BELGIUM'S GREENHOUSE GAS INVENTORY (1990-2003)

National Inventory Report 2005
submitted under the United Nations Framework Convention on Climate Change

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CHAPTER 1: INTRODUCTION

1.1. Overview

This fourth 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 3/CP.5 and 11/CP.4 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 1990-2003. Inventory data for the years 1990 to 2002 have been recalculated, what constitutes a major update on the inventories reported previously.

This fourth 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 2002, are provided as an annex to this report, under electronic format. 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, a discussion of these estimates and their trends (including an analysis of the key source categories), and information on recalculation, uncertainties, 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 FCCC guidelines for the common reporting format. 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 big 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. 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, for approval, before its submission to the Conference of the Parties to the United Nations Framework Convention on Climate Change and to the EC, under the Council Decision 280/2004/EC concerning a Mechanism for Monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

1.3. 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 sectors and for fluorinated gases (see section 4.2.5).

As the QA/QC procedures are not fully implemented in Belgium for the time being, these are not described in chapters 3 to 8 for each sector, but a general description is provided in section 1.5 below. Section 1.6 gives a detailed description of the uncertainty analysis of the emission inventory of 2001 that is carried out for the first time in Belgium.

Inventory data for the years 1990 to 2002 have been recalculated, as a consequence of methodological changes, harmonisation of allocation and/or methods between the regions, and access to new data sources. Emission figures of the greenhouse gases for 2003 are estimated on a temporary basis in Belgium in this submission.

1.3.1. Flemish region

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

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. This is based on available statistical data and models, on the information coming from the obliged annual reporting of industrial emissions (mainly class I and class II companies and for emissions exceeding a given threshold value, compulsory since 1993) 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 : Independant methodology'). Last publication of this document dates from August 2004. 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).

The other CO_2 emissions (non-energy consumption, waste incineration) and process emissions from steel production are calculated by using a country-specific methodology.

In general, mostly Tier 1 methodology, the sectoral approach, was used for estimating CO_2 emissions. Sinks in Flanders are presumably small compared to Belgium. Some data on carbon sinks in the Flemish region came only available recently and are consequently for the first time reported in the CRF tables of this submission. (See section 7 for further information).

CH_4 and N_2O emissions

CH_4 and N_2O emissions are calculated by multiplying an activity data with an emission factor. Some of the emission factors used originate from CITEPA [2], an institute that established these factors in the framework of the CORINAIR inventory. In some cases these emission factors correspond with the emission factors described in the joint EMEP/CORINAIR handbook [3]. Other sources of emission factors are TNO [4] and country specific emission factors. Emissions of road transport are estimated using a country-specific methodology (the so-called TEMAT-methodology, Transport Emission Model to analyse Technological measures) . As the emissions from road traffic for Belgium are not calculated as the sum of the emissions of the 3 regions (see section 3.2.3), no more details about this methodology are given in this section. The methodology used by the Flemish region to calculate the emissions of road transport is mainly developed for policy objectives.

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 using the results of monitoring work.

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.

The regional inventory system will be fully described in the National Inventory System which will be reported by the end of this year.

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 examined with all industrial sectors. In some cases as agriculture and forestry, the emissions estimates are based on a specific study reflecting the Walloon environment.

The regional inventory system will be fully described in the National Inventory System which will be reported by the end of this year.

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 CORINAIR methodology (or IPCC for some sectors). The emissions are calculated by multiplying an 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 joint EMEP/CORINAIR handbook [3, 44] as well as in other reference works (IPCC Guidelines, specific bibliographies like PARCOM, TNO, EPA,…). The different sectors taken into account in the Brussels emission inventory reflect the characteristics of a strict urban environment.

The regional inventory system will be fully described in the National Inventory System which will be reported by the end of this year

1.4. Key sources categories

Key source categories were identified according to the Tier 1 method 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) were conducted.

The key source analysis was realised on the basis of a set of sub-categories, at the level of detail of the Sectoral Report Tables. When appropriate (detail for sub-categories not available), sub-categories were aggregated at a higher level. Sources that do not occur in Belgium, as well as those that are not estimated (no data) were excluded. LUCF sources were not considered for this analysis. Each greenhouse gas emitted from a single source category was considered separately. This procedure led to the determination of a set of fifty-one source categories, covering 99.5% of the total aggregated emissions. The key source analysis was then performed, 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 (see Annex 1) resulted in the identification of 27 key sources, covering 95%[1] of the total national aggregated emissions. 28 key sources were identified from the Trend Assessment (see Annex 1), as those that contribute 95% to the trend of the inventory. Key source categories identified form the Level and the Trend Assessments overlap to a large extent. As a whole (Level and Trend Assessments), 35 key source categories were determined (Table 1.1). The absolute change in direct greenhouse gas emissions of these key sources over the period 1990-2003 is listed in Table 1.1 and shown in Figure 1.1.

Road transportation is the first key source of greenhouse gas emissions in Belgium (16.8% of total aggregated emissions). It constitutes one of the main drivers of emissions trends (Annex 1). The absolute increase in CO_2 emissions from road transportation is the highest among the key sources (Table 1.1). Road transportation, electricity production and space heating in the residential sector are pointed out by the Level Assessment as the three main key source categories, each contributing to 15 to 17% of the total national emissions (together, these three sources cover 48.1% of the total emissions). The iron and steel industry and the IPCC category 1.A.2.c (chemicals) also constitute major key sources, which respectively account for 8.0 % and 5.2 % of the total emissions.

The three most important key sources of non-CO_2 emissions in Belgium are CH_4 emissions from cattle (enteric fermentation) (2.6%), N_2O emissions from nitric acid production (2.0%), and N_2O emissions from agricultural soils (1.4% of the total emissions). One may finally notice that the five key source categories which displayed the most important absolute increase in their emissions over the period 1990-2003 (figure 1.1, table 1.1), are CO_2 from road transportation (+5543 Gg CO_2-eq.), CO_2 from residential (+2304 Gg CO_2-eq.), CO_2 from commercial & institutional (+2141 Gg CO_2-eq.), CO_2 from chemicals (+1425 Gg CO_2-eq.) and HFCs from refrigeration and air conditioning equipment (+977 Gg CO_2-eq.). On the contrary, CO_2 from Iron and steel (-2397 Gg CO_2-eq.), CH_4 from managed waste disposal on land (-1713 Gg CO_2-eq.), SF6 from production of Halocarbons and SF_6 (-1559 Gg CO_2-eq.), PFCs from production of Halocarbons and SF_6 (-1545 Gg CO_2-eq.) and CO_2 from other manufacturing industries and construction (-775 Gg CO_2-eq.) are the source categories that displayed the most important drop in GHG emissions between 1990 and 2003.

[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.

IPCC Source Categories	Direct Greenhouse Gas	Criteria for identification	Absolute emission trend (1990-2003)
			(Gg CO_2 eq.)
ENERGY			
1.A.1.a. Public Electricity and Heat Production	CO_2	Level, Trend	82
1.A.1.b. Petroleum Refining	CO_2	Level, Trend	857
1.A.2.a. Iron and Steel	CO_2	Level, Trend	-2397
1.A.2.c. Chemicals	CO_2	Level, Trend	1425
1.A.2.e. Food Processing, Beverages and Tobacco	CO_2	Level, Trend	-756
1.A.2.f. Other (Manufacturing Industries and Construction)	CO_2	Level, Trend	-775
1A.2. Manufacturing Industries and Construction	N_2O	Trend	-127
1A.3. Transport	N_2O	Level, Trend	442
1.A.3.b. Road Transportation	CO_2	Level, Trend	5543
1.A.4.a. Commercial/Institutional	CO_2	Level, Trend	2141
1.A.4.b. Residential	CO_2	Level, Trend	2304
1.A.4.c. Agriculture/Forestry/Fisheries	CO_2	Level, Trend	-437
1A.4. Other Sectors	N_2O	Level	63
1.B.2.b. Natural Gas	CH_4	Trend	-124
INDUSTRIAL PROCESSES			
2.A.1. Cement Production	CO_2	Level	115
2.A.2. Lime Production	CO_2	Level	-12
2.B.1. Ammonia Production	CO_2	Level, Trend	553
2.B.2. Nitric Acid Production	N_2O	Level, Trend	-640
2.B.5. Other (Chemical Industry)	CO_2	Level, Trend	562
2.B.5. Other (production of caprolactam)	N_2O	Trend	-157
2.C.1. Iron and Steel Production	CO_2	Level	36
2.E. Production of Halocarbons and SF6	SF_6	Trend	-1559
2.E. Production of Halocarbons and SF6	PFCs	Trend	-1545
2.F.1. Refrigeration and Air Conditioning Equipment	HFCs	Level, Trend	977
2.G. Other (industrial processes)	CO_2	Trend	-164
AGRICULTURE			
4.A.1. Cattle	CH_4	Level, Trend	-473
4.B.1. Cattle	CH_4	Level, Trend	-183
4.B.12. Solid Storage and Dry Lot	N_2O	Level	-88
4.B.8. Swine	CH_4	Level	65
4.D.1. Direct Soil Emissions	N_2O	Level, Trend	-212
4.D.2. Animal Production (2)	N_2O	Level	-93
4.D.3. Indirect Emissions	N_2O	Level, Trend	-223
WASTE			
6.A.1. Managed Waste Disposal on Land	CH_4	Level, Trend	-1713
6.D. Other (composting)	CH_4	Trend	278

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

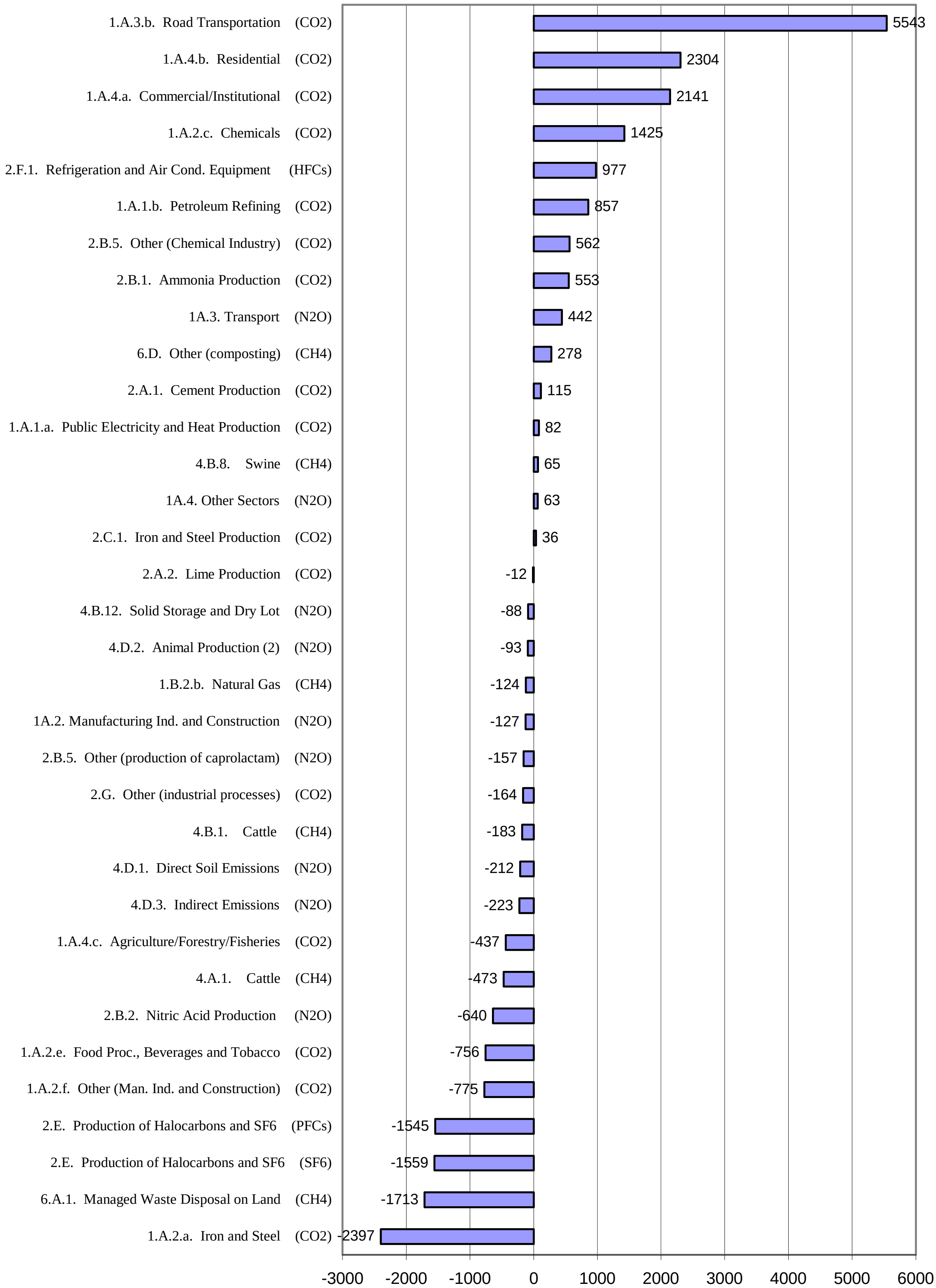


Figure 1.1. : Key source category analysis : GHG Emission Trends 1990-2003 (Gg CO_2 equivalent).

1.5. QA/QC plan and related issues

The Working Group on « Emissions » of the *Co-ordination Committee for International Environmental Policy* (CCIEP) has conducted intern quality insurance and quality control work by continuously exchanging information about methodologies used and estimated results. Feedback is given and extra controls are made by the responsable person for compiling the Belgian emission inventory of greenhouse gases. As a consequence this all gives extra checks of the regional emission inventories as well.

Following the IPCC Good Practice Guidance [10] and Uncertainty Management in National Greenhouse Gas inventories (June 2001), QC procedures (Tier 1) will be implemented to check the inventory on selected sets of data and processes. In a first approach, the key sources categories will be checked over their input data, their parameters and their calculations. In this view, several technical meetings are conducted since January 2003 with the three regions to identify for each sector on which level the Good Practice Guidance (e.g. uncertainty analysis, QA/QC,…) has to be implemented and to devise a work programme until the next submission.

Independent audits of the greenhouse gas inventories of the regions and the national inventory have started in the course of 2002 and all the results of the 3 regions in Belgium 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 met between the present process of information and the IPCC Guidelines and the obligations need to be fulfilled in the framework of 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 and the fulfilling of the IPCC Guidelines is mainly the absence of the complete implementation of the IPCC Good Practice Guidance [10]. As mentioned already above 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.

In Flanders, the procedures to prepare the Flemish energy balance are part of a certified ISO9001 system.

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 system (among others further description in detail of all the procedures involved) as well as a first internal review will become operational in the course of 2005, full implementation for all sectors and on the most detailed level is expected in the course 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 are defined.
In what follows a summary is given of all procedures involved in the QA/QC-system (state of affairs february 2005) :

More general procedures :
VMM/AMO/GP1/0.006 : Procedure for the management of quality care-personnel files
VMM/AMO/GP1/0.008 : Procedure for the performance of audits
VMM/AMO/GP1/0.010 : Procedure for setting up a general quality care–management report
VMM/AMO/GP1/0.011 : Procedure for the management of documents

More detailed procedures :
VMM/AMO/GP2/5.001 : Procedure to determine non-conformities, quality problems and proposals for improvement and follow-up by means of corrective and preventive measures
VMM/AMO/GP2/5.002 : Procedure for the training of the personnel of the service "Emissie Inventaris Lucht" (Emission Inventory Air)
VMM/AMO/GP2/5.003 : Procedure to fill in the crf-tables
VMM/AMO/GP2/5.004 : Procedure to manage the Balanced Score Card

The results of this Flemish study will be taken into account to set up a comparable system in the 2 other regions in Belgium.

In Wallonia, the inventory is conducted by the Air Cell, which is part of the General Directorate for Natural Resources and Environment, and the latter has now obtained its EMAS certification. An ISO 9001 certification is also foreseen.

For what concerns the measures used to determine country-specific emission factors, it can be mentioned that in Wallonia, before performing any air emissions measure, all the laboratories must first be agreed by ISSEP, which conducts a review of material and methodologies used and check the compliance with the requirements of a legal decree (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 updated list of agreed laboratories is published on the website of DGRNE, the responsible institut in Wallonia.

In the Brussels region, the energy balance is established by an independent institute, ICEDD (Institut de Conseil et d'Etudes en Développement Durable), who is certified ISO 9001 for its internal procedures. For information, the emissions from energy consumption constitutes nearly all the emissions of this urban environment.

Calculations of uncertainties on greenhouse gas emissions on the national level are calculated on Tier 1- -level (see section 1.6 for more details).
These uncertainties and the quality system that is in progress include all the recommendations expressed in the "IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories"(IPCC 2000) and the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1996).

1.6 Tier 1 uncertainty calculation

1.6.1. General approach

The IPCC Good Practice Guidance Tier 1 method has been applied to make a first assessment of the uncertainty in the emission inventory of 2001. This uncertainty calculation is applied on the Belgian greenhouse gas emission inventory as submitted on the 15th of January 2005 to the European

Commission. This is an important remark because some more changes on the emission inventory of greenhouse gases after this date have been carried out in Belgium. These changes include recalculations of the emissions as well as some changes in allocation of the emissions.

In Flanders, a complete study of the uncertainty was conducted 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 errorpropagation equation from the Good Practice Guidance, in order to produce one single table 6.1 (as expessed in the guidelines).

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 Netherlands and 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. Comment by category

1A1 Energy industries

According to IPCC Good Practice Guidance (table 2.6), the uncertainty on activity data is less than 1% in the case of 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 come 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 judgment and 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 IPCC Good Practice Guidance (table 2.6), the uncertainty on activity data is between 2 and 3 % in the case of survey. In Belgium, the annual survey is cross-checked with other sources of information for 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 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 by IPCC Good Practice Guidance (page 2.49), which mentions that it 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 IPCC Good Practice Guidance. A higher uncertainty is estimated for N_2O , taking into account 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, 78% of the Belgian railways are using electricity, whose uncertainty is treated under energy. 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 is the main activity data in this sector. Surveys are combined with extrapolations in order to estimate the consumption. The uncertainty on activity data is based on IPCC Good Practice Guidance (table 2.6) 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 (table 2.5, IPCC Good Practice Guidance).

1B Fugitive emissions from fuels

Fugitive emissions under 1B1 are linked to the production of coke. Production is assumed 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 for the activity data and for the emission factors assumed to be the same as in the category 1A1b (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 IPCC Good Practice Guidance (page 2.92). Since the activity data (lenght of pipelines for the different materials of pipelines) is based on information of the gas distribution company, the uncertainty is estimated at 10%. Emission factors (= leak rates) are based on statistics on measurements from this company and their uncertainty is estimated at 30%.

2A Mineral products

For lime and cement plants, the uncertainty on activity data comes from IPCC Good Practice Guidance (pages 3.15 and 3.21). The uncertainty on emission factors is assumed to be low, as plant-specific emission factors are used in both sectors.

The uncertainty on activity data for glass production is assumed to be comparable with the others industrial productions. The CO_2 emission factor cited in the EMEP/CORINAIR guidebook comes 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

For ammonia production, the Norwegian uncertainty calculation [41] and the Irish NIR were the only references found. Following expert judgement, average values from those references were used in this study.

Since there is only one producer of nitric acid remaining since 2000 in the Flemish region with reliable production data available, the uncertainty in 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 the companies of the emission factor used.
For the production of caprolactam the same uncertainty in activity data is used as for the production of nitric acid (2%). 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 well developed statistical systems. As the emission factors are mainly plant-specific, their uncertainty is assumed to be in the low range of IPCC values.

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. Given the features of the monitoring (census twice a year, individual earmarks and registration for all bovines, …), the uncertainty is judged small. The emission factors are mainly taken from 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, so 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 for N_2O emissions. 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

For CH_4, this small source is linked to the manure applied during grazing. The same uncertainty than 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… The uncertainty on activity data is thus estimated at 30%, which seems in line with the values cited 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 in this calculation.

6A Solid waste disposal on land

In Wallonia, complete statistics on the amount of waste put 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 due to activity data.

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 comes from IPCC 1996 Guidelines, table 4.18, with a given range of 0.0025-0.0225. This range represents an uncertainty of –75% / +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, but uncertainty on activity data is estimated at 20% according to expert judgement. The uncertainty on the emission factor is also estimated at 20 %.

6D Composting

The uncertainties both on activity data and emission factors for CH4 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 8,1 % in the 2001 inventory f Belgium and a trend uncertainty of 3,8 %. While the uncertainty on CO_2 emission is estimated at 3,6 %, the emissions of CH_4 and N_2O are much more uncertain, respectively 24 per cent and 91 %.

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 other sectors of which the combined uncertainty represent more than 1 % of total national emissions are N_2O emissions from liquid fuels in the residential sector, N_2O from nitric acid production in the chemical industry and CH_4 from enteric fermentation.

It can be pointed that, given the relatively limited change in the emissions from agricultural sources between 1990 and 2001, their influence is not as large in the case of the trend. Anyway, more reliable data on this sector is certainly needed on a global level.

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 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 147.7 Mt CO_2 eq in 2003 (Table 2.1.), which is 1.4 % above 1990 emissions. Compared to the base year emissions[2], emissions have increased by 0.6 % in 2003 (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 2003 were 5.5 index points above this target path.

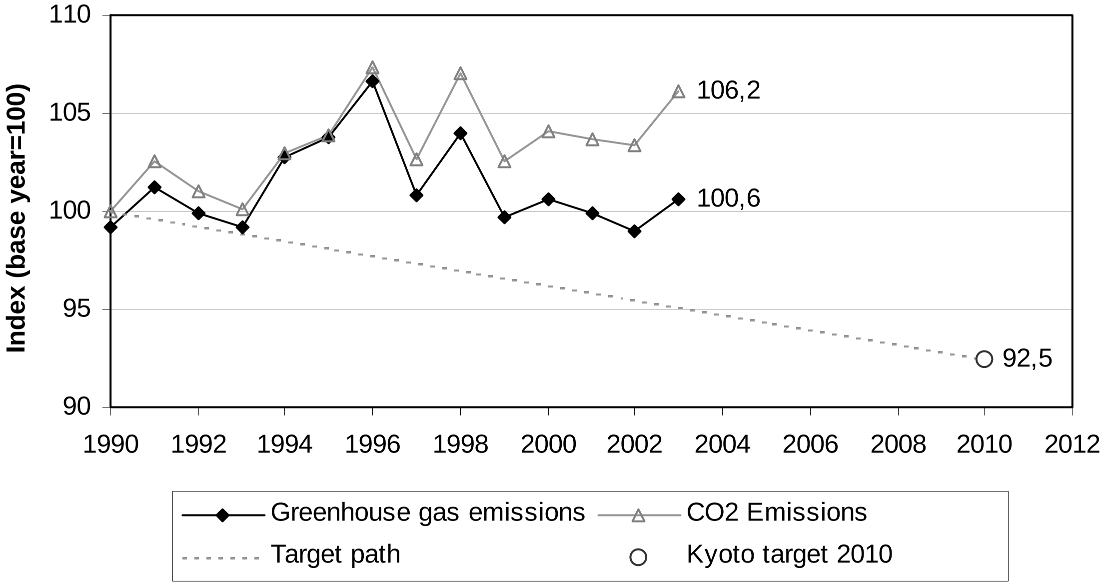


Figure 2.1. : Belgium GHG and CO_2 emissions 1990-2003 compared with Kyoto target (excl. LULUCF).

