BELGIUM'S GREENHOUSE GAS INVENTORY (1990-2006)

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

April 2008

Prepared by:

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

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

General Directorate for natural resources and environment (DGRNE)
Av. Princes de Liège 155100 Jambes Belgium
Telephone +32 (0) 81-33 51 84
Fax +32 (0) 81 33 51 22
http://environnement.wallonie.be
E-Mail: i.higuet@mrw.wallonie.be and a.guns@mrw.wallonie.be

Brussels Institute for the Management of the Environment(IBGE-BIM)
Gulledelle 100 1200 Brussel Belgium
Telephone +32 (0)2 775 7681
Fax +32 (0)2 775 76 21
http://www.ibgebim.be
E-Mail: lbo@ibgebim.be

Interregional Cell for the Environment (IRCEL)
Avenue des Arts/Kunstlaan 10-11 1210 Brussels
Telephone +32 (0)2 227 57 01
Fax +32 (0)2 227 56 99
http://www.irceline.be

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

TABLE OF CONTENT

CHAPTER 1: INTRODUCTION

1.1. Overview

This seventh 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 SF6), indirect greenhouse gases (CO, NO_x, NMVOCs) and SO_2. It covers the period 1990-2006. Inventory data for the years 1990 to 2005 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 from 4 to 9 June 2007 in Brussels, Belgium.
The revision of the Belgian greenhouse gas inventory as a result of the in-country review of June 2007 is attached to this report together with the Reports of the individual review of the greenhouse gas inventory of Belgium submitted in 2006 and of the review of the initial report of Belgium (CDROM, annex 4).

This seventh National Inventory Report is presented according to the structure outlined in document FCCC/CP/2002/8, amended to fit to the Belgian national context. Complete CRF tables, for years 1990 to 2006, are provided as an annex to this report, under electronic format. The national CRF tables (CRFReporter) as well as the regional CRF tables are annexed (CDROM, annex 4) to this report. Next to the emissions 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.

1.2. Institutional arrangements and process of inventory preparation

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 form 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 duties of the Working Group on « Emissions » of the *Co-ordination 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.

1.3. General description of methodologies and data sources used

As a consequence of the responsibility of the regions in compiling greenhouse gas inventories, concomitant methodologies have been developed by the three regions for compiling 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 4.2.4).

As the QA/QC procedures are not fully implemented for the Belgian greenhouse gas inventory for the time being, these are not described in detail in the chapters 3 to 8 for each category but in a more general way in section 1.5. The QA/QC procedures for the Flemish greenhouse gas inventory are already reasonable developed and are described more in detail in this section.

Section 1.6 gives a detailed description of the uncertainty analysis of the emission inventory of 2005 and 2006.

Inventory data for the years 1990 to 2005 have been recalculated (in a much less important way compared with previous submissions) as a consequence of methodological changes, harmonisation of allocation and/or methods between the regions, and access to new data sources. 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 , held in Brussels from 4 to 9 June 2007. Some other recalculations are also performed after the in-country review for the 2008 submission. See sections 3 to 8 for further details.
Emission figures of the greenhouse gases for 2006 are estimated on a temporary basis in this submission and will be further optimized during the 2009 submission.
Time consistency is obviously guaranteed for all sectors of optimization.

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).

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 regions (see section 3.2.3 for further information). These emissions are calculated based on the national statistics (fuels sold on the Belgian territory) and IPCC default emission factors as was agreed upon the UNFCCC-experts in 2003. The other greenhouse gases originating from road transport are estimated in Belgium by calculating the sum of the emissions of the regional models, based on fuel combustion in the vehicles that travel within the country's territory.

The regional and national inventory systems are fully described in the National Inventory System which has been reported by the end of 2006 to the secretariat of UNFCCC.

1.3.1. Flemish region

In Flanders, the greenhouse gas inventory is set up by the *Department Air, Environment and Communication* of the *Flemish Environmental Agency* (VMM).

Since the reporting year of 1993 most important industrial companies in the Flemish region in relation with air pollution are obliged to report annually about their emissions when exceeding a defined threshold value.

In 2005 (starting from the 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 thresholdvalues 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.

Mainly for the refineries, the iron and steel sector and the chemical industry (process emissions) this obliged reporting of emissions remains since that time an important source of information for the international reporting obligations.

The Flemish region has taken into account the information from the EU-ETS data based on Directive 2003/87/EC in a sense that reported sources in the EU-ETS framework are compared with the reported sources in the greenhouse gas emission inventory and completed if necessary. Next to this, the emissions of CO_2 of the most important sources are also compared in these two datasets for the available years and tuned where possible and relevant.

CO_2 emissions

CO_2 emissions are mainly calculated on the basis of the energy balance, which is annually established by the *Flemish Institute for Technological Research* (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'). Last publication of this document dates from May 2007 and contains a definitive energy balance for the year 2005. The energy balances of all years can be found on 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 mostly 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. In general, mostly Tier 1 methodology, the sectoral approach, was used for estimating these CO_2 emissions. See section 4.2 for more information.

The emissions from the LUCF-sector in Flanders were completed during the 2006 submission. More in particular, the emissions and sinks of CO2 (total net emissions) of terrestrial ecosystems were newly estimated at that time. This source includes the emissions originating from the changes in carbon stock of grasslands, arable lands and forests, changes in biomass (aboveground) of trees in forests and the emissions as a result of cutting down the trees in forests. See section 7 for further detailed information.

CH_4 and N_2O emissions

The energetic emissions of CH_4 and N_2O are mostly calculated by multiplying an 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, the so called MIMOSA-model, is mainly developed for policy objectives. This MIMOSA-model calculates the traffic emissions based on the COPERT III methodology and on data of mobility per road segment. These emissions are calculated based on a traffic flow model of the Flemish region, which means that a geographical distribution is possible.

Emissions of air traffic are calculated using the EMEP/CORINAIR methodology [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 plant. 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 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.

1.3.2. Walloon region

The emission inventories of the Walloon region are compiled by the *General Directorate for natural resources and environment* (DGRNE) using the IPCC methodology (or EMEP/CORINAIR 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 emissions 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 DGTRE (Directorate general for Technology, Research and Energy). 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 inventory preparation 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.

1.3.3. Brussels region

The emission inventories of the Brussels region are compiled by the *Brussels Institute for Environmental Management* (IBGE-BIM) using the IPCC- and EMEP/CORINAIR-methodology. The emissions are calculated by multiplying activity data by an emission factor. Generally, these activity data and emission factors used in the Brussels inventory are estimated on the basis of research projects funded by IBGE-BIM (for instance, the annual energy balance that is established on a survey among energy suppliers, federations and individual consumers). These projects combine the socio-economic Brussels specificities and the reference values found in the IPCC Guidelines, specific bibliographies like PARCOM, TNO, EPA,… as well as in the joint EMEP/CORINAIR handbook [3, 44] . The different sectors taken into account in the Brussels emission inventory reflect the characteristics of a strict urban environment.

Nearly all the emissions of this urban region originates from energy consumption.

1.4. Key sources categories

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 [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, 2005 and 2006 and trend analysis is carried out for the years 1990-2005 and 1990-2006. See annex 1 for more details.

The key source analysis is realised on the basis of the set of sub-categories, at the level of detail of the sectoral report tables. Sources that do not occur in Belgium as well as those that are not estimated (no data) are excluded from the analysis. Contrary to previous submissions, the LUCF-data are included in this analysis for the first time. Each greenhouse gas emitted by a single source category is considered separately. This procedure leads to the determination of a set of 35 source categories during the level assessment 2006). , covering 99.6% of the total aggregated emissions 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 for 2006 (see Annex 1) results in the identification of 25 key sources, covering 95%[1] of the total national aggregated emissions. These 25 key sources are to a large extent the same as those identified for the years 1990 and 2005 (see annex 1). Differences are identified for the categories 6A1 (solid waste disposal sites) which just falls out the key source categories for 2006, the categories 1A1c (Manufacturing of solid fuels) and 2E1 (By-product emissions) which are key sources in 1990 but no longer in 2005 and 2006 and 4B1 (manure management, cattle) which is still a key source in 1990 and 2006 but just falls out in 2005.

[1] 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.

33 key sources are identified from the trend assessment 1990-2006 (see Annex 1) as those that contribute 95% to the trend of the inventory. Although there are differences in amount of key sources between the trend assessments for the years 1990-2005 (26 key sources) and 1990-2006 (see annex 1) the identified key sources overlap to a large extent.

Key source categories identified form the level and the trend assessments also overlap to a large extent. As a whole (level and trend Assessments), 39 key source categories are determined (Table 1.1). The absolute change in direct greenhouse gas emissions of these key sources over the period 1990-2006 is listed in Table 1.1 and shown in Figure 1.1.

CO_2 emissions from road transportation is the first key source of greenhouse gas emissions in Belgium (18 % of total aggregated emissions in 2006). It constitutes the main driver of emissions trends (annex 1). CO_2 emissions from road transportation, electricity production and residential space heating are pointed out by the level assessment as the three main key source categories, each contributing to 15 to 18% of the total national emissions (together, these three sources cover around 50% of the total emissions in 2006). Energetic emissions of CO_2 from iron and steel industry (category 1A2a) and chemical industry (category 1A2c) also constitute major key sources, which respectively account for 6.9 % and 5.7 % of the total emissions in 2006.

The three most important key sources of non-CO_2 emissions in Belgium are CH_4 emissions from cattle (enteric fermentation) (2.4% in 2006), N_2O emissions from agricultural soils (1.6% in 2006) and N_2O emissions from nitric acid production (1.5% in 2006).
One may finally notice that the five key source categories which displayed the most important absolute increase in their emissions over the period 1990-2006 (figure 1.1, table 1.1), are CO_2 from road transportation (+5171 Gg CO_2-eq.), CO_2 from commercial & institutional (+1770 Gg CO_2-eq.), energy related CO_2 from chemicals (category 1A2c, +1221 Gg CO_2-eq.), CO_2 from process emissions in the chemical industry (category 2B5, +1130 Gg CO_2eq) and CO_2 from ammonia production (category 2B1, +870 Gg CO_2eq).
On the contrary, energetic emissions of CO_2 from the iron and steel sector (-4897 CO_2 eq.), emissions of CH_4 from waste disposal on land (-1949 CO_2-eq.), emissions of CO_2 from solid fuels (category 1A1c, -1749 Gg CO_2-eq.) and N_2O emissions of nitric acid production (-1480 Gg CO_2 eq) are the source categories that displayed the most important drop in GHG emissions between 1990 and 2006.

IPCC category	direct greenhouse gas	base year emissions 1990 (1995 F-gases) Gg CO2eq	emissions 2006 Gg CO2eq	criteria for identification	absolute emission trend 1990-2006 Gg CO2eq
1A1a Public Electricity and Heat Production	CO2	23504	22637	trend, level	-867
1A1b Petroleum Refining	CO2	4299	4522	trend, level	223
1A1c Manufacture of Solid Fuels and Other Energy Industries	CO2	2144	395	trend	-1749
1A2a Iron and Steel	CO2	14213	9315	trend, level	-4897
1A2c Chemicals	CO2	6585	7806	trend, level	1221
1A2e Food Processing, Beverages and Tobacco	CO2	2998	2044	trend, level	-954
1A2f Other (as specified in table 1.A(a) sheet 2)	CO2	8069	7192	trend, level	-877
1A3b Road Transportation	CO2	19270	24441	trend, level	5171
1A3b Road Transportation	N2O	333	773	trend, level	440
1A3d Navigation	CO2	411	498	trend	87
1A4a Commercial/Institutional	CO2	4272	6042	trend, level	1770
1A4b Residential	CO2	20213	20112	trend, level	-101
1A4c Agriculture/Forestry/Fisheries	CO2	2730	2336	trend, level	-394
2A1 Cement Production	CO2	2824	3116	trend, level	292
2A2 Lime Production	CO2	2097	2139	trend, level	42
2B1 Ammonia Production	CO2	420	1290	trend, level	870
2B2 Nitric Acid Production	N2O	3562	2082	trend, level	-1480
2B5 Other (as specified in table 2(I).A-G)	CO2	224	1354	trend, level	1130
2B5 Other (as specified in table 2(I).A-G)	N2O	372	484	trend	112
2C1 Iron and Steel Production	CO2	1946	1620	trend, level	-326
2E1 By-product Emissions	CF4	450	7	trend	-443
2E2 Fugitive Emissions	C5F12	407	26	trend	-382
2E2 Fugitive Emissions	C6F14	244	78	trend	-166
2F1 Refrigeration and Air Conditioning Equipment	HFC-134a	72	538	trend	466
2F1 Refrigeration and Air Conditioning Equipment	HFC-143a	4	434	trend	430
2F1 Refrigeration and Air Conditioning Equipment	HFC-125	3	321	trend	319
2F2 Foam Blowing	HFC-134a	324	78	trend	-247
2F4 Aerosols/Metered Dose Inhalers	HFC-134a	35	175	trend	140
4A1 Cattle (1)	CH4	3813	3284	trend, level	-528
4B1 Cattle (1)	CH4	851	712	level	-139
4B13 Solid Storage and Dry Lot	N2O	892	769	level	-123
4B8 Swine	CH4	1245	1137	level	-107
4D1 Direct Soil Emissions	N2O	2367	2174	level	-194
4D2 Pasture, Range and Paddock Manure (3)	N2O	936	791	level	-145
4D3 Indirect Emissions	N2O	1242	928	trend, level	-314
5B1 Cropland remaining Cropland	CO2	471	575	trend	105
5C1 Grassland remaining Grassland	CO2	1303	1141	level	-163
6A1 Managed Waste Disposal on Land	CH4	2630	680	trend	-1949
6C Waste Incineration	CO2	253	78	trend	-175

Table 1.1. : Key source category analysis: summary (see details in Annex 1).

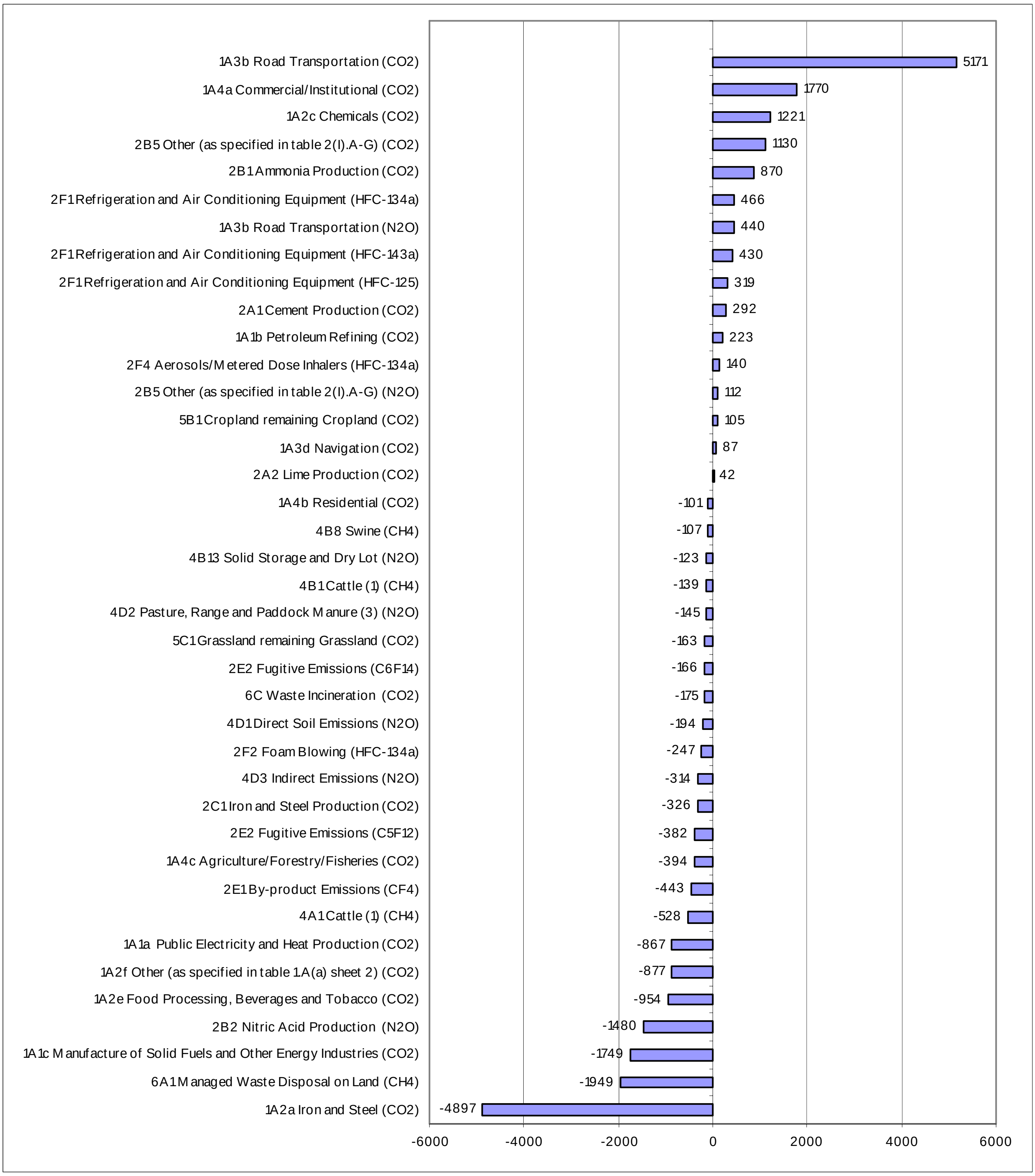
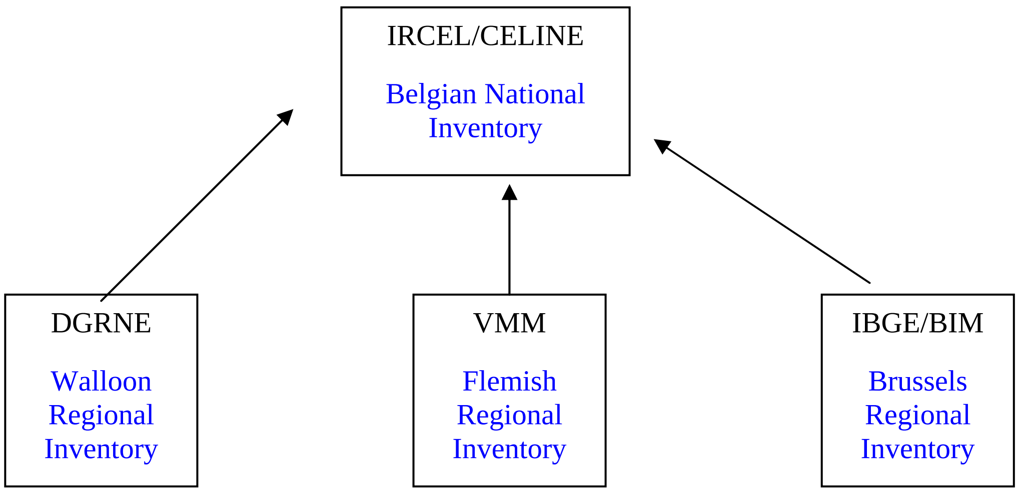


Figure 1.1. : Key source category analysis : GHG Emission Trends 1990-2006 (Gg CO_2 equivalent).

1.5. QA/QC

1.5.1. Structure of the inventories

Belgium is a federal state organized in 3 Regions : Flanders, Wallonia and the metropolitan Region of Brussels. Each is responsible for the GHG inventory of its own territory; Consequently every year, 3 inventories are compiled and aggregated into a national dataset, which is managed by the IRCEL/CELINE interregional cell, as presented on the next figure.



The various organisms who take responsibility for the inventories are shown in the figure :

IRCEL/CELINE	an interregional cell constituted by members of all 3 Regional administrations;
DGRNE	the Walloon regional administration for Natural Resources and Environment;
VMM	the Flemish Environmental Agency;
BIM/IBGE :	the Brussels Institute for Environment Management.

More information on the various actors can be found in the general description of the Belgian National Inventory System [1].

1.5.2. Expert Review Report (June 2007)

An in-country review of Belgium's Initial Report under the Kyoto Protocol and 2006 national greenhouse gas inventory took place in June 2007. The Expert Review Team (ERT) concluded that the Belgium inventory is largely complete and has been submitted in accordance with the relevant provisions [4]. It also commended Belgium, notably for significant improvements concerning the harmonization of emission factors and data allocations between the 3 regions.

The expert review team (ERT) pointed out however that Belgium did not elaborate an inventory Quality Assurance / Quality Control (QA/QC) plan as specified in Paragraph 12.d of Decision 19/CMP.1. The ERT however acknowledged that elements of QA/QC activities existed at both the regional and the national level and that actors involved in the inventory process were able to answer most questions that were raised.

However, it considered that the absence of a QA/QC plan for the national inventory could compromise the quality of the Belgian GHG inventory and therefore expressed, among other, the following recommendations to Belgium :

- develop and implement a QA/AC Plan and procedures in accordance with the requirements stipulated by decision 19/CMP.1 [5];
- make all archived inventory information accessible by collecting and gathering it at one single location;
- improve the transparency of the inventory by structuring the presentation in accordance with the UNFCCC reporting guidelines, providing improved documentation of methodologies, emission factors and activity data;
- improve the completeness of the CRF-tables;
- allocate sufficient resources to QA/QC activities.

1.5.3. Follow-up

In July 2007, Belgium transmitted a first document presenting an action plan establishing the framework for the development and implementation of a QA/QC Plan [3]. The document identifies the quality objectives to be met and the elements of the QA/QC plan to be developed in order to meet those objectives.

The recommendation concerning the allocation of resources to QA/QC activities should be met by the designation of one fulltime additional member of the IRCEL/CELINE cell, whose responsibilities are :

- the compilation of all 3 Regional inventories into the official national database;
- the establishment and maintenance of that national inventory database;
- the coordination of all other tasks related to the greenhouse gas emission inventory;
- the development and implementation of a QA/QC plan, 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.

The CCIEP Working group on Emissions is responsible for optimizing the QA/QC plan, on the basis of the annual evaluation and improvement procedures. The regions are responsible for providing the relevant documentation to the national compiler, in due time, according to the procedures of the national system.

The Regions, through their representatives in the National Climate Commission, are committed to reinforce the human resources of CELINE/IRCEL. This decision was approved by the National Climate Commission and by the Coordination Committee of CELINE/IRCEL.

The present document builds on the previous action plan of July 2007. It proposes a QA/QC plan, to be implemented by the Regions and the national compiler. It aims at :

- identifying already existing QA/QC procedures;
- classifying types of inventory data by categories, identifying risks of errors or omissions and QC procedures and checks in order to minimize those;
- recording all information flows and listing secondary sources of information on which the inventories partly rely and whose quality procedures will have to be checked;
- proposing QA general guidelines and identifying actors who would apply them
- elaborating a procedure to record, store and archive all required documentation;
- state objectives for the development and implementation of a QA/QC plan.

1.5.4. Definitions

As a reminder, IPCC Guidelines provide the following basic definitions [6], [7]:

<u>Quality control</u> (QC) :

A system of routine technical activities to assess and maintain the quality of the inventory as it is being compiled. It is performed by personnel compiling the inventory and is designed to provide checks ensuring data integrity, correctness and completeness, identify and address errors and omissions and document, and archive inventory material and record all QC activities.

<u>Quality assurance</u> (QA) :

A planned system of review procedures on the inventory (when it is completed) that will be applied by persons not directly involved in the inventory compilation. The review is performed on completed inventories following the QC procedures. Its aim is to verify that quality and accuracy objectives are respected.

Quality assurance must also achieve a permanent and continuous <u>improvement</u> process.

<u>Verification</u> :

The application of methods external to the inventory by persons external to the procedure in order to try and establish its reliability. It includes comparison with estimates done in other countries (regions) and/or with estimates obtained by alternative methods.

In the present note, we shall consider that the verification process is part of the QA process. Actually, it is already performed by the UNFCCC itself, which regularly establishes comparisons among national inventories and issues questions to inventory experts.

1.5.5.Quality objectives

The quality objectives for the national GHG inventory aim at ensuring its consistency with UNFCCC Guidelines for annual inventories and with relevant decisions of the COP and COP/MOP.

Quality objectives also aim at continuously improving the quality of the national inventory, and facilitating the review of information submitted under Article 7, as required by Article 8 of the Kyoto Protocol.

Quality objectives of an inventory are the following :

Completeness :	all GHG sources or sinks occurring on the territory are covered by the national inventory.
Consistency :	emissions are estimated in a consistent manner over the complete time series.
Comparability :	GHG emissions are estimated and allocated in a consistent way among the three regions.
Transparency :	methods and data used are explained in detail (a.o. in the National Inventory Report), which facilitates their evaluation in the quality assurance process.
Accuracy :	estimates are as accurate as possible considering the scientific knowledge available, and uncertainties are reduced as far as practicable.
Timeliness :	the national system ensures that the national inventory is provided within the required time for its submission to the UNFCCC and the European Commission.

1.5.6. Existing procedures

The Working Group on « Emissions » of the *Co-ordination Committee for International Environmental Policy* (CCIEP) with representatives of the 3 regions and of the federal public services has conducted quality assurance and quality control work by continuously exchanging information about methodologies used and estimated results. Feedback is regularly given and extra controls are made by the responsible person for compiling the Belgian emission inventory of greenhouse gases.

As a consequence, the quality and assurance controls already carried out within the responsible regions, are supplemented by those extra controls of the regional emission inventories. Finally, after completion of the Belgian greenhouse gas emission inventory by the national compiler, regions carry out a last validation of the national inventory before the official submission takes place.

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 and national emission inventories in order to improve the quality and completeness of the Belgian national emission inventory and to evaluate the differences between the actual process and the obligations in the framework of the IPCC Guidelines and the Kyoto Protocol.

The results of these audits of greenhouse gases show clearly that - taking into account the limitations in available time, manpower and means – the Belgian national inventory is of qualitative good value. The difference between the actual 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 try to limit the inconsistencies between the 3 regional emission inventories in Belgium as much as possible. The overall conclusion in the different technical working groups was that the regional and the national inventories in Belgium are set up to the best of the ability, that appropriate methods are used for all sectors and in accordance with the IPCC Good Practice Guidance.

Calculations of uncertainties on greenhouse gas emissions on the national level are calculated on Tier 1-level (see [9] , Chapter 1.6, for more details).

All 3 regions perform QC procedures, however Flanders may be the most advanced in documenting and certifying those procedures. Hereunder, the state of the art in the 3 regions is briefly described.

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 completely 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 have been 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;
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;
VMM/EIL/GP/5.002:	Procedure for the training of the personnel of the service "Emissie Inventaris Lucht" (Emission Inventory Air);
VMM/EIL/GP/5.003:	Procedure for the main process: setting up the greenhouse gas emission inventory;
VMM/EIL/GP/5.004:	Procedure to manage the Balanced Score Card.

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 describes 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 the procedure to manage the Balanced Score Card was simplified with respect to the definition of the indicators and an actualization of the other procedures occurred. 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 this procedures became official in the beginning of 2008.

Also in 2007 a management evaluation of the quality system was performed. This document formulates conclusions and recommendations with respect to the improvement of the effectiveness of the quality system and the involved processes to improve the system in relation with the requirements of the clients and the needs of means.

An internal audit took place on the 15th of June 2007. Its conclusions noted the uncomplete implementation of some of the (general) procedures 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.

All the technial 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 of the latest Belgian National Inventory 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 are part of a certified ISO 9001 system since July 2000[2]. This certificate is currently applicable to the development and implementation of complete evaluation methods and management concepts for the sustainable use of materials, energy and environment, including the electronic distribution of information on energy and environmental information (EMIS).

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

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

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

The mentioned EMIS-procedures for the preparation of the energy balance for Flanders are part of the covering quality system of the expertise center IMS (Integral Environmental Studies) in VITO. The quality handbook of the expertise center gives an overview on the global quality system with references to the specific procedures of specific activities. An example of a general procedure is

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

'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.

QA/QC in the Walloon region

In the Walloon Region, the inventory is conducted by the Cell Air, which is part of the General Directorate for Natural Resources and Environment (DGRNE).

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 European Emission Trading 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[3]. The updated list of agreed laboratories is published on the website of DGRNE, the responsible Institute in Wallonia.

GHG inventories rely heavily on energy balances. Those are established by an independent institute, ICEDD (Institut de Conseils et d'Etudes en Développement Durable), whose activities are covered by an ISO 9001 certification.

QA/QC in the Brussels region

Procedures directly applied to the inventories

The methodologies used are described in fact sheets (methods, data used, sources of information, results by gas over the years), the completeness of the inventory is checked by comparing the energy balance and the list of new environmental permits delivered each year, the consistency is implemented by recalculating all inventories when a new methodology is applied, timeliness is enforced by means of an annual "Personal work programme" which integrate the various reporting deadlines, independent experts review the inventory annually, archiving procedures are implemented.

The above mentioned work has been included in a quality handbook for the Brussels region which has been developed since the 2007 in-country review. The current available handbook is the first version, so different ways are already considered to improve it.

The next step should consist in elaborating forms as it is set-up in the Flemish region. Forms which describe the required characteristics of input data. To this end, some elements will be take of the handbook. It should result a better further work from this.

Procedures on secondary data

[3] 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) .

The Brussels Capital region is an urban region, the emissions from energy consumption constitute in Brussels nearly all its emissions.

GHG inventories rely heavily on energy balances. Those are established by ICEDD, whose activities are covered by an ISO 9001 certification. These activities are strictly planning in order to get the information needed for updating the inventory in the required times.

Uncertainties analyses (« Uncertainties on energy balances in the Brussels-Capital Region ») has been lead by the ICEDD. The last version is from April 2007.

1.5.7. Quality controls

Operations to perform

Further operations needed to meet quality objectives are already identified in the action plan submitted in July 2007. They are briefly recalled here.

Completeness

It is the task of the national compiler to keep a detailed record of all sources covered by the 3 Regions. His duty is to fill in "notation keys" for all source category with no regional estimate on the basis of information provided by the Regions and submits the records to the Regions for explanations and approval. He keeps then a written track of all explanations given.

Furthermore, if national aggregate emission estimates per sector and gas are available, they are to be compared to the sum of regional estimates and differences must be justified and documented for archives. This assessment is actually already reported in a dedicated chapter of the National Inventory Report (NIR) : report on the assessment of completeness, see [9].

Consistency

Regions are responsible for checking time-series consistencies on their inventory, through trends analysis on emission estimates, activity variables and emission factors. Checks are documented and archived.

As a double check, the national compiler performs similar operations on the national consolidated dataset.

Comparability

Regions are already devoting large efforts in improving the consistency of the methodologies used for estimating emissions. Methods of evaluation are discussed in the context of the CCIEP (Coordination Committee of International Environmental Policy) Working group on Emissions, on the basis of previous evaluations (UNFCCC review and annual reviews). Regions take the responsibility of selecting the methods of evaluation.

This work is done according to chapters 2 to 5 of the IPCC good practice guidance. The choice of the estimation method at the source category level is assessed by means of the decision trees. The choices of emission factors and activity data are compared with the information provided in the guidebook.

The work is primarily focused on the national key sources in order to make the most efficient use of available resources.

The recruitment of the national compiler is an opportunity to improve the process. Indeed, his data aggregation task puts him in a privileged position to identify inconsistencies between regional estimates.

This exercise will be reported in a dedicated chapter of the NIR (report on the assessment of the comparability) from the 2009 submission on.

Transparency

Methods and data have to be systematically documented to facilitate replication and evaluation of the inventory by users and reviewers. See ”Documentation and archives” here after.

Accuracy

The check procedures recommended by the IPCC Good Practice Guidance will guide this work of accuracy during the quality control work.

As a basis, Tier 1 QC checks will be applied at both regional and national levels, on the basis of Tier 1 general inventory level QC procedures described in the IPCC Good Practice Guidance (table 8.1).

The Regions will be responsible for the checks on regional key sources and regional trends, and the national compiler for the national trends and key sources. This analysis will consider emissions, activity data and emission factors.

These checks are to be performed on selected sets of data and processes, such that identified key source categories are considered every year. Checks on other source categories will be conducted less frequently. A sample of data and calculations from each sector will be included in the QC process each year to ensure that all sectors are addressed on an ongoing basis.

Source-category specific QC procedures (Tier 2) are to be applied on a case-by-case basis, at the regional level, focusing an key source categories, or source categories where significant methodological or data revisions have taken place. These procedures will also address emission data, activity data, and uncertainty estimates.

The IPCC Good Practice Guidance, and in particular chapter 7, will be used to identify the source categories that have the greatest contribution to overall inventory uncertainty in order to make the most efficient use of available resources.

Timeliness

The detailed calendar with the actions, responsibilities and data flows will be further elaborated in dialogue with all the parties involved within the CCIEP Working group on Emissions, and will be reported more formally during the 2009 submission ; the evaluation of the previous year delivery data will be assessed and if needed, the calendar will be updated. The annual progress report of the EU Commission (Status and Consistency report), in the context of the “Monitoring Mechanism” decision[4] will be used for this assessment.

[4] Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol

Source categories

Basic QC principles contain often more or less the same standard operations : identify risks of errors or omissions, list and apply a series of checks to minimize those risks, document all operations performed to estimate emissions and to apply QC procedures.

Data collected and managed to evaluate emission estimates can be classified among a limited number of categories :

A individual emission data;
B individual activity data and emission factor(s);
C sum of individual data;
D calculated emissions from statistical data and emission factor(s);
E combination of the above categories;
F computer model.

For each category, it is possible to list the various risks of error, omission or other inaccuracy and for each type of risk, one or more QC procedures can be defined. Therefore, the preparation of direct QC procedures can be limited to a series of 6 checklists, one for each category of data.

Each emission source (characterized by a CRF classification) is then classified into one of the 6 categories and receives its corresponding checklist.

Hereafter, we review the different source categories, identifying possible risks of error that could occur in handling the data and QC procedures to be applied to minimize those risks. The lists hereafter are not exhaustive and may improve during implementation.

At this time, most procedures and checklists are already part of the operational procedures applied in Flanders. Many quality control checks are also regularly applied also in the other Regions, but mostly need to be properly described, documented and archived .

A Individual emission data

Example of data

Data can be emissions measured on an industrial site or emissions which are calculated by the personnel of an industrial company and certified, for instance, in a validation process for the Emission Trading reporting.

Risks of error

- omission of the source by the inventory compiler;
- error in the communication of the value (the source provides a wrong value);
- error in recording the value in the inventory (wrong transcription);
- error in allocating the value to a specific CRF category (wrong category or misunderstanding of the source description);
- error in conversion of units.

QC procedures

- verify if the value is certified (for instance, if it represents an official emission level report within the framework of Emission Trading assessments). If so, the certificate should be assessed or stored in archives;
- perform a trend analysis;
- verify if the contact providing the value is the same person as previous years. Record coordinates of contact in archives;
- verify the coherence between CRF category allocations in the 3 Regions.

Finally, all records of the operations must be stored and secured in archives.

Archives

- coordinates of contact;
- copy of certificate or notification of certification, if any;
- completed checklist of QC performed.

B Individual activity data and emission factor

Example of data

Production data in an industry (tonnes/year) or natural gas consumption of an individual industrial site.

Risks of error

- same as above (A);
- use of an inconsistent emission factor (if standard value);
- use of a wrong emission factor (if measured);
- incompatibility between units used to express activity data and emission factor.

QC procedures

- same as above (A)
- establish a unique table of emission factors (standard emission factors) and check correct use;
- compare emission factor with standard value (id measured);
- establish a unique table of unit conversion factors.

Archives

- coordinates of contact;
- reference to table of unit conversion factors;
- reference to table of standard emission factors;
- completed checklist of QC performed.

C Sum of individual data

Example of data

Individual data can be of type A (i.e. emissions from different factories), or of type B (energy consumptions of different sites and distributed among various fossil fuels).

Risks of error

- same as above (A or B, depending of type of individual data);
- error in calculating the sum.

QC procedures

- same as above (A and B)
- establish a table gathering all individual data, including emission factors if needed, and performing calculations (Excel file), where all parameters are explicitly specified (never include parameters values in the formulas), verify that the sum covers the correct number of data values.
- document the table if necessary;

Archives

- coordinates of all contacts;
- reference to table of unit conversion factors;
- reference to table of standard emission factors;
- table of data and calculations including explanations;
- completed checklist of QC performed.

D Calculated emissions from statistical data and emission factors

Examples of data

- Data from the energy balance: annual energy consumptions by sector or sub-sector and distributed among various fossil fuels.
- Mobility data from national statistics.

Risks of error

- uncertainties inherent to the method used to establish the statistical data;
- errors in transcription of data by the institute establishing statistics;
- different classification of data by the institute and in the inventory, yielding interpolation calculations;
- misunderstanding of the classification used in the statistics;
- use of wrong emission factors;
- wrong units conversion;
- calculation errors.

QC procedures

- verify if institute is certified (ISO, EMAS, other);
- verify if it applies internal QA/QC procedures; is it compatible with UNFCCC requirements?
- check the procedure applied to officially approve the statistics;
- find documentation about the source and the methodology used to establish the statistics;
- document all calculations and spreadsheets;
- refer to tables of emission factors;
- verify coherence with inventories in other Regions (same source of information? Same evaluation of data quality?)

Archives

- copy of statistical data or clear reference (website, reference of publication and location of document,…);
- evaluation of quality of data (eventually personal comments);
- documentation about the procedure/methodology applied to establish statistics;
- reference to table of unit conversion factors;
- reference to table of standard emission factors;
- table of data and calculations including explanations;
- completed checklist of QC performed.

E Combination of the above categories

Examples of data

Emissions of an industrial sector where part of the industries are concerned by the emission trading mechanism, part is not but provides activity data and residual emissions are computed using the energy balance.

Risks of error

All risks listed above

QC procedures

All listed above

Archives

All listed above

F Model

Examples of data

Emissions from domestic waste landfills have to be computed, taking into account the progressive production and emission of landfill gas due to organic matter decay.

Risks of error

- uncertainties linked to the model;
- computational errors within the model;
- errors in data inputs;
- errors in unit conversion of inputs or outputs of the model;
- application of a model out of the range of validity the theory of underlying equations.

QC procedures

- trend analysis;
- all QC procedures identified under A or B and applied to individual input data;
- evaluation of input data quality as described under D (if relevant);
- consult other Regions and harmonize approaches.

Archives

- documentation of model;
- eventually document reasons to apply the model;
- model files, if available, clearly identifying input data and results;
- documentation of input data sources;
- completed QC checklists on input data

1.5.8 Information flows and secondary data sources

For many source categories, estimation methods rely on the use of activity data and associated input variables that are not directly prepared by organisms responsible for inventories. Moreover, part of the inventory (fluorinated greenhouse gases) is established by an external consortium of consultants (Econotec/VITO).

As mentioned in the *« IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories »* chapters 8.6 (General QC Procedures - Tier 1) and 8.7 (Source Category-Specific QC procedures - Tier 2): 'responsible organisms for inventories have to verify that adequate QC procedures have been implemented by consultants, agencies or offices producing these data'.

Different "status of data" have to be considered :

- site-specific data ;
- secondary data sources ;
- emissions estimated by a consultant.

Flowcharts presented in Annex 6 show, for each Region, the flows of activity data used to estimate emissions from key sources. Specific figures have been established for Energy, Industry, Agriculture and Waste. For Brussels, only one chart (for Energy) is presented because the other sectors are not relevant in this region.

It is the responsibility of the inventory experts to verify if adequate QA/QC procedures are implemented by the different organisms identified in the flowcharts and providing the necessary data and to evaluate the quality of the data used to establish inventories. As some of the data sources are common in the 3 regional inventories, it is recommended that a concerted action by the 3 Regions is taken for these common sources under the coordination of the national compiler.

The sources that are consulted for key source activities will be assessed in a first phase, others can be addressed later as part of the continuous improvement of the inventories.

Annex 7 presents a glossary of terminology and acronyms used in Annex 6.

1.5.9. Quality Assurance

Quality assurance is performed by means of reviews on the compiled and verified datasets. Reviews are led by external persons to the inventory process and/or by peers. However, procedures and programmes are to be prepared by the national compiler.

The quality assurance is covered by the following aspects:

Implementation of a procedure for the main process of the national GHG inventory.

This procedure describes the methodology which is used by the national compiler and the regional personnel to carry out the phases of the inventory. This procedure also defines the key resources and responsibilities of the staff members (at regional and interregional levels) involved in the inventory process.

Implementation of a procedure to define an internal audit evaluation of the inventory process.

Audits should verify the availability and completeness of documentation, the recording of QC checks , the respect of archiving procedures,…. The programme and calendar of audits are defined by the national compiler, but audits themselves are be performed by external persons to the inventory process

Each audit covers a selected number of items. Audits will in a first phase focus on key emission sources. However, the programme of the whole review should ensure that successive audits cover the totality of the inventory categories on a period of 5 years (covering for instance the whole Kyoto commitment period, 2008-2012).

