	12873	11346	10824	1148
Dry beans	1385	783	636	444	445	287	271	426	657	877	1154
Horse beans	305	111	255	249	187	404	243	193	354	303	306
Peas	20570	21021	26507	21566	23545	19720	19567	19205	16344	17439	16168
Green beans	9084	16699	33777	46958	48939	45566	39426	35178	44663	39776	10693
Non N-fixing crops											
Rape	31406	31406	14319	2508	1789	1977	2466	2339	3274	3169	3169
Winter wheat	448959	523349	573362	615856	595771	557808	647751	669716	677765	478292	630637
Spring wheat	6557	11211	12630	8811	9854	5859	7307	10520	8077	31807	3292
Rye	11638	7292	4251	1816	2170	1445	1284	1253	1058	1164	1242
Spelt	285	391	928	1694	2057	2381	3302	2657	3160	2731	3955
Brewing barley	874	527	1106	841	990	933	1162	1317	1697	614	250
Winter barley	163150	71295	71875	71402	89206	91299	94586	102377	94971	83657	98604
Spring barley	9035	68580	9891	8707	8198	6348	8047	9158	4820	9865	3009
Oat	13147	8072	8291	6429	5167	4256	5345	5410	4949	3922	3618
Chicory	23290	85612	155990	128689	71013	67797	82767	96078	76182	68310	50241
Flax	30032	30384	38032	37177	37092	28004	22541	27597	21027	34480	55098
Winter rape	171	948	372	523	3270	3490	1594	1888	2660	2227	2848
Tobacco	1394	1134	1069	719	191	158	176	146	199	175	122
Hop	605	899	460	359	352	362	332	366	352	215	284
Grain mais	47766	178825	378447	602103	544095	657088	809445	769233	696350	770953	663688
Silage mais	3294690	3917639	4760325	5208092	4522410	5266776	5693221	5687822	5521125	5309617	4657887
Other mais	105462	107173	84110	66950	53797	56215	62438	65451	69655	69441	67838
Sugarbeet	2283412	2008026	2254656	2229416	2096534	2120283	1548595	1659715	1548556	1820665	1577362

Crop production Flanders	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Fodderbeet	838829	523442	538889	298530	265857	266474	320059	315934	290782	467793	215521
Seed potatoes	14705	14452	17103	28884	33640	35466	31697	38311	46700	42268	35403
Early potatoes	215770	318359	416885	343371	351638	466420	388349	432108	416589	513450	299648
Bintje (variety of potato)	874736	996946	1140232	971766	866609	1012028	875504	871992	879524	1049277	IE
Other potatoes	146231	155942	333342	362553	378746	465254	453791	555870	612366	776070	1221355

Table 9.2a: Evolution of the crop production (ton) in Flanders (1990-2012).

Crop production Wallonia	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
	ton	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**	**ton**
Beet (sugar/fodder)	4.268.796	3.758.970	3.643.965	3.830.627	3.597.261	3.608.488	3.146.824	3.467.943	2.974.066	3.723.147	3.243.129
Maize	2.216.158	2.432.406	2.434.935	2.601.453	558.957	680.845	739.879	761.513	747.898	756.137	677.653
Rape	20.203	28.690	26.306	25.241	30.848	36.585	31.566	39.706	42.828	49.592	45.372
Potatoes	542.919	787.790	969.290	1.121.366	997.423	1.256.645	1.219.075	1.435.981	632.629	1.810.017	1.270.215
Winter wheat	918.777	944.906	1.059.422	1.110.963	1.058.673	1.000.637	1.186.895	1.223.459	1.182.727	1.097.471	1.129.037
Spring wheat	101.169	129.268	124.696	144.577	142.568	127.549	172.027	157.520	166.569	129.063	179.182
Winter barley	371.854	228.152	225.191	184.948	239.722	248.201	295.839	314.958	254.709	234.999	250.482
Chicory	81.209	329.339	743.240	772.740	300.705	314.130	343.662	378.794	313.340	289.533	198.565
Spring wheat	44.797	46.235	52.545	70.564	61.893	54.362	47.430	49.522	44.248	10.687	16.026
Other	20.999	104.872	126.962	148.595	178.060	133.619	89.039	82.419	158.175	77.445	51.479
N-fixing crops											
Beans	21.277	16.855	22.965	27.102	27.222	25.481	24.459	22.718	32.542	28.161	31.118
Peas	71.554	62.357	52.289	54.313	59.400	57.236	60.701	80.029	66.093	77.145	80.206

Table 9.2b: Evolution of the crop production (ton) in Wallonia (1990-2012).