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

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

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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Net CO_2 emissions/removals	115.906	119.246	117.111	116.048	119.430	120.700	124.736	119.172	124.505	119.165	120.679	118.944	119.004	122.971
CO_2 emissions (without LUCF)	119.010	122.064	120.242	119.109	122.519	123.618	127.707	122.165	127.382	121.985	123.815	123.355	122.984	126.331
CH_4	10.788	10.799	10.758	10.608	10.729	10.777	10.587	10.526	10.397	10.078	9.798	9.231	8.792	8.530
N_2O	12.192	12.221	11.821	12.152	13.173	13.114	13.521	13.102	13.291	13.096	12.853	12.729	12.223	11.253
HFCs	255	255	255	255	255	255	386	526	669	691	759	920	1.148	1.322
PFCs	1.753	1.678	1.830	1.759	2.113	2.335	2.217	1.211	669	348	361	228	108	209
SF_6	1.663	1.576	1.744	1.677	2.035	2.205	2.120	525	270	120	109	105	94	75
Total (with net CO_2 emissions/removals)	142.557	145.775	143.518	142.498	147.736	149.386	153.568	145.062	149.801	143.498	144.558	142.157	141.368	144.360
Total (without CO_2 from LUCF)	145.660	148.593	146.649	145.559	150.825	152.305	156.539	148.056	152.678	146.318	147.695	146.569	145.349	147.719

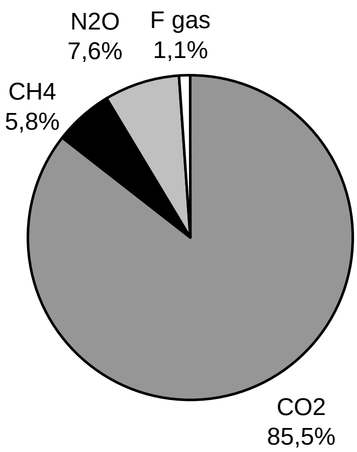
Table 2.1. : Overview of Belgium GHG emissions and removals from 1990 to 2003 (Gg CO_2 equivalents).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy	113130	117162	115586	114633	116797	116886	121659	115866	120995	115702	116987	117135	116207	119562
Industrial processes	16089	15146	14799	14765	17756	19026	18883	16241	15784	15001	15413	14670	14902	14342
Solvent and other product use	253	249	249	247	241	242	238	238	238	238	256	256	253	253
Agriculture	12779	12760	12691	12816	12797	12994	12702	12577	12665	12615	12358	12294	11913	11557
Land-use Change and forestry	-3103	-2817	-3132	-3061	-3088	-2918	-2971	-2993	-2877	-2820	-3137	-4412	-3980	-3359
Waste	3409	3276	3324	3098	3234	3157	3057	3134	2996	2762	2681	2214	2074	2005

Table 2.2. : Overview of GHG emissions and removals in the main sectors from 1990 to 2003 (Gg CO_2 equivalents).

2.2. Emission trends by gas

The major greenhouse gas in Belgium is carbon dioxide (CO_2), which accounts for 85.5 % of total emissions in 2003. Methane (CH_4) accounts for 5.8 %, nitrous oxide (N_2O) for 7.6 %, and fluorinated gases for 1.1% (Figure 2.2). Emissions of CO_2 increased 6.2% during 1990-2003, while N_2O, CH_4 and fluorinated gas emissions have dropped with respectively 7.7%, 20.9% and 66.5 %[3] during the same period.



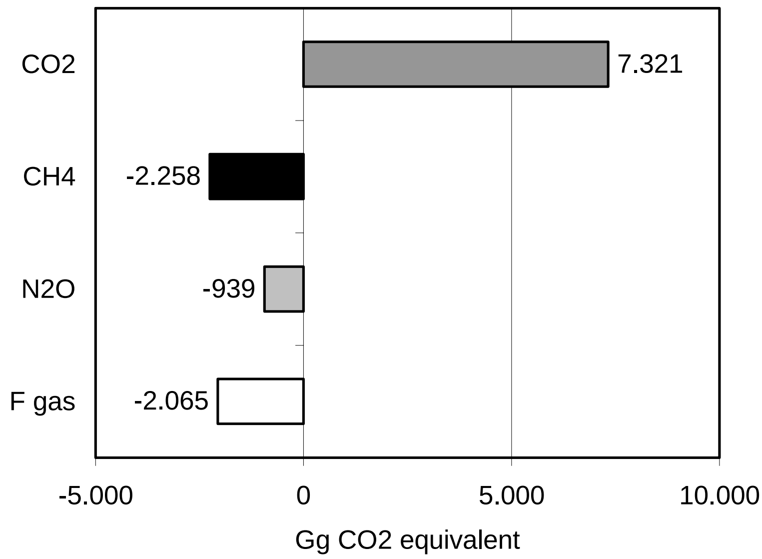


Figure 2.2. : Share of greenhouse gases in Belgium (2003), and changes 1990-2003.

Total CO_2 emissions (without LUCF) in Belgium amounted to 126.3 Mt CO_2 eq in 2003 (Table 2.1.). A net sink of 3359 kton CO_2 eq is reported for the LUCF sector, which offers only a tiny compensation for these emissions (2.7%). Due to the large contribution of CO_2 to total emissions (85.5%), GHG emissions in Belgium are closely connected with the emissions of CO_2.

Total CH_4 emissions amounted to 8.5 Mt CO_2 eq in 2003 (Table 2.1). CH_4 emissions have substantially decreased since 1990 (-20.9%), mainly due to the deep cut in emissions from landfills.

Total N_2O emissions in Belgium amounted to 11.3 Mt CO_2 eq in 2003 (Table 2.1). The largest key sources that contribute to N_2O emissions are nitric acid production and direct soil emissions, followed by indirect emissions and transport. Other various sources contribute to a lesser extent to N_2O emissions.

Emissions of fluorinated gases in Belgium amounted to 1.6 Mt CO_2 eq in 2003. Compared to 1990, this represents a decrease of 56.3% (66.5% when compared to 1995). The major decrease is observed in the production of PFC's and SF_6 (-93.7%). In the meantime, emissions from refrigeration and air conditioning have increased.

[3] compared to 1995 emissions

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, as in previous submissions, the most important sectors in the total GHG emissions in 2003. Agriculture (7.8 %) and waste (1.4%) account for the remaining part. Main drivers of the total increase in GHG emissions are the transport sector and space heating (residential, commercial, institutional and agriculture sector). In absolute terms, these sectors have respectively increased by 6.0 Mt CO_2 eq and 4.0 Mt CO_2 eq (Figure 2.3). On the contrary, total emissions from energy industries, industry (energy and process), agriculture and waste have declined over the period 1990-2003.
The sections below give a detailed picture of the largest key sources that contribute to GHG emissions in each of the four sectors : energy, industrial processes, agriculture and waste.

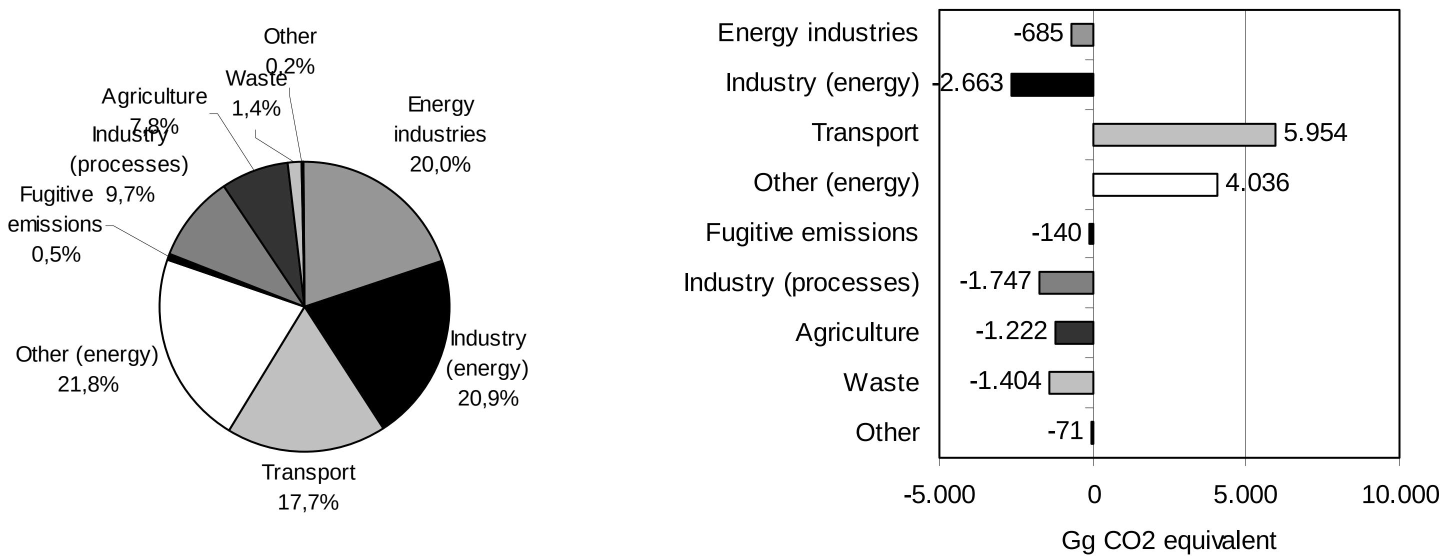


Figure 2.3. : GHG emissions : share of main sectors (2003) and changes from 1990 to 2003.

2.3.1. Energy

Energy consumption accounts for 81% of total GHG emissions in Belgium. The largest key source category in the energy sector is road transport (21%), followed by 'public electricity and heat production' (20%), by space heating (residential) (IPCC category 1.A.4.) (19%), iron and steel (10%) and chemicals (6%). All together, these five categories account for more than 75% of the emissions of this sector (Figure 2.4).

Total GHG emissions from the energy sector in 2003 are 5.7% above 1990 emissions. These emissions still have increased by 2.9% between 2002 and 2003. The main drivers of this continuous increase are road transport and the commercial/institutional sector, as shown in Figure 2.4. N_2O emissions from transport have more than doubled between 1990 and 2003. 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).

CO_2 emissions from the iron and steel sector and from manufacturing industry and construction have decreased with 16.8% and 9.6% respectively.

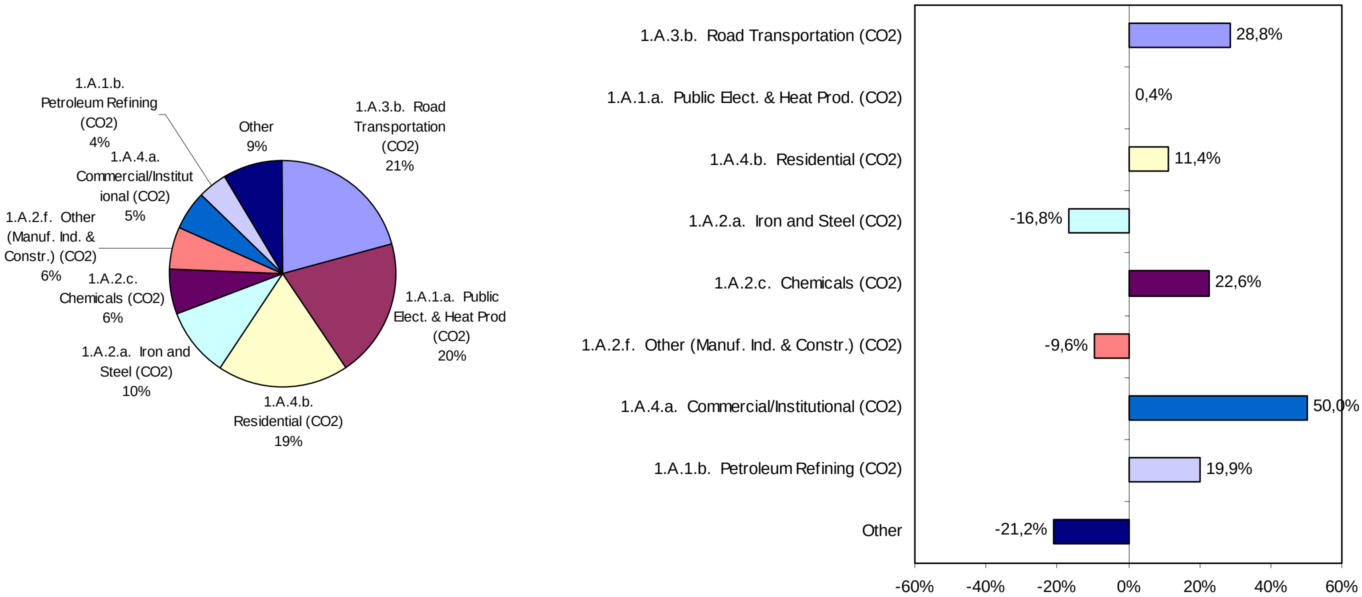


Figure 2.4. : GHG emissions in sector 1 'Energy': share of largest key sources in 2003 and changes from 1990 to 2003.

2.3.2. Industrial processes

GHG emissions from industrial processes account for 9.7% of total emissions in 2003. The share of emissions by the largest key sources in this sector is shown in figure 2.5, as well as changes in emissions over the period 1990-2003. N_2O emissions from nitric acid production contribute to 21% of the sector emissions. CO_2 emissions from productions of cement account also for 21%, they are followed by lime (15%), iron and steel (13%) and ammonia (9%). Other key sources include HFCs emissions from refrigeration and air conditioning equipment (7%) and other industrial processes in the chemical industry (5%).

As a whole, GHG emissions from industrial processes have dropped with 10.9% between 1990 and 2003. This reduction mostly originates in the PFCs and SF_6 emissions from the category 'production of halocarbons and SF_6', which peaks in 1995, and then drops to almost zero (-91.7%). Emissions from nitric acid production have decreased by 18% while emissions of ammonia production have grown with 79.7%, as well as HFCs emissions from refrigeration and air conditioning equipment (+1260.5% !).

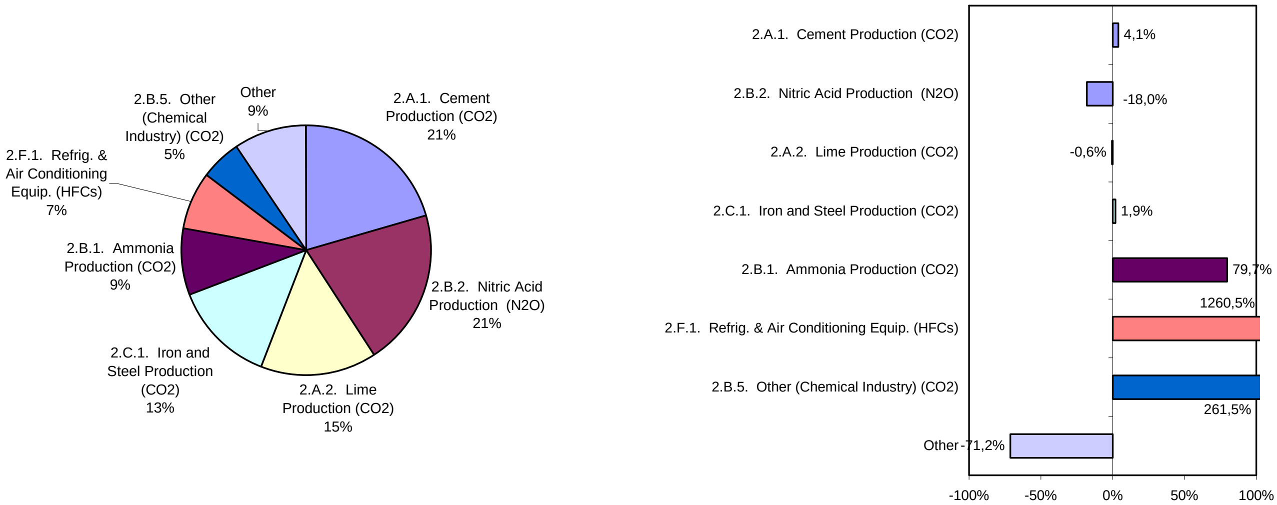


Figure 2.5. : GHG emissions in sector 2 'Industrial processes': share of largest key sources in 2003 and changes from 1990 to 2003.

2.3.3. Agriculture

GHG emissions from agriculture accounted for 7.8% of the total emissions in Belgium in 2003. About one third of these emissions are CH_4 emissions from cattle (Figure 2.6). N_2O emissions from soil account for another 18%, followed by CH_4 emissions from swine (12%), N_2O indirect emissions (8%), and CH_4 emissions from manure management (8.0%). Overall, emissions from agriculture have decreased by 9.6% between 1990 and 2003. All key sources of this sector remained stable, or have been reduced, except methane emissions from swine, which increased by 5% (Figure 2.6).

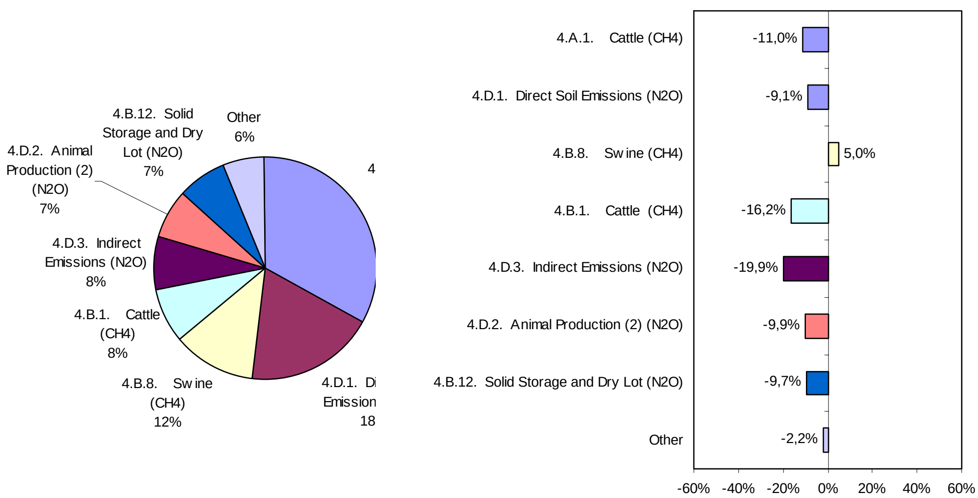


Figure 2.6. : GHG emissions in sector 4 'Agriculture': share of largest key sources in 2003 and changes from 1990 to 2003.

2.3.4. Waste

GHG emissions from waste account for 1.4% of the national emissions in 2003. CO_2 emissions from waste disposal on land represent 45% of total emissions of the sector (Figure 2.7). Another key source in this sector is the CH_4 emission from composting (17%). CH_4 emissions from landfills (45%) have continuously decreased since 1990 (Figure 2.7), mainly as a result of the increased use of flaring, leading to a decrease of GHG emissions for the entire sector (-41.2%), despite an increase of CO_2 emissions from composting (+479.4%).

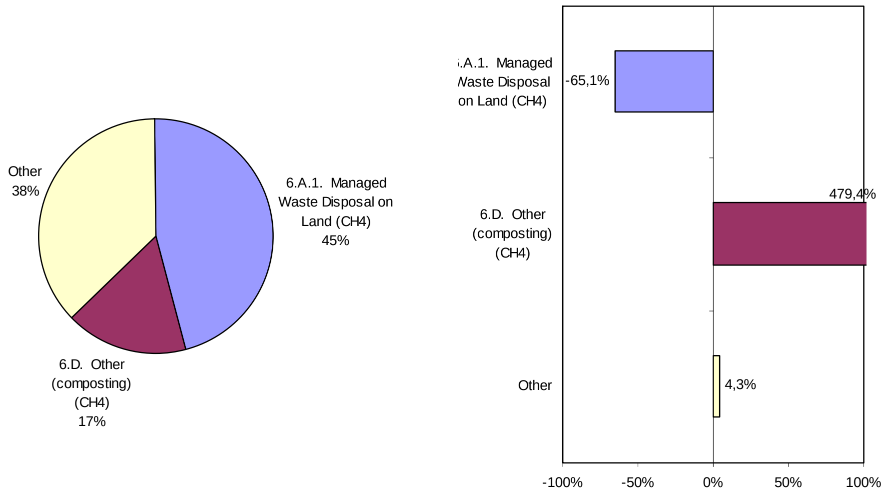


Figure 2.7. : GHG emissions in sector 6 ‘Waste’: share of largest key sources in 2003 and changes from 1990 to 2003.

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 2.8 (share of sectors and changes 1990-2003). These data are commented below.

2.4.1. Nitrogen oxides (NO_X)

The primary NOx emitting source in Belgium is transport (52.2% in 2003), followed by manufacturing industries (17.8%) and energy industries (14%). Total NO_x emissions have substantially decreased (-22.2% in 2003 compared with 1990), mainly as a result of improved performances in the production of electricity. Emissions from transport have decreased with 21% between 1990 and 2003, thanks to the use of catalytic converters on petrol-engine cars (since 1993-94). On the other hand, emissions from energy consumption in industrial and residential sectors have increased (notably as a result of the more widespread use of natural gas for heating).

2.4.2. Carbon monoxide (CO)

CO emissions in Belgium come mainly from energy consumption in industry (44.1%), transport (33.3%), and industrial processes (11.9%). Fuel combustion for space heating also contributes slightly (9.3%).
Between 1990 and 2003, national CO emissions fell by 44.9%, 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 the use of solvents and other products (37.8%), followed by combustion of petrol for transport (26.2%). Some industrial processes also contribute (13%), as well as fugitive emissions from fuels (12.3%). On the whole, these emissions decreased by 43.3% between 1990 and 2003, partly as a result of altered vehicle emission standards, and partly as a result of the prevention of solvent use.