A procedure of annual reviewing of the whole inventory process by a panel of national experts not directly involved in the inventory process.

It is proposed here that the National Climate Commission selects the external experts who will be in charge of the reviews.

A process of approval of the national inventory by the National Climate Commission

The procedure already exists, it just has to be documented and referenced.

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 between regional datasets and that emissions allocations are similar. The procedure could be led by the national compiler and the main responsible personnel of the regional inventories. It would include the verification that methodologies applied to estimate emission levels always respect UNFCCC requirements (i.e. basically Tier 2 methods are to be applied for all identified key sources).

A second level consists in a peer review with similar foreign countries following the completeness of the inventory. Incidentally, such an exercise has already 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.

1.5.10. Documentation and archiving

The objectives of archives are :

- store and secure inventory data on the regional and the national level;
- store, organize and secure a thorough documentation of all emission sources, data, uncertainties, calculation methods and models as well as of the various information sources;
- record all QA/QC procedures and checklists;
- establish an information databank to facilitate reporting and review processes.

Following the expert review team recommendations, archives and inventory data should preferably be located at a unique central location. However, due to the peculiarity of Belgium, documentation and methodologies are developed and maintained by the regional experts involved in the inventory process. The adequate maintenance of archives, which is a permanent process, regularly implementing improvements and recalculations in inventories, imposes a close proximity between datasets and documentation. Moreover, some data has been transmitted to regional experts under cover of confidentiality and cannot be transferred without very particular care.

It is therefore proposed here that the notion of “unique central location” applies to each regional inventory and not (only) to the national dataset. This would ensure that the necessary documentation is not spread among different administrations and persons, but will respect the proximity requirement of documentation and archives.

The regions will be responsible for archives covering their own datasets, and all documentation related to their information sources, calculation methods and models. They will also archive QC procedures and checklists. Systematic procedures and labelling in all 3 regions will be pursued in order to facilitate the reviewing and QA processes.

National archives will also be maintained, containing :

- the official national inventory datasets;
- the documentation covering the consolidation process that the national compiler performs to aggregate regional datasets;
- the result and trace of any QA/QC procedures on the national dataset;
- the history of official data and documentation submitted to the UNFCCC, as well as all synthesis and assessment reports, expert review questions and reports, and answers to all official communications.

National archives will also include a general catalogue of existing archives in all 3 regions, to be held by the national compiler.

Finally, the national compiler will be responsible for defining and implementing a secure back-up procedure of all official documents, including official inventory datasets.

1.5.11. Timetable

The QA/QC process for the national inventory still must be developed and implemented in Belgium. This process will use inventory data for 2007 to test procedures and work programmes. The workprogramme is detailed hereunder

Completeness

Lack of notation keys is identified as the main completeness issue in the Belgian inventory. These will be completed for the next inventory submission (april 2009).

Consistency

In 2007, The IRR concluded : " The ERT concluded that Belgium's national inventory generally provides a consistent time series in accordance with the IPCC good practice guidance, although consistency is hampered by inventory improvements and recalculations in some cases being applied independently in each region ". Better coordination of the improvements will be developed at the national level by the working group emissions and the national compiler, for the april 2009 submission.

QC procedures have been set up or are currently developed in the 3 regions. The aim is to implement them for the key sources by the next submission (april 2009). Similar procedures will be developed and implemented at the national level for the 2009 submission, in priority for the key sources.

Comparability

The ERT concluded in 2007 " Belgium's inventory is comparable with those of other Annex I Parties" and " Comparability of the inventory, particularly the methods and EFs used, could be enhanced through improving documentation of these in the NIR (paragraph 29) at both regional and national levels." The NIR has been developed in that view for the present 2008 submission.
Methodologies and emission factors have been largely harmonised between the 3 regions in the recent submissions. Remaining inconsistencies will be identified and reported for the 2009 submission. The possible further harmonisation will be discussed in the working group emissions, as for some sectors available activity data sets are not the same.

Transparency

The IRR report concluded that " Belgium's inventory is generally transparent; however, the transparency and comparability of the inventory is compromised when regional inventories are aggregated into the national inventory, as not all supporting regional information is included in the NIR." Consequently, the NIR has been largely developed for the present 2008 submission, following the ERT recommandations in the IRR report 2007 : " The ERT was provided with considerable additional information for all sectors during the in-country visit and the ERT recommends that Belgium include this information in the NIR".

Accordingly, more detailed description of methodologies and activity data are included. The need of furhter development of the NIR for the next submission (april 2009) will be discussed in the working group emission.

Accuracy

The 2007 ERT recommandations regarding accuracy have been implemented : base year revised estimate have been submitted in july 2007 and Tier 2 has been developed and used for enteric fermentation in the present april 2008 submission.

Other aspects

Regarding the secondary activity data and information flows, the existence of adequate QA/QC procedures will be assessed by the 2009 submission.

Existing QA procedures such as approval of the inventories by the National Climate Commission and reviews under the UNFCCC and the Kyoto Protocol will be in 2008-2009, but by the next submission, priority will be given to the development of QC procedures and their implementation at both the regional and national level. It seems more consistent to first improve the internal QC procedures and other identified issues in the inventory, before the developement of external QA.

1.6 Tier 1 uncertainty calculation

1.6.1. General approach

The IPCC Good Practice Guidance Tier 1 methodology has been applied to assess the uncertainty in the emission greenhouse gas inventory. The uncertainty calculation is applied on the Belgian greenhouse gas emission inventory for the years 2005 and 2006 as submitted on the 15th of March 2008 to the European Commission.
A trend uncertainty analysis is performed for the years 1990 (1995 for F-gases) and 2005-2006. All sectors and greenhouse gases are included in this calculation.
The uncertainty calculation at a Tier 1-level of the fluorinated greenhouse gases has been carried out from 2005 on by Econotec and the Vito for the years 1995 (base year for F-gases), 2003, 2004 and 2005. See reference [45] for the most recent published report of emissions of F-gases.

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’.

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 3 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/CORINAIR guidebook [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 then 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 III.

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.

1.6.2. Methodology of the uncertainty calculation in detail by CRF category

1A1 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.

1A2 Manufacturing industries and construction.

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.

1A3 Transport

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 uncertainty 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 a electrical way. 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/CORINAIR guidebook 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/CORINAIR guidebook.

The CO_2 emissions under category "other" includes 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).

1A4 Other sectors

Commercial and residential fuel consumption are 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).

1B Fugitive emissions from fuels

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.
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%.

2A Mineral products

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/CORINAIR 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.

2B Chemical industry

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 is only one producer of nitric acid remaining in the Flemish region since 2000 with reliable production data, the uncertainty of the activity data is estimated at 2%. Based on the Finnish evaluation in 2001, the uncertainty on the N_2O emission factor is estimated at 80% in spite of an agreement of this company for the emission factor used.
The same uncertainty in activity data is used for the production of caprolactam as for the production of nitric acid (2%) for the same reason. The uncertainty of the emission factor is estimated at 30% by expert judgment.

2C Metal production

The uncertainty on activity data is estimated at 2% because these figures come directly from the companies which dispose of good developed statistical systems., Their uncertainty is assumed to be in the low range of IPCC values as the emission factors are mainly plant-specific.

2E Production of halocarbons

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 (see 1.6.1 [45]) 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).

2F Consumption of halocarbons

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 been estimated in general 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.

2G Feedstocks

The uncertainties both on activity data and emission factors for CO_2 are mainly based on expert judgment. Information originated from the emission inventories of Finland and the Netherlands is also taken into account to obtain a final uncertainty of 25% on activity data and of 30% on the emission factor.

3D 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/CORINAIR 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.

4A Enteric fermentation

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 1 methodology. Consequently, the IPCC uncertainty estimate of 40% is used for the emission factor.

4B Manure management

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.

4D Agricultural soils

This small source for CH_4 is linked to the manure applied during grazing. The same uncertainty as for CH_4 from manure management is applied.

In comparison with the previous agricultural sectors, N_2O emissions from soils involves 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.

6A Solid waste disposal on land

In the Flemish region input data of waste disposal sites are available since 1990. There isn't waste disposal site in the Brussels region.
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 25 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 overall 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 adopted for this calculation.

6B Wastewater handling

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.

6C Waste incineration

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 %.

6D Composting

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.

1.6.3. Results and discussion

The Tier 1 analysis of the uncertainty results in an overall uncertainty of 7.65 % in the 2005 inventory for Belgium and a trend uncertainty 1990-2005 of 3.37 %.

As in other Parties, this outcome 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 uncertainty analysis for 2006 is still provisional (the F-gases still need to be included). The Tier 1 analysis for 2006 gives an overall uncertainty of 7.69 % and a trend uncertainty 1990-2006 of 2.70 %.

1.7 Completeness analysis

Sources and sinks

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

- o CO_2 from *asphalt roofing* (2A5), due to missing activity data*;*
- o CO_2 from *road paving* (2A6), due to missing activity data*;*
- o N_2O from *Industrial wastewater (*6B1), due to missing activity data. No CH4 sources from *Industrial wastewater (*6B1) were identified (see chapter 8).
- o Agriculture sector in the Brussels region, due to negligible amounts (see chapter 6.1.2. for details)
- o Precursor emissions (i.e. CO, NO_x, NMVOC and SO_2)

No additional sources and sinks specific for Belgium have been identified for the time being

Gases

All direct greenhouse gases are covered by the Belgian inventory.
Precursor emission estimates (i.e. CO, NO_x, NMVOC and SO_2) could be refined as it seems that some sources were not properly exported from the Collecter database to the CRF format. This was not seen as a prior issue given the recalculations performed for the 2008 submission regarding direct greenhouse gases accounted under the Kyoto Protocol.

Geographic coverage

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

Notation keys

This is the main completeness issue identified in the Belgian inventory. The use of the Reporter database should ease this process in the Belgian inventory for the future submissions, but this work could not be conducted for the 2008 submission, given the recalculations performed following the in-country review of june 2007.

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 fourth National Communication. 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. A division of GHG emission trends at the regional level is presented in Annex 2. Trends of indirect GHG and SO_2 are presented at the end of the chapter.

2.1. Emission trends for aggregated greenhouse gas emissions

Total greenhouse gas emissions (without LUCF) in Belgium amounted to 135.9 Mt CO_2 eq in 2006 (Table 2.1.), which constitutes an decrease by 5.2 % compared to GHG emissions in 1990. Emissions in 2006 are 6.0 % under base year emissions[5] (Figure 2.1). Under the Kyoto Protocol and the EU ‘burden sharing’ agreement, Belgium is committed to reduce its GHG emissions by 7.5%. Assuming a linear target path from 1990 to 2010, total GHG emissions in 2006 were on target path, but recent changes in the industrial sector are likely to increase the emissions in the coming years.

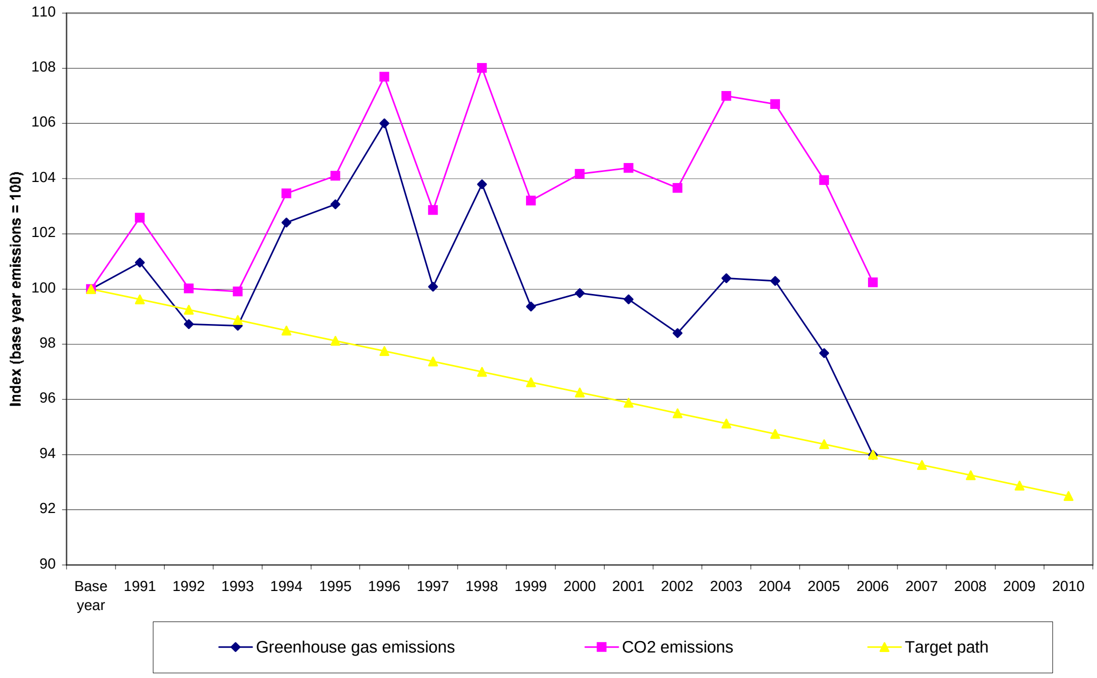


Figure 2.1. : Belgium GHG and CO_2 emissions 1990-2006 (excl. LULUCF), compared with Kyoto target.

Unit: Index point (base year emissions = 100).For the fluorinated gases, the base year is 1995.

[5] Base year is 1995 for fluorinated gases, 1990 for other gases

Table 2.1. : Overview of Belgium GHG emissions and removals from 1990 to 2006, excluding LULUCF (Gg CO_2 equivalents).

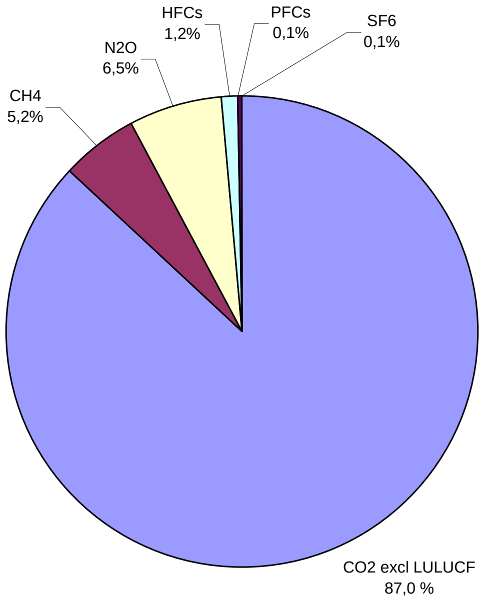
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
CO2 excl LULUCF	118817	121887	118835	118715	122928	123688	127952	122213	128341	122621	123780	124031	123169	127130	126776	123500	119107
CO2 incl LULUCF	117386	120695	117272	117231	121363	122302	126695	120805	127056	121398	122229	121233	120831	125413	125603	123129	118046
CH4	10404	10204	10042	9883	9866	9870	9569	9429	9240	9057	8775	8415	7946	7592	7471	7275	7086
N2O	10774	10664	10304	10640	11206	11662	12092	11815	11937	11840	11533	11304	10794	9799	10008	9851	8954
HFCs	439	439	439	439	403	439	527	639	779	817	952	1083	1303	1466	1508	1494	1595
PFCs	2434	2358	2510	2439	2793	2335	2220	1224	686	348	361	223	82	209	306	141	152
SF6	1662	1576	1744	1677	2035	2205	2121	526	271	122	112	129	112	100	84	84	75
Total excluding LULUCF	**144530**	**147128**	**143874**	**143792**	**149232**	**150199**	**154481**	**145847**	**151255**	**144805**	**145511**	**145185**	**143406**	**146296**	**146154**	**142346**	**136970**
Total including LULUCF	**143099**	**145936**	**142310**	**142308**	**147666**	**148813**	**153224**	**144438**	**149970**	**143581**	**143961**	**142387**	**141069**	**144579**	**144980**	**141976**	**135909**

Table 2.2. : Overview of GHG emissions and removals in the main sectors from 1990 to 2006 (Gg CO_2 equivalents)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1. Energy	112736	116301	113179	113180	115980	116350	121365	115269	121021	115330	116388	117129	115334	119258	118589	115230	110860
2. Industrial Processes	16401	15724	15620	15640	18150	18736	18402	15909	15741	15088	15195	14561	15078	14585	15318	15172	14458
3. Solvent and Other Product Use	246	246	249	247	244	240	238	238	237	236	253	252	250	250	250	249	249
4. Agriculture	11751	11601	11539	11660	11720	11854	11698	11650	11645	11689	11352	11248	10952	10497	10423	10279	10182
5. Land Use, Land-Use Change and Forestry(5)	-1431	-1192	-1563	-1483	-1566	-1386	-1257	-1408	-1285	-1223	-1550	-2798	-2337	-1717	-1173	-370	-1061
6. Waste	3395	3256	3287	3065	3139	3018	2778	2781	2611	2462	2322	1995	1793	1706	1575	1415	1221
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**143099**	**145936**	**142310**	**142308**	**147666**	**148813**	**153224**	**144438**	**149970**	**143581**	**143961**	**142387**	**141069**	**144579**	**144980**	**141976**	**135909**

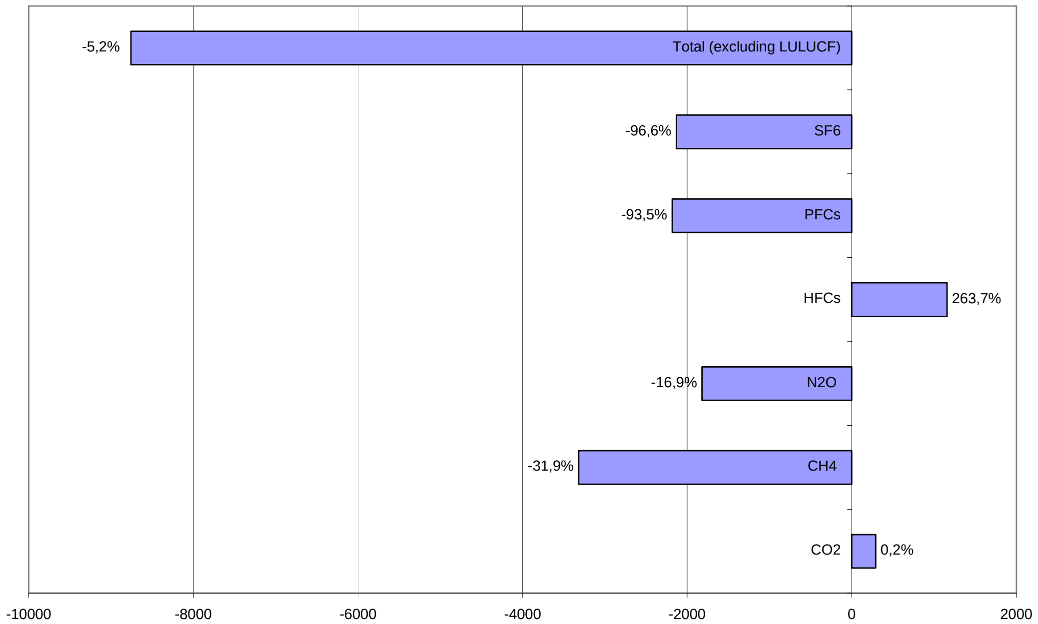
2.2. Emission trends by gas

The major greenhouse gas in Belgium is carbon dioxide (CO_2), which accounted for 87.0 % of total GHG emissions in 2005. Methane (CH_4) accounts for 5.2 %, nitrous oxide (N_2O) for 6.5 %, and fluorinated gases for 1.4% (Figure 2.2). Emissions of CO_2 increased by 0.6% during 1990-2006, while $CH_{4,}$ N_2O and fluorinated gas emissions have dropped with respectively 31.9%, 16.9% and 59.8 %[6] during the same period.



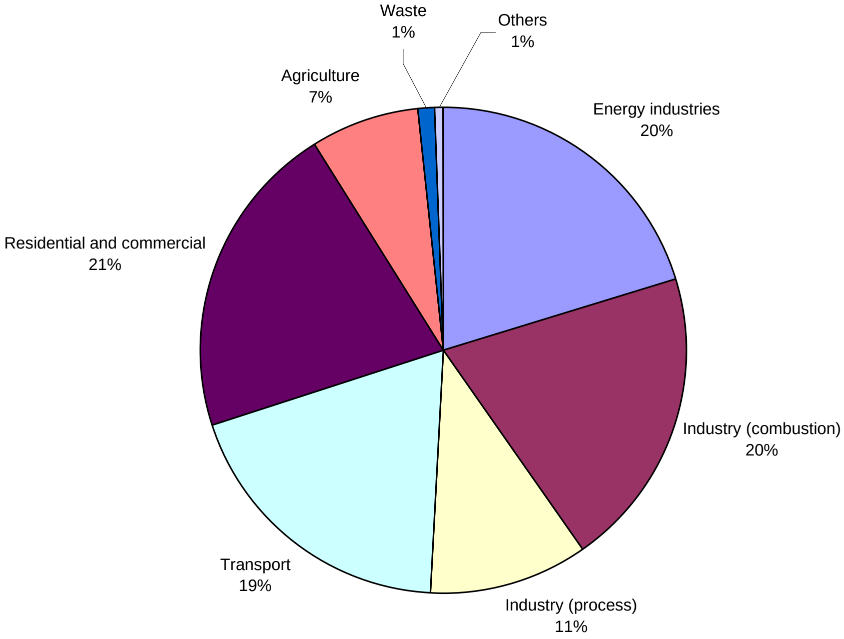
[6] compared to 1995 emissions

Figure 2.2. : Share of greenhouse gases in Belgium (2006), and changes compared to base year (1990 for CO_2, CH_4 and N_2O; 1995 for F gases)



2.3. Emission trends by source

An overview of the contribution of the main sectors to Belgium greenhouse gas emissions is given in Figure 2.3. Energy industries, manufacturing industry, transport, space heating and industrial processes are the most important sectors in the total GHG emissions in 2006.



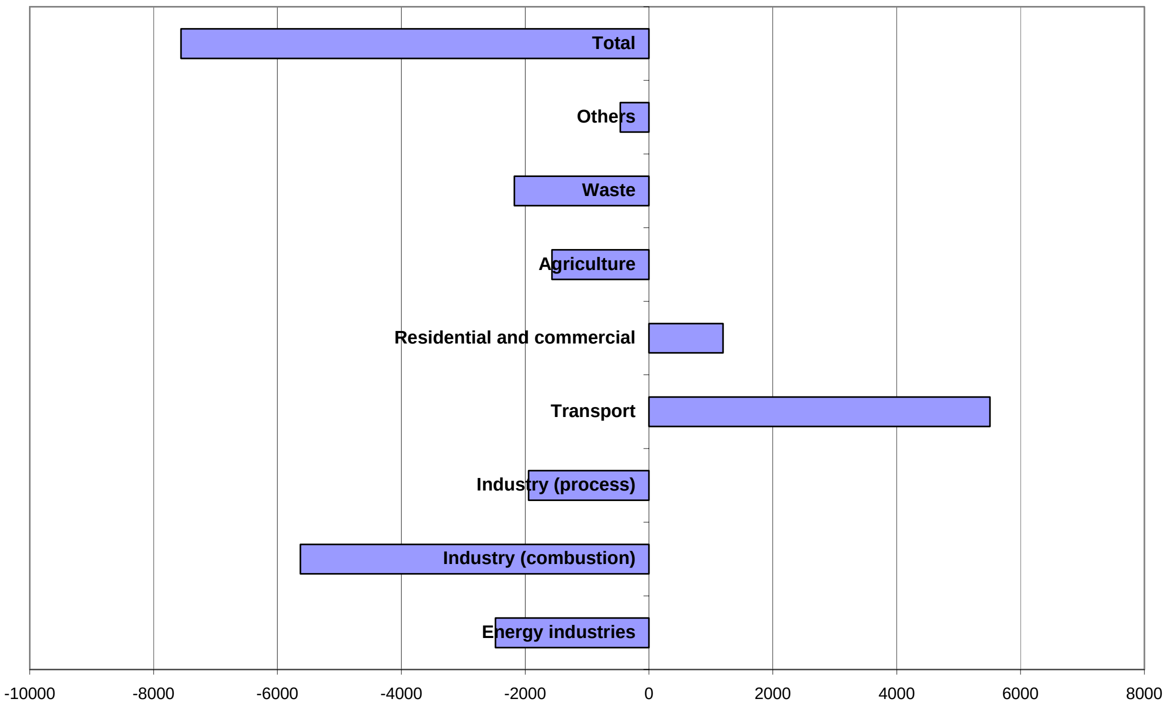


Figure 2.3 : GHG emissions : share of main sectors in 2006 (a) and changes from 1990 to 2006 (b).

Figure 2.3 summarises the impact of the main sectors on the national trend. It clearly the sharp increase in road transport on the one hand, but also to emissions from buildings in the residential and commercial sectors on the other hand. Since 1990, those two sectors have been responsible for a 4.6 % increase in total emissions.

This trend is counterbalanced by the 9.8 % decrease in emissions in the other sectors, particularly industry, giving an overall decrease of –5.2 % compared to 1990.

The drivers of these trends are analysed and commented upon in the following pages, sector by sector.

2.3.1. Energy industries (1A1)

The main source for this sector is public electricity and heat generation (1A1a), which accounted for 82% of sectoral emissions in 2006. Petroleum refining (1A1b)and manufacture of solid fuels (1A1c) accounted for 17% and 1% respectively.

Emissions from the manufacture of solid fuels have decreased by 82% since 1990 (-1750 Gg CO2 equivalent) due to the closure of four coke plants in 1993, 1994, 1997 and 2002. In the meantime, emissions from petroleum refining have increased by 5%, owing to higher production and the general economic context.

As mentioned above, however, the main driver in this sector is public electricity and heat generation. While electricity production has risen by 38 % since 1990, emissions have slightly decreased due to technological improvements and the switch from solid fuels to gaseous fuels. This is illustrated in Figure 2.4. It is estimated that some 7000 Gg CO2 equivalent have thus been avoided.

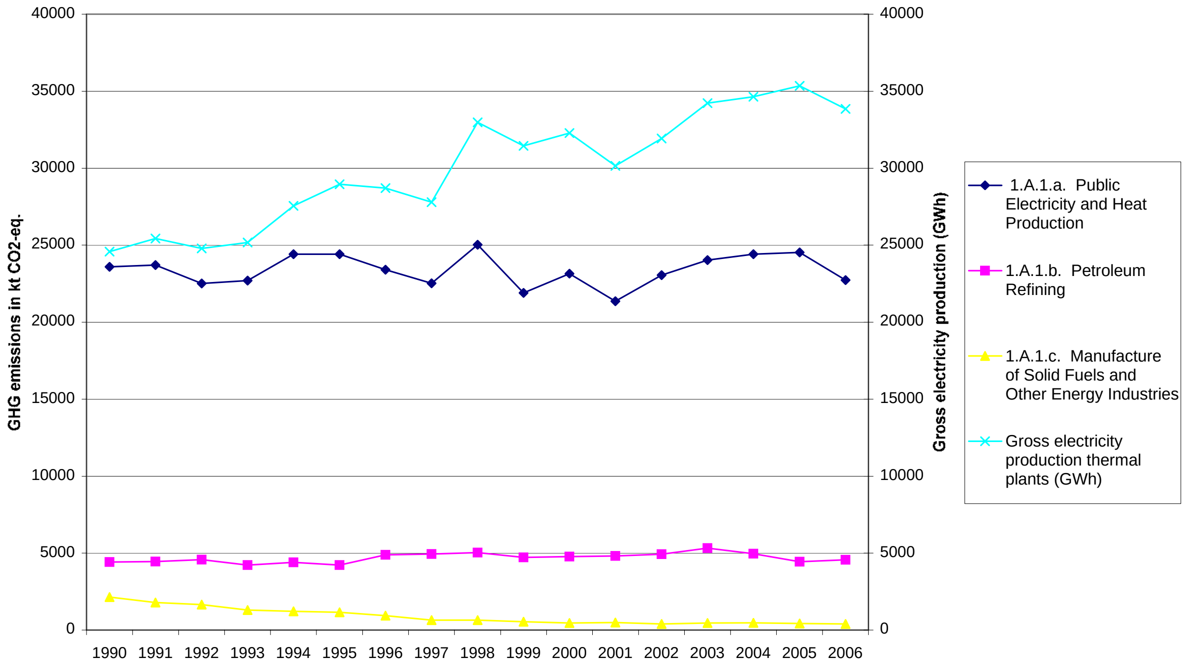


Figure 2.4: GHG emissions from public electricity and heat generation, in relation to gross electricity generation [1].

2.3.2. Manufacturing industries (1A2)

In the manufacturing industries, added value [1] has increased by 25% since 1990. One fifth of this growth stems from the chemistry sector, where added value rose 65% between 1990 and 2006. Significant growth was also seen in sectors such as food, paper, lime and cement.

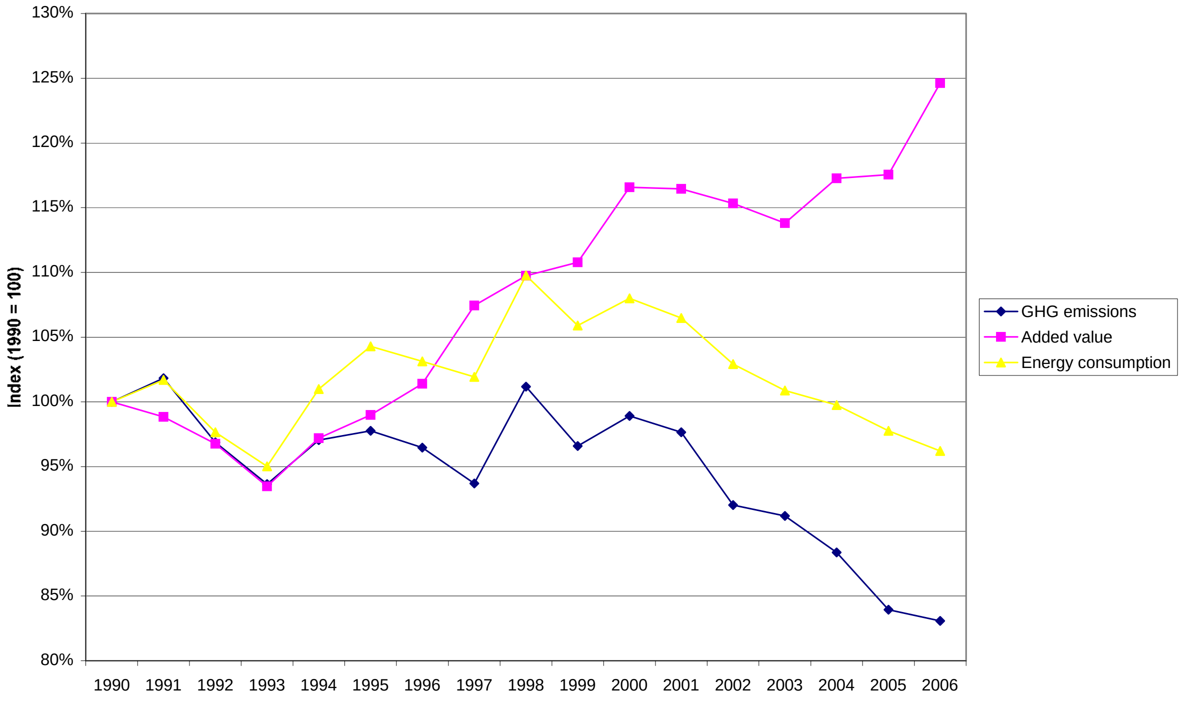


Figure 2.5 : Manufacturing industries: index of GHG emissions, energy consumption and added value [1].

As seen in Figure 2.5., primary energy consumption decreased by 4% between 1990 and 2006. This 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 represents in 2006 33% of the energy consumption (fossil fuels) by the manufacturing industries and consequently has a significant impact on the global trend.
- In the chemistry sector, energy consumption has increased by 38% 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 2006, his sector represents 30% 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 used for 73% of production compared to 61% in 1990.

Figure 2.5. 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 2.6.

The increasing use of 'other fuels' (see Figure 2.6) 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 34% of their energy consumption in 2003 , compared to 7% 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.

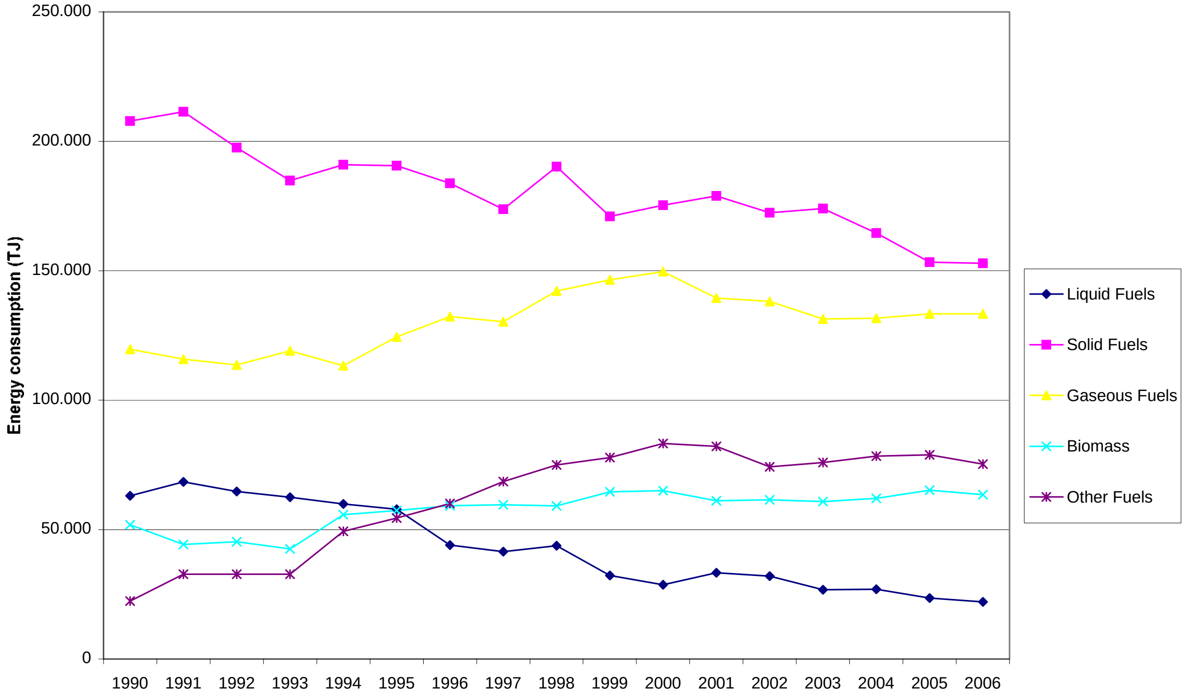


Figure 2.6 : Type of fuels used in the manufacturing industries.

2.3.3. Transport (1A3)

Transport emissions accounted for 14% of total GHG emissions in 1990 and 19% in 2006. This increasing level is due to road transport, which represents 97% of total emissions by the sector.

Emissions from domestic navigation are fairly stable and represent 2 % of total emissions. Emissions from railways 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: the number of cars has increased by 36% since 1990, together with traffic (vehicle km) which has risen in the meantime by 37% [4].

There is a marked switch from petrol engines to diesel. The number of petrol engines has dropped slightly since 1990 (-8%), while the number of diesel engines has more than doubled (+ 130%) for the same period. This is reflected in their respective emissions (Figure 3.10).

The average engine capacity has also increased since 1995, reflecting the switch to diesel on the one hand and the growing success of SUV vehicles on the other [5]. The average age of the cars has increased (improved rust protection and overall resistance), as has the average distance travelled.

The number of cars using LPG has increased by 52% since 1990 and represents 1.1% of private cars compared to 0.8% in 1990 [4]. This relative progress is rather limited, however, in regard to the price of this fuel and available subsidies.

N_2O emissions from transport more than doubled between 1990 and 2006. This is partly due to the introduction of catalytic converters (the use of catalytic converters on all petrol-engine cars was made compulsory in Belgium in 1993), but also to the ageing of the first converters, which leads to an increase in their N_2O emissions. Finally, although there is considerable uncertainty, N_2O emissions represent only 3% of total GHG emissions from road transport.

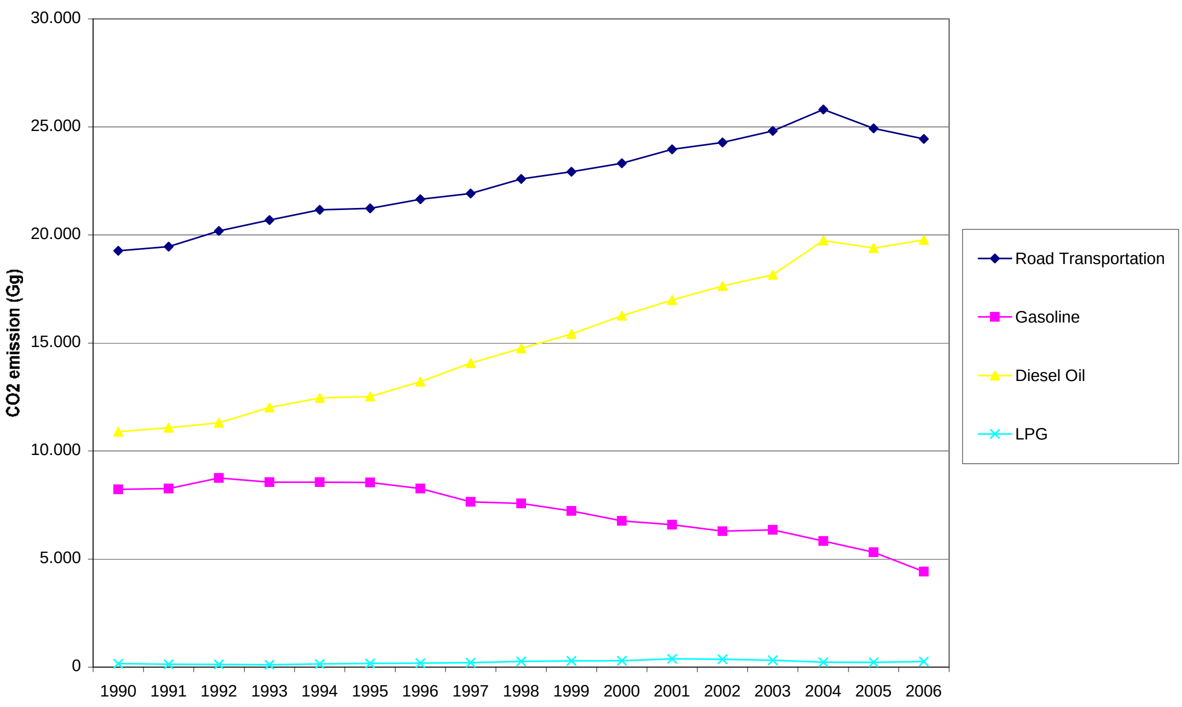


Figure 2.7 : Emission trends in the transport sector

Road transport is the leading source of greenhouse gas emissions in Belgium, in terms of level and trend analysis. With an increase of GHG emissions by 28 % between 1990 and 2006, it constitutes one of the main drivers of emissions trends. The absolute increase in CO_2 emissions from road transport between 1990 and 2006 is the highest among the key sources (+5440Gg CO2 eq.).

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 2006, these emissions accounted for 24 % of national emissions, with maritime transport representing the most important source (89 % of this category). Emissions from international aviation have increased by 14% since 1990, while emissions from maritime transport have risen by 87%.

2.3.4. Residential and commercial (1A4)

In the residential sector in 2006, fuel consumption has increased by 5% since 1990. This is mainly linked to the growing number of houses. Annual fluctuations are of course climate-related: this is particularly clear for 1996, a cold year with a marked peak of emissions from heating, but also for 2006, with a winter exceptionally mild and marked decrease of the consumption. Since 1990, gaseous fuels consumption has increased from 34 to 46% of total energy consumption, together with a decrease in solid fuels and liquid fuels. Liquid fuels still account for 49%, 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 sector, fuel consumption has increased by 49% since 1990. One reason is the rising number of employees, which has risen by more than 20% since [3]. A clear switch from liquid fuels to gaseous fuels has been observed since 1995 and gaseous fuels represent 68% of the sector's energy consumption. In the meantime, electricity consumption has also grown by more than 50%, mainly due to the development of Information Technologies and the increased use of refrigerated areas and air conditioning.

For both sectors, other fuels and biomass remain negligible for the time being. In the commercial sector, a slow increase has been observed since 1999, but biomass represents less than 1 % of the sector's energy consumption .

2.3.5. Industrial processes (category 2)

The 'industrial processes and F-gases' sector covers emissions from industrial activity, but not resulting from fossil fuel combustion. In 2006, these emissions of greenhouse gases were mainly caused by mineral products (cement and lime production, 39% of emissions) and the chemical industry (nitric acid and ammonia production, 36% of emissions). Metal production and fluorinated gases accounted for 12% and 13% respectively of total emissions in this sector.