Crop production Brussels	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton
N-fixing crops											
Clover	0,0	0,0	0,0	19,2	0,0	8,7	26,2	43,6	43,6	24,4	24,2
Alfalfa	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Dry beans	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Horse beans	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Peas	13,9	6,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Green beans	15,7	0,04	0,1	0,02	0,1	0,0	0,0	0,0	0,0	0,02	0,02
Non N-fixing crops											
Turnip	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Winter wheat	1063,8	766,3	869,1	409,3	438,0	446,3	468,4	473,1	502,0	461,4	459,7
Spring wheat	1,1	1,6	7,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Rye	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Spelled wheat	0,0	2,4	9,5	47,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Malting barley	4,4	0,0	17,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Winter barley	381,8	178,1	311,2	68,1	92,6	58,1	63,0	72,6	66,3	70,1	72,0
Spring barley	2,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Oats	13,8	19,7	84,0	39,2	25,3	40,3	46,8	44,4	41,1	36,1	39,8
Triticale	4,6	21,8	8,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Other grain crops	0,0	0,0	5,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Chicory	0,0	14,8	2,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Flax	34,5	122,0	40,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Winter rape	0,0	7,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Spring rape	0,0	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Tobacco	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hop	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Grain maize	7,3	45,3	25,1	52,5	36,2	55,5	43,3	31,2	57,7	45,2	41,5
Fodder maize (whole plant)	713,2	1175,1	1207,3	470,6	503,0	597,0	614,9	625,5	408,8	536,5	481,8

Fodder maize (green flask)	0,0	4,4	0,0	64,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Sugar beet	650,4	618,7	555,4	265,5	398,3	448,0	248,4	39,7	38,8	290,8	260,5
Fodder beet	75,3	62,7	35,5	34,5	36,8	15,3	35,9	54,5	44,3	40,0	32,8
Seed potatoes	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Early potatoes	186,5	2,0	5,7	0,0	0,0	0,0	0,0	0,1	35,2	0,0	7,7
Bintje	124,3	79,1	74,4	149,2	49,7	78,9	37,4	0,0	0,0	39,2	31,3
Other potatoes	18,0	254,2	2,2	82,9	224,3	191,6	285,9	353,8	189,7	277,5	219,9

Table 9.2c: Evolution of the crop production (ton) in Brussels (1990-2012).

Annex 10: Flemish multi-phase model for emissions from 'recent' solid waste disposal sites: calculation of the amount of organic carbon (Co,i,j)

In the Flemish multi-phase model (see chapter 8.2.2.), the amount of organic carbon in each phase in year j ($C_{o,i,j}$) (kg C/ton) is calculated based on the composition of waste, using the equation:

$$C_{o,i,j} = (w_i * d_i * o_i * c_i) * 1000$$

With, for each degradation rate phase i (slowly, moderately, rapidly degradable):

- w = the fraction (%) in the total amount of waste disposed with a specific biodegradation rate (e.g. fraction of slowly degradable waste = % textiles + % carpets etc.)
- d = the fraction (%) of dry material
- o = the fraction (%) of organic material in the dry material
- c = the organic carbon content of the organic dry material

Different values have been calculated for the three waste categories (household waste; bulky waste & waste from municipalities; industrial waste), because of their different compositions.

<u>Calculation amount of organic carbon (Co,i,j) in household waste</u>

Household waste refers to all waste generated by the normal operation of a private household, excluding bulky waste (see further).
The values for the composition of household waste (fractions, w) are based on waste sorting analysis studies performed by OVAM in 1985, 1993-1994, 1994-1995 and 1995-1996 [70]. In these studies, the household waste is divided into 10 main fractions. In the multi-phase model, these fractions have been assigned to one of three degradation rate phases (slow, moderate or rapid degradable), or labeled as non-degradable.