2.4.4. Sulphur dioxide (SO_2)

SO_2 emissions produced by the energy, industry and residential (space heating) sectors declined sharply in Belgium between 1990 and 2003, leading to a general drop of these emissions by 64.5%. These reductions basically coincide with fuel substitution and with cuts in the sulphur content of the oil products used. The energy sector still accounts for 38.7% of SO_2 emissions, followed by energy consumption in industry (23.8%) and heating (22.5%).
In the transport sector, sulphur dioxide emissions have dropped (-92% in 2003 compared with 1990), mainly due to the constant reduction in the sulphur content of fuels since 1996.

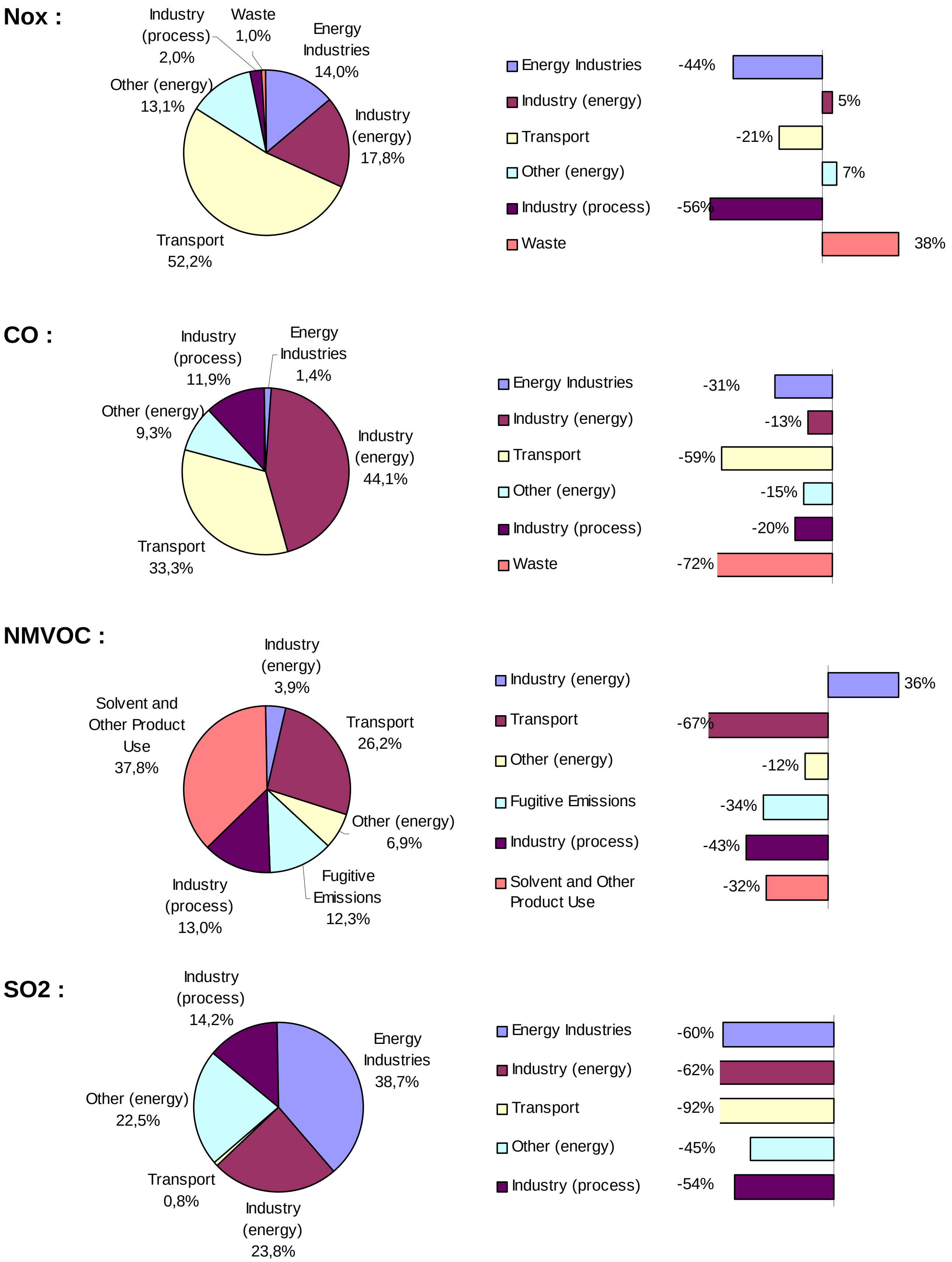


Figure 2.8. : Indirect GHG emissions and SO_2 : share in 2003 and changes 1990-2003.

CHAPTER 3: ENERGY

3.1 Overview

3.1.1 Energy

In 2003, Belgium's apparent gross consumption of primary energy rose to 58,36 Mtoe (Million tonnes oil equivalent), i.e. approximately 5.64 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 (44,81 Mtoe in 2003). This was made up of 6,21 Mtoe of coal, 24,15 Mtoe of oil (crude and petroleum products), and 14,44 Mtoe of gas. In 2003, the primary production of energy, 94% of which was derived from nuclear fuels (whose use provided 56% of the electricity produced), amounted to 13,07 Mtoe. Although the hydroelectric potential is vigorously exploited in Belgium, its share in the production of energy remains negligible given the topography of the country. The production of wind energy is also very limited, 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, which is currently insignificant, could also eventually contribute to the primary energy production, assuming regional objectives are met.
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 (+71% from 1979 to 2003). During the same period, the industrial sector as a whole saw its overall consumption decrease by 9%. 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.

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. One exception on this general rule is the calculation of the emissions of CO_2 originating from road transport (see further section 3.1.3).

The energy industries imply the public electricity and heat production, petroleum refining and the manufacture of solid fuels and other energy industries. Petroleum refining only occurs in the region.

The category 'Public Electricity and Heat production (1.A.1.a)' 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 1.A.2 'Manufacturing Industries and Construction' and 1.A.4 'Other sectors'. The sub-category 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. In Flanders, 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 this case, all fuel in the energy balance is included in the energy sector. The same allocation is applied in Wallonia.

The emissions originating from category 1.A.1.c 'Manufacture of Solid Fuels and Other Energy Industries' are the emissions coming form the combustion in the cokes ovens. Only the CO_2 emissions are reported in this category. The emissions of the others pollutants are reported in the category 1.A.2.a. in Flanders and in category 1.A.1.c in Wallonia and Brussels, but those CH_4 emissions are in fact negligible and the N_2O emissions are rather small.

3.1.2 Industry

The following industries are integrated in category 1.A.2.f (Other): 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 satisfy the establishment of the great surfaces required by industry. With the exception of a manufacturer of cars, Brussels industry is made up of small and very small manufactures with high added value or close to the ultimate consumer. All these “industries” are integrated in category 1.A.2.f (Other).

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.

Since the previous submission, the CO_2 emisions 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 were not calculated, based on the Belgian energy statistics, but are the sum of the emissions calculated by the 3 regions using the COPERT methodology in the Walloon and Brussels region and a country-specific methodology (TEMAT see also section 1.3.1) for the Flemish region.

3.2 Methodological issues

Greenhouse gas emissions are mostly reported directly by the individual large companies on the basis of their fuel consumption. For most sectors the remainder of the emissions is calculated on the basis of the remaining fuel consumption (estimated as the difference between energy consumption reported in the regional energy statistics for the whole sector and the fraction reported by the large companies) and standard emission factors. The emission factors of CO_2 are the same for all sectors and are listed below.

Products	**emission factors (g CO_2/MJ)**		
	Flanders	Wallonia	Brussels
coal tars	92,7	-	
coking coal	92,7 (7)	92,7	94 (5)
Brown coal/lignite		99,2	
coke oven coke	106,0	106 (3)	
crude oil	72,6	-	
Refinery gas	55,1 - 56,5 (1)	-	
LPG	62,4	-	
Gasoline	68,6	-	
Kerosene	70,8	-	
gas/diesel oil	73,3	73,3	74 (5)
lamp petroleum	71,1	-	
residual fuel oil	76,6	76,6	78 (5)
Naphta	72,6	-	
petroleum coke	99,8	99,8	
other petroleum	72,6	-	
natural gas	55,8	55,8	56 (5)
coke oven gas	47,4	47.4	
blast furnace gas	258-260 (6)	265,5 (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 (IPPC 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) EMEP/CORINAIR
(4) country specific
(5) Specific study IBGE-BIM [12]-Corinair
(6) inquiry with the electricity sector and iron and steel sector
(7) the default IPCC value, this is not used for the large power plants

In the lime and cement plants, the CO_2 emission factors originates from the IPCC 1996 Guidelines.

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 per fuel in lime and cement plants.
(Source : IPCC[i] and EMEP/CORINAIR[c])

3.2.1 Energy industries (category 1.A.1)

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

CO_2

The activity data are collected from energy statistics and from surveys of the individual companies. The number of companies is limited and well known. For the large power plants in the public electricity sector in Flanders, the CO_2 emissions directly reported by the power plants and based on analyses of the fuels are used for the first time (in the previous submissions, default IPCC emission factors for CO_2 were used). For the smaller plants for which no emissions of CO_2 are reported directly, default CO_2 emission factors are used except for specific fuel types (see table 3.1). In that case more detailed information of the individual companies is used. In Wallonia the power plants give directly their CO_2 emissions without emission factor and these figures are directly used. They make some measurements of the carbon content of theirs fuels.
In the Brussels region there is only one significant power plant. The electricity used is produced from the municipal waste incineration. The CO_2 emission factors from EPA are used. The fraction of organic-synthetic municipal waste has been deduced from analyses of dustbins [37] and have led to a fraction of 47 % of biomass origin. For the smaller plants in Brussels, default CO_2 emission factors are used (see table 3.1).

CH_4 and N_2O

In Flanders, emission factors from TNO (Netherlands) [4] (Table 3.2) are now used to calculate the emissions of N_2O for the installations for public electricity and from CITEPA [2] to calculate the emissions of CH_4. These emission factors are situated within the range of emission factors described in the EMEP/CORINAIR handbook [3] and are agreed with the electricity producers. In Wallonia, emissions of CH_4 and N_2O are calculated using emission factors of the IPCC Guidelines.

Fuel	UNIT	CH$_4$			N$_2$O		
		Fl (1)	**Wall (2)**	**Br (1)**	**Fl (3)**	**Wall (2)**	**Br (1)**
Coal	g/GJ	0,6	1	/	1,40	1.40	/
Fuel	g/GJ	0,7	3	/	0,60	0.60	/
diesel oil	g/GJ	0,3	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	/
Cokesgas	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	-	/	0,60	-	/
Agricultural waste	g/GJ	-	30	/		4	/
Municipal waste	g/GJ			-	60 g/ton (1)		7.25

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: CITEPA
(2) source: IPCC
(3) source : TNO

Petroleum refining (category 1.A.1 b)

Petroleum refining only occurs in Flanders. For CO_2, the emissions reported by the the Belgian Petroleum Federation and the petroleum refining companies are reported since the previous submission in the inventory.

CH_4 and N_2O emissions from petroleum refining are calculated using emission factors of CITEPA [2] 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).

Manufacture of solid fuels and other energy industries (category 1.A.1.c)

In Wallonia, in the category 1.A.1.C the emission factors for CO_2 and CH_4 are those proposed in the EMEP/CORINAIR guidebook and the IPCC Guidelines [24]. The emission factor for CO_2 for the blast furnace gas is given directly by the power plant. For N2O, emission factors from the Table 1.8 of the Revised 1996 IPCC Guidelines [28] are used.

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) IPCC
(2) EMEP/CORINAIR

There was a coke plant in the Brussels region until 1993. The emission factors are the same as Wallonia.

In Flanders the emissions of CH_4 and CO_2 of this sector are calculated in a different way and are put in the categories 1.A.1.c (emissions of CO_2 from production of cokes) and 1.B.1.b (emissions CH4 from production of cokes) (see these sections for more explanation of the methodology used).

3.2.2 Manufacturing industry and construction (category 1.A.2)

CO_2

The energy consumption data originate from the regional energy balances, supplemented with specific information from the companies themselves, for example activity data from iron and steel industry. For CO_2, the emission factors listed in table 3.1 are used.
The CO_2 emissions from electric arc furnace (100 kg CO_2/ t steel) are based on an average emission factor studied with the steel-manufacturing sector. CO_2 emissions comes from the combustion of coal injected in these furnaces.
In the lime and cement plants, the CO_2 emission factors come from the table 3.2.

CH_4 and N_2O

The emissions of CH_4 and N_2O in Flanders are calculated using emission factors originating from CITEPA [2] (Table 3.5).
The emission factors used to calculate the emissions of CH_4 and N_2O in Wallonia are based upon those proposed in the EMEP/CORINAIR guidebook and the Revised IPCC Guidelines.
In the Brussels region, a specific study has been funded on behalf of the IBGE-BIM [12] to determine the emission factors to take into account specific socio-economic conditions in Brussels.

			Flanders [1]	Wallonia	Brussels [4]	Flanders [1]	Wallonia	Brussels
Fuel	**Boiler**	**Unit**	**CH_4**			**N_2O**		
Coal		g/GJ	0.27	10 [2]	1.5	12.3	1,4 [2]	3
Coke oven gas		g/GJ	0.5	1 [2]		3	0,1 [2]	
coke		g/GJ	-	10 [2]		-	4 [2]	
Natural gas	>50MW	g/GJ	0.3	1 [2]		3	0,1 [2]	
	<50MW			4 [3]	2.5			1,5
blast furnace-		g/GJ	0.5	1 [2]		3	0,1 [2]	
Fuel	>50MW	g/GJ	0.1	3 [2]		13.4	0,6 [2]	
	<50MW			2 [2]	3			14
Diesel oil	>50MW	g/GJ	-	1,5 [2]		-	0,6 [2]	
	<50MW			2 [2]	1			12
Biogas	< 50MW	g/GJ	-	4 [3]		-	0,1 [2]	
Waste gas	<50MW	g/GJ	-	2,5 [3]		-	0,1 [2]	
Industrial waste	<50MW	g/GJ	-	10 [3]		-	2 [3]	
Black liquor	< and >	g/GJ	-	15 [3]		-	0,6 [2]	
Wood	< and >	g/GJ	-	30 [2]		-	4 [2]	

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

(1) Source : CITEPA
(2) Source: IPCC
(3) EMEP/CORINAIR
(4) Specific study IBGE-BIM [12]-Corinair

For iron and steel plants in Wallonia following CH_4 and N_2O emission factors 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 per fuel in the Iron and Steel Plants in Wallonia.

(1) IPCC
(2) 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 Flanders the emissions from the iron and steel sector are partly put in category 1.A.2.a (energetic part) and partly in category 2.C.1 (process part).

In Flanders the emissions of CH_4 of this sector are calculated in a different way and are put in the categories 1.B.1.b (production of cokes) and 2.C.1 (production of sinter) (see these respective sections for more explanation of the methodology used).

In Wallonia, the sector of glass making is subdivided into three sub sectors : container glass, flat glass and glass wool/glass fibber. The adopted methodology divides the energy issue into two contributions

- the energy consumption linked to the fusion of glass
- the energy consumption for other operations

The emission factors for the fusion of glass are those proposed in the EMEP/CORINAIR guidebook.

Fuel	**UNIT**	**CH_4**	**N_2O**		
			Container glass	Flat glass	Glass wool/fibre
Fuel	g/GJ	3	6	14	Not used
Diesel oil	g/GJ	1,5	2	12	Not used
natural gas	g/GJ	2,5	1	3	2

Table 3.7. : Emissions factors per fuel for the fusion of glass in Wallonia (EMEP/CORINAIR).

The corresponding emission factors for the other combustions are those proposed in the EMEP/CORINAIR guidebook for CH_4 and the IPCC factors for N_2O.

Fuel	**UNIT**	**CH_4**	**N_2O**
Diesel oil	g/GJ	1,5	0,6
natural gas	g/GJ	2,5	0.10

Table 3.8. : Emissions factors per fuel in the other combustion processes in glass production (EMEP/CORINAIR and IPCC).

Sothe implied emission factor is coming from two sources : the fusion of glass and the energy used in the other operations.

In the lime and cement plants, the emissions of CH_4 and N_2O are plant-specific and determined by measurement. Implied emission factors for CH_4 and N_2O are then derived from the energy consumption data and the reported emissions.

3.2.3. Transport (category 1.A.3 and 1.A.5.b)

Road transport

The energy consumption and CO_2 emissions for road transport are based upon federal (Belgian) energy statistics. The activity data (combustion figures) and emissions of CO_2 represent the amount of fuels sold in Belgium for road transport. These activity data are multiplied with default IPCC emission factors to calculate the CO_2 emissions. Emissions of CH_4 and N_2O are calculated by compiling the emissions of each region based on the use of the model COPERT III.

Air transport

In the two regions where air transport is relevant, a slightly different approach was taken in estimate the emissions from air transport.

In Flanders, concerning air transport, only domestic air traffic is considered for calculating the CO_2 emissions. All kerosene used in 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 impossible to split these fuels otherwise and because, due to the small size of Belgium (and Flanders), most kerosene is used for international transport. A default IPCC emission factor for CO_2 is used to calculate the emissions. CH_4 and N_2O emissions 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 5 airports for military aviation (Kleine Brogel, Brasschaat, Koksijde, Sint-Truiden and Goetsenhove).

In Wallonia, the emissions from civil aviation (category 1.A.3.a) are estimated on the basis of the number of LTO in two airports (Liège and Charleroi), following a very simple methodology described in the EMEP/CORINAIR guidebook [3]. Some information on the country's total number of LTO is available. Unfortunately, there is no general knowledge about the aircraft types carrying out the aviation activities. 56 % of the LTO are supposed to be domestic flights. A distinction is also made between emissions from domestic and international LTO and cruise activities. Emissions 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 airtransport is assigned to the bunker fuels. Data on LTO activities and fuel consumption in the airports of Charleroi and Liège come from the statistics of these airports.

Railways

For railways in Flanders, the fuel consumption is based on a proportional fraction of fuel used in Belgium for rail transportation. Default IPCC emissions factors are used for CO_2 (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 emissions factors of the EMEP/CORINAIR handbook [3]. Other emissions are calculated with the results of a model developed by the Vito [1] and based on the registered kilometres with distinction between different types of trains.

The emissions from railways are estimated in the Walloon region and in the Brussels region by multiplying the train's fuel consumption [21 and 11] by the fuel specific emission factors. For CO_2, the emission factors used are those in table 3.1. For CH_4 and N_2O, the specific emission factors are those described in table 8.1 of the EMEP/CORINAIR guidebook [3].

Navigation

For navigation, fuel consumption is taken from the regional energy balances (in Flanders statistics are used to calculate the total freight kilometres and to calculate the total amount of fuel used). Fuel consumption is multiplied with a CO_2 emission factor (see table 3.1).

Emissions of CH_4 and N_2O are calculated by using the activity data (fuel consumption) of the regional energy balances combined with emission factors of the EMEP/CORINAIR handbook [3].
Other emissions in Flanders are calculated with the results of a model developed by the Vito [1] and based on registered ton kilometres and calculated fuel consumption. In the two other regions, other emissions are calculated using emission factors of the EMEP/CORINAIR handbook [3].

3.2.4 Other sectors (category 1.A.4)

The fuel consumption of the service sector is based on general statistics of natural gas, supplemented with results from surveys for solid and liquid fuels. Agricultural fuel consumption is estimated from statistical information concerning area used, etc., combined with specific energy consumption from literature. The energy consumption of these sectors is then given in the regional energy balances. Emission factors for CO_2 are listed in table 3.1.
In Wallonia, the emissions of other non-road transport (forestry, industry…) are not included in this category because there is not (yet) a possibility to split the fuels into the different sectors involved. Agriculture is negligible in the Brussels region, so no greenhouse gases from this sector are taken into account

In table 3.9 below, the emission factors for CH_4 are listed.

			Flanders	**Wallonia**	**Brussels**
Fuel		**Unit**	**CH_4**		
Coal	Commercial	g/GJ	10 (1)	10 (2)	/
	residential	g/GJ		300 (2)	200(4)
	Agriculture heating	g/GJ	0,3 (1)	-	/
Natural gas	Heating	g/GJ	1 (1)	5 (2)	5 (4)
	Heating agriculture	g/GJ	0,3 (1)		/
Fuel/diesel oil	Heating	g/GJ	3 (1)	10 (2)	7 (4)
	Heating agriculture	g/GJ	0,1 (1)		/
	Farming vehicles.	g/GJ	4 (2)	4 (3)	/
Fuel	Fishing activities	g/GJ	5 (2)	-	/
Heavy fuel		g/GJ	3 (1)	-	3 (4)
Propane/butane/		g/GJ	0 (1)	-	5 (4)
Lamppetroleum		g/GJ	3 (1)	-	/
wood		g/GJ	150(1)	300 (2)	300 (4)

Table 3.9. : Emission factors of CH_4 for category 1.A.4 Other sectors (households and service sector).

(1) source: Citepa
(2) source: IPCC
(3) EMEP/CORINAIR
(4) Specific study on behalf of IBGE-BIM [12]-Corinair

In table 3.10 below, the emission factors for N_2O are listed.

			Flanders	Wallonia	Brussels
Fuel		**Unit**	**N_2O**		
Coal	Heating	g/GJ	12 (1)	1,4 (2)	12 (4)
	Agriculture heating	g/GJ	14 (1)	-	/
Natural gas	Heating	g/GJ	2 (1)	0,1 (2)	2 (4)
	Heating agriculture	g/GJ	3 (1)		/
Fuel/diesel oil	Heating	g/GJ	12 (1)	0,6 (2)	12 (4)
	Heating agriculture	g/GJ	14 (1)		/
	Farming vehicles.	g/GJ	30 (2)	30 (3)	/
Fuel	Fishing activities	g/GJ	0,6 (2)	-	/
Heavy fuel		g/GJ	12 (1)	-	14 (4)
Propane/butane/		g/GJ	3 (1)	-	2 (4)
Lamppetroleum		g/GJ	12 (1)	-	/
wood		g/GJ	4(1)	4 (2)	4 (4)

Table 3.10. : Emission factors of N_2O for category 1.A.4 : Other sectors (households and service sector).

(1) source: Citepa
(2) source: IPCC
(3) EMEP/CORINAIR
(4) Specific study on behalf of IBGE-BIM [12]-Corinair

3.2.5. Other (category 1.A.5.a and 1.A.5.b)

In this section the emissions originating from the military transport (domestic air transport) are included.