Mineral products

These emissions occur during the production of clinkers 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 was multiplied by a factor 4.6 in 2003 compared with 1990. In parallel, these plants have taken measures to reduce emissions from their processes and one of the plants is still testing catalysts to further decrease its emissions. Consequently, the emissions remained rather stable although production rose substantially.

Metal production

In the iron and steel sector, CO_2 emissions decreased by 19% in 2006 compared to 1990. This is more or less in line with the production of pig iron.

Fluorinated gases

Emissions of fluorinated gases accounted for 1.3% of total greenhouse gas emissions in 2006. 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 2.7) 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 2.7) 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 CO2 for rigid foams, etc.

SF6 emissions originating from the production of acoustic double-glazing have been cut through the use of alternate products, however, SF6 consumption emissions are likely to increase in the coming years due to the dismantling of existing equipment.

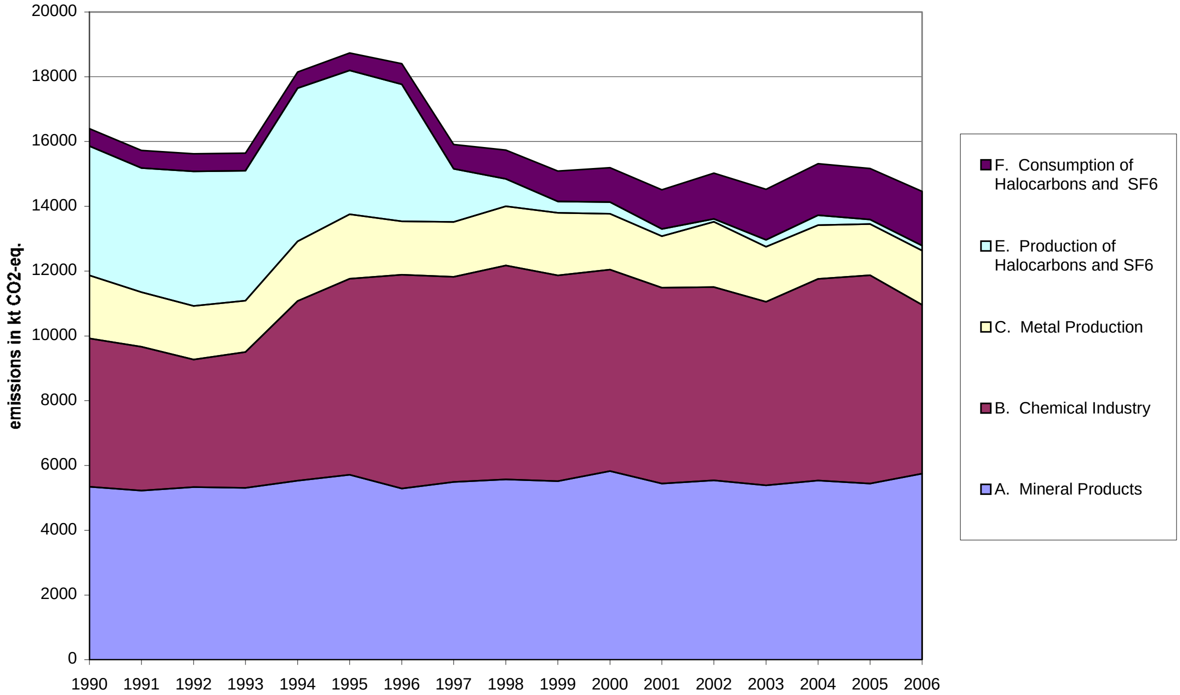


Figure 2.7. : GHG emissions in sector 2 'Industrial processes': changes from 1990 to 2006 (Gg CO_2 equivalent)

2.3.3. Agriculture

GHG emissions from agriculture accounts in 2006 for 7,4 % of the total emissions in Belgium. Overall, they have decreased by 13.4 % between 1990 and 2006.

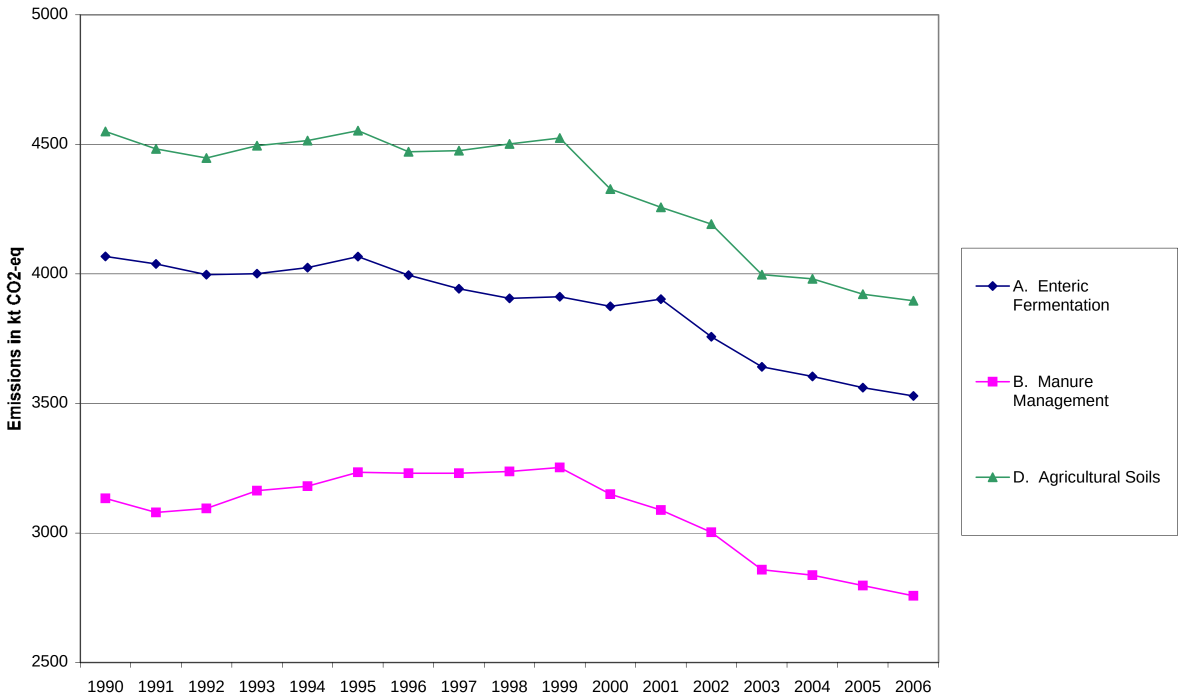


Figure 2.8 : Emission trends in agriculture

One third of these emissions are CH_4 emissions from enteric fermentation, cattle are for 95% responsible for these emissions. Those emissions decreased by 13 % since 1990, 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.

Almost one third (27 %) of the emissions are CH4 emissions from manure management of which swine accounts for 59 %, cattle for 37 % and poultry for 4 %. 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.

The last third of the emissions in the agriculture are originating from N2O emissions from soils. Those have decreased by 14 %, 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.

The share of largest key sources in the agricultural sector are presented on figure 2.9

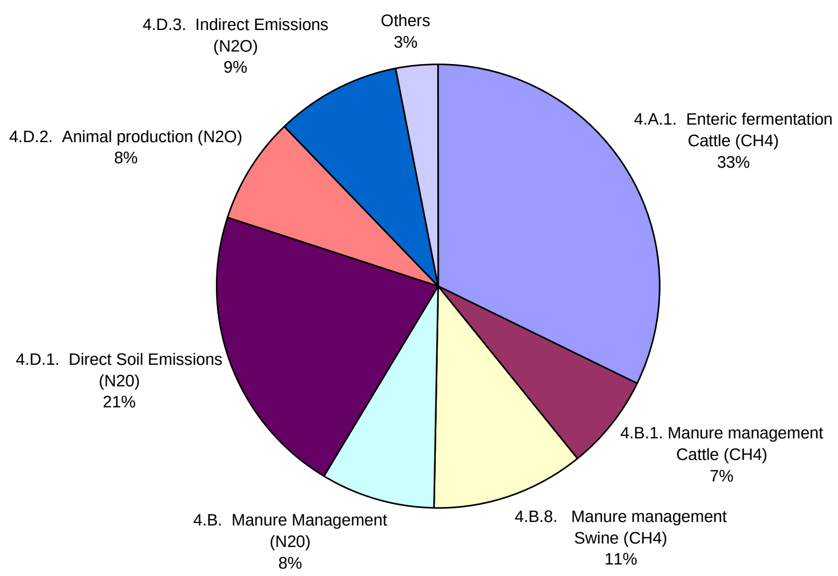


Figure 2.9. : share of largest key sources in the agriculture sector (2006)

2.3.6. Waste

GHG emissions from waste accounted for 0.9 % of national emissions in 2006, compared to 2.3% in 1990. This decrease is due to CH_4 emissions from solid waste disposal on land, which represents 56% of total emissions for the sector in 2006. Biogas recovery in landfills by flaring or for energy purposes -according to its richness- has been developed on a wide scale since 1990 and is the main driver of the trend in this sector. Emissions in this sector have dropped by 58 % since 1990.

The remaining 44% of GHG emissions stems in similar quantities from three sources: waste incineration, wastewater handling and composting. Emissions from waste incineration in this sector only covers chemical industry and hospital waste. Municipal waste incineration is allocated in the energy sector, as all the municipal waste incineration plants are also electricity producers. Wastewater handling and green waste composting emissions are gradually increasing, together with the implementation of policies.

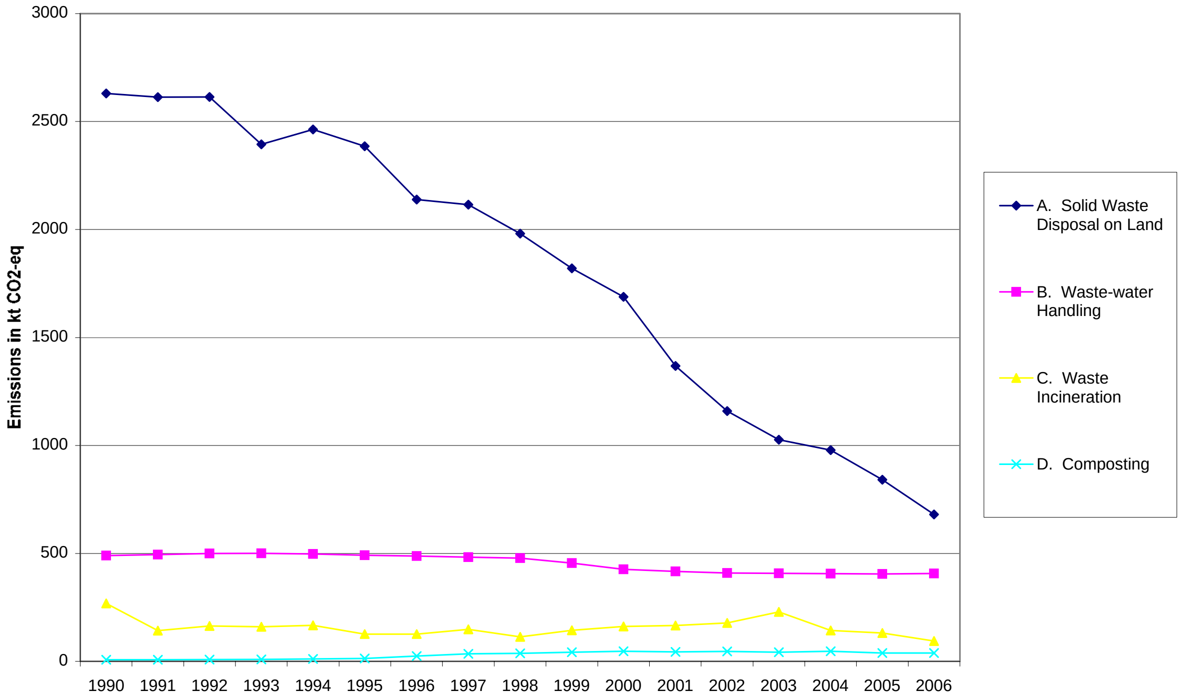


Figure 2.10 : emission trends in the waste sector

2.4. Emission trends for indirect greenhouse gases and SO_2

Emissions of ozone precursors (CO, NO_X, NMVOCs) and SO_2 are presented in Figure 2.11 (share of sectors and changes 1990-2006). These data are commented below.

2.4.1. Nitrogen oxides (NO_X)

The primary NO_x emitting source in Belgium is transport (59% in 2006), followed by energy industries (15%) and manufacturing industries (8 %). Total NO_x emissions have substantially decreased (-48% in 2006 compared with 1990), mainly as a result of improved performances in the production of electricity. Emissions from transport have decreased with 54% between 1990 and 2006, thanks to the use of catalytic converters on cars (since 1993-94), as well as emissions from energy consumption in industry. On the other hand, NO_x emissions from space heating have increased by 9 %.

2.4.2. Carbon monoxide (CO)

CO emissions in Belgium come mainly from energy consumption in industry (23%), transport (41%), and industrial processes (17%). Fuel combustion for space heating also contributes to some extent (16%).
Between 1990 and 2006, national CO emissions fell by 68 %, chiefly as a result of the introduction in 1993 of catalytic converters and to some extent following efforts made by industry, particularly the steel industry and refineries, and the diminished use of coal for heating purposes.

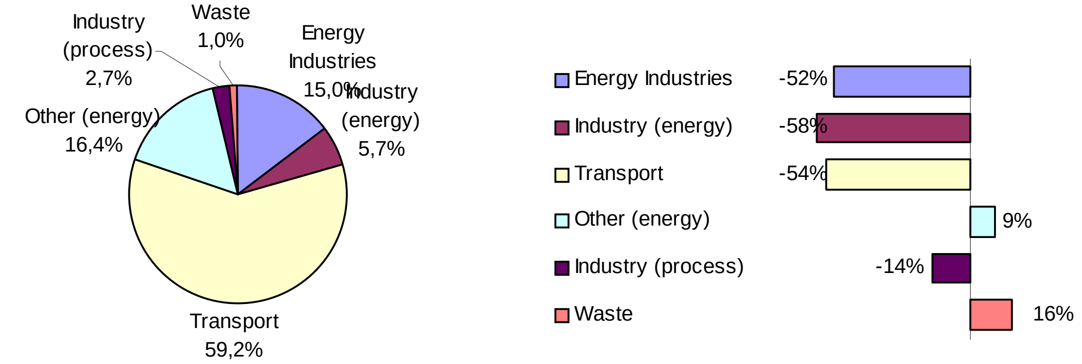
2.4.3. NMVOC

NMVOC emissions are caused mainly by fugitive emissions from fuels (40 %) and use of solvents and other products (26%), followed by transport (14%). Some industrial processes also contribute (17.9%), as well as fugitive emissions from fuels (14.1%). On the whole, these emissions decreased by 65% between 1990 and 2006, as a result of altered vehicle emission standards, reduced fugitive emissions and prevention of solvent use.

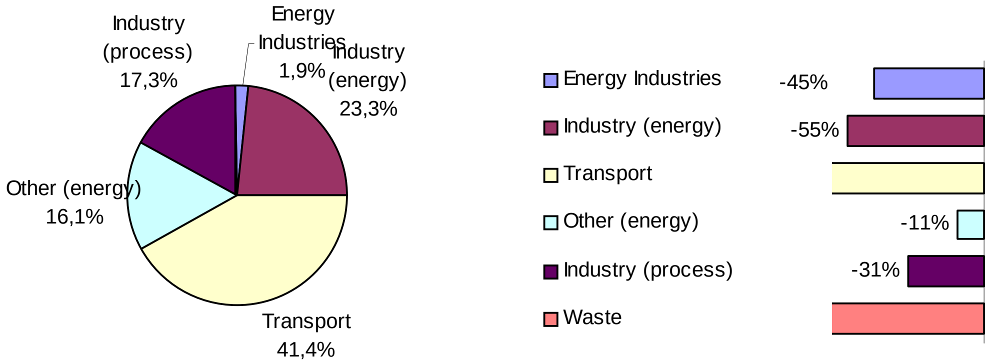
2.4.4. Sulphur dioxide (SO_2)

SO_2 emissions produced by the energy sector , industry and residential (space heating) sectors decreased sharply in Belgium between 1990 and 2006, leading to a general drop of these emissions by 65%. These reductions are the result of fuel substitution and reduced sulphur content in the oil products used. The energy sector still accounts for 49% of SO_2 emissions, followed by space heating (26%) and industry (19%).
In the transport sector, sulphur dioxide emissions have dropped (-95% in 2006 compared with 1990), mainly due to the constant reduction in the sulphur content of fuels since 1996.

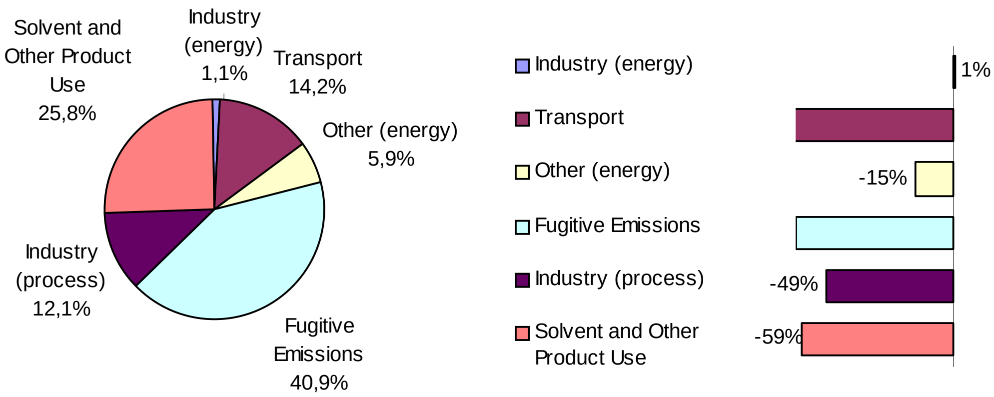
NO_x :



CO :



NMVOC :



SO_2 :

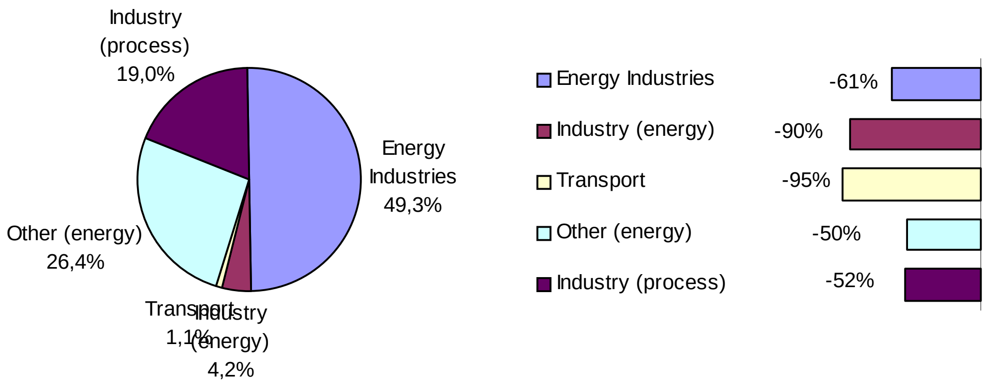


Figure 2.8. : Indirect GHG emissions and SO_2 : share in 2006 and changes 1990-2006.

CHAPTER 3: ENERGY

3.1 Overview

To prepare the Belgian greenhouse gas inventory for the section energy, the regional energy balances of Flanders, Wallonia and Brussels are the prime source of activity data and not the Belgian energy balance because of the regional responsibility to set up the atmospheric emission inventories. One exception on this general rule is the calculation of the emissions of CO_2 originating from road transport (see sections 1.3 and 3.1.3) for further details.
Differences in emissions of CO_2 between the reference approach and the Belgian national emission inventory are described in detail in section 3.3 'Reference approach' of this report.

Next to this a short description (including the allocation procedure) of the energy sector is given (energy industries, industry and transport) followed by the methodological issues in the energy sector (section 3.2), the reference approach (section 3.3) and the recalculations and planned improvements (section 3.4).

3.1.1 Energy industries

In 2006, Belgium's apparent gross consumption of primary energy rose to 56.047 Mtoe (Million tonnes oil equivalent, preliminary data), i.e. approximately 5.33 toe per inhabitant. This level is higher than the consumption per inhabitant in neighbouring countries and above the European average. Nearly 75% of Belgium's energy needs are met by the import of fossil fuels (41.489 Mtoe in 2005). This was made up of 5,167 Mtoe of coal, 21,708 Mtoe of oil (crude and petroleum products), and 14,614 Mtoe of gas. In 2006, the use of nuclear fuels provided 54,9% of the electricity produced. Although the hydroelectric potential is vigorously exploited in Belgium, its share in the production of energy remains negligible given the topography of the country (0,4% of electricity produced). The production of wind energy is also very limited (0,4% of total electricity produced in 2006), 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. The use of other renewable sources of energy, in particular biomass, and other recovered fuels (non renewables) contribute about 3% to the total electricity production in Belgium in 2006.

The residential and other sectors are the largest end consumer of energy in Belgium. The transport sector has the most spectacular increase recorded over last 25 years (+65% from 1979 to 2005). During the same period, the industrial sector as a whole saw its overall consumption decrease by 16%. Structural and technological changes have undeniably played a dominant role in this evolution. The recent evolution of the energy market in Belgium is furthermore marked by a very strong reduction in the consumption of solid fuels, mainly on the part of industry (cokes, iron and steel). The primary consumption of gas is increasing sharply, especially because of a stronger demand for electricity generation.

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 'Public Electricity and Heat production (1A1a)' includes fuel combustion emissions associated with the generation of electricity for commercial or public sale. The auto-generators category is mapped out in the IPCC category 1A2 'Manufacturing Industries and Construction' and 1A4 'Other sectors'. The allocation to the sub-categories under 1A2 and 1A4 depends on the type of the sector or industry where the energy is used. However, the allocation of CHP (Combined Heat and Power) plants needs more explanation. The most recent CHP units are in joint venture with the energy

sector, in which all heat is delivered to the industrial plant and the electricity 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 of CO_2 originating from category 1A1c ‘Manufacture of Solid Fuels and Other Energy Industries’ are the emissions coming form the combustion in the cokes ovens. Also the emissions of CO_2 of some energetic activities in the mines (mainly an auto-generator) in the Flemish region during the beginning of the nineties is included in this category 1A1c. Emissions of CH_4 and N_2O allocated in this category 1A1c are the emissions originating from these energetic activities in the mines in the Flemish region and the emissions of CH_4 and N_2O from the cokes ovens in the other regions (CH_4 emissions are in fact negligible and the N_2O emissions are rather small).

In Wallonia and Brussels, the emissions of other indirect greenhouse gases from the cokes ovens are also reported in category 1A1c. The fugitive emissions are reported in category 1B1b.
In the Flemish region the emissions of the others pollutants from the cokes ovens are reported in the category 1A2 except for the NMVOC-emissions (allocated in category 1A1c) and the CH_4-emissions are reported in category 1B1b. During the next submission the emissions from CH4 from the cokesovens in the Flemish region will also be allocated in the same category 1A1c to harmonize with the other regions.

3.1.2 Industry

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. The two other key sectors of industrial activity are the chemical industry and the food processing industry, which contribute respectively 3.8% and 2.5% to the GDP.

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-ferous 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).

The urban environment of the Brussels region does not provide the great surfaces required for the establishment of industry. With the exception of a producer of cars, the Brussels industry is made up of small and very small industrial companies with high added value or close to the ultimate consumer. All these industries are integrated in category 1.A.2.f (Other industries).

The emissions of N_2O of the sector iron and steel in the Flemish region are negligible, the emissions of CH_4 of this sector are allocated to the categories 1B1b (coke oven, see section 3.1.1) and 2C (sinterproduction). In the Walloon region, the emissions of N_2O and CH_4 of the sector iron and steel are in the category iron and steel (1A2a) and a part of the emissions of CH_4 of this sector are allocated to the categories 1B1b.

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.

3.1.3 Transport

Belgium is provided with a very dense road (4.7 km/km²) and rail (112 m/km²) network. 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 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. Even though congestion is lower than in the neighbouring countries, the number of road accident victims is very high, but is going down. Damages to the environment resulting from fuel use in road traffic are considerable. Goods are transported, on average, over a longer distance by railway (125.3 km in 1998) than by navigable waterways (58.4 km), but the gap between these two modes of transport has lessened in recent years.

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.

Since the submission in 2004, the CO_2 emissions for road transport are based on fuels sold. These figures are originating from the Belgian energy balance of fuels sold. Emissions of CH_4 and N_2O are not calculated based on the Belgian energy statistics, but are the sum of the emissions calculated by the 3 regions using a methodology based on the COPERT methodology in the Walloon and Brussels region and a country-specific methodology (the so-called MIMOSA-model see also section 1.3.1) in the Flemish region.

3.2 Methodological issues

3.2.1. 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. The regional CRF-tables are annexed to this report (annex 4). To obtain the national energy consumption data, the regional energy consumption data are added up.

Flemish energy balance:

Since the mid nineties, VITO establishes in commission of the Flemish administration a yearly energy balance. The first independent energy balance was set up for the year 1994. In 1999 the independent energy balance was set up for the reference year 1990. The years 1991 to 1993 are estimates, mainly based on a calculation derived from the Belgian energy statistics and energy data from the other regions (Flanders = Belgium – Wallonia – 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. 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 obigations (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 industry on a voluntary basis to estimate the emissions of air pollutants and greenhouse gases. Once the reporting obligations of greenhouse gases became valid, Flanders started with using the independent methodology of the Flemish energy balance to improve the green house gas inventory.

In what follows a short description is given of the main datasources 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 gaz 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: the surveys carried out until 2003 by the Belgian Electricity Federation in cooperation with the Vito, from 2004 on the annual obliged integrated environmental reports (observance by the Flemish Environment Agency and the department of Environment, Nature & Energy), from May 2005 an obliged reporting for the producers of renewable heat, combined heat & power installations and the auto-producers in the Flemish region. This information is used to determine total input, output and own-use of the sector of electricity and heat. To conclude 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.
- The data sources 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 (refuse bag) 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 inatallations 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 datasources 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 source 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 are installations in joint-venture with the electricity producers and are allocated to the sector of electricity and heat.
- 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 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 last figures are available for 2004.

2) Industry:

- The non-energy use in the energy balance is the sum of feedstocks of the chemical industry (mainly nafta, 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. 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 were 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 benchmarkconvenant (deliverded through the federations), data from the surveys carried out by the chemical federation (Essencia) and the annual integrated environmental reports. There is also a cooperation with the other federations [Agoria (technological sectors) Fedustria and Centexbel (textile, wood) and Fevia (food)]. The petroleumproducts 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 off 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 gridoperators 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 performed in the energy balance.

  The consumption of the rest 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 Fedichem. 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 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 prof. 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 1990). 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, back-fitting and scrapping 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 first calculates the number of households in the Flemish region with the main-heating of 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) performed by the Flemish Energy Agency or models (coal, biomass). The consumption of electricity is based on the information of the distribution grid operators.

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 is 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 countings (on the 15th 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 gridoperators 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.

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: The results of an environmental impact module for road transport, MIMOSA, are used to calculate the emissions of CO_2. These emissions are used to calculate the energy consumption data in the energy balance with default emission factors of IPCC. The model is simulating the emissions of the air pollutants originating from road traffic. The model is calculating the emissions at the outlet on the basis of mobility data, vehicle parc data and emission factors. The output of the model gives emissions per road segment which allow a geographical distribution of the emissions. The implied emission factors are based on the Copert-III methodology but actualized with the results of the 'on-road' measurements carried out by the Vito. For more information : http://www.vito.be/english/environment/environmentalstudy9d2.htm
  However, CO2 emissions calculated for road transport do not originate from the regional energy balances, but the federal sale statistics are used to calculate the CO2-emissions for Belgium for road transport.
- 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 Flanders is based on the Belgian data of gasoil consumption and the regional information on driven train- and tonne-kilometers of persons and goods. The electricity consumption can be determined in the same way but from 2002 on the data of the grid operators are used.
  - tram cars: The energy consumption of the tram cars (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 about 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.
- 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. The fishery is allocated to the agriculture sector. The energy consumption for the traffic of goods is based on the tonne-kilometers on the different rivers and channels and an average energy consumption per tonne-kilometer. For the traffic of passengers a rough estimate is made for the commercial pleasure cruising. For the non-commercial pleasure cruising the sold vignettes are used in combination with an average consumption per vignette. The Flemish bunkers are the same as the Belgian bunkers because the Flemish region is the only region which is located to the seasite in Belgium. The Belgian data of international and local bunkering in the navigation sector are originating from the national petroleum balance.

- 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) and the grid operators.

Walloon energy balance

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

The report of the regional energy balance is in French available, but not in English and can be found on the following website.

Walloon energy balance: http://energie.wallonie.be/xml/doc-IDC-5098-.html

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

There weren'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 280 companies).
- 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's from the companies are reported to Regine (280 companies) and 800 others companies reports also their data's.
  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's of the autoproducers 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's 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's on the amount of natural gas and electricity sold in this sector (CWaPE), on the basis of national data's (liquid fuels and solid fuels), on the basis of the socio-economic survey of 2001and on the basis of weather data's.

4) commercial and institutional sector:

- The energy consumption in the service sector is calculated using the energy data of different sources (regional data's 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: CO2 emissions calculated for road transport do not originate from the regional energy balances, but the federal sale statistics are used to calculate the CO2-emissions for Belgium for road transport.
- 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 MET (regional ministry for transport). 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 MET 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 regional energy balance is prepared by ICEDD in convention with the IBGE (Brussel's environnement).

The report of the regional energy balance will be available on the Brussel's environnement website (www.bruxellesenvironnement.be) in june (final version), only in French.

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

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

2) Industry:

- The energy consumption of the industry sector is calculated on the basis of a survey. This survey is conducted by the biggest industries. Then a extrapolation is achieved, based on the electricity consumptions.

3) households:

- The energy consumption of the households sector is calculated on the basis of regional data's from SIBELGA and Febupro (electricity and gas) and SPF EPMECME (liquid and solid fuels).

4) commercial and institutional sector:

- High-voltage : the energy consumption is calculated using the energy data based on a survey and direct contacts with "high voltage" consumers and big international public organisms.
- Low-voltage : the energy consumption is calculated by the "topdown" method. The consumption of oil-products is estimated from the fuel/naturel gas ratio and the Belgian consumptions.

5) agriculture:

- No agriculture in the region.

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: The results of the COPERT III model are used to calculate the emissions of CO_2. This model is revised every year in order to take into account the new calcul conventions from the European experts. The details of the COPERT model are available on the website of the autors : http://lat.eng.auth.gr/copert/. The input of the model comes from an other model "Myrtille", developed for the region and base on COPERT III.
  However, CO2 emissions calculated for road transport do not originate from the regional energy balances, but the federal sale statistics are used to calculate the CO2-emissions for Belgium for road transport.
- 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.
- air traffic: not in the brussel's inventory.
- navigation: The energy consumption for the traffic is given by the Brussel's port.
- pipelines: There is some energy required to transport gases through pipelines. The energy consumption needed for the transport, the transit and the distribution of gas in the Brussel region is estimated based on the 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 for CO_2 are mainly used in the sector of energy. These emission factors are summarized below. In these emission factors of CO_2 the IPCC default oxidation factors are already adjusted. These oxidation factors take into account that not 100% of the carbon in the fuel is transmitted to CO_2. This factor is 0.98 for solid fuels and 0.99 for liquid and 0.995 for gaseous fuels.

Products	**emission factors (g CO_2/MJ)**		
	Flanders	Wallonia	Brussels
Anthracite		96,3	
coal tars	92,7	-	
coking coal	92,7 (6)	92,7	92.7
Brown coal/lignite		99,2	
Butane/propane		62,75	
coke oven coke	106,0	106 (3)	
crude oil	72,6	-	
Refinery gas	55,1 - 56,5 (1)	-	
LPG	62,4	62,4	
Gasoline	68,6	-	
Kerosene	70,8	70,8	
gas/diesel oil	73,3	73,3	73.3
lamp petroleum	71,1	-	
residual fuel oil	76,6	76,6	76.6
Naphta	72,6	-	
petroleum coke	99,8	99,8	
other petroleum	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	-	75 [3]	
Waste gas	-	66-72,5 [3]	
Industrial waste	-	86,6 [3]	
Black liquor	-	100 [3]	
wood	-	100 [3]	

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

[1] Inquiry with the refineries
[2] Depending on the product in question, information through inquiries with the companies involved or default
[3] Source: EMEP/CORINAIR
[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

The Net calorific value of these differents products are mentionned in the annex 5.

In the lime and cement plants, which are only located in the Walloon region, the IPCC 1996 emission factors of CO_2 are used until 2004. Afterwards CO_2 emissions from solid fuel and waste are reported directly by the companies and based on their fuel consumption and fuel analyses.

Fuel		**UNIT**	**CO_2 x 10^3**
Fuel	cement	g/GJ	78[c]
Diesel oil	cement	g/GJ	74[c]
Coal	cement	g/GJ	92,7-105
Petroleum coke	cement	g/GJ	96
Industrial waste	cement	g/GJ	75-102
Gas naturel	cement	g/GJ	56[c]
Coal	Lime	g/GJ	92,7-105
Industrial waste	Lime	g/GJ	88
Coke	Lime	g/GJ	100[c]
Fuel	Lime	g/GJ	77,2[i]
natural gas	Lime	g/GJ	55,8[i]

Table 3.2. : Emissions factors of CO_2 in lime and cement plants in Wallonia.
(Source : IPCC[i] and EMEP/CORINAIR[c])

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 3.2.2. to 3.2.8.

3.2.2. Energy industries (category 1A1)

Public electricity and heat plants (category 1A.a)

The activity data reported in this sector are the fuel consumption data as reported in the regional energybalances (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 (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).

CO_2

For the large power plants in the public electricity sector, the CO_2 emissions are reported directly by the power plants and based on analyses of the fuels.
For the smaller plants for which no emissions of CO_2 are reported directly to the responsible authorities, default CO_2 emission factors are used except for some specific fuel types. In the latter case more detailed information of the individual companies is used (see table 3.1).

In the Brussels region there is only one significant power plant. The electricity is produced from the municipal waste incineration. The CO_2 emission factor from EPA is used. The fraction of organic municipal waste has been deduced from analyses of dustbins [37 and 48] and have led to a fraction of biomass origin, variable for the whole time series, from 62 % to 53 %.
For the smaller plants in Brussels, default CO_2 emission factors are used (see table 3.1).

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 3.3.
In Flanders, emission factors from TNO (Netherlands) [4] are used to calculate the emissions of N_2O for the installations for public electricity and from the EMEP/CORINAIR handbook (table 27) [3] to calculate the emissions of CH_4. These emission factors are agreed with the electricity producers.
For the combined heat-power installations the Flemish region uses the emission factors of natural gas (in gas turbines) as described in table 3.3 for the industrial sector, 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 CITEPA90 emission factors for the agriculture sector (i.e. 1 g CH_4/GJ and 2 g N_2O/GJ for gas and 3 g CH_4/GJ and 12 g N_2O/GJ for fuel).

In Wallonia and in Brussels, emissions of CH_4 and N_2O are calculated using emission factors of the 1996 IPCC Guidelines.

As the table 3.3 makes clear especially for N_2O the emission factors of IPCC 1996 and TNO (Netherlands) are largely consistent.

Fuel	UNIT	CH_4			N_2O		
		Fl (1)	**Wall (2)**	**Br (2)**	**Fl (3)**	**Wall (2)**	**Br (2)**
Coal	g/GJ	0,6	1	/	1,40	1,40	/
Fuel	g/GJ	0,7	3	/	0,60	0,60	/
diesel oil	g/GJ	0,03	1,5	/	0,60	0,60	/
natural gas (in gas turbine	g/GJ	2,5	2,5	2.5	0,10	0,10	0.1
natural gas	g/GJ	0,1	1	/	0,10	0,10	/
Cokes gas	g/GJ	0,1	1	/	0,10	0,10	/
blast furnace-gas	g/GJ	0,1	1	/	0,10	0,10	/
H_2-gas	g/GJ	0,00	-	/	0,00	-	/
Dry sludge	g/GJ	0,6	-	/	1,4	-	/
Bisfenol-resin	g/GJ	0,6	-	/	1,4	-	/
Agricultural waste	g/GJ	-	30	/		4	/
Municipal waste				-	60 g/ton (1)		60 g/ton (1)
Coffee	g/GJ	-			1,4		
Olive seeds	g/GJ	0,6			1,4		
Biofuel	g/GJ	0,7			0,6		

Table 3.3 : Emission factors of CH_4 and N_2O for the sector 1.A.1.a Public electricity and Heat Production.

(1) Source: EMEP/CORINAIR
(2) Source: IPCC 1996
(3) Source : TNO

Petroleum refining (category 1A1b)
The activity data of the petroleum refining are taken over from the Flemish energy balance (see section 3.2.1 for more information).

As indicated in section 3.1.1. petroleum refining only occurs in Flanders. 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 (see section 1.3.1).

The emissions of the petroleum refineries are allocated to the sectors

- 1A1a (for the combined heat-power installations of the refineries in joint venture with the electricity producers)
- 1B2c for the flaring emissions of CO_2
- 1B2a for the total CH4-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 and from the combined heat-power installations.

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 CH4/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)

As indicated in section 3.1.1. the emissions originating from category 1A1c 'Manufacture of Solid Fuels and Other Energy Industries' are the emissions coming form the combustion in the cokes ovens. Since the in-country review of UNFCCC in June 2007 the energetic activities of the mine industry, active in the Flemish region, are also included in this category 1A1c. These activities consist of an auto-producer of electricity that was active untill 1996 (the waste of the coal was used to produce electricity) and of energy needed for the sorting machines which were active untill 1999.

In Wallonia, in the category 1A1c the emission factors for CO_2 and CH_4 are those proposed in the EMEP/CORINAIR guidebook and the IPCC Guidelines [24] until 2004. Since 2005, the CO_2 emissions have been giving directly by the plant in their reporting under the emission trading scheme. For N_2O, emission factors from the Table 1.8 of the Revised 1996 IPCC Guidelines [28] are used.
The emissions of CH_4 are negligable and the emissions of N_2O are very small.

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 3.4. : CH_4 and N_2O emissions factors per fuel in the coking works.

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

There was one coke plant in the Brussels region until 1993. The emission factors used, are the same as the one used in the Walloon region except for CH_4 for which emission factors from EPA 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 cokesovens 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 fron the mine activities and are also calculated by using the IPCC 1996 emission factors.
The emissions of CH4 from the cokesovens in the Flemish region are during this submission still allocated in the category 1B1b (see this section for more explanation of the methodology used).

During the 2009 submission the emissions of CH4 from the cokesovens in the Flemish region will be allocated in the category 1A1c instead of the sector 1B1b to harmonize with the other regions in Belgium. Contacts with the relevant industry in Flanders indicates that no emissions of N_2O occurs in this sector.

3.2.3. Manufacturing industry and construction (category 1A2)

The energy consumption data for the category 1A2 originate from the regional energy balances in the 3 regions (see section 3.2.1). Also some specific information from the companies themselves are used to calculate the greenhouse gas emissions. The latter is the case for the iron and steel sector.
In the iron and steel sector the energy consumption data in the Flemish region originates directly from the steel company which delivers the information separately for the cokes ovens and for the rest of the company. This information is combined with the energy consumption data of the other (smaller) companies in this region to obtain total energy consumption in this sector (see section 3.2.1 for more information).

Emissions of CO_2

In general the emissions of CO_2 are calculated by using the IPCC 1996 default emission factors listed in table 3.1.

Iron and steel sector (category 1A2a)

The CO2-emissions from the iron and steel sector are partly put in category 1A2a (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 the Flemish region the emissions of CO_2 of the biggest steel plant are calculated by using specific emission factors obtained through analyses performed by this company (also recorded in the monitoring protocol of emissions of CO_2). The emissions of CO_2 of the other (smaller) companies are calculated by using mainly IPCC 1996 emission factors.
The CO_2 emissions from the blast furnace gas used are included in the category 1A1a where the energy is used i.e. in the Flemish region a power installation located in the neighbourhood of the steel company.

In Wallonia, 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”.

The CO_2 emissions from the blast furnace gas used are included in the category where the energy is used.

Category where the fuel is used in 2006	1A1a Public Electricity	1A2a Iron and steel
Blast furnace gas (TJ)	17444,3	10761,1

Other sectors

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 are used as presented in table 3.2, CO_2 plant specific emission factors are used.

Emisisons of CH_4 and N_2O

General

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). Before this 2008 submission, emission factors of CITEPA (Flemish region), IPCC 1996 and EMEP/CORINAIR (Walloon region) and from a specific study (Brussels region) were used.