1. Organic fraction (kitchen and garden waste): rapidly degradable
2. Paper and cardboard: moderately degradable
3. Glass: non-degradable
4. Metals: non-degradable
5. Plastics: non-degradable
6. Textiles: slowly degradable
7. Household hazardous waste: non-degradable
8. Mixed fraction: a) hygienic fraction: slowly degradable; b) cartons (packaging): non-degradable
9. Non-recyclable fraction (carpets, leather and rubber): slowly degradable
10. Inert residual fraction (sand, stones): non-degradable

To take the selective collection of household waste into account, the model distinguishes between two periods: before 1991 (sorting analysis in 1985) and from 1991 onwards (average from the sorting analyses in 1993-1994, 1994-1995 and 1995-1996). Table annex 10.1. gives an overview of the composition of household waste in the different sorting analyses.

Composition household waste (%)	Percentage of total weight				
	1985 (= before 1991)	1993-1994	1994-1995	1995-1996	average from 1991 onwards
Rapidly degradable: organic fraction (kitchen and garden waste)	43,7	49,5	48,4	48,3	48,7
Moderately degradable: paper and cardboard	23,9	16,1	18,5	17,8	17,5
Slowly degradable: textiles, hygienic fraction, non-recyclable fraction	8,8	10,1	9,8	11,4	10,4
Non-degradable: glass, metals, plastics, hazardous household waste, carton packaging, inert residual fraction	23,6	24,3	23,3	22,5	23,4
Total	100	100	100	100	100

Table annex 10.1. Comparison of composition of household waste in 1985, 1993-1994, 1994-1995 and 1995-1996 ([71] based on [70])

Based on the composition of household waste (fractions, w) (see Table annex 10.1) and values from literature for d (dry material), o (organic material) and c (organic carbon content), the amount of organic carbon in each degradation phase ($C_{o,i,j}$) is calculated as follows:

Household waste, before 1991:

	w	d	o	c	C_o = w*d*o*c*1000
rapid	0,44	0,44	0,51	0,45	44,4
moderate	0,24	0,70	0,85	0,45	64,3
slow	0,09	0,77	0,73	0,45	22,8

Household waste, from 1991 onwards:

	w	d	o	c	C_o = w*d*o*c*1000
rapid	0,49	0,44	0,51	0,45	49,5
moderate	0,17	0,70	0,85	0,45	45,5
slow	0,1	0,77	0,73	0,45	25,3

<u>Calculation amount of organic carbon (Co,i,j) in bulky waste & waste from municipalities:</u>

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. An analysis by the Flemish Public Waste Agency (OVAM) in 1998-1999 showed that the bulky waste (total fraction: household waste collection + civic amenity sites) consisted mainly of furniture (27%), materials (wood, metals, plastics, green waste, …) (30%), textiles (including carpets) (11%), WEEE (waste electrical and electronic equipment) (8%) and construction waste (7%) [72].

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.

The values for the composition of bulky waste (fractions, w) in the multi-phase model are based on data from OVAM for 1995:

- Moderate degradable: paper and cardboard (3%), green waste: prunings (10%)
- Slow degradable: wood (20%), textiles (6%)

Due to the lack of information on waste from municipalities at the time the multi-phase model was developed, the same values for w are used as for bulky waste.
In the absence of data for d (dry matter), o (organic matter) and c (organic carbon content) the same values were used as for household waste. The amount of organic carbon in each degradation phase ($C_{o,i,j}$) is calculated as follows:

Bulky waste & waste from municipalities:

	w	d	o	c	C_o = w*d*o*c*1000
rapid	0,0	0,44	0,51	0,45	0,0
moderate	0,13	0,70	0,85	0,45	34,8
slow	0,26	0,77	0,73	0,45	65,8