3.2.6. Fugitive emissions from fuels (category 1.B.1 and 1.B.2)

Petroleum refineries (category 1.B.2.a)

Since this emission factor of CITEPA [2] for calculating the emissions of CH_4 from refineries is divided into a part 'fugitive emissions' and a part 'emissions from combustion', the fugitive emissions are put here under category 1.B.2.a (fugitive emissions from fuels/Oil) and the rest is put under category 1.A.1.b (energy industries/petroleum refining).
To calculate the fugitive emissions of the petroleum refineries in Belgium (only located in the Flemish region in Belgium), an emission factor of 5 g CH_4 / ton crude oil is used (source CITEPA [2]).

Production of coke (category 1.B.1.b)

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 coke from the ovens. Emissions of CH_4 originating from the production of cokes are estimated 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). Activity data (tons of cokes) are delivered by the corresponding industry.
In 1994, the only coking plant based in the Brussels region has been closed.

Gas distribution (category 1.B.2.b)

The methodology to calculate the emissions of CH_4 originating from the gas distribution (category 1.B.2.b iv) is completely optimised since the previous submission for all the regions during this submission of greenhouse gas emissions in Belgium.

The emissions originating from gas distribution are determined on the basis of the length of gas distribution pipelines. The lengths of the main pipelines (exclusive additional pipelines which are pipelines going to households) per public utility board are available. The number of additional pipelines in Flanders is estimated at 1 500 000 for the year 2003 and this with an increase of 24 000 every year. In Wallonia, it's estimated at 588 458 for the year 2002. The length per additional pipeline measures 5 m. In Brussels, the number of additional pipelines is estimated at 183 325 for the year 2003 and the average length is 3m (urban environment).

Depending on the material of the pipeline other emission factors are used. In particular 869, 7865, 869 and 95 m^3/y/km for respectively steel, cast 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 by its emission factor. This results in de total natural gas emission in m^3 per year. Multiplying this figure by the methane content and the density of methane we obtain the methane emission originating from gas distribution.

Emissions of CH_4 and CO_2 (category 1.B.2.b.iii) originating from the storage and transport of natural gas in Belgium are newly calculated and added to the inventory. The emissions are recently estimated for the years 1990 and 2003 by Fluxys (independent natural gas transport company), the emissions for the others years are approximated by a linear regression. As soon as the emission estimates for the other years became available by this transport company, these emissions will be included in the greenhouse gas inventory. The activity data is the annual total natural gas amount, consumed in Belgium. As a consequence of the development of this new methodology to estimate the emissions from the storage and transport of natural gas and to avoid double counting of the emissions of CO2, these energetic CO_2 emissions, during the previous submission put under category 1.A.3.c 'Transport through pipelines', are removed in this submission.

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

Marine bunkering comes from the Belgian energy statistics. For international air transport, bunkers fuel consumption of the international air transport is given directly by the two Walloon airports. 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 of transport above). Default emission factors to calculate the CO_2 emissions for all products are used (see table 3.1).

3.2.8. 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.

3.2.9. Non-energy use of fuels and related emissions (categories 1.A.2, 2.B and 2.G)

The emissions of non-energy use of fuels and related emissions (emissions from recovered fuels from processes) are reported under categories 1.A.2, 2B and 2G. These were recalculated for the Flemish region. More details can be found in section 3.3.1.

3.3. Recalculations and planned improvements

3.3.1 Recalculations

- Emissions of CH_4 and CO_2 originating from the storage and transport of natural gas in Belgium are newly calculated and added to the inventory (category 1.B.2.b iii), it was a source of smaller importance but which was still missing in the greenhouse gas inventory in Belgium. The emissions are estimated only for the years 1990 and 2003, the emissions for the time series are estimated by a linear interpolation. As a consequence and to avoid double counting of emissions, the energetic emissions of CO_2, during the previous submission put in category 1.A.3.c (Other transportation – Transport through pipelines) are removed in this submission.
- A harmonization with the Flemish and the Walloon region has been carried out in Brussels to estimate the emissions of CH_4 originating from the gas distribution. A recalculation of the emissions of CH_4 in this sector is carried out in Flanders due to an optimization of the activity data (length of pipelines, adaption cast-iron pipelines and steely pipelines).
- The energy consumption in the quarries is taken into account in category 1.A.2.f.(Wallonia).
- There are new energy consumption’s in households coming from new statistics (houses number, heating system type,…) (Wallonia and Brussels).
- In Wallonia, the methane content of natural gas is re-estimated for the calculation of the emissions of CH_4 originating from the gas distribution (85 %).
- Some implied emission factor and allowance of fuels are corrected following the Synthesis & Assessment report (Wallonia and Brussels).
- Emissions of CH_4 and N_2O from the electric arc furnaces are allocated in the energy part, category 1.A.2.a instead of the process part, category 2C (Wallonia).
- Emissions of CO_2 from the electric arc furnaces are recalculated and allocated in the category 1.A.2.a (Wallonia).
- Error in the activity data in 2001 for the category 1.A.2.f is corrected in this submission (Wallonia).
- Errors in the activity data between 1998 and 2001 for the category 1.A.2.a are corrected in this submission, as there was a double counting (Wallonia).
- Cement plant plants have now delivered sufficiently detailed data on the use of biomass fuels in cement kilns from 1995 to present. This allowed a calculation of the use of biomass fuels in category 1.A.2.f since 1995. As a consequence, there is a shift from "other fuels" to "biomass fuels" compared to the previous submission. There is an increasing use of biomass fuels in cement kilns, particularly since 2001 (Wallonia).
- For Flanders, in the electricity sector, the CO_2 emissions reported directly for the large power plants in the public electricity sector are used, instead of a calculation based on activity data multiplied with default CO_2 emissions factors. Especially for the power plants using coal or related gases (blast furnace gas, coke oven gas), the default CO_2 emission factors used previously differ significantly from the measured values reported by the sector. The recalculation was made for all years. The difference between the recalculated results and the previous submission is larger in the early years. In the early years, more coal, blast furnace gas and cokeovengas and also refinery gas was used to produce electricity. In the more recent years, more natural gas is used and some of the coal fired plants were closed down. It is the emission factors for coal and related gases where there is a large difference between the default IPCC values and those measured by the

industry itself. For example: blast furnace gas default CO_2 emission factor used in the previous submission for Flanders was 240,8 kton CO_2/PJ, the data from the industry indicate emission factors between 258 -260 kton CO_2/PJ. For coal, the default emissions factor used in the previous submission was 92,7 kton CO_2/PJ, data from industry indicate values around 95 kton CO_2/PJ.

In the next figure, a comparison was made between the CO_2 emissions of the sector 1.A.1 in Flanders from the previous submission and the recalculted values for this submission (all fuels included).

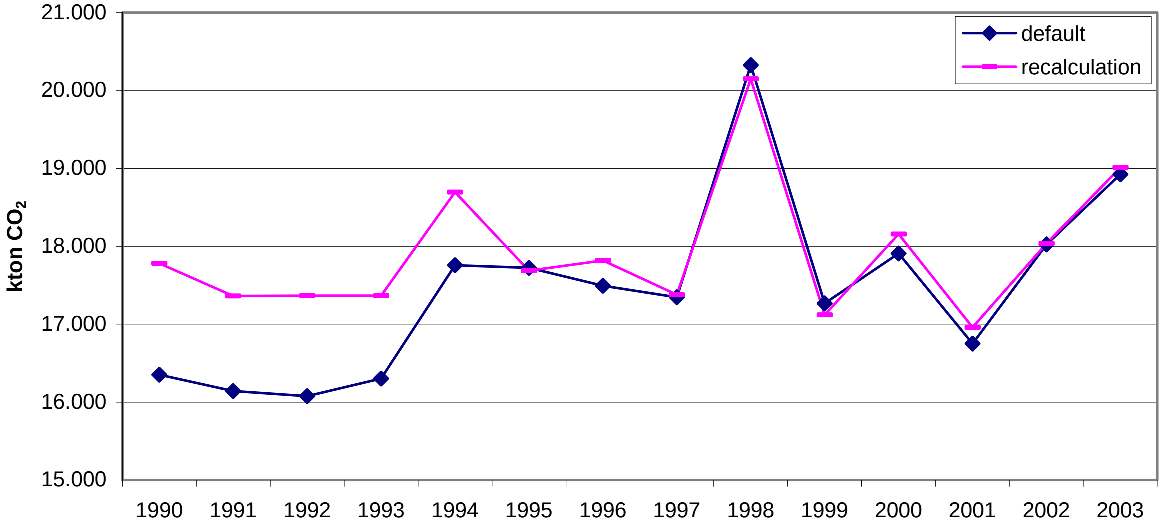


Figure 3.1. : Comparison of the recalculated CO_2 emissions and the values in the previous submission (default) for the public electricity and heat production in Flanders.

In 1990, the difference was more then 1 Mton CO_2, in 2003 the difference was 380 kton CO_2.

- Since the emission factor of blast furnace gas in the electricity sector was adjusted to measured values in the electricity sector, the same values were used in the iron and steel sector (1.A.2.a). (Flanders). The adjustement on the CO_2 emission from solid fuels in iron steel is presented in the following figure. The difference was 178 kton in 1990 and 147 kton in 2003.

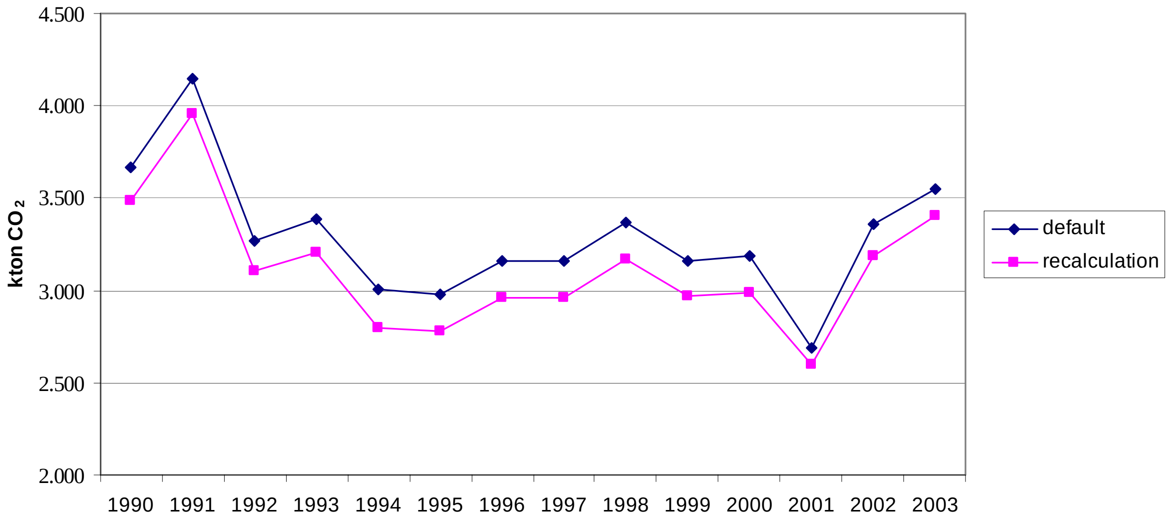


Figure 3.2. : Comparison of the recalculated CO_2 emissions and the values in the previous submission (default) for the solid fuel use in the iron and steel sector in Flanders.

- Also in the electricity sector in Flanders emissions of CH_4 and N_2O are optimized due to changements in activity data from 1995 on.

- In Flanders, recalculation of the non-energy use and related CO_2 emissions was performed, based on the results of a study conducted in 2003 [43]. The recalculation was made for all years. The largest part of the resulting emissions is reported under 1.A.2 c. This includes other fuels in the chemical sector, a result of recovered fuels in the cracking units in petrochemical industry (approx. 2/3) and other recovered fuels from the chemical industry (approx. 1/3). The steamcrackers in Antwerp are the main sources of non-energetic use of naphta and LPG. An other part of the emissions surveyed in the study, are considered to be process emissions and are reported under 2.B. A small part of non-energy use is still calculated using the default IPCC emission factors (mostly use of lubricants and solvents) and is reported under 2.G. In the table below, data from the previous submission and the recalculation in this submission are shown.

[kton CO_2]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
previous submission	**2.846**	**2.107**	**2.557**	**2.437**	**4.779**	**5.280**	**5.385**	**6.298**	**6.488**	**6.535**	**6.709**	**7.110**	**7.110**
1.A.2 c 'other'	*2.110*				*3.072*	*3.355*	*3.602*	*4.077*	*4.771*	*4.645*	*4.827*	*5.016*	*5.016*
2B1 (ammonia production)	*82*	*156*	*725*	*738*	*869*	*906*	*830*	*852*	*814*	*1.019*	*1.046*	*1.083*	*1.083*
2G	*654*	*1.951*	*1.832*	*1.698*	*838*	*1.019*	*952*	*1.369*	*903*	*871*	*836*	*1.011*	*1.011*
recalculation	**2.296**	**2.009**	**2.009**	**2.009**	**3.754**	**4.105**	**4.468**	**5.102**	**5.342**	**5.659**	**5.965**	**5.511**	**5.249**
1.A.2 c 'other'	1.834	1.834	1.834	1.834	2.618	2.893	3.242	3.835	4.123	4.209	4.524	4.196	3.598
2B1 (ammonia production)	0	0	0	0	732	763	699	717	686	858	881	775	853
2B5	175	175	175	175	123	157	239	271	260	268	293	368	675
2G	287	0	0	0	282	292	288	279	273	324	267	171	123

Table 3.11. : Recalculation in Flanders for the non-energy-use of fuels and the allocation of related emissions.

In the previous submission, the non-energy use was calculated using the default % of carbon stored from IPCC, except for the use of naphta in the steam crackers, where specific information was already available and for the use of natural gas for the production of ammonia where the CO_2 emissions calculated was based on the amount of natural gas used as raw material. (see 2.B.1).

The default % of carbon stored in the IPCC Guidelines were considered to be inaccurate in the Flemish situation. Therefore, a study was conducted in 2003, where the major sources of CO_2 emissions form processes and non-energy-use in the chemical industry were inventarised in more detail with the help of the industry itself. A distinction was made between :

* 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 (reported under 1.A.2 c ‘other fuels’). This is the largest source of CO_2 emissions. The industry was asked to report CO_2 emissions directly for these recovered fuels.
* CO_2 emissions occuring 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 2.B.1 and 2B.5 other). The industry was asked to report CO_2 emissions directly for these processes.
* use of products as solvent or lubricants (reported under 2G as ‘non-energy use’). Here an estimate was made. This source is the least important one.

The global difference between the previous submission and the present is shown in the figure below.

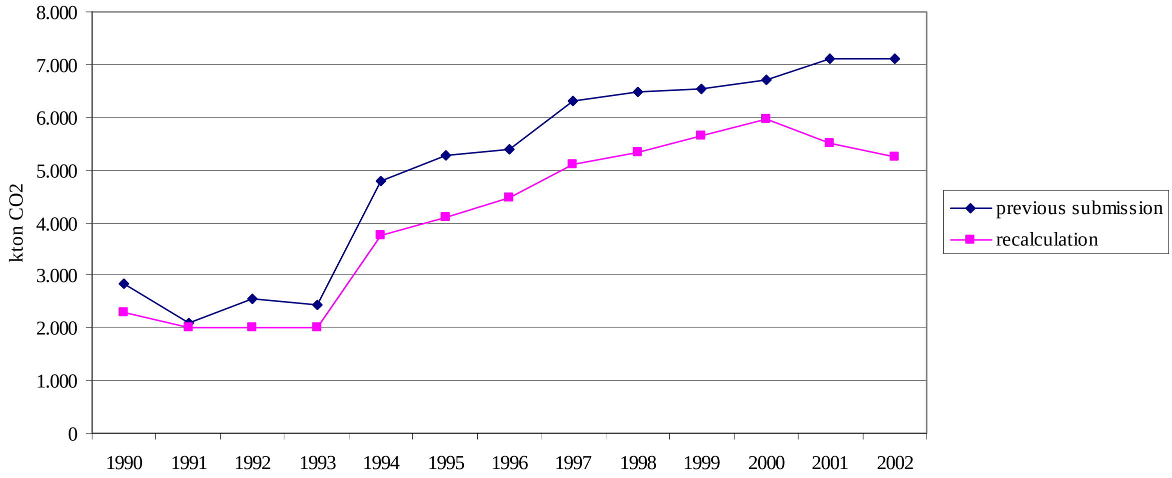


Figure 3.3 : Difference between the CO_2 emissions related to the non-energy use of fuels in chemistry in Flanders in the previous submission and in the present, recalculated submission.

The difference in 1990 was about 0,55 Mton CO_2, in 2002 the difference was already 1,86 Mton CO_2. This is mostly because the (petro)chemical industry has increased during this time period, for example, there were only 2 steam cracking units in 1990, since 1994 there are 4. Ammonia production started only in 1994. Adjustments in methodology have therefore a larger effect in the most recent years.

- A better division between renewable (biomass) and non-biomass fuels for all sectors and recalculated for all years. This also includes an adjustement of the partition of waste into a biogenic fraction and non-biogenic fraction. Most part of waste incineration in Flanders occurs with energy recuperation and is therefore allocated under 1.A.1. As a consequence the emissions put under the category ‘Memo items and CO2 emissions from biomass’ in the previous submission are removed and put in this submission in category 6.C. a (Flanders).
- Some smaller changements in the energy balance data has been carried out in Flanders in the industry sector which lead to recalculations of the emissions .
- The municipal waste incineration in Brussels occurs also with energy recuperation and is as a consequence now allocated under 1.A.1. and not anymore under 6.C.

- Adjustment and optimization in the calculation of activity data on internal navigation and the related emissions for all years. The new activity data are based on a survey in the sector (Flanders).
- A study has improved the estimation of the non-CO_2 emissions from road transport in the Brussels region; the emissions are completely recalculated based on new figures of the driven km by car type.

3.3.2 Planned improvements

- Following the implementation of the Emission Trading Directive, some industries have to calculate the C content of the fuel, especially for solid fuels, waste fuels,…This could eventually lead to some modifications in CO_2 emission factors in the inventory (Wallonia and Flanders).

3.4 Reference Approach

CO_2 emissions from fuel combustion were also 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 guidelines were adopted for carbon emission factors, fraction of carbon oxidised, and fraction of carbon stored (feedstock's). The details of this estimation are provided in the CRF tables 1.A(b), 1.A(c), 1.A(d)) for all years.

The comparison with the sectoral approach (Table 1.A(c)) shows a differences between -0,96% (in 2002) and +6,99% (in 2000). The difference between the reference apporach and the national inventory for all years is visualised in the next figure.

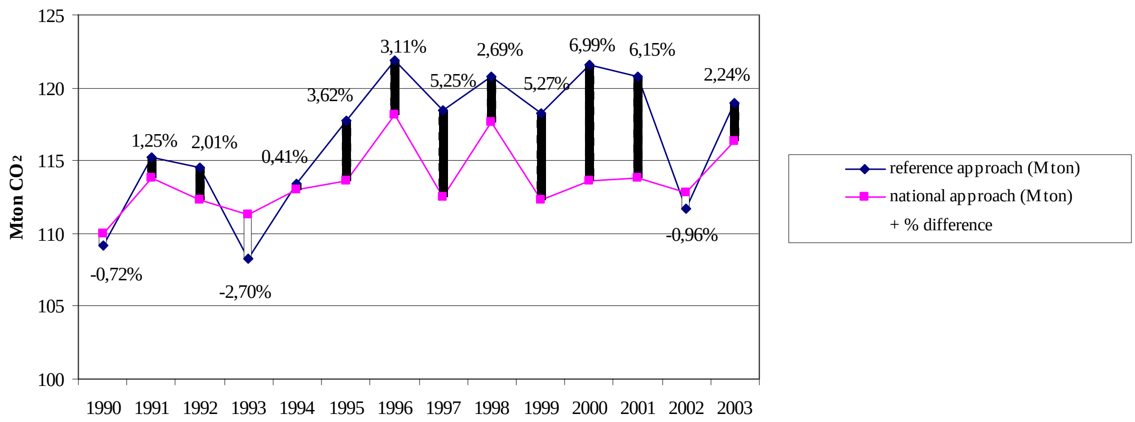


Figure 3.4. : Difference between the Reference approach and the national inventory.

There can be several reasons why there is a difference between the results of the reference approach and the national inventory and also why the difference seams to be getting larger.

Reason number 1: The results for the reference approach and the national inventory are based on different data sets which show different results

The IPCC Reference Approach is ‘top-down’, based on statistics of production, imports, exports and stock changes of fuels from federal statistics. The Federal Energy balance is based on transparent and statistical rules and elaborated according to the rules of International institutions (common questionnaire IEA, Eurostat, United Nations). For the petroleum sector, data are directly asked from all petroleum operators working on Belgium territory via a common questionnaire (Federal Energy Administration and NIS=National Institute of Statistics). In addition, the questionnaire sent to all petroleum operators was validated by NIS. However, presently the federal government is working on improving their petroleum statistics, which includes an extension of the number of actors that are obligated to fill out the questionnaires.

The national inventory is based on a ‘bottom-up’ approach that uses fuel consumption data from regional energy balances based on information from plants or studies with extrapolation, models and surveys. The work is done in close cooperation with profesional federations and individual companies.

A significant proportion of the discrepancy between the IPCC Reference Approach and the ‘bottom up’ approach arises therefore from these differences in methodology between federal and regional energy balances and in the difference in collecting data particularly with solid and liquid fuels.

This problem of inconsistency between regional and national energy balances is well known for several years, and continuous efforts are made in order to harmonise the methodologies used by the different institutions. During 2002, a study was conducted to examine the differences between the national top-down energy balance, and the sum of the regional bottom-up balance. The year under investigation was 1999 [38].
The main objectives of the study were :

- To compare the sum of the three regional balances with the federal balance
- To highlight the most significant differences between the two methodologies
- To propose some leads for improvement

The main results and conclusions of the study show :

- The two approaches are different. The federal balance is a supply balance, the regional balance is a consumption balance
- Some problems remain in the housing and the transport sectors (work is currently going on to solve them, by adding some information to the questionnaires, allowing a further disagregation of the federal balance)
- The main problem stems from oil and the different petroleum products; in particular, the biggest problem is due to the non-energy use of oil (naphta for the petrochemistry, only in Flanders).

  In the figure below, the evolution of the consumption of naphta in the petrochemical industry is shown, based on the federal petroleum balance and based on data received from industry itself in the Flemish energy balance.