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

		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	-	4 (1)	-	-	0,1	-
Waste gas	g/GJ	-	2,5 (1)	-	-	0,1	-
Industrial waste	g/GJ	-	10 (1)	-	-	2 (1)	-
Black liquor	g/GJ	-	15 (1)	-	-	0,6	-
Wood	g/GJ	-	30	-	-	4	-

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

(1) Source: EMEP/CORINAIR

Iron and steel sector

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

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

Fuel		UNIT	CH_4	N_2O
Coke breeze	Sinter and pelletizing plants	g/GJ	50 (2)	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 (1)	0.1 (1)
blast furnace-gas	Blast furnace	g/GJ	112 (1)	0.1 (1)
Coal	Electric arc furnace	g/GJ	15 (2)	1,4 (1)
Coke breeze	Electric arc furnace	g/GJ	15 (2)	4 (1)
Natural gas	Electric arc furnace	g/GJ	2,5 (2)	0.1 (1)
natural gas	Reheating furnaces steel and iron	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.

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

The consumption of coal not used as a reducing agent in the blast furnace is calculated by a CO_2 balance on the furnace in Wallonia and the emissions are reported in this section. Only CO_2 emissions are calculated.

In the Flemish region the emissions of CH_4 of the iron and steel sector are allocated in the categories 1B1b (production of cokes) and 2C1 (production of sinter) (see these respective sections for more explanation of the methodology used).
First contacts with the involved industry in the Flemish region indicates that the emissions of N_2O in the iron and steel sector are negligible. Further contacts with the involved industry will be taken to try to harmonize these methodology with the Walloon region.

Other sectors

Glass industry

In the Walloon region the emission factors used in the glass industry are those proposed in the EMEP/CORINAIR guidebook for CH_4 and the IPCC factors for N_2O as shown in table 3.7.

In the Flemish region the emission factors as shown in table 3.5 are used.

Fuel	UNIT	CH_4	N_2O
Fuel	g/GJ	3	0,6
Diesel oil	g/GJ	1,5	0,6
Natural gas	g/GJ	2,5	0,1

Table 3.7. : Emission factors per fuel in glass production (EMEP/CORINAIR and IPCC) in Wallonia.

Lime and cement industry

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. Implied emission factors for CH_4 and N_2O are then derived from the energy consumption data and the reported emissions.

3.2.4. Transport (category 1A3 and 1A5b)

Road transport (1A3b)

The energy consumption data and CO_2 emissions from road transport in the Belgian emission inventory are, in contrary with the other sectors where the sum of the regional data is calculated, 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 fuels sold in Belgium for road transport. These activity data are multiplied with default IPCC 1996 emission factors to calculate the CO_2 emissions. An overview of these activity data and emissions of CO_2 is given in annex 5 of this report 'Activity data and emissions of CO_2 for road transport in Belgium (category 1A3b)'.
Emissions of CH_4 and N_2O are calculated by compiling the emissions of each region based on the use of the specific models used in the 3 regions (based on COPERT III in the Walloon and the Brussels region and on the MIMOSA-model in the Flemish region).

See section 3.2.1 for more information about the used MIMOSA-model in the Flemish region. The complete detailed description of the MIMOSA-model can be found in annex 4 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 7.3.3. with the data acquisition plan for road traffic in the Flemish region.

During the 2008 submission and as a result of the in-country review in June 2007 the emissions of CH_4 and N_2O in the Walloon region have been recalculated using the COPERT III-methodology. This recalculation is performed in order to harmonize with the methodologies used in the other regions.

Air transport (1A3a and 1A5)

The energy consumption data for the sector of air transport in Belgium are these as reported in the regional energy balances. See section 3.2.1 for more information.
The emissions and energy consumption data of the civil and military aviation are allocated respectively to the sectors 1A3a and 1A5.

In the two regions (Flemish and Walloon region) where air transport is relevant, a slightly different approach was taken in estimating the emissions from air transport.

In Flanders only domestic air traffic is considered for calculating the CO_2 emissions. All kerosene used in the air transport is assigned to the bunker fuels, all gasoline for air transport is allocated to domestic air transport. This approach was chosen because it is not easy to split these fuels otherwise and because, due to the small size of Belgium (and Flanders) it seems logic that the share of the inland traffic is indeed very limited and most kerosene is used for international transport. A default IPCC emission factor for CO_2 is used to calculate the emissions.
The emissions of CH_4 and N_2O and the emissions of the other air pollutants from air transport are calculated for the Landing and Take-Off cycle. The methodology is mainly based on the methodology

described in the EMEP/CORINAIR handbook [3]. These emissions are calculated for 3 airports for civil aviation (Antwerp, Ostend and the international airport of Brussels-National) 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 untill 2006 (Kleine Brogel, Brasschaat, Koksijde, Melsbroek).
There has been made some changes to this methodology in the Flemish region after the initial review by the expert review team of UNFCCC in June 2007. Afterwards a redistribution in airplane movements was performed between the civil aviation and the international aviation. The consequence of this redistribution is a slight increase of the greenhouse gas emissions of the base year 1990 with 0,03 kton CO_2 eq.
The complete detailed description of this model can be found in annex 4 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 7.3.4. 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/CORINAIR guidebook [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.
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 based on the table 8.2 in the EMEP/CORINAIR guidebook [3]. The emissions from domestic LTO and cruise activities are reported under the category 1.A.3.a (civil aviation), while emissions from international LTO and cruise activities are reported under "international bunkers : aviation". Kerosene used in international air transport is assigned to the bunker fuels.

Railways (1A3c)

The greenhouse gas emissions from the railway traffic is 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 3.2.1. 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/CORINAIR handbook [3]. These emission factors are the same as the emission factors from the IPCC Revised 1996 guidelines.

In the Flemish region the emissions of the other air pollutants are calculated by using the results of a model developed by the Vito [1] and based on the registered kilometres with distinction between different types of trains. The complete detailed description of this model can be found in annex 4 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 railways traffic in the Flemish region.

Navigation (1A3d)

The energy consumption data in the sector of navigation (category 1A3d) are taken from the regional energy balances. See section 3.2. for more details.

To calculate the emissions of CO_2, the fuel consumption data are multiplied with IPCC 1996 default emission factors as reported in table 3.1.

In Flanders statistics are used to calculate the total freight kilometres and to calculate the total amount of fuel used for inland waterways navigation. To calculate the emissions of CO2, the fuel consumption data are multiplied with IPCC 1996 default emission factors.The emissions of CH_4 and N_2O are estimated by using the so-called SUSATRANS-model which is developed by the Vito [1] and is technology-related. The emissions of the other pollutants are calculated in Flanders with this same model [1].

Compared to previous submission the methodology to calculate the emissions from the sea navigation (departure and arrival in Belgian sea ports) is optimized 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's 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 this model can be found in annex 4 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 7.3.5. with the data acquisition plan for navigation in the Flemish region.

In the Brussels and the Walloon regions the non-CO2 emissions are calculated by using emission factors of the EMEP/CORINAIR handbook [3].

Other transportation (1A3e)

In this category 1A3e the energetic emissions originate from the compression activities in the sector storage and transport of natural gas. See section 3.2.1. ('pipelines' in the Flemish energy balance) for more information.

The emissions of CO_2 are estimated by using the IPCC 1996 default emission factors as reported in table 3.1.

In the Flemish region 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.

In the Brussels and Walloon regions, these emissions are not estimated. They will be estimated in the next submission.

3.2.5. Other sectors (category 1A4)

The activity data, energy consumption data, of the sector ‘other sectors’ (category 1A4) are taken from the regional energy balances and added up for recording in the Belgian emission inventory. This category 1A4 contains the subsectors commercial/institutional, residential and agriculture/forestry/fishery.
The combined heat-power installations of the service and the agriculture sectors are allocated to the sector 1A1a ‘Public electricity and heat production’.

The category 1A4c Agriculture/Forestry/Fisheries is negligible in the Brussels region. As a consequence no greenhouse gases from this sector are taken into account for this region.

To calculate the emissions of CO_2, all regions use the default IPCC 1996 emission factors (see table 3.1).

As a result of the in-country review in June 2007 an harmonization of the applied emission factors for CH_4 and N_2O in this sector was performed. As a consequence the Flemish region switched from emission factors from CITEPA90 to IPCC 1996 emission factors and the Brussels region switched from emission factors from a specific study carried out in the past to IPCC 1996 emission factors. The Walloon region did already use the IPCC 1996 emission factors during the previous submissions.
During the revision one exception was applied for the farming vehicles. For this subsector the Flemish and the Walloon region do use the emission factors from the EMEP/CORINAIR handbook instead of the IPCC 1996 emission factors because more detail was obtained in that way.

In the tables 3.8 and 3.9 the emission factors for CH_4 and N_2O for the ‘other sectors’ (category 1A4) are listed. These are IPCC 1996 emission factors except for the farming vehicles where emission factors of EMEP/CORINAIR are used.

Fuel	**Subsector 1A4**	**Unit**	**CH_4 [(1)]**
Coal	Commercial	g/GJ	10
	residential	g/GJ	300
	Agriculture heating	g/GJ	-
Natural gas	Heating comm/residential	g/GJ	5
	Heating agriculture		
Fuel/diesel oil	Heating comm/residential	g/GJ	10
	Heating agriculture	g/GJ	
	Farming vehicles.	g/GJ	4 [(2)]
Fuel	Fishing activities	g/GJ	-
Heavy fuel	Commercial	g/GJ	10
	residential		
	Agriculture heating		-
Propane/butane/LPG		g/GJ	5
Lamp petroleum	Commercial	g/GJ	-
	residential		
	Agriculture heating		-
wood		g/GJ	300

Table 3.8. : Emission factors of CH_4 for category 1A4 Other sectors (service, residential and agriculture sector).

(1) IPCC 1996
(2) EMEP/CORINAIR

Fuel	Subsector 1A4	Unit	N_2O (1)
Coal	Heating comm/residential	g/GJ	1,4
	Agriculture	g/GJ	-
Natural gas	Heating comm/residential	g/GJ	0,1
	Heating		
Fuel/diesel oil	Heating comm/residential	g/GJ	0,6
	Heating agriculture		
	Farming vehicles	g/GJ	30 (2)
Fuel	Fishing activities	g/GJ	-
Heavy fuel	Heating comm/residential	g/GJ	0,6
	Agriculture heating		-
Propane/butane/LPG		g/GJ	0,1
Lamppetroleum	Heating comm/residential	g/GJ	-
	Agriculture heating		-
wood		g/GJ	4

Table 3.9. : Emission factors of N_2O for category 1A4 Other sectors (service, residential and agriculture sector).

(1) IPCC 1996
(2) EMEP/CORINAIR

3.2.6. Other (category 1A5b)

The category 1A5 contains 'other' stationary and mobile sources.
In this section the energetic activities and emissions originating from the military transport (domestic air transport) are allocated in category 1A5b.
The energy consumption data are taken from the regional energy balances. See section 3.2.1 for more information.
The emissions of the military transport in Belgium are calculated in the same way as explained in section 3.2.4./ air transport.
No activities under category 1A5a take place in Belgium.

3.2.7. Fugitive emissions from fuels (category 1B1 and 1B2)

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 untill 1992 there still was some mining activity in the Flemish region. Untill 1999 energetic mining activities remain existing. These activities consist of an auto-producer of electricity that was active untill 1996 (the waste of the coal was used to produce electricity) and of energy needed for the sorting machines which were active untill 1999. The latter energetic activities

are allocated to the category 1A1c. See sections 3.2.1.(Flemish energy balance) and 3.2.2 (Manufacturing of solid fuels and other energy industries) for more information about this sector.
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 slighthly 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. The emissions of CH_4 decreases from 14 kton in 1990 to 3 kton in 1992.

Solid fuel transformation (category 1B1b)

Emissions during the cokes production are caused by the loading of the coal into the ovens, the oven/door leakage during the coking period and by extracting the cokes from the ovens.
The activity data, production data of cokes, are directly reported by the companies involved. See also section 3.2.1. for more information.

Emissions of CH_4 originating from the production of cokes were estimated in Flanders until the 2005 submission by using emission factors of CITEPA [2], which are in line with the emission factors of the EMEP/CORINAIR handbook (400 g CH_4/ton cokes).
During the previous submission in 2006 a revision of the emissions of CH_4 was carried out due to the availability of more detailed information of the industry involved. Based on monitoring results carried out in 2001, 2002 and 2004, the emissions of CH_4 were optimized from 1990 on. During the 2009 submission the emissions of CH_4 of the cokes ovens will be allocated to the sector 1A1c to harmonize with the other regions. After consulting the company involved in the Flemish region, these emissions of CH_4 are considered as total emissions of the cokesovens.

In Wallonia and Brussels, the CH_4 emissions are estimated with the emission factor of the EMEP/CORINAIR handbook (400 g CH_4/ton cokes). Activity data (tons of cokes) are delivered by the corresponding industry.

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 obliged reporting obligations in the Flemish region via the annual integrated environment 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 mentioned in section 3.2.2.: 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 3.2.2. 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.

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 gridoperators 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 ii/distribution) is completely optimized for all the regions in Belgium since the submission in 2004. All information is reported by SYNERGRID, the federation of the gridoperators 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 (untill 2002) and 30 000 (from 2003 on). In Wallonia, the number of these pipelines is estimated at 620 000 for the year 2006. The length per additional pipeline is 5 m in the Flemish and the Walloon region. In Brussels, the number of additional pipelines is estimated at 186 555 for the year 2006 and 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.

Based on the composition of the natural gas distributed, emissions of CO_2 from the gas distribution sector are calculated and added to the inventory (natural gas contains +/- 1% of CO_2) in category 1.B.2.bii/distribution.

Emissions of CH_4 (category 1.B.2.b.ii/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 is registered as accurate as possible. All information is obtained from Fluxys, the independent operator of the gas network in Belgium.

3.2.8. International bunkers (category Memo Items – International Bunkers)

Information about the international bunkering comes from the regional and the Belgian energy statistics. See also section 3.2.1 for more information about the activity data for international bunkering.

For the airports in Flanders, the reported kerosene fuel is assigned to the bunker fuels and all gasoline for air transport is allocated to domestic air transport (see justification of this approach in the section 3.2.4). Default IPCC 1996 emission factors are used to calculate the CO_2 emissions (see table 3.1). The EMEP/CORINAIR methodology (emissions per LTO-cycle) is used for the calculation of the emissions of CH_4 and N_2O from kerosene (aviation bunkers).

Also for the marine bunkering, the emissions of CO_2 are calculated by using the IPCC 1996 emission factors. In the Flemish region the emissions of CH_4 and N_2O of the marine bunkers are calculated by using emission factors of CITEPA90 [2] i.e. 0.1 CH_4 g/GJ and 13,4 g/GJ N_2O for fuel (marine bunkering).

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 caculated 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/CORINAIR guidebook [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.

3.2.9. 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. These emissions are probably not complete. More attention will be going to this item in the near future.

3.2.10. Non-energy use of fuels and related emissions (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 1A2**,** 2B1 and 2B5.
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 are no longer included in the Belgian emission inventory. 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 advise of the expert review team, these emissions of CO2 from the use of solvents and lubricants will only arise when they are burned or destroyed. As a consequence these emissions are excluded out of the Belgian emission inventory during this submission.

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.

To 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 also.

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

1. The use of recovered fuels from cracking units or other processes where a fuel is used as a 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. The involved industry is reporting the CO_2 emissions and PJ for these recovered fuels.

2. CO_2 emissions occurring during chemical processes, for example the production of ammonia based on natural gas or the production ethylene oxide where CO_2 is formed in a side reaction (reported respectively under 2B1 and 2B5 other). The industry involved is reporting these CO_2 emissions directly for these processes.

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.

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 this sector is a key source).

The resulting emissions are reported under different sections. The first and largest part (recovered fuels) of the resulting emissions is reported under 1A2c, under 'other fuels'. 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] to establish a yearly Flemish energy balance. The choice was made to allocate these fuels under 'other fuels' and not 'liquid fuels' or 'gaseous fuels', for transparency reasons.

Another part of the emissions surveyed in the study, are considered to be process emissions and are reported under 2B. These include the CO_2-emission during the production of ammonia (2B1) and other process CO_2 emissions (2B5) 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, etc). 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.

3.3.Reference approach

CO_2 emissions from fuel combustion were estimated in accordance with the "Reference Approach" (Tier 1 Approach – IPCC Guidelines). This estimation is based on the national energy balance, which is derived from national statistics of fuel supply. 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 naphta, where a fraction of carbon stored of 100% is taken.
Reason for this 100% is that the amount of naphta 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 naphta equals the amount of naphta used as feedstock minus the part that was recovered as fuel (approximately 20 to 25% each year). This means that the reported naphta is considered to equal a 'net' amount of C that is stored in products. The recovered fuels of the naphta cracking are reported in the sectoral approach and are reported as 'other fuels' in the chemical industry (category 1A2c).

The details of this estimation are provided in the categories 1AB (reference approach), 1AC (difference reference approach and sectoral approach) and 1AD (feedstocks and non-energy use) in the CRFReporter.

The comparison with the sectoral approach (Table 1.A(c)) shows a differences between -4.1% (in 2002) and +4,0% (in 2000). The difference between the reference approach and the national inventory for all years is visualised in the figure 3.1 below.

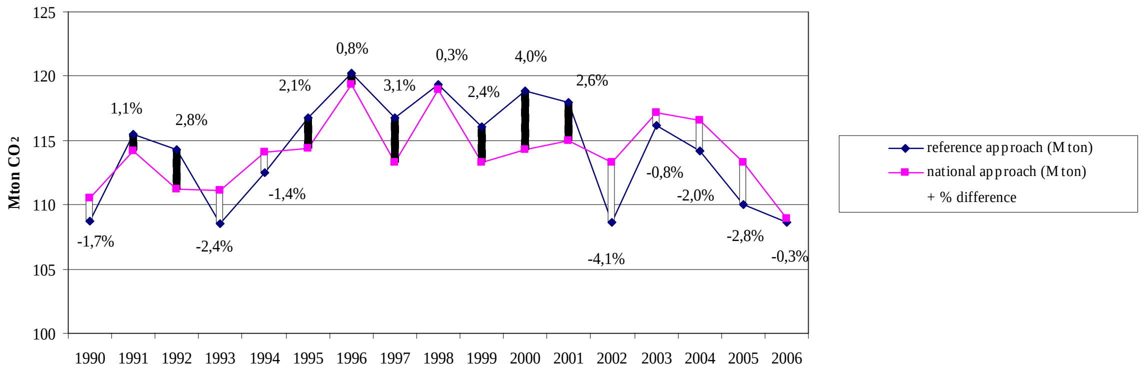


Figure 3.1. : Difference between the Reference approach and the national inventory.

There are several reasons why there is a difference between the results of the reference approach and the national inventory. These differences and their potential reasons have been already discussed in previous National Inventory Reports of Belgium. Except for the differences in the amount of naphta used in the sectoral approach and the reference approach, the reasons are:

- Reason number 1: the results for the reference approach and the national inventory are based on different data sets (top-down and bottom-up)
- 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
- Reason number 3 : emissions from solid fuels are partially located under industrial emissions in the national approach contrary to the reference approach

A working group 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 are going on 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, electronical 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 petroleum balance), it is obvious that this process takes time. In 2007, 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 statstics for 2006 between federal and regional administrations. In follow up, procedures are being developed 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

3.4. Recalculations and planned improvements

3.4.1 Recalculations

<u>Recalculations after fixing the assigned amount for Belgium (based on the results of the initial review of UNFCCC in June 2007)</u>:

- There has been made some changes to the methodology to calculate the emissions from air transport (<u>category 1A3a</u>) in the Flemish region after the initial review by the expert review team of UNFCCC in June 2007. A redistribution in airplane movements was performed between the civil aviation and the international aviation afterwards. The consequence of this redistribution is a slight increase of the greenhouse gas emissions of the base year 1990 with 0,03 kton CO_2 eq.

- Compared to previous submission the methodology to calculate the emissions originating from the transport between the North Sea ports (<u>category 1A3d</u>) is optimized in the Flemish region. This optimization did occur after the initial review by the expert review team of UNFCCC in June 2007. The consequence of this optimization is an increase of the green house gas emissions of the base year with 145 kton CO_2 eq.

<u>Recalculations based on the results of the initial review of UNFCCC in June 2007:</u>

- As a result of the in-country review in June 2007, the 3 regions did perform an harmonization of the emission factors used to calculate the emissions of CH4 and N2O in the sector of manufacturing industry and construction (<u>category 1A2</u>). Before this 2008 submission, emission factors of CITEPA (Flemish region), IPCC 1996 and EMEP/CORINAIR (Walloon region) and from a specific study (Brussels region) were used.

- As a result of the in-country review in June 2007 an harmonization of the applied emission factors for CH_4 and N_2O in the service, residential and agriculture (<u>category 1A4</u>) sector was performed in the Belgian greenhouse gas inventory. As a consequence the Flemish region switched from emission factors from CITEPA90 to IPCC 1996 emission factors and the Brussels region switched from emission factors from a specific study carried out in the past to IPCC 1996 emission factors. The Walloon region did already use the IPCC 1996 emission factors during the previous submissions.

- During the 2008 submission and as a result of the in-country review in June 2007 the emissions of CH_4 and N_2O in the Walloon region have been recalculated in the sector of road transport (<u>category 1A3b</u>) using the COPERT III-methodology. This recalculation is performed in order to harmonize with the methodologies used in the other regions.

- 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 untill 1992 there still was some mining activity in the Flemish region. Untill 1999 energetic mining activities remain existing. These activities consist of an auto-producer of electricity that was active untill 1996 (the waste of the coal was used to produce electricity) and of energy needed for the sorting machines which were active untill 1999. The emissions of CO_2 were already included in the Belgian emission inventory as these energetic activities were already included in the Flemish energy balance. These activities are allocated to the category 1A1c. During this 2008 submission the emissions of CH_4 and N_2O were newly estimated and added to the Belgian emission inventory. The underground mining activities are newly allocated during this submission to the category 1B1a. The diffuse emissions originating from these mining activities of CH_4 decreases from 14 kton in 1990 to 3 kton in 1992.

- 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 are no longer included in the Belgian emission inventory. 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 advise of the expert review team, these emissions of CO_2 from the use of solvents and lubricants will only arise when they are burned or destroyed. As a consequence these emissions are excluded out of the Belgian emission inventory during this submission and the base year emissions decrease with 415 kton CO_2eq in the Belgian emission inventory.

3.4.2 Planned improvements

- During the 2009 submission the emissions of CH_4 from the cokesovens in the Flemish region will be allocated in the category 1A1c instead of the sector 1B1b to harmonize with the other regions in Belgium.
- During the 2009 submission the emission factors of CH_4 and N_2O from the combined heat-power installations in the agriculture and service sectors will be harmonized between the 3 regions.
- During the 2009 submissions the emissions of CH_4 en N_2O from "other transportation" will be estimated in the Walloon region.
- Further contacts with the iron and steel sector in the Flemish region will be taken with respect to harmonize methodologies for estimating the emissions of N_2O (and CH_4) in this sector.
- During the 2009 submission the emissions from railways will be recalculated with EMMOSS-model in the Flemish region (http://www.tmleuven.be/project/emmoss/index.htm)
- During the 2009 submission the emissions from inland waterways (navigation) will be recalculated with EMMOSS-model in Flemish region (http://www.tmleuven.be/project/emmoss/index.htm).
- For road transport in Flemish Region there will be an upgrade of the MIMOSA-model during 2008 : the emission functions of COPERT IV will be implemented instead of COPERT III, and the emissions will be calculated based on hourly counts of road traffic (instead of traffic flow model). Emissions for 1990 – 2006 will be recalculated with the new version of the model.

CHAPTER 4: INDUSTRIAL PROCESSES

4.1. Overview

4.1.1. Description of the sector

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. The metallurgy and textile sectors have been relatively stable, after several waves of closures and restructuring. The metallurgy 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, which contribute respectively 3.8% and 2.5% to the GDP.

In this sector of industrial processes the emissions of industrial activities are included which are not related to the combustion of fossil fuels. Also the emissions of F-gases are included in this sector.

4.1.2. Allocation of emissions

The industrial processes in Belgium are covered by

(1) categories 2A1 (cement production) and 2A2 (lime production), activities which take place only in the Walloon region and category 2A3 (limestone and dolomite use), activities which take place in the Flemish and the Walloon region.
[The latter activities were allocated to the sector 2A7 (other/production of glass and ceramics) in the previous submissions. The allocation changed as a result of discussions with the expert review team of UNFCCC during the in-country review in June 2007].

(2) categories 2B1 (ammonia production), 2B2 (nitric acid production), these activities take place both in the Flemish and the Walloon regions and category 2B5 other industrial in the chemical industry in the Walloon region i.e. the production of maleic anhydride and in the Flemish region i.e. the production of caprolactam and other process emissions reported by the chemical industry (f.e. the production of ethylene oxide, acrylic acid, …);

(3) category 2C1 (metal production i.e. iron and steel industry), these activities take place both in the Flemish and the Walloon regions;

(4) categories 2E (production of halocarbons and SF_6) and 2F (consumption of halocarbons and SF_6);

4.2. Methodological issues

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, EMEP/CORINAIR handbook [3], CITEPA [2] or other specific bibliographies or calculated via measurements carried out by the industrial companies in Blegium.

The activity data recorded in this category also derive mainly directly from the companies involved.

4.2.1. Mineral products (category 2A)

The mineral industry is one of the most important sectors of industrial process emissions in Belgium and contributes to 31% in 2006 of greenhouse gas emissions in this sector.

In Belgium, cement production (category 2A1) only take place in the Walloon region. The activity data is the clinker production collected directly from individual plants.
CO_2 emissions occur from the calcination of carbonates in the raw materials used to produce the clinker, from the partial or full calcination of cement kiln dust or bypass dust removed from the process and in some instances from the non-carbonate carbon content of raw materials. These emissions are estimated by using a plant-specific emission factor. Emission factors used in Wallonia are estimated between 464 and 567 kg CO_2/T clinker. An average emission factor by plant has been estimated in 2002 and is applied on the all time-series 1990-2001. Since 2002, the emission factor varies each year and was calculated directly by the plant. Since 2004, plant data's include information on the CaO content of the clinker and non-carbonate sources of CaO. The decarbonatation of the dust reinjected in the furnace is also taking account.

Production of lime (category 2A2) also occurs only in the Walloon region of Belgium. These emissions of lime production are estimated by using a plant-specific emission factor (741-839 kg CO_2/T lime ordolomite). This is presented in table 4-1. 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 4-1).
The activity data is the lime and dolomite lime production and is collected directly from individual plants. The emission factors are also collected directly from individual plants.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Lime (kt)	2091	2037	1981	1962	2057	2080	1897	1993	2050	2075	2085	1770	1742	1785	1927	1721	1830
IEF lime (kg CO2/t)	0,75	0,76	0,75	0,75	0,76	0,76	0,75	0,75	0,75	0,75	0,75	0,75	0,74	0,74	0,75	0,75	0,71
Dolomite lime (kt)	570	452	408	393	401	374	360	347	385	419	555	823	939	826	851	880	929
IEF dolomite lime (kg CO2/t)	0,91	0,91	0,91	0,91	0,91	0,91	0.91	0,91	0,91	0,91	0,91	0,91	0,91	0,91	0,91	0,83	0,89
IEF global (kg CO2/t)	0,79	0,78	0,78	0,78	0,78	0,78	0,78	0,78	0,78	0,78	0,78	0,8	0,8	0,8	0,8	0,78	0,78
CO2 emissions (kt)	2097	1951	1865	1828	1921	1921	1756	1819	1895	1944	2066	2070	2144	2072	2228	2018	2139
CO2 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	48	56,1	61,5	62,3	62,3	72,5

Table 4-1 : Lime and dolomite lime production in Wallonia.

The CO_2 emissions in the sector of "limestone and dolomite use" (category 2A3) include the process emissions of the glass and ceramic industry in Belgium. In previous submissions these process emissions were allocated to the category 2A7 Mineral products/other (glass production & ceramics). As a result of the in-country review in June 2007 and after discussions with the expert review team, the allocation of these emissions has been changed because limestone and dolomite is used in these sectors. No activity data are recorded in the Belgian emission inventory in this sector 2A3 because of the allocation of different subsectors into the same category.

The production of glass (category 2A3) in Belgium takes place in the Flemish and in the Walloon regions.
The CO_2 emission factors used in the Walloon region in the glass production for the decarbonation are originating from the joint EMEP/CORINAIR handbook [3] and are 150 kg/ton glass

(container glass and glass wool) and 140 kg/ton glass (flat glass). Since 2003, the CO_2 emission factors are calculated by the glass plant. It's difficult to make a recalculation in the Walloon region between 1990 and 2002 due to a lack of data.

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, is mainly used in this sector. One company did revise this emission factor in the current of 2006 to 300 kg process CO_2/ton glass. As a result of the in-country review of June 2007, this revised emission factor was also used in the base year 1990. As a consequence the emissions of the base year did increase from 13,928 to 33,427 kton CO_2 in this sector of glass production.

Because of the comparability of the melting process in the production of glass and enamel, both industries are related in Flanders and consequently put under the same category 2A3. 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 glass. 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. As a result of the in-country review of June 2007, these revised emission factor was also used in the base year 1990. As a consequence the emissions of the base year did decrease from 13,484 to 1,475 kton CO_2 in this sector of enamel production.

Also put in the category 2A3 in the 2008 submission are the process emissions of CO_2 originating from the ceramic sector 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 and is based on production information and the evolution of the gamut of products .

In the Walloon region an average emission factor was established in 2005 by the plants involved in the ceramic industry. Since the submission 2005, each plant gives their own emissions under the emission trading scheme. During the in-country review in June 2007, the expert review team detected this missing part in the Belgian inventory. During this 2008 submission the emissions of CO_2 from ceramics in the Walloon region are included in the Belgian emission inventory. It exists of 11,57 kton CO_2 in 1990.

Also in the iron and steel sector (category 2C), more specifically during the sinter production, limestone and dolomite is used. The emissions of CH_4 are allocated to the sector 2C. Also the process emissions of CO_2 in the iron and steel sector are also allocated in this category 2C. See section 4.2.3 for more information.

The CO_2-emissions due to the use of limestone in pollution control are assumed to be negligible in Belgium and are consequently not estimated.

Soda ash production (category 2.A.4) 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 stoechiometric 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.

4.2.2. Chemical industry (category 2B)

The chemical industry is the most important sector in industrial processes in Belgium and contributes for 36% in 2006 of greenhouse gas emissions in this sector. The different sectors involved are the ammonia production (category 2B1), the nitric acid production (category 2B2) and the other, non specified sector (category 2B5) with the production of caprolactam as the most important sector.

4.2.2.1. Ammonia production (category 2B1)

Nowadays there is ammonia production in 2 companies in Belgium.

In Flanders the emissions of CO_2 originating from the production of ammonia are obtained as a result of the yearly surveys carried out by the chemical federation in cooperation with the Vito [1] (see also section 3.2.1 and 3.2.10 for more information). In the past the same methodology as in Wallonia was used, nowadays the methodology is adapted because a part of the emissions of CO_2 is recuperated in the plant and no longer emitted.

In the Walloon region, until 2002, the CO_2 emissions were calculated based on the natural gas used as feedstock. 100% per cent of the carbon content of the natural gas was presumed to be emitted; the default IPCC emission factor for CO_2 for natural gas (55,8 kton CO_2/PJ) was used to calculate the total CO_2 emissions. The amount of natural gas used in the process was given directly by the regional energy balance. It appeared during the indepth revieuw that the energy balance overestimated this data and considered that all natural gas consumed by the plant was used in the ammonia process and no natural gas was used in the combustion. It has no influence on the total CO_2 emissions of this source (combustion + process) but it was corrected this year with an average ratio calculated with the ratio of the years 2002 to 2006 as the plant gives the part of natural gas used in the process and the part for these years.
Since 2005, CO_2 emissions have been given directly by the reporting of the plant under the emission trading scheme.
A part of the process CO_2 emissions is used by two other plants and released after use but all the CO_2 emissions are allocated to the ammonia plant.

4.2.2.2. Nitric acid production (category 2B2)

Production figures of nitric acid in Belgium are wel known and recorded in the category 2B2 ‘nitric acid production’.
The N_2O emissions from the production of nitric acid (category 2B2) are estimated in Flanders untill 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 is still involved in this sector. From 2003 on lower emission factors in this plant are reported, based on monitoring results (approx. 5.6 kg N_2O/ton HNO_3). The use of catalysts reduces these emissions. A further reduction of these emissions will be obtained in the future because of the extension of the use of catalysts in the different installations involved.
Although the closure of 2 plants in the Flemish region, in 1995 and in 2000 respectively, the production of nitric acid increases and the emissions of N2O decreases in time due to undertaken measures. From 2003 to 2005 a more or less stabilization in production and emissions occur.

The producer of nitric acid in the Walloon region provides the N_2O emissions based on their production and on monitoring. There are three installations on the plant. The global emission factor used in this region of Belgium is 4,26 kg/t in 2006. For the time being , there is only one installation with an abatement technology (SCR) installed in 1996. However, this installation did not lead to a decrease in the N_2O emissions because of the strong increase of the production since 1996.

4.2.2.3. Other (category 2B5)

In the other chemical industrial processes, the CO_2 -emissions originate from

(1) the non-energy used of fuels i.e. the use of n-butane for the production of maleic anhydride in the Walloon region. The emissions are estimated by the chemical industry;

(2) the emissions of N_2O originating 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. This company estimated the emissions of the previous years from 1990 on as accurate as possible.

(3) other process CO_2 emissions 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, the emissions of CO_2 of flaring in the chemical industry etc). These CO_2 emissions result from surveys in the chemical sector in Flanders (see also sectios 3.2.1. an 3.2.10 for more details).

4.2.3. Metal production (category 2C)

Metal production, more specific the iron and steel production (category 2C) is the third most important sector of industrial process emissions in Belgium and contributes to more than 10% (12% in 2006) of greenhouse gas emissions in this sector of industrial processes. These activities are situated in the Flemish and the Walloon regions .

Also in the iron and steel sector (category 2C), more specifically during the sinter production, limestone and dolomite is used. The emissions are not allocated to the sector 2A3 'mineral products/limestone and dolomite use' but are allocated to this sector 2C. This category 2C 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 region). All activity data recorded in this sector (fluid steel, pig iron, sinter and cokes) originate directly from the companies involved.

In Flanders, the calculation of the process CO_2 emissions from iron and steel production is based on the production figures of fluid steel and pig iron and on the consumption of electrodes of the only two industrial plants in this sector and with an emission factor approved by these plants (% carbon blown off and an emission factor of 158 kg CO_2/ton pig iron).
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. Because of the switch of cokes grit into anthracite from 2004 on (because of environmental technical reasons) emissions of respectively 1964 and 2699 ton CH_4 are measured in 2005 and 2006. Emissions of CH_4 in the remaining years are negligible.

In the Walloon region, iron is produced through the reduction of iron oxides (ore) with metallurgical coke (as the reducing agent) in a blast furnace to produce pig iron. Steel is made from pig iron and/or scrap steel using electric arc or basic oxygen.
The emission estimates in this sub-sector include also emissions from the production of steel in basic oxygen type furnaces but not emissions from the combustion of the fuel. Until 2004, the emission factors in the basic oxygen furnace steel plant are used as indicated in table 4-3. The plants approved these emission factors. Until 2002, 100 % of the CO_2 in the pig iron produced the blast furnace has

been estimated to be emitted in the basic oxygen furnace due to the lack of data's (purchased pig iron, C in steel produced, C in steel scrap). According to the industry, the amount of C in steel scrap is equivalent of the amount of C in steel produced and consequently the amount of C is approximately zero. This assumption was confirmed with the emission trading data.

Until 2004, the process CO_2 emissions from electric arc furnaces were based on the consumption of electrodes with an emission factor of 5 kg CO_2/ t steel.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
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	4,66	4,66
CO_2 emission factor (kg/t pig iron)	169	169	169	169	169	169	169	169	169	169	169	169	169	171	171
CO_2 emission factor (kg/t steel) basic oxygen furnace	153	152	154	155	158	158	161	166	165	169	167	164	165	164	162
CO_2 emission factor (kg/t steel) electric arc furnace	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Table 4-3: Emission factors used in the iron and steel sector in the Walloon region (Source: plant specific /ULG)

Since 2005, CO_2 emissions have been obtained directly by the obliged reporting of the plants under the emission trading scheme.
This sub-sector included a part of the CO_2 emission in the sinter plant. Until 2004, these emissions were calculated by using an IPCC 1996 emission factor of 200 kg CO_2/ton sinter. The emissions calculated involved combustion and process emissions. Combustion emissions were reported in the energy sector (fuel consumption x emission factor (table 3-1) and the remaining emissions were reported in the process sector. These process emissions are originating from additive in the furnace as limestone. In the future, it will be difficult to make a recalculation for the complete time series due to the lack of necessary data. Since 2005, CO_2 emissions have been obtained directly by the reporting of the plants under the emission trading scheme.
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 rcorded in table 3-6). See section 3.2.3. for more information.

4.2.4. Fluorinated gases (categories 2E and 2F)

The emissions of the categories 2E and 2F (production and consumption of halocarbons and SF6) contribute to 13% of total greenhouse gas emissions in 2006 in the sector of industrial processes in Belgium.
For estimating the emissions of the F-gases described in Annex A to the Kyoto Protocol (hydrofluorocarbons HFCs, perfluorocarbons PFCs, sulphur hexafluoride SF6), a country-specific methodology was developed by 2 consultancies (ECONOTEC and ECOLAS) in 1999 based on the IPCC Guidelines [35][10][28] and since then updated every year and further optimised by ECONOTEC. This optimization did occur in collaboration with VITO since 2005 [45].

The present contribution of the F-gases to the total GHG emissions covered by the Kyoto Protocol (1.3% in 2006) is significantly lower compared to 1995 (3.3%), mainly thanks to abatement measures in the chemical industry. Since 1999, the total F-gas emissions have been increasing every year (except in 2005, which can entirely be explained by the reduction of PFCs in the chemical industry), 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. 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. As a result, the Belgian emission inventory of fluorinated gases from 1995 to 2006 can be considered as time consistent for the complete time series.

2E Production of halocarbons

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 2006 at about 150 kt CO2 equivalents (for the gases covered by the Kyoto Protocol), down from 4.4 Mton CO2 equivalents in 1995.
The processes 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 processes 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 cannot be 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).

2F Consumption of halocarbons

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 the category 2F.

As explained in [45], the potential emissions of each substance for each application are calculated as the 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.

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 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, which is 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 distributors on their national supply by refrigerant mixture[7], 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 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 still no survey concerning the fraction of new car registrations with air conditioning in Belgium. However, the federal public services of Mobility in collaboration with GOCA (association of the companies carrying out the technical control of automobiles) have 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 are used as a basis in the calculations of the emissions.

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 of 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.

[7] This inquiry does not cover the supply to equiment manufacturers, which, as already mentioned, are the subject of a separate survey.

The figures for the consumption of foaming agents are obtained from FEBELPLAST[8], for the members of this association and from a direct enquiry, for non members. They are collected separately for the manufacture of polyurethane foam (PUR) 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 latter source is much larger than the former. The emissions during manufacturing are based on data obtained from the manufacturers. The emissions of HFCs contained in polyurethane cans sold in Belgium are based on estimates from the leading manufacturer, complemented by figures from the literature. They are based on estimates of the evolution of the number of cans consumed, the share of the cans containing HFCs, the 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 assumed to be negligible.

For fixed fire extinguishing installations, an annual questionnaire is being sent to the eight companies that install such systems in Belgium, asking for their consumption of HFCs (HFC 227ea and HFC 125). All companies have responded.

The emissions resulting from the consumption of metered dose inhalers (MDI) are based on the data on annual sales of MDIs in Belgium, which are 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.

The former CFC aerosol market has practically completely moved to alternative propellants, such as hydrocarbons. However, in the technical aerosol sector there are some applications for which it is inappropriate, usually for safety reasons, to use these alternative propellants, 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 are based on a study carried out at the European level.

The SF_6 emissions originating from the production and the stock of soundproof double-glazing are calculated from the SF6 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 and export 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, as previously. The emission from production of acoustic double glazing is assumed to be 33% of the SF_6 consumption. The disposal emissions are based on an assumed unique lifetime of 25 years.

SF_6 emissons from the electricity sector are based on stock and emission factor data obtained from the SYNERGRID association.

In total, the "Kyoto" HFC gas emissions expressed in tonnes CO2-equivalents have been gradually increased (+257 % between 1995 and 2006), as a result of the current regulations related to CFC and HCFC substitution. The main uses are the refrigeration sector and the production of synthetic foams.

[8] Belgian Association of Plastics and Rubber Converters.