Calculation amount of organic carbon (Co,i,j) in industrial waste

Industrial waste refers to all waste arising from a commercial, industrial or institutional activity, similar to non-hazardous municipal wastes. Therefore, this category includes waste from the industry sector as well as the trade & services sector.
In the absence of further information, the following values were taken from the literature for the amount of organic carbon in each degradation phase ($C_{o,i,j}$):
Industrial waste:

	C_o
rapid	49,0
moderate	8,0
slow	18,0

Annex 11: Comparison between data reported under the ETS-Directive and CRF-tables

2008						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**AGGREGATE ACTIVITY DATA**		**EMISSIONS**		**DIFFERENCES**	
	Consumption		**CO2**	**CO2 (ETS)**	**TJ ETS/TJ CRF**	**CO2 ETS/CO2 CRF**
	(TJ)	**(TJ) ETS**	**kt**	**kt**		
1.A.1. Energy Industries	380.173,37	331.595,07	25.326,84	22.035,98	87,22%	87,01%
Liquid Fuels	65.998,09	60.771,74	4.415,65	3.746,07	92,08%	84,84%
Solid Fuels	70.924,83	70.232,12	8.331,42	8.146,74	99,02%	97,78%
Gaseous Fuels	189.997,54	180.593,24	10.715,97	10.098,54	95,05%	94,24%
Biomass	34.564,62	19.348,14	3.577,90	0,00	55,98%	0,00%
Other Fuels	18.688,30	649,84	1.863,81	44,64	3,48%	2,39%
a. Public Electricity and Heat Production	302.491,48	265.091,06	20.414,26	18.287,81	87,64%	89,58%
b. Petroleum Refining	70.875,42	59.708,39	4.630,23	3.627,76	84,24%	78,35%
c. Manufacture of Solid Fuels and Other Energy Industries	6.806,48	6.795,62	282,35	120,41	99,84%	42,65%
1.A.2 Manufacturing Industries and Construction	462.896,86	306.695,82	28.145,76	23.640,42	66,26%	83,99%
Liquid Fuels	50.398,99	26.687,68	3.909,17	2.142,53	52,95%	54,81%
Solid Fuels	139.043,33	54.280,88	10.602,48	9.679,49	39,04%	91,29%
Gaseous Fuels	166.143,37	125.232,64	9.275,93	7.061,56	75,38%	76,13%
Biomass	23.942,03	16.597,60	2.248,34	0,00	69,32%	0,00%
Other Fuels	83.369,15	83.897,03	4.358,17	4.756,84	100,63%	109,15%
a. Iron and Steel	150.189,49	64.172,24	10.461,39	9.462,82	42,73%	90,45%
b. Non-Ferrous Metals	7.077,95	5.911,15	460,22	383,30	83,52%	83,29%
c. Chemicals	137.361,81	123.785,29	7.229,35	6.877,28	90,12%	95,13%
d. Pulp, Paper and Print	18.807,35	13.946,39	514,11	334,96	74,15%	65,15%
e. Food Processing, Beverages and Tobacco	34.907,15	21.830,17	2.049,50	1.275,31	62,54%	62,23%
f. Other (please specify)(4)	114.553,11	77.050,58	7.431,19	5.306,76	67,26%	71,41%
1.A.4 Other Sectors	0,00	0,00	0,00	0,00	0,00%	0,00%
a. Commercial/Institutional	101.106,34	17.515,03	6.062,25	308,75	17,32%	5,09%
c. Agriculture/Forestry/Fisheries	28.563,74	0,00	1.927,22	0,00	0,00%	0,00%
			CO2	**CO2 (ETS)**		
			kt	**kt**		
Total Industrial Processes						
A. Mineral Products			5.961,23	5.828,40		97,77%
1. Cement Production			3.032,53	3.031,38		99,96%
2. Lime Production			2.054,00	2.054,27		100,01%
3. Limestone and Dolomite Use			383,47	260,70		67,98%
7. Other (as specified in table 2(I).A-G)			491,23	482,05		98,13%
Glass Production			270,46	261,28		96,61%
ceramics			220,77	220,77		100,00%
C. Metal Production			1.656,20	3.152,53		190,35%
1. Iron and Steel Production			1.656,20	3.152,53		190,35%
Wallonia : ETS process emission in 2C1 / CRF in 1A2a				389,867		
Flanders : ETS process emission in 2C1 / CRF in 1A2a				1001,71		
Flanders : ETS process emission in 2C1 / CRF in 2A3				105		
6. waste incineration (chemical industry)			601,69	included under 'other fuels' in 1A2c		
1.B.2.c flare refining			116,08	116,08		100,00%