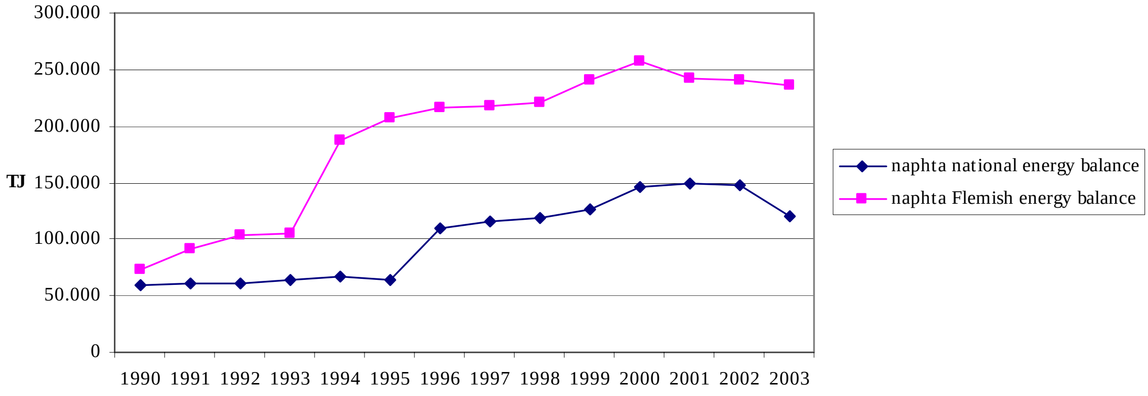


Figure 3.5. : Evolution of the consumption of naphta in the petrochemical industry in Belgium based on the federal energy balance and of the consumption in Flanders, based on data used in the Flemish energy balance from the industry itself.

In 1990, there were only 2 steam cracking units which used naphta as input. In 1992, a third unit was put into operation, followed by a 4th in 1994. In the Flemish energy balance, data for these units are made available by the industry itself. It seems that from a certain point in time, not all naphta is included in the statistics made up by the federal government. In 1990, the difference in the datasets was 14 PJ, in 2003 the difference is almost 116 PJ.

In the following figure, the total results are shown as the difference between federal energy balance and the sum of the regional balances.

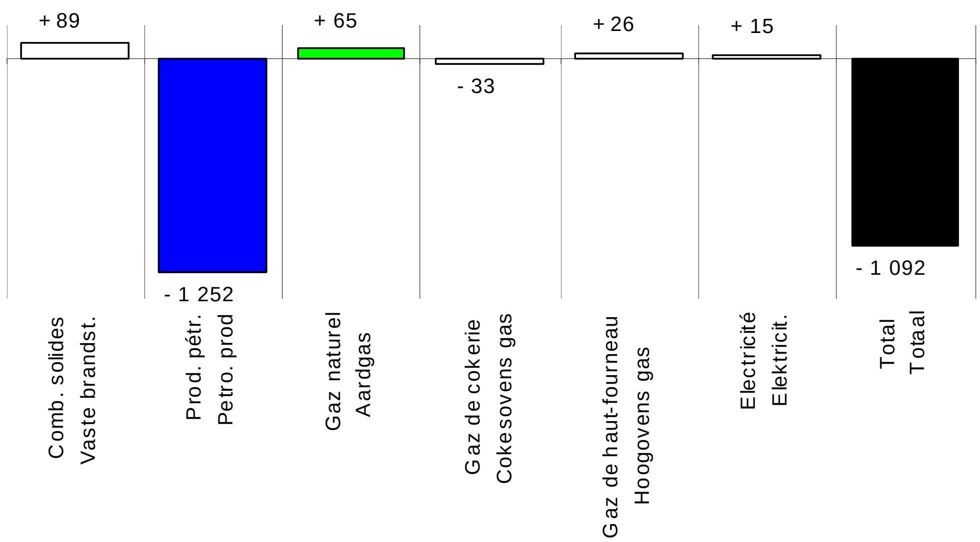


Figure 3.6. : Differences per energy sources in the global balances (values 1999 in ktoe NCV) [38].

In percentage, the total federal energy balance shows an energy use of 3% less than the sum of the regional energy balances.

In 2003, a working group under the National Climate Commission was installed, to further the work of harmonizing the different energy balances as far as possible. The work is still ongoing.

Reason number 2: Methodology of reference approach – effect of liquid fuels

The IPCC Reference Approach uses data on primary fuels such as crude oil and natural gas liquids, which are then corrected for imports, exports and stock changes of secondary fuels. Thus the estimates obtained will be highly dependent on the conversion factors and the default carbon contents used for the primary fuels. The 'bottom-up' approach is based wholly on the consumption of secondary fuels where the carbon contents are known with greater certainty. In particular the carbon contents of the primary liquid fuels are likely to vary more than those of secondary fuels.

In Belgium, the apparent consumption is made up of about 50% of liquid fuels. A preliminary analysis was made on the reference apporach of 2001, where the uncertainty on the apparant consumption of liquid fuels in tonnes, on the conversion factors from tonnes to TJ and on the emission factors was chosen to be 1% (95% uncertainty interval, normal distribution). The effect on cell O29 of table 1.A(b) = 'carbon content of liquid fossil fuels total' was studied.

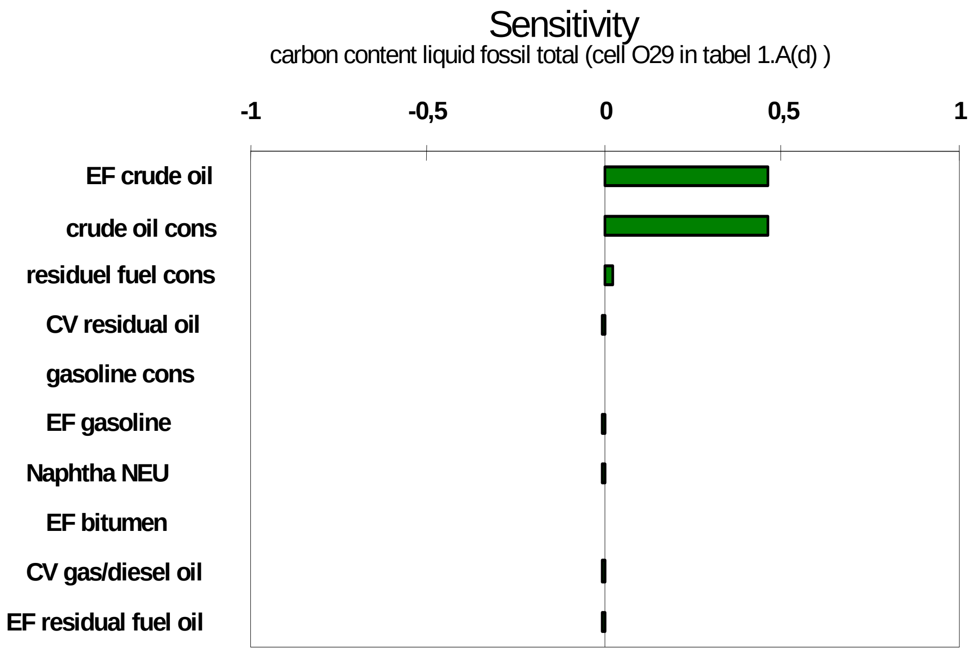


Figure 3.7. : Sensitivity chart for the 'total carbon content of liquid fuels total' in 2001, based on certain assumptions on tonnes of liquids consumed, conversions factors to TJ and carbon content.

Only 2 factors are important in the calculation of the carbon content of the liquid fossil fuels consumed: the total tonnes of apparant consumption of crude oil and its carbon content. An uncertainty of 1% in both, can cause the value (95% interval) of the total carbon content of the fossil fuel to ly between 18,3 or 20,9 Mton C (calculated value is 19,5 Mton C). This means that the uncertainty introduced in the data on crude oil, can have an effect on the overall CO_2 emissions of approximately 4 Mton CO_2 more or less. In the figure below, the resulting uncertainty range is visualised.

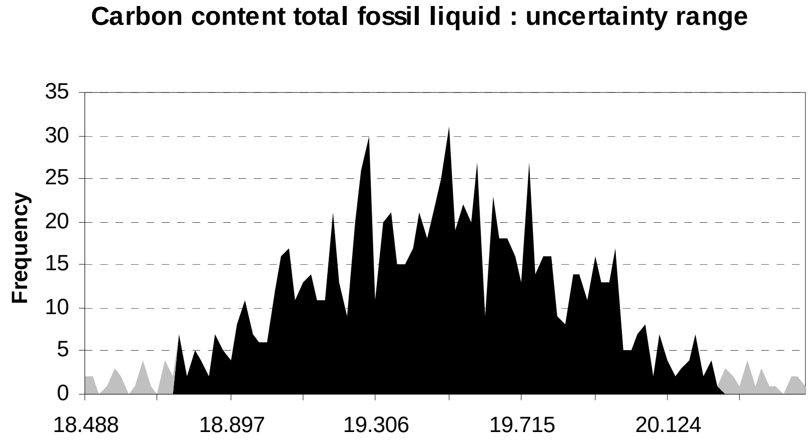


Figure 3.8. : Uncertainty range of “carbon content total fossil liquid” in 2001, based on certain assumptions on tonnes of liquids consumed, conversions factors to TJ and carbon content (Monte Carlo Analysis, using Crystal ball software).

This very rude and preliminary analysis simply indicates that for countries where the calculation of the apparent consumption is mainly based on 1 product like it is in Belgium for crude oil, small uncertainty on these data (tonnes consumed, conversion factors and carbon content) has a enormous total effect on the calculation of the reference approach for liquid fuels.

Reason number 3 : Methodology of reference approach – effect of solid fuels

In the reference approach, all the apparent consumption of solid fuels is multiplied by its carbon content to become CO_2 estimates for the energy use of solid fuels. However, in the bottom-up approach using the regional energy balances, not all CO_2 from the solid fuels used in iron and steel is reported under the energy section. A considerable part is considered to be ‘process emission’ (where coke is used as a reducing agent) from iron steel and is reported under the section of industrial processes. Therefore the CO_2 emissions based on the apparant consumption of solid fuels in the reference approach and the reported CO_2 emissions in the energy sector in the national inventory are not entirely comparable. Approximately, about 1Mton CO_2 (depending on the year) in the reference approach is considered to be ‘process emission’ in the national inventory.

Reason number 4: Stored carbon from non-energy use of fuels

Estimates of the non-energy use of fuels differ between the bottom-up and top down approach, especially the naphta input of the bottom-up approach (used in the national inventory) is much larger than this of the Reference Approach. Also, to calculate CO_2 emissions, the IPCC Reference Approach uses default IPCC storage factors that are not applicable to the Belgian (Flemish) situation.

In the figure below, the effect is shown if data from the bottom-up Flemish energy balance would be used in the reference approach in table 1.A (d), instead of the data from the federal petroleum balances (see also figure 3.16). According to the default fraction stored from naphta in products (80%), the difference in stored C in 1990 would be 0,23 Mton C and in 2002 1,5 Mton between the federal data or the regional data (i.e. equivalent CO_2 emissions respectively 0,8 Mton and 5,5 Mton CO_2).

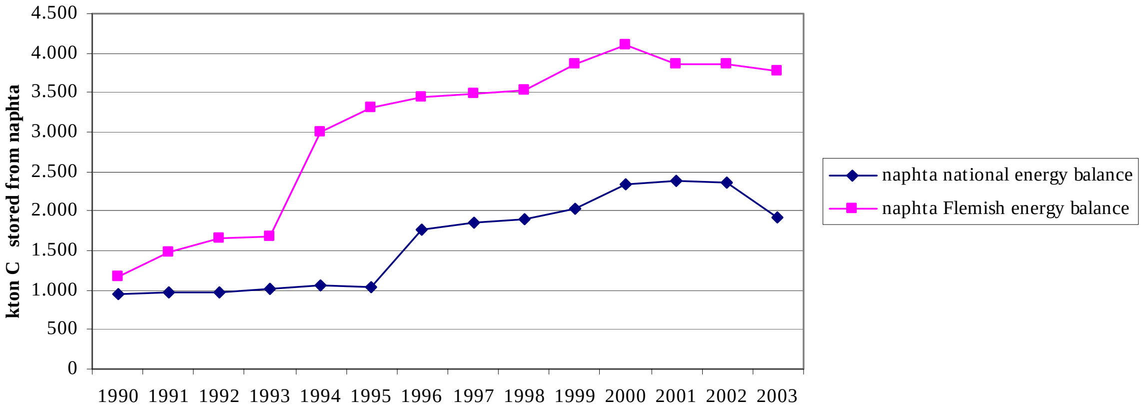


Figure 3.9. : Kton C stored based on default IPCC % of stored naphta, calculated based on federal statistics and on Flemish bottom-up data.

Conclusion

The reasons mentioned in this section, are the most pertinent reasons that come to mind trying to explain the differences in results from the reference approach and the national inventory for Belgium. There may still be other reasons than those stated above.

It is very difficult to put a accurate quantitative measure on the correction needed on the reference appoach, but an attempt is made in the following table. A first correction (substraction) is made for the difference in carbon stored when data for the non-energy use of naphta from the regional Flemish energy balance would be used instead of those of the federal petroleum statistics (see reason 4). A second correction is made by substracting an estimate of C reported under 'process emissions'in the national inventory instead of the energy sector for the iron and steel industry (see reason 3).

	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003
reference approach (Mton CO_2)	109,1	117,7	121,9	118,4	120,8	118,3	121,6	120,8	111,7	119,0
national approach (Mton CO_2)	109,9	113,6	118,2	112,5	117,6	112,3	113,6	113,8	112,8	116,4
difference in %	*-0,72%*	*3,62%*	*3,11%*	*5,25%*	*2,69%*	*5,27%*	*6,99%*	*6,15%*	*-0,96%*	*2,24%*
naphta stored correction (Mton CO_2)	0,8	8,4	6,2	6,0	6,0	6,7	6,4	5,4	5,5	6,8
CO_2 from iron and steel correction (Mton CO_2)	1	1	1	1	1	1	1	1	1	1
reference approach corrected for naphta stored (Mton CO_2)	108,3	109,3	115,7	112,4	114,8	111,6	115,1	115,3	106,2	112,2
difference in %	*-1,49%*	*-3,74%*	*-2,13%*	*-0,05%*	*-2,41%*	*-0,68%*	*1,31%*	*1,38%*	*-5,84%*	*-3,59%*
reference approach corrected for naphta and solid fuels (process emissions from iron and steel industry, where solid fuels are partly used as an reducing agent) (Mton CO_2)	107,3	108,3	114,7	111,4	113,8	110,6	114,1	114,3	105,2	111,2
difference in %	*-2,40%*	*-4,62%*	*-2,98%*	*-0,93%*	*-3,26%*	*-1,57%*	*0,43%*	*0,50%*	*-6,72%*	*-4,45%*

Table 3.10. : Corrections and their effect on the result of the reference approach and the difference between reference approach and national inventory for the years 1990; 1995-2003.

In the following figure, the data from the tabel are visualised for all years.

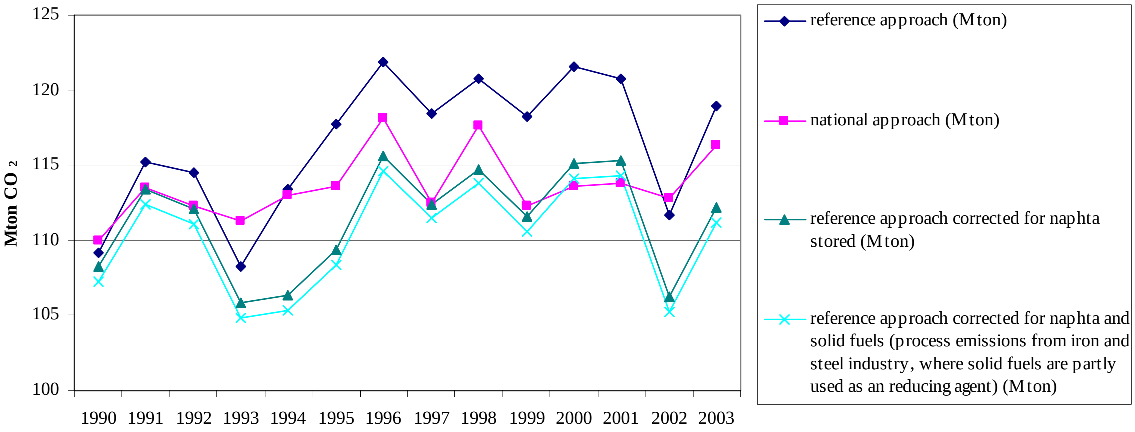


Figure 3.11. : Possible corrections and their effect on the result of the reference approach in comparison with the national inventory.

For some years, the reference approach after correction and the national inventory are more comparable (for example 1999, 2000 and 2001). For other years, the corrections make the difference larger (for example, in 2002, where the reference approach is low due to a significant decrease in solid fuels in comparison to prior years. This decrease is not present in the bottom-up approach. A clear explanation is not yet found)

As demonstrated in reason 2, an uncertainty of 1% on data for crude oil in the calculation of the total carbon content of liquid fossil fuels, can give rise to an uncertainty of approximately 4 Mton CO_2 more or less on the total emissions from liquid fuels. This 4 Mton represent approximately 3,5 to 4% of the total corrected data for the reference approach, which seems to be a reasonable figure.

In the following figure, this uncertainty range is visualised in relation to the data from the national inventory.

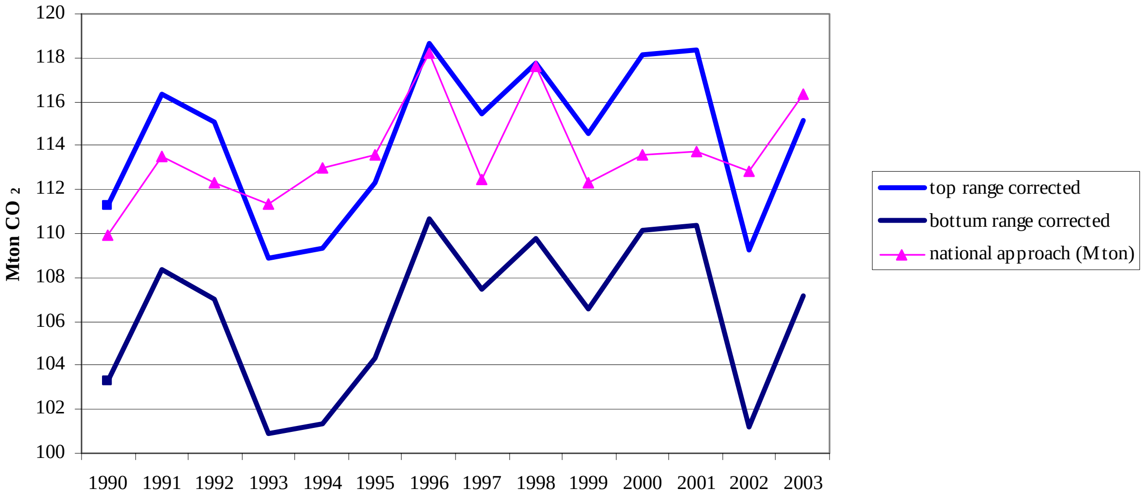


Figure 3.11. : The uncertainty margins (+ or - 4Mton CO_2) on the corrected data for the reference apporach in relation to the results for the national inventory.

The results of the national inventory lie between the top range and bottom range of the corrected data of the reference approach or even above this top range (for the years 1993,1994,1995, 2002 and 2003).

The general conclusion is that there are several reasons why the reference approach may differ from from the estimate in the national inventory for Belgium. A brief explanation was given for some reasons. Where possible, a rough estimate was made on the quantity of CO_2 involved. When these corrections are made on the results of the reference approach and an uncertainty range was included, the national bottom-up inventory estimates approach these of the (top-range of) reference approach.

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.

4.1.2. Allocation of emissions

The industrial processes in Belgium are covered by
(1) categories 2.B.1 (ammonia production), 2.B.2 (nitric acid production), 2.C.1 (metal production i.e. iron and steel industry), these activities take place both in the Flemish and the Walloon regions;
(2) categories 2.A.1 (cement production) and 2.A.2 (lime production), activities which take place only in the Walloon region;
(3) category 2.G (other industrial processes) i.e. A small amount of emission from the non-energy use of energy carriers used as solvents or lubricants in different (industrial) sectors (only Flanders).
(4) category 2.B.5 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.
(5) categories 2.E (production of halocarbons and SF6) and 2.F (consumption of halocarbons and SF6).

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 directly originating from the industrial plant, combined with emission factors presented in reference works like CITEPA [2], EMEP/CORINAIR handbook [3], IPCC Guidelines or other specific bibliographies or calculated via measurements carried out by the industrial companies.

4.2.1. Mineral products (category 2.A)

The mineral industry is after the chemical sector the second most important sector of industrial process emissions in Belgium and contributes to more than 30% (2001) of greenhouse gas emissions in this sector.

In Belgium, cement production (category 2.A.1) only takes place in Wallonia. The activity data is the clinker production. These emissions are estimated by using a plant-specific emission factor. The emission factor is determined on the basis of the CaCO3 content of raw material (analysis), the CaO produced and the stoechiometric ratio of the equation : $CaCO_3 \rightarrow CaO + CO_2$. The emission factor can be further adjusted taking into account the process efficiency ($CaCO_3$ may be not fully converted

into CaO or the CaO produced sometimes contains impurities). Emission factors used in Wallonia are estimated between 522 and 529 kg CO_2/T clinker.
Production of lime also occurs only in the Walloon region of Belgium. These emissions of lime production (category 2.A.2) are estimated by using a plant-specific emission factor (754-790 kg CO_2/T lime, 910 kg CO_2/T dolomite). The changing ratio of lime and dolomite production causes fluctuations in the implied emission factor. This is presented in table 4.1.

One recalculation was also performed concerning 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 anymore (CO_2 biomass in table 4.1).

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Lime (kt)	2165	2148	2056	1962	2057	2080	1897	1993	2050	2075	2085	1770	1742
Dolomite (kt)	570	452	408	393	401	374	360	347	385	419	555	823	939
IEF (kg CO_2/t)	788	783	752	776	782	783	778	777	778	779	783	798	800
CO_2 emissions (kt)	2156	2035	1853	1828	1921	1921	1756	1819	1895	1944	2066	2070	2144
CO_2 biomass emissions (kt)	40,9	42,8	42,8	16,6	38,4	30,8	41,9	41,9	45,6	45,6	57,2	48	56,1

Table 4.1. : Lime and dolomite production in Wallonia.

The production of glass in Belgium takes place in both regions. The CO_2 emission factors used in the Walloon region in the glass production (category 2.A.7) 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).
In the Flemish region these process emissions of CO_2 from the glass production are newly added in this 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 used. Because of the comparability of the melting process in the production of glass and enamel, both industries are related in Flanders and consequently put under the same category 2.A.7. For the one company involved in Flanders in this enamel production, an emission factor of 650 kg CO_2/ton is used. This emission factor is given by the company involved.