During the 2008 submission, the following changes have been made to the inventory data for the F-gases for the period 1995-2005:

- Emissions from car air conditioning have been re-estimated for all years.
- Emissions from polyurethane (One-Component-Foam) have been improved for all years.
- Emissions from refrigeration and air conditioning “installations” have been revised for all years, as the consumption of these systems is estimated, amongst other things, on the consumption of mobile air conditioning.
- The SF_6 emissions from double glazing have been revised, in particular to include one more manufacturer. The disposal emissions have been added.
- Some minor mistakes or inconsistencies have been removed. All of them only have a marginal impact on the total emissions.

As a consequence of this recalculation of emissions, the emissions of F-gases as reported in the previous submission have been revised, actually increased, for the years 1995-2005.

For 1995, reference year of the Kyoto protocol for the F-gases in Belgium, the only changes compared to the previous 2007 submission is related to the emissions from aircos in cars and cooling "installations"; The total impact in terms of CO2-eq for the Kyoto gases is about 0,1%.
For the other years, the impact of the changes on total emissions reaches a few per cent in a number of cases, up to 5,9% for the emissions of the Kyoto gases in CO2-eq in 2001. The changes relate to the cooling sector (the emissions of car aircos and “installations”), One-Component-Foam and the SF_6 emissions of double glazing.

4.2.5. Non-energy use of fuels (category 2G)

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 are no longer included in the Belgian emission inventory. 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 advise of the expert review team, these emissions of CO2 from the use of solvents and lubricants will only arise when they are burned or destroyed. As a consequence these emissions are excluded out of the Belgian emission inventory during this 2008 submission and the emissions of CO_2 in the base year decrease with 415,544 kton CO_2.

4.3. Recalculations and planned improvements

4.3.1. Recalculations

- In the Flemish region the process emissions of CO_2 in the glass industry (category 2A3) 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 CO2/ton glass, as proposed by the glass federation, is mainly used in this sector. One company did revise this emission factor in the current of 2006 to 300 kg process CO2/ton glass. As a result of the in-country review of June 2007, this revised emission factor was also used during this submission in the base year 1990. As a consequence the emissions of the base year did increase from 13,928 to 33,427 kton CO2 in this sector of glass production.

- Because of the comparability of the melting process in the production of glass and enamel, both industries are related in Flanders and consequently put under the same category 2A3. 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 CO2/ton glass. 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 CO2 occurred. As a result of the in-country review of June 2007, these revised emission factor was also used in the base year 1990 during this submission. As a consequence the emissions of the base year did decrease from 13,484 to 1,475 kton CO2 in this sector of enamel production.

- In the Walloon region an average emission factor was established in 2005 by the plants involved in the ceramic industry (category 2A3). During the in-country review in June 2007, the expert review team detected this missing part in the Belgian inventory. During this 2008 submission the emissions of CO_2 from ceramics in the Walloon region are included in the Belgian emission inventory. It exists of 11,57 kton CO2 in 1990.

- A mistake in an emission factor in a cement plant was corrected for the years 2001, 2002 and 2002. The difference is about 50 kt CO_2.

- During the 2008 submission, the following changes have been made to the Belgian inventory of the F-gases (category 2E en F) for the period 1995-2005:

    - Emissions from car air conditioning have been re-estimated for all years.
    - Emissions from polyurethane (One-Component-Foam) have been improved for all years.
    - Emissions from refrigeration and air conditioning “installations” have been revised for all years, as the consumption of these systems is estimated, amongst other things, on the consumption of mobile air conditioning.
    - The SF_6 emissions from double glazing have been revised, in particular to include one more manufacturer. The disposal emissions have been added.
    - Some minor mistakes or inconsistencies have been removed. All of them only have a marginal impact on the total emissions.

  As a consequence of this recalculation of emissions, the emissions of F-gases as reported in the previous submission have been revised, actually increased, for the years 1995-2005.
  For 1995, reference year of the Kyoto protocol for the F-gases in Belgium, the only changes compared to the previous 2007 submission is related to the emissions from aircos in cars and cooling "installations"; The total impact in terms of CO2-eq for the Kyoto gases is about 0,1%.
  For the other years, the impact of the changes on total emissions reaches a few per cent in a number of cases, up to 5,9% for the emissions of the Kyoto gases in CO2-eq in 2001. The changes relate to the cooling sector (the emissions of car aircos and “installations”), One-Component-Foam and the SF6 emissions of double glazing.

- 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 are no longer included in the Belgian emission inventory. 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 advise of the expert review team, these emissions of CO_2 from the use of solvents and lubricants will only arise when they are burned or destroyed. As a consequence these emissions are excluded out of the Belgian emission inventory during this submission and the base year emissions decrease with 415 kton CO_2eq in the Belgian emission inventory.

4.3.2. Planned improvements

No specific improvements are planned in the near future in the estimation of greenhouse gas emissions in Belgium in the sector of industrial processes.

CHAPTER 5: SOLVENT AND OTHER PRODUCTS USE

5.1 Overview

In Belgium the emissions of NMVOC in the source category ‘Solvent and other product use’ include paint application (building industry & households), 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, storage and handling of products, recuperation of solvents and 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 except in the Flemish region where emissions of CO_2 from the non-energy use of lubricants and solvents are reported under category 2G.

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

5.2. 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] and [20].
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 as follows :

- All emissions of category 3A (NMVOC emissions for Paint Application…) as well as some of category 3.D (other domestic use, wood coating, wood conservation, recovery of solvents, treatment of rubber, coating of synthetic material and paper) are estimated 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.

- The remaining emissions of categories 3C (production of paints, inks and glues) and 3D (storage and handling of products and assembly of automobiles, extraction of oil seeds, textile coating and printing industry) are estimated based on information gathered in the industrial databases mainly originating from the yearly reporting obligations of the industrial companies.

- The emission calculation for the emission of N_2O from anaesthesia (3D) 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 an 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..

- There is no estimation carried out in Belgium of the CO_2 equivalents calculated out of the emissions of NMVOC of the solvent consumption because of the unreliability of this factors proposed in literature.

5.3 Recalculations and planned improvements

5.3.1. Recalculations

No main recalculations of greenhouse gas emissions are made in the sector of solvent and other product use during this 2008 submission. However, as with all other sectors, a constant actualization of the inventory is performed. Consequently most recalculations of the emission inventory 1990-2006 are performed in the last years (2004 and 2005) because more accurate information became available for these years.

5.3.2. Planned improvements

In the Flemish region a study will be conducted in the near future for the optimization of the inventory of NMVOC, specific for the sectors of coating, cleaning & degreasing and dry cleaning. This study will start in June 2008, results are expected in June 2009.

CHAPTER 6: AGRICULTURE

6.1. Overview

6.1.1. Description of the sector

The main types of rearing and cultivation business and their numbers are represented in 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 (see 6.2.1). Tables 6.1 and 6.2 give an overview of the sector in Belgium.

	Belgium	Evolution 2005-2006	Flemish Region	Walloon Region	Brussels Capital region
Number of businesses	49.850	-3.3%	33.272	16.557	21
Agricultural land (ha)	1.382.390	-0.2%	625.207	756.811	372
Grassland (ha)	600.509	-1,1%	226.314	374.054	141
Grains (ha, without maize)	273.114	1.9%	92.212	180.822	80
Maize (ha)	217.678	-0.2%	162.503	55.124	51
Sugar beet (ha)	82.912	-3.1%	30.968	51.921	23
Potatoes (ha)	67.267	-3.6%	42.114	25.124	28
Others (ha)	148.538	1.8%	76.474	72.035	29

Table 6.1. : Main types of cultivation in Belgium (NIS, 2006 http://www.statbel.fgov.be/downloads/cah2006m_fr.xls).

	Belgium	Evolution 2005-2006	Flemish Region	Walloon Region	Brussels Capital region
Bovins (total)	**2.663.076**	**-1.3%**	**1.332.923**	**1.329.814**	**339**
Bovines under 1 year	778.448	-1.1%	433.800	344.549	99
Male bovine between 1 and 2 years	133.710	-5.7%	72.977	60.733	0
Female bovine between 1 and 2 years	377.018	-0.3%	182.430	194.554	34
Male bovine more than 2 years	34.473	-7.9%	17.046	17.421	6
Female bovine more than 2 years	345.867	-1.4%	166.878	178.912	77
Dairy cows	507.327	-3.0%	283.727	223.538	62
Brood cows	486.233	1.2%	176.065	310.107	61
Porcs (total)	**6.294.904**	**-0.4%**	**5.924.171**	**370.729**	**4**
Piglet under 20 kg	1.649.625	-0.7%	1.595.582	54.043	0
Piglet between 20 and 50 kg	1.297.657	0.5%	1.195.273	102.382	2
Fattening pigs more than 50 kg	2.755.630	-0.3%	2.565.577	190.051	2
- Breeding males	9.078	-10.2%	8.516	562	0
Sows	582.914	-1.6%	559.223	23.691	0
Sheep	**153.976**	**1.0%**	**97.359**	**56.607**	**10**
Goats	**27.985**	**6.8%**	**16.566**	**11.399**	**20**
Horses	**33.404**	**4.6%**	**21.684**	**11.659**	**61**
Poultry (total)	**35.569.320**	**-2.6%**	**30.385.744**	**5.182.800**	**776**
laying hens	12.397.129	-6.2%	10.904.455	1.492.468	206
Broilers	19.710.886	-6.5%	16.596.740	3.114.149	0
Others	758.635	-40.8%	643.625	114.436	574

Table 6.2. : Number of heads in the main livestock categories in Belgium (NIS, 2006 http://www.statbel.fgov.be/downloads/cah2006m_fr.xls).

The land used for agriculture in 2006 extends to 1.382.390 hectares (Table 6.1) or 45.3% of Belgium. In 2006, the number of agricultural and horticultural businesses amounted to 49850. This number had dropped by 16% in 5 years, the disappearing of small businesses being a general trend in the sector, also reinforced by the successive crises that have hit the agricultural sector (BSE [*Bovine Spongiform Encephalitis*], dioxin). 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 occured. Nevertheless the land area used for agricultural purposes remained identical during this period. In 2006 Wallonia has 55% of the land used for agriculture, but 67% of agricultural businesses are situated in Flanders. The land area used for farming is on average 19 ha per farm in the Flemish region and 46 ha per farm in the Walloon region.

Organic farming and the businesses in transition towards this type of farming only represent 1,7% of the total area in 2004 (2,7 % in Wallonia, 0,5 % in Flanders http://www.bioforum.be/fr/pdf/stat_agri_bio05.pdf) . The evolution of the Belgian agricultural sector is of course directly related to the Common Agricultural Policy of the European Union.

6.1.2 Allocation of emissions

Some agricultural sectors such as rice cultivation, prescribed burning of savannahs (categories 4C and 4E) and field burning of agricultural residues (category 4F) are not occurring in Belgium. The agricultural sector in Belgium covers the categories 4A, 4B and 4D.

As result of the in-country initial review of June 2007 the emissions put in category 4G during previous submissions were excluded in the 2008 submission. The expert review team considered that the emissions were already included in emissions from fertiliser reported under direct soil emissions in the agriculture sector (category 4D) and are consequently double-counted. See section 6.2.5. for more information.

The agricultural activities on the Brussels territory are extremely small compared with the 2 other regions in Belgium. As one can see in table 6.2, the agricultural area or the number of animals in the Brussels region does not exceed 0.02 % of the national figure. Keeping in mind the large uncertainty on agricultural emissions, the emissions in the Brussels region are deemed negligible and are consequently not estimated.

6.2. Methodological issues

6.2.1. 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. The National Institute of Statistics (NIS) [26] publishes these numbers yearly. All agricultural businesses have to fill in a form each year about the situation on the 1st of May of that year and send it to the National Statistics (NIS). Further details on the agricultural census methodology and QA/QC issues can be found on the NIS website: www.statbel.fgov.be.

With an average temperature of 9,8 °C (11.4°C in 2006, 11.5°C in 2007 www.meteo.be), Belgium as a whole has a "cool" climate.

In Flanders, data as average animal weight, weight gain, feeding situation, milk production and nitrogen fertiliser use come from the *Department Agriculture and Fishery*. The milk production is derived from the milk quota.
For fertilizer use the Department and the *Institute for Agricultural and Fisheries Research* (the so-called IVLO) conducts surveys on a representative sample of the different types of agricultural businesses and produces yearly weighted average values on the fertiliser use, taking into account manure pressure [50]. The processed animal manure used in the CH_4-model originate from the Manure Bank of *the Flemish Land Agency* (www.vlm.be).

In Flanders the allocation of animals to AWMS as well as the detailed data for nitrogen excretion factors originate from the Manure Bank and is based on the regional situation. The used nitrogen excretion factors are described in the Manure Action Plan (MAP2bis). Only for bovine (with exception for calves) the MAP2bis nitrogen excretion factor is corrected (increased) with ± 12%. This increment is the result of further scientific research done by the *Institute for Agricultural and Fisheries Research*.

The nitrogen leaching (taken into account in the N_2O model) is based on the SENTWA model (System for the Evaluation of Nutrient Transport to Water) which is updated yearly [50]. This model empirically calculates 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.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 N volatilised as NH_3 form fertiliser use and animal manure is derived from the models used to calculate the respective NH_3-emissions [51]. The model used to calculate NH_3 emission from animal manure takes into account four emission stages: indoor stable, outdoor storage of manure, manure application to land and emissions from grazing animals. The factors used in this model are updated yearly if necessary. A copy of this model can be found in annex 4 of this report.

In Wallonia, the emissions are calculated using a model developed by a consultant agency Siterem [30] with recognised experience in this field. Some amendments have been applied on the model in order to better comply with the UNFCCC requirements and to keep only the relevant regional specific emission factors. Different data are used as input in the model which then calculates CH_4, N_2O and NH_3 emissions (NH_3 is used for other mandatory reporting than UNFCCC). Four emissions sources were pointed: animal husbandry, the excreta of agricultural animals deposited in buildings and collected as either liquid slurry or solid manure, application of animal manure to land and mineral fertilisers.

In Wallonia, the data on sludge spreading on agricultural soils are available on the website of DGRNE (http://www.environnement.wallonie.be/). The allocation of animals to animal waste management system (AWMS) comes from the NIS agricultural census of 1992 and 1996, where those data were collected by animal type. Those data are not collected on a yearly basis by the NIS given their slow pace of change. However, an update of the 1996 data would likely be useful in the near future. So far we have no information about the NIS planning regarding this update.

6.2.2. Enteric fermentation (category 4A)

Because CH_4-emissions from enteric fermentation are a key source category for cattle a Tier 2 approach is required in both regions, Flanders and Wallonia. For this submission the Tier 2

methodology is used for the first time. This methodology is based on the IPCC Good Practice Guidance and therefore mainly harmonised between the two regions.
CH_4 emissions from enteric fermentation from the other, non key source, animal categories (sheep, goats, swine, horses and mules and asses) are estimated using the Tier 1 methodology as described in the IPCC Good Practice Guidance [10].

Key source category

The cattle population is divided into different groups in Flanders and Wallonia as can be seen in table 6.3.

The average animal weight and weight gain, as discussed in 6.2.1, originate in Flanders from the *Department Agriculture and Fishery* and in Wallonia from average weights published by the federal finance departement :
http://www.fisconet.fgov.be/nl/?bron.dll&root=V:/sites/FisconetNldAdo.2/&versie=04&file=fdi2005/fdi2005&zoek=000000000&name=0111/74@0111/75&Style=-1&hdr_referer=&type=2&.

Subcategories	Average weight (kg)	Weight gain (kg/day)
Flanders		
Slaughter calves	162	1,100
Bovine under 1 year	184	0,750
Bovine between 1 and 2 years	427	0,700
Bovine more than 2 years	660	0,250
Dairy cows	600	0,650
Brood cows	600	0,650
Wallonia		
Bovine under 1 year	164	0,700
Male bovine between 1 year and 2 years	184	0,700
Female bovine between 1 and 2 years	184	0,650
Male bovine more than 2 years/ fattening	427	0,700
Male bovine more than 2 years / breeding	617	0,700
Female bovine more than 2 years	501	0,650
Dairy cows	600	0,650
Brood cows	600	0,650

Table 6.3. : Average weight and weight gain for the different cattle categories in Belgium.

The emission factors for each category of cattle are estimated based on the gross energy (GE) intake and the methane conversion rate for each category. 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 4 of this report a copy of the calculation of the GE intake and emission factors in Flanders can be found. The methodology is the same in the Walloon region. The different steps and the formulas used are discussed in detail.

For the calculation of the net energy for feeding (NEfeed) in Wallonia a coefficient of 8.5% of the net energy for maintenance (NEm) is used, considering that all animal categories spend half of the time on pasture.
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%.
The formula used for the calculation of the net energy for pregnancy (NEp) originates from the IPCC guidelines 2006 (equation 10.13).

In Flanders, data for feed digestibility (DE%) originate from a report [http://www.rivm.nl/bibliotheek/rapporten/680125001.html] [53] from the Netherlands, a neighbouring country with comparable feeding situations. Table 6.4 gives an overview of the feed digestibility of the different feed types. Slaughter calves in Flanders are only fed with milk replacer. 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 17.5 kg milk/day/cow in 2006. For non-dairy cows the feeding situation is not yet specified, a DE% of 75% is used. 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.

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

Table 6.4. : Digestibility of the feed of cattle in %.

In both regions a methane conversion rate (Ym) of 6% is used to calculate the emission factor for each cattle type. The emission factors for all categories with exception for dairy cows stay constant over the entire time series. For dairy cows the emission factor increases with increasing milk production. In Flanders from 98 kg CH_4/head in 1990 to 118,8 kg CH_4/head in 2006. In Wallonia from 99,8 kg CH_4/head in 1990 to 114,4 kg CH_4/head in 2006.
Table 6.5 shows the calculated emission factors in Flanders and Wallonia for the different cattle types in 2006.

Subcategories	Emission factor (kg CH4 / head)
Flanders	
Slaughter calves	19,59
Bovines under 1 year	25,80
Bovines between 1 and 2 years	47,16
Bovines more than 2 years	50,45
Dairy cows	118,80
Brood cows	67,81
Wallonia	
Bovines under 6 months	20,2
Bovines between 6 months and 1 year: male	24,8
Bovines between 6 months and 1 year: female	26,9
Bovines more than 1 year for fattening: male	48,7
Bovines more than 1 year for reproduction: male	46,5
Bovines more than 1 year: female	50,6
Dairy cows	114,4
Brood cows	68,3

Table 6.5. : Emission factor for each animal category (2006).

Non key source categories

Sheep, goats, swine, horses and asses are no key source category. Therefore a Tier 1 methodology is used:

CH_4 emission (ton) = number of animals * emission factor

In Flanders the IPCC 1996 emission factors in table 4-3 of the Guidelines are used for all non-key source animal categories. In Wallonia the emission factors for each animal category have been developed by Siterem [30], and are adapted from a study by Vermorel in France http://www.inra.fr/internet/Produits/PA/an1997/num972/vermo/mv972.htm#chap3, where the conditions were deemed comparable to Wallonia. The classification of the animal categories occurs according to the IPCC 1996 methodology.

The emission factors presented in the CRF tables are a weighted average of the emission factors used at the regional level. Table 6.6 gives an overview of the emission factors used in both regions.

Categories	Emission factor (kg CH_4 / head) Flanders	Emission factor (kg CH_4 / head) Wallonia
sheep	8,0	8,5
goats	5,0	14,2
Swine	1,5	1,5
Horses	18	23,7
Mules and asses	10	-

Table 6.6. : The emission factors (kg CH_4/head) for the different non key source categories.

6.2.3. Manure management (category 4B)

Methane

Flanders

CH_4 emissions from manure management in Flanders are estimated using the Tier 2 IPCC 1996 methodology. Because of the availability of detailed statistics on livestock composition in Flanders, including average weight and slaughter weight, country specific data are integrated [6].
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 4 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 (m^3) = number of animals * average weight[(1)] (kg) * integrator[(2)] * manure production[(2&3)] (kg/day/1000kg) * 365/1000 * volatile solid[(3)] (%) * emission potential[(3)] (m^3/kg VS) * CH_4 potential[(3&4)] (m^3)

[(1) Source : Department Agriculture and Fishery; (2) Source : Flemish Land Agency; (3) Source : Casada & Safley [46], (4) Source : IPCC Guidelines].

CH_4 emission (ton) = CH_4 emission (m^3) * 0,662kg/m^3

Since 1996 Flanders has got a Manure Action Plan (MAP), which foresees in processing of the surplus of manure (based on the Nitrate Directive). A study performed by the Flemish Institute for Technological Research (Vito), indicates that CH_4 emissions during manure processing are negligible.

The amount of manure which is processed or transported outside Flanders, is brought in reduction with respect to the total produced manure. The manure which is transported to a manure processing company or outside Flanders is registered by the manure bank of the VLM.

For poultry the slaughter weight and an integrator (value less than 1) are used (see table 6.7) taking into account that the weight of the cattle 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.

Category	***Weight (kg)***	***Integrator***	**Manure production (kg/d/1000kg)**	**VS (%)**	**Emission Potential (m^3/ kg VS)**	**MCF (%)**
Bovine						
Slaughter calves in stable	162	1	86	12.4	0,33	15
Dairy and Brood Cows						
In stable	600	1	86	12.4	0,24	13.4
On pasture	600	1	58	11.6	0,24	1
Bovine under 1 year						
In stable	184	1	86	12.4	0,17	12
On pasture	184	1	58	11.6	0,33	1
Bovine from 1 to 2 year						
In stable	427	1	86	12.4	0,17	12
On pasture	427	1	58	11.6	0,33	1
Bovine more than 2 year						
In stable	660	1	86	12.4	0,17	12
On pasture	660	1	58	11.6	0,33	1
sheep	50	1	40	23	0,19	3.66
goats	50	1	41	26.6	0,17	3.66
swine						
Piglet under 20 kg	10	1	84	10.1	0,45	14.6
Piglet between 20 and 50 kg	35	1	84	10.1	0,45	14.6
Fattening pigs between 50 and 80 kg	65	1	84	10.1	0,45	14.6
Fattening pigs between 80 and 110 kg	95	1	84	10.1	0,45	14.6
Fattening pigs more than 110 kg	112	1	84	10.1	0,45	14.6
Breeding male	200	1	84	10.1	0,45	14.6
Breeding sows and old males and sowes	250	1	84	10.1	0,45	13.8
Horses	500	1	51	19.6	0,33	1
Mules	250	1	51	19.6	0,33	1
poultry						
Broilers (for breeding)	2	1	85	19.4	0,32	10
Broilers (for fattening)	1,3	0,52	85	19.4	0,32	10
Laying hens	2	1	85	19.4	0,32	7.8
Young laying hens	1,3	0,52	85	19.4	0,32	7.8
Ducks	2,5	0,54	85	19.4	0,32	15
Goose	7,5	0,65	47	19.4	0,30	15
Turkeys	7	0,49	47	19.4	0,30	10
Guinia fowl	1,2	0,55	85	19.4	0,32	10

Table 6.7. : 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]).

The MCF values for the different manure management systems originate from Casada and Safley, as written in the report 'Global methane emissions from livestock and poultry manure; 1992' [53].
One exception is the MCF value for pasture/range and paddock (MCF 1%) which originates from the IPCC guidelines, for cool climate. Casada and Safley suggest 10%, but after comparison with a study [46] in the Netherlands (a neighbouring country with comparable climate) a factor of 1% is used analogously to table 4-8 of the IPCC guidelines.

The values for volatile solids (VS) and Emission potential (Bo) originate entirely from Casada and Safley.

Wallonia

Emission factors for each animal category 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 in France. Those emission factors are multiplied by the number of animals to estimate the total emissions from manure management.

The resulting EF are comparable to the default IPCC EF (table 4-6 of the IPCC 1996 guidelines for western Europe, cool climate) : in 2004, the EF used in Wallonia are 5,18 kg/head.year for non-dairy cattle (IPCC default = 6), 12,47 for dairy cattle (IPCC default = 14) and 2,54 for swine (IPCC default = 3). For non-dairy cattle and swine, the implied EF in the CRF tables for Wallonia is a weighted average of specific EF for further disaggregated animal categories (see table 6.2 for example). For this reason, the EF is changing from year to year, according to the changing proportions of the subcategories of swine and non dairy cattle. The EF for sheep is 0,25 compared to 0,19 in the 1996 IPCC guidelines. It can be pointed that in 2004, sheep represents only 0,16 % of the CH4 emissions from manure management in Wallonia.

Nitrous oxide

For the calculation of the N_2O emissions from agriculture in Flanders a methodology is developed by the University of Ghent [7] as described in the IPCC 1996 GPG. 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 4 of this report and is similar to the model used in Wallonia. The model integrates the three N_2O sources: emissions from manure management, discussed here, indirect and direct emissions discussed below in 6.2.4.

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.

The origin of the nitrogen excretion factors in Flanders is described above in 6.2.1 (see also table 6.8).

In Wallonia such 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/pdf/arretenitrates_mb2.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. In Wallonia, the allocation of animals to AWMS comes from the NIS agricultural census of 1992 and 1996, where those data were published by animal type. Those data are not collected yearly by the NIS given their slow pace of change. The factors are presented on table 6.8a.

	Nex (kg/head.yr)	Solid storage	liquid storage	% stable vs pasture
Bovines under 1 year	13,4	87%	13%	100%
Male bovine between 1 year and 2 years	37,5	90%	10%	50%
Female bovine between 1 and 2 years	30,8	87%	13%	50%
Male bovine more than 2 years/ fattening	97,8	87%	13%	50%
Male bovine more than 2 years / breeding	84,4	77%	23%	50%
Female bovine more than 2 years	58,9	77%	23%	50%
Dairy cows	120,5	56%	44%	56%
Brood cows	97,8	91%	9%	50%
		0%		
Piglet under 20 kg	4,7	42%	58%	100%
Piglet between 20 and 50 kg	10,4	42%	58%	100%
Fattening pigs more than 50 kg	16,1	33%	67%	100%
Sows	37,5	47%	53%	100%
Breeding males	42,9	52%	48%	100%
		0%		
Lambs	4,4	100%	0%	100%
Sheep <1 year	4,4	100%	0%	50%
Sheep >1year	8,8	100%	0%	50%
		0%		
Goats <1year	4,4	100%	0%	50%
Goat > 1 year	8,8	100%	0%	50%
Horses	75,0	100%	0%	50%
		0%		
Broilers	0,4	89%	11%	100%
Laying hens	0,8	6%	94%	100%
Other poultry	0,6	26%	74%	100%

Table 6.8a.: Nitrogen excretion factors and allocation of animals to AWMS for each category in Wallonia (2006).

In Belgium, the local excretion factors are more or less comparable to the 1996 IPCC default value, especially if the principle of Table 4.14 of the IPCC Good Practice Guidance is taken into account : adjustment factors for the IPCC 1999 table 4-20 are given according to the age range, and in Belgium, the agricultural census allows a detailed disaggregation in subcategories according to the age or the weight of the animals (see table 6.2).

In Flanders, the allocation of animals to AWMS comes from the *Flemish Land Agency* (see table 6.8b).

Category	**N ex (kg N/animal/yr)**	**AWMS**
Bovine		
Slaughter calves	10,5	100% liquid storage

Other bovine under 1 year		
Male	25,76	24% liquid storage 36% solid storage 40% pasture ditto
Female	36,96	ditto
Bovine from 1 to 2 year		
Male		
for the reproduction	67,08	ditto
other	68,32	ditto
Female		
Fattening cows	68,32	ditto
For replacement of dairy cows	62,72	ditto
Bovine more than 2 year	86,24	ditto
Dairy and Brood cows	108,64	39% liquid storage 19% solid storage 42% pasture
Sheep		
Sheep under 1 year	4,36	19% liquid storage 81% pasture
Sheep more than 1 year and goats	10,5	ditto
Swine		
Piglet under 20 kg	2,44	96% liquid storage 4% daily spreading
Piglet between 20 and 50 kg	11,4	ditto
Fattening pigs between more than 50 kg	14,89	ditto
Breeding pigs more than 50 kg		ditto
Boars	22,21	ditto
Sows		
coverred sows	22,09	76% liquid storage 24% solid storage
Non-coverred sows	21,99	ditto
Horses		
Horses under 6 months	35	96% pasture 4% other
Farming horse more than 6 months	65	ditto
Other horses more than 6 months	50	ditto

Mules	35	ditto
Rabbit	8,64	ditto
Furred animals	3,22	ditto
poultry		
Broilers (for breeding)	0,89	85% solid storage 15% other
Broilers (for fattening)	0,59	ditto
Laying hens (for breeding)	0,51	44% storage within housing 23% solid storage 33% other
laying hens	0,63	ditto
Breeding cocks	0,67	100% solid storage
Turkeys	1,77	ditto
ostriches	8,6	100% liquid storage
other	0,24	ditto

Table 6.8b.: Nitrogen excretion factors and allocation of animals to AWMS for each category in Flanders (2006).

After determination of the excreted nitrogen per AWMS, in both regions the IPCC default emission factors from table 4.12 and 4.13 from the IPCC GPG for liquid systems, solid storage, daily spread, pasture and other are applied (respectively 0,001; 0,02; 0; 0,02; 0,005 kg N_2O-N/kg N excreted). For storage within housing in Flanders 0,001 kg N_2O-N/kg excreted is used.

6.2.4. Agricultural soils (category 4D)

Methane

Wallonia calculates the CH_4 emissions on the basis of the manure applied during grazing. This source is very small compared to enteric fermentation and manure management.

In the Flemish region the emissions of CH_4 originating from the manure applied during grazing are allocated to the category 4Ba. See section 6.2.3. for more detailed information.

Nitrous oxide

The N_2O emission estimation from agricultural soils can be divided into direct and indirect emissions as described in the IPCC 1996 methodology. The N_2O emissions are calculated according to this IPCC methodology using country or region specific data where available. In annex 4 of this report a copy of the excel file can be found for the Flemish region. The same methodology is used in Wallonia.

N_2O is also emitted as a by-product during soil nitrification and denitrification processes. There is a very high variability in the emission rates and the estimation methodologies try to take into account local conditions to reduce the uncertainty.

The N_2O direct soil emissions (category 4D1) include the N_2O emissions from daily spread, spreading of mineral fertilisers, spreading of organic fertilisers and nitrogen from crop residues.

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. In Wallonia the average rate of 2.3 % is based on the default values recommended by IIASA for different types of fertilisers. In Flanders the average rate for NH_3 volatilisation in 2006 is 2.8%. This is calculated by the model that estimates the NH_3 emissions from synthetic fertiliser as developed by ILVO. The rate for NO volatilisation in Flanders is 1.5%. The IPCC 1996 emission factor from table 4-18 of 1.25% kg N_2O-N/kg N is used.

The N_2O emissions from animal manure application are calculated in the same way as N_2O emission from mineral fertiliser spreading. The animal manure nitrogen used as fertiliser is again adjusted for volatilisation. The fraction volatilised as NH_3 and NO in Flanders ($Frac_{GASM}$) varies from 0,36 kg(NH_3-N+NO-N)/kg Nex in 1990 to 0,20 kg(NH_3-N+NO-N)/kg Nex in 2006. The reason for this strong reduction of $Frac_{GASM}$ can be found in the implementation of the different successive Manure Action Plans in Flanders. 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.

In Wallonia and Flanders no animal manure is burned.In Flanders the animal manure nitrogen used as fertiliser is also corrected for the amount of manure transported outside Flanders or to a fertiliser processing company. In both regions the IPCC 1996 emission factor of 1.25% kg N_2O-N/kg N is used.

The N_2O emissions from crop residues can vary according to the preceding culture. The nitrogen fixed by the N-fixing crops is estimated by multiplying, for each culture, the cultivated area by the edible dry matter crop production and the $Frac_{NCRBF.}$ The dry matter content of the crops in Flanders are region specific. In both regions the IPCC 1996 emission factor of 1.25% kg N_2O-N/kg N is used.

The nitrogen from grazing (category 4D2) is estimated, taking into account the number of days in pasture and the nitrogen excreted by each animal category. Available nitrogen is the difference between the manure nitrogen content and the manure nitrogen volatilisation in NH_3 and NO form. The IPCC default emission factor of 0,02 kg N_2O-N / kg N is then used to estimate the emissions.

In Flanders the implied emission factor for histosols is 8 kg N_2O-N / kg N. 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 is held constant for the entire time series [48]. No histosol cultivation occurs in Wallonia, where the only recorded organic soils are part of a nature reserve.

The indirect emission (category 4D3) considers the N_2O emissions from atmospheric deposition, leaching and runoff. The used emission factors are IPCC 1996 defaults. The atmospheric deposition is estimated at 10,9 kg N/ha. The N_2O emissions from leaching and runoff are estimated by multiplying available nitrogen quantity in soil (animals excreta from grazing, mineral and organic fertilisers spreading, crop residues decomposition, sludge and atmospheric deposition) by two factors. The first estimates the fraction of nitrogen lost by leaching and runoff, with a value coming from local studies and which falls into the IPCC range (0.17 kg N / kg N available) [51]. The second estimates the volatilisation rate in N_2O form with the IPCC default value (0,025 kg N-N_2O / kg N, table 4.18 of the IPCC Good Practice Guidance).

The category other (category 4D4) consists of N_2O emission from sludge spreading on agricultural soils. It is considered a fixed contribution of 0,1 kg N/ha x year and an emission factor equal to 0,0125 kg N-N_2O/kg N from sludge.

6.2.5. Other (category 4G)

As result of the in-country review of June 2007 the emissions put in category 4G during previous submissions were excluded in the 2008 submission. The emissions from coniferous, deciduous and market gardening were recorded in this category 4G. The expert review team of UNFCCC reviewed the supporting documentation in the Flemish region from market gardening and concluded this to be a general emission factor for a land use. The expert review team considered consequently that the emissions of market gardening would be from nitrogen fertilizer and already included in emissions from fertiliser reported under direct soil emissions in the agriculture sector (category 4D) and are consequently double-counted. The reported emissions originating from coniferous, deciduous and market gardening originate from the Flemish region only and did overestimate the base-year emissions with 0,765 kton N_2O or 237,15 kton CO_2eq.

6.3.1 Recalculations

- In the Flemish region a correction has been made after the 2007 submission concerning the allocation to AWMS for slaughter calves (category 4Bb). Before the allocation was identical to those of bovine. This was incorrect because slaughter calves are kept 100% of their lifetime on stable, in a liquid waste management system. This adjustment results in a very small reduction of the N2O emissions.

- In 2005 the population of poultry in the N2O-model in Flanders was incorrect during the 2007 submission (category 4Bb). The subcategory ‘other poultry’ was not yet filled in. This results in a small increment of the N2O emissions during the 2008 submission.

- Since September 2003 there is an obligation in the Flemish region for all new stables of poultry and pigs to be build in an NH3 emission poor way (category 4D). The results of this action are taken into account from 2005 on during this 2008 submission.

Recalculations based on the results of the initial review of UNFCCC in June 2007:

- As a result of the in-country review of June 2007 the MCF for grazing animals has been corrected in the Flemish region from 10% to 1% conform the IPCC 1996 guidelines (category 4Ba). This results in a reduction of CH4 of 7904 ton CH4 or 166 kton CO2-equivalenten in the base year 1990.

- As result of the in-country review of June 2007 the emissions put in category 4G during previous submissions were excluded in the 2008 submission. The expert review team considered that the emissions were already included in emissions from fertiliser reported under direct soil emissions in the agriculture sector (category 4D) and are consequently double-counted. The reported emissions originating from coniferous, deciduous and market gardening originate from the Flemish region only and did overestimate the base-year emissions with 0,765 kton N2O or 237,15 kton CO2eq.

Recalculations after fixing the assigned amount for Belgium (based on the results of the initial review of UNFCCC in June 2007):

- Before this 2008 submission Belgium used a Tier 1 methodology for all animal types (category 4A). Cattle however is a key source category for CH4 emissions from enteric fermentation. As a consequence the expert review team did recommend Belgium to set up a Tier 2 methodology for cattle. These recalculations result in a decrease of the emissions for the entire time series during the 2008 submission. Consequently a decrease of the emission of 17538 ton CH_4 in Flanders and 5695 ton CH_4 in Wallonia in the base-year 1990 occur.

- In Flanders, the data and factors used in the CH_4-model for manure management have been reconsidered (category 4Ba). This as a result of harmonisation between the different models used (CH_4 from enteric fermentation, manure management and the allocation to AWMS in the N_2O-model) as advised by the expert team during the initial review. For the estimation of CH_4 emissions from enteric fermentation using the Tier 2 methodology the average weight of different animal subcategories were obtained. Before this submission the slaughter weight was used, multiplied with an integrator (see table 6.8). Now, the average weight for cattle and swine are used, bringing the integrator to one. Where necessary VS and Bo are adjusted. For this multiple source reports were consulted [6, 10, 53, 54]. The allocation to AWMS in the CH_4-model and N_2O-model has been harmonized. Therefore the MCF's for some animal types have changed. All these changes result in a decrease of the emissions for the entire time series. Fore the base year this is a reduction of 16447 ton CH_4 or 345 kton CO_2-equivalenten.

- Also in Flanders before this submission the brood cows were considered dairy cattle (categories 4A and 4B). For this submission they are allocated to non-dairy cattle. This only has implications on the allocation of animal numbers, CH_4 emissions, the excreted nitrogen to the different animal types and AWMS. This correction has no implications on the CH_4 and N_2O emissions.

6.3.2. Planned improvements

- In the Flemish region a study has been carried out to calculate the NH_3-, N_2O- and the CH_4-emissions from outdoor manure storage (categories 4B and 4D). The results of this study will be taken into account during the next submissions.

- In Flanders a revision of the model used to calculate the emissions of NH_3 started at the end of 2007. Special attention goes to the emissions from manure processing, a revision of the emission factors of NH_3, uncertainty determination, geographical allocations of the NH_3 emissions and inventorying mineral fertilizer type and application. The results of this study (expected november 2008) will also have an impact on the direct and indirect emissions of N_2O (category 4D) and will be taken into account during the 2010 submission.

CHAPTER 7: LAND-USE CHANGE AND FORESTRY

7.1. Overview

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

Belgium decides to adopt 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 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 2005 Forest Resource Assessment (FRA 2005).

The distribution of forests in Belgium is shown in table 7.1. The total productive forest area in Flanders amounted to 144700 ha in 2000, based on the regional forest mapping (Van de Walle *et al*, 2005), while Walloon forests covered 458700 ha (Perrin *et al.*, 2000). Moreover, the non-productive areas as open spaces, roads, rivers etc. in the Flemish and Walloon forests were also excluded from the analysis.

Considering the very small forest area in the Brussels region (0,3 % of the total forested area), no inventory of the emissions has been conducted so far.

Regions	**Total area**	**Forest area**	**Forest cover**	**% of the total**
	(km2)	**(km2)**	**(%)**	**Belgian forest area**
Wallonia	16845	4587	27,2%	75,8%
Flanders	13521	1447	10,7%	23,9%
Brussels Capital	162	20	12,3%	0,3%
Belgium	**30366**	**6054**	**19.9%**	**100,0%**

Table 7-1: Forest cover in Belgium (source: National Institute of Statistics and regional forest inventories, Year 2000)

7.2. 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 2000) to establish the LULUF inventory.

7.3. Forest lands

7.2.1 Forest land remaining forest land

A. Change in carbon stocks in living biomass

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. For plots at edges or borders, the plot centre was moved towards the inside of the plantation. The overall impact of changing the plot centre don't conduct to any systematic bias (still a random procedure (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, commercial quality for broadleaf species with a section exceeding 22 cm circumference, 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 (Dagnelie et al., 1999).

The first Walloon forest inventory was completed in 1984. The current permanent systematic sampling started in 1994 and covers each year 10 % of the approximately 11000 sampling points (Lecomte & Rondeux, 1994). In 2000, 50 % of the sample points of the second inventory were measured. In Flanders, 2665 plots were sampled in the framework of the first forest inventory, which was constituted in the period 1997-1999 (AB&G, 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.

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).

Based on the information of the regional forest inventories, the total solid wood volumes (TSW) of each species, spread over three age classes, were calculated for Flanders and Wallonia, as given in table 7.2. Values for Belgium were calculated by summing up the Flemish and Walloon forest areas and wood volumes.