2009						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		EMISSIONS		DIFFERENCES	
	Consumption		CO2	CO2 (ETS)	TJ ETS/TJ CRF	CO2 ETS/CO2 CRF
	(TJ)	(TJ) ETS	kt	kt		
1.A.1. Energy Industries	403.523,99	352.659,92	25.742,79	22.738,53	87,40%	88,33%
Liquid Fuels	59.642,69	51.658,83	3.983,26	3.162,09	86,61%	79,38%
Solid Fuels	62.249,55	59.737,63	7.178,44	7.047,07	95,96%	98,17%
Gaseous Fuels	230.279,10	223.174,99	12.953,57	12.493,16	96,91%	96,45%
Biomass	34.793,49	17.665,05	3.646,16	0,00	50,77%	0,00%
Other Fuels	16.559,15	423,42	1.627,52	36,21	2,56%	2,22%
a. Public Electricity and Heat Production	324.261,58	289.285,23	20.773,88	18.976,10	89,21%	91,35%
b. Petroleum Refining	74.098,37	61.576,04	4.757,76	3.682,74	83,10%	77,40%
c. Manufacture of Solid Fuels and Other Energy Industries	5.164,04	1.798,65	211,15	79,70	34,83%	37,75%
1.A.2 Manufacturing Industries and Construction	362.726,29	970.538,39	19.809,12	15.548,08	267,57%	78,49%
Liquid Fuels	36.491,17	736.176,31	2.771,27	1.441,60	2017,41%	52,02%
Solid Fuels	77.640,55	36.581,34	4.849,59	4.131,48	47,12%	85,19%
Gaseous Fuels	138.383,67	93.019,60	7.723,73	5.545,71	67,22%	71,80%
Biomass	27.771,29	23.558,73	2.710,26	0,00	84,83%	0,00%
Other Fuels	82.439,61	81.202,42	4.464,53	4.429,28	98,50%	99,21%
a. Iron and Steel	77.009,67	35.540,09	4.081,47	3.374,73	46,15%	82,68%
b. Non-Ferrous Metals	6.506,02	5.267,78	424,49	341,63	80,97%	80,48%
c. Chemicals	126.173,19	114.378,89	6.696,38	6.186,29	90,65%	92,38%
d. Pulp, Paper and Print	18.139,67	732.411,13	479,75	353,79	4037,62%	73,75%
e. Food Processing, Beverages and Tobacco	32.523,11	18.306,98	1.874,59	1.142,51	56,29%	60,95%
f. Other (please specify)(4)	102.374,62	64.633,53	6.252,44	4.149,12	63,13%	66,36%
1.A.4 Other Sectors	0,00	0,00	0,00	0,00	0,00%	0,00%
a. Commercial/Institutional	101.306,50	1.060,20	6.059,20	64,89	1,05%	1,07%
c. Agriculture/Forestry/Fisheries	31.295,65	0,00	1.954,18	0,00	0,00%	0,00%
			CO2	CO2 (ETS)		
			kt	kt		
Total Industrial Processes						
A. Mineral Products			4.690,98	4.598,20		98,02%
1. Cement Production			2.795,20	2.795,20		100,00%
2. Lime Production			1.399,32	1.399,26		100,00%
3. Limestone and Dolomite Use			105,71	20,08		19,00%
7. Other (as specified in table 2(I).A-G)			390,75	383,66		98,19%
Glass Production			206,19	205,03		99,44%
ceramics			184,57	178,64		96,79%
C. Metal Production			858,86	1.676,15		195,16%
1. Iron and Steel Production			858,86	1.676,15		195,16%
Wallonia : ETS process emission in 2C1 / CRF in 1A2a				118,004		
Flanders : ETS process emission in 2C1 / CRF in 1A2a				633,67		
Flanders : ETS process emission in 2C1 / CRF in 2A3				66		
6. waste incineration (chemical industry)			501,17	included under 'other fuels' in 1A2c		
1.B.2.c flare refining			116,73	116,73		100,00%