Also newly put in this submission are the process emissions of CO_2 originating from the ceramic sector in Flanders for the complete time series. In consultation with the federations involved, an estimate is given of these emissions of CO_2.

4.2.2. Chemical industry (category 2.B)

The chemical industry is the most important sector in industrial processes in Belgium and contributes to about 40% (2001) of greenhouse gas emissions in this sector. The different sectors involved are described below according to their importance in contribution to total greenhouse gas emissions

4.2.1.1. Nitric acid production (category 2.B.2)

The N_2O emissions from the production of nitric acid (category 2.B.2) are estimated in Flanders by using an emission factor of 8 kg N_2O/ton HNO_3 from CITEPA [2]. The three plants involved in

Flanders since 1990 agreed with this factor of 8 kg N_2O/ton HNO_3 and give their nitric acid production figures each year. Since 2000 only one plant is still involved in this sector.
The producer of nitric acid in the Walloon region provides the N_2O emissions based on their production and on monitoring in 2002 (provisional figure for 2003). The global emission factor used in this region is 5.189 kg/t.

4.2.1.2. Ammonia production (category 2.B.1)

There is ammonia production in 2 companies in Belgium.
The CO_2 emissions are calculated based on the natural gas used as feedstock as recommended by the IPCC Good Practice Guidance [10]. 100% per cent of the carbon content of the natural gas is presumed to be emitted ; the default IPCC emission factor for CO_2 for natural gas (55.8 kton CO_2/PJ) is used to calculate the total CO_2 emissions.
A part of the process CO_2 emissions in the Walloon region is used by two other plants and released after use.

4.2.1.3. Other (category 2.B.5)

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

(1) the non-energy of fuels i.e. the use of n-butane for the production of maleic anhydride in the Walloon region ;

(2) the emissions of N_2O originating 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 estimates the emissions of the previous years from 1990 on as accurate as possible ;

(3) other process CO_2 emissions reported by the chemical industry 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 surveys in the chemical sector in Flanders.

4.2.3. Metal production (category 2.C)

Metal production, more specific the iron and steel production (category 2.C.1.) is the third most important sector of industrial process emissions in Belgium and contributes to more than 10% (2001) of greenhouse gas emissions in this sector. The Flemish and the Walloon regions are 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 in Flanders and with an emission factor approved by these plants.

CH_4 emissions from the production of sinter are estimated by using an emission factor of CITEPA [2], which is in line with the emission factor of the EMEP/CORINAIR handbook [3] and showed in table 4.2.

Category	**gas**	**Emission factor**
2.C.1 Metal production – Iron and steel production	CH_4	Production of cokes : 400 g CH_4 / ton cokes Sinterplants : 300 g CH_4 / ton sinter

Table 4.2. : Emission factors used for Industrial processes in the Flemish region (Source : plant specific / CITEPA).

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 form pig iron and/or scrap steel using electric arc or basic oxygen.

This sub-sector includes a part of the CO_2 emissions in the sinter plant. These emissions are calculated by using an IPPC emission factor of 200 kg CO_2/T sinter. The emissions calculated involve combustion and process emissions. Combustion emissions are reported in the energy sector (consumption x emission factor (table 3.1) and the remaining is in the process sector. These process emissions are coming from additive in the furnace as lime.

CH_4 and N_2O emissions are included in the energy sector (emission factors in table 3.6).

The emissions estimate in this sub-sector include also emissions from the production of steel in basic oxygen type furnaces but no emissions originating from the combustion of the fuel.

The emissions factors have been studied with the steel-manufacturing sector and are found in table 4.3.

Type of plant	**Emission factor**
Basic oxygen furnace steel plant	140 kg CO_2/t steel

Table 4.3. : Emission factors used in the iron and steel sector in the Walloon region (Source : plant specific /ULG).

The process CO_2 emissions from electric arc furnaces is based on the consumption of electrodes with an emission factor of 5kg CO_2/ t steel.

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

Listed here are the CO_2 emissions calculated using the IPCC default factors of carbon stored during the use of lubricants and solvents in Flanders, mostly in industry. These emissions are relatively small.

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

Emissions of ozone-depleting substances, which also act as greenhouse gases, are estimated on the basis of the use of the different substances for each application, the export, and the rate of elimination, recuperation or recycling in Belgium.
These emissions are covered by the categories 2.E (production of halocarbons and SF6) and 2.F (consumption of halocarbons and SF6).
A country-specific methodology was developed by 2 consultancies (Econotec and Ecolas) in 1999 based on the IPCC Guidelines [34][35][10][28] and since then updated each year and further optimised by Econotec.
The present contribution of the F-gases to the total greenhouse gas emissions in Belgium is rather low (about 1% in 2002- see CRF 2002 10s5).
Even so, HFC emissions have been gradually increasing (+518% between 1995 and 2003), reflecting the current regulations relating to CFCs substitution. HFCs are mainly used in the refrigeration sector and for the production of synthetic foams.

Potential emissions have been estimated on the basis of the production, consumption and destruction figures directly and not with the official statistics on external trade which are not available for the relevant substances. The actual emissions of HFCs originates from the following categories : refrigeration (industrial & commercial and household refrigerators) and air conditioning equipment (in private cars and in buses and coaches), foams (closed cell foams, polyurethane cans and foam in refrigerators/freezers), Metered Dose Inhalers (MDI), aerosols other than MDIs, fire extinguishing (fixed and portable installations) and solvent uses.

The SF6 emissions originates from the manufacturing and from the stock of acoustic double-glazing and also in some electric installations, this last source corresponding to only 0,1 % of the total F-gas emissions in CO_2-equivalents.

No systematic inventories of the F-gases described in Annex A to the Kyoto Protocol (hydrofluorocarbons HFCs, perfluorocarbons PFCs, sulphur hexafluoride SF_6) were made for the years prior to 1995 during the previous submissions. The reason for this lack of information was that it was very difficult to obtain reliable information for these gases in Belgium for the period 1990-1994.
In the course of 2003 a new source (an electrochemical synthesis plant) was detected and included in the greenhouse gas inventory for the first time in the previous submission. Because the emissions of fluorinated gases of this new source are known from 1990 on and because of the important share of this new source of fluorinated emissions in total fluorinated greenhouse gas emissions (93% in 1995), the emissions of F-gases were estimated in Belgium for the complete time series 1990-2003.
As a result the emission inventory of fluorinated gases from 1995 to 2003 can be considered as time consistent for the complete time series. For the years 1990 to 1994, the other, already detected emissions of fluorinated gases (for more details see section above) in previous submissions (about 7% of total fluorinated gases in 1995) were taken over from the year 1995, which is consequently only a rough estimation of these emissions.
The gases emitted by the electrochemical synthesis plant are SF6, CF4, C2F6, C3F8, C4F10, C5F12 and C6F14. The emissions are non-fugitive and fugitive emissions.
Total emissions of this plant are estimated for 1995 at 4.4 Mton CO_2 equivalents.
Because a gas incinerator, with a recovery of HF, has been installed in 1998 to reduce the non-fugitive emissions of this plant and because of a substantial change in product mix in 2001, the estimated emissions of this plant changed from 4.4 Mton CO_2 equivalents in 1995 to 209 kton CO_2 equivalents in 2003.
Compared to the previous submission, the years 1990 to 2002 have been modified, as a result of some new assumptions, better data, improved calculation methods or error corrections, with the aim to keep the emission inventories of fluorinated substances consistent for the complete timeseries. The overall results obtained for these years are only marginally different. As in the previous updates, a number of improvements have been made in the data and in the calculation model. The main improvements are summarized below in section 4.3.

4.3. Recalculations and planned improvements

4.3.1. Recalculations

- Some implied emission factors are corrected following the Synthesis & Assessment report. (Wallonia) : emission factor in the glass sector between 1997 and 2001.
- In the Lime sector, one recalculation was performed concerning the kraft pulping process in Wallonia : 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 anymore (CO_2 biomass in table 4.1).

- In the Flemish region the process emissions of CO_2 from the glass production are newly added in this submission for the complete timeseries after consultation with the industrial companies involved.
- Also newly reported in this submission are the process emissions of CO_2 originating from the ceramic sector in Flanders for the complete timeseries.
- The study conducted to improve the knowledge on the carbon flows in the (petro)chemical industry in Flanders [43], resulting in new data set on CO_2 emissions in this sector. The largest part of CO_2 emissions results from recovered fuels. The recalculation was made for all years. The largest part of the resulting emissions is reported under 1.A.2 c. This includes other fuels in the chemical sector, a result of recovered fuels in the cracking units in petrochemical industry (approx. 2/3) and other recovered fuels from the chemical industry (approx. 1/3). The steamcrackers in Antwerp are the main sources of non-energetic use of naphta and LPG. An other part of the emissions surveyed in the study, are considered to be process emissions and are reported under 2.B. A small part of non-energy use is still calculated using the default IPCC emission factors (mostly use of lubricants and solvents) and is reported under 2.G. See also chapter 3 for more details. In relation to the above mentionned recalculation, the CO_2 emissions from ammonia production were slightly adjusted for Flanders for all years. The differences in emissions between the previous submission and this submission due to the results of this new study are shown in the section 3.3.1.
- In comparison with the update in the previous submission, the following improvements have been made in the emission inventory of fluorinated gases :

- As pointed out in the latest update of the inventory, the quality of the refrigerant consumption in industrial and commercial installations, which used to be obtained from the professional association of refrigerant suppliers, has been declining in the latest years. To solve this problem, an inquiry has now directly been organised among the gas supply companies, in consultation with the federal and regional authorities.
- The refrigerant consumption of car manufacturers (used for calculating potential emissions) has now for the first time been obtained through a direct enquiry among the companies (instead of from the refrigerant suppliers' association).
- Partly as a results of this enquiry and partly due to the appearance of new products on the market, the number of refrigerants, and as a consequence the number of fluorinated substances taken into account, is significantly increased. This has required substantial modifications.

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 were emissions of CO_2 from the non-energy use of lubricants and solvents is reported under category 2.G.

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

5.2. Methodological issues

The regions in Belgium are using comparable methodologies to estimate the emissions 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 3.A (NMVOC emissions for Paint Application…), and 3.C (Chemical Products, Manufacture and Processing) as well as some of category 3.D (other domestic use, wood and textile coating, printing industry, wood conservation, recovery of solvents) 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 category 3.D (treating of rubber, coating of synthetic material and paper, storage and handling of products and assembly of automobiles, extraction of oil seeds) 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).

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

During this submission the activity data used for calculating the emissions of N_2O from anaesthesia are actualized from 1995 on (Flanders).

5.3.2. Planned improvements

Emission estimates of NMVOC originating from coating processes will be revised in the near future in the Flemish region.

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.

	Flemish region	**Brussels region**	**Walloon region**	**Total**
Number of businesses	37.895	28	18.989	56.912
Agricultural land (ha)	635.886	237	756.567	1.392.690
Grassland (ha)	186.913	82	349.015	536.011
Grains (ha, without maize)	87.225	58	175.821	263.104
Maize (ha)	45.114	13	2.265	47.392
Sugar beet (ha)	36.317	12	60.129	96.457
Potatoes (ha)	39.967	2	21.716	61.699
Others (ha)	240.350	70	147.621	388.027

Table 6.1. : Main types of cultivation in Belgium (NIS, 2002).

	Flemish region	**Brussels region**	**Walloon region**	**Total**
Bovine under 6 months	276.175	33	224.675	500.883
Male bovine between 6 months and 1 year	73.023	22	50.681	123.726
Female bovine between 6 months and 1 year	116.772	22	98.836	215.630
Fattening male bovine more than 1 year	109.719	47	91.479	201.245
Young female bovine more than 1 year	340.440	103	369.231	709.774
Dairy cows	335.183	76	267.017	602.276
Brood cow	205.914	67	331.747	537.728
Total	**1.457.226**	**370**	**1.433.666**	**2.891.262**
Piglet under 20 kg	1.771.076	0	64.937	1.836.013
Piglet between 20 and 50 kg	1.370.776	1	85.576	1.456.353
Fattening pigs more than 50 kg	2.598.601	2	157.986	2.756.589
Breeding males	11.063	0	896	11.959
Sows	645.394	0	29.114	674.508
Total	**6.396.910**	**3**	**338.509**	**6.735.422**
Ewes	46.436	9	30.961	77.406
Other sheep	46.591	6	22.423	69.020
Total	**93.027**	**15**	**53.384**	**146.426**
Female Goat	8.199	7	7.179	15.385
Other goats	5.459	2	4.169	9.630
Horses	20.535	42	10.652	31.229
Total	**34.193**	**51**	**22.000**	**56.244**
Broilers	20.767.628	350	3.082.485	23.850.463
Laying hens	12.813.149	201	1.264.238	14.077.588
Other poultry	727.173	95	53.173	780.441
Total	**34.307.950**	**646**	**4.399.896**	**38.708.492**

Table 6.2. : Number of heads in the main livestock categories in Belgium (NIS, 2002).

The land used for agriculture in 2002 extends to 1.392.690 hectares (Table 6.1), or 45.6% of Belgium. In 2000, the number of agricultural and horticultural businesses amounted to 61,926%. This number had dropped by 15% in 5 years, especially in the wake of successive crises that have hit the agricultural sector (BSE [*Bovine Spongiform Encephalitis*], dioxin). Nevertheless the land area used for agricultural purposes remained identical during this period. In 2002 Wallonia has 54% of the land used for agriculture, but 67% of agricultural businesses are situated in Flanders. The land area used for farming is on average 17 ha per farm in the Flemish region and 40 ha per farm in the Walloon region.

Organic farming and the businesses in transition towards this type of farming only represent 1% of the total. 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 4.C and 4.E) and field burning of agricultural residues (category 4.F) are not occurring in Belgium.
The agricultural sector in Belgium covers the categories 4.A, 4.B and 4.D.

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 never 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 not estimated.

6.2. Methodological issues

6.2.1. Data sources

The main activity data are the land-use and the livestock figures. The National Institute of Statistics (NIS) [26] publishes these numbers yearly. All agricultural businesses have to fill a form each year and sent it to the NIS. Further details on the agricultural census methodology and QA/QC issues can be found on the NIS website: www.statbel.fgov.be.

For nitrogen fertiliser use, data from the Centre for Agricultural Economics are used. The institute conducts surveys on a representative sample of the different types of agricultural businesses and produces yearly weighted average values on the fertiliser use.

In Wallonia, the data on sludge spreading on agricultural soils are available on the website of DGRNE (http://www.environnement.wallonie.be/).

In Flanders the detailed data for animal manure (processed or not) originate from the Manure Bank of the Flemish Land Institute. The nitrogen leaching (N_2O model) comes from the SENTWA model (System for the Evaluation of Nutrient Transport to Water) that is yearly updated. The N_2O emission calculation model follows IPCC methodology but uses region-specific data wherever available.

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 inputs 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.

6.2.2. Enteric fermentation

CH_4 emissions from enteric fermentation from animal husbandry are estimated using the Tier 1 methodology described in the IPCC Good Practice Guidance [10].

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

The IPCC emission factors are used for most animal categories, except if country specific data are available. Further harmonisation of the emission factors between the regions is foreseen. The classification of the animal categories occurs according to the IPCC methodology.

The emission factors presented in the CRF tables are a weighted average of the emission factors used at the regional level.

6.2.3. Manure management

Flanders

CH_4 emissions from manure management in Flanders are estimated using the Tier 2 method integrating country-specific data. The integrator used in following formula takes into account the fact that the weight of the cattle over the whole lifetime is not the same as the slaughter weight, and integrates therefore between the weight at birth and the slaughter weight.

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. Further studies are undertaken to estimate N_2O losses during manure processing.

CH_4 emission (m^3) = number of animals * average adult weight (kg) * integrator * manure production (kg/day/1000kg)[(1)] * 365/1000 * volatile solid[(1)] (%) * emission potential[(1)] (m^3/kg VS) * CH_4 potential[(1)] (m^3) [(1) Source : Casada & Safley].

CH_4 emission (ton) = CH_4 emission (m^3) * density (kg/m^3)

Category	Weight (kg)	Integrator
Bovine		
Slaughter calves in stable	160	0,62
Bovine under 1 year		
In stable	300	0,56
On pasture	300	0,56
Bovine from 1 to 2 year		
In stable	400	0,88
On pasture	400	0,88
Bovine more than 2 year		
In stable	500	1
On pasture	500	1
sheep	50	1
goats	50	1
swine		
Piglet under 20 kg	20	0,75
Piglet between 20 and 50 kg	35	1
Fattening pigs between 50 and 80 kg	65	1
Fattening pigs between 80 and 110 kg	95	1
Fattening pigs more than 110 kg	150	0,87
Breeding male	140	1
Breeding sows and old males and sowes	125	1
Horses	500	1
Mules	250	1
poultry		
Broilers (for breeding)	2	1
Broilers (for fattening)	1,3	0,52
Laying hens	2	1
Young laying hens	1,3	0,52
Ducks	2,5	0,54
Goose	7,5	0,65
Turkeys	7	0,49
Guinia fowl	1,2	0,55

Table 6.3. : Calculation factors used for the CH_4 emissions from manure management in the Flemish region (Source: Flemish Land Institute).

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.

6.2.4. Agricultural soils

Methane

During this submission Flanders used (after expert consultation) a new approach for the estimation of CH_4 emissions from agricultural soils (category 4.D). This new approach includes two sources of CH_4 emissions and one sink (methane oxidation in forest soils, agricultural soils and grassland). The two sources are wetlands and surface waters (rivers and inland waters). Because no data are yet available to give a rough sketch of the evolution over time, the same emission (of 2000) has been used for the entire timeseries. In the future efforts will be done to obtain more accurate data for the complete timeseries.

gas	Source/sink	Emission factor
CH_4	*Source*	
	Wetlands (≠ groundwater classes)	Between 0,4 and 1,4 ton CH_4 / km² /year (1)
	Surface waters	204 kg CH_4 / ha / year (2)
	sink	
	Forest soils	3,5 kg CH_4 / ha / year (3)
	Agricultural soils	1,3 kg CH_4 / ha / year (3)
	grassland	2,1 kg CH_4 / ha /year(3) year

Table 6.4 : Emission factors used for the agricultural sector in the Flemish region.

(1) Source: Boeckx & Van Cleemput (1997)
(2) Source: Bouwman & Van der Hoek
(3) Source: Boeckx & Van Cleemput (2001)

Wallonia calculates the CH_4 emissions on the basis of the manure applied during grazing.

In both regions, this source is very small compared to enteric fermentation and manure management.

Nitrous oxide

The N_2O emission estimation depends on two major sources : the manure storage and the emission from agricultural soils (direct and indirect). The N_2O emissions are calculated according to IPCC methodology but uses country or region specific data where available.

The N_2O emission estimation from manure storage 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 and solid storage. The IPCC default emission factors for liquid systems and solid storage are then applied (respectively 0,001 and 0,02 kg N- N_2O/kg N excreted).

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 4.D.1) 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 from mineral nitrogen to NH_3 (In Wallonia the average rate of 2,3 %

based on the default values recommended buy IIASA for different types of fertilisers and in Flanders the weighted average for NH_3 and NO volatilisation is 4.3%). The N_2O emissions from organic fertiliser spreading are calculated in the same way than N_2O emission from mineral fertiliser spreading. The N_2O emissions from crop residues can vary according to the preceding culture. The nitrogen residual from soil is estimated by multiplying, for each culture, the cultivated area by the nitrogen residual average quantity for the culture considered. The N_2O emission from these 3 sources is estimated by applying the IPCC default emission factor (0.0125 kg N-N_2O/kg nitrogen).

The nitrogen from grazing 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-N_2O / kg N is then used to estimate the emissions.

The indirect emission (category 4.D.3) considers the N_2O emissions from atmospheric deposition, leaching and runoff.

The atmospheric deposition is estimated at 10.9 kg N/ha. It is considered that 1 % of this nitrogen is volatilised as N_2O. 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 emission 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). The second estimates the volatilisation rate in N_2O form with the IPCC default value (0.025 kg N-N_2O / kg N).

The category other (4.D.4) 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.

6.3. Recalculations and planned improvement

6.3.1 Recalculations

- In Flanders recalculations over the entire timeseries (1990-2003) have been done for the N_2O emissions from animal waste management systems (category 4.B(b)). A region specific distribution for the AWMS has been used for each animal group (source: Flemish Land Institute).
- Also in Flanders the nitrogen content in the non-N-fixing crops has been changed from the IPCC default values to cropspecific values (category 4.D). The same has been done for the fraction of crop residue that is removed from the field as crop. This implicates different direct N_2O emissions for the entire timeseries.
- For calculating the emissions of CH_4 from agricultural soils in Flanders an entire new methodology has been used. Because of lack of data for the complete timeseries the emissions of 2000 have been used for the entire time series.
- Emissions of N_2O from human sewage are replaced from the agricultural sector (category 4.D) in the previous submission to the waste sector (6.B) in this submission in the Flemish region.
- A correction of the total emissions of N_2O in the sector of agriculture is made in the CRF tables for 1990 (table 4s1 - cel C7). The formula to calculate this total was removed by mistake for this year.
- In Wallonia, following the S&A report 2003, the IPCC default value is now used for the swine category for the calculation of CH_4 emissions from enteric fermentation. The mineral fertiliser volatilisation rate has also been corrected.This mainly changes the NH3 emissions (important for other reporting obligations), but also has a small effect on N_2O emissions from soils.

6.3.2. Planned improvements

- CO_2 emissions from agricultural soils are not estimated. A study is going on at the national level, but will not be finalised before 2005. In the category 4.D.4 the consistency of the methodologies applied in Flanders and in Wallonia need to be checked.
- In Flanders for the estimation of the CH_4 emissions from agricultural soils (category 4.D) an effort will be done to obtain yearly input data for calculating the evolution for the entire time series.
- In Wallonia the methane emissions from the manure applied during grazing are reported under agricultural soils (category 4.D). It will be checked if these emissions should not rather be included in the manure management category.

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. The definitions of ‘forest’ in the Belgian inventories are based on minimum requirements : an area of 0.5 ha and 0.3 ha, a width of 25 m and 9 m and a canopy closure of 20 % and 10 % in Flanders and Wallonia respectively (Lecomte & Rondeux, 1994 and AB&G, 2001). These slight differences are due to specific aspects of the two regional policies on land use management. The consequences on the total wood volume however are negligible. The distribution of forests in Belgium is shown in table 7.1. The total forest area in Flanders amounted to 146381 ha in 2000, based on the regional forest mapping (Van de Walle *et al*, 2005), while Walloon forests covered 544800 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**
	(km^2)	(km^2)	(%)	**Belgian forest area**
Wallonia	16845	5448	32.3	78.6
Flanders	13521	1447	10.8	21.1
Brussels Capital	162	20	12.3	0.3
Belgium	**30528**	**6931**	**22.7**	**100.0**

Table 7.1. : Forest cover in Belgium (source : National Institute of Statistics and regional forest inventories, 2000).