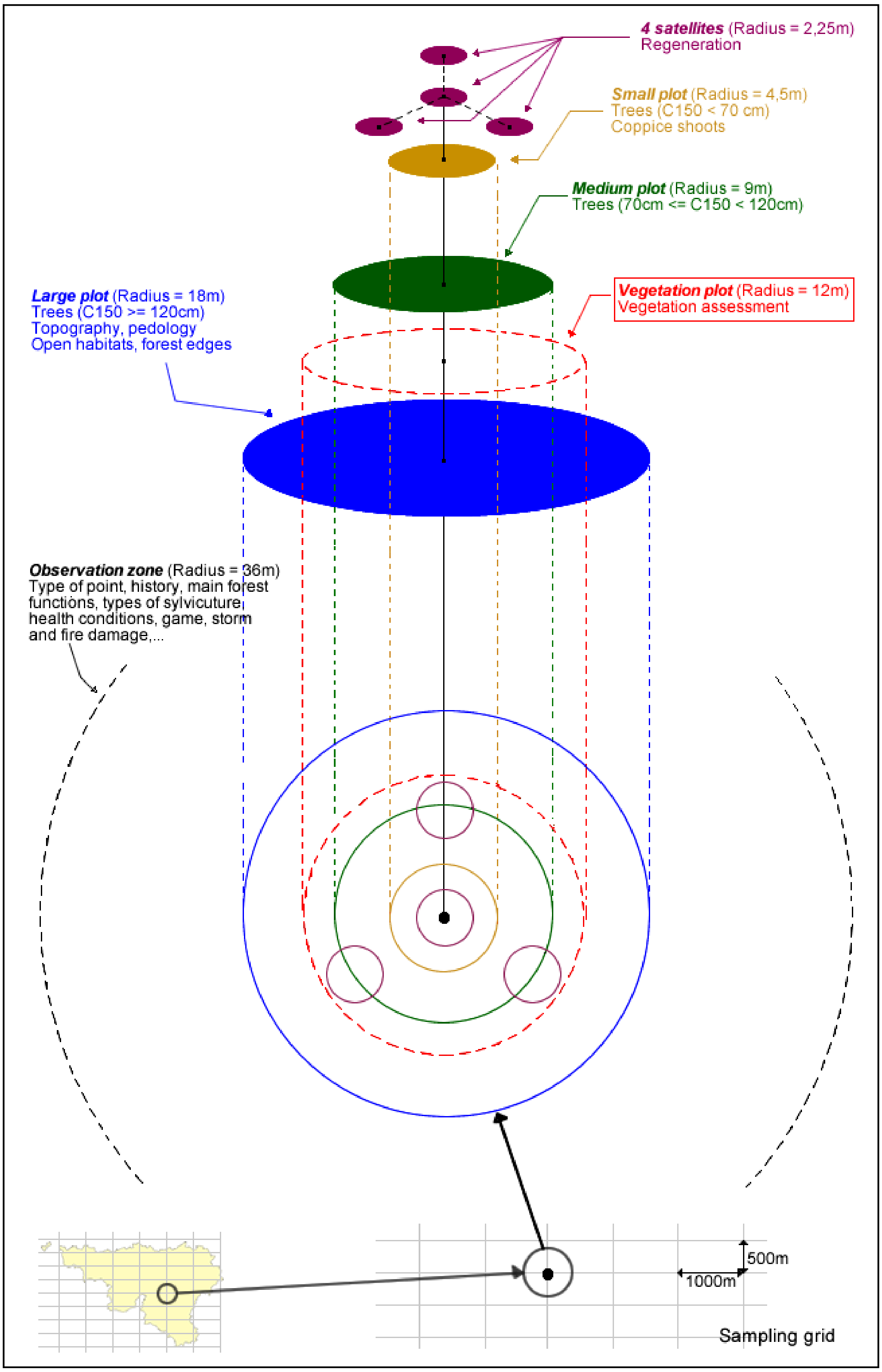


Figure 7.1. : schema of a sampling unit and data collected (Rondeux *et al*, 2005)

Species	Wallonia	Flanders	TOTAL
Picea abies (Norway Spruce)	52,5	0,5	**53,0**
Quercus petraea et Q. robur (Oaks)	25,2	3,6	**28,9**
Fagus silvatica (Beech)	16,3	2,4	**18,7**
Pinus silvestris (Scots Pine)	2,9	8,6	**11,5**
Populus sp (Poplars)	2,8	5,1	**7,9**
Betula sp (Birch)	3,4	1,4	**4,8**
Pinus laricio (Corsican Pine)	0,4	3,9	**4,4**
Fraxinus excelsior (Ash)	3,6	0,4	**4,0**
Larix sp (Larch)	2,6	0,8	**3,4**
Pseudotsuga menziesii (Douglas fir)	2,9	0,4	**3,3**
Other species	13,0	4,5	**17,6**
Total	125,7	31,7	**157,4**

Table 7.2 : volume per specie in the forest inventories (TSW in Mm^3)

The calculation of the amount of carbon stored in the biomass of trees is usually based on biomass expansion factors s.l 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 1 or BEF 1); above-ground dry biomass in total dry biomass (roots included, biomass expansion factor 2 or BEF2) and total dry biomass in carbon quantities (carbon content or CC). Some explicit conditions were applied for the selection of biomass expansion factors s.l. from the literature. For the expansion factors s.s., foliage had to be included, in accordance with the IPCC-methodology (IPCC, 2003). The analysis was limited to data reported for Austria, Belgium, Denmark, France, Germany, Great Britain, Ireland and The Netherlands. Values were selected for ‘coniferous’ and ‘deciduous’ species separately, but also for the most important tree species in the Belgian forests: pines (Pinus sp.), Douglas fir (Pseudotsuga menziesii (Mirb.) Franco), larches (Larix sp.), Norway spruce (Picea abies (L.) Karst.), beech (Fagus sylvatica L.), oaks (Quercus robur L. and Q. petraea L.), mixed ‘noble’ species (including maple (Acer pseudoplatanus L.), elms (Ulmus sp.), ash (Fraxinus excelsior L.) and red oak (Quercus rubra L.)) and poplars (Populus sp.). We established the frequency distribution of the values used in neighboring countries and selected the median (see Vandewalle et al, 2005). The selected factors are shown in table 7.3.

Table 7-3 : Conversion factors used to derive forest inventory data for deciduous and coniferous forests in Belgium (METAGE report, 2006)

Species	Wood density ($t.m^{-3}$)				Carbon content ($t.t^{-1}$)			
	Min	**Max**	**Med**	**#**	**Min**	**Max**	**Med**	**#**
Spruce	0.34	0.45	0.38	15	0.40	0.51	0.50	5
Pines	0.39	0.60	0.48	13	0.40	0.55	0.50	9
Douglas fir	0.37	0.54	0.45	7	0.50	0.50	0.50	1
Larch	0.41	0.55	0.47	8	0.40	0.50	0.50	3
Other resinous	0.35	0.50	0.40	20	0.40	0.50	0.50	7
Beech	0.55	0.72	0.56	11	0.44	0.51	0.49	10
Oaks	0.50	0.72	0.60	9	0.45	0.50	0.50	3
« Nobles » species	0.52	0.69	0.59	9	0.50	0.50	0.50	1
Poplars	0.34	0.55	0.41	48	0.50	0.50	0.50	1
Other deciduous	0.38	0.77	0.55	34	0.45	0.50	0.50	6
Species	**BEF 1 : Total aboveground biomass / Solid wood mass ($t.t^{-1}$)**				**BEF 2 : Total below ground biomass / total above ground biomass ($t.t^{-1}$)**			
	Min	**Max**	**Med**	**#**	**Min**	**Max**	**Med**	**#**
Spruce	1.14	1.71	1.29	9	0.2	0.2	0.2	
Pines	1.14	1.40	1.32	5	0.16	0.16	0.16	1
Douglas fir	1.18	2.24	1.28	10	0.17	0.17	0.17	1
Larch	1.14	1.36	1.30	3	0.2	0.2	0.2	
Other resinous	1.14	1.71	1.33	5	0.18	0.25	0.20	3
Beech	1.16	2.04	1.34	9	0.23	0.25	0.24	2
Oaks	1.24	1.39	1.32	2	0.2	0.2	0.2	
« Nobles » species	1.29	1.29	1.29	1	0.2	0.2	0.2	
Poplars	1.4	1.4	1.4		0.2	0.2	0.2	
Other deciduous	1.24	1.40	1.32	2	0.20	0.22	0.21	2

The geographic distribution of the biomass organic carbon (BOC) stock in Belgian forests in 2000 is shown in Figure 7.2. The high BOC stocks of the broadleaf forest on loam soils in central Belgium are visible, as well as in the Walloon Ardennes. The low BOC stocks on the sand soils of Kempen, Sand Region and the coast region are visible as well.

Figure 7-3 gives the evolution of biomass carbon stock (BOC). For then 1990-2000 simulation, a working hypothesis of a linear trend in forest areas and overall biomass increase was made. A distinction was made between the main deciduous and coniferous species for estimating the annual wood growth. The annual wood harvest is estimated through a comparison of the estimated annual increase of the carbon stock (based on the annual wood growth) with the effective annual carbon stock variation observed in the inventories.

For the 2001-2003 period, a model simulating the evolution of the forest biomass, called EFOBEL which stands for 'Evolutions de la FOrêt BELge' (Trends for Belgian Forest in English) was used (Laitat et al, 2005). EFOBEL is a dynamic .xls spreadsheet using 20 tables. The complete description is done in Perrin (2005). The inputs of the model refer to every grid cells of the Belgian Forest Inventories as published for the year 2000: the solid wood volume and the area of the stands, by species and by age classes. The parameters are the annual growth increment for each species, the revolution, the period between harvest and replanting (also called latency), and the percentage replacement of one species by another according policy rules under implementation by the respective forest administrations. The prediction of BOC result from various scenarios. The most probable scenario is the continuation of the current forestry practices in a scenario "Sylviculture has usual".The parameters relating to such a scenario are obtained either by the inventories themselves, or by literature searches in reference works.

A comparison between the annual wood harvest calculates with the model EFOBEL and the result of forest statistic confirm the accuracy of the methodology.

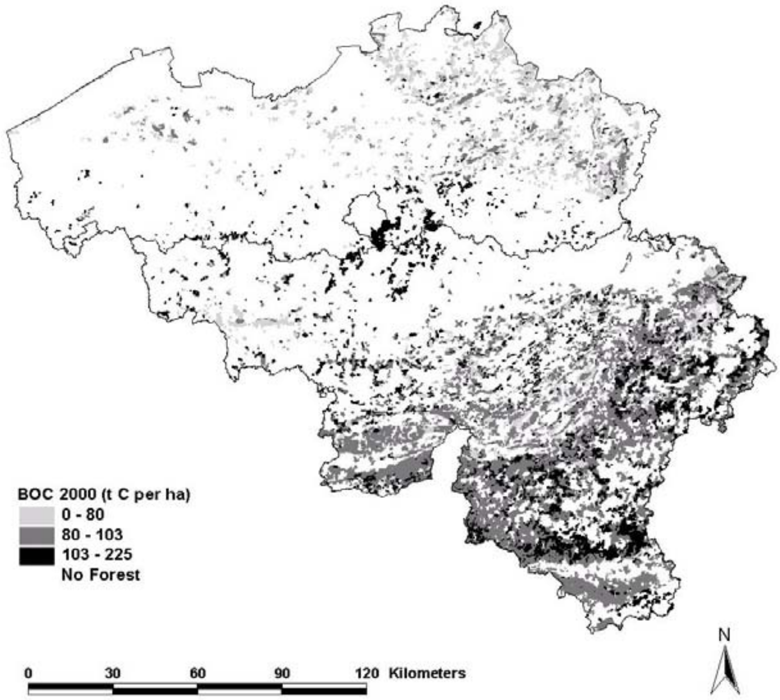


Figure 7.2. Biomass organic carbon (BOC) stock (t C ha-1) in forest in 2000 (Lettens et al, 2003)

Belgium use two different methodologies based on stock change approach: a linear interpolation for the 1990-2000 period and a mechanistic model for the 2001-2004 period. A significant overestimation of carbon sink in biomass are observed during 2001, 2002 and 2003, due to a underestimation of real harvest (link to the model assumption). After 2003, the model shows a stabilisation of the annual carbon net removals (1300 - 1500 Gg CO2 per year). Belgium will improve the time-series consistency, using the result of a scientific study (Agricultural University of Gembloux) and the actualization of the forest inventories and wood harvest statistics.

The table 7.4. represents the confidence interval (cl 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).

Table 7.4. confidence interval associated with the volume estimation per species (2000 forest inventories)

		Wallonia	Flanders
Spruce	Picea excelsa	2,20%	15,10%
Douglas fir	Pseudotsuga menziesii	13,20%	14,40%
Larches	Larix sp,	9,50%	15%
Pines	Pinus sp	6,80%	6,50%
Other resinous		7,50%	20,20%
Beech	Fagus sylvatica	4,70%	12%
Oaks	Quecus robur and Q. petraea	3%	12,40%
"Noble" broadleaves		4,20%	11,10%
Other broadleaves		5,20%	2,20%
Poplars		17,10%	11,70%

Solid stem wood volume was converted to carbon as described in the figure at the left with conversion factors preferably selected from COSTE21 publications (Table 7.2.).

A frequency distribution was established for the values used in neighbouring countries, assuming a normal distribution of the selected variable. The relative error could be derived from this frequency distribution. Consecutively a Monte Carlo analysis (10000 simulations) was applied to the calculation of the 2000 stock.

According our calculations, the carbon stock in the biomass averages 59.8 Mton in 2000, with a relative confidence interval (CI95%) on the mean of 10.3%.

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 (ie 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). We assume that the actual stock (1.38 Mt.C) remains constant.

For the carbon in litter pool, the default IPCC factors are used. The C stock in litter pool was estimated about 13.73 Mt.C. Despite the increase of above and below ground biomass, Belgium consider the stability of the C stock (conservative approach).

C. Soil organic carbon in agricultural and forest mineral soils

For the soil C modelling at the large spatial scale (Walloon region), two models were coupled: EFOBEL and YASSO. EFOBEL was developed to integrate the results of the Permanent Forest Inventory of Walloon Region and to simulate the forest biomass growth. The outputs of EFOBEL were used as the inputs of YASSO, a model which aims at estimate soil C fluxes due to the climatic variable and forest biomass evolutions. The methology is described in Perrin (2005).

The C fluxes in soil is 0.0434 tC .ha^{-1}

d. Land converted to forest land

A slight decrease of forest land is observed in Belgium.
A study on the impacts of the land-use change activities is planned.

7.4. Cropland and grassland

7.4.1. Cropland remaining cropland and grassland remaining grassland

a. Change in carbon stocks in living biomass
The majority of the cultures are annually harvested. Belgium does not consider modifications in the C stock in living biomass biomass.

b. Change in carbon stocks in soils

Methodology

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.

Due to the generalised nature of the CLC geo-dataset and the Soil Association map, LSUs are pseudo-homogeneous with respect to soil and land use composition. This is especially true in highly fragmented landscapes, as those present in major parts of Belgium, and is illustrated by the fact that according to CLC, there is 1,782,028 ha of arable and grassland in Belgium while official net land use statistics show 1,400,300 ha (NIS, 2000). Moreover, a CLC compatible geo-dataset for 1960 and 2000 is not available. Therefore, LSUs derived from CLC-1990 are used for 1960 and 2000 as well. Hence, spatially explicit land use changes between 1960, 1990 and 2000 are not accounted for and no data can be generated on the effect of land use change on SOC stocks as derived from multi-temporal assessments. This assumption of absent land use changes may be fairly realistic with regard to the overall delineation of the LSUs. The total agricultural area for example, increased by less than 3% between 1990 and 2000, as indicated by agricultural statistics (NIS, 1990). However, the increase of within-LSU heterogeneity of land use, e.g. the obvious growth of rural residential areas, mostly at the expense of agricultural land fragments, is disregarded.

The methodology uses the stock change method for estimating CO2 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 CO2 flux is equal to the observed change in SOC stock in CO2 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 a 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.

For LSUs for which no measurements are available, the stocks can be estimated using a mechanistic model (YASSO for forest soils, ROTH C for agricultural soils). This has been done for the 1990-stocks of forested LSUs.

Result

Due to the absence of forests in the 1990 assessment, the SOC content of only 130 agricultural LSU can be compared between the years 1990 and 2000 by means of a pair-wise comparison. The SOC stock in the 0-20 cm layer of 87 LSUs (74% of the total agricultural area) decreased between 1990 and 2000. For 25 (48% of the total agricultural area) of these LSU, the decrease is significant at the 95% confidence level. Those LSUs are mostly under cropland and all of them occur in northern or central Belgium. Most of the remaining 43 LSUs (26%) with increased SOC content are situated in southern or central Belgium. Also the 1 LSU (3%) that shows a significant increase of SOC content is located in southern Belgium.

On average, the SOC content of both the land use type grassland and cropland decreased significantly between 1990 and 2000. Grassland SOC decreased from 64 t C ha-1 in 1990 to 60 t C ha-1 in 2000 (0-20 cm). Cropland soils stored 38 t C ha-1in 1990 and 36 t C ha-1 in 2000. If only the soil associations are considered, 39 of the 65 associations have lost SOC between 1990 and 2000. They are situated in the coastal zone and in northern and central Belgium. The 16 associations with a significant decrease in SOC are restricted to northern and central Belgium. The 4 associations with a significant increase in SOC are all situated in southern Belgium.

Finally, the total SOC stock in agricultural land was compared between 1990 and 2000. In 1990 this stock amounted to 178 Mt C in the upper 100 cm and for 2000 it decreased to 169 Mt C. This decrease is significant at the 95% confidence level (Figure 7.4.).

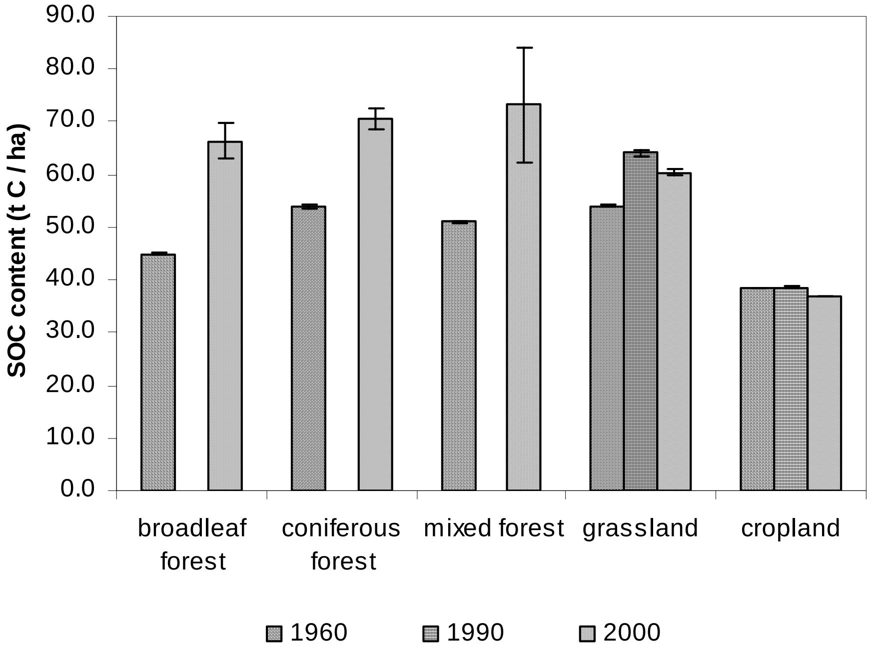


Figure 7.4. : Average SOC content and 95% confidence intervals (t C ha-1) for 0-20 cm for the land use types broadleaf forest, coniferous forest, mixed forest, grassland and cropland for 1960, 1990 and 2000 (Lettens et al, 2003)

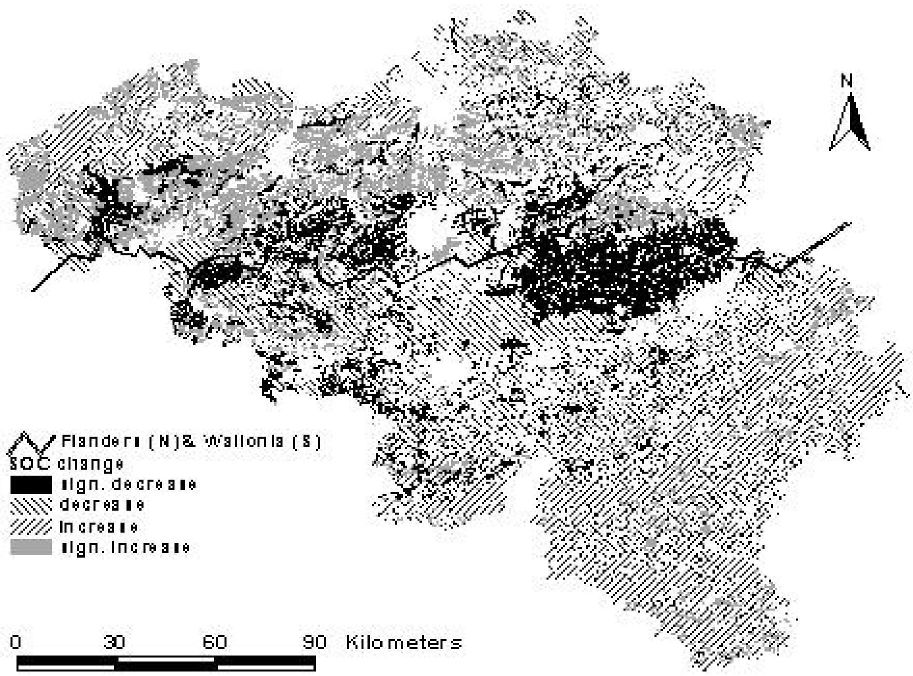


Figure 7.5 : SOC change of landscape units in Belgium between 1960 and 2000 in the upper 20 cm of mineral soil. Hatched areas represent non-significant changes (Lettens et al, 2003)

7.4.2. Land converted to cropland or grassland

A decrease of agricultural land is observed in Belgium.
A study on the impacts of the land-use change activities is planned in 2008.

7.5. Wetland, settlement and other lands

These sectors are not estimated. A study on the impacts of the land-use change activities is in hand.

7.3. Recalculations and planned improvement

7.3.1. Recalculations

Since the previous submission, all categories of the land-use change and forestry are covered in the Belgian greenhouse gas inventory.

7.3.2. Planned improvements

Regarding the category "forest land remaining forest land", Belgium will improve the time-series consistency when the update of the forest inventory will be available.

CHAPTER 8: WASTE

8.1. Overview

8.1.1. Description of the sector

The production of waste arising from the residential sector and from commercial activities ('municipal waste') amounted to 535 kg per inhabitant in 1999, 52% of which was not recycled. Manufacturing industry is the largest source of waste (13.8 Mt). The three regions have implemented waste management plans.
The objectives and actions of the Flemish region for waste are defined in the report *MiNa [Flemish Environmental Policy Plan 2003-2007]*. For further information the website www.ovam.be of the institute responsible for waste management in Flanders (OVAM) can be consulted.
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 2003-2007* also subscribes to this double strategy of waste prevention and recovery.

In addition, 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 industries most intensive in manpower are textile recycling, the recycling of paper and of construction materials.

8.1.2.Allocation of emissions

The waste emission inventory in Belgium covers categories 6A, 6B, 6C and 6D.

Category 6A1 contains the emissions of CH_4 originating from the solid waste disposal sites in Belgium. No waste disposal sites are located in the Brussels region in Belgium.

The emissions from the treatment of domestic wastewater are calculated and allocated to the category 6B2. Category 6B1 is also discussed in this chapter.

The waste incineration category (category 6C) includes incineration of municipal and industrial waste, incineration of hospital waste and the incineration of corpses. Emissions originating from flaring activities are allocated partly to the sectors 1B2a and 1B2c (Flemish region, refineries, see section 3.2.7 for more information) and 2B5 (Flemish region, see section 4.2.2.3 for more information) and partly to the sector 6C (Walloon region). The emissions of the waste incineration plants with energy recuperation are allocated to the category 1A1a.

CH_4 emissions from the production of compost are put under category 6D Waste/Other.

In Brussels only category 6B (municipal wastewater treatment plant since half 2000) and 6C (waste incineration) are relevant in this waste section. The only one municipal waste incineration plant in this region occurs with energy recuperation and is consequently allocated under category 1A1.

8.2. Methodological issues

8.2.1. Solid waste disposal on land (category 6A)

The methodology used to calculate the emissions from solid waste disposal on land differs slightly between the Flemish and the Walloon region in Belgium, where these solid waste disposal sites are located.

Flanders

In the Flemish region the CH_4 emissions from solid waste disposal on land (category 6A1) were studied by the Vito [1] in 1994 [8]. The data available for Flanders are specific and accurate, what allows a more refined methodology than the one proposed in the IPCC 1996 Guidelines. The main source of data collection and information needed for the model is originating from the public Flemish institute for waste management (OVAM), located in Mechelen.
Since 1994 waste policies in Flanders (cfr. Ladder of Lansinck which prefers waste burning over waste dumping) have made some results. The amount of waste of households dumped decreased since 1994 and from 1998 on, more waste is burned than dumped. A real moratorium in dumping organic waste is set up since 2000.
In the current of 2002 an actualization of the model was performed, taken into account the new situation of flaring and valorization of the waste gas in the Flemish region.
From 2005 on consultations with the Flemish waste experts of the institute OVAM started in order to evaluate and further optimize this model. These consultations resulted in actualized emissions for the Flemish region from 2006 on.
The in-country review of UNFCCC in June 2007 did not detect any anomalies in the methodology used in Belgium. Anyway, the Flemish region did contact the UNFCCC-expert of waste Ms. Sirinthornthep Towprayon after the in-country review in January 2008 with some more questions because more information from the waste institute OVAM to integrate in the model became available at that time.

In the Flemish region a combination of 2 models is used: a multiphase model for the estimation of emissions of the sites which are permitted and a first order decay model for all other, old waste disposal sites which are no longer permitted to dispose but where still emissions occur after the ban of disposal on these sites (these are the so-called solid waste disposal sites in after-care).

A short presentation of the 2 models is given below:

1) <u>The first order decay model</u> takes into account residential and industrial waste. Data for these sites are available from 1981 on. It has been assumed that the ratio of waste landfilled to waste produced in the period 1970 to 1980 is the same as for the year 1981.
The methodology of this first order kinetic model of methane production in the stable phase of methane fermentation takes into account the different factors which influence the velocity and the volume of methane generation. One of the most important input parameters is the total amount of waste disposed yearly.
An assumption is made that the waste decomposes during a period of 25 years. With respect to the waste composition a biodegradable fraction of 18% is assumed, conform to studies carried out in the Netherlands [Van Amstel et al., Methane: the other greenhouse gas, RIVM Report 481507001, 58-59, 1993].
In an other study conducted in the Netherlands [Verschut et al., Broeikasgassen uit vuilstorts in Nederland, TNO Report 91-444, 1991] methane emissions at 3 landfilles sites have been measured and a mean degradation coefficient calculated of k = 0,1/year. An active lifetime is assumed of 25 years for the Flemish landfills, including an aerobic period of 1 year and an anaerobic period of 24 years.

The composition of the organic waste fraction can be described as $C_6H_{10}O_4$ and the reaction for the production of biogas of organic material is:

$C_6H_{10}O_4 + 1.5\ H_2O = 2.75\ CO_2 + 3.25\ CH_4$ (Parken & Owen, 1986)

The formula used to calculate the emissions of methane in solid waste disposal sites is:

St = a*Qi*Bo*k*exp-kt (first order kinetic approach of waste gas production S on time t after disposal) based on biodegradation of $C_6H_{10}O_4$

With a = conversion factor from 1 kg organic waste to $1m^3$ waste gas (based on the reaction above and equal to $1m^3$/kg C)
St = waste gas production on time t after disposal (in m^3)
Qi = the amount of disposed biodegradable waste on time t=0 (in ton)
Bo = the initial concentration of biodegradable material in the disposed waste (in kg/ton)
k = the first order velocity constant of biodegradation (in year-1)

The biogas contains 55% of methane (see reaction of Parken & Owen) and an oxidation of methane of 10% in the upper layer is assumed.

The first order velocity constant of biodegradation depends on a few parameters such as humidity and composition of the disposed waste. The composition of the waste varies in time to a smaller amount of biodegradable waste because of the selective waste collection. The consequence is a lower value of k in time (from 0.5/year for mixed waste to 0.05/year for paper, wood and textile). This first order model assumes a k-value of 0.1/year.

To calculate total emissions of CH_4 of these waste disposal sites, the above equation is calculated for all disposed waste in all years.
The overall methodology is described as the Tier-2-IPCC-methodology.

2) The multiphase model treats 15 solid waste disposal sites (category II) which are permitted in Flanders and contains mainly domestic waste.

a) The domestic waste is divided into residential, rough and urban waste.
Because a different interpretation of different local authorities, urban waste is supposed to be similar to domestic waste.
This model uses velocities of gas production that are more accurate compared to first order models. The model assumes that the gas production starts 1 year after disposal and goes immediately to a maximum.
The following biodegradation rates are used (practical experience):

Quick biodegradation: k1=0.173 (t1/2=4)
Average biodegradation: k2=0.069 (t1/2=10)
Slow biodegradation : k3 = 0.023 (t1/2 = 30)

The amounts of organic matter (Co,i,j) for different kinds of waste categories can be determined by the composition of the waste and originates from literature. The following equation is used:

$C_{o,i} = w_i d_i o_i c_i \times 1000$

For each biodegradation rate is

w= fraction of total waste disposed
d = fraction dry material in this phase
o = fraction organic material in the dry material
c = the organic C in the organic dry material

Domestic waste is divided into 10 main fractions during sorting analysis in the Flemish region. These analyses were carried out in 1985, 1993-1994, 1994-1995 and 1995-1996 by the Flemish institute OVAM. These fractions are connected to 1 of the 3 biodegradation rates (quick, average and slow). Some of the fractions are determined as 'not biodegradable'.
- quick biodegradable for waste of kitchen and garden
- average biodegradable for paper and carton
- slow biodegradable for textiles, hygienic fraction, leather, rubber, …
- not degradable for glass, metals, synthetics, small hazardous waste, inert fractions (sand, stones), …

The selective collection which started in 1991 seemed to have no influence on the relative composition of the waste but did have an influence on the absolute values. The study carried out did take into account the selective collection by taken 2 different periods into account: one before 1991 and one after 1991. For the first period before 1991 the 'fraction of total waste disposed' of 1985 is used as average values, for the second period after 1991 an average value for this parameter is used of the 3 periods of 1993-1994, 1994-1995 and 1995-1996.

The biodegradable fractions of rough waste on the solid waste disposal sites are (analyses carried out in 1995):
paper and carton: 3%
trim wood (from gardening): 10%
wood (construction & demolition, furniture): 20%
textile: 6%

No data are available before 1991. No much information is available about rough waste. Same values parameters of d, o and c are used as for domestic waste.

The amount of organic C in each phase of biodegradation rate of domestic waste (dw) and rough waste (rw) are presented in table 8.1.

Biodegradation rate	wdw (…-1990)	wdw (1991-…)	wrw	d	o	c
quick	0.44	0.49	0.00	0.44	0.51	0.45
average	0.24	0.17	0.13	0.70	0.85	0.45
slow	0.09	0.10	0.26	0.77	0.73	0.45

Tabel 8.1: Characteristics for the determination of the fraction of organic carbon in each phase of biodegradation rate of domestic waste (dw) and rough waste (rw).

b) The calculation of organic carbon in the category II <u>industrial waste</u> uses other w-values. Following characteristics could be defined (source = diposal registers and yearly inquiries in the Flemish region):

Process waste: 36%
Non-process waste: 36%
Recycled residues: 3%
Sludge: 9%
Medical waste: 1%
Inert rest: 15%

Because further information is missing, the values for the relative composition for the 3 biodegradation rates and for the amount of organic material in each of the phases are taken from literature:

Biodegradation rate	C_{iw}	w_{iw}
quick	$C_{0,1}$ = 49 kg/ton	0.52
average	$C_{0,2}$ = 8 kg/ton	0.03
slow	$C_{0,3}$ = 18 kg/ton	0.05

Tabel 8.2: Characteristics for the determination of the fraction of organic carbon in each phase of biodegradation rate of industrial waste (iw)

c) The above mentioned parameters are used in the multiphase model for all permitted solid waste disposal sites in Flanders except for 2 sites (DDS for domestic waste after 1991 and DEVOPAN for industrial waste) where more accurate information was given by the operator. In these 2 cases the parameters were adapted to local conditions.

d) Other parameters to calculate the waste gas production:

The fraction of biodegradable material is assumed to be 77%.

The biogas contains 50% of methane and an oxidation of methane of 10% in the upper layer is assumed.

e) The production of waste gas Q_g in the year t (in m^3/year) is finally calculated as:

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

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

with a the factor to transfer the amount of carbon to the amount of waste gas (1,87 m^3/kg C)
with A_j the amount of waste disposed in year i (in ton/year)
with the biodegradation rate k_i of each phase of biodegradation rate (in 1/year) with the total amount of phases = 3 (quick, average and slow)
with $C_{0,i,j}$ the amount of organic carbon in each phase
with ζ a formation factor for the reduction of waste gas in some parts of the disposal site (because of local unfavourable conditions of micro-organisms. This factor corrects for uncertainties such as level of humidity, pH, temperature, … and indicates how much gas is really formed. In practice this factor is assumed to be more or less 0,6.

The recoverable amount of waste gas Q_r is determined by the recovering efficiency η:

$$Q_r(t) = \eta \, Q_g(t) \qquad (8)$$

The recovering efficiency η is determined by the ratio of the disposed volume out of which the waste gas is recovered effectively and the total disposed volume; The recovery efficiency can be improved by an extension of the amount of sources and/or the placement of impenetrable over- or under-coverage.

Wallonia

The CO_2 and CH_4 emissions from solid waste disposal on land are calculated with a first order decay model that considers separately the emissions of industrial and municipal waste. The model, developed by the Vito [24], acknowledges the fact that methane is emitted over a long period of time. A first order decay model is used to take into account the various factors that influence the rate and extent of methane generation and release from landfill.

The model calculates the biogas emissions using the following relation :

$$S_{P,Y} = Q_Y * DOC * k * C * \exp^{(-k * \Delta t)}$$

$S_{P,Y}$ = biogas generation rate at year P (m^3)
Q_Y = the quantity of waste disposed year Y (Ton)
DOC = initial degradable organic carbon (kg/Ton)
k = biodegradation rate constant (% / year)
C = % of DOC really degraded (%)
Δt = the time since initial disposal (Y-P) (year)

In order to estimate the current biogas emissions from waste placed in all years, the equation is solved for all values of Q_Y and the results summed. The methane production is then calculated taking into account the biogas composition and an oxidation factor of 10% in the upper layer. The overall methodology follows the Tier 2 IPCC methodology (equation 5.1, IPCC Good Practice Guidance [10]). The constants used for household and industrial waste are presented in the table 8.3.

Constant	Municipal waste	Industrial waste
DOC(x) (in kg C/tonne waste)	180 (before 1986) 170 (1986-1990) 142,9 (1995) 112,5 (2000) 99,9 (2002)	26,8 (1970-1995) 23,6 (2000) 16,4 (2002)
K	10	10
DOCf	77	77

Table 8.3. : Solid waste disposal on land. Constants used in the model in Wallonia. For DOC, linear interpolation is used to estimate the intermediate values.

The model assumes that :

- the waste decompose during 25 years
- there is a aerobic period of 1 year where there is no methane production
- the landfill gas contain 55 % of CH4 and 45 % of CO_2

- there is a CH_4 oxidation in the upper layer (10 %)
- the DOC reduction reflects the increased sorting of municipal waste

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. This CH_4 is assumed to be completely converted into CO_2 through the combustion process. In previous submissions, this CO_2 emission was included in national totals. The CO_2 produced by the biogas recovery is not reported anymore in the CRF tables 6.A, according to footnote 4 on page 5.10 of the IPCC Good Practice Guidance [10].

CH4 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.

In the Walloon region the quantity of waste disposed comes from the statistics of OWD (Walloon Waste Office). It publishes each year the industrial and municipal waste disposed, based on the taxes declaration forms covering 50 solid waste disposal sites of various sizes. The data are classified according to 12 main categories (119 subcategories), thus allowing an accurate calculation of the amounts of waste and its degradable organic carbon content (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. The evolution of the ratio of biogenic waste in the waste incineration sector reflects the implementation of the Wallonia Waste Plan, as 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.

The DOC value calculated for municipal waste lies in the default value range from IPCC revised 1996 Guidelines. The value for industrial waste was calculated using the detailed waste types from OWD and the IPCC Good Practice Guidance methodology (equation 5.4, page 5.9). This detailed estimation led to a complete recalculation, as the new estimated DOC were much lower than the default value previously used.

The biodegradation rate constant and the rate of DOC really degraded also come from the revised 1996 IPCC Guidelines and the IPCC Good Practice Guidance [10]. The new default value of 0,5-0,6 for DOCf , proposed in the IPCC Good Practice Guidance if lignin is included in the DOC value, has been tested in the model. It leads to a major problem in the sense that from 2002 and on, the biogas recovery (measured in volume and CH4 fraction, thus appearing to be reliable estimate) becomes larger that the emissions as estimated by the model. Consequently, the former default value of 0,77 has been deemed more suited to the Walloon context and kept in the model.

Each year, all the landfills with CH_4 recovery (12 in 2002) are contacted to collect data on the amount and CH_4 content of the biogas recovered (flaring or energy purposes). 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). 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. Seven main sites are followed for the time being and the report includes biogas analysis. Details can be found on the website of DGRNE.

8.2.2. Wastewater treatment (category 6B)

The CO_2 emissions from municipal wastewater treatment plants are not included in the Belgian greenhouse gas inventory in this category of domestic and commercial wastewater handling (category 6B2) because the carbon derives from biomass raw materials. In this category, two sources of methane emissions are taken into account, the municipal wastewater treatment plant and the sceptic tanks.

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 produce 60 g BOD/day, whose 60 % eventually settles (IPCC fraction that readily settle). It is considered that only 25 % of the BOD loading is anaerobically degraded (60*0.6*0.25), because the septic tanks are regularly emptied and consequently the sludge is then treated aerobically. The annual emission factor becomes 1,971 kg CH_4/inhab*year (60*60%*25%*0,6gCH_4/kg BOD). This emission factor has been always used in the Walloon region. In the Flemish region untill the 2007 submission the factor of 1,5 g CH_4/inhab*day was used. As a result of the in-country review in June 2007 the Flemish region did recalculate the emissions from waste water treatment / septic tanks and harmonizes the methodology with the other regions also by using the emission factor of 1,971 kg CH_4/inhab*year. 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 the Walloon region, after discussion with the regional responsible for municipal wastewater treatment plants, it appears that most of the plants are conducted aerobically. Those who use anaerobical digestion of the sludge recover the CH_4 for energy purpose. Consequently, no CH_4 emissions are accounted in this subcategory. Emissions originating from the anaerobical treatment of industrial wastewater (category 6B1) are not estimated because in Wallonia, the plants that apply this treatment also recover the CH4 for energy purposes. . Consequently, as for the anaerobical municipal wastewater treatment plants, no CH_4 emissions are accounted in this subcategory.

In the Brussels region, the municipal wastewater treatment plant is also conducted aerobically, no CH_4 emissions are consequently estimated for this subcategory.

In the Flemish region the emissions of CH_4 of the municipal waste water treatment plants are estimated by using the methodology as described in the EMEP/CORINAIR guidebook [3]. An emission factor of 0,3 kg CH_4/inhabitant*year is used to calculate these emissions.

The N_2O emissions from human sewage are estimated by using the methodology described in the IPCC 1996 Guidelines. The default values for N fraction in protein and N_2O emission factor are 16 % and 0.01 kg N-N_2O / kg protein. The figure of protein consumption originates from the FAO statistics (30,069 kg protein/person in 2006). The population figures comes from the National Institute of Statistics.

8.2.3. Waste incineration (category 6C)

Waste incineration

N_2O emissions from domestic waste incineration are calculated using activity data known from the individual companies involved combined with the emission factor of CITEPA [2], which is 60 g N_2O/ton waste.

CH_4 emissions are not relevant here, as IPCC Good Practice Guidance [10] 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 %.

Wallonia

In Wallonia, following a legal decree in 2000, the air emissions from municipal waste incineration are measured by ISSEP and the results are validated by a Steering Committee . These results allow a crosscheck with the results of measurements directly transmitted by the incinerators to the environmental administration. 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 2000, more precise data are reported by the waste incineration plants in the context of their environmental reporting. In 2005, the average organic content is 31 %. These emissions are now reported in the energy sector, according to IPCC guidelines.

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 has closed. Some hospital waste are incinerated in the municipal waste incineration plants. As the 4 municipal waste incineration plants produce electricity, these emissions are allocated in the energy sector.

Brussels

The emission factors for the incineration of hospital and municipal waste and corpses are estimated by measurements in situ in connection with EPA and EMEP/CORINAIR emission factors.

<u>Flaring in the chemical industry</u>

The emissions of CO_2 from the flaring in the chemical industry are reported in category 6C according to the IPCC Guidelines. This is the case for the Walloon region. In the Flemish region the emissions of CO_2 from the flaring activities in the chemical industry are allocated to the category 2B5 instead of category 6C because these emissions are included in the surveys which are carried out in this region on a yearly basis by the chemical federation in cooperation with the Vito and it is not easy to take out these flaring emissions.

8.2.4. Others (category 6D)

CH_4 emissions from compost production are estimated using regional activity data combined with a default emission factor of 2,4 kg CH_4/ton compost. The emission factor of 2,4 kg CH_4/ton compost is used after consultation the colleagues in the Netherlands who uses this factor as a result of measurements carried out. 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.