2010						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		EMISSIONS		DIFFERENCES	
	Consumption		CO2	CO2 (ETS)	TJ ETS/TJ CRF	CO2 ETS/CO2 CRF
	(TJ)	(TJ) ETS	kt	kt		
1.A.1. Energy Industries	411.981,74	286.054,10	26.312,32	19.863,85	69,43%	75,49%
Liquid Fuels	59.735,48	44.590,72	3.828,00	3.025,66	74,65%	79,04%
Solid Fuels	58.891,90	54.519,02	7.361,50	7.310,24	92,57%	99,30%
Gaseous Fuels	237.182,70	169.974,11	13.406,71	9.491,27	71,66%	70,79%
Biomass	38.077,59	16.546,83	3.852,69	0,00	43,46%	0,00%
Other Fuels	18.094,07	423,42	1.716,12	36,69	2,34%	2,14%
a. Public Electricity and Heat Production	329.196,97	226.675,81	21.343,15	16.074,43	68,86%	75,31%
b. Petroleum Refining	76.363,17	56.958,63	4.709,69	3.688,79	74,59%	78,32%
c. Manufacture of Solid Fuels and Other Energy Industries	6.421,60	2.419,66	259,48	100,63	37,68%	38,78%
1.A.2 Manufacturing Industries and Construction	418.210,66	284.157,83	23.540,38	18.671,52	67,95%	79,32%
Liquid Fuels	36.506,19	18.247,91	2.742,55	1.417,12	49,99%	51,67%
Solid Fuels	99.876,49	47.048,02	6.955,82	5.878,05	47,11%	84,51%
Gaseous Fuels	162.249,59	116.222,93	9.065,74	6.477,79	71,63%	71,45%
Biomass	31.759,24	21.731,00	3.138,19	0,00	68,42%	0,00%
Other Fuels	87.819,15	80.907,96	4.776,27	4.898,56	92,13%	102,56%
a. Iron and Steel	102.857,30	49.727,27	6.285,82	5.199,80	48,35%	82,72%
b. Non-Ferrous Metals	6.841,06	5.504,78	436,19	348,96	80,47%	80,00%
c. Chemicals	137.358,63	118.195,80	7.308,52	6.720,69	86,05%	91,96%
d. Pulp, Paper and Print	22.428,79	16.552,24	620,38	476,65	73,80%	76,83%
e. Food Processing, Beverages and Tobacco	38.891,56	21.747,66	2.222,40	1.231,62	55,92%	55,42%
f. Other (please specify)(4)	109.833,33	72.430,10	6.667,07	4.693,80	65,95%	70,40%
1.A.4 Other Sectors	0,00	0,00	0,00	0,00	0,00%	0,00%
a. Commercial/Institutional	109.009,68	1.651,50	6.496,74	69,29	1,51%	1,07%
c. Agriculture/Forestry/Fisheries	35.527,64	196,50	2.147,16	10,97	0,55%	0,51%
			CO2	CO2 (ETS)		
			kt	kt		
Total Industrial Processes						
A. Mineral Products			4.804,55	4.675,15		97,31%
1. Cement Production			2.582,49	2.582,50		100,00%
2. Lime Production			1.648,32	1.648,30		100,00%
3. Limestone and Dolomite Use			212,12	91,70		43,23%
7. Other (as specified in table 2(I).A-G)			361,63	352,65		97,52%
Glass Production			228,83	227,65		99,48%
ceramics			132,80	125,00		94,13%
C. Metal Production			898,69	2.087,87		232,32%
1. Iron and Steel Production			898,69	2.087,87		232,32%
Wallonia : ETS process emission in 2C1 / CRF in 1A2a				121,752		
Flanders : ETS process emission in 2C1 / CRF in 1A2a				966,5		
Flanders : ETS process emission in 2C1 / CRF in 2A3				105		
6. waste incineration (chemical industry)			592,00	included under 'other fuels' in 1A2c		
1.B.2.c flare refining			102,61	102,61		100,00%