7.2. Methodological issues

7.2.1 Changes in Forest and Other Woody Biomass Stocks

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 (Lecomte & Rondeux, 1994 and 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). 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 km^2, forest inventories in Belgium have one of the highest sampling rates in Europe. Compared to other countries or regions, the Belgian sampling grid, with each sampling point representing 50 ha of forest, is very dense (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 area (ha) covered by different species, and the total solid wood volumes (m^3) of these species, spread over three age classes, were calculated for Flanders and Wallonia, as given in table 7.2. Information on coppice is also included in this table. Values for Belgium were calculated by summing up the Flemish and Walloon forest areas and wood volumes.

		Wallonia			**Flanders**	
	Area	Volume	% of total	Area	Volume	% of total
Species	(ha)	(1000 m^3)	volume	(ha)	(1000 m^3)	volume
PINE	14800	3743.4	3.0	63550	12867.2	39.9
Douglas fir	10800	2387.2	1.9	1280	371.0	1.2
Larch	8200	2081.2	1.7	3060	782.3	2.4
Spruce	171700	52502.8	41.8	2860	527.1	1.6
Other coniferous	19600	4955.4	3.9	910	174.0	0.5
Total coniferous	***225100***	***65669.9***	***52.2***	***71660***	***14721.5***	***45.7***
Beech	42200	12278.0	9.8	7790	2500.5	7.8
Oak	81600	20372.4	16.2	14320	3696.4	11.5
Mixed noble	57100	15041.4	12.0	10250	2357.0	7.3
Poplar	9500	2703.9	2.2	19060	5217.2	16.2
Other deciduous	43200	9661.7	7.7	21650	3753.1	11.6
Total deciduous	***233600***	***60057.3***	***47.8***	***73070***	***17524.1***	***54.3***
TOTAL	**458700**	**125727.1**	**100.0**	**144730**	**32245.5**	**100.0**

Table 7.2. : Volume and area per specie in the forest inventories.

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 according the figure 7.3. 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, submitted). The selected factors are shown in table 7.3.

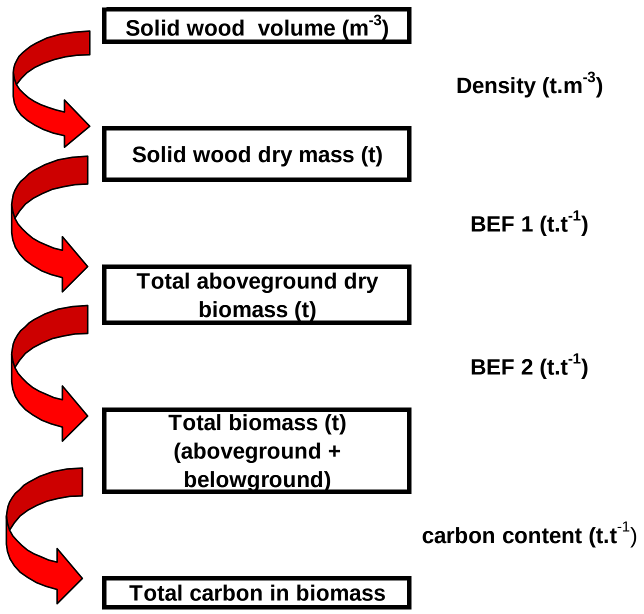


Figure 7.1. : Principle of the conversion of wood volume to carbon mass.

Factors	Unit	Broadleaved				Coniferous				
		Beech	**Oak**	**Poplar**	**Others**	**Spruce**	**Douglas fir**	**Pine**	**Larch**	**Others**
Density	[t·m-3]	0,57	0,59	0,43	0,56	0,39	0,46	0,48	0,47	0,39
Above ground biomass/ total solid wood	[/]	1,42	1,39	1,40	1,29	1,30	1,29	1,23	1,30	1,30
Below ground biomass/ aboveground biomass	[/]	0.20				0.20				
Carbon in biomass	[t C/t]	0.5				0.5				
Wood growth	[m3·ha-1·y-1]	6.25	3.80	6.50	6.38	17.41	23.30	8.78	11.39	15.51

Table 7.3. : Conversion factors used to derive forest inventory data for deciduous and coniferous forests in Belgium.

Figure 7.2 gives the evolution of biomass carbon stock (BOC). For the 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 2000-2003 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, 2000). EFOBEL is a dynamic .xls spreadsheet using 20 tables. The complete description is done in Perrin et al (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 for the period of 2008 to 2012 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.

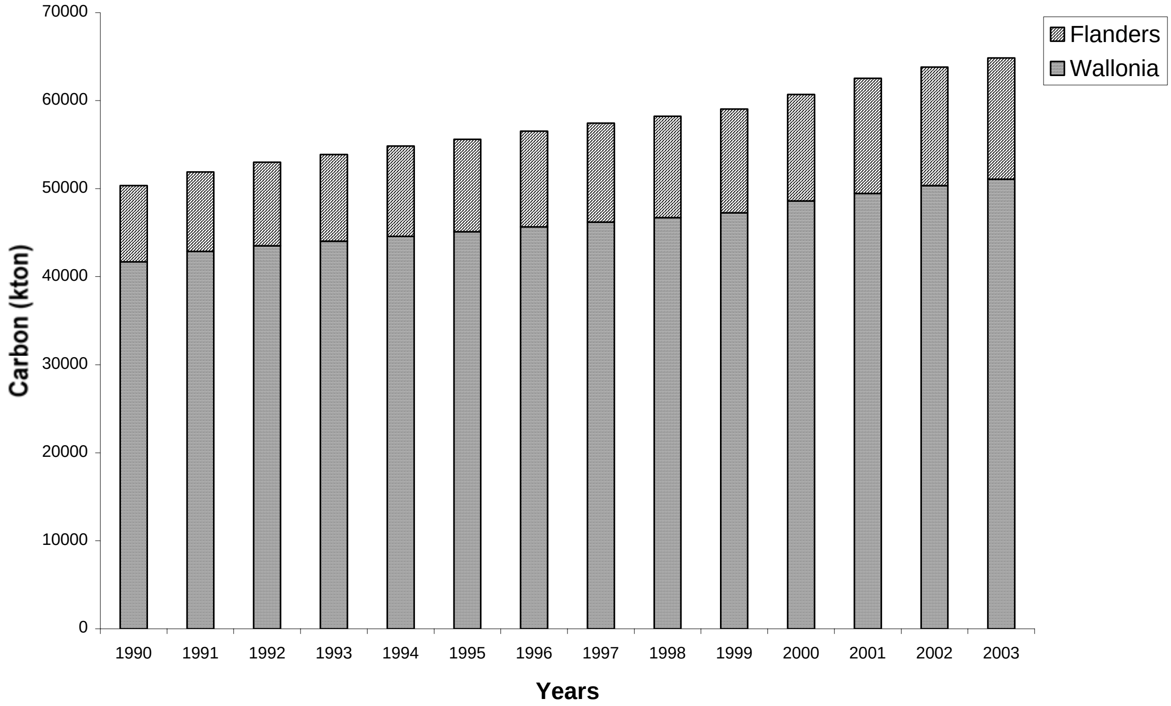


Figure 7.2. : Evolution of biomass carbon stock in belgian forest.

7.3. Recalculations and planned improvement

7.3.1. Recalculations

For the first time, the C sequestration was calculated for overall Belgium. A slight revision of the conversion factors was conducted in 2004. The wood density (above ground biomass/total solid wood in t/dm³ in table 7.3) is now specific for the main deciduous and coniferous species. The below ground biomass/aboveground biomass conversion factor has been revised according to the latest results available. The mean annual growth has also been fine-tuned according to the last results of the inventory. A new methodology is applied to estimate the annual harvest.

7.3.2. Planned improvements

A first improvement will be the geographical location of LULUCF activities.

The evolution of forest soil organic carbon will be available for the next submission. A first estimate of the impact of the forest and grassland conversion should also be available at the national level.

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 1998-2002* 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 6.A, 6.B, 6.C and 6.D.

The industrial wastewater (category 6.B.1) is not considered because a lack of data. Only domestic wastewater emissions are calculated in Belgium for the time being.

CH_4 emissions originating from the production of compost in Flanders is put under category 6.D Waste/Other.

In Brussels only category 6.B (municipal wastewater treatment plant since 2000) and 6.C (waste incineration) are relevant in this waste section.

Waste incineration category includes incineration of municipal wastes, incineration of hospital wastes, incineration of corpses and flaring in the chemical industry.

8.2. Methodological issues

8.2.1. Solid waste disposal on land

Methodology

The CO_2 and CH_4 emissions from solid waste disposal on land are calculated with a 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. We use a first order decay model 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 constant used for household and industrial waste are presented in the table 8.1.

Constant	Municipal waste	Industrial waste
DOC	180 (before 1986) 170 (1986-1990) 142,9 (1995) 112,5 (2000)	26,8 (1970-1995) 23,6 (2000)
K	10	10
C	77	77

Table 8.1. : Solid waste disposal on land. Constant used in the model. 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 reported in this submission and included in national totals (see also section 8.3.3, planned improvements). 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].

Data source : Wallonia

In Wallonia, 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 for municipal waste lies in the default value range from IPCC revised 1996 Guidelines and was chosen according to national expert judgement. The value for industrial waste was estimated 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].

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 following 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.

Data source : Flanders

CH_4 emissions from solid waste disposal on Land (category 6.A.1) 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 Guidelines.

Since 1994 waste policies in Flanders (cf. 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 was burned than dumped. A real moratorium in dumping organic waste is set up since 2000.

8.2.2. Wastewater treatment

In the category domestic and commercial wastewater (category 6.B.2), the CO_2 emissions from municipal wastewater treatment plant are not reported in Belgium 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 individual wastewater treatment plant (septic tank) is based on an article (Vasel, 1992) [32], which describes the characteristics and parameters of individual septic tank. For the CH_4 emission factor, the recommended default value of 0.25 kg CH_4/kg BOD in the EMEP/CORINAIR handbook is used [3]. It is considered that only 10 % of the BOD loading is anaerobically metabolised (60*2/3*0.6*0.25). The emission factor becomes 1,5 g CH_4/inhab*day. 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 municipal wastewater treatment plants, the CH_4 and N_2O emissions are estimated by using the methodology described in the EMEP/CORINAIR guidebook [3]. There is a distinction between the emissions from water treatment and sludge treatment.

The N_2O emissions are estimated by using the methodology described in the IPCC 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 data's concerning the protein consumption come from the FAO statistic. The population comes from the National Institute of Statistics.

8.2.3. 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)".

For CO_2 emissions, each region applies its own methodology according to the available activity data (see below).

The emissions of CO_2 from the flaring in the chemical industry are reported in category 6.C according to the IPCC Guidelines.

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 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.
There is a distinction between the emission from municipal waste incineration and hospital waste incineration. The 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. The CO_2 emissions from hospital waste incineration are measured by the Walloon incinerators and are fully reported. Emissions from the incineration of corpses are calculated using the EMEP/CORINAIR emission factors and statistical data on the number of corpses.

Brussels

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

8.2.4. Others

CH_4 emissions from compost production are estimated in Flanders using regional activity data combined with emission factors of CITEPA (20 kg CH_4/ton compost).

8.3. Recalculations and planned improvements

8.3.1. Recalculations

Flanders

- An adjustement of the partition of waste into a biogenic fraction and non-biogenic fraction is made for all years. Most part of waste incineration in Flanders occurs mostly with energy recuperation and is therefore allocated under 1.A.1. Only the remaining part of waste incineration where no energy is recuperated is allocated under 6.C. (Flanders).

- An actualization of the activity data used for estimating the emissions from wastewater treatment plants is carried out in Flanders from 1999 on resulting in an adaption of the emissions of CH_4 and N_2O in this sector.

- An actualization of the activity data used for estimating the emissions of CH_4 from compost production is carried out in Flanders from 2000 on.

- The emissions of N_2O from human sewage (sector 6.B) are no longer put in category 4.D but in category 6.B in this submission and are optimized from 1995 on.

Wallonia

It has been noticed during this submission that , due to a small bug in the Reporter software (Reporter is an interface developed by the European Environment Agency which is used to fill in the CRF tables from the Collecter database), the emissions from hospital waste were previously not reported in the CRF tables. This causes a small change in the emissions of waste incineration from 1997 to present.

Brussels

The municipal waste incineration occurs with energy recuperation and is now therefore allocated under 1.A.1. Only the remaining part of incineration where no energy is recuperated is allocated under 6.C. (hospital waste until 1998 and crematoria).
The emission from the municipal wastewater treatment plant (its activity began on half 2000) is now estimated from 2000 to 2003.

8.3.2. Planned improvements

Belgium

- CH_4 recovery in the wastewater treatment plant has not been estimated for the time being because lack of data. It will be tried to collect those data for a future submission.
- The CO_2 emissions from biomass should be reported under "memo items" in the CRF tables. The effective reporting of these emissions has to be checked for the time series.

Flanders

Some points of attention to optimise the emissions of the waste sector in the future :

- the methodology to calculate the emissions of CH_4 originating from the production of compost
- the methodology to calculate the emissions of CO_2 due to landfilling (solid waste disposal on land) with special attention for the percentages organic/inorganic fraction.

Wallonia

According to the IPCC Good Practice Guidance [10], (page 5.10), , the recovered emissions of CH_4 in solid waste disposal should be subtracted from the amount generated before applying the oxidation factor. This is not the case for the time being. Consequently the CH_4 emissions could be a bit overestimated.

CHAPTER 9: RECALCULATIONS AND PLANNED IMPROVEMENTS

9.1. Recalculations and achieved improvements

The sector specific recalculations and methodological improvements achieved since the last submission are presented in the respective chapters of this report. This chapter presents the general issues that have been addressed since the last submission.

The efficiency of the institutional arrangements for the preparation of the inventory still has been improved. A detailed planning for the co-ordinated preparation of the inventory allows the timely submission of the inventory at the European and international level. On the technical side, all the national sectoral tables have been fulfilled in this submission (in the 2003 submission, some regional sectoral tables were included in the annexes of the NIR).

In all regions, the emissions were completely updated for the time series 1990-2002 and provisional emissions are calculated for 2001.

The results of the draft desk review report of the 2004 greenhouse gas inventory submission of Belgium (letter of Mr. R. Acosta of 31th of January 2005 to the Belgians UNFCCC National Focal Point) are taken into account as much as possible during this submission.

In Wallonia one of the main recalculation is the accounting of biomass fuels in cement kilns since 1995 (see 3.3.1). Some double counting in the iron and steel sector were also corrected (1998-2000). The lime sector was recalculated for the years 1991 to 1994 (a double counting of some emissions was linked to a bug in the database), leading to a decrease of more or less 1 Mt CO_2-eq for each of those years. The energy consumption in the quarries is also taken into account for the whole time series.

Some of the recalculations made in Flanders have a significant effect on the over-all Flemish and Belgian inventory. One important recalculation is the use of directly reported CO_2 emissions for large power plants based on fuel analyses in sector 1A.1. instead of calculations based on activity data and default IPCC CO_2 emissions factors. Another important recalculation that was made for the Flemish inventory (which was already planned and mentioned in the previous submission), is the recalculation of CO_2 emissions related to the non-energy use of products in the chemical industry [43]. Apart from the recalculations mentioned above, some other changes of minor importance are made in Flanders (see the respective chapters for more details).

9.2. Implication on emission levels and trends

- The recalculation of biomass fuels used in cement kilns in Wallonia (see 3.3.1) induces a reduction of the net emissions, particularly since 2001 (almost 0,5 Mt in 2001).
- One important recalculation in Flanders is the use of directly reported CO_2 emissions for large power plants based on fuel analyses in sector 1A.1. instead of calculations based on activity data and default IPCC CO_2 emissions factors. The difference between the recalculated results and the previous submission is larger in the early years. In the early years, more coal, blast furnace gas and coke oven gas and also refinery gas was used to produce electricity. In the more recent years, more natural gas is used and some of the coal fired plants were closed down. In 1990, the difference was more then 1 Mton CO_2, in 2003 the difference was 380 kton CO_2 (see section 3.3.1 for more details).
- An other important recalculation that was made for the Flemish inventory (which was already planned and mentioned in the previous submission), is the recalculation of CO_2 emission related to

the non-energy use of products in the chemical industry [43] (see also section 3.3.1 for more details).

9.3. Planned improvements

- As explained in section 1.5, independent audits are realised in the 3 regions in Belgium. However, some identified gaps, such as the lack of human resources, have not been adjusted so far, despite the signals sent by the inventory agencies. Nevertheless, a National Climate Commission has been put in place and its permanent secretariat is likely to provide some help for the preparation of the UNFCCC reporting.
- A working group has been established in order to improve the consistency of the energy balances available at different levels (regional, national, Eurostat). Some main gaps have already been identified but their correction requires changes in the data collection system at different levels. This long-term work is still ongoing (see section 3.4).
- A first meeting with the expert colleagues of greenhouse gas inventories in the Netherlands is planned shortly after the publication of this National Inventory Report. The purpose of this meeting is a first discussion about a possible peer review that will take place in the course of 2005 between the 2 countries in order to further improve the Belgian emission inventory.

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ANNEXES

Annex 1 : Key sources analysis

Level assessment

IPCC Source Categoriesa	Direct Greenhouse Gas	Sector	Base Year Estimate (1990)	Current Year Estimate (2003)	Level Assessment (2003)	Cumulative Total
			(Gg CO_2 eq.)			
1.A.3.b. Road Transportation	CO2	energy	19270	24813	16,8%	16,8%
1.A.1.a. Public Electricity and Heat Production	CO2	energy	23465	23548	16,0%	32,8%
1.A.4.b. Residential	CO2	energy	20224	22527	15,3%	48,1%
1.A.2.a. Iron and Steel	CO2	energy	14242	11845	8,0%	56,1%
1.A.2.c. Chemicals	CO2	energy	6311	7737	5,2%	61,3%
1.A.2.f. Other (Manufacturing Industries and Construction)	CO2	energy	8070	7294	4,9%	66,3%
1.A.4.a. Commercial/Institutional	CO2	energy	4278	6419	4,4%	70,6%
1.A.1.b. Petroleum Refining	CO2	energy	4299	5156	3,5%	74,1%
4.A.1. Cattle	CH4	agriculture	4301	3828	2,6%	76,7%
2.A.1. Cement Production	CO2	industrial processes	2824	2939	2,0%	78,7%
2.B.2. Nitric Acid Production	N2O	industrial processes	3562	2922	2,0%	80,7%
1.A.4.c. Agriculture/Forestry/Fisheries	CO2	energy	2730	2293	1,6%	82,3%
1.A.2.e. Food Processing, Beverages and Tobacco	CO2	energy	2998	2242	1,5%	83,8%
2.A.2. Lime Production	CO2	industrial processes	2156	2144	1,5%	85,2%
4.D.1. Direct Soil Emissions	N2O	agriculture	2343	2130	1,4%	86,7%
2.C.1. Iron and Steel Production	CO2	industrial processes	1873	1908	1,3%	88,0%
4.B.8. Swine	CH4	agriculture	1315	1380	0,9%	88,9%
2.B.1. Ammonia Production	CO2	industrial processes	694	1247	0,8%	89,7%
2.F.1. Refrigeration and Air Conditioning Equipment	HFCs	industrial processes	78	1054	0,7%	90,5%
4.B.1. Cattle	CH4	agriculture	1128	945	0,6%	91,1%
6.A.1. Managed Waste Disposal on Land	CH4	waste	2630	917	0,6%	91,7%
4.D.3. Indirect Emissions	N2O	agriculture	1121	898	0,6%	92,3%
4.D.2. Animal Production (2)	N2O	agriculture	941	848	0,6%	92,9%
1A.4. Other Sectors	N2O	energy	784	847	0,6%	93,5%
4.B.12. Solid Storage and Dry Lot	N2O	agriculture	909	821	0,6%	94,0%
1A.3. Transport	N2O	energy	356	797	0,5%	94,6%
2.B.5. Other (Chemical Industry)	CO2	industrial processes	215	777	0,5%	95,1%
1.A.2.d. Pulp, Paper and Print	CO2	energy	637	720	0,5%	95,6%
1A.2. Manufacturing Industries and Construction	N2O	energy	662	535	0,4%	96,0%
1.A.2.b. Non-Ferrous Metals	CO2	energy	624	524	0,4%	96,3%
1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries	CO2	energy	2143	438	0,3%	96,6%
2.A.7. Other (Mineral Products)	CO2	industrial processes	402	429	0,3%	96,9%
1.B.2.b. Natural Gas	CH4	energy	514	390	0,3%	97,2%
1A.1. Energy Industries	N2O	energy	284	360	0,2%	97,4%
6.C. Waste Incineration	CO2	waste	339	344	0,2%	97,6%
1.A.3.d. Navigation	CO2	energy	267	343	0,2%	97,9%
6.D. Other (composting)	CH4	waste	58	336	0,2%	98,1%
4.B. Wastewater Handling	N2O	waste	278	306	0,2%	98,3%
3.D. Other (Use of N2O for Anaesthesia)	N2O	solvent	253	253	0,2%	98,5%
2.B.5. Other (production of caprolactam)	N2O	industrial processes	372	215	0,1%	98,6%
2.E. Production of Halocarbons and SF6	PFCs	industrial processes	1753	209	0,1%	98,8%
4.A.8. Swine	CH4	agriculture	155	152	0,1%	98,9%
1.B.2.c. Venting and Flaring (Fugitive Emissions from Fuels)	CO2	energy	84	145	0,1%	99,0%
1.B.2.b. Natural Gas	CO2	energy	197	141	0,1%	99,1%
1.A.3.c. Railways	CO2	energy	202	126	0,1%	99,1%
2.G. Other (industrial processes)	CO2	industrial processes	287	123	0,1%	99,2%
2.F.4. Aerosols/ Metered Dose Inhalers	HFCs	industrial processes	35	121	0,1%	99,3%
2.F.2. Foam Blowing	HFCs	industrial processes	141	108	0,1%	99,4%
4.D. Agricultural Soils	CH4	agriculture	103	103	0	99,5%
4.B.9. Poultry	CH4	agriculture	105	97	0	99,5%
1.A.5. Other (Fuel Combustion)	CO2	energy	166	96	0	99,6%
1.A.4. Other Sectors	CH4	energy	129	94	0	99,7%
6.B.2. Domestic and Commercial Wastewater	CH4	waste	81	77	0	99,7%
2.F. Consumption of Halocarbons and SF6	SF6	industrial processes	103	75	0	99,8%
4.B.11. Liquid Systems	N2O	agriculture	63	59	0	99,8%
1.A.2. Manufacturing Industries and Construction	CH4	energy	57	42	0	99,8%
1.A.3. Transport	CH4	energy	73	40	0	99,9%
2.F.3. Fire Extinguishers	HFCs	industrial processes	1	39	0	99,9%
2.C.1. Iron and Steel Production	CH4	industrial processes	33	33	0	99,9%
4.C. Waste Incineration	N2O	waste	23	25	0	99,9%
1.B.1.b. Solid Fuel Transformation	CH4	energy	44	22	0	99,9%
4.A.3. Sheep	CH4	agriculture	28	21	0	99,9%
4.B.6. Horses	CH4	agriculture	12	18	0	100,0%
1.A.3.a. Civil Aviation	CO2	energy	12	15	0	100,0%
4.A.6. Horses	CH4	agriculture	8	12	0	100,0%
4.B.13. Other (Manure Management)	N2O	agriculture	3	9	0	100,0%
1.A.1. Energy Industries	CH4	energy	3	9	0	100,0%
4.A.4. Goats	CH4	agriculture	2	5	0	100,0%
1.B.2.a. Oil	CH4	energy	3	5	0	100,0%