8.3. Recalculations and planned improvements

8.3.1. Recalculations

As a result of the in-country review in June 2007 the Flemish region did recalculate the emissions from waste water treatment / septic tanks (category 6B2) and harmonized the methodology with the other regions by using the same emission factor of 1,971 kg CH_4/inhab*year. See section 8.2.2. for more information. The CH_4 emissions are estimated by multiplying these emission factors by the number of inhabitants not connected with a municipal wastewater treatment plant. This recalculation resulted in an increase of emissions of CH_4 of 6422 ton or 135 kton CO_2 eq in the base year.

8.3.2. Planned improvements

- The in-country review of UNFCCC in June 2007 did not detect any anomalies in the methodology used in Belgium to estimate the emissions from solid waste disposal sites (category 6A). Anyway, the Flemish region did contact the UNFCCC-expert of waste, Ms. Sirinthornthep Towprayon, after the in-country review in January 2008 with some more questions because more information from the waste institute OVAM became available at that time. Depending on the outcome of this consultation, the methodology can be revised/optimized during the next 2009 submission in the Flemish region.

CHAPTER 9: RECALCULATIONS AND PLANNED IMPROVEMENTS

9.1. Recalculations and achieved improvements

The specific recalculations and methodological improvements achieved since the last 2007 submission are presented in the respective chapters of all sectors in this National Inventory Report.
A constant actualization of all sectors of the inventory is performed (mostly in most recent years) from the moment more accurate data become available
Most 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 this submission for the time series 1990-2005 and provisional emissions are calculated for 2006.
On the technical side, all the national sectoral tables have been fulfilled in this submission.
Most important recalculations performed during this 2008 submission are the results of the in-country review of UNFCCC in June 2007. A summary of these recalculations is given below. More details about these recalculations are also attached in annex 4 of this report. The Reports of the individual review of the greenhouse gas inventory of Belgium submitted in 2006 (December 11, 2007) and of the review of the initial report of Belgium (December 12, 2007) are also attached in annex 4 of this report.

Recalculations based on the results of the initial review of UNFCCC in June 2007:

- As a result of the in-country review in June 2007, the 3 regions did perform an 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). Before this 2008 submission, emission factors of CITEPA (Flemish region), IPCC 1996 and EMEP/CORINAIR (Walloon region) and from a specific study (Brussels region) were used.

- During the 2008 submission and as a result of the in-country review in June 2007 the emissions of CH_4 and N_2O in the sector of road transport (category 1A3b) in the Walloon region have been recalculated using the COPERT III-methodology. This recalculation is performed in order to harmonize with the methodologies used in the other regions.

- As a result of the in-country review in June 2007 an harmonization of the applied emission factors for CH_4 and N_2O in the service, residential and agriculture (category 1A4) sector was performed in the Belgian greenhouse gas inventory. As a consequence the Flemish region switched from emission factors from CITEPA90 to IPCC 1996 emission factors and the Brussels region switched from emission factors from a specific study carried out in the past to IPCC 1996 emission factors. The Walloon region did already use the IPCC 1996 emission factors during the previous submissions.

- 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 untill 1992 there still was some mining activity in the Flemish region. Untill 1999 energetic mining activities remain existing. These activities consist of an auto-producer of electricity that was active untill 1996 (the waste of the coal was used to produce electricity) and of energy needed for the sorting machines which were active untill 1999. The emissions of CO_2 were already included in the Belgian emission inventory as these energetic activities were already included in the Flemish energy balance. These activities are allocated to the category 1A1c. During this 2008 submission the emissions of CH_4 and N_2O were newly estimated and added to the Belgian emission inventory. The underground mining activities are newly allocated during this submission to the category 1B1a. The diffuse emissions originating from these mining activities of CH_4 decreases from 14 kton in 1990 to 3 kton in 1992.

- 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 are no longer included in the Belgian emission inventory. 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 advise of the expert review team, these emissions of CO_2 from the use of solvents and lubricants will only arise when they are burned or destroyed. As a consequence these emissions are excluded out of the Belgian emission inventory during this submission and the base year emissions decrease with 415 kton CO_2eq in the Belgian emission inventory.

- In the Flemish region the process emissions of CO_2 in the glass industry (category 2A3) 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 CO2/ton glass, as proposed by the glass federation, is mainly used in this sector. One company did revise this emission factor in the current of 2006 to 300 kg process CO2/ton glass. As a result of the in-country review of June 2007, this revised emission factor was also used during this submission in the base year 1990. As a consequence the emissions of the base year did increase from 13,928 to 33,427 kton CO2 in this sector of glass production.

- Because of the comparability of the melting process in the production of glass and enamel, both industries are related in Flanders and consequently put under the same category 2A3. 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 CO2/ton glass. 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 CO2 occurred. As a result of the in-country review of June 2007, these revised emission factor was also used in the base year 1990 during this submission. As a consequence the emissions of the base year did decrease from 13,484 to 1,475 kton CO2 in this sector of enamel production.

- In the Walloon region an average emission factor was established in 2005 by the plants involved in the ceramic industry (category 2A3). During the in-country review in June 2007, the expert review team detected this missing part in the Belgian inventory. During this 2008 submission the emissions of CO_2 from ceramics in the Walloon region are included in the Belgian emission inventory. It exists of 11,57 kton CO2 in 1990.

- 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 are no longer included in the Belgian emission inventory. 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 advise of the expert review team, these emissions of CO_2 from the use of solvents and lubricants will only arise when they are burned or destroyed. As a consequence these emissions are excluded out of the Belgian emission inventory during this submission and the base year emissions decrease with 415 kton CO_2eq in the Belgian emission inventory.

- As a result of the in-country review of June 2007 the MCF for grazing animals has been corrected in the Flemish region from 10% to 1% conform the IPCC 1996 guidelines (category 4Ba). This results in a reduction of 7904 ton CH4 or 166 kton CO2-equivalenten in the base year 1990.

- As result of the in-country review of June 2007 the emissions put in category 4G during previous submissions were excluded in the 2008 submission. The expert review team considered that the emissions were already included in emissions from fertiliser reported under direct soil emissions in the agriculture sector (category 4D) and are consequently double-counted. The reported emissions originating from coniferous, deciduous and market gardening originate from the Flemish region only and did overestimate the base-year emissions with 0,765 kton N2O or 237,15 kton CO2eq.

- As a result of the in-country review in June 2007 the Flemish region did recalculate the emissions from waste water treatment / septic tanks (category 6B2) and harmonized the methodology with the other regions by using the same emission factor of 1,971 kg CH4/inhab*year. See section 8.2.2. for more information. The CH4 emissions are estimated by multiplying these emission factors by the number of inhabitants not connected with a municipal wastewater treatment plant. This recalculation resulted in an increase of emissions of CH4 of 6422 ton or 135 kton CO2 eq in the base year.

Recalculations after fixing the assigned amount for Belgium (based on the results of the initial review of UNFCCC in June 2007):

- There has been made some changes to the methodology to calculate the emissions from air transport (category 1A3a) in the Flemish region after the initial review by the expert review team of UNFCCC in June 2007. A redistribution in airplane movements was performed between the civil aviation and the international aviation afterwards. The consequence of this redistribution is a slight increase of the greenhouse gas emissions of the base year 1990 with 0,03 kton CO_2 eq.

- Compared to previous submission the methodology to calculate the emissions originating from the transport between the North Sea ports (category 1A3d) is optimized in the Flemish region. This optimization did occur after the initial review by the expert review team of UNFCCC in June 2007. The consequence of this optimization is an increase of the green house gas emissions of the base year with 145 kton CO_2 eq.

- Before this 2008 submission Belgium used a Tier 1 methodology for all animal types (category 4A). Cattle however is a key source category for CH4 emissions from enteric fermentation. As a consequence the expert review team did recommend Belgium to set up a Tier 2 methodology for cattle. These recalculations result in a decrease of the emissions for the entire time series during the 2008 submission. Consequently a decrease of the emission of 17538 ton CH4 in Flanders and 5695 ton CH4 in Wallonia in the base-year 1990 occur.

- In Flanders, the data and factors used in the CH4-model for manure management have been reconsidered (category 4Ba). This as a result of harmonisation between the different models used (CH4 from enteric fermentation, manure management and the allocation to AWMS in the N2O-model) as advised by the expert team during the initial review. For the estimation of CH4 emissions from enteric fermentation using the Tier 2 methodology the average weight of different animal subcategories were obtained. Before this submission the slaughter weight was used, multiplied with an integrator (see table 6.8). Now, the average weight for cattle and swine are used, bringing the integrator to one. Where necessary VS and Bo are adjusted. For this multiple source reports were consulted [6, 10, 53, 54]. The allocation to AWMS in the CH4-model and N2O-model has been harmonized. Therefore the MCF's for some animal types have changed. All these changes result in a decrease of the emissions for the entire time series. Fore the base year this is a reduction of 16447 ton CH4 or 345 kton CO2-equivalenten.

- Also in Flanders before this submission the brood cows were considered dairy cattle (categories 4A and 4B). For this submission they are allocated to non-dairy cattle. This only has implications on the allocation of animal numbers, CH4 emissions, the excreted nitrogen to the different animal types and AWMS. This correction has no implications on the CH4 and N2O emissions.

- During the 2008 submission, the following changes have been made to the Belgian inventory of the F-gases (category 2E en F) for the period 1995-2005:

    - Emissions from car air conditioning have been re-estimated for all years.
    - Emissions from polyurethane (One-Component-Foam) have been improved for all years.
    - Emissions from refrigeration and air conditioning "installations" have been revised for all years, as the consumption of these systems is estimated, amongst other things, on the consumption of mobile air conditioning.
    - The SF_6 emissions from double glazing have been revised, in particular to include one more manufacturer. The disposal emissions have been added.
    - Some minor mistakes or inconsistencies have been removed. All of them only have a marginal impact on the total emissions.

  As a consequence of this recalculation of emissions, the emissions of F-gases as reported in the previous submission have been revised, actually increased, for the years 1995-2005.
  For 1995, reference year of the Kyoto protocol for the F-gases in Belgium, the only changes compared to the previous 2007 submission is related to the emissions from aircos in cars and cooling "installations"; The total impact in terms of CO2-eq for the Kyoto gases is about 0,1%. For the other years, the impact of the changes on total emissions reaches a few per cent in a number of cases, up to 5,9% for the emissions of the Kyoto gases in CO2-eq in 2001. The changes relate to the cooling sector (the emissions of car aircos and "installations"), One-Component-Foam and the SF6 emissions of double glazing.

9.2. Implication on emission levels and trends

Level

The numbers cited hereunder for the level implications refer to the 1990 inventory year and are expressed in CO2-eq.

The main implication on level for CH4 commes from the revision of the EF in the residential sector (+112 kt.) and fugitive emissions (+299 kt) , partly conterbalanced by the reductions in the agricultural sector (enteric fermentation and manure management, respectively –488 and –511 kt), giving an overall trend of –421 kt for CH4.

The main implication on level for N2O commes from the revision of the EF in the industrial sector (-320kt) and residential sector (-648 kt.) and by the reductions in the agricultural sector (mainly 4.G - coniferous, deciduous and market gardening, -237 kt), giving an overall trend of –1236 kt for N2O.

Regarding CO2, transport and energy industries are the drivers of the level reduction of –264 kt in 1990.

Trend

The important recalculations conducted between the 2007 and 2008 submissions have constrasted effect on the time series. If we consider 1990 and 2005 (2006 is not considered for trend , as it was not yet reported in the 2007 submission), the main drivers of the change in trend are the reductions in the agriculture and energy sector, partly conterbalanced by the rise of emissions in the industrial processes since 2003. The overall result of the recalculation for the trend between 1990 and 2005 is a further reduction of the 2005 emissions by 267 kt CO2-eq. compared to the 1990 emissions.

9.3. Planned improvements

- During the 2009 submission the emissions of CH_4 from the cokesovens in the Flemish region will be allocated in the category 1A1c instead of the sector 1B1b to harmonize with the other regions in Belgium.

- During the 2009 submission the emission factors of CH_4 and N_2O from the combined heat-power installations in the agriculture and service sectors will be harmonized between the 3 regions.
- Further contacts with the iron and steel sector in the Flemish region will be taken with respect to harmonize methodologies for estimating the emissions of N_2O (and CH_4) in this sector.

- During the 2009 submission the emissions from railways will be recalculated with EMMOSS-model in Flemish region (http://www.tmleuven.be/project/emmoss/index.htm)

- During the 2009 submission the emissions from inland waterways (navigation) will be recalculated with EMMOSS-model in Flemish region (http://www.tmleuven.be/project/emmoss/index.htm).

- In the Flemish region a study will be conducted in the near future for the optimization of the inventory of NMVOC, specific for the sectors of coating, cleaning & degreasing and dry cleaning. This study will start in June 2008, results are expected in June 2009.

- In the Flemish region a study has been carried out to calculate the NH3-, N2O- and the CH4-emissions from outdoor manure storage (categories 4B and 4D). The results of this study will be taken into account during the next submissions.

- In Flanders a revision of the model used to calculate the emissions of NH3 started at the end of 2007. Special attention goes to the emissions from manure processing, a revision of the emission factors of NH3, uncertainty determination, geographical allocations of the NH3 emissions and inventorying mineral fertilizer type and application. The results of this study (expected november 2008) will also have an impact on the direct and indirect emissions of N2O (category 4D) and will be taken into account during the 2010 submission.

REFERENCES

[1] Vito Vlaamse Instelling voor Technologisch Onderzoek = Flemish Institute for Technological Research, Boeretang 200, B-2400 MOL (www.emis.vito.be).

[2] CITEPA Centre Interprofessionnel Technique d'Etudes de la Pollution Atmosphérique, rue du Faubourg Poissonnière 10, F-75010 PARIS – Emission Inventory of CH_4 and N_2O in the European Community 10/10/1990.

[3] Joint EMEP/CORINAIR Atmospheric emission inventory guidebook, second edition, prepared by the EMEP Task Force on Emission Inventories, edited by Stephen Richardson – September 1999.

[4] TNO Institute of Environmental Sciences, P.O. Box 342, 7300 Apeldoorn.

[5] Copert III, Computer Programme to calculate Emissions from Road Transport, European Environment Agency, Technical reports n°49 & 50, Leonidas Ntziachristos and Zissis Samaras ETC/AEM – November 2000.

[6] Greenhouse gas emissions from agriculture and livestock management, W. Debruyn and J. Van Rensbergen, ENE.RA9408 Energy division – April 1994.

[7] Inventarisatie van de N_2O emissies uit de landbouw in Vlaanderen 1990-2000, Pascal Boeckx en Oswald Van Cleemput, Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen, Universiteit Gent – Oktober 2001.

[8] Greenhouse gas emissions from municipal and industrial wastes, W. Debruyn and J. Van Rensbergen ENE.RA9410 Energy division – October 1994.

[9] TEMAT model : Onderzoeksopdracht "Milieu-impactbepaling van het ontwerp Mobiliteitsplan Vlaanderen d.m.v. strategische m.e.r" - Deelrapport 1: Conceptontwikkeling voor strategische milieueffectrapportage van mobiliteitsplannen (UA, september 2001).

[10] IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

[11] Bilans énergétiques de la Région de Bruxelles-Capitale ; 11 rapports finaux ; Institut Wallon ; 1990-2001.

[12] Collecte des données sur les émissions atmosphériques liées à des consommations énergétiques en Région de Bruxelles-Capitale, rapport final ; Institut Wallon ; décembre 1997.

[13] Recensement de la circulation, Ministère des Communications et de l'Infrastructure, 1990-2000.

[14] Collecte des données sur les émissions atmosphériques liées au transport routier en Région de Bruxelles-Capitale, 6 rapports finaux ; Institut Wallon ; 1995-2000.

[15] Ntziachristos L., Samaras Z, 2000. COPERT III, Computer programme to calculate Emissions from Road transport, Methodology and emissions factors. European Environment Agency, Technical report N°49.

[16] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des imprimeries ; Aries ; Décembre 1997.

[17] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des nettoyage à sec ; Aries ; Décembre 1997.

[18] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des stations-services; Aries ; Décembre 1997.

[19] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des incinérateurs; Aries ; Décembre 1997.

[20] Etude sectorielle des émissions atmosphériques spécifiques, Collecte des données liées aux émissions du secteur des carrosseries ; Aries ; Décembre 1997.

[21] DGTRE (2001), Bilan énergétique de la région wallonne 1999, rapport juillet 2001, réalisé par l'Institut Wallon.

[22] Econotec (1997), Analyse prévisionnelle des émissions de gaz à effet de serre, CH_4, N_2O et CO_2 en Région wallonne à l'horizon 2000-2005, Etude réalisée pour le Ministère de la Région Wallonne, DGRNE, Namur.

[23] Econotec (2001), Analyse prévisionnelle des émissions atmosphériques liées au secteur du transport en région wallonne. Etude réalisée pour le Ministère de la Région wallonne, DGRNE, Namur.

[24] EMEP/CORINAIR Emission Inventory Guidebook - 3rd edition (2001), European Environment Agency.

[25] FEDIEX (1990), Phone contact between the DGRNE and the Fediex (Fédération Belge des Industries Extractives).

[26] INS-agriculture (2001), "Recensement agricole et horticole au 15 mai 1999", (2002) "Recensement agricole et horticole au 15 mai 2000", (2002)"Recensement agricole et horticole provisoire au 15 mai 2001", Ministère des affaires économiques, Institut national de statistiques.

[27] INS-transport (2001), "parc des véhicules à moteur au 1er août 1999", Ministère des affaires économiques, Institut national de statistiques.

[28] IPCC (1996), revised 1996 IPCC Guidelines for National Greenhouse Gas inventories.

[29] MCI (2000), Recensement de la circulation en 1999. N° 17. Ministère des communications et de l'infrastructure Août 2000.

[30] Siterem (2001), "Estimation des émissions dans l'air de CH_4, NH_3 et N_2O par le secteur agricole en région wallonne". Rapport final demandé par le Ministère de la Région Wallonne, Direction Générale des Ressources Naturelles et de l'Environnement.

[31] ULG (1998), Inventaire des émissions atmosphériques en Région Wallonne pour 1996 réalisé par l'Université de Liège.

[32] Vasel J.L. (1992), La fosse septique. Les dispositifs d'épuration individuel, Tribune de l'eau, n°560/6-Nov.Déc.1992.

[33] Perrin D. and al., Calculation on the impacts of forestation, afforestation and reforestation on the C-sequestration potential in Belgian forests ecosystems, Biotechnol. Agron. Soc. Environ. 2000 (4), 259-262.

[34] Econotec (2000), Update of the emission inventory of ozone depleting substances, HFCs, PFCs and SF6 for 1998 and 1999, Study carried out for the Vlaamse Milieu Maatschappij.

[35] Econotec, Ecolas (1999), Développement d'une méthodologie d'inventaire des émissions des substances détruisant la couche d'ozone et des gaz à effet de serre HFC, PFC et SF6, Etude réalisée pour le compte des Services Fédéraux des Affaires environnementales et de la Vlaamse Milieu Maatschappij.

[36] IPPC (1999), Best Available Techniques Reference Document on the Production of Iron and Steel.

[37] Centre Entreprise-Environnement, UCL, (2000), « analyse des déchets ménagers et de certains flux de déchets non ménagers à haut potentiel recyclable », rapport demandé par l' IBGE.

[38] Bilan energétique de la Belgique - energiebalans België 1999 (comparaison entre le bilan du Ministère des Affaire Economiques et le bilan agrégé des bilans régionaux, pour le compte du Ministère des Affaires Economiques), November 2002.

[39] Econotec (1997), Inventaire 1996 des émissions atmosphériques en région wallonne, groupes 2, 5 et 6 de la nomenclature snap, Etude réalisée pour le Ministère de la Région Wallonne, DGRNE, Namur.

[40] S. Monni and S. Syri, (2001) Uncertainties in the Finish greenhouse gas emission inventory. VTT research notes 2209(www.vtt.fi/inf/pdf).

[41] K. Rypdal and L-C. Zhang (200) Uncertainties in the Norwegian greenhouse gas emission inventory. Report 2000/13 , Statistics Norway.

[42] Rypdal, K. and Winiwarter, W. (2001) Uncertainties in greenhouse gas inventories – evaluation, comparability and implications. Environmental Science and Policy, Vol 4. Issue, 2-3, pp 107-116.

[43] Theunis et al., Vlaamse koolstofbalans voor het niet-energetisch verbruik, Vito trapport 2003/IMS/R/185.

[44] Joint EMEP/CORINAIR Atmospheric emission inventory guidebook, third edition, prepared by the EMEP Task Force on Emission Inventories and Projections – September 2004.

[45] ECONOTEC, VITO (2008), Update of the emission inventory of ozone depleting substances, HFCs, PFCs and SF6 for 2006 in Belgium, Final report, study commissioned by de Vlaamse Milieumaatschappij, 10 januari 2008

[46] Van Amstel et al., Methane: the other greenhouse gas, RIVM Report 481507001, 58-59, 1993.

[47] Verschut et al., Broeikasgassen uit vuilstorts in Nederland, TNO Report 91-444, 1991.

[48] IBGE, « Le projet de plan de prévention et de gestion des déchets » , septembre 1991.

[49] Campens V. en Lauwers L.: Kunstmestgebruik en gewasproductie als determinanten van de nutriëntenemissie, uitgevoerd door de VMM en CLE, 2002.

[50] Pauwelyn J. & Depuydt S. (1997): Studie der kwantificering van de nutriëntenverliezen per stroombekken naar het oppervlaktewater door landbouwactiviteiten in Vlaanderen: een praktijkgericht onderzoek ter ondersteuning van het milieu- en landbouwbeleid. Instituut voor Scheikundig Onderzoek. 54p.

[51] Pollet I. & Van Langenhove H. (1996). *Onderzoeks- en ontwikkelingsovereenkomst inzake de* NH_3*-emissies door de landbouw*. Universiteit Gent, Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen. Studie uitgevoerd in opdracht van de Vlaamse Milieumaatschappij. Rapport 174M3495, 193 p.

[52] Smink W. & all (2004). *Methaanproductie als gevolg van pensfermentatie bij rundvee berekend middles de IPCC-GPG Tier 2 methode*. Feed Innovation Services. Studie uitgevoerd in opdracht van SenterNovem, Utrecht. Rapport FIS: FS 04 12, 45 p.

[53] Safley L.M. Jr. & Casada M.E. (1992). *Global methane emissions from livestock and poultry manure.* EPA report, 145 p.

ANNEXES

Annex 1: Key sources analysis

Level assessment for 1990

IPCC category	sector	Base year emissions (1995 F-gases) Gg CO2 eq	Direct greenhouse gas	level assessment 1990 (1995 F-gases) %	Cumulative total %
1A1a Public Electricity and Heat Production	energy	23504	CO2	16,37	16,37
1A4b Residential	energy	20213	CO2	14,08	30,46
1A3b Road Transportation	energy	19270	CO2	13,42	43,88
1A2a Iron and Steel	energy	14213	CO2	9,90	53,78
1A2f Other *(as specified in table 1.A(a) sheet 2)*	energy	8069	CO2	5,62	59,40
1A2c Chemicals	energy	6585	CO2	4,59	63,99
1A1b Petroleum Refining	energy	4299	CO2	2,99	66,99
1A4a Commercial/Institutional	energy	4272	CO2	2,98	69,96
4A1 Cattle (1)	agriculture	3813	CH4	2,66	72,62
2B2 Nitric Acid Production	industrial processes	3562	N2O	2,48	75,10
1A2e Food Processing, Beverages and Tobacco	energy	2998	CO2	2,09	77,19
2A1 Cement Production	industrial processes	2824	CO2	1,97	79,15
1A4c Agriculture/Forestry/Fisheries	energy	2730	CO2	1,90	81,06
6A1 Managed Waste Disposal on Land	waste	2630	CH4	1,83	82,89
4D1 Direct Soil Emissions	agriculture	2367	N2O	1,65	84,54
1A1c Manufacture of Solid Fuels and Other Energy Industries	energy	2144	CO2	1,49	86,03
2E1 By-product Emissions	industrial processes	2102	SF6	1,46	87,50
2A2 Lime Production	industrial processes	2097	CO2	1,46	88,96
2C1 Iron and Steel Production	industrial processes	1946	CO2	1,36	90,31
5C1 Grassland remaining Grassland	LUCF	1303	CO2	0,91	91,22
4B8 Swine	agriculture	1245	CH4	0,87	92,09
4D3 Indirect Emissions	agriculture	1242	N2O	0,87	92,95
4D2 Pasture, Range and Paddock Manure (3)	agriculture	936	N2O	0,65	93,61
4B13 Solid Storage and Dry Lot	agriculture	892	N2O	0,62	94,23
4B1 Cattle (1)	agriculture	851	CH4	0,59	94,82
2E1 By-product Emissions	industrial processes	660	C2F6	0,46	95,28
1A2d Pulp, Paper and Print	energy	637	CO2	0,44	95,72
1A2b Non-Ferrous Metals	energy	624	CO2	0,43	96,16
1B2b Natural Gas	energy	519	CH4	0,36	96,52
5B1 Cropland remaining Cropland	LUCF	471	CO2	0,33	96,85
2E1 By-product Emissions	industrial processes	450	CF4	0,31	97,16
2A3 Limestone and Dolomite Use	industrial processes	421	CO2	0,29	97,46
2B1 Ammonia Production	industrial processes	420	CO2	0,29	97,75

1A3d Navigation	energy	411	CO_2	0,29	98,03
2E2 Fugitive Emissions	industrial processes	407	C_5F_{12}	0,28	98,32
2B5 Other *(as specified in table 2(I).A-G)*	industrial processes	372	N_2O	0,26	98,58
1A3b Road Transportation	energy	333	N_2O	0,23	98,81
2F2 Foam Blowing	industrial processes	324	HFC-134a	0,23	99,04
1B1a Coal Mining and Handling	energy	299	CH_4	0,21	99,24
6B2 Domestic and Commercial Waste Water	waste	270	N_2O	0,19	99,43
2E1 By-product Emissions	industrial processes	264	C_4F_{10}	0,18	99,62
6C Waste Incineration	waste	253	CO_2	0,18	99,79
3D1 Total Solvent and Other Product Use	solvent	246	N_2O	0,17	99,96
2E2 Fugitive Emissions	industrial processes	244	C_6F_{14}	0,17	100,13
2E1 By-product Emissions	industrial processes	233	C_3F_8	0,16	100,30
2B5 Other *(as specified in table 2(I).A-G)*	industrial processes	224	CO_2	0,16	100,45
6B2 Domestic and Commercial Waste Water		219	CH_4	0,15	100,60
TOTAL		143543			

Level assessment for 2005

IPCC category	sector	2005 emissions	Direct greenhouse gas	level assessment 2005	Cumulative total
		Gg CO2 eq		%	%
1A3b Road Transportation	energy	24928	CO2	17,56	17,56
1A1a Public Electricity and Heat Production	energy	24462	CO2	17,23	34,79
1A4b Residential	energy	21918	CO2	15,44	50,23
1A2a Iron and Steel	energy	9469	CO2	6,67	56,90
1A2c Chemicals	energy	7751	CO2	5,46	62,35
1A2f Other *(as specified in table 1.A(a) sheet 2)*	energy	7275	CO2	5,12	67,48
1A4a Commercial/Institutional	energy	6149	CO2	4,33	71,81
1A1b Petroleum Refining	energy	4353	CO2	3,07	74,88
4A1 Cattle (1)	agriculture	3317	CH4	2,34	77,21
2B2 Nitric Acid Production	industrial processes	3066	N2O	2,16	79,37
2A1 Cement Production	industrial processes	2934	CO2	2,07	81,44
1A4c Agriculture/Forestry/Fisheries	energy	2382	CO2	1,68	83,12
1A2e Food Processing, Beverages and Tobacco	energy	2209	CO2	1,56	84,67
4D1 Direct Soil Emissions	agriculture	2197	N2O	1,55	86,22
2A2 Lime Production	industrial processes	2018	CO2	1,42	87,64
2B5 Other *(as specified in table 2(I).A-G)*	industrial processes	1692	CO2	1,19	88,83
2C1 Iron and Steel Production	industrial processes	1535	CO2	1,08	89,91
2B1 Ammonia Production	industrial processes	1330	CO2	0,94	90,85
5C1 Grassland remaining Grassland	LUCF	1148	CO2	0,81	91,66
4B8 Swine	agriculture	1144	CH4	0,81	92,47
4D3 Indirect Emissions	agriculture	918	N2O	0,65	93,11
6A1 Managed Waste Disposal on Land	waste	841	CH4	0,59	93,70
4D2 Pasture, Range and Paddock Manure (3)	agriculture	803	N2O	0,57	94,27
4B13 Solid Storage and Dry Lot	agriculture	787	N2O	0,55	94,82
1A3b Road Transportation	energy	775	N2O	0,55	95,37
4B1 Cattle (1)	agriculture	721	CH4	0,51	95,88
1A2d Pulp, Paper and Print	energy	619	CO2	0,44	96,31
5B1 Cropland remaining Cropland	LUCF	576	CO2	0,41	96,72
2F1 Refrigeration and Air Conditioning Equipment	industrial processes	513	HFC-134a	0,36	97,08
1A2b Non-Ferrous Metals	energy	501	CO2	0,35	97,43
2A3 Limestone and Dolomite Use	industrial processes	490	CO2	0,35	97,78
1A3d Navigation	energy	485	CO2	0,34	98,12
1A1c Manufacture of Solid Fuels	energy	429	CO2	0,30	98,42

and Other Energy Industries					
2F1 Refrigeration and Air Conditioning Equipment	industrial processes	406	HFC-143a	0,29	98,71
1B2b Natural Gas	energy	389	CH4	0,27	98,98
2B5 Other *(as specified in table 2(I).A-G)*	industrial processes	344	N2O	0,24	99,22
2F1 Refrigeration and Air Conditioning Equipment	industrial processes	298	HFC-125	0,21	99,43
6B2 Domestic and Commercial Waste Water	waste	272	N2O	0,19	99,62
3D1 Total Solvent and Other Product Use	solvent	249	N2O	0,18	99,80
4A8 Swine	agriculture	199	CH4	0,14	99,94
2F4 Aerosols/Metered Dose Inhalers	industrial processes	157	HFC-134a	0,11	100,05
1A4b Residential	energy	139	CH4	0,10	100,15
6B2 Domestic and Commercial Waste Water	waste	133	CH4	0,09	100,24
1A3e Other Transportation *(as specified in table 1.A(a) sheet 3)*	energy	131	CO2	0,09	100,34
1A3c Railways	energy	115	CO2	0,08	100,42
6C Waste Incineration	waste	115	CO2	0,08	100,50
1B2c Venting and Flaring	energy	104	CO2	0,07	100,57
TOTAL		141976			

Level assessment for 2006

IPCC category	sector	2006 emissions Gg CO2 eq	Direct greenhouse gas	level assessment 2006 %	Cumulative total %
1A3bRoad Transportation	energy	24441	CO2	17,98	17,98
1A1a Public Electricity and Heat Production	energy	22637	CO2	16,66	34,64
1A4b Residential	energy	20112	CO2	14,80	49,44
1A2a Iron and Steel	energy	9315	CO2	6,85	56,29
1A2c Chemicals	energy	7806	CO2	5,74	62,04
1A2f Other *(as specified in table 1.A(a) sheet 2)*	energy	7192	CO2	5,29	67,33
1A4a Commercial/Institutional	energy	6042	CO2	4,45	71,77
1A1b Petroleum Refining	energy	4522	CO2	3,33	75,10
4A1 Cattle [(1)]	agriculture	3284	CH4	2,42	77,52
2A1 Cement Production	industrial processes	3116	CO2	2,29	79,81
1A4c Agriculture/Forestry/Fisheries	energy	2336	CO2	1,72	81,53
4D1 Direct Soil Emissions	agriculture	2174	N2O	1,60	83,13
2A2 Lime Production	industrial processes	2139	CO2	1,57	84,70
2B2 Nitric Acid Production	industrial processes	2082	N2O	1,53	86,23
1A2e Food Processing, Beverages and Tobacco	energy	2044	CO2	1,50	87,74
2C1 Iron and Steel Production	industrial processes	1620	CO2	1,19	88,93
2B5 Other *(as specified in table 2(I).A-G)*	industrial processes	1354	CO2	1,00	89,93
2B1 Ammonia Production	industrial processes	1290	CO2	0,95	90,87
5C1 Grassland remaining Grassland	LUCF	1141	CO2	0,84	91,71
4B8 Swine	agriculture	1137	CH4	0,84	92,55
4D3 Indirect Emissions	agriculture	928	N2O	0,68	93,23
4D2 Pasture, Range and Paddock Manure [(3)]	agriculture	791	N2O	0,58	93,81
1A3bRoad Transportation	energy	773	N2O	0,57	94,38
4B13 Solid Storage and Dry Lot	agriculture	769	N2O	0,57	94,95
4B1 Cattle [(1)]	agriculture	712	CH4	0,52	95,47
6A1 Managed Waste Disposal on Land	waste	680	CH4	0,50	95,97
1A2d Pulp, Paper and Print	energy	678	CO2	0,50	96,47
5B1 Cropland remaining Cropland	LUCF	575	CO2	0,42	96,90
2F1 Refrigeration and Air Conditioning Equipment	industrial processes	538	HFC-134a	0,40	97,29
1A3d Navigation	energy	498	CO2	0,37	97,66
2A3 Limestone and Dolomite Use	industrial processes	493	CO2	0,36	98,02
1A2b Non-Ferrous Metals	energy	488	CO2	0,36	98,38
2B5 Other *(as specified in table 2(I).A-G)*	industrial processes	484	N2O	0,36	98,74

2F1 Refrigeration and Air Conditioning Equipment	industrial processes	434	HFC-143a	0,32	99,06
1B2b Natural Gas	energy	403	CH4	0,30	99,35
1A1c Manufacture of Solid Fuels and Other Energy Industries	energy	395	CO2	0,29	99,64
2F1 Refrigeration and Air Conditioning Equipment	industrial processes	321	HFC-125	0,24	99,88
6B2 Domestic and Commercial Waste Water	waste	273	N2O	0,20	100,08
3D1 Total Solvent and Other Product Use	solvent	249	N2O	0,18	100,26
4A8 Swine	agriculture	198	CH4	0,15	100,41
2F4 Aerosols/Metered Dose Inhalers	industrial processes	175	HFC-134a	0,13	100,54
1A3e Other Transportation *(as specified in table 1.A(a) sheet 3)*	energy	155	CO2	0,11	100,65
1A4b Residential	energy	136	CH4	0,10	100,75
6B2 Domestic and Commercial Waste Water	waste	134	CH4	0,10	100,85
1B2c Venting and Flaring	energy	130	CO2	0,10	100,95
1A3c Railways		119	CO2	0,09	101,03
1A5b Mobile/Military use		95	CO2	0,07	101,10
TOTAL		135909			

Trend assessment 1990-2005

IPCC Category	Direct greenhouse gas	Base year emissions 1990 (1995 F-gases)	emissions 2005	level assessment 2005	trend assessment 1990-2005	contribution to trend	cumulative total
				%	%	%	%
1A3b Road Transportation	CO2	19270	24928	17,56	4,18	19,30	19,30
1A2a Iron and Steel	CO2	14213	9469	6,67	3,27	15,09	34,40
1A4b Residential	CO2	20213	21918	15,44	1,37	6,33	40,73
1A4a Commercial/Institutional	CO2	4272	6149	4,33	1,37	6,33	47,06
6A1 Managed Waste Disposal on Land	CH4	2630	841	0,59	1,25	5,79	52,85
1A1c Manufacture of Solid Fuels and Other Energy Industries	CO2	2144	429	0,30	1,21	5,57	58,42
2B5 Other (as specified in table 2(I).A-G)	CO2	224	1692	1,19	1,05	4,84	63,25
1A2c Chemicals	CO2	6585	7751	5,46	0,88	4,07	67,32
1A1a Public Electricity and Heat Production	CO2	23504	24462	17,23	0,87	4,00	71,32
2B1 Ammonia Production	CO2	420	1330	0,94	0,65	3,01	74,33
1A2e Food Processing, Beverages and Tobacco	CO2	2998	2209	1,56	0,54	2,49	76,81
1A2f Other (as specified in table 1.A(a) sheet 2)	CO2	8069	7275	5,12	0,50	2,32	79,14
2B2 Nitric Acid Production	N2O	3562	3066	2,16	0,33	1,50	80,64
4A1 Cattle (1)	CH4	3813	3317	2,34	0,32	1,49	82,13
1A3b Road Transportation	N2O	333	775	0,55	0,32	1,46	83,60
2F1 Refrigeration and Air Conditioning Equipment	HFC-134a	72	513	0,36	0,31	1,45	85,05
2E1 By-product Emissions	CF4	450	14	0,01	0,31	1,42	86,47
2F1 Refrigeration and Air Conditioning Equipment	HFC-143a	4	406	0,29	0,29	1,32	87,79
2E2 Fugitive Emissions	C5F12	407	7	0,01	0,28	1,30	89,09
2C1 Iron and Steel Production	CO2	1946	1535	1,08	0,28	1,28	90,37
1A4c Agriculture/Forestry/Fisheries	CO2	2730	2382	1,68	0,23	1,04	91,42
4D3 Indirect Emissions	N2O	1242	918	0,65	0,22	1,02	92,44

2F1 Refrigeration and Air Conditioning Equipment	HFC-125	3	298	0,21	0,21	0,97	93,41
2F2 Foam Blowing	HFC-134a	324	73	0,05	0,18	0,82	94,23
2E2 Fugitive Emissions	C6F14	244	82	0,06	0,11	0,52	94,75
4D1 Direct Soil Emissions	N2O	2367	2197	1,55	0,10	0,48	95,23
2A1 Cement Production	CO2	2824	2934	2,07	0,10	0,46	95,69
5C1 Grassland remaining Grassland	CO2	1303	1148	0,81	0,10	0,46	96,15
6C Waste Incineration	CO2	253	115	0,08	0,10	0,45	96,60
1B2b Natural Gas	CH4	519	389	0,27	0,09	0,41	97,01
4D2 Pasture, Range and Paddock Manure (3)	N2O	936	803	0,57	0,09	0,40	97,41
2F4 Aerosols/Metered Dose Inhalers	HFC-134a	35	157	0,11	0,09	0,40	97,82
4B1 Cattle (1)	CH4	851	721	0,51	0,09	0,40	98,21
1A2b Non-Ferrous Metals	CO2	624	501	0,35	0,08	0,38	98,59
5B1 Cropland remaining Cropland	CO2	471	576	0,41	0,08	0,36	98,96
1A1b Petroleum Refining	CO2	4299	4353	3,07	0,07	0,33	99,29
4B13 Solid Storage and Dry Lot	N2O	892	787	0,55	0,07	0,32	99,61
4B8 Swine	CH4	1245	1144	0,81	0,06	0,29	99,89
1A3c Railways	CO2	202	115	0,08	0,06	0,28	100,17
6B2 Domestic and Commercial Waste Water	CH4	219	133	0,09	0,06	0,28	100,45
1A3d Navigation	CO2	411	485	0,34	0,06	0,26	100,71
2A3 Limestone and Dolomite Use	CO2	421	490	0,35	0,05	0,24	100,95
1A5b Mobile	CO2	166	95	0,07	0,05	0,23	101,18
1A4b Residential	CH4	208	139	0,10	0,05	0,22	101,40
1A3e Other Transportation (as specified in table 1.A(a) sheet 3)	CO2	196	131	0,09	0,04	0,21	101,60
1A3b Road Transportation	CH4	117	58	0,04	0,04	0,19	101,79
2A2 Lime Production	CO2	2097	2018	1,42	0,04	0,19	101,98
		143543	141976				

Trend assessment 1990-2006

IPCC category	Base year emissions 1990 (1995 F-gases)	Direct green-house gas	emissions 2006	level assessment 2006	trend assessment 1990-2006	contribution to trend	cumulative total
				%	%	%	%
1A3b Road Transportation	19270	CO2	24441	17,98	4,81	20,43	20,43
1A2a Iron and Steel	14213	CO2	9315	6,85	3,22	13,66	34,09
1A4a Commercial/Institutional	4272	CO2	6042	4,45	1,55	6,59	40,68
6A1 Managed Waste Disposal on Land	2630	CH4	680	0,50	1,41	5,97	46,65
1A1c Manufacture of Solid Fuels and Other Energy Industries	2144	CO2	395	0,29	1,27	5,39	52,04
1A2c Chemicals	6585	CO2	7806	5,74	1,22	5,18	57,23
2B2 Nitric Acid Production	3562	N2O	2082	1,53	1,00	4,26	61,48
2B5 Other (as specified in table 2(I).A-G)	224	CO2	1354	1,00	0,89	3,77	65,25
1A4b Residential	20213	CO2	20112	14,80	0,76	3,21	68,46
2B1 Ammonia Production	420	CO2	1290	0,95	0,69	2,94	71,40
1A2e Food Processing, Beverages and Tobacco	2998	CO2	2044	1,50	0,62	2,62	74,03
2F1 Refrigeration and Air Conditioning Equipment	72	HFC-134a	538	0,40	0,37	1,55	75,57
1A3b Road Transportation	333	N2O	773	0,57	0,36	1,51	77,08
1A1b Petroleum Refining	4299	CO2	4522	3,33	0,35	1,49	78,57
1A2f Other (as specified in table 1.A(a) sheet 2)	8069	CO2	7192	5,29	0,35	1,48	80,05
2A1 Cement Production	2824	CO2	3116	2,29	0,34	1,46	81,51
2F1 Refrigeration and Air Conditioning Equipment	4	HFC-143a	434	0,32	0,33	1,42	82,93
2E1 By-product Emissions	450	CF4	7	0,01	0,33	1,38	84,31
1A1a Public Electricity and Heat Production	23504	CO2	22637	16,66	0,30	1,26	85,57
2E2 Fugitive Emissions	407	C5F12	26	0,02	0,28	1,19	86,76
4A1 Cattle (1)	3813	CH4	3284	2,42	0,25	1,07	87,83
2F1 Refrigeration and Air Conditioning Equipment	3	HFC-125	321	0,24	0,25	1,05	88,89
1A4c Agriculture/Forestry/Fisheries	2730	CO2	2336	1,72	0,19	0,82	89,71
4D3 Indirect Emissions	1242	N2O	928	0,68	0,19	0,82	90,53
2F2 Foam Blowing	324	HFC-134a	78	0,06	0,18	0,76	91,28
2C1 Iron and Steel Production	1946	CO2	1620	1,19	0,17	0,73	92,02
6C Waste Incineration	253	CO2	78	0,06	0,13	0,53	92,55
2A2 Lime Production	2097	CO2	2139	1,57	0,12	0,51	93,06
2E2 Fugitive Emissions	244	C6F14	78	0,06	0,12	0,50	93,56
2F4 Aerosols/Metered Dose Inhalers	35	HFC-134a	175	0,13	0,11	0,47	94,03

2B5 Other (as specified in table 2(I).A-G)	372	N2O	484	0,36	0,10	0,43	94,46
5B1 Cropland remaining Cropland	471	CO2	575	0,42	0,10	0,43	94,89
1A3d Navigation	411	CO2	498	0,37	0,08	0,36	95,25
1A2b Non-Ferrous Metals	624	CO2	488	0,36	0,08	0,34	95,59
4D2 Pasture, Range and Paddock Manure (3)	936	N2O	791	0,58	0,07	0,31	95,90
2A3 Limestone and Dolomite Use	421	CO2	493	0,36	0,07	0,31	96,21
4B1 Cattle (1)	851	CH4	712	0,52	0,07	0,31	96,52
5C1 Grassland remaining Grassland	1303	CO2	1141	0,84	0,07	0,31	96,83
1B2b Natural Gas	519	CH4	403	0,30	0,07	0,29	97,12
4B13 Solid Storage and Dry Lot	892	N2O	769	0,57	0,06	0,25	97,37
1A2d Pulp, Paper and Print	637	CO2	678	0,50	0,06	0,25	97,62
1A1b Petroleum Refining	129	N2O	48	0,04	0,06	0,24	97,86
6B2 Domestic and Commercial Waste Water	219	CH4	134	0,10	0,06	0,24	98,11
1A3c Railways	202	CO2	119	0,09	0,06	0,24	98,35
4D1 Direct Soil Emissions	2367	N2O	2174	1,60	0,05	0,22	98,57
1A5b Mobile	166	CO2	95	0,07	0,05	0,21	98,78
1A4b Residential	208	CH4	136	0,10	0,05	0,20	98,98
	143543		135909				

Annex 2: GHG emission trends in the three Regions

Introductory note: Greenhouse gas emissions follow very different patterns in the three regions of Belgium (Flanders, Wallonia, Brussels-Capital), due to the different structure of the sectors, and to local circumstances.