2011						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		EMISSIONS		DIFFERENCES	
	Consumption		CO2	CO2 (ETS)	TJ ETS/TJ CRF	CO2 ETS/CO2 CRF
	(TJ)	(TJ) ETS	kt	kt		
1.A.1. Energy Industries	358.186,31	305.421,49	22.916,98	20.001,39	85,27%	87,28%
Liquid Fuels	51.213,15	46.530,32	3.361,79	2.760,22	90,86%	82,11%
Solid Fuels	53.274,46	49.226,96	7.118,27	6.943,50	92,40%	97,54%
Gaseous Fuels	190.462,76	183.835,04	10.687,85	10.256,81	96,52%	95,97%
Biomass	45.627,50	25.073,11	4.741,99	0,00	54,95%	0,00%
Other Fuels	17.608,44	756,07	1.749,06	40,87	4,29%	2,34%
a. Public Electricity and Heat Production	283.970,57	245.082,32	18.406,47	16.539,76	86,31%	89,86%
b. Petroleum Refining	67.849,29	58.020,41	4.267,28	3.377,74	85,51%	79,15%
c. Manufacture of Solid Fuels and Other Energy Industries	6.366,44	2.318,76	243,23	83,89	36,42%	34,49%
1.A.2 Manufacturing Industries and Construction	404.986,67	278.665,05	22.871,21	18.156,93	68,81%	79,39%
Liquid Fuels	35.731,44	17.169,76	2.714,26	1.357,39	48,05%	50,01%
Solid Fuels	95.175,43	42.216,88	6.756,08	5.588,15	44,36%	82,71%
Gaseous Fuels	158.245,22	113.448,37	8.832,11	6.351,28	71,69%	71,91%
Biomass	26.700,41	20.976,61	2.525,64	0,00	78,56%	0,00%
Other Fuels	89.134,17	84.853,44	4.568,76	4.860,11	95,20%	106,38%
a. Iron and Steel	96.736,97	42.279,74	6.016,88	4.793,50	43,71%	79,67%
b. Non-Ferrous Metals	6.607,79	5.412,65	427,37	345,87	81,91%	80,93%
c. Chemicals	136.632,59	121.771,77	7.073,82	6.743,10	89,12%	95,32%
d. Pulp, Paper and Print	21.516,88	17.419,29	544,35	420,65	80,96%	77,28%
e. Food Processing, Beverages and Tobacco	35.987,19	21.730,83	2.048,33	1.256,54	60,38%	61,34%
f. Other (please specify)(4)	107.505,26	70.050,77	6.760,46	4.597,28	65,16%	68,00%
1.A.4 Other Sectors	0,00	0,00	0,00	0,00	0,00%	0,00%
a. Commercial/Institutional	87.861,08	1.012,06	5.186,84	55,19	1,15%	1,06%
c. Agriculture/Forestry/Fisheries	31.847,94	178,30	1.952,00	9,95	0,56%	0,51%
			CO2	CO2 (ETS)		
			kt	kt		
Total Industrial Processes						
A. Mineral Products			5.095,95	4.960,71		97,35%
1. Cement Production			2.761,55	2.761,70		100,01%
2. Lime Production			1.741,47	1.737,60		99,78%
3. Limestone and Dolomite Use			206,08	84,70		41,10%
7. Other (as specified in table 2(I).A-G)			386,85	376,71		97,38%
Glass Production			233,22	223,31		95,75%
ceramics			153,63	153,39		99,84%
C. Metal Production			539,79	1.777,72		329,33%
1. Iron and Steel Production			539,79	1.777,72		329,33%

Wallonia : ETS process emission in 2C1 / CRF in 1A2a 116,7

Flanders : ETS process emission in 2C1 / CRF in 1A2a 1013,18

Flanders : ETS process emission in 2C1 / CRF in 2A3 108

6. waste incineration (chemical industry)			436,65	included under 'other fuels' in 1A2c		
1.B.2.c flare refining			92,66	92,66		100,00%