Trend assessment

IPCC Source Categoriesa	Direct Greenhouse Gas	Sector	Base Year Estimate (1990)	Current Year Estimate (2003)	Trend Assessment	Contribution to Trend	Cumulative Total
			(Gg CO_2 eq.)				
1.A.3.b. Road Transportation	CO2	energy	19270	24813	0,035	17,6%	17,6%
1.A.2.a. Iron and Steel	CO2	energy	14242	11845	0,017	8,7%	26,3%
1.A.4.a. Commercial/Institutional	CO2	energy	4278	6419	0,014	7,0%	33,3%
1.A.4.b. Residential	CO2	energy	20224	22527	0,013	6,7%	40,0%
6.A.1. Managed Waste Disposal on Land	CH4	waste	2630	917	0,012	5,9%	45,9%
1.A.1.c. Manufacture of Solid Fuels and Oth	CO2	energy	2143	438	0,012	5,8%	51,7%
2.E. Production of Halocarbons and SF6	SF6	industrial processes	1559	0	0,011	5,3%	57,0%
2.E. Production of Halocarbons and SF6	PFCs	industrial processes	1753	209	0,010	5,3%	62,2%
1.A.2.c. Chemicals	CO2	energy	6311	7737	0,009	4,5%	66,7%
2.F.1. Refrigeration and Air Conditioning Equ	HFCs	industrial processes	78	1054	0,007	3,3%	70,0%
1.A.2.f. Other (Manufacturing Industries and	CO2	energy	8070	7294	0,006	3,0%	72,9%
1.A.2.e. Food Processing, Beverages and T	CO2	energy	2998	2242	0,005	2,7%	75,6%
1.A.1.b. Petroleum Refining	CO2	energy	4299	5156	0,005	2,7%	78,3%
2.B.2. Nitric Acid Production	N2O	industrial processes	3562	2922	0,005	2,3%	80,6%
2.B.5. Other (Chemical Industry)	CO2	industrial processes	215	777	0,004	1,9%	82,5%
2.B.1. Ammonia Production	CO2	industrial processes	694	1247	0,004	1,8%	84,3%
4.A.1. Cattle	CH4	agriculture	4301	3828	0,004	1,8%	86,1%
1.A.4.c. Agriculture/Forestry/Fisheries	CO2	energy	2730	2293	0,003	1,6%	87,7%
1A.3. Transport	N2O	energy	356	797	0,003	1,5%	89,1%
6.D. Other (composting)	CH4	waste	58	336	0,002	0,9%	90,0%
1.A.1.a. Public Electricity and Heat Productic	CO2	energy	23465	23548	0,002	0,8%	90,9%
4.D.1. Direct Soil Emissions	N2O	agriculture	2343	2130	0,002	0,8%	91,7%
4.D.3. Indirect Emissions	N2O	agriculture	1121	898	0,002	0,8%	92,5%
4.B.1. Cattle	CH4	agriculture	1128	945	0,001	0,7%	93,2%
2.G. Other (industrial processes)	CO2	industrial processes	287	123	0,001	0,6%	93,7%
2.B.5. Other (production of caprolactam)	N2O	industrial processes	372	215	0,001	0,5%	94,3%
1A.2. Manufacturing Industries and Construc	N2O	energy	662	535	0,001	0,5%	94,7%
1.B.2.b. Natural Gas	CH4	energy	514	390	0,001	0,4%	95,2%
1.A.2.b. Non-Ferrous Metals	CO2	energy	624	524	0,001	0,4%	95,5%
4.D.2. Animal Production (2)	N2O	agriculture	941	848	0,001	0,4%	95,9%
4.B.12. Solid Storage and Dry Lot	N2O	agriculture	909	821	0,001	0,3%	96,2%
2.F.4. Aerosols/ Metered Dose Inhalers	HFCs	industrial processes	35	121	0,001	0,3%	96,5%
1.A.3.c. Railways	CO2	energy	202	126	0,001	0,3%	96,8%
2.A.1. Cement Production	CO2	industrial processes	2824	2939	0,000	0,2%	97,0%
1.A.2.d. Pulp, Paper and Print	CO2	energy	637	720	0,000	0,2%	97,3%
1.A.5. Other (Fuel Combustion)	CO2	energy	166	96	0,000	0,2%	97,5%
1.A.3.d. Navigation	CO2	energy	267	343	0,000	0,2%	97,8%
1A.1. Energy Industries	N2O	energy	284	360	0,000	0,2%	98,0%
1.B.2.c. Venting and Flaring (Fugitive Emissi	CO2	energy	84	145	0,000	0,2%	98,2%
1.B.2.b. Natural Gas	CO2	energy	197	141	0,000	0,2%	98,4%
1A.4. Other Sectors	N2O	energy	784	847	0,000	0,2%	98,6%
4.B.8. Swine	CH4	agriculture	1315	1380	0,000	0,2%	98,7%
2.A.2. Lime Production	CO2	industrial processes	2156	2144	0,000	0,1%	98,9%
2.F.3. Fire Extinguishers	HFCs	industrial processes	1	39	0,000	0,1%	99,0%
1.A.4. Other Sectors	CH4	energy	129	94	0,000	0,1%	99,1%
2.F.2. Foam Blowing	HFCs	industrial processes	141	108	0,000	0,1%	99,2%
1.A.3. Transport	CH4	energy	73	40	0,000	0,1%	99,4%
2.F. Consumption of Halocarbons and SF6	SF6	industrial processes	103	75	0,000	0,1%	99,4%
4.B. Wastewater Handling	N2O	waste	278	306	0,000	0,1%	99,5%
1.B.1.b. Solid Fuel Transformation	CH4	energy	44	22	0,000	0,1%	99,6%
2.A.7. Other (Mineral Products)	CO2	industrial processes	402	429	0,000	0,1%	99,7%
1.A.2. Manufacturing Industries and Construc	CH4	energy	57	42	0,000	0,1%	99,7%
4.B.9. Poultry	CH4	agriculture	105	97	0,000	0,0%	99,8%
2.C.1. Iron and Steel Production	CO2	industrial processes	1873	1908	0,000	0,0%	99,8%
4.A.3. Sheep	CH4	agriculture	28	21	0,000	0,0%	99,8%
4.B.13. Other (Manure Management)	N2O	agriculture	3	9	0,000	0,0%	99,8%
4.A.8. Swine	CH4	agriculture	155	152	0,000	0,0%	99,9%
4.B.6. Horses	CH4	agriculture	12	18	0,000	0,0%	99,9%
1.A.1. Energy Industries	CH4	energy	3	9	0,000	0,0%	99,9%
6.B.2. Domestic and Commercial Wastewate	CH4	waste	81	77	0,000	0,0%	99,9%
4.B.11. Liquid Systems	N2O	agriculture	63	59	0,000	0,0%	99,9%
3.D. Other (Use of N2O for Anaesthesia)	N2O	solvent	253	253	0,000	0,0%	99,9%
4.A.6. Horses	CH4	agriculture	8	12	0,000	0,0%	99,9%
4.A.4. Goats	CH4	agriculture	2	5	0,000	0,0%	100,0%
1.A.3.a. Civil Aviation	CO2	energy	12	15	0,000	0,0%	100,0%
4.C. Waste Incineration	N2O	waste	23	25	0,000	0,0%	100,0%
1.B.2.a. Oil	CH4	energy	3	5	0,000	0,0%	100,0%
4.D. Agricultural Soils	CH4	agriculture	103	103	0,000	0,0%	100,0%
4.B.3. Sheep	CH4	agriculture	6	4	0,000	0,0%	100,0%

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. Emission trends of the main greenhouse gases and for the main sectors are for the three Regions presented in this annex.

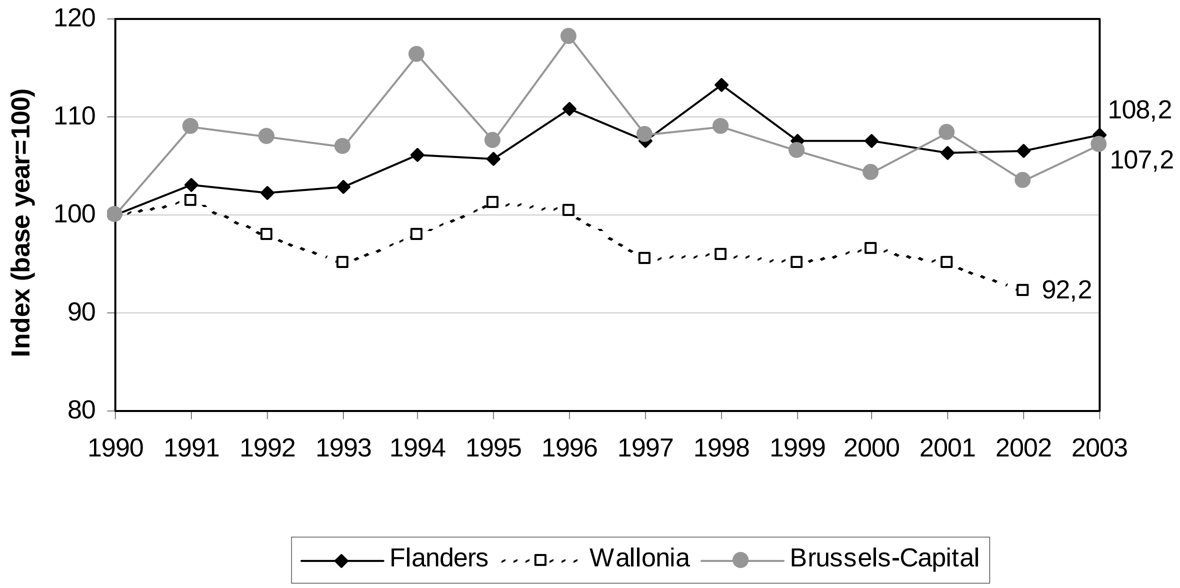
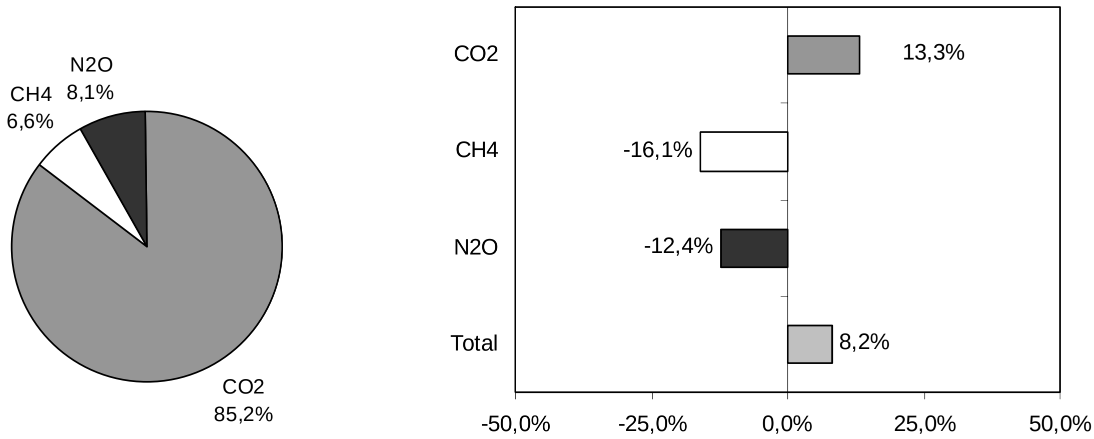
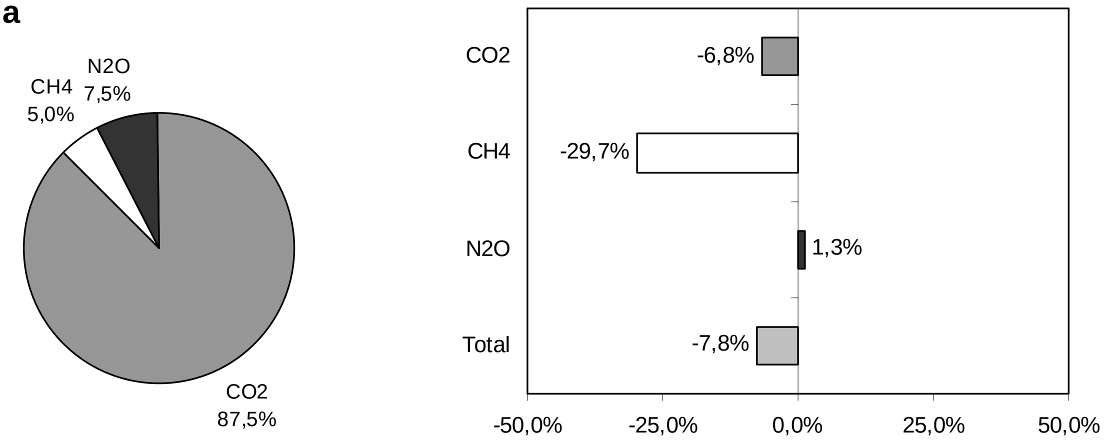


Figure 1. : GHG emissions 1990-2003[4] in the three regions (excl. F-gases & LULUCF).
Unit : Index point (1990 level = 100).

[4] estimates of GHG emissions for the walloonn Region are only available until 2002



Wallonia



Brussels

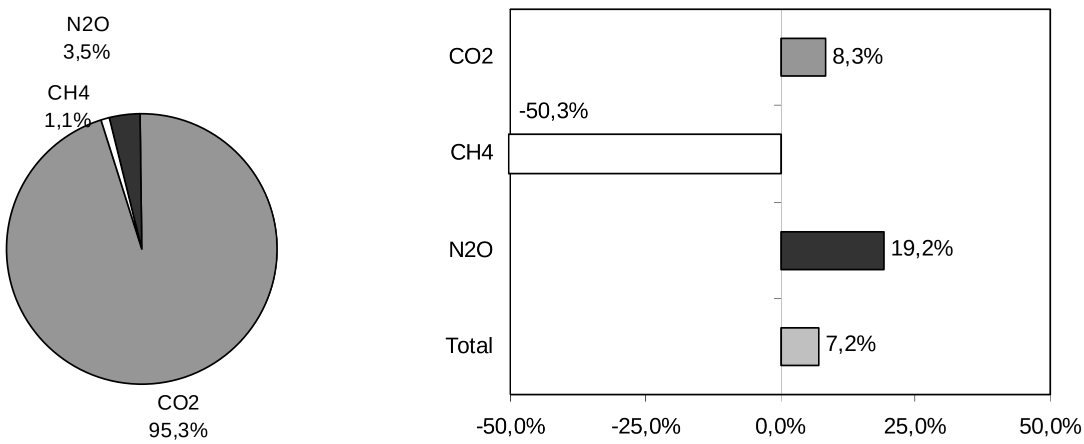
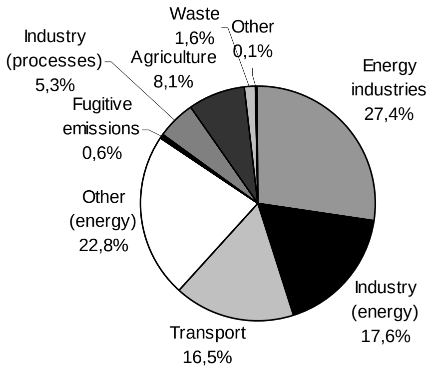
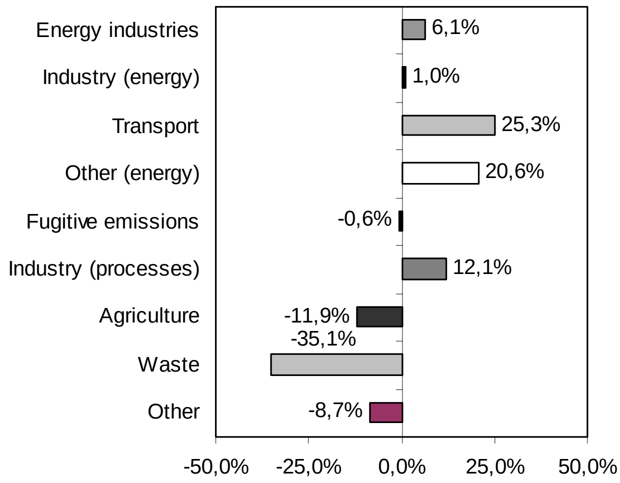
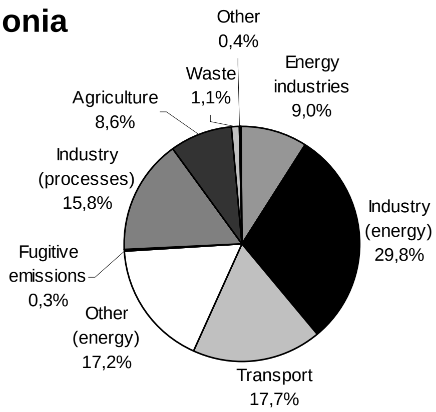


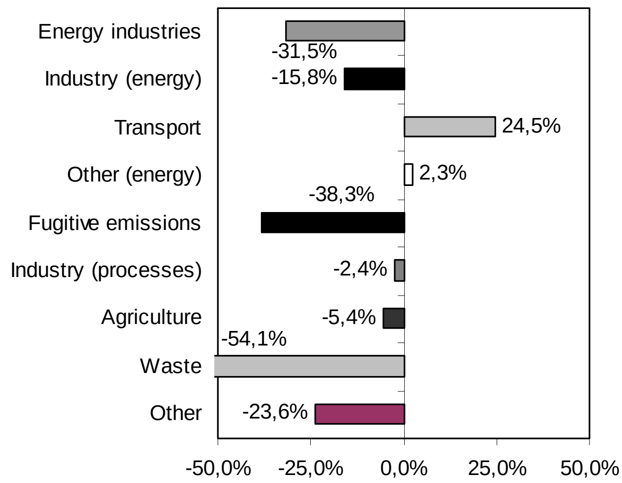
Figure 2. : Share of greenhouse gases in the three regions (2003) and changes 1990-2003.



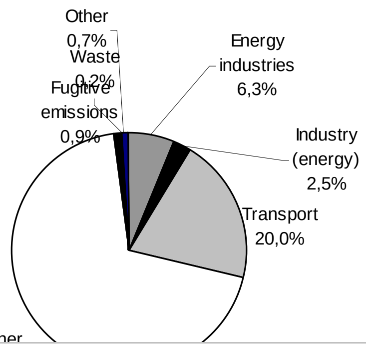


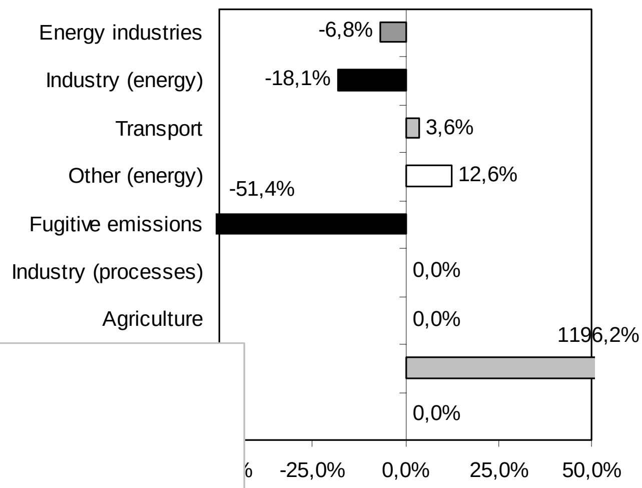
Wallonia

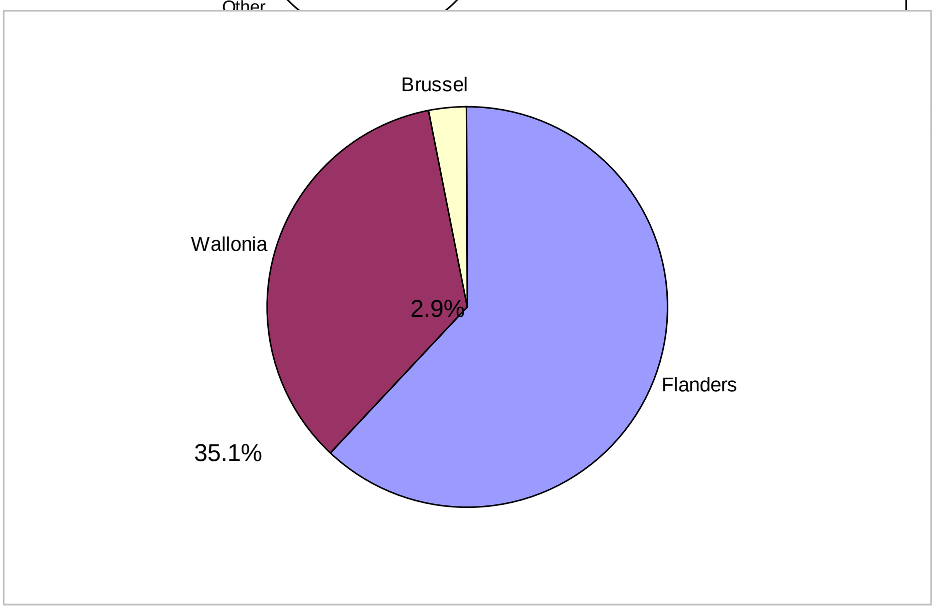




Brussels







gions & changes 1990-2003.

Figure 4. : GHG emissions : share of the three regions (2002).