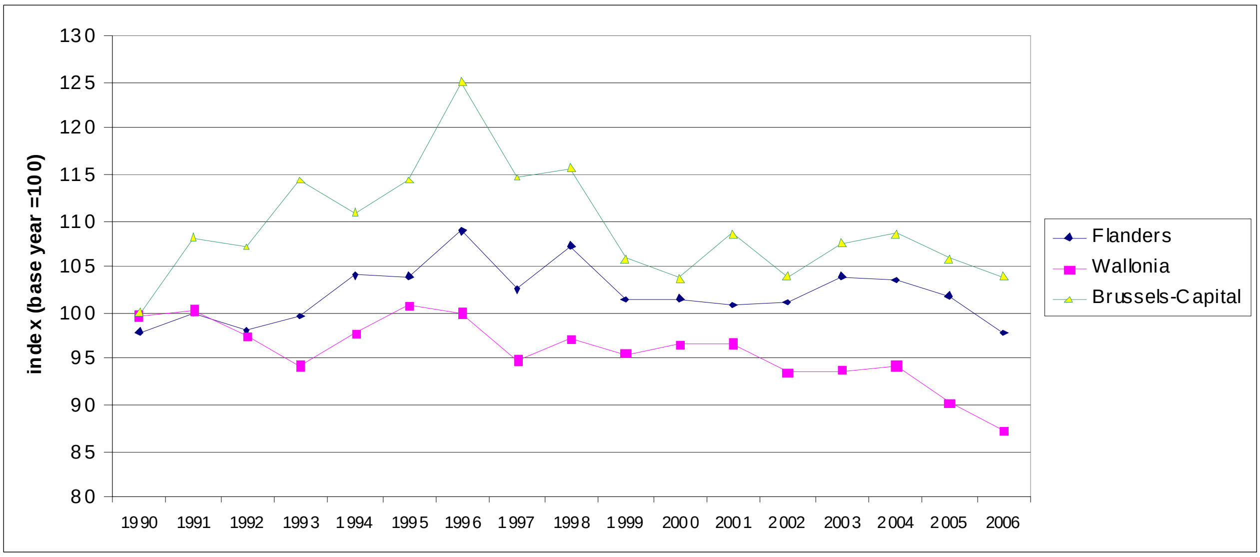


Figure 1. GHG emissions 1990-2006 in the three regions (excl. LUCF).

Unit: Index point (base year emissions = 100).

Note: For the fluorinated gases, the base year is 1995; as the y-axis refers to the base year, the index value for the year 1990 is not necessarily 100.

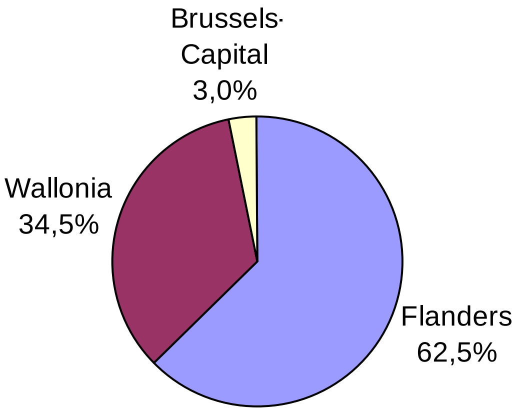


Figure 2. GHG emissions : share of emissions between the three regions (2006).

Annex 3: Uncertainty analysis

See attached pdf-files

Annex 4: CDROM with

- National CRF tables (CRFReporter) for the years 1990-2006

- regional CRF tables for the years 1990-2006
  Remark1: The tables 1A(b), 1A(c) [Reference approach] and 1A(d) [Feedstocks and non-energy use of fuels] are only completed on the national level and not on the regional level;
  Remark2: No LUCF-data are included in the regional CRF tables;
  Remark3: No data on F-gases (categories 2E and 2F) are included in the regional CRF tables.

- The documents with the revision of the Belgian greenhouse gas inventory as a result of the in-country review of June 2007

- The Reports of the individual review of the greenhouse gas inventory of Belgium submitted in 2006 (December 11, 2007) and of the review of the initial report of Belgium (December 12, 2007)

- 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

- 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 (1990).

- A copy of the model used to calculate the direct and indirect N2O emissions (category 4D) and the N2O emissions from manure management (category 4B(b)) in Flanders (1990).

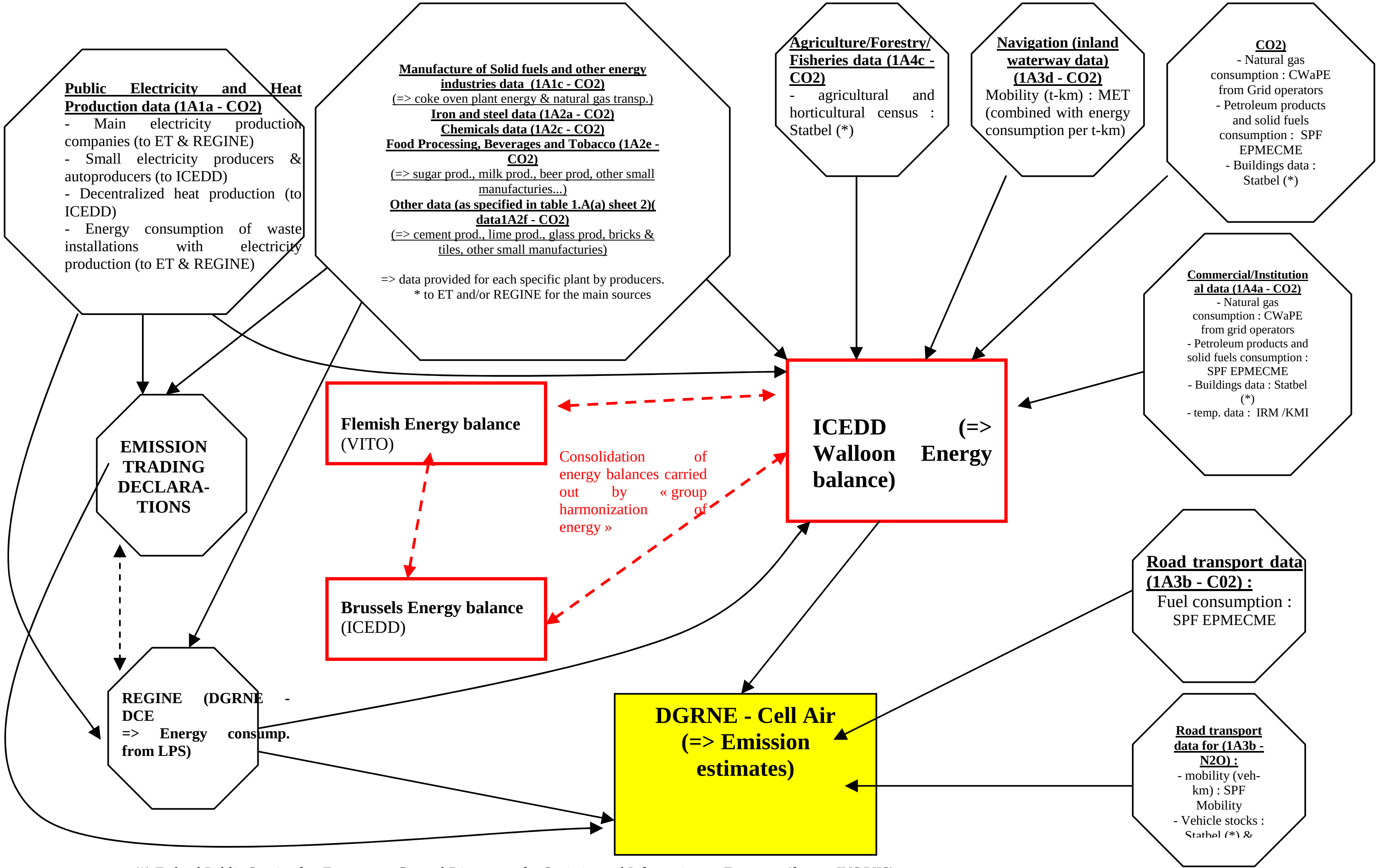
- A copy of the model used to calculate the NH_3 emissions from cattle breeding/animal manure in Flanders (1990).

Annex 5 : Net calorific value of the main products

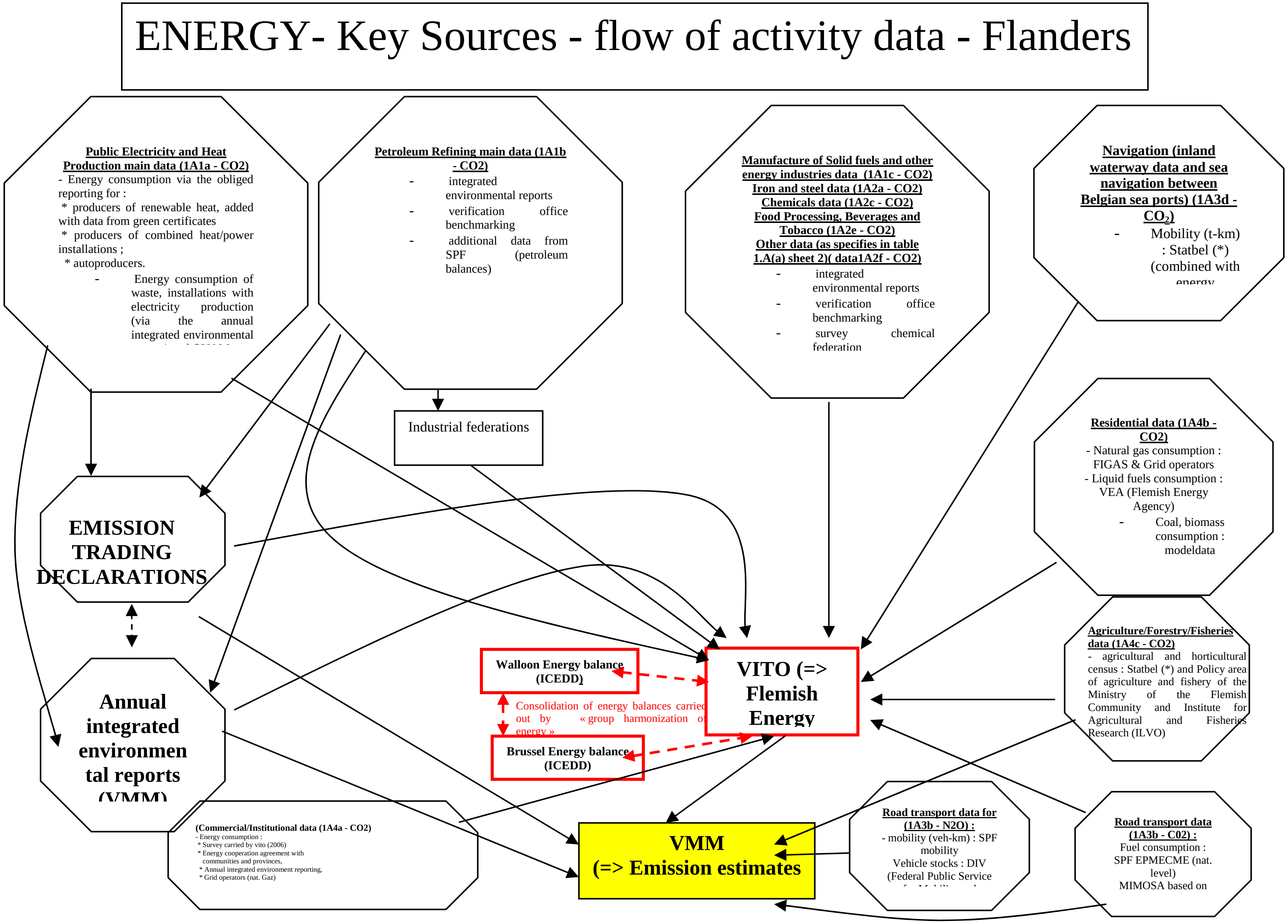
Products	Net calorific value(TJ/kton)
Anthracite	34,90
coking coal	29,30
Butane	45,73
Propane	46,14
coke oven coke	29,30
LPG	45,95
gas/diesel oil	42,7
lamp petroleum	43,12
residual fuel oil	40,6
petroleum coke	31,4

Annex 6 : Key sources : flows of activity data

ENERGY- Key Sources - flow of activity data Wallonia

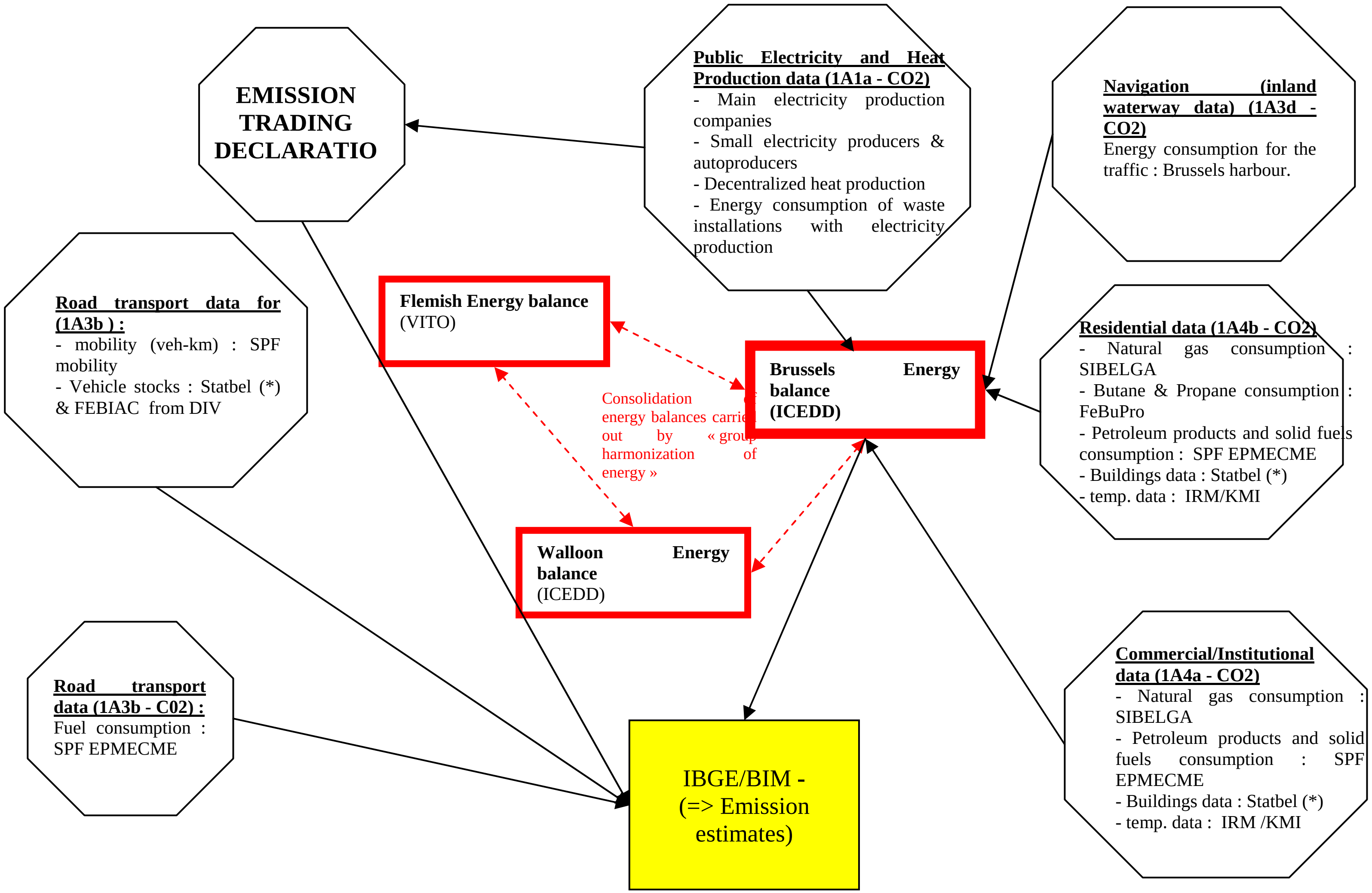


(*) Federal Public Service for Economy – General Directorate for Statistics and Information on Economy (former INS/NIS)



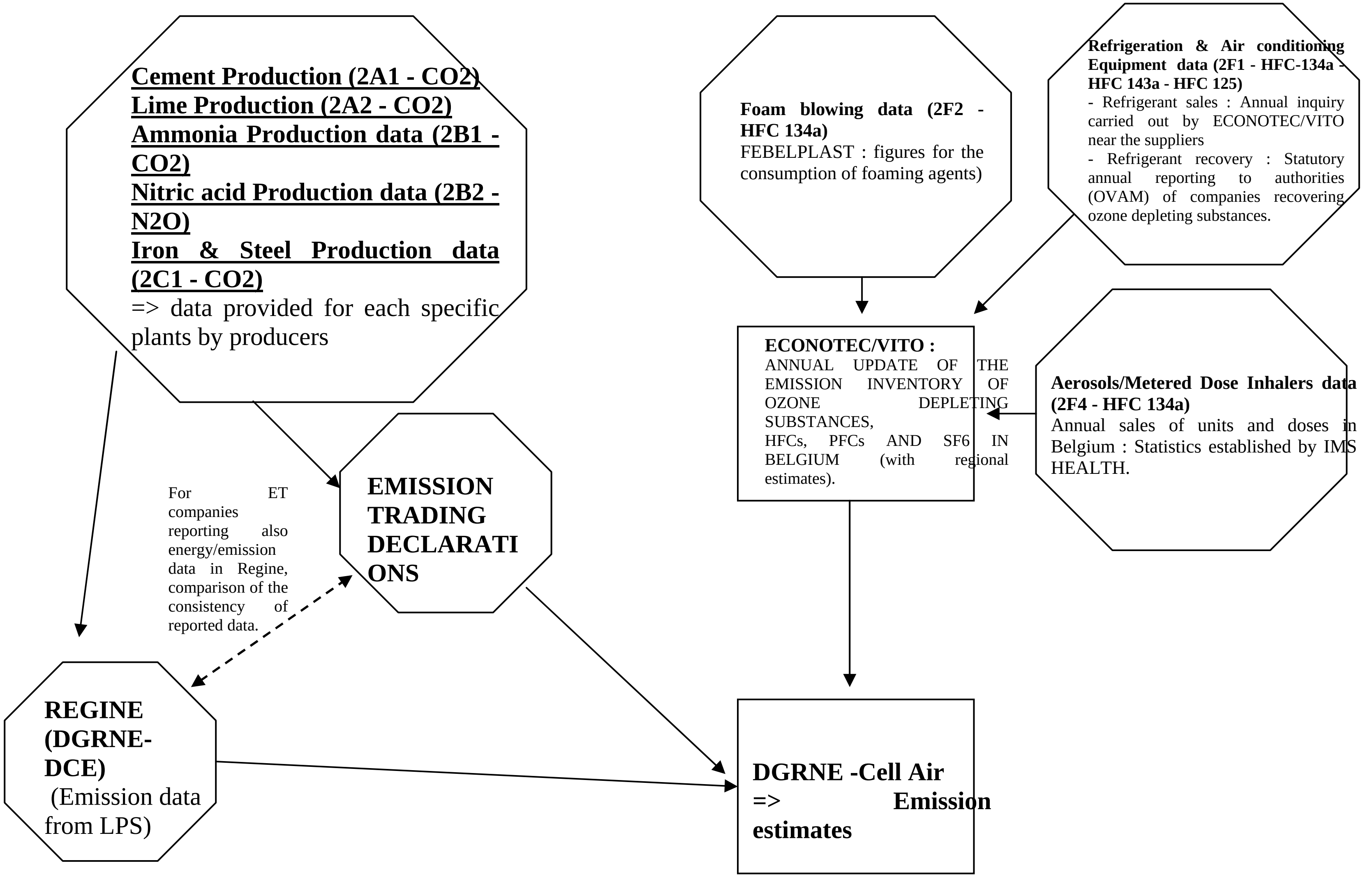
ENERGY- Key Sources - flow of activity data - Flanders
Public Electricity and Heat Production main data (1A1a - CO2)
- Energy consumption via the obliged reporting for :
* producers of renewable heat, added with data from green certificates
* producers of combined heat/power installations ;
* autoproducers.
- Energy consumption of waste, installations with electricity production (via the annual integrated environmental
Petroleum Refining main data (1A1b - CO2)
- integrated environmental reports
- verification office benchmarking
- additional data from SPF (petroleum balances)
Manufacture of Solid fuels and other energy industries data (1A1c - CO2)
Iron and steel data (1A2a - CO2)
Chemicals data (1A2c - CO2)
Food Processing, Beverages and Tobacco (1A2e - CO2)
Other data (as specifies in table 1.A(a) sheet 2)(data1A2f - CO2)
- integrated environmental reports
- verification office benchmarking
- survey chemical federation
Navigation (inland waterway data and sea navigation between Belgian sea ports) (1A3d - CO2)
- Mobility (t-km) : Statbel (*) (combined with
Industrial federations
Residential data (1A4b - CO2)
- Natural gas consumption : FIGAS & Grid operators
- Liquid fuels consumption : VEA (Flemish Energy Agency)
- Coal, biomass consumption : modeldata
EMISSION TRADING DECLARATIONS
Walloon Energy balance (ICEDD)
VITO (=> Flemish Energy
Consolidation of energy balances carried out by « group harmonization of energy »
Brussel Energy balance (ICEDD)
Agriculture/Forestry/Fisheries data (1A4c - CO2)
- agricultural and horticultural census : Statbel (*) and Policy area of agriculture and fishery of the Ministry of the Flemish Community and Institute for Agricultural and Fisheries Research (ILVO)
Annual integrated environmental reports (VMM)
(Commercial/Institutional data (1A4a - CO2)
- Energy consumption :
* Survey carried by vito (2006)
* Energy cooperation agreement with communities and provinces,
* Annual integrated environment reporting,
* Grid operators (nat. Gaz)
VMM (=> Emission estimates
Road transport data for (1A3b - N2O) :
- mobility (veh-km) : SPF mobility
Vehicle stocks : DIV (Federal Public Service
Road transport data (1A3b - C02) :
Fuel consumption : SPF EPMECME (nat. level)
MIMOSA based on

ENERGY- Key Sources - flow of activity data - Brussels

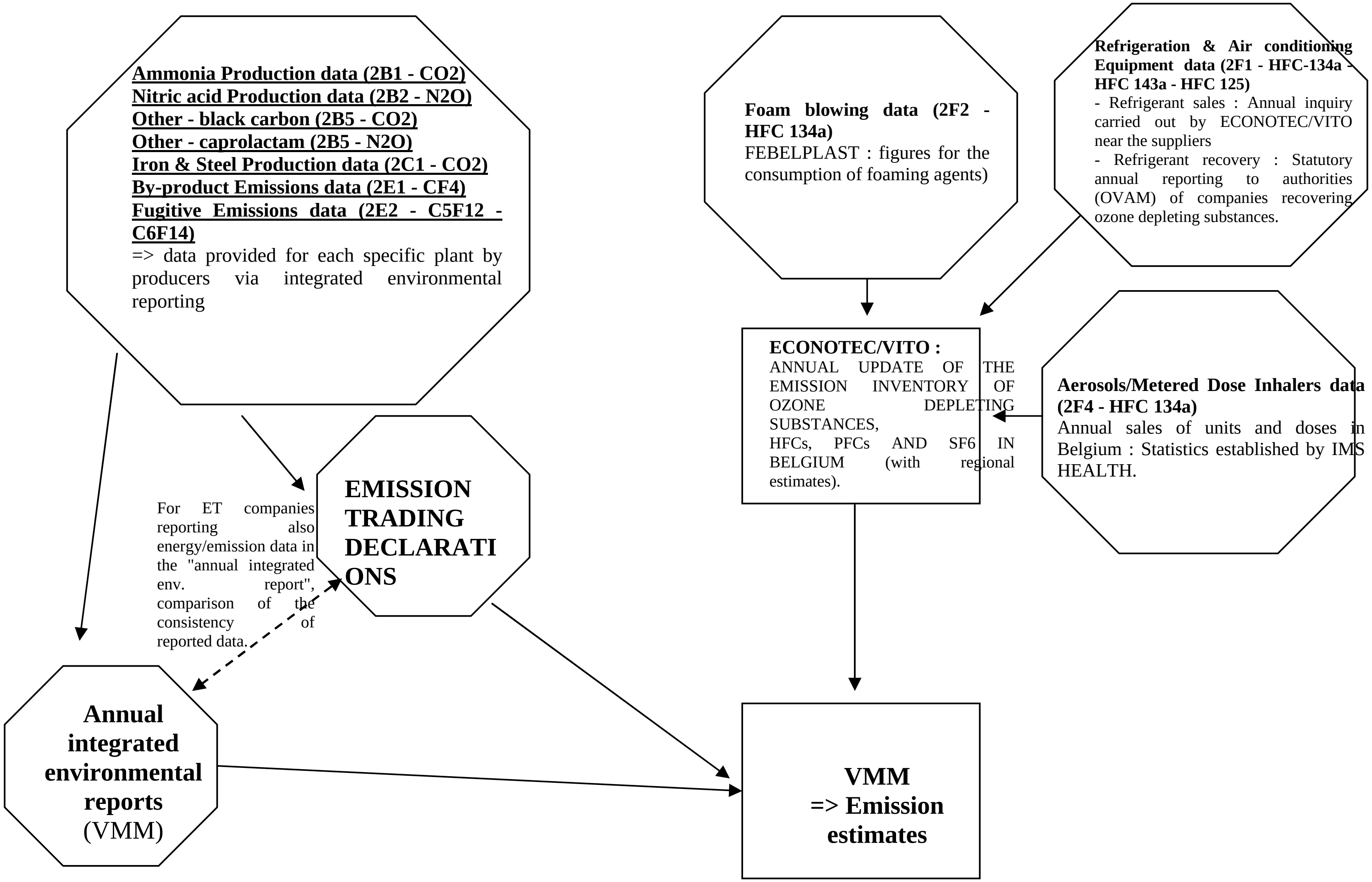


(*) Federal Public Service for Economy – General Directorate for Statistics and Information on Economy (former INS/NIS)

INDUSTRY - Key Sources - Flow of activity data - Wallonia



INDUSTRY - Key Sources - Flow of activity data - Flanders



AGRICULTURE - Key Sources - Flow of activity data - Wallonia

ENTERIC FERMENTATION (4A)
Cattle (4A1-CH4)
- livestock figures ad housing: Statbel (*)
  - Average animal weight and weight gain : Federal Finance Department
  - Milk production : CSWAAA

MANURE MANAGEMENT (4B)
- Cattle (4B1-CH4)
- Swine (4B8 - CH4)
- Solid storage and dry lot (4 B13 - N20)
- livestock figures : Statbel (*)
- - Manure production : Nitrawal (implementation of the nitrates directive)

DGRNE - Cell Air => Emission estimates

AGRICULTURAL SOILS (4D)
Direct soil Emissions (4D1 - N2O)
Indirect emissions (4D3 - N2O)
(=> Em. from atm. deposition, leaching and runoff)
Pasture, range,and paddock manure (4D2 - N2O)

- livestock figures : Statbel (*)
- Manure production : Nitrawal (implementation of the nitrates directive)
- N Atmospheric deposition : UCL (Catholic University of Louvain)
- Mineral fertiliser : IEA (Institute of agricultural economy)

(*) Federal Public Service for Economy – General Directorate for Statistics and Information on Economy (former INS/NIS)

AGRICULTURE - Key Sources - Flow of activity data - Flanders

<u>ENTERIC FERMENTATION (4A)</u>
Cattle (4A1-CH4)
- livestock figures : Statbel (*)
- Average animal weight, milkproduction, feeding situation and weight gain : Flemish Department Agriculture and Fishery

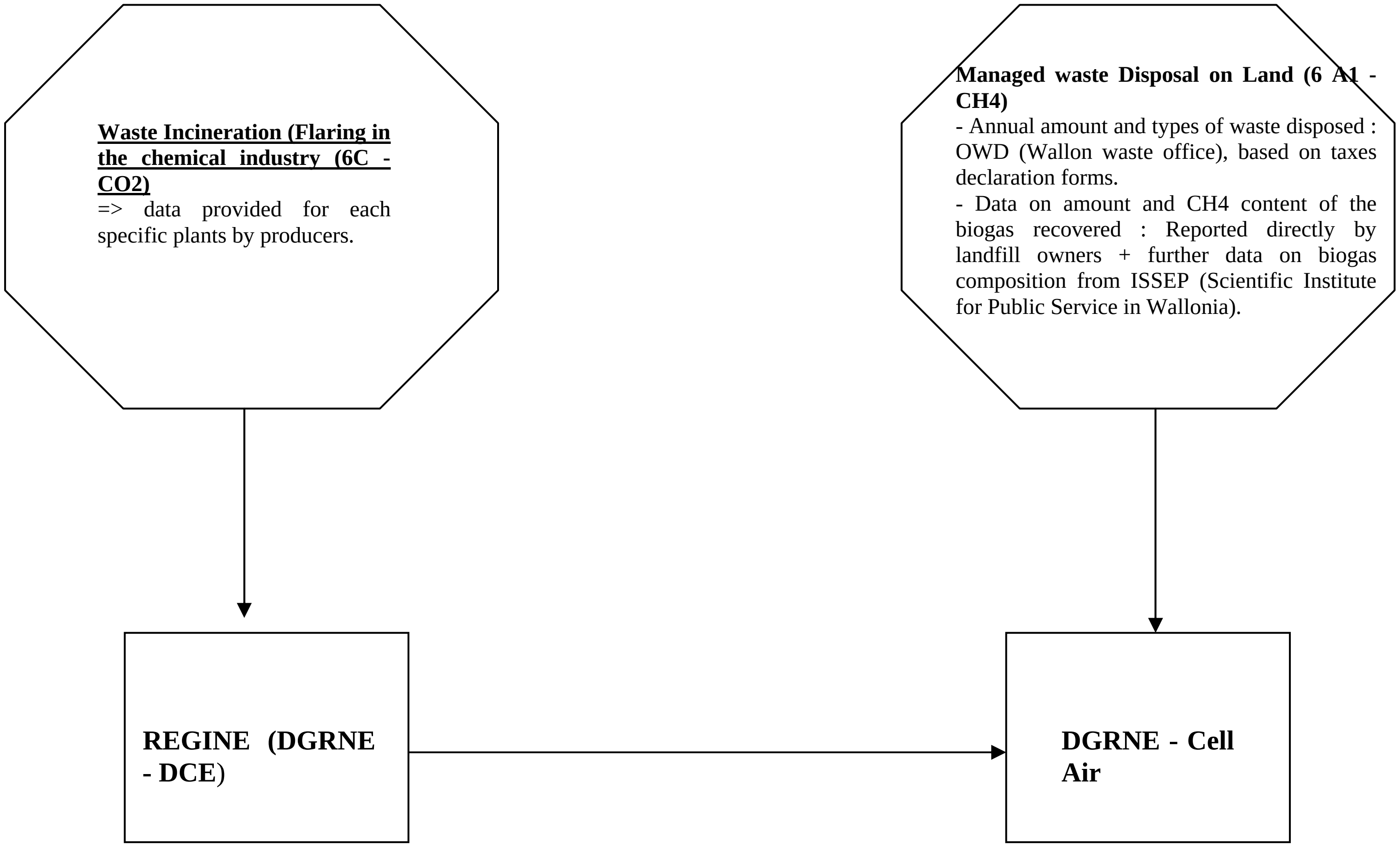
VMM
=> Emission estimates

<u>MANURE MANAGEMENT (4B)</u>
<u>- Cattle (4B1-CH4)</u>
<u>- Swine (4B8 - CH4)</u>
<u>- Solid storage and dry lot (4 B13 - $N_2$0)</u>
- livestock figures : Statbel (*)
- average weight : Department Agriculture and Fishery.
- Integrator : Flemish Land Agency
- Manure production : Flemish Land Agency (& Cascada & Safley)
- Amount of manure processed : Manure bank of the Flemish Land Agency
- Allocation to AWMS : Flemish Land Agency

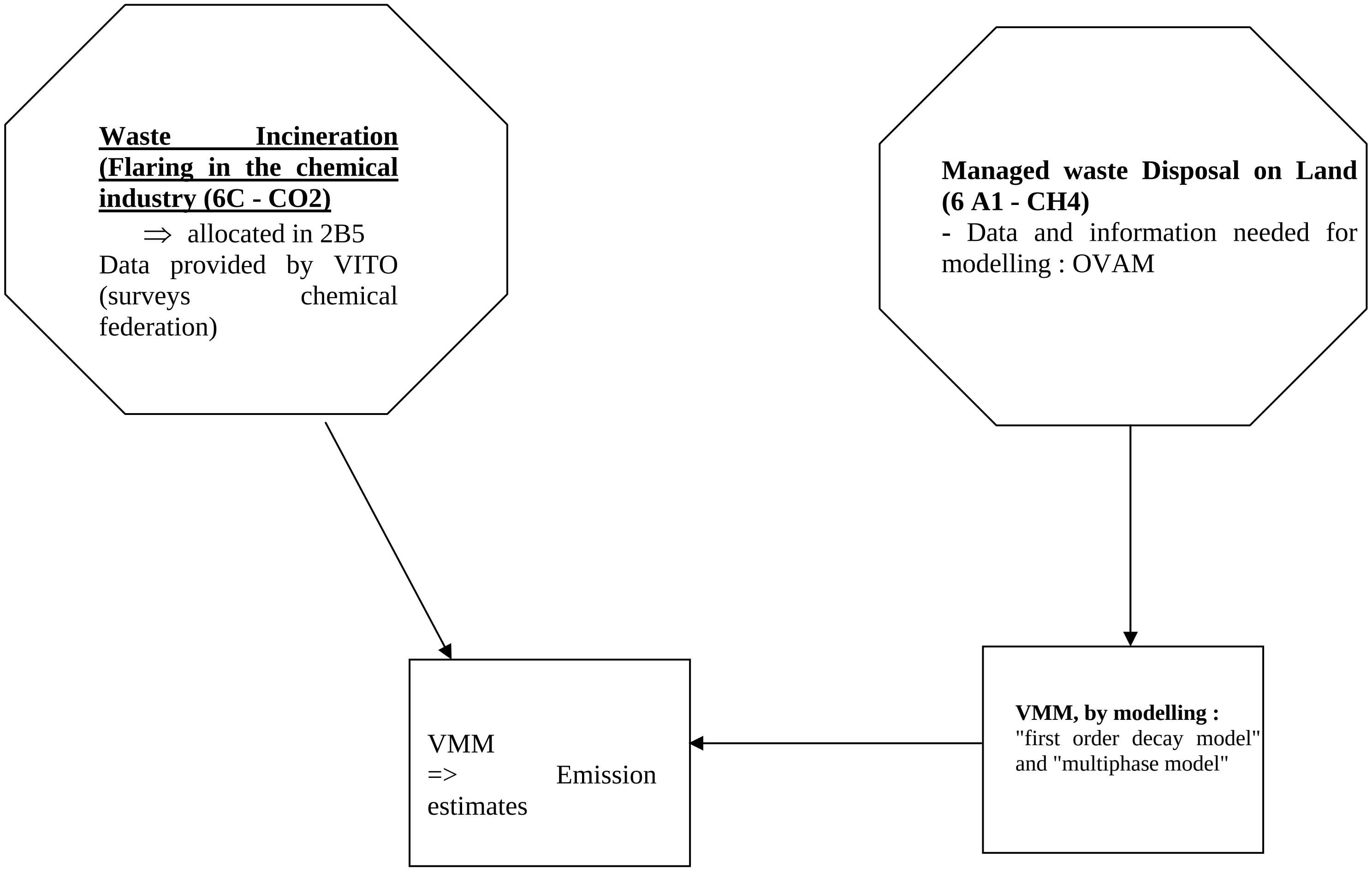
<u>AGRICULTURAL SOILS (4D)</u>
<u>Direct soil Emissions (4D1 - N2O)</u>
<u>Indirect emissions (4D3 - N2O)</u>
(=> Em. from atm. deposition, leaching and runoff)
<u>Pasture, range,and paddock manure (4D2 - N2O)</u>
- Area organic soils : University of Leuven
- Nitrogen leaching & run-off and N-atmosperic deposition: VMM
- livestock figures, agricultural land area, edible crop production: Statbel (*)
- Fertilizer use : Department and Institute for agricultural & Fisheries research
- Amount of manure exported or processed : Flemish Land Agency

(*) Federal Public Service for Economy – General Directorate for Statistics and Information on Economy (former INS/NIS)

WASTE - Key Sources - Flow of activity data - Wallonia



WASTE - Key Sources - Flow of activity data - Flanders



Annex 7 : Glossary

Organisms and sources of information

CELINE/IRCEL	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 DGRNE responsible of the coordination of environmental matters.
DGRNE	Walloon Ministry for natural resources and environment in charge of GHG inventories
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 Researcha.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