2012						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**AGGREGATE ACTIVITY DATA**		**EMISSIONS**		**DIFFERENCES**	
	Consumption		**CO2**	**CO2 (ETS)**	**TJ ETS/TJ CRF**	**CO2 ETS/CO2 CRF**
	(TJ)	**(TJ) ETS**	**kt**	**kt**		
1.A.1. Energy Industries	350.989,84	283.651,28	22.691,69	19.292,00	80,81%	85,02%
Liquid Fuels	55.382,43	46.372,12	3.685,26	2.807,94	83,73%	76,19%
Solid Fuels	54.332,58	50.252,59	7.551,69	7.376,05	92,49%	97,67%
Gaseous Fuels	171.509,96	161.653,69	9.585,53	9.044,37	94,25%	94,35%
Biomass	50.613,86	24.287,20	5.273,94	0,00	47,99%	0,00%
Other Fuels	19.151,02	1.085,67	1.869,21	63,63	5,67%	3,40%
a. Public Electricity and Heat Production	272.407,36	223.652,10	17.855,82	15.774,65	82,10%	88,34%
b. Petroleum Refining	72.652,46	58.149,13	4.610,97	3.453,53	80,04%	74,90%
c. Manufacture of Solid Fuels and Other Energy Industries	5.930,03	1.850,04	224,90	63,82	31,20%	28,38%
1.A.2 Manufacturing Industries and Construction	376.745,48	268.649,69	20.711,86	16.048,24	71,31%	77,48%
Liquid Fuels	31.221,47	12.194,26	2.346,64	934,23	39,06%	39,81%
Solid Fuels	78.630,94	41.501,34	5.083,54	4.324,61	52,78%	85,07%
Gaseous Fuels	161.478,03	113.286,84	9.011,78	6.321,84	70,16%	70,15%
Biomass	27.420,45	22.742,20	2.624,17	0,00	82,94%	0,00%
Other Fuels	77.994,59	78.925,06	4.269,90	4.467,57	101,19%	104,63%
a. Iron and Steel	79.799,59	38.354,39	4.377,63	3.335,62	48,06%	76,20%
b. Non-Ferrous Metals	6.763,57	5.344,17	431,18	339,05	79,01%	78,63%
c. Chemicals	126.794,96	115.979,02	6.825,82	6.402,64	91,47%	93,80%
d. Pulp, Paper and Print	21.666,10	18.460,39	525,72	440,32	85,20%	83,75%
e. Food Processing, Beverages and Tobacco	37.262,72	22.529,93	2.102,84	1.263,44	60,46%	60,08%
f. Other (please specify)(4)	104.458,54	67.981,77	6.448,66	4.267,18	65,08%	66,17%
1.A.4 Other Sectors	0,00	0,00	0,00	0,00	0,00%	0,00%
a. Commercial/Institutional	101.154,89	1.143,25	5.911,36	57,15	1,13%	0,97%
c. Agriculture/Forestry/Fisheries	34.884,99	204,35	2.118,65	11,41	0,59%	0,54%
			CO2	**CO2 (ETS)**		
			kt	**kt**		
Total Industrial Processes						
A. Mineral Products			4.691,11	4.572,66		97,47%
1. Cement Production			2.642,59	2.642,60		100,00%
2. Lime Production			1.611,91	1.611,90		100,00%
3. Limestone and Dolomite Use			101,88	3,41		3,35%
7. Other (as specified in table 2(I).A-G)			334,74	314,75		94,03%
Glass Production			188,37	179,37		95,22%
ceramics			146,37	135,38		92,50%
C. Metal Production			443,82	1.552,49		349,80%
1. Iron and Steel Production			443,82	1.552,49		349,80%
Wallonia : ETS process emission in 2C1 / CRF in 1A2a				69,3		
Flanders : ETS process emission in 2C1 / CRF in 1A2a				957,1		
Flanders : ETS process emission in 2C1 / CRF in 2A3				82		
6. waste incineration (chemical industry)			431,96	included under 'other fuels' in 1A2c		
1.B.2.c flare refining			92,02	92,02		100,